REPORT ON GENDER-SENSITIVE CLIMATE RISK ASSESSMENTS FOCUSSING ON FILLING THE INFORMATION GAPS AND PRIORITY ACTIONS THAT ADDRESS CLIMATE-DRIVEN VULNERABILITIES AND GENDER-DISAGGREGATED IMPACTS OF THE HEALTH SECTOR

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Contents

List of maps

List of figures

List of tables

Abbreviations

CC	Climate Change
DALYs	Disability-adjusted life years
EEA	European Environmental Agency
EPA	Environmental Protection Agency
ESPN	European Social Policy Network
EU	European Union
HC	Health Care
HDI	Human Development Index
IHME	Institute for Health Metrics and Evaluation
IHR	International Health Regulations
LTC	Long Term Care
MICS	Multiple Indicators Cluster Surveys
MNE	Montenegro
MoH	Ministry of Health
MONSTAT	Statistical Office of Montenegro
MSDT	Ministry of Sustainable Development and Tourism
NPHI	National Public Health Institute
O_3	Ozone
PM_{10}	Particulate matters from 10 microns
$PM_{2.5}$	Particulate matters from 2.5 microns
RCP	Representative Concentrations Pathways
TB	Tuberculosis
TNC	Third National Communication
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WNV	West Nile Virus

Scope of this document

The scope of this document is to identify existing and future climate change risks, vulnerabilities and impacts on the population health and health sector in Montenegro. The results will form part of Montenegrin climate change response strategies and support the implementation of the country's wider National Adaptation Plan (NAP). Prior to the development of this report, an analysis of the policy framework has been undertaken to identify opportunities for mainstreaming climate change into health-related policies and planning processes.

Executive summary

Strategic and legal framework for climate adaptation of the health sector

The assessment of climate change legal and policy planning processes has concluded that despite the existence of various Laws and planning processes that somehow relate to climate change adaptation, in Montenegro there are no legally established framework and institutional mechanisms for climate adaptation planning and coordination. This also applies for the heath sector. The coordination and the adaptation planning are done on an ad-hock or project driven bases, with no clearly defined stakeholders, roles and responsibilities.

The Program for adapting the health system in Montenegro to climate change for the period 2020-2022 with the Action Plan for the period 2020-2021 (MoH, 2020) is the only policy document devoted to the climate change adaptation in the health sector. The document does not include assessment of climate sensitive health risks and impacts, climate vulnerabilities and sectoral capacities for climate policy planning and adaptation and is conceptualised in a manner to define operational objectives emphasizing the need of multisectoral response and coordination, the needs for research, and among others is devoted to raising public awareness for climate change. The programme also does not contain gender perspective on vulnerabilities and health hazards from climate change negative impacts.

The other existing climate change policy documents in the country including the TNC don't not contain a separate chapter on health. Instead in some of the documents climate change health threats and priorities for action were mentioned in assessing the priority sectors for climate change action (as for instance the Updated NDC). The accent is put on the importance to consider that climate change could negatively affect the capacities of the health sector to deal with emergencies.

Having in mind the available references, it can be concluded that

- All policy documents and publications are missing data on vulnerable groups including gender status. Beside the elderly over 65 and children, in the vulnerable groups from climate change extremes are considered also the people using long-term social or health care institutions, homeless, socially and economically disadvantaged groups, communal, agricultural and fishery workers.
- There is still no adaptation strategy for the public health system and a general vulnerability assessment is lacking. The information base and capacities are not sufficient, so it is unclear to what extent diseases caused by climate change could present a risk and could be prevented (UNECE, 2015).
- Detailed health impact assessment is missing, especially during the heat wave periods but also in different climate scenarios and projections. The missing data includes alsomonthly all-cause mortality data with regional distribution disaggregated by age and sex. These data should be provided by MONSTAT.
- The health sector is facing a lack of sex-disaggregated data in terms of assessing the gender-based vulnerabilities in the context of climate change adaptation processes.

Demogrphic profile of Montenegro, social and geographical determinants and available health infrasticture

Of the total population of Montenegro, 28.7% live in the North, 47.3% in the Central, and 24.0% in the Coastal Region. The average population density is 44.9 inhabitants per km2, while in the Northern region it is 26.6, in the Central region 56.8, and in the Primorska (South) region 91.8 inhabitants per km2. This inequality in terms of population stemmed from the process of urbanization and the demographic movement of the population from the north to the central and south parts of the country. Most of the health care facilities are located in Podgorica (44.24%), and then in Bar (12.72%), Budva (10.09%), Herceg Novi (8.48%), Nikšić (6.66%), etc.

Although the number of healthcare professionals is steadily increasing over the past few years, this number is still very much behind the average of EU countries. The staff is well trained, but they lack good facilities and supplies. Furthermore, from the aspect of the health sector, the geographic–regional discrepancies within the country mean that people in the north and in rural areas face multiple aspects of exclusion and vulnerability. There are fewer economic opportunities, higher rates of poverty, greater distance to health centers, and fewer available services. These structural factors thereby further compromise an existing poor situation in which an aging population remains subject to lower quality care in rural, northern areas, while more skilled and younger people migrate to urban areas and to the south[1].

There are geographical differences also in the level of education, where the share of people who are without school or have completed only primary school is significantly lower in the Coastal and Central regions than in the Northern region. The northern region has also a lower share of highly educated people in the population (6.8%, while in the Coastal region that percentage is 12.4%, and in the Central region 14.7%.)[5]

The last projection for the life expectancy for the population of Montenegro was 75.9 (73.2 for males and 78.8 for females). Changes in birth rates and mortality had a significant impact on natural population growth. The natural growth rate in the country decreased from 14.2% in 1968 to only 1.2% in 2018. Most of the municipalities especially in the North region are affected by a negative natural growth ratio (Andrijevica, Berane, Bijelo Polje Kolašin, Cetinje, Danilovgrad, Mojkovac, Plav, Pljevlja, Plužine, Žabljak). The vital index[2]also indicates a negative trend in population movement.]

Old people (over 65) are among the most vulnerable population groups to environmental health threats including climate change. The share of people aged 65+ in Montenegro was 15.1% in 2018; having into consideration that the female population above the age of 65 years represent 17% of the population, while the male population above 65 represents 13.1% of the population. Having a closer look in the trends, it can be noted that the share of people aged 65+ in Montenegro has been increasing from 13.5% in 2014 to 15.1% in 2018. Depending on fertility and mortality trends and levels

[1] https://www.euro.who.int/__data/assets/pdf_file/0014/340205/montenegro-report.pdf

[2] Vital index is defined as the ratio of births to deaths within a population during a given time.

of migration, the share of people aged 65+ will be further increased and in 2061 would range from 23.6% to 28.5% of the population.

The status of all previously mentioned determinants of health could make regions (especially the Northern region) and population groups more sensitive to climate change and climate extremes.

Climate risks, impacts and vulnerabilities of the health sector

A trend of increasing temperature in each decade since 1970-th was observed in each region of Montenegro[3]. The valley of River Zeta has the hottest summers in Montenegro and the highest average summer temperature was recorded in Podgorica (29.2 C). as well as the highest daily temperature of up to 44.8 C in August 2007.

The **heat waves also** became an increased climate hazard for the country, having in mind that they occur more frequently and last longer in comparison with the past data. Urban areas like Podgorica and southern (coastal) cities like Bar are at the highest risk. Heatwaves with longest duration are usually observed in August, but there are also short heatwaves in June and July.

Increasing concentrations of greenhouse gases lead to an increase in the average but also extreme temperatures and other extreme climatic events. As health consequences that will lead to increased rates of deaths, heat stress, and diseases, which will especially affect the sensitive population groups like children, elderly, pregnant woman, physically, socially and economically disadvantaged groups, people working outside, and the homeless people. They can also worsen chronic conditions such as cardiovascular diseases and respiratory and cerebrovascular diseases. People over 65 are the most vulnerable to heat-related illnesses since they live in some degree of constant dehydration, regardless of the weather conditions.

Regarding the mortality linked with climate extremes, in the absence of specific cause of deaths mortality data and according to the modelling data from the "Program for adapting the health system to climate change in Montenegro for the period 2020-2022, in the baseline climate change scenario, annual high-temperature mortality was estimated at 55 deaths.

Increased inland and coastal flooding expose the population to a range of negative health impacts like drowning, injuries, mental health effects, and intestinal and other illnesses. These effects can happen before, during, or after the flood events. Floods like some other climate extremes can cause serious disruption in the infrastructure, which includes electric power, water, transportation, and communication systems that are essential to maintain access to health care and emergency response services that are of the highest importance in such events.

During the four big floods that occurred in Montenegro in the period, 1991 to 2015 around 8,000 people were affected. According to the Program for adapting the health system in Montenegro to climate change for the period 2020-2022 from all natural disasters, the risk of flooding in the country

[3] MSDT, UNDP 2020: Montenegro III National Communication on Climate Change 2020, https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/8596012_Montenegro-NC3-1-TNC%20-%20MNE.pdf last visit on 22.01.22

is ranked highest: 4.9 out of 10. In addition, in terms of lack of capacity to overcome problems, the lack of health services is ranked highest: 5.9 from 10.

The population in the age groups 55-64 and 65+ are the most represented in the labour force in the agricultural holdings mostly as outdoor workers in Montenegro, which requires separate attention by the climate change-related actions, due to the fact that these groups are identified as vulnerable in terms of health and climate change hazards.

Droughts are another climate extreme to have multiple negative impacts on society, especially on the economy, environment and public health. According to Lancet countdown indicators of climate change vulnerabilities in 2021, up to of 19% of the global land surface was affected by extreme drought in any given month.

The analysis of the demographic, social economic, health and climate profile of Montenegro confirmed that there is a significant health risk for the population from climate change, especially from certain climatic extremes.Although sufficient quality health data covering a longer historical period have not been obtained, nor have specific studies on the direct connection of climate change with health have been developed, the indirect indicators and existing models - predictions confirm that the occurrence of high temperature and heat waves, especially in the summer period, is the highest climate change risk for the population in Montenegro[4]. Cardio-respiratory morbidity and mortality are the main health outcomes to expect as a result of extreme temperatures and heat waves.

Of course, not all population groups are equally at risk, so the focus of the risk is on the old population above the age of 65, the chronically ill, homeless, workers who work outdoors (which includes agricultural workers, fishermen and tourism workers) and socially marginalized groups that live in substandard conditions.

In terms of the geographical region, it seems that the coastal region and the urban zones (mainly Podgorica) are the most threatened by this climate extreme. However, if we add the additional adverse health impact of air pollution, then the geographically endangered zones extend to parts of the central and northern regions (Niksic and Plevlja).

In the absence of specific studies on the direct impact of climate extremes on health, data from strategic documents and available manuscripts show that **floods, drought, and forest fires pose a moderate to high risk to health** to the health system in Montenegro. The health risk is indirect through damage to health and other basic infrastructure, availability of safe water and food (floods and droughts) or air pollution (from fires).

The combination of **high temperature and floods or high precipitation** can be assumed as a **moderate health risk** for the population in the endangered regions. Increased incidence of some intestinal water and food-borne diseases (during floods) or transmissive infectious diseases (during high temperatures and high precipitation), with deterioration of the drinking water quality, are among the main health

[4] The statement is based on the research done in the framework of this assignment and the expert judgement.

risks-impacts. The regions at highest risks are the Northern regions which have mostly rural unsafe water supply systems, as well as the regions suitable for the Asian Tiger mosquito (Aedes albopictus).

Effects on the agricultural sector like **undernutrition** could be also considered as a public health threat. Namely, as it is concluded from this assignment, the increased temperature, more frequent and prolonged heatwaves, reduction of rainfalls in some regions, and increased number of summer and tropical days will have a very negative impact on crops and livestock, increase heat stress, reduce productivity and particularly affect livestock with disturbed welfare.

Last but not least**, extended pollen season** and more days with high pollen counts could be assumed as future climate change risks with **low to moderate** intensity in the country. There are no data for the dimension of the pollen-sensitive population, but the existing monitoring system could be used for epidemiological studies to explore the impact of pollen concentrations and distribution and define the regions with risk.

For this report, the definition of climate change health vulnerability is a function of the exposure, sensitivity, and adaptive capacity of the health and other sectors relevant for the health impact assessment.

Climate change's negative impacts are affecting everybody, although there is strongly related gender-based negative health consequences from the climate extremes.

The following sex-disaggregated data are defining the gendered vulnerability in the health sector. The daya are based on the only study on the health risks and sex/biological factors from the region (developed in Slovenia), so it can be considered that the health consequences and biological factors are common):

Table 1 Sex-disaggregated data that are defining the gendered vulnerability in the health sector

Hazard	**Vulnerable groups**		
Heatwaves	6% more deaths than expected in male population	10% more deaths than expected in female population[5]	Subgroups of aged 75+, circulatory diseases age 65-74, respiratory diseases, and all causes

[5] [5] PubMed: Number of Heat Wave Deaths by Diagnosis, Sex, Age Groups, and Area, in Slovenia, 2015 vs. 2003, Simona Perčič, Andreja Kukec, Tanja Cegnar, and Ana Hojs, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5800272/

Droughts	87% male holders of agricultural holdings	94% male managers of business entities	65% unpaid female family workers
Energy poverty Indoor pollution	76.4% male household owners	40.1% of female owners are facing one or two material deprivations	Households using wood as the main source of cooking in Montenegro is represented by 35%
			Women cooking and/or doing housework, every day (18+ population) is 68%
Food and nutrition	Severe food insecurity in the adult population is slightly higher among women with 13.4% against 13.2% of men	8.5% female children are starving	20.8% Roma female children are starving
		6.2% male children are starving	21.5% Roma male children are starving
Reproductive health and humidity and temperature rise	32.9% of women in Montenegro reported that their need for family planning was satisfied with modern methods in 2018		
Horizontal labour segregation at public health institutions	69% women in general practice (2018)	65% women specializing (2018)	65% women specialist (2018)

In addition to the assessment of the direct and the indirect impact of the climate change to the human health, an assessment of the heath sector infrastructure risks, vulnerabilities and impacts has been made. **The results from this assessment present significant vulnerability of the health care facilities from all four potential climate hazards(heat waves, droughts, floods and forest fires), especially in the health workforce preparedness and the level of adaption of the current system, infrastructure, technologies, and sustainability in facility operations during the particular climate change hazards.**

Future risks and impacts

The estimation of the attributable fraction of deaths to mean apparent temperatures above the comfort threshold was done by use of research data from meteorological models and combining the heat-mortality function estimated from historical data with meteorological projections for the future

time laps 2035–2064 and 2071–2099, developed under the Representative Concentration Pathways (RCP) 4.5 and 8.5.[6]

The findings of this study clearly show that the attributable heat-related deaths (AD) during summer are expected to be higher in Mediterranean and Eastern Europe countries, especially under the RCP 8.5 scenarios. For Montenegro, it means that under this scenario in the period 2036-2064, we can expect 26 additional deaths than under the reference scenario (observed in the period 1971-2001) (AD_{ref}) and 100 additional deaths in the period 2071-2099. Still, these numbers are the lowest in the region.

The economic damage of premature mortality due to the effects of climate change was also estimated in the framework of this assignment. In the first variant of the VSL value, in the near future scenarios, these damages could be around EUR 2 to 4 million per year in the final year of observation, which would be cumulatively around EUR 25 to 50 million for the total observed period (until 2050). In the distant future, these damages in the final years would be from about 6.5 to about 10 million EUR per year, so the cumulative amount of these damages for the total period up to 2100 would be from about 200 to 300 million EUR. In addition to this economic damage of premature mortality, the country and its citizens will be also faced with increased expenditures for treating diseases related to Climate change (Lyme disease, Malaria, leishmaniasis, salmonellosis etc).

Mapping of the future health risks and impacts

The creation of climate health risk maps is a complex process that needs applying a specific methodology and using a wide number of vulnerability and exposure metric data for any region (or settlement) in the country. In the absence of very accurate and properly disaggregated demographic, socio-economic data, and some exposure data in Montenegro, the following maps have been produced as an attempt to initiate the real process of mapping the climate health risks in Montenegro and inform the health authorities about the approach that could be used during the prioritization process of climate adaptation actions.

Namely, we have used the climate projections maps of some climate extremes (exposure metrics) like high temperature, heat waves, tropical nights, and days with or without rain[7]. The map of the distribution of the health care institutions is used as a vulnerability metric. For some regions and /or cities some additional data should be used to enhance the level of assessment of the health risk (like at-risk poverty ratio, illiteracy rate, and the share of people over 60) which are not available for all regions in a detailed form. Accordingly, in chapter 1.3. it was documented that the **northern region** of the country has many additional vulnerability factors like the highest % of people over the age of 60, highest at poverty risk ratio and illiteracy rate, as well problems with the accessibility of the health care services in some settlements together with a lower number of health care specialists. As described in 4.1 some cities in the region (especially Bijelo Polje and Plevlja) have a higher level of air

[6] Kendrovski Vladimir et al. (Int. J. Environ. Res. Public Health 2017, 14, 729; doi:10.3390/ijerph14070729 Available on https://www.mdpi.com/1660-4601/14/7/729, last visit 26.12.2021

[7] *Third National Report of Montenegro on Climate Changes according to UNFCC, Gjurgjevic, V. Report on future climate projections and analysis of changes in extreme weather and climate events, 2018*

pollution as an additional exposure factor. All of this makes the climate health risk level of this region higher than in other regions despite the actual risk from the climate extremes registered or projected for the region. Other cities with high air pollution (as an additional exposure factor) like Nikšić and Podgorica are also assessed with higher health risks than the others. In the climate projections we have used, the future climate change is primarily characterized by a further increase in the temperature, which will also cause changes in extreme weather and climate anomalies, so that we can expect a decrease in the number of temperature extremes with low temperatures and an increase in the number of warm extremes, i.e., a significant increase in very hot days and an extended duration and increased frequency of heat waves.

Table 2 Climate extrenes and associated health risks

Type of climate extreme	**Health risk:**
Changes in Temperature	The population of the coastal region (Ulcinj, Bar, Budva) and partly the central region (the urban areas of Podgorica and Danilovgrad) will be at the highest health risk (see Map 1,2). The capacities and medical staff in the general hospitals, medical centers, and emergency care services in these regions must be well prepared for dealing with and providing services during periods of high-temperature extremes, especially for vulnerable population groups. As health consequences, we can expect increased rates of deaths, heat stress, and diseases, or worsening chronic conditions such as cardiovascular , cerebrovascular and respiratory diseases. People over 65 are the most vulnerable to heat-related illnesses, as well chronically ill people, outdoor workers (including touristic, agricultural and construction workers), homeless and socially disadvantaged people. An extended pollen season and more days with high pollen concentrations are also expected in those regions.
Tropical nights	**Health risks** especially to older people and chronically ill patients will be extremely high and the capacities and medical staff in the health care services including emergency care must be well prepared to work in climate extreme circumstances according to the findings from the vulnerability checklist (Map 3,4).
Heat waves	**Health risks** during the heat waves and the vulnerable groups are the same as during extremely high-temperature periods - people over 65, chronically ill people, outdoor workers (including touristic, agricultural and construction workers), homeless and socially disadvantaged people. The highest burden will be on the health care services (Clinical center, general and special hospitals and medical centers in the areas marked with yellow and red on the maps). For the reasons explained above, Northern regions of the country and cities with heavy polluted air will have even higher level of health risk than presented from the mapping of the results.

Days with rains more than 20 mm and flood risk in regions in the country	In the regions with an increasing number of rainy days and floods it is expected to have frequent outbreaks of water-related infectious diseases, an increment in some intestinal water and food-borne diseases, and deterioration of the drinking water quality. Since the northern region already has a lot of other vulnerable factors and a large population group of people over 60, as well as people living in remote areas and villages, this region will be again at the highest health risk. This makes this region also highly prioritized when planning the enhancement of the health care services well prepared to work in climate extremes. The regions that will have at the same period higher temperature and higher precipitation or floods, will be exposed to more other health risks like the increased prevalence of infectious transmissive diseases and survival of certain arthropods such ticks, and mosquitos, as well as lower productivity in agriculture, lower quality of food, and increased risk from undernutrition. There is also a significant risk of injuries or drownings and major deterioration of the public infrastructure which will disable the efficacy in providing urgent medical services. According to this, the health care institutions in all regions should be well prepared to adapt to the flood risks.
Consecutive days without rainfall and droughts	There is an indirect health impact on the population in these regions through decreased water availability, water supply safety, food safety and undernutrition, and forest fires risks. Remoted and socially deprived population groups especially in rural areas are at higher risk (people dependant on their personal agricultural products, Roma population included). Health care institutions especially in these regions should be prepared to work in such conditions.
Forest fires	Besides destroying huge areas of forest and wood mass, the fires emit fine particles and ozone precursors and can increase the risk of premature deaths and adverse chronic and acute cardiovascular and respiratory health outcomes. The water resources, infrastructure, traffic, and accessibility to health and emergency care will be also threatened. Elderly and patients with chronic diseases, remoted and socially deprived population groups, especially in rural areas (Roma population included) are at the highest risk.

Priority actions that address climate-driven vulnerabilities and gender disaggregated impacts

The main areas for intervention for addressing the gender driven climate related vulnerabilities of the health sector of Montenegro are divided on policy level actions, health care infrastucture and health protection actions and specific actions for monitoring and addresing climate-driven vulnerabilities and gender and solcially disaggregated impacts. The detailed list of actions presented below this text, as well as this specific assessment report should serve as a basis for drafting of the national Adaptation Plan of Montenegro, as well as for drafting of other relevant national and local policy documents and action plans.

Policy level – planning, monitoring, financing	- Define, legally regulate and institutionalise the national climate adaptation planning processes. - Develop a Long-Term Strategy on Climate Action which is in line with the EU requirements and prospects for climate action until 2050. - Prepare and adopt a comprehensive and cross-sectorial National Health Climate Change Adaptation Strategy and Action Plan.

	- Introducing evidence-based heat protection action plans - Development and constant promotion of general guidelines for the population during heat waves and extremes. - Establish an intersectoral body and process to monitor the impact of climate change on the health sector and the human health in general, as well as to monitor the development and implementation of the relevant national policy documents - To establish an integrated (intersectoral) information system, with timely, spatially and gender (where applicable) disaggregated data/information of all cause and cause specific mortality, climate sensitive health outcomes and hospital admissions, environment, water and food safety and security, social issues and disaster risk data etc. - Introducing of a special fund for dealing with climate change and climate extremes. - Develop gender responsive, cross-sectorial and coherent policies relevant for the health sector and its climate adaptation. -

Health care infrastructure and health protection	- To enhance the regular public health related climate actions (heat and cold waves and warnings, air quality, pollen concentration in air, transmissive diseases vectors distribution, water and food security and safety etc);
	- To introduce an Early warning system during the weather extremes and prepare the health sector for appropriate response;
	- To enhance the knowledge and the skills of the health sector policy making level regarding the climate change health impact/risks.
	- To enhance knowledge and skills of the human resources in the health care facilities to deal with various climate extremes and climate impacts.
	- To provide the health care system in the country with essential medical products, service delivery, technologies, and health care infrastructure for climate adaptation and resilience
	- Urgently invest in measures for disaster risk mitigation for all eath facilities in the country
	- Conduct as many as possible climate change and health field research studies on prioritized health risks per specific regions and micro locations (heat, flood, drought, wildfires) with aim to assess the level of risk and impact and future impact
	- Enhancing of the capacities of the health care facilities to deal with health risks from climate change,
	- Providing healthy and safe working conditions and enough health workers who are well trained, informed, and knowledgeable to respond to climate risks and minimize environmental threats resulting from the operation of the health care facility.
	- Enhanced monitoring and assessment:
	  - The healthcare facilities should have sufficient information regarding water, sanitation, chemical use, healthcare waste management, and energy services considering climate resilience and environmental sustainability.
	  - The health sector should be capable to assess and manage the water safety and security, sanitation, chemicals, and health care waste and energy-related risks to workers, patients and served communities, by including assessments of climate resilience and

	environmental sustainability in responding to hazards and identifying and reducing exposures and vulnerabilities[8]. - Water safety and security, sanitation, chemical safety and health care waste regulations should be designed and implemented taking into consideration climate change variability and impact over time, as well as environmental sustainability. - Activities should be introduced for adaptation of the current systems and infrastructures through building regulations implemented in the construction and retrofitting of health care facilities to ensure climate resilience and environmental sustainability. - New digital technologies should be promoted to enhance the capacities of the heath sector and their outreach to the general population related aspects related to climate adaptation - Facilities should have established a special procedures and budget for emergency preparedness and response to climate hazard

Specific actions for monitoring and addresing climate-driven vulnerabilities and gender and solcially disaggregated impacts	- Setting up procedures, legal and institutional mechanisms for systematic collection of the following data:
	  - Daily or monthly morbidity and mortality data (with causes of death), hospital bad occupancy with proper sex and age disaggregation
	  - Incidence of food, water-borne, vector-borne diseases, pollen allergies, number of office/clinic visits on monthly /daily level for last 10 years; the causes of disease/visit, emergency care calls with sex disaggregation
	  - Health workers sex disaggregated at national and municipality level
	  - Food safety data
	  - Long-term health and social care data (for the vulnerable groups) and
	  - Epidemiological and/or research data-evidence on direct or indirect impact of climate change on health on general or vulnerable group of population in MNE as well on health care system in general (including facilities).
	- Setting up an institutional and operational structure (procedures) for gender mainstreaming (collecting sex-disaggregated data, provision of a systematic gender analysis, ensuring gender-responsive policy design, monitoring and reporting)
	- Gender-responsive budgeting to support adaptation measures targeted to address the gender-based vulnerabilities.
	- Collection of sex-disaggregated data on policy, program, project level in the health sector related to gender-based vulnerability assessment in terms of creation of gender-responsive adaptive solutions;
	- Analysis of sex-disaggregated data in corelation with other types of vulnerabilities in relation to heat waves, droughts, food, nutrition, water sufficiency and management, adaptive food related practices, indoor and ambient pollution and health risks, which are a combination of psychological, biological, behavioural, and social factor.

[8] https://www.mdpi.com/1660-4601/17/23/8849

- Field research on homelessness in the country (in line with the National strategy to fight homelessness and housing exclusion of Montenegro).
- Preventive and protection activities of mortality attributed to household air pollution and energy poverty, such as financial support (subvention for purchasing energy efficient sources of heating and cooking) and other types of informative actions. These actions should be targeted, especially towards most vulnerable groups: female owners of households facing material deprivations, single parents etc.
- Design of gender responsible adaptation measures attributed to heatwaves and floods;
- Design of gender responsible adaptation measures for owners and workers in agricultural holdings and unpaid labour force;
- Design and implementation of measures for preventing health hazards by the water consumption and water usage;
- Design and implementation of measures related to humidity and temperature rise and reproductive health.

1. Overview of the characteristics of the health sector in Montenegro

1.1. Geographic profile relevant for the sector and overview of the sectoral infrastructure

A healthy population is the most important resource of society and all its segments of development, as it contributes to overall social and economic progress. Therefore, it is necessary to pay special attention to health and, by engaging all social sectors, create conditions for its preservation and improvement. The principles of solidarity, universality, equality, accessibility, and quality form the basis for building a sustainable and integrated health care system centred on the citizen. These principles are also the bearers of the socially oriented European health care system, which Montenegro strives for, as a country in the process of EU integration. The following general goals are defined by the health policy: prolonging life expectancy, improving the quality of life related to health, reducing health disparities, and insuring against financial risk. Human health in Montenegro is the responsibility of the Ministry of Health, i.e., the Institute of Public Health of Montenegro.

Of the total population, 28.7% live in the North, 47.3% in the Central, and 24.0% in the Coastal Region. The average population density is 44.9 inhabitants per km2, while in the Northern region it is 26.6, in the Central region 56.8, and in the Primo ska (South) region 91.8 inhabitants per km2. This inequality in terms of population stemmed from the process of urbanization and the demographic movement of the population from the north to the central and south parts of the country.

Accordingly, the highest degree of urbanization was achieved in the central part of Montenegro over 78%, on the coast about 62%, while the degree of urbanization is lowest in the north with an amount of 41.38% of the urban population.

Positive net migration is recorded in two Montenegrin regions, and it is higher in the Central region the amount is 898 persons, while in the Coastal region it is 772 persons. In the North region of Montenegro, net negative migration is recorded with 1 670 persons. It is assumed that in the near future (until 2060) the Coastal and Central regions will constantly have a positive annual migration balance, but in the Northern region, the migration balance would be declining constantly negative until 2041. The projected reduction of the population in this region would range from 12.4% (high fertility variant) to 71.2% (constant variant),

In Montenegro, the state is the main founder of healthcare for the entire population. The state offers services through public and in some cases through private institutions by subcontracting them. The care services exist at three levels: primary, secondary and tertiary.

In 2018, Montenegro had 18 health centres, seven general hospitals, three special hospitals, the Clinical Centre of Montenegro, the Institute for Public Health, Emergency Medical Assistance, the Blood Transfusion Institute, and Pharmacies of Montenegro "Montemar"[9]. Organizationally, a primary health care center has three basic units: The outpatient clinic of the chosen doctor, i.e., the teams of

[9] NIPH. Health Statistical Yearbook 2018 of Montenegro Available on https://www.ijzcg.me/me/publikacije/statisticki-godisnjaci-o-zdravlju-stanovnistva-i-zdravstvenoj-zastiti-u-crnoj-gori, last visit on 07.12.2021

chosen doctors (chosen paediatrician, chosen doctor for adults and chosen gynaecologist); Support centers for chosen doctors organized at the local and regional level for lung diseases and TB, diagnostics, mental health, children with special needs, prevention, etc.; Units for home visiting team, primary level physical therapy and patient transport service[10]. The level of secondary health care is provided through specialist outpatient clinics and hospital wards, as well as the tertiary level of health care with the development of subspecialist outpatient clinics. Private care is available through around 100 private practices, but usually, a limited group of people uses them. Most of the health care facilities are located in Podgorica (44.24%), and then in Bar (12.72%), Budva (10.09%), Herceg Novi (8.48%), Nikšić (6.66%), etc.

Although the number of healthcare professionals is steadily increasing over the past few years, this number is still very much behind the average of EU countries. The staff is well trained, but they lack good facilities and supplies. Furthermore, from the aspect of the health sector, the geographic–regional discrepancies within the country mean that people in the north and in rural areas face multiple aspects of exclusion and vulnerability. There are fewer economic opportunities, higher rates of poverty, greater distance to health centers, and fewer available services. These structural factors thereby further compromise an existing poor situation in which an aging population remains subject to lower quality care in rural, northern areas, while more skilled and younger people migrate to urban areas and to the south. There is unequal availability of resources in the primary health care for the population living in certain municipalities, resulting in inability to provide certain specialist health services in a timely manner. Following the indicators on the number of inhabitants per one specialist doctor at the primary level of health care, by municipalities, the availability of health care to the population is not adequate and in line with WHO strategies and recommendations[11] (Graph.1). There are huge discrepancies in the number of inhabitants per doctor by municipality - from 841 inhabitants in Plav with Gusinje to 2777 inhabitants in the Municipality of Plužine.

Regarding the impact of climate change to the heath sector, it is very evident that climate change is one of the greatest threats to human health and the health system itself.

In addition to the geographical distribution of the health facilities, the health inequalities are also conditioned to differences between population groups in a wide range of factors which affect health. These include living conditions; health related behaviours; education, occupation, and income; health care, disease prevention and health promotion services as well as public policies influencing the quantity, quality, and distribution of these factors[12]. Health inequalities start at birth and persist into older age[13]. Inequalities experienced in earlier life in access to education, employment, and health care as well as those based on gender and social status can have a critical bearing on the health status

[10] https://www.gov.me/en/article/organisation-of-health-care

[11] NIPH. Human resources analysis in the Montenegro health sector 2008-2018

Available on https://s3.eu-central-1.amazonaws.com/web.repository/ijzcg-media/files/1591772227-analiza-ljudskih-resursa-2019.pdf last visit 25.12.2021

[12] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52009DC0567:EN:HTML

[13] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0567:FIN:EN:PDF

of people throughout their lives. The combination of poverty with other vulnerabilities such as childhood or old age, disability or minority background further increases health risks[14].

Taking into consideration the available health infrastructure, the geographic, the demographic and the economic profile of the country it can be concluded that the access to the health services is less constrained on the south in comparison with the northern part of the country.

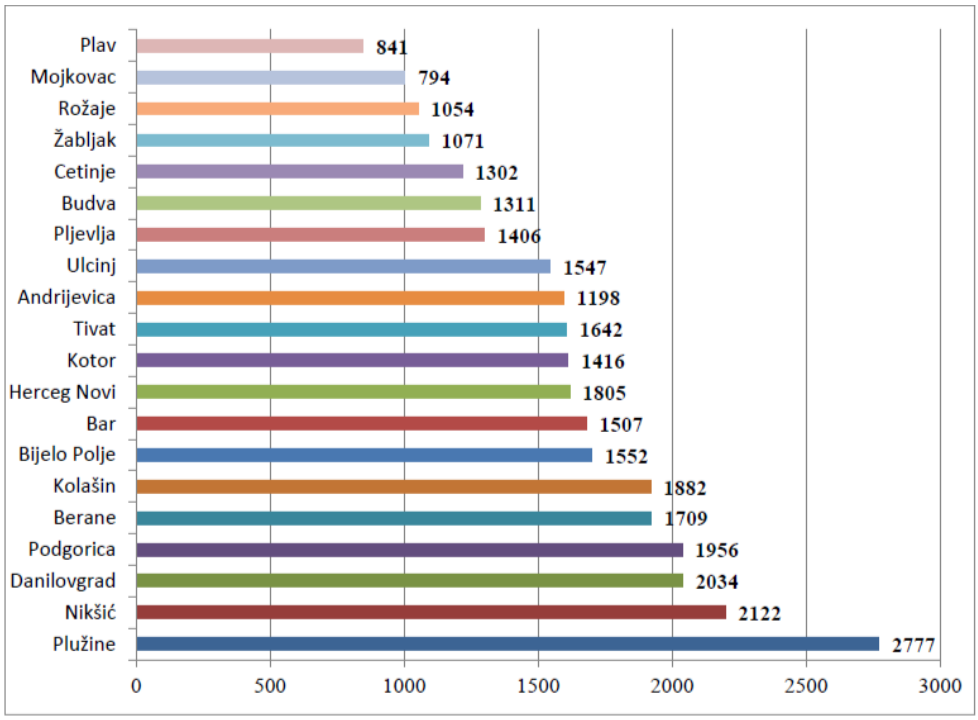

Figure 1 Graph 1 Number of inhabitants per one specialist doctor at the primary level of health care, in the municipalities of Montenegro, 2017 (Source: NIPH 2019. Human resources analysis in the Montenegro health sector 2008-2018)

1.2.Social determinants of health in Montenegro – trends (sensitivity factors)

With an official population number of 620029 (in the 2011 census) the overall annual mortality rate in Montenegro significantly increased from 6.41% in 1968 to 12.7% for males and 10.8 % for females in 2018.

The last projection for the life expectancy in the population was 75.9 (73.2 for males and 78.8 for females). Changes in birth rates and mortality had a significant impact on natural population growth. The natural growth rate in the country decreased from 14.2% in 1968 to only 1.2% in 2018. Most of the municipalities especially in the North region are affected by a negative natural growth ratio

[14] https://eurohealth.ie/action-plan-2108/

(Andrijevica, Berane, Bijelo Polje Kolašin, Cetinje, Danilovgrad, Mojkovac, Plav, Pljevlja, Plužine, Žabljak).

The vital index[15]also indicates a negative trend in population movement. With values above 300 until 1977, that value decreased below 200 in 1993 and reached a value of 97.3 in 2020. The natural growth ratio declined from 1.8 in 2016 to -0.3 in 2020.

The infant mortality rate[16] in Montenegro decreased from 42.6% in 1968 to 1.7% in 2018. This is very significant indicator of the health status of the population and the level of development of the health care system, as well as an indicator of the overall socio-economic, educational, cultural development of the society, which.

It is important to highlight that the at-risk of poverty rate decreases with the increase of the educational level. Furthermore, in addition to positive trends in reducing the participation of illiterates in all municipalities of Montenegro, differences between individual municipalities are still pronounced. The highest illiteracy rate is in some Northern region municipalities (like Plav, where 5.9% of the female population is illiterate). There are differences also in the level of education, where the share of people who are without school or have completed only primary school is significantly lower in the Coastal and Central regions than in the Northern region. The northern region has also a lower share of highly educated people in the population (6.8%, while in the Coastal region that percentage is 12.4%, and in the Central region 14.7%.)[5]

The status of all above mentioned determinants of health could make regions (especially the Northern region) and population groups more sensitive to climate change and climate extremes.

Table 3 At the risk of poverty ratio in Montenegro regions (%), Source – MONSTAT- Statistical Yearbook of Montenegro 2021

	2015	**2016**	**2017**	**2018**	**2019**
Center	17.1	16.8	17.1	14.4	16.6
South	18.4	19.8	19.6	23.2	19.9
North	41.4	39.5	37.9	40.0	41.2

Old people (over 65) are among the most vulnerable population groups to environmental health threats including climate change. The share of people aged 65+ in Montenegro was 15.1% in 2018; having into consideration that the female population above the age of 65 years represent 17% of the population, while the male population above 65 represents 13.1% of the population. Having a closer look in the trends, it can be noted that the share of people aged 65+ in Montenegro has been increasing from 13.5% in 2014 to 15.1% in 2018. Depending on fertility and mortality trends and levels

[15] Vital index is defined as the ratio of births to deaths within a population during a given time.

[16] The infant mortality rate is the number of infant deaths for every 1,000 live births.

of migration, the share of people aged 65+ will be further increased and in 2061 would range from 23.6% to 28.5% of the population.

Analysing the geographical context, the share of older people in the total population is higher among municipalities in the northern region. According to 2011 census data, 7 out of (at that time existing) 21 municipalities in the country had an average population aged over 40, and 5 of them are located in the northern region.

In 2016, the share of people with difficulties or disorders due to a long-term illness or disability was 40% for people aged 65 to 84, and 61% for those aged 85+.

Analysing the total population, the most common cause of the inability to complete everyday activities was illness (6%); age (1.2%) and work-related injuries (1.2%).

The long-term care[17] (LTC) for the elderly is still in process of development. In 2018 there were 474 users of services in residential care units.[18]

Besides the elderly over 65 and children, among the vulnerable groups from climate change extremes are considered also the people using long-term social or health care institutions, communal, agricultural, and fishery workers. There is a need for accurate data on the number of beneficiaries of the institutions of social protection and homeless people and the capacities they are accommodated in order to obtain a clear picture of this vulnerable portion of the population. The data from 2015 state that 36 persons were looking for assistance in social work centers and were considered homeless, while some unofficial sources presented in the media estimate this number in the range between 80 and 300 homeless people. Most of the homeless people are based in the capital Podgorica and in April 2017 a shelter for homeless people was opened in this city.

Having in mind the existing internationally comparable data on income, poverty, living conditions in a particular time frame, health, education, and topics that are important for assessing the situation and circumstances in which children, women, and men live in Montenegro, Roma settlements in the country could be also considered as health sensitive on climate change[19].

Though accurate data are missing, it is obvious that all the above mentioned population groups and adequate social care services will be under the greatest threat of the climate change effects.

According to the data from the "Program for adapting the health system to climate change in Montenegro for the period 2020-2022, in the baseline scenario it was determined annual mortality of 55 deaths caused by high temperatures. However, there is no reliable data on the impact of climate

[17] Long-term care involves a variety of services designed to meet a person's health or personal care needs during a short or long period of time. These services help people live as independently and safely as possible when they can no longer perform everyday activities on their own.

[18] EC – ESPN. Long-term care for older people Montenegro 2021 Available on https://ec.europa.eu/social/BlobServlet?docId=24032&langId=en, last visit 26.12.2021

[19] Monstat/UNICEF 2019 MICS project: Montenegro and Roma settlements in Montenegro Multiple Indicators Survey 2018 Research Findings Report Available on https://www.unicef.org/montenegro/en/reports/multiple-indicator-cluster-survey-2018 last visit on 07.12.2021

change on human health, as this data has not been integrated with compulsory health records. However, the authorities have identified this bottleneck and make some efforts to strengthen the national capacities to introduce bio-forecasting in order to quantitatively assess the impact of weather and climate on human health in Montenegro.

1.3. Socio-economic trends in the sector

In total, activities related to the health sector are performed by 494 entities, with revenues of € 52.95 million, and 2,676 employees. The loss in these entities amounts to € 4.40 million. So, this segment of business in Montenegro is dispersed, employs a small number of people, and records a loss in business.

The highest revenues in this sector were generated in Podgorica (€ 27.80 million), Herceg Novi (€ 13.20 million) and Budva (€ 3.15 million). The biggest profits were made in Podgorica, Budva and Bar. When we look at the number of workers, most of them are employed in Podgorica, Herceg Novi and Bar.[20]

The highest revenue is generated in hospitals (€ 23.40 million), followed by specialist medical practice (€ 11.10 million) and dental practice (€ 8.90 million). The most profitable activities are specialist medical practice (€ 1.50 million), dental practice and other health care (€ 0.30 million each).

In 2019, € 805 948 940 was allocated for social protection benefits, which is an increase by 3.7 percentage compared to 2018. Total social protection expenditures increased due to the increase in total expenditures for social protection benefits in the function Sickness/Health care, function Disability, function Old age, function Survivors and Unemployment[21]. In 2019, the amount of social protection benefits representing 97.0 percentage of the total social protection expenditure, which is at approximately the same level as in the previous year. By type of social protection, in 2018, the largest share of the total social protection expenditure refers to function Old age € 305 818 199, i.e. 39.1%, while function Sickness/Health care € 239 765 694 i.e. 30.7%. The third group by expenditures on social protection benefits was function Survivors, amounted € 92 052 883, i.e. 11.8%, followed function Disability and function Family/Children.

Based on the distribution of the number of doctors by years for the period 2008-2018 presented in Human resources analysis in the Healthcare system of Montenegro[22], it can be concluded that the number changed from 2008 to 2018 in outpatient health care activities. In the period 2008 to the 2012 their number decreased by 13.10%, while in the period 2012 to 2018 increased by 35.22%. The increase indicates that Montenegro is trying to reach the EU standards to meet the needs of certain

[20] Programme for development of health tourism until 2023, predlog-programa-razvoja-zdravstvenog-turizma-crne-gore-2021-2023-godine-s-predlogom-akcionog-plana-do-2023-godine.pdf

[21] https://www.monstat.org/eng/novosti.php?id=3339

[22] Human resources analysis in the Healthcare system of Montenegro, https://www.ijzcg.me/me/publikacije/analiza-ljudskih-resursa

categories of health workers / associates / doctors of medicine, whose rates in EU per 100,000 inhabitants are significantly higher than in Montenegro.
Ensuring a functional, stable, reliable, effective and sustainable health care system, particularly in the conditions created by Covid-19 pandemic, is one of the highest priorities of the state. In accordance with the agreement signed between Government of Montenegro and the trade unions, the wages in healthcare sector were additionally increased in 2021 by 3 percent and are planned to be increased by 12.5 percent in 2022 (resulting from implementation of the programme Europe Now). Moreover, abolition of the health insurance contributions charged to employers and employees is proposed in order to reduce the labour tax wedge, and in doing so the state takes over financing of the health care system, while maintaining the same coverage of health care services.

The Government's measures on the revenue side contained in the 2021 Budget Law are primarily focused on the increase of excise tax to suppress negative effects of excisable goods on population health, as well as to suppress informal economy through implementation of electronic fiscalisation.

Government's measures focused on public spending trends related to the heath sector:

- Wage increases of the health sector employees by additional 12.5 percent in 2022;
- Additional annual allocations of around 24 million for introduction of child allowance for all children up to 18 years;
- Minimum pension increase will lead to an increase in social transfers by around 17 million € per year;
  Regular annual adjustment of pensions and social benefits.

2. Overview of the climate adaptation planning processes in Montenegro

2.1. Overall climate adaptation planning process in Montenegro

The assessment of climate adaptation in the relevant sectoral and climate protection legislation has concluded that there is no legally established framework for climate adaptation planning in the country, despite the existence of various Laws and planning processes that somehow relate to climate change adaptation. The assessment has resulted in the following specific conclusions:

- The Law on climate protection of Montenegro (Article 5) recognises the National Adaptation Plan (in the further text NAP) as basis climate planning instrument and defines the minimum content of the NAP.
- According to the prescribed minimum content of the NAP in the Law (Article 9), the NAP would also need to define the institutional framework for climate adaptation in the country.
- The Law doesn't prescribe mechanisms for cross-sectoral policy alignment and mainstreaming of the adaptation priorities in the sectoral policies and plans.
- The Law doesn't prescribe climate change coordination mechanism as for example National Climate Change Committee, Climate Council or Sustainable development council.
- The Government of Montenegro (GoM) supported by international organisations have taken steps to develop a long-term adaptation planning process in the process of the preparation of the National Climate Change Strategy by 2030 and the preparation of the Third National Communication. However, all these processes have been project based and haven't been institutionalised and legally established.
- The National Climate Strategy by 2030 has been prepared in 2013 and its content is not aligned with the latest EU requirements for long term strategic planning for climate action defined in the Regulation 1999/2018 (the Energy Governance Regulation).
- Even though the National Climate Strategy by 2030 has adaptation aspects into its content, the document only provided an overview of the internationally recommended approaches for climate adaptation, provides information on the preparatory elements and the processes essential for the development and implementation of the NAP. The table containing the preparatory elements and the process for development and implementation of the NAP is well elaborated, but it is general for all sectors, and it doesn't set clear responsibilities for specific institutions, timelines and institutionalised coordination mechanism needed for implementation of such steps in a form of a specific action plans.
- In addition, the National Climate Strategy by 2030 provides an overview of the proposed adaptation measures by sectors as defined in the draft Second National Communication, which are not sufficiently described and the process of identification of the vulnerabilities and definition of this measures is not elaborated.
- The TNC of Montenegro prepared in 2020 in its Sector vulnerability and adaptation analysis provides very clear recommendation that the priority activity for climate adaptation is the strengthening of the strategic planning for climate change adaptation at the local and regional levels, as well as in the sector-level planning process. In addition the TNC recommends this to be accomplished through the development of action plans for climate change adaptation at the local and regional levels, development of action plans for climate change adaptation of vulnerable sectors, integration of adaptation measures in strategic and development documents, preparation of plans for the prevention of climate change impacts in sectors vulnerable to climate change, and through the development of methods and standards for

implementation of adaptation measures. Also, an additional proposed measure is strengthening of local and regional governments and other relevant national, regional, and local stakeholders regarding climate change adaptation. All these measures are very valid, but again, they don't describe and prescribe the national coordination mechanism for climate adaptation, the legal and the institutional aspects for establishment of such mechanism, as well as the processes and the responsibilities for climate change adaptation on national and local level.

- Even though in the framework of the TNC a vulnerability assessment and adaptation measures for all priority sectors has been done, the adaptation planning process done in the framework of the preparation of the TNC is not prescribed and responsible stakeholders and processes for coordination, elaboration, implementation and monitoring of the climate adaptation are not defined.
- Montenegro's Updated NDC provides a development framework and guidance for more ambitious adaptation goals to be developed under the project "Enhancing Montenegro's capacity to integrate climate change risks into planning". According to the Updated NDC, the goals defined by the NDC will have a clear effect on project activities focusing on addressing the gaps of an underperforming coordination framework, the lack of institutional capacity, the insufficient information and lack of finance to fund adaptation investments and will also improve the capacity of the private sector to understand and respond to climate vulnerabilities and risks.

Taking into consideration all conclusions listed above, one of priorities of the NAP Project should be to define, legally regulate and institutionalise the national climate adaptation planning processes.

2.2.Assessment of the sectoral planning process in Montenegro

Identifying and assessing current policies, programs and infrastructure to manage current and future climate-related health outcomes to and from the health sector

There is no formally established climate adaptation planning process relevant for the health sector. The coordination and the adaptation planning are done on an ad-hock or project driven bases, with no clearly defined stakeholders, roles and responsibilities.

- In 2020, the Ministry of Health issued the only policy document focused so far on climate change adaptation priorities in the country - **The program for adapting the health system in Montenegro to climate change for the period 2020-2022 with the Action Plan for the period 2020-2021**. The main objective and goal of the Program are to integrate the climate change adaptation of the health sector into the overall climate related strategic framework and develop a chain of activities that will aim to reduce the impact of climate change on human health in the country. The document does not include assessment of climate sensitive health risks and impacts, climate vulnerabilities and sectoral capacities for climate policy planning and adaptation, and is conceptualised in a manner to define operational objectives emphasizing the need of multisectoral response and coordination, the needs for research, and among others is devoted to raising public awareness for climate change. The programme also does not contain gender perspective on vulnerabilities and health hazards from climate change negative impacts.The program for adapting the health system in Montenegro to

climate change for the period 2020-2022 with the Action Plan for the period 2020-2021 has the following operational objectives:

- Protection of human health from the side effects of climate change through a multisectoral response that will ensure the inclusion of health in all policies;
- Risk management of extreme weather events;
- Reduction of morbidity and mortality from infectious diseases (communicable diseases vectors, water, air and food) attributed to climate change;
- Generating evidence for the impact of climate change on health at the national and subnational level through research and studies;
- Raising public awareness of climate change and its impact on health;
- Planning, risk assessment and preparation, and maintenance of health system readiness for possible natural disasters caused by climate change[15].

So far there is no evidence of the implementation of the action plan objectives.

- The SDG3 (Good Health and Well-being) goals of Montenegro are supported by the Strategy for Development of Integrated Health Information System (IHIS) and eHealth for the period from 2018 to 2022, Mental Health Care and Improvement Strategy in Montenegro 2019-2023, Strategy for improving the quality of health care and Patient safety for the period from 2019 to 2023. However, climate change and climate adaptation policy planning and coordination aspects are not considered in the mentioned policy documents.
- According to the current legislation, an alert system is introduced in the HC system in case of an unusual or unexpected event for a particular place and time that may indicate the use of a biological agent or event that causes or may cause significant disease and / or dying in humans or endangering local and/or national capacities for adequate the answer. This include the appearance of infectious diseases during the natural disasters like climate change are, so the Alert system can contribute to the HC system appropriate response (MoH, 2019).
- The General Crisis Plan when food could be a health threat contains responses to specific crises in the field of food safety, which includes extraordinary events with sources of ionizing radiation and nuclear activity, terrorist attack, war and natural disasters. Actions in these specific crises are performed in accordance with this plan and special emergency management plans (Official Gazette 008/20).
- DesInventar Sendai as widely used software that implements all the indicators and data required for the Monitoring of Targets A to D of the Sendai Framework for Disaster Risk Reduction also includes data relevant for the health risk assessment like substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries[23].
- The existing climate change policy documents in the country including the TNC did not have a separate chapter on health. Instead in some of the documents climate change health threats and priorities for action were mentioned in assessing the priority sectors for climate change

[23] https://www.preventionweb.net/sendai-framework/sendai-framework-at-a-glance

action (as for instance the Updated NDC). The accent is put on the importance to consider that climate change could negatively affect the capacities of the health sector to deal with emergencies.

- **The Podgorica Climate Change Adaptation Vulnerability Assessment and Adaptation Action Plan is the only Climate Change Action Plan** at the local level in the country. The project analysed the situation in various sectors in the city in the context of exposure and vulnerability to extreme weather events and recognized the relevant measures of adaptation to expected climate change. Implementation of defined activities will contribute to the resilience of the Podgorica urban system in changing climate parameters, including the preservation of the environment and improvement of the quality of life of citizens. A total of 27 interventions were selected, that were evaluated according to the analysis of several criteria and based on which they were ranked on short-, medium- and long-term activities related to the highest risks/which include health risks in different climate scenarios and population groups affected.[24]

Detection, preparedness, and response to (health related) emergencies

Besides the assessment of the policy and institutional framework for implementing the International Health Regulations (IHR), in cooperation with WHO a **self-assessment process examined 19 IHR relevant technical areas**, which include the areas of food safety, emergency response preparedness, and workforce development, linking public health and security authorities. A 5-step Likert scale scoring system was applied. The tool, process, and findings are important for the climate change vulnerability assessment of the capacities of the health centers. Legislation and administrative arrangements, real-time surveillance of communicable diseases, and emergency response operations and coordination are with the highest score, and workforce development and available financing are among the worst.[25]

According to the current legislation, an **alert system** is introduced in the health care system in case of an unusual or unexpected event for a particular place and time that may indicate the use of a biological agent or event that causes or may cause significant disease and/or dying in humans or endangering local and/or national capacities for adequate responses. This includes the appearance of infectious diseases during natural disasters like climate change, so the Alert system can contribute to the HC system's appropriate response.[26]

*The **General Crisis Plan** when food could be a health threat* contains responses to specific crises in the field of food safety, which includes extraordinary events with sources of ionizing radiation and nuclear

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[24] GIZ 2015, Podgorica Climate Change Adaptation Vulnerability Assessment and Adaptation Action Plan https://www.giz.de/de/downloads/Report%20%E2%80%93%20Vulnerability%20Assessment%20and%20Adaptation%20Action%20Plan%20for%20Podgorica%20Montenegro%20(2015).pdf last visit on 27.07.2022

[25] WHO. 2019. Joint external evaluation of the IHR core capacities in Montenegro. Available on https://apps.who.int/iris/bitstream/handle/10665/340196/9789240018228-eng.pdf?sequence=1&isAllowed=y, last visit 10.12.2021

[26] Official Gazette of Montenegro (Sluzbeni List Crne Gore). Rulebook on the method of reporting infectious diseases, hospital infections, conditions and deaths of persons suffering from these diseases (Official Gazette of Montenegro, No. 20/19)

activity, terrorist attack, war and natural disasters. Actions in these specific crises are performed in accordance with this plan and special emergency management plans (*Official Gazette 008/20*). The Plan determines the procedure for managing a crisis when food poses a risk to human health in accordance with the Law on Food Safety. The Plan also sets out the practical procedures needed to improve coordination, communication, and preparedness in a case of crisis.[27]

[27] Official Gazette of Montenegro (Sluzbeni List Crne Gore). 2020. General crises plan for crisis management when food is a risk to human health - Opsti krizni plan za upravljanje kriznim situacijama kada hrana predstavlja rizik za zdravlje ljudi. Official gazette 008/20)

3. Data constrains, gaps and recommendations

3.1. Available sectoral information for climate sensitive vulnerability assessment of the sector health

- The basic vital indicators for the country (live births, infant deaths, mortality, natural growth and vital index) are presented in the NIPH statistical yearbook (NIPH 2018). There are also few publications, mainly from MONSTAT, which presents a valuable source of information for the basic demographic and socio-economic profile of the country which among others will enable the process of selecting the vulnerable groups of population.
- The publication "A demographic model for population projection until 2060, with a structural analysis of the population of Montenegro" gives quantitative and qualitative analysis of basic population structures by census periods (1991, 2003 and 2011). The analysis covers the movement of the total population, gender and age structure of the population, educational structure of the population as well population structure by work activity. Also, this publication includes the analysis of the above-mentioned population structures by regions (MONSTAT,2014).
- "Income and living conditions statistic 2013-2017", presents valuable data regarding the poverty data in the country, emphasizing the most deprived and poverty vulnerable regions and population groups in the country, which is an important health determinant for assessing the climate change vulnerability (MONSTAT, 2018). This research in the Multiple Indicator Cluster Survey (MICS) report provides insight into internationally comparable data on living conditions, health, education and topics that are important for assessing the situation and circumstances in which children, women and men live in Montenegro. Report responds to the need to monitor progress towards the 2030 Agenda for Sustainable Development, adopted in September 2015 by all member states of the United Nations. (MONSTAT/UNICEF 2019).
- To have a clear picture for this vulnerable portion of population among others there is a need of accurate data on number of beneficiaries of the services of social protection institutions and homeless people and the capacities they are accommodated in. The last data from Montenegro statistical Agency (MONSTAT) are from 2014. Some data can be also found in the Strategy for development of the social protection system in Montenegro 2018-2022 (Ministry of labour and social care, 2018) or the European Commission's ESPN report on homelessness in MNE (EC ESPN 2019).
- Health Statistical Yearbook of Montenegro provides data regarding -basic demographic statistic and vital indicators in the country, some parameters of environment and health status (food and drinking water quality), health sector data like number and structure of the health workers and co-workers in the country, health care institutions – categorized with regional dispersion, level of immunization, communicable diseases on country and municipality level with monthly distribution; sex and age disaggregation on some groups of diseases; morbidity structure (office and clinic visits and hospital bad occupation)(NIPH, 2018).
- In the regular monthly reports the NIPH provide basic hospital morbidity and mortality data registered in public hospital institutions and presents selected indicators of the condition and functioning of inpatient institutions; average length of treatment, bad occupancy (NPHI,

2010); comparative presentation of individual groups of infectious diseases in the structure of diseases (NPHI, 2021) as well as basic health sector capacities data like description of basic characteristics of MNE Health Care(HC) regions and system, health network of HC institutions on different level of health care (NPHI 2019). During the vulnerability assessment process, these data will be used to present current and past burden of diseases which could be related to climate change as well presenting the current human, technical capacities in the HC system in different parts of the sector (with focus on hospitals and emergency care units) and the different regions of the country.

- The most recent National Gender Equality Strategy 2021-2025 and its Action Plan 2021-2022 define the measure 3.8 to "Assess the impact and implement prevention measures to reduce the negative impact of climate change and natural disasters on the health of women, men, people of different gender and gender identities, as well as marginalized and particularly vulnerable people and groups". As defined this measure is mostly focusing on the health sector – in terms of identification and prevention of health-related impacts of climate change based on gender differences.
- With WHO assistance, Montenegro undertook a self-assessment based on a JEE tool developed by the WHO to assess capacities related to the International Health Regulations (IHR) (2005). The self-assessment process examined 19 technical areas, which includes the areas of food safety, emergency response preparedness and workforce development, linking public health and security authorities. The results could be of significant value in the process of assessing the climate change resilience and preparedness of the sector (WHO2019).
- It is very well known that high level of air pollution has a synergistic harmful effect with climate change extremes on human health, so the air quality data is of high significance in the climate change health vulnerability assessment process. Having in mind the distribution of the basic sources of pollution in MNE, there are significant differences in the air pollution level between the regions. This will be an important fact while assessing regional distribution of climate change health risks. Monitoring of pollen concentrations and the duration of the pollen season is also of great importance for assessing the risks of exacerbation of allergic reactions in sensitive population groups. Given that climate change significantly affects pollen concentrations in the air, this monitoring is extremely important. The Environment Protection Agency of MNE has very accurate database on the air quality level in the country and published them on regular base every year, together with the data on pollen distribution in the air and drinking water quality in all regions and cities of MNE. All these data will be used as a special climate change Environment and health indicators in presenting the current public and environmental health profile in the country (EPA 2021). A very comprehensive overview of the air quality status in the country is described also in the Draft Strategy for Air quality management in Montenegro 2021-2029 (Ministry for environment protection, spatial planning, and urbanism, 2021).

The analysis of climate projections presented in the TNC on climate change shows that "the mean annual and extreme temperatures may increase, which may lead to more frequent and longer heat waves, more hot days and nights, fewer days with frost, and fewer cold days and nights. In addition, less precipitation is expected, which may lead to more frequent droughts, as well as an increase in the

number of wildfires. It is expected that climate change will increase the frequency and severity of many types of extreme weather events; besides droughts and forest fires, there may also be floods and storms, among other things. Moreover, seasonal patterns may shift, which will lead to greater variability that may affect agriculture in Montenegro" (MSDT, UNDP 2020). The projections for mean annual and seasonal temperatures from this document could be used for qualitative assessment of health outcomes in different adaptation scenarios. However, for estimation of the attributable fraction of deaths to mean apparent temperatures above the comfort threshold, we will use research data which use other meteorological models like combining the heat-mortality function estimated from historical data with meteorological projections for the future time laps 2035–2064 and 2071–2099, developed under the Representative Concentration Pathways (RCP) 4.5 and 8.5. (Kendrovski et al., 2017) or the models from the 2021 Report of the Lancet Countdown on health and climate change (Lancet, 2021). Namely, Lancet Countdown Report on climate change for 2021 presents some useful indicators and calculations (which includes MNE data) such are: vulnerability to extreme of heat, exposures of vulnerable populations on heat waves, heat-related mortality, health and weather extremes, climate sensitive infectious diseases, food security and malnutrition.

Regarding the future projections of climate sensitive health risks and outcomes, in one of the several climate change and health vulnerability assessments made from WHO, the annual burden of mortality from selected health outcomes due to climate change was estimated for world regions. Future cause-specific mortality in 2030 and 2050 (in the absence of climate change) was estimated using regression methods for three development futures: base case, high growth, and no growth scenarios. Global climate-health models were developed for a range of health outcomes known to be sensitive to climate change: heat-related mortality in elderly people, mortality associated with coastal flooding, mortality associated with diarrhoeal disease in children aged under 15 years, malaria population at risk and mortality[28], dengue population at risk and mortality, under nutrition (stunting) and associated mortality (WHO, 2014).

3.2. Gaps and constrains in the sectoral information for climate sensitive vulnerability assessment of the sector health

Having in mind the available references, it can be concluded that

- All policy documents and publications are missing data on vulnerable groups including gender status. Beside the elderly over 65 and children, in the vulnerable groups from climate change extremes are considered also the people using long-term social or health care institutions, communal, agricultural and fishery workers.
- ➢ There is still no adaptation strategy for public health system and a general vulnerability assessment is lacking. The information base and capacities are not sufficient, so it is unclear to what extent diseases caused by climate change could present a risk and could be prevented (UNECE, 2015).

[28] https://climate-adapt.eea.europa.eu/en/metadata/publications/quantitative-risk-assessment-of-the-effects-of-climate-change-on-selected-causes-of-death-2030s-and-2050s

- Detailed health impact assessment is missing, especially during the heat wave periods but also in different climate scenarios and projections are the monthly all-cause mortality data with regional distribution disaggregated by age and sex. These data should be provided by MONSTAT.
- The health sector is facing a lack of sex-disaggregated data in terms of assessing the gender-based vulnerabilities in the context of climate change adaptation processes. Namely, the following categories of data, sex-disaggregated, are needed for enabling detailed gender sensitive climate risk and vulnerability assessment of the health sector:
    - Gender-based vulnerability in the health sector in relation to climate change in general,
    - Socio-economic structure: poverty rate, employment rate, unemployment rate, informal labour (data available)
    - Decision-making structure: private and public entities (there are no official data in one place);
    - Gender responsiveness in the legal and policy level: laws, policies, national communications, national projects, programs and strategies (no data provided);
    - Labour force in related sectors: vertical and horizontal labour segregation (public and private entities) (partial data existing);
    - Adaptation measures and their effects (policy and program level).

3.3. Recommendations for improved data collection and management of gender sensitive climate relevant data for the health sector

A process of establishing a basic set of climate change environment and health indicators in the country will enable a regular process of monitoring the climate change health risks in different population groups and regions in the country.

There should be also work on a broader integrated environment and health information system which will integrate various set of indicators from different sectors relevant for the monitoring of the adaptation process. A process of providing data/information on climate change vulnerability assessment of HC capacities/facilities, and preparedness of the health sector to cope with climate change could also be conducted in the forthcoming period using the WHO tools and checklist referenced in this document.

Other sector (agencies) data/information's are also of high relevance for the assessment like climate change scenarios- predictions, energy, agricultural, urban planning, and other climate change adaption polices on national and/or local level or social sector data on elderly and homeless people.

The importance of adaptation measures in the health sector should focus on the strengthening of existing institutional capacities, information dissemination, and monitoring systems to better understand the impacts of climate change on human health in Montenegro.

In assessing capacities and the level of climate change resilience of the HC facilities we will recommend use of the WHO Guidance for climate-resilient and environmentally sustainable health care facilities– which aims is to: guide professionals working in health care settings to understand and effectively prepare for the additional health risks posed by climate change; strengthen capacity to effectively conduct surveillance of climate-related diseases; and monitor, anticipate, manage and adapt to the health risks associated with climate change (WHO, 2020). Other useful document in this assessment process is the WHO checklist for assessing vulnerabilities in the health care facilities (WHO, 2021).

- **Gender responsive coherence, governance and operational procedures in the health sector:** Development of institutional structure (in a form of procedures) for sex-disaggregated data collection on policy, program, project level in health sector to identify gender gaps in in the needs as well as the level of inequality in the access to adaptation services and resources;
- **Creation of the set of gender-sensitive indicators** based on the existing practices on collecting sex-disaggregated data upgraded with the international sets of gender indicators (SDGs);
- **Capacity building** on the methods and instruments for collecting sex-disaggregated data, as well as monitoring and reporting through design of gender indicators.
- **Monitoring and reporting**: Development of institutional structure (in a form of procedures) for monitoring progress on gender equity and equality and tracking gender-differentiated results.

To assess the specific climate change burden of diseases and burden on the health sector capacities - on the level of statistical data there is a need of:

- Daily or monthly morbidity and mortality data (with causes of death), hospital bad occupancy with proper sex and age disaggregation
- Incidence of food, water-borne, vector-borne diseases, pollen allergies, number of office/clinic visits on monthly /daily level for last 10 years; the causes of disease/visit, emergency care calls with sex disaggregation
- Health workers sex disaggregated at national and municipality level
- Food safety data
- Long-term health and social care data (for the vulnerable groups) and
- Epidemiological and/or research data-evidence on direct or indirect impact of climate change on health on general or vulnerable group of population in MNE as well on health care system in general (including facilities).

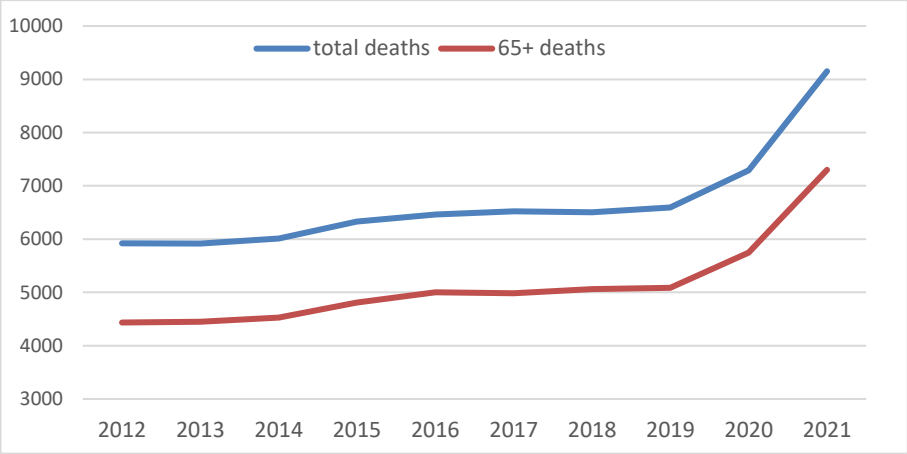
4. Findings on sectoral risks, vulnerabilities and impacts from the past and the present climate variability in Montenegro

4.1.Baseline health profile of Montenegro

Annual trends of all-cause and specific mortality data in Montenegro

T**he all-cause mortality of the population in Montenegro** in the last 10 years has an increasing trend from 5922 deaths registered in 2012 to 7301 deaths in 2021. Of this number, the largest percentage (75% in 2012 and even 79.8% in 2021) belong to the age category over 65 years, which is considered the most vulnerable to climate change (Graph 2).

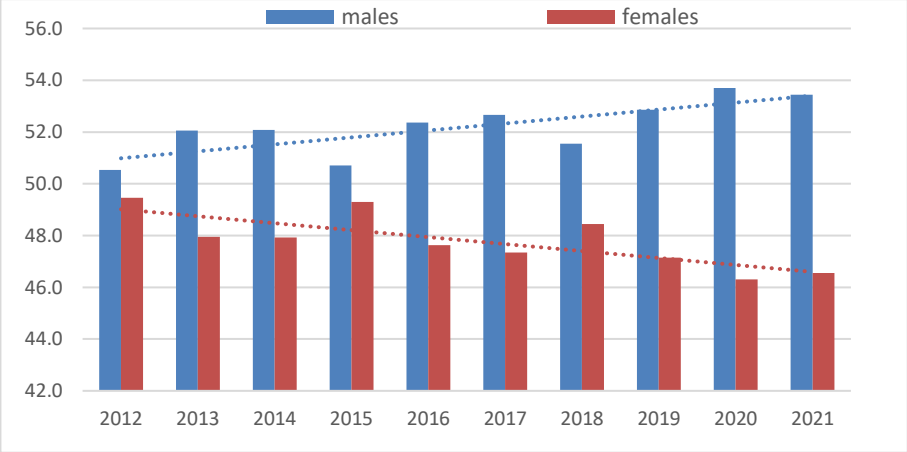
Graph 1 All-cause mortality in Montenegro, 2012-2021



Source: MONSTAT 2021

In the country's structure of all-cause mortality, the percentage of deaths is higher in men with an increasing trend from 50.5% in 2012 to 53.4% in 2021, unlike women whose death rate decreases from 49.5% in 2012 to 46.6% in 2021 (Graph 3).

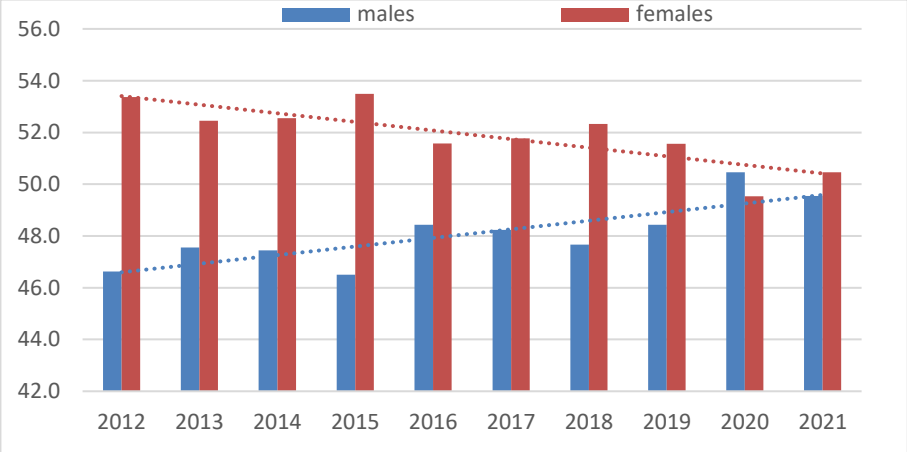
Graph 2 All-cause mortality in Montenegro, sex structure (%)



Source: MONSTAT 2021

However, in the most vulnerable age group population (over 65 years) mortality is higher among women, having a decreasing trend from 53.4% in 2012 to 50.5% in 2021 (Graph 4).

Graph 3 Death structure (%), age group 65 and over

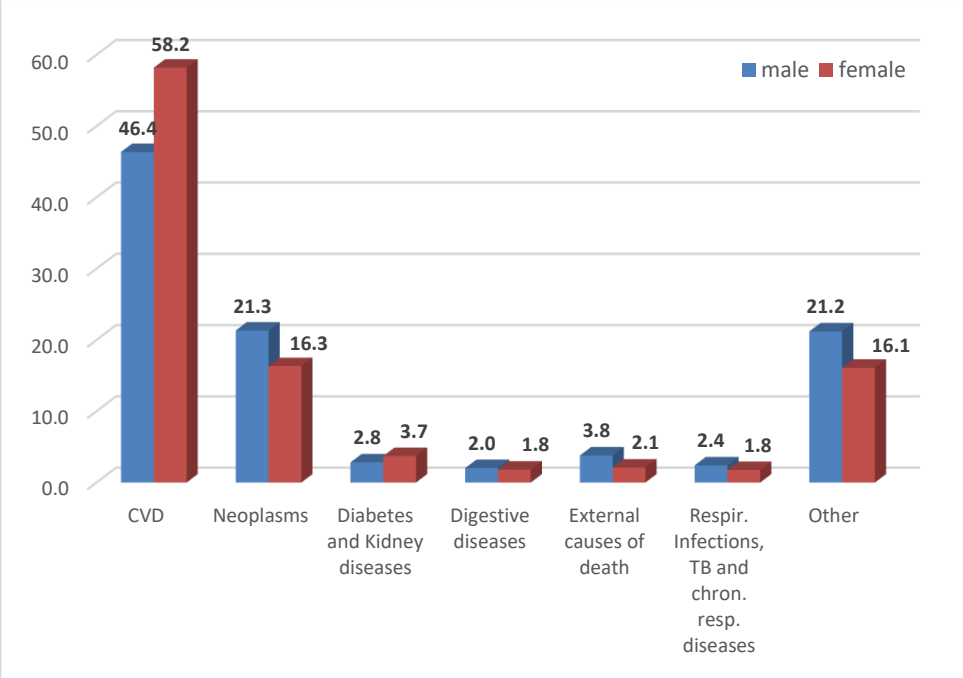


Source: MONSTAT 2021

Causes of deaths in Montenegro population

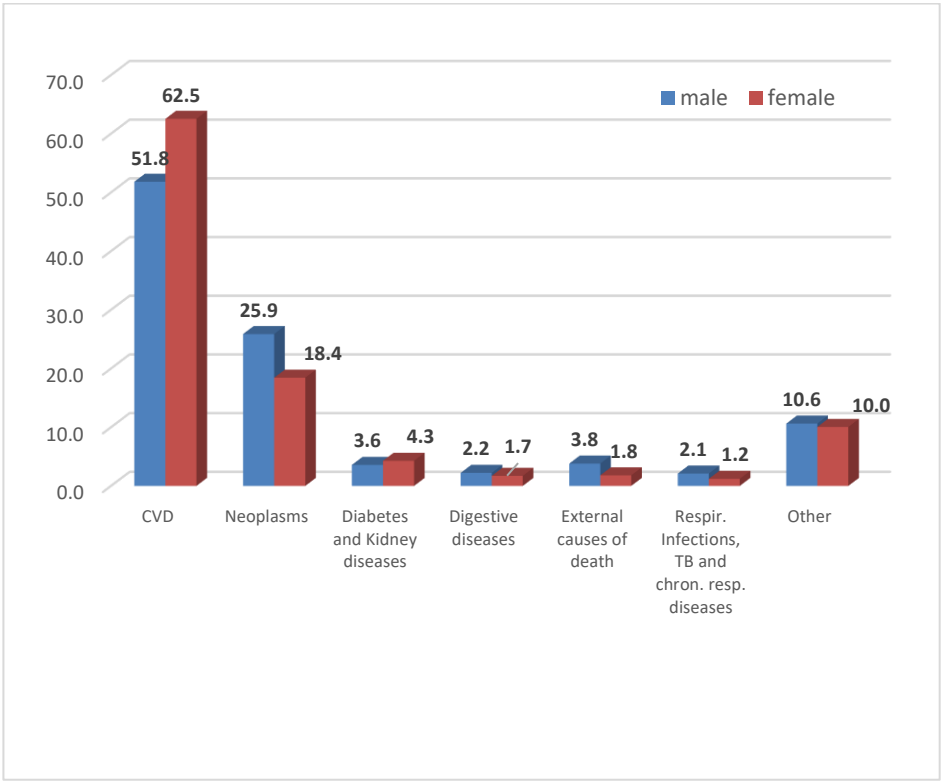
Noncommunicable diseases are the cause of most deaths in Montenegro, especially cardiovascular diseases and cancer. In 1990, those two causes (diseases) accounted for an estimated 80% of all deaths and in 2019 for more than 82 %. Of course, the older population groups are at much higher risk. Women over 50 in Montenegro have a significantly greater risk of dying from cardiovascular diseases than men (62.5% and 51.8% of total deaths respectively in 2019). Furthermore, 86% of the deaths from these diseases were among the population group over 60 of age. The opposite is with cancer as the second leading cause of death. Men over 50 are affected to a greater extent (25.9% and 18.4 % of total deaths respectively in 2019) (Graphs 5 and 6).

Graph 4 Cause-specific mortality (%) in MNE (1990), age group 50 and over



Source: IHME database 2019

Graph 5 Cause-specific mortality (%) in MNE (2019), age group 50 and over



Source: IHME database 2019

In the list of top-10 leading causes between 2009 and 2019, the two leading causes remained the same, and a slight increase appeared in the percentage of diabetes and kidney diseases and neurological disorders as causes of death. Cardiovascular diseases are also the leading cause of

disability-adjusted life years (DALY[29]s) with stroke as a cause of 15.2 % of total DALYs and ischemic heart disease as a cause of 12.9 % of total DALYs. Ischemic heart disease is the number one cause of total DALYs among men, and stroke is number one among women. After circulatory diseases, lung cancer is the third leading cause of death for both men and women with rate 2.6 times higher in men than in women in 2019.

Montenegro also has a high prevalence of behavioural risk factors. Tobacco accounts for 24% of the overall burden of disease in 2017 (measured in DALYs). Dietary risks and alcohol use are also among the top three behavioural risk factors -Institute for Health Metrics and Evaluation, 2017 Washington[30].According to WHO data from 2016, 48% of men and 44% of women 15 years and older reported current smoking, with an average of 46% of people smoking at age 15 years and older.

Intestinal and transmissive infectious diseases

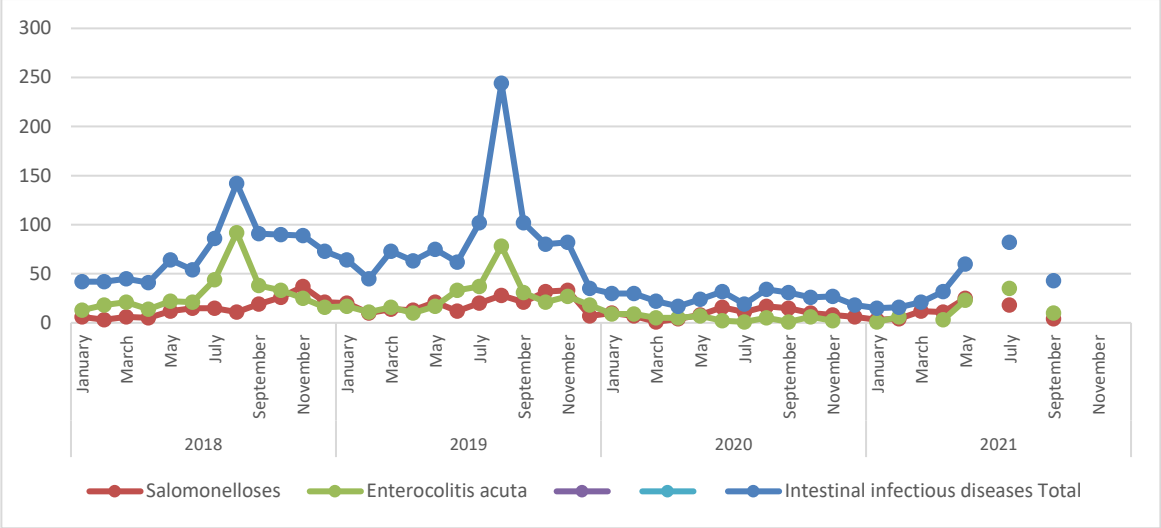
Diarrheal diseases, like salmonellosis and campylobacter, are more common when temperatures are higher or can occur more frequently in conjunction with usually high or low precipitation. Furthermore, an increase in vector-borne (transmissive) infectious diseases such as malaria, dengue, Lyme diseases, etc have been linked to climate variability and are expected to increase further as a result of climate change.

Observed by groups of infectious diseases, in 2018 in Montenegro the number of reported cases was highest in the group of respiratory infectious diseases (78%, without influenza), followed by intestinal infectious diseases (11.5%) and parasitic diseases (7.8%). Similar findings could be observed when analysing NIPH annual report on infectious diseases for the period 2018-2021. Of the disease that could be linked with climate change events, Salmonellosis and Enterocolitis acuta were among the most frequent intestinal infectious diseases with visible seasonal variations in 2018 and 2019 (more frequent in the hot periods of the year) (Graph. 7)

Graph 6 Intestinal infection diseases in Montenegro in 2018-2021, seasonal variations

[29] One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost to due to premature mortality (YLLs) and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population.

[30] https://www.healthdata.org/policy-report/findings-global-burden-disease-study-2017 last visit 25.07.2022



Source: NPHI. Annual reports on infectious diseases in Montenegro, 2018-2021

Some zoonoses like Leishmaniasis could be also impacted by climate change. Aiming to determine the ecological and epidemiological characteristics of Leishmaniasis in Montenegro in the extensive timeframe 1945-2011, Dr. Medenica found a trend of a significant decline in the number of cases by 3.1% annually for the whole country in the period 1945-1981, while during 1981-2014 trend of a significant increase in a number of cases by 4.0% per year was recorded. Pre-school and school age children accounted for 79.1% of the total number of cases. A positive correlation between the number of patients, a 1°C increase in temperature (on annual basis in all three areas) and a 1 mm increase in precipitation was registered in all geographical regions of the country (the number of patients increased by 0,150).[31]

Climate change is likely to have short and long-term effects on *vector-borne infectious disease* transmission and infection patterns, affecting both seasonal and geographic changes in disease occurrence over long periods. Since there are also many other factors to interact in this process it is difficult to predict the real effects of climate change on vector-borne diseases.

The suitability for transmission of many infectious diseases is influenced by shifts in temperature and precipitation. Dengue is a mosquito-borne disease that can cause febrile illnesses and, in severe cases, organ failure and death, with children under five, particularly at risk. With temperatures changing across the globe, this indicator tracks how this is affecting the climate suitability for these infections. The Lancet countdown (2021) indicator tracks the environmental suitability for the transmission of arboviruses (dengue, chikungunya, and Zika), malaria, and *Vibrio* bacteria. For arboviruses, it uses an improved model to capture the influence of temperature and rainfall on vectorial capacity and vector abundance and overlays it with human population density data to estimate the R0 (the expected number of secondary infections resulting from one infected person). The findings say that the R0 for

[31] Sanja Medenica, Epidemiological and ecological characteristics of Leishmaniosis in Montenegro, Doctoral dissertation, University of Niš, 2016

all arboviral diseases tracked has increased, and, in 2020, was 13% higher for transmission by *A. aegypti* and 7% higher for transmission by *A. albopictus* than in baseline years.[32]

The climate-sensitive vector-borne infections include viral infections such as Dengue, Zika and Hantavirus infections; bacterial infections such as Lyme disease, plague, and tularemia; or parasitic infections such as malaria and leishmaniasis. Lyme borreliosis is the most important vector-borne disease in temperate zones of the northern hemisphere in terms of the number of cases. In Europe, at least 85,000 cases are reported every year and the prevalence is greater eastwards. The disease is prevalent in Bosnia and Herzegovina, Serbia, and Montenegro[33]. When temperature increases, rainfall and moisture also increase, water-borne infections such as cholera, as well as leptospirosis, and Weil's disease or leishmania infections are more frequent in the relevant regions and mosquitos get more abundant to transmit infections such as malaria or Dengue fever[34]. When temperature increases but rainfall and moisture decrease, meningococcal meningitis and West Nile virus infection can get more frequent. Balkan countries including Montenegro are also endemic to Crimean Congo Hemorrhagic Fever (caused by Norovirus transmitted to humans by Hyalomma ticks) with a high fatality ratio.[35]

There is no systematic mosquito surveillance currently done or published in Montenegro. The Lovčen project is the only project that published the findings of a few mosquito species in Montenegro that are pathogen vectors for transmission of certain diseases like Malaria, Chikungunya, Dengue, West Nile viruses and Leishmania. The Asian tiger mosquito (Aedes albopictus) has become established in many parts of Europe since its introduction at the end of the 20th century. It can vector a range of arboviruses, of which Chikungunya and Dengue are the most significant in Europe. Montenegro is also among those countries at risk. In 2018, a study was conducted on analysing the expected climate change and the related shift in the climate zones for Montenegro and its impact on the establishment of Ae. Albopictus[36]. The results pointed to a significant increase in suitability for the mosquito and a vertical shift to higher altitudes by the end of the century. The contribution of this change is most significant for the northern mountains, while for the coastal areas where the annual temperature was high CC did not induce insignificant changes in suitability. Similarly, the expected drop in precipitation does not significantly affect the suitability since the annual precipitation is still above the threshold for egg survival[37]. The contribution of this change is most significant for the northern highlands, while for the coastal areas where the annual temperature was high CC did not induce significant changes in

[32] Lancet countdown 2021 report. Available on www.lancetcountdown.org, last visit 25.07.2022

[33] Climate Change Post. Climate change and health in Montenegro Available on https://www.climatechangepost.com/montenegro/health/

[34] https://www.researchgate.net/figure/Frequency-histograms-describing-associations-between-human-and-domestic-animal-high_fig1_318862633

[35] Kayacan ZC, Akgul O. Climate change and its extensions in infectious diseases: South-Eastern Europe under focus (Review article). SEEJPH 2022, posted 21 January 2022. DOI: 10.11576/seejph-5111

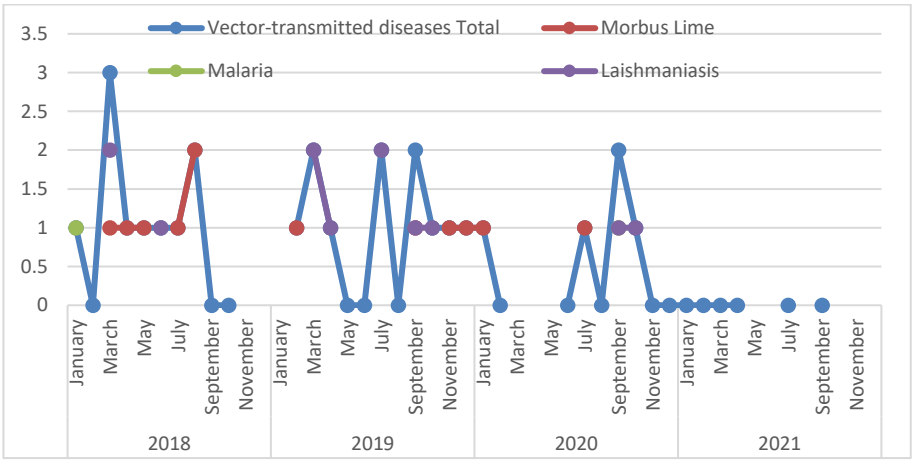
[36] Aedes albopictus (Stegomyia albopicta), from the mosquito (Culicidae) family, also known as the (Asian) tiger mosquito or forest mosquito, is a mosquito native to the tropical and subtropical areas of Southeast Asia. In the past few centuries, however, this species has spread to many countries through the transport of goods and international travel.

[37] https://www.mdpi.com/2073-4433/9/11/453

suitability[38]. While vulnerabilities to arboviruses transmitted by *A. albopictus* and *A. aegypti* have decreased across all countries in the world since the year 2000, countries in the low Human Development Index group remain on average the most vulnerable.[11]

Even though malaria's current main location is Africa, the European Environment Agency (EEA) projected that different countries including Turkey and some of South-Eastern Europe will be affected due, among other factors, to the changing climate. According to the data presented in the "Program for adapting the health system to climate change in Montenegro for the period 2020-2022", in Montenegro, the share of patients with vector-borne infectious diseases in 2013 was 0.2% of the total number of patients with infectious diseases. That year 13 vector cases of infectious diseases were registered in Montenegro (1 case of imported malaria, 4 cases of Lyme disease) diseases, 4 cases of leishmaniasis, and four cases of West Nile fever.[39] However, in the latest NIPH reports on transmissive infectious diseases in Montenegro, those groups of diseases did not have an increasing trend. Given the very small number of these diseases, some specific seasonal or regional matrix of their occurrence in Montenegro could still not be found (Graph 8).

Graph 7 Vector-transmitted diseases in Montenegro in 2018-2021, seasonal variations



Source: NPHI. Annual reports for infectious diseases in Montenegro, 2018-2021

Environmental factors that have a direct influence on climate change vulnerability of the health and health sectors

Air quality in Montenegro

A high level of air pollution has a synergistic harmful effect with climate change extremes on human health, so the air quality data is of high significance in the climate change health vulnerability assessment process. Climate change can affect human health by increasing ground-level ozone and/or particulate matter air pollution. Climate change factors that affect ozone formation include heat and

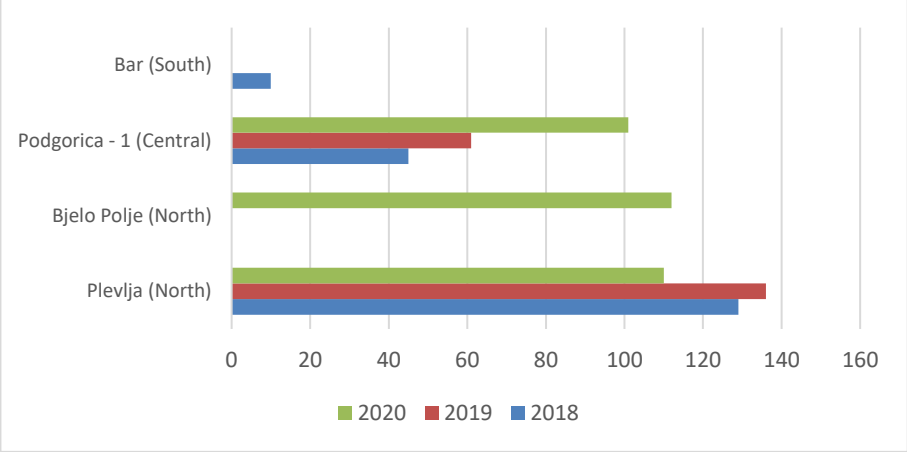
[38] M.Petric. Et al. Expected Changes of Montenegrin Climate, Impact on the Establishment and Spread of the Asian Tiger Mosquito (Aedes albopictus), and Validation of the Model and Model-Based Field Sampling (Atmosphere 2018, 9, 453; doi:10.3390/atmos9110453

[39] Ministarstvo zdravlja (MoH). Program for adapting the health system in Montenegro to climate change for the period 2020-2022 with the Action Plan for the period 2020-2021.

particulate matter concentrations, which could be affected by forest fire emissions and air stagnation episodes. Reports on the state of the environment in Montenegro prepared by EPA present a very comprehensive overview of the air quality status in the country (through the state air quality monitoring network) which enables following the trends of air pollution and regional distribution which is of significant importance in the process of climate change health vulnerability assessment including climate-sensitive outcomes that are synergistic with the climate change health effects. Having in mind the distribution of the basic sources of pollution in Montenegro, there are significant differences in the air pollution level between the regions. Following the air quality data for the period 2018-2020, it can be concluded that the air in the urban areas of the North Region is heavily loaded with suspended particles PM10 and PM2.5 (during the heating season) and that all prescribed limit values have been exceeded for many days (Graph 9). The average annual concentration of benzo (a) pyrene is also many times higher than the prescribed target value. The most polluted cities in this region are Plevlja and Bijelo Polje. Emissions resulting from the combustion of coal in power plants and combustion in households are the main contributors to the poor air quality in Pljevlja. The highest air pollution especially with suspended particles PM_{10} and $PM_{2.5}$ in the **Central region** of the country is recorded in Nikšić (where there is a steel factory) and Podgorica (caused by the urban air pollution).

A much better air quality was registered in the **South region** with only a few days of exceedances in Bar during 2018.[40]

Graph 8 Number of days with PM_{10} exceedances over the limit, 2017-2020



Source: SoER of Montenegro (EPA 2020)

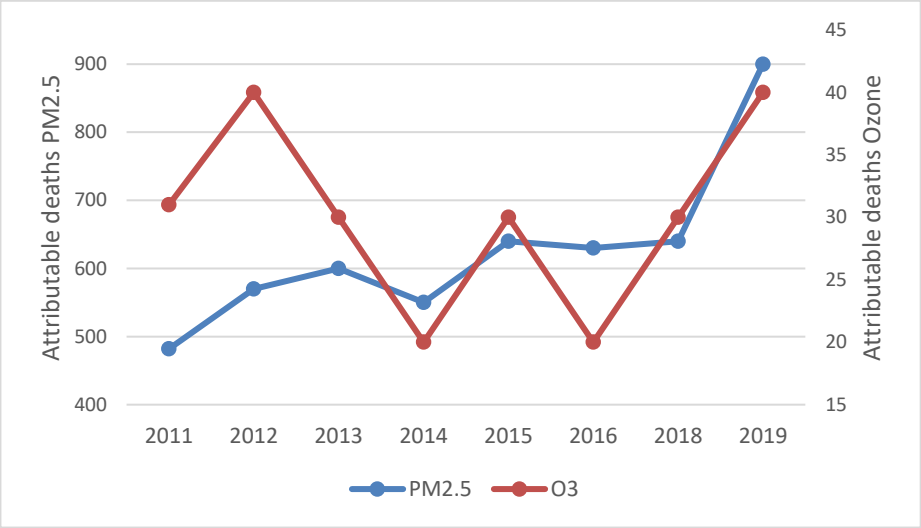
In addition to this, indoor air quality is also a problem in the country. According to the WHO Health and environment scorecard for Montenegro, 38% of the population doesn't use clean fuels and technology for cooking purposed[41].

[40] Ministry for environment protection, spatial planning, and urbanism- Environmental Protection Agency - Information on the state of the environment in Montenegro for 2018-2020

[41] WHO Health and environment scorecard – Montenegro, https://cdn.who.int/media/docs/default-source/country-profiles/environmental-health/environmental-health-mne-2022.pdf?sfvrsn=94db1347_4&download=true last access25 July 2022

Regarding the health effects of such a level of air pollution in the country, European Environment Agency (EEA) is reporting a serious increasing trend in the premature deaths in Montenegro due to PM and O_3 air pollution (Graph 10).

Graph 9 Premature deaths attributable to $PM_{2.5}$ and Ozone in Montenegro



Source: European Environmental Agency (EEA)

It is estimated that 20 % of deaths from stroke and ischaemic heart disease in the country are caused by air pollution.

Measuring pollen concentrations in Montenegro

Pollen is a fine powder produced by trees, flowers, grass and is one of the most common causes of allergies. Many people have a negative immune response when they inhale pollen. The immune system usually prevents disease by defending the body against harmful invaders, such as viruses and bacteria. In people with pollen allergies, the immune system mistakenly identifies harmless pollen as a dangerous intruder. An allergic reaction leads to a number of irritating symptoms, such as sneezing, stuffy nose and watery eyes.

Once a person develops a pollen allergy, it is unlikely to go away. However, symptoms can be treated with allergy medications and vaccines.

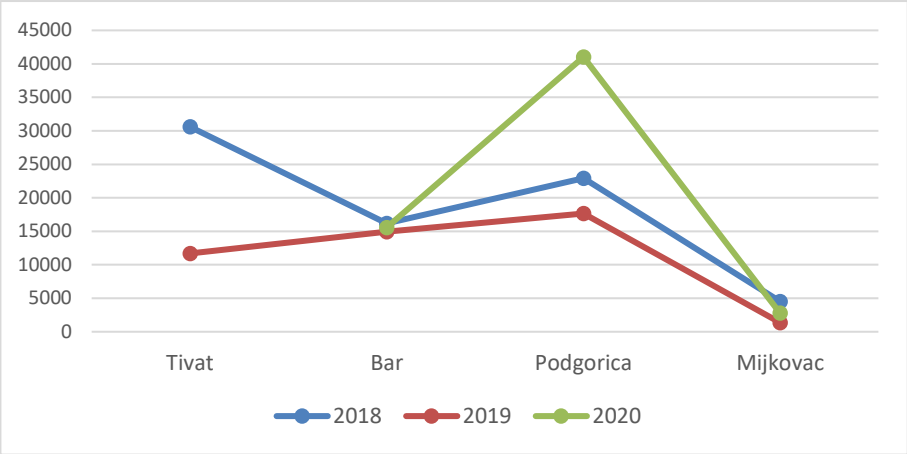
The tiny seeds of pollen can be carried out on the wind and can cause various symptoms of allergies in some individuals who are exposed to them. Most frequently the pollen exposure can result in “allergic rhinitis and/or conjunctivitis” with symptoms of sneezing, congestion, and runny nose and/or eyes. Pollen concentrations are also strongly linked to susceptibility to viral infections through exacerbating respiratory inflammation and weakening immune responses. Climate change can affect pollen levels by shifting the precipitation patterns, more frost-free days, warmer seasonal air temperatures, and more carbon dioxide in the atmosphere. These changes can affect the start and duration of the pollen season, the quantity of pollen production by the plants, and the way they affect human health.

Measurement of pollen concentration in the air of Montenegro is performed within the state network for monitoring of allergenic pollen performed by Environmental Protection Agency. In 2020, the network had four measurement stations of the Hirst type, in the cities of Podgorica, Mojkovac, Tivat and Bar. Based on the concentration of pollen in the air, a "traffic light" report is prepared for a specific area. “Traffic light" reports for each city, as well as data on measurements, allergenic plants, weather, and other data are available on the website of the Environmental Protection Agency (www.epa.org.me). Measurements include three flowering seasons:

- Tree flowering season - from February to August
- Grass flowering season - from April to October
- Weed flowering season - from April to November.

Analysis of the results showed that the highest total concentration of all pollen grains (pg/m3) was recorded in Podgorica - 41,022 pg/m3 in 2020 and in Tivat 30595 grains / m^3 followed by Bar 16,187 pg / m^3 in 2018 (Graph 11).

Graph 10 Number of pollen seeds (No/m^3)



Source: SoER-EPA MNE

Based on the results of the pollen measurement in the air, it is concluded that a higher number of pollen grain concentrations was recorded in 2020 compared to previous years (especially in Podgorica). Concentrations of ragweed, birch and grass pollen grains were also higher than previously. The grass pollination Podgorica lasted for 134 days, in Mojkovac 51, and in Bar 97 days in the year. Although ragweed is recognized as a strong allergen, responsible for over 50% of all allergies caused by pollen in the air, this species is represented in small concentrations in the country and mostly below the limit values of pollen concentrations grains that could cause allergic reactions. The period of high concentrations of pollen in the air is not constant and ranges from March (Bar), April (Podgorica), May (in Podgorica and Bar) to June (Mojkovac). However, these concentrations, their duration, and the allergenic potential of the particular plant are still not of the highest risk for the sensitive population groups.

According to the data above, it could be concluded that the area of Montenegro is currently favourable for persons suffering from allergies caused by these allergens, and in particular for persons suffering from allergies caused by ragweed pollen grains.[16]

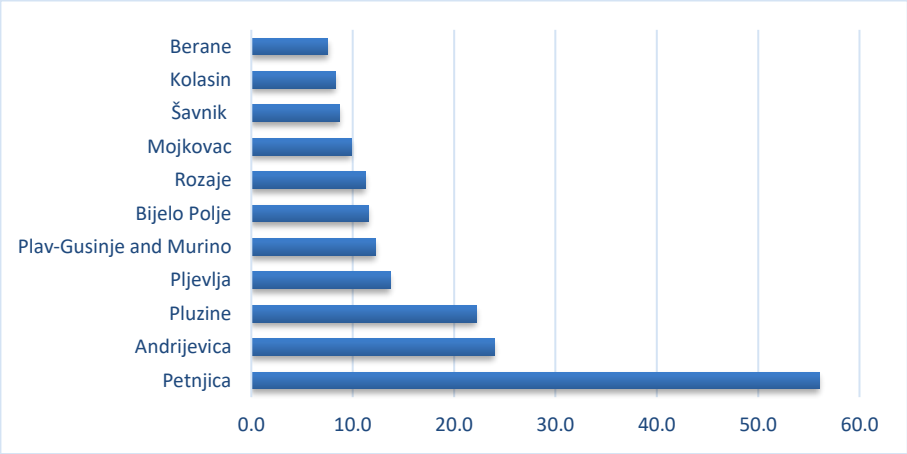
Drinking water quality in Montenegro

Water supply systems can be threatened by rising temperature, changing rainfall patterns, and increased risk of extreme drought or flooding. Exposure to a variety of pathogens in water (and food) causes diarrheal (intestinal infectious) diseases which can be a major public health risk during climate extremes (especially during periods of increased temperature, heatwaves, high or low precipitation, and floods).

According to the current regulations in Montenegro, control of quality and health safety of drinking water, as well as the sanitary and hygienic condition of water supply facilities is performed by public health institutions. In 2020 testing of drinking water was performed by the Institute of Public Health of Montenegro, Hygienic and Epidemiological Service of the Health Center Bar, and Podgorica enterprise "Vodovod i kanalizacija" Podgorica.

There are regional discrepancies in the drinking water quality, especially regarding microbiological safety. Of the total number of tested chlorinated water samples in the period 2014-2018 the highest number of non-chlorinated drinking waters which did not meet the standards were registered in the North region of the country (from 2.3% of samples in Kolašin to 58.8 % in Petnica) (Graph 12)

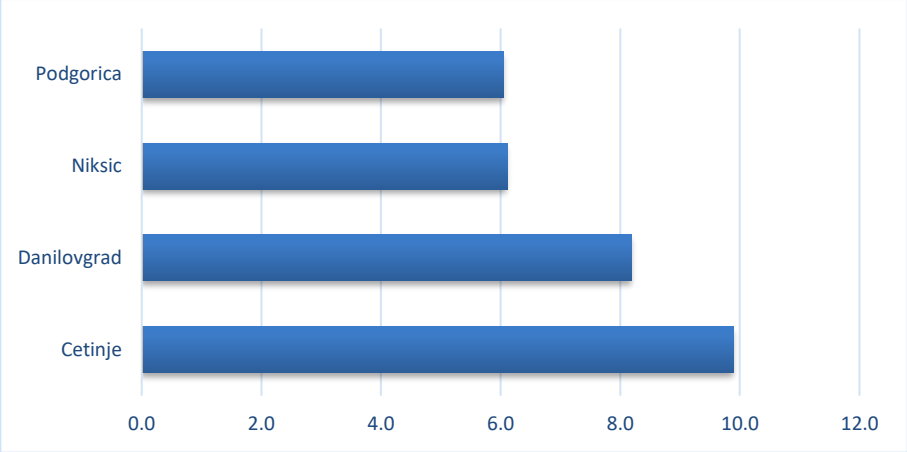
Graph 11 Microbiological safety of drinking waters in Montenegro - average % of noncompliance, North region, 2014-2018



Source: National Institute of Public Health Podgorica, 2018

Much better are the findings in the Central and South region. The capital city of Podgorica has the best quality of drinking water in the country with only 6% of findings that did not meet the limits (as same as the city of Nikšić) (Graph 13).

Graph 12 Microbiological safety of drinking waters in Montenegro - average % of noncompliance, Central region, 2014-2018



Source: NIPH, 2018

The water supply system In Bar had the highest percentage samples of non-chlorinated water that did not meet the microbiological standard In the South region of the country (Graph 14).

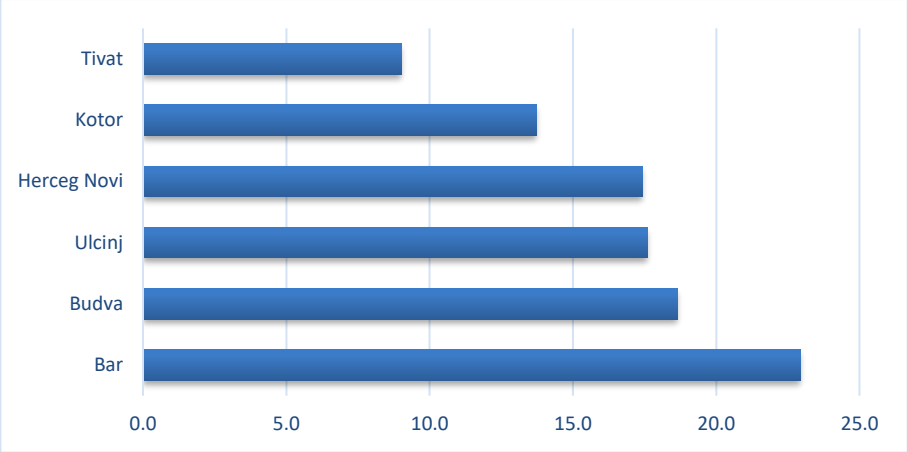
There are many reasons behind these findings, which makes the water supply facilities improperly safe, especially during the disasters like climate extremes. Some of the causes are as follows:

- Legally prescribed zones of sanitary protection are not fully established (except for the first zone).
- The reservoirs that exist in the systems of several city water supply systems are not adequately sanitary protected. The distribution network of most city waterworks is quite old, which causes frequent failures, and significant network losses, which also poses an epidemiological risk.
- Water disinfection is not conducted continuously on all city water supply systems, with the exception of a few large cities.

The above mentioned weaknesses in addition to the evident regional discrepancies in drinking water safety should be seriously taken into consideration while drafting the climate change actions in the public health system of the country.

Roma and rural populations are the most vulnerable groups when it comes to access to safe drinking water and improved water services, as well as access to water in sufficient quantities for household purposes.

Graph 13 Microbiological safety of drinking waters in Montenegro - average % of noncompliance, South-coastal region, 2014-2018



Source: National Institute of Public Health Podgorica, 2018

Nutrition and food security

Climate change has an impact on the nutrition status of the population especially those in poor countries. The global number of undernourished people worldwide has been steadily increasing worldwide. Undernutrition overwhelmingly affects children under five years old, being responsible for more than half of the deaths globally for this age group[42]. The indicator uses changes in climate to track declines in crop yield potential due to warmer temperatures for the world's major crops: maize, wheat, rice, and soybean. This indicator tracks the change in crop growth duration (the time taken to reach a target sum of accumulated temperatures and a proxy for crop yield potential) for maize wheat, rice, and soybean, using a 1981-2010 reference period. If this sum is reached early, then the crop matures too quickly, and yields are lower than average[43]. The findings confirmed that the crop yield potential in the world continues to follow a downward trend, with 6,0% reduction in the crop yield potential of maize, 3,0% for winter wheat, 5,4% for soybean, and 1,8% for rice, relative to the 1981–2010 average crop yield potential. The estimated percentage change in maize growth duration from a 1981-2010 baseline (5-year averages) for Montenegro is 8 % (North Macedonia 8,0%, Serbia 4%, Albania 4 %). Crop yield potential also continues to follow a downward trend, with 6,0% reduction in the crop yield potential of maize, 3,0% for winter wheat, 5,·4% for soybean, and 1,·8% for rice, relative to the 1981–2010 average crop yield potential.[11]

Climate change is also expected to threaten certain aspects of food quality. Because of the combined effects of changes in rainfall, severe weather events, and increasing competition of weeds and plants it is expected many crop yields to decline. The nutritional value of some foods is also predicted to decline. Farmers are expected to need to use more herbicides and pesticides because of increased growth of pests and weeds, as well as decreased effectiveness and duration of some chemicals.

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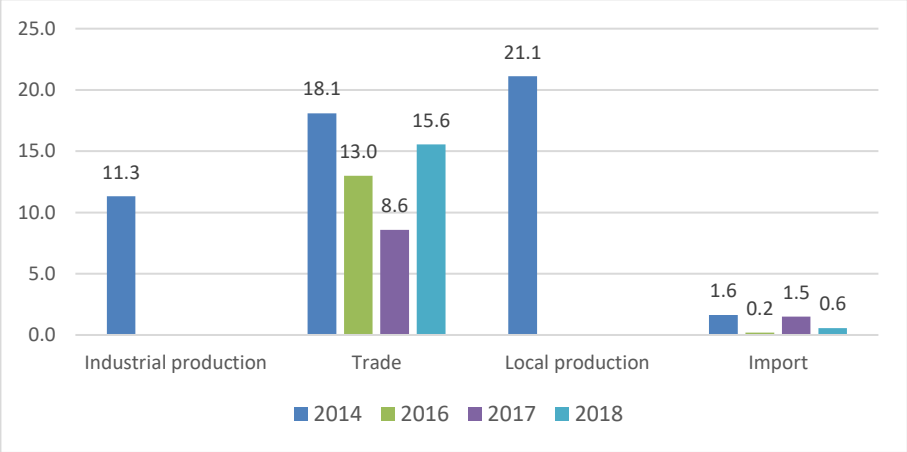
42 https://www.lancetcountdown.org/data-platform/climate-change-impacts-exposures-and-vulnerability/1-4-climate-sensitive-infectious-diseases/

43 https://www.lancetcountdown.org/data-platform/climate-change-impacts-exposures-and-vulnerability/1-4-climate-sensitive-infectious-diseases/

Food safety testing in Montenegro is conducted in three laboratories: the National Institute of Public Health of Montenegro, the Center for Ecotoxicological Research, and the veterinary laboratories in the Department of Food Testing of Animal Origin. In 2018, 14.2% of the total analysed food samples did not meet the legally prescribed microbiological limits (Graph 15). The highest number (and percentage) of improper samples were among locally produced food items. Samples with the increased presence of E. coli were mainly from the categories of milk and milk products and meat and meat products. The presence of coagulase-positive staphylococci was identified in 784 or 7.3%, while bacteria are from the family Salmonella spp. isolated in 4 or 0.04% of the samples from domestic trade and 2 or 0.03% of imported samples. The presence of Listeria Monocytogenes was identified in a small percentage (0.06% of samples) of dairy products.

Results are lacking for some of the products in other years, which makes it difficult to get a true picture of food safety in the country, which is extremely important for assessing the level of public health vulnerability, especially during the climate change extremes.

Graph 14 Percentage of microbiologically improper food samples in the period 2014-2018



Source: NIPH 2018

4.2. Observed historic and current impacts of Climate Change on the health and health sector

Montenegro doesn't have an official statistic and research data or the direct health effects (impacts) of climate change and climate extremes on the human health and the health system in Montenegro. Having in mind the lack of official data, we assessed the climate change sensitivity by analysing data/information from the previous (historical) climate change events and their spatial distribution.

A trend of increasing temperature in each decade since 1970-th was observed in each region of Montenegro[44]. The valley of River Zeta has the hottest summers in Montenegro and the highest

[44] MSDT, UNDP 2020: Montenegro III National Communication on Climate Change 2020, https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/8596012_Montenegro-NC3-1-TNC%20-%20MNE.pdf last visit on 22.01.22

average summer temperature was recorded in Podgorica (29.2 C). as well as the highest daily temperature of up to 44.8 C in August 2007.

In relation to this, the **heat waves also** became an increased climate hazard for the country, having in mind that they occur more frequently and last longer in comparison with the past data. Urban areas like Podgorica and southern (coastal) cities like Bar are at the highest risk. Heatwaves with longest duration are usually observed in August, but there are also short heatwaves in June and July.

The average length of the heatwave in the coastal region is 28.5 days per year, in the central region it is 23 days, and in the northern region 18.4 days. In 2012, a strong heatwave hit Montenegro, affecting more than 4,500 people[18]. The maximum duration of the heatwave of 128 days was recorded in 2018 in Bar.

Increasing concentrations of greenhouse gases lead to an increase in the average but also extreme temperatures and other extreme climatic events. As health consequences that will lead to increased rates of deaths, heat stress, and diseases, which will especially affect the sensitive population groups like children, elderly, pregnant woman, physically, socially and economically disadvantaged groups, people working outside, and the homeless. They can also worsen chronic conditions such as cardiovascular diseases and respiratory and cerebrovascular diseases. People over 65 are the most vulnerable to heat-related illnesses since they live in some degree of constant dehydration, regardless of the weather conditions. As a result, their circulatory system and their cooling system no longer works as well, making them predisposed to heat exhaustion and heat stroke. High temperatures in summer have been associated with a West Nile Fever (WNF) epidemic in 2010 in Southeast Europe and following outbreaks have followed the same trend. The largest outbreak of human WNV infections in the European Union/European Economic Area (EU/EEA) was in 2018, with 11 countries reporting 1,548 locally acquired mosquito-borne infections.

Lancet countdown (2021) indicator of climate change impacts and vulnerability could also be used to assess the heat vulnerability in the country and the region.

This indicator **tracks a population's vulnerability to heat using a composite index ranging from 0 to 100,** which combines data on the proportion of the population older than 65 years; the prevalence of chronic respiratory disease, cardiovascular disease, and diabetes in this population, and the proportion of the total population living in urban areas[45].

Table 4 Tracking the Heat Vulnerability Index in some countries of Southeast Europe

Country	1990	2019
Montenegro	31	38
Serbia	33	39
Albania	26	34
North Macedonia	36	39

[45] https://books.google.com/books?id=ZDCHEAAAQBAJ

Greece	39	42

Source: Lancet countdown 2021 report [46]

Although vulnerability to heat in the low and medium Human Development Index (HDI) country groups is 27–38% lower than in the very high HDI group, it is increasing in all groups and, since 1990, it has increased by 19% in the low HDI group and by 20% in the medium HDI group. For Montenegro, the increase is 19.5 %. It should be emphasized that this indicator does not capture the existence or the absence of effective adaptation measures, such as early warning systems for heat waves, cooling devices, and green areas in cities.

Regarding the mortality linked with climate extremes, in the absence of specific cause of deaths mortality data and according to the modelling data from the "Program for adapting the health system to climate change in Montenegro for the period 2020-2022, in the baseline climate change scenario, annual high-temperature mortality was estimated at 55 deaths[16].

Increased inland and coastal **flooding** expose the population to a range of negative health impacts like drowning, injuries, mental health effects, and intestinal and other illnesses. These effects can happen before, during, or after the flood events. Floods like some other climate extremes can cause serious disruption in the infrastructure, which includes electric power, water, transportation, and communication systems that are essential to maintain access to health care and emergency response services that are of the highest importance in such events.

During the big four floods that occurred in Montenegro in the period, 1991 to 2015 around 8,000 people were affected. Of all the natural disasters, the risk of flooding in the country is ranked highest: 4.9 out of 10. In addition, in terms of lack of capacity to overcome problems, the lack of health services is ranked highest: 5.9 from 10.[16] For the territory of Montenegro, two categories of floods are characteristic: the first category includes floods which are a result of abundant rain series of a few days with a large amount of rainfall, which in extreme cases can reach about 500~1000 lit/m^2, covering larger space. They connect with river systems and lakes in such a way that water levels have extremely high values; they rarely occur, and when they occur, certain thresholds are reached and exceeded. The second category are typical meteorological floods (flash floods) which are local; they are more likely to occur, and they are related to torrents and urban environments or a certain fragment of space. They are of short time span but can be very aggressive, destructive and difficult to foresee and locate in time and space[47]. The largest floods in Montenegro since the half of the past century until now have occurred in 1963, 1979, 1999, 2000, 2010 and 2011. At the end of 2010, large floods occurred caused by abundant precipitation in the territory of Albania and Montenegro in the basin of

[46] Romanello M et al. The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(21)01787-6.pdf

[47] https://flat-project.org/profile-montenegro//

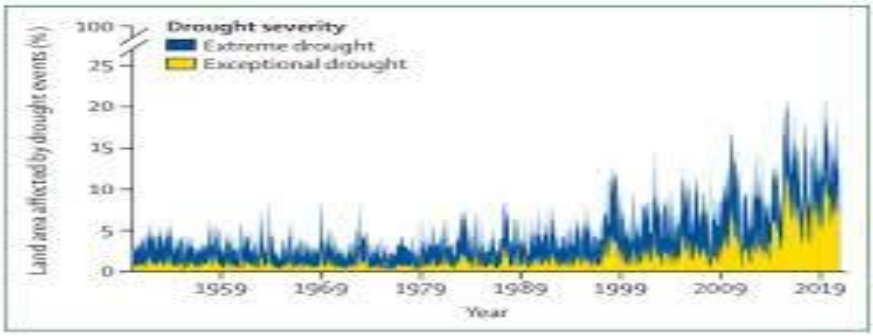
Skadar Lake and Drim and Bojana Rivers[48]**.** Floods in Montenegro mostly endanger large area of land along the edge of Skadar Lake, in the zone of the lower flow of Moraca, as well as along the Bojana River. This includes the urban areas from Sutomore and Virpazar, old town of Kotor, Sutorina, Herceg Novi, and Crkvica, but we should not neglect the flood risk to the karst fields of Niksic and Cetinje. [18] According to current data and information, the sources of public water supply in Montenegro do not float during extreme floods, though there are problems with water blur and breaks in the supply of consumers during that period or issuing warnings about the need for water purification.

The population in the age groups 55-64 and 65+ are the most represented in the labour force in the agricultural holdings mostly as outdoor workers in Montenegro, which requires separate attention by the climate change-related actions, due to the fact that these groups are identified as vulnerable in terms of health and climate change hazards.

Droughts are another climate extreme to have multiple negative impacts on society, especially on the economy, environment and public health. According to Lancet countdown indicators of climate change vulnerabilities in 2021, up to of 19% of the global land surface was affected by extreme drought in any given month.

Graph 15 Global land area affected by drought events per month

Extreme drought is defined by a SPEI of ≤1·6 and exceptional drought is defined by a SPEI of ≤2.
SPEI=standardised precipitation-evapotranspiration index



Source: Lancet countdown 2021 report [19]

According to country strategic documents, the sectors of agriculture, fishery, hydroelectric plants forestry, and tourism are the most affected by droughts in Montenegro. Changes in the water balance are of increasing concern for drought-susceptible countries like Montenegro. The droughts in Montenegro have become more frequent since the beginning of the 21st century, and in particular, 2000, 2003, 2007, 2008, 2011, 2012, 2017 and 2018. The draught of 2011 with the extreme hydrological deficit in the Zeta- Bjelopavlići region affected agriculture activities in this region at most with the quantity, quality and nutritional deficit of the yield but was also followed by forest fires in the following year. Hydrological droughts in 2017, 2018 and 2019 primarily decreased the water levels of rivers Morača, Zeta, and Skadar Lake[18]. According to the Drought vulnerability map, the southern

[48] Analysis of flood and landslide risks for Montenegro, Podgorica 2018 https://flat-project.org/doc/me/analysis.pdf last visit 26.07.2022

parts of Montenegro are likely to have more days without rain, than the central and northern parts (**National Draught Plan 2020**). The occurrence and magnitude of the periods with draughts are expected to increase in the future.[49] Data from the agricultural sector are indicating that men can be more affected by **droughts** due to the fact that 87% are holders of individual agricultural holdings, 60% are agricultural workers, in 94% are managers of business entities. Still, the fact that 65% of women are unpaid family workers has to be also evidenced in the gender differences of the burden of labour in the cases of droughts. No direct data are available regarding the health and/or public effects of the drought periods in the country. However, having in mind the water resources shortage during drought and their impacts, the most vulnerable sectors in Montenegro that will also have an impact on public health besides water supply are agriculture, including food and milk production.[50]

Forest fires (wildfires) can also have a negative impact among others on the public health in Montenegro. Besides destroying huge areas of forest and wood mass, the fires emit fine particles and ozone precursors and can increase the risk of premature deaths and adverse chronic and acute cardiovascular and respiratory health outcomes. Due to forest fires, the water resources, infrastructure, traffic, and accessibility to health and emergency care will be also threatened.

There were around 800 large forest fires in Montenegro during the period 2005-2015 with more than 18,000 ha of forests destroyed. The worst damage was registered in the worm periods (July-August). The most affected regions in the country were the municipalities of Nikšić, Plevlja, and Žabljak, the coast, area of Cetinje, and Podgorica.[18]Lancet indicator for population exposure to wildfires uses both model-based wildfire danger and satellite-observed exposure. Climatological wildfire danger was estimated by combining daily very high or extremely high wildfire danger (a fire danger index score of 5 or 6) with climate and population data. Human exposure to wildfires, in person-days (with one person-day being one person exposed to a wildfire in one day), was tracked using satellite and population data. In these calculations, there are some limits. The fire danger index is calculated based on meteorological parameters. The actual fire events can be also influenced by anthropogenic factors, such as human-induced land use and land cover changes, industrial-scale fire suppression, and human-induced ignition. The satellite data does not account for cloud cover or smoke and data is not collected at night. It also assumes that those affected by a wildfire are the population limited to a 10km. radius of the fire grid point and do not track exposure to wildfire smoke[51]. Population exposure to wildfires is measured in thousands of person-days of exposure.

Table 5 Annual person-days of exposure to wildfire (in thousands) in 2001-2004 and 2017-2020 for some countries in southeast Europe

Country	2001-2004	2017-2020

[49] MSDT Montenegro National Draught Plan 2020. Available on https://www.unccd.int/sites/default/files/country_profile_documents/Montenegro%20national%20drought%20plan_0.pdf last visit 26.07.2022

[50] Luka Mitrović, Mirjana Ivanov, Miraš Drljević, Nataša Pažin, Slavica Micev and Tonka Popović. "The frequency occurrence of the drought in Montenegro from 1981-2017, vulnerability and impacts". Available on http://www.meteo.co.me/Meteorologija/kli-promjene/IHMS_article_final.pdf, last visit 07.12.2021

[51] https://www.lancetcountdown.org/data-platform/adaptation-planning-and-resilience-for-health/2-2-climate-information-services-for-health/2-2-3-urban-green-space/

Montenegro	4.09	21.3
Serbia	81.1	115
Albania	12.2	22.3
BiH	24.6	42.4
North Macedonia	12.3	26.0

Source: Lancet countdown 2021 report [19]

Nearly 60% of countries had an increase in the number of days people were exposed to very high or extremely high fire danger in 2017–20 compared with 2001–04, and 72% of countries had increased human exposure to wildfires across the same period. Montenegro and the countries in the region are also highly exposed to this risk. [11]

4.3.Mapping of the identified climate risks and impacts

The analysis of the demographic, social economic, health and climate profile of Montenegro confirmed that there is a significant health risk for the population from climate change, especially from certain climatic extremes (Table 4).

Although sufficient quality health data covering a longer historical period have not been obtained, nor have specific studies on the direct connection of climate change with health have been developed, the indirect indicators and existing models - predictions confirm that the occurrence of **high temperature and heat waves**, especially in the summer period, is the **highest climate change risk** for the population in Montenegro. Of course, not all population groups are equally at risk, so the focus of the risk is on the old population, the chronically ill, workers who work outdoors (which includes agricultural workers and fishermen) and socially marginalized groups who live in substandard conditions. In terms of the geographical region, it seems that the coastal region and the urban zones (mainly Podgorica) are the most threatened by this climate extreme. However, if we add the additional adverse health impact of air pollution, then the geographically endangered zones extend to parts of the central and northern regions (Niksic and Plevlja). In conditions of such a health risk, there will be a special burden on the health system with a focus on certain services (for adults and the elderly and emergency medical care) whose strengthening must be among the first priorities in order to enable climate adaptation and resilience.

Cardio-respiratory morbidity and mortality are the main health outcomes to expect as a result of extreme temperatures and heat waves.

In the absence of specific studies on the direct impact of climate extremes on health, data from strategic documents and available manuscripts show that **floods, drought, and forest fires pose a moderate to high risk to health** to the health system in Montenegro. The health risk is indirect through damage to health and other basic infrastructure, availability of safe water and food (floods and droughts) or air pollution (from fires).

Geographically, the highest risk of these floods is in the regions where these extremes have been historically reported with highest frequency, and those who are predicted in the national climate scenarios to be at risk, as well as the group of particularly sensitive groups including the elderly, chronically ill, and socially marginal groups, including the population that lives in remote rural

settlements in endangered areas. In these regions, access to health services will be difficult, and a special burden on the health system will be the overloading of primary and emergency medical services. Injuries, drowning, compromised mental health or increased numbers of infectious diseases transmitted through contaminated drinking water are also expected to be more frequent.

The combination of **high temperature and floods or high precipitation** can be assumed as a **moderate health risk** for the population in the endangered regions. Increased incidence of some intestinal water and food-borne diseases (during floods) or transmissive infectious diseases (during high temperatures and high precipitation), with deterioration of the drinking water quality, are among the main health risks-impacts. The regions at highest risks are the Northern regions which have mostly rural unsafe water supply systems, as well as the regions suitable for the Asian Tiger mosquito (Aedes albopictus).

Effects on the agricultural sector like **undernutrition** could be also considered as a public health threat. Namely, as it is concluded from this assignment, the increased temperature, more frequent and prolonged heatwaves, reduction of rainfalls in some regions, and increased number of summer and tropical days will have a very negative impact on crops and livestock, increase heat stress, reduce productivity and particularly affect livestock with disturbed welfare.

Last but not least and though currently, the pollen concentrations are not at a risky level**, extended pollen season** and more days with high pollen counts could be assumed as future climate change risks with **low to moderate** intensity in the country. There are no data for the dimension of the pollen-sensitive population, but the existing monitoring system could be used for epidemiological studies to explore the impact of pollen concentrations and distribution and define the regions with risk.

4.4. Risk metrics - criteria and indicators used for the prioritization exercise

In the presented, historical, current, and future Health Risk matrix (Table 4) the main criteria for prioritization and indicators for monitoring include:

- The type of risk - hazard,
- Vulnerable population group and region,
- Assessing the probabilities to happen (evidence-based or expert assumption),
- The burden (impact) on the health sector, and
- Indicators to monitor

Table 6 Climate change (current and future) Health Risk matrix and metrics – Montenegro (expert's assumptions)

Probability to happen/level of risk	Low	Low to moderate	Moderate	Moderate to high	High

Climate Change extreme - hazard	Risk-impact on health and health sector	Vulnerable groups	Vulnerable regions	Expert assumptions (e.a) and/or Confirmed in MNE study	Impact-consequences on the health sector	Indicator(s) to monitor
Increased average (especially summer) temperature and heatwaves	- Increased heat-related mortality (basic estimation of 55 attributable deaths for 2020-2022 - Increased emergency calls	Elderly, chronic patients, physically and economically disadvantaged groups, outdoor workers and homeless	Coastal and urban areas	e.a No local impact assessment studies (only in models-scenarios)	Increased demands on health and adult care services including emergency medical care services	- All-cause and cause-specific mortality disaggregated to sex, age group, and geographic region - Daily and monthly data on emergency calls
Increased average (especially summer) temperature	Increased frequency and intensity of air pollution (PM + ozone)	Elderly, chronic ill patients) those who have heart failure, kidney failure, poor circulation, or high blood pressure are at high-risk)	Air polluted urban (Podgorica) and North regions cities (Nikšić, Plevlja)	e.a. + Available air quality data	Increased cardio-respiratory morbidity and mortality and hospital admissions	- Air quality – daily and monthly data - All-cause and cause-specific morbidity and mortality data
Increased average temperature and Floods	Increment in some intestinal water and food-borne diseases, deterioration of the drinking water quality	Rural and socially deprived population groups	A large part of the Northern regions and mostly rural unsafe water supply systems	e.a + high percent of microbiologically unproper drinking water samples	Health impacts like increased number of outbreaks of waterborne (diarrheal) diseases	- Enhanced monitoring of drinking water and food safety data

Climate Change extreme - hazard	Risk-impact on health and health sector	Vulnerable groups	Vulnerable regions	Expert assumptions (e.a) and/or Confirmed in MNE study	Impact-consequences on the health sector	Indicator(s) to monitor
						- Daily and monthly data on waterborne and foodborne diseases
Higher temperature and precipitation	Increased prevalence of infectious transmissive diseases and survival of certain arthropods such ticks, and mosquitos lower productivity in agriculture, lower quality of food, the risk from undernutrition	No specific vulnerable group	Regions suitable for the Asian Tiger mosquito (Aedes albopictus)	e.a + research data from the region	Increased number of vector-borne diseases,	Daily and monthly data on infectious transmissive diseases
Increased average temperature	Extended pollen season and more days with high pollen counts	Sensitive population groups	Seasonal and regional distribution of high pollen concentrations -	e.a + data from the Measurement of pollen concentration	Increased number of patients manifesting allergic symptoms	- Continuous data from the pollen monitoring system - Health data regarding sensitive patients
Floods (and sea levels rise)	Direct and indirect health effects as well as the impact on health system infrastructure	Rural and socially deprived population groups (including Roma settlements) are at higher risk	Data and regional projections from the Montenegro III National Communication on CC 2020	e.a + Data and projections from the Montenegro III National Communication on CC 2020	Increased number of injuries, drownings, mental health Increased demands on the emergency and health services	- data/information on flooded areas on the population groups affected - Daily and monthly data on injuries and drownings, emergency calls, during

Climate Change extreme - hazard	Risk-impact on health and health sector	Vulnerable groups	Vulnerable regions	Expert assumptions (e.a) and/or Confirmed in MNE study	Impact-consequences on the health sector	Indicator(s) to monitor
						extreme events in the regions affected
Drought	Indirect health impact through decreased water availability, water supply safety, forest fires risks,	Remoted and socially deprived population groups especially in rural areas (Roma population included)	The southern parts of Montenegro are likely to have more days without rain.	e.a + data-information from the National Drought Plan 2020	Increased number of waterborne and mental disease	- Data/information on affected areas with the structure of the population groups at risk - Daily and monthly data on health care and emergency calls, during drought events in the regions affected
Forest fires (Wildfires)	Destroyed huge areas of forest and wood mass, increased emission of fine particles and ozone precursors - increase risk of premature deaths and adverse chronic and acute cardiovascular and respiratory health outcomes.	Elderly and patients with chronic diseases Remoted and socially deprived population groups especially in rural areas (Roma population included)	Historically most affected regions in the country like the municipalities (Nikšić, Plevija, and Žabljak, the coast, area of Cetinje, and Podgorica)	e.a + data information from Montenegro III National Communication on Climate Change 2020	Increased demands on emergency and health care services The water resources, infrastructure, traffic, and accessibility to health and emergency care will be also threatened	- Regular data/information on affected areas with the structure of the population groups at risk - Daily and monthly data on health care and emergency calls, during the events in the regions affected

4.5. Climate-driven vulnerabilities and gender-disaggregated impacts of the health sector

For this report, the definition of climate change health vulnerability will be a function of the exposure, sensitivity, and adaptive capacity of the health and other sectors relevant for the health impact assessment.

The previous chapter describes the current climate-related exposures and health sensitivity outcomes and regions, while the future risks are described in the next chapter. Many of the determinants of exposure and sensitivity are similar to those that influence the system's adaptive capacity.

Climate change's negative impacts are affecting everybody, although there is strongly related gender-based negative health consequences from the climate extremes. In this sense it has to be highlighted that, natural disasters are affecting (killing) more women than men in the poorer countries, and countries with low(er) socioeconomic status of women[52]. In that regard, it can be concluded that the greater gender disparities in the society are proportional with the climate change impacts on women.

Gender-based health differences until now have been mostly related to the reproductive women`s health, still, in the climate change context, there are other health aspects that must be examined to define the gender-based vulnerabilities in the health sector. Gender differences in health risks, which are a combination of psychological, biological, behavioural, and social factors, are likely to be exacerbated by climate change.

Food, nutrition, water consumption, exposure to pollution, and other factors have to be examined in correlation to the gender-based differences (mental and physical) in tight correlation to the gender-based societal roles[53].

In relation to the water and health correlation, it has to be mentioned that "women tend to be at a greater risk of schistosomiasis than men because they have more contact with water"[54]. Although this may be not applicable to Montenegro, still, the fact that women have more contact with water, requires safe water to be provided in order to maintain their health.

There are two types of health risks associated with meteorological hazards: direct and indirect.

The following sex-disaggregated data are defining the gendered vulnerability in the health sector:

[52] The Gendered Nature of Natural Disasters: The Impact of Catastrophic Events on the Gender Gap in Life Expectancy, 1981–2002

[53] Gender-planned health services, A Raikes , R Shoo, L Brabin

[54] Gender-related differences in the impact of tropical diseases on women: what do we know?

C Vlassoff , E Bonilla

Table 7 Sex-disaggregated data that are defining the gendered vulnerability in the health sector

Hazard	Vulnerable groups		
Heatwaves	6% more deaths than expected in male population	10% more deaths than expected in female population[55]	Subgroups of aged 75+, circulatory diseases age 65-74, respiratory diseases, and all causes
Droughts	87% male holders of agricultural holdings	94% male managers of business entities	65% unpaid female family workers
Energy poverty Indoor pollution	76.4% male household owners	40.1% of female owners are facing one or two material deprivations	Households using wood as the main source of cooking in Montenegro is represented by 35%
			Women cooking and/or doing housework, every day (18+ population) is 68%
Food and nutrition	Severe food insecurity in the adult population is slightly higher among women with 13.4% against 13.2% of men	8.5% female children are starving	20.8% Roma female children are starving
		6.2% male children are starving	21.5% Roma male children are starving
Reproductive health and humidity and temperature rise	32.9% of women in Montenegro reported that their need for family planning was satisfied with modern methods in 2018		

[55] [55] PubMed: Number of Heat Wave Deaths by Diagnosis, Sex, Age Groups, and Area, in Slovenia, 2015 vs. 2003, Simona Perčič, Andreja Kukec, Tanja Cegnar, and Ana Hojs, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5800272/

Horizontal labour segregation at public health institutions	69% women in general practice (2018)	65% women specializing (2018)	65% women specialist (2018)

Figure 2: Gender-based vulnerable groups: Health

Heatwaves

Direct effects are referring primarily to direct health consequences from the climate extremes in weather, i.e., "the majority of European studies have shown that women are more at risk, in both relative and absolute terms, of dying in heatwaves, as well as a higher rate of deaths in floods"[56].

For example, in Slovenia, the examination of deaths by sex in 2015, showed that there were overall 52 (6%) more deaths than expected during heat waves in the male population, and a higher percentage and more deaths in the female population 89 (10%) than expected during heat waves.[57]

In addition, in the study "Heat threatens health: key figures for Europe" the WHO indicates that at the level of individual differences in the ability to cope with the heat stress in EU cities, the elderly suffered the greatest effects and women noticed higher mortality than men[58].

Furthermore, according to the same study, women are more affected by the heat waves in the subgroups of aged 75+, circulatory diseases age 5-74, respiratory diseases, and all causes.

Those are direct health risks associated with meteorological hazards with a gender difference.

Indirect or long-term effects of climate-related negative impacts, such as drought, are related to the long-term influences on women's health, labour burden, and food security, as presented in the further text.

Drought

As one of the climate change consequences droughts are strongly affecting both men`s and women`s mental health (in agricultural areas), and additionally burden the women in the households due to the water insufficiency. Data from the agricultural sector are indicating that men can be more affected by

[56] WHO, "Gender, Climate Change and Health"

[57] PubMed: Number of Heat Wave Deaths by Diagnosis, Sex, Age Groups, and Area, in Slovenia, 2015 vs. 2003, Simona Perčič, Andreja Kukec, Tanja Cegnar, and Ana Hojs, available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5800272/

[58] WHO: Heat threatens health: key figures for Europe available at: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/archive/heat-threatens-health-key-figures-for-europe

droughts due to the fact that they are holders of 87% of the individual agricultural holdings, are representing 60% of the agricultural workers, and are managers of 94% of the business entities. In addition to that it has to be underlined that 65% of women are unpaid family workers and that have to be taken into consideration when assessing the burden of labour in the cases of droughts.

Energy poverty and air pollution

The energy poverty which is strongly related to climate change is also directly correlated to health hazards. Women as more present in the unpaid family labour are suffering greater consequences for taking care of the availability of drinking water, cooking and hygiene, food consumption, as well as spending more time in houses without heating or with healthy hazardous heating and cooking practices such as burning of wood.

Gender-based roles are essential for the identification of gender vulnerabilities and to assess the gender disparities when it comes to climate change and social vulnerabilities.

Although mainly related to the mitigation practices, households` heating and cooking patterns are a very important source of data for vulnerability identification, and they are worth mentioning here.

Namely, the **household structure[59] in Montenegro shows high male dominance of the household's ownership with** 76.4% male owners and in 23.6% women. In the Roma settlements, men are owners of the households in 79.9% and 20.1% of the households are owned by women. An extremely important fact here is that 40.1% of female owners are facing one or two material deprivations in comparison to 34.5% of male owners, 30.6% of women-headed households are facing three or more deprivations, in comparison to 34.5% of male-owned. These figures should be considered when developing adaptation measures in terms of proper targeting the gender based vulnerable groups.

Households using wood as the main source of cooking in Montenegro is represented by 35%[60], out of which 70.3% are among the poorest population[61]. In 89.5% of those household using polluting fuels for cooking, the cookstove is in the main and only room in the house[62].

From the facts analysed before it can be concluded that the poorest population uses highly polluting sources for cooking and heating, which are hazardous for them and for the environment.

If we compare these data with the data from the Gender Equality Index[63] in Montenegro, the percentage of women cooking and/or doing housework in a daily manner (for population above 18) is

[59] Multiple Indicator Cluster Survey 2018, Montenegro and Montenegro Roma Settlements, available at https://www.unicef.org/montenegro/media/15976/file/mne-media-publication1002.pdf

[60] Table TC.4.2: Primary reliance on solid fuels for cooking

[61] Table TC.4.2: Primary reliance on solid fuels for cooking

[62] Table TC.4.3: Polluting fuels and technologies for cooking by type and characteristics of cookstove and place of cooking

[63] Gender Equality Index, Montenegro, 2019

68% and male`s share is 10.3%, from which we can conclude that women are more exposed to air pollution connected with energy security that men. In addition to that in the category caring and educating children or grandchildren, elderly or people with disabilities on a daily basis (population above 18 years), where the share of women is 42.7% while male share is 23.8%. These findings are strongly correlated to the health hazards women are facing, being more exposed to indoor pollution.

From all this it can be consulted that ***woman facing poverty and risk of poverty, rural women, and Roma women are highly vulnerable groups from climate change in Montenegro.***

Food and nutrition

In the context of healthy food and nutrition, the prevalence of severe food insecurity in the adult population is slightly higher among women than man (13.4% against 13.2%)[64]. In addition, according to the UNICEF data[65], the gender disparities are obvious with 8.5% of female children and 6.2% male children facing stunting[66]. The situation is worse among Roma children where this prevalence is much higher (20.8%), and male children are slightly more represented with 21.5% than female children with 20.1%[67].

According to the Gender equality index, Domain of Health[68]: self-evaluation of health as good or very good, 65.3% of women evaluated their health as good or very good compared to 73.2% of men[69]

In the context of the health-related behaviour, according to the same source, the proportion of people who were physically active for at least 150 minutes per week and/or consumed at least 5 portions of fruit and vegetables per day was 58% among women and 63.1% among men[70].

[64] UNWOMEN, https://data.unwomen.org/country/montenegro

[65] MICS 2018; http://www.monstat.org/userfiles/file/MICS/ENG/eng/Montenegro%20(National%20and%20Roma%20Settlements)%202018%20MICS%20SFR_English_v4.pdf; Table TC.8.1R; Page 302, 303

[66] Percentage of children under age 5 - Moderate and Severe (%), at the national level for 2018 of the Stunting prevalence .Stunting, or chronic malnutrition, is the result of failure to receive adequate nutrition in early life over an extended period and/or recurrent or chronic illness.

[67] MICS 2018; http://www.monstat.org/userfiles/file/MICS/ENG/eng/Montenegro%20(National%20and%20Roma%20Settlements)%202018%20MICS%20SFR_English_v4.pdf; Table TC.8.1R; Page 302, 303

[68] The Domain of Health consists of three sub-domains: Status of health, Behaviour including healthy lifestyle habits and Access to health care.

[69] Gender Equality Index Montenegro 2019 – EuroGender, https://eurogender.eige.europa.eu/system/files/events-files/gender_equality_index_2019_report_final.pdf, page 33

[70] Gender Equality Index Montenegro 2019 – EuroGender, https://eurogender.eige.europa.eu/system/files/events-files/gender_equality_index_2019_report_final.pdf, page 33

Humidity and temperature rise and reproductive health.

In relation to reproductive health, it has to be mentioned that there is a connection between the weather (meteorological conditions) and the high blood pressure during the pregnancy, with possible explanations found by the impact of humidity and the rise of the temperature.[71] In terms of reproductive health, it worth mentioning is that 32.9% of women in Montenegro reported that their need for family planning was satisfied with modern methods in 2018[72].

According to the above-presented figures, it can be concluded that there are strong correlations between gender and sex/gender factors with the vulnerability to health hazards in the climate change context.

According to the Health Statistical Yearbook 2018 of Montenegro[73], when it comes to the horizontal labour structure of the health personnel in Montenegro, an interesting fact is that women are more represented in the category doctors: General practice in 69%, Specializing in 65%, specialist in 63%.

The gender disparities are even higher when assessing the supporting medical staff, where the percentage of women with academic education is 86%, while with high school education is 85%.

These numbers have to be strongly considered in the climate change adaptation and communication strategies targeting health workers, but also in the policy development of the adaptation practices in the health sectors. In addition, the gender balance in decision making processes has to be strongly considered, due to the fact that, majority of the personnel are women, and their experiences have to be strongly considered in the policy development processes.

The governance structure of the medical utilities is not presented in the statistical yearbooks and other official data. It is important to analyse the vertical labour segregation in the health sector since is directly corelated to the decision-making processes and this information should be publicly available.

Assessing the current capacity of the health system to address the risks of climate-sensitive health outcomes

In order to pilot the climate change vulnerability assessment of the health care facilities in the country, a standard WHO checklist to assess vulnerabilities in health care facilities in the context of climate change (WHO 2021) was applied for four climate change exposure extremes (heatwaves, floods, drought, and wildfires) in four hospitals in the country where historically climate change hazards (and

[71] WHO, "Gender, Climate Change and Health"

[72] UNWOMEN

[73] INSTITUTE OF PUBLIC HEALTH OF MONTENEGRO, Health Statistical Yearbook 2018 of Montenegro

exposure) happened.[74] These regions were also pointed out as especially vulnerable to particular climate change hazards in the latest climate projections described in the strategic document of the country [18]

- Clinical center – Podgorica (checked for heatwaves, floods, drought and wildfires)
- General Hospital -Nikšić (floods and wildfires)
- Special Hospital for Lung Diseases and Tuberculosis "Dr. Jovan Bulajić "Brezovik in Nikšić (floods and wildfires)
- General Hospital Bar (heatwaves and drought).

The focus of the assessment was on the four fundamental requirements (and weak points) for providing safe and good-quality care in the context of climate change (a. health workforce; b. water, sanitation - WASH, hygiene, and health care waste management; c. sustainable energy services; and d. infrastructure, technologies, and products). Namely, it was confirmed that the climate change health outcomes could compromise the delivery of good health care quality through the pressure on these four segments and functions in the healthcare facility.

Findings

Though the process of responding to the checklist was self-reporting which brings the risk of subjective responses, the findings can confirm the various serious type of vulnerabilities in the health care facilities from all four areas of assessment, especially in the health workforce preparedness and the level of adaption of the current system, infrastructure, technologies, and sustainability in facility operations during the particular climate change hazards.

Regarding the exposure to heatwaves, the main vulnerabilities in the facility are the water sanitation and waste monitoring, information and risk management and the activities for adaptation of the current health care infrastructure and technologies. The last ones are a serious problem observed in all other assessed hazards and facilities in the country (Table 5).

Table 8 Level of healthcare facilities preparedness (in %) to climate hazards – HEATWAVES*

Vulnerability	High	Medium	Low
Health workforce	33-55	22-61	6-23
Water, sanitation and waste	40-50	35-45	5-15
Energy	28	25	16
Infrastructure, technology, and product process	53	36	11

[74] WHO. 2021. Checklist to assess vulnerabilities in health care facilities in the context of climate change. Available on https://www.who.int/publications/i/item/checklists-vulnerabilities-health-care-facilities-climate-change, last visit 10.12.2021

* **High** – unprepared (high risk); **Medium**: basic to incomplete preparation, low level of response (medium risk); **Low**-prepared, able to respond (Lower risk)

It seems that exposure to floods will be among the main challenges for the healthcare facilities, especially in workforce working conditions, development, and awareness. According to the responses received, the level of unpreparedness in the healthcare workforce is very high (70%). This level of risks/vulnerabilities is similarly high when coping with the hazard such as drought (Table 6, 7)

Table 9 Level of healthcare facilities preparedness (in %) to climate hazards – FLOODS*

Vulnerability	High	Medium	Low
Health workforce	70	25	5
Water, sanitation and waste	46-50	28-32	18-22
Energy	40	47	13
Infrastructure, technology, and product process	55	35	10

* **High** – unprepared (high risk); **Medium**: basic to incomplete preparation, low level of response (medium risk); **Low**-prepared, able to respond (Lower risk)

Table 10 Level of healthcare facilities preparedness (in %) to climate hazards – DROUGHT*

Vulnerability	High	Medium	Low
Health workforce	59-63	27-31	10
Water, sanitation and waste	41-56	18	11
Energy	38	25-38	16-18
Infrastructure, technology, and product process	69	25	6

* **High** – unprepared (high risk); **Medium**: basic to incomplete preparation, low level of response (medium risk); **Low**-prepared, able to respond (Lower risk)

Information, monitoring, risk management and proper application of health and safety regulations regarding water, sanitation, chemical use, and healthcare waste management are the main challenges for the facilities exposed to wildfire (Table 8).

Table 11 Level of healthcare facilities preparedness (in %) to climate hazards – WILDFIRES*

Vulnerability	High	Medium	Low
Health workforce	45-55	45-55	-
Water, sanitation and waste	60-65	30	5
Energy	17	65	18
Infrastructure, technology, and product process	50	50	-

* **High** – unprepared (high risk); **Medium**: basic to incomplete preparation, low level of response (medium risk); **Low**-prepared, able to respond (Lower risk)

When summarizing the findings from the Checklist exercise **the level of risk** (unpreparedness of the system to cope with the hazard) is considered **high** equally in almost all assessed facilities (Table 9).

Table 12 Risk matrix - The level of risk of unpreparedness of health care facilities to the climate hazards (Summary of Checklist findings)

		AREAS OF HEALTH CARE FACILITIES IMPACTED/AT RISK			
		Level of risk upon check with changed conditions (%)			
CLIMATE HAZARD TYPE	**IS HAZARD OR EXPOSURE PRESENT? Yes/No**	**Health workforce**	**WASH and health care waste**	**Energy services**	**Infrastructure, technologies, products, processes**
Flood	possible	High-medium	High-medium	Medium	High-medium
Drought	possible	High-medium	High-medium	Medium	High-medium
Heatwave	possible	High-medium	High-medium	Medium	High-medium
Wildfire	possible	High-medium	High-medium	Medium	High-medium

As a conclusion of the Checklist process, it is obvious that to avoid or minimize the long list of possible health outcome impacts because of insufficient adaptation capacities of the health care facilities, the country has a long list of priorities to be applied to minimize the various types of vulnerabilities emphasized in the Checklists response. There are no significant differences* (including between the regions) in the level of risk among the institutions explored in this process. In the absence of responses from the institutions in the North region of the country, these regional discrepancies could not be sufficiently explored.

5. Future risks to the health sector from climate change

5.1. Impact modelling of future risks in international references

For estimation of the attributable fraction of deaths to mean apparent temperatures above the comfort threshold, we present the research data that use other meteorological models like combining the heat-mortality function estimated from historical data with meteorological projections for the future time laps 2035–2064 and 2071–2099, developed under the Representative Concentration Pathways (RCP) 4.5 and 8.5.[75]

The findings of this study clearly show that the attributable heat-related deaths (AD) during summer are expected to be higher in Mediterranean and Eastern Europe countries, especially under the RCP 8.5 scenarios. For Montenegro, it means that under this scenario in the period 2036-2064, we can expect 26 additional deaths than under the reference scenario (observed in the period 1971-2001) (AD_{ref}) and 100 additional deaths in the period 2071-2099. Still, these numbers are the lowest in the region (Table 10).

Table 13 ***Attributable deaths per warm season*** *expected for the future time slices 2036-2064 and 2071-2099 under the reference scenario (apparent temperatures at the historical levels observed during the period 1971-2001) and additional attributable deaths in respect to this counterfactual as expected under the RCP 4.5 and RCP 8.5 scenarios, by country*

Country	2036-2064			2071-2099		
	AD_{ref}	Additional AD in Respect to AD_{ref}		AD_{ref}	Additional AD in Respect to AD_{ref}	
	No Change	RCP 4.5	RCP 8.5	No Change	RCP 4.5	RCP 8.5
Montenegro	2	15	26	2	26	100
Albania	24	185	283	26	303	910
North Macedonia	13	176	285	14	305	871
Serbia	63	478	809	69	830	2684
Bosnia and Herzegovina	9	99	162	9	171	634

AD: Attributable deaths; AD_{ref} Attributable deaths under the reference scenario.

Source: Kendrovski et al. 2017.[28]

The analysis of climate projections presented in the TNC on climate change shows that "the mean annual and extreme temperatures may increase, which may lead to more frequent and longer heat waves, more hot days and nights, fewer days with frost, and fewer cold days and nights. In addition, less precipitation is expected, which may lead to more frequent droughts, as well as an increase in the number of wildfires. It is expected that climate change will increase the frequency and severity of

[75] Kendrovski Vladimir et al. (Int. J. Environ. Res. Public Health 2017, 14, 729; doi:10.3390/ijerph14070729 Available on https://www.mdpi.com/1660-4601/14/7/729, last visit 26.12.2021

many types of extreme weather events; besides droughts and forest fires, there may also be floods and storms, among other things. Moreover, seasonal patterns may shift, which will lead to greater variability that may affect agriculture in Montenegro".[18] The projections for mean annual and seasonal temperatures from this document could be used for qualitative assessment of health outcomes in different adaptation scenarios.

Regarding the future projections of climate-sensitive health risks and outcomes, in one of the several climate change and health vulnerability assessments made by WHO, the annual burden of mortality from selected health outcomes due to climate change was estimated for world regions (Montenegro included in Central Europe countries). Future cause-specific mortality in 2030 and 2050 (in the absence of climate change) was estimated using regression methods for three development futures: base case, high growth, and no growth scenarios. Global climate-health models were developed for a range of health outcomes known to be sensitive to climate change: heat-related mortality in elderly people, mortality associated with coastal flooding, mortality associated with diarrhoeal disease in children aged under 15 years, malaria population at risk and mortality, dengue population at risk and mortality, undernutrition (stunting) and associated mortality).[76] This assessment involves the development of outcome-specific models to estimate future climate change attributable health effects and future annual mortality. Mortality forecasts are based on empirical models of observed mortality trends in relation to major drivers such as socio-economic development, education, and technology, together with projections of the future trajectories of these drivers on a national scale. It is assumed that recent trends in socio-economic development, education, and technology will continue for the next 15–50 years, resulting in a continued decline in mortality from infectious diseases and undernutrition. The findings for the Central Europe countries confirmed the level of the risk is decreasing for undernutrition, transmissive diseases (Malaria and Dengue), and diarrhoeal diseases except for heat mortality which is obviously the most probable health impact (for Central Europe countries from 880 in average for 2030 to 1680 in 2050). In this method, Heat mortality is estimated for the most vulnerable population group over 65 (assuming 50% adaptation) (Table 11).

Table 14 Additional deaths attributable to climate change, [a] under A1b emissions and the base case socioeconomic scenarios, Source: WHO. 2014. Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s.

Region		Malaria	Dengue	Diarrhoeal disease [c]	Heat [d]
Europe, Central	2030	0	0	1	880
		(0 to 0)	(0 to 0)	(0 to 1)	(570 to 1 523)
	2050	0	0	0	1 680
		(0 to 0)	(0 to 0)	(0 to 0)	(989 to 2 769)

[76] WHO. 2014. Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. https://apps.who.int/iris/bitstream/handle/10665/134014/9789241507691_eng.pdf?sequence=1&isAllowed=y, last visit 10.12.2021

a. Unless otherwise stated, the central estimate is the mean, based on five global climate model runs, and the uncertainty interval (in brackets) is the lowest and highest estimate; for each region, the first line is the mean estimate, and the second line is the lowest and highest estimates

b Undernutrition estimates are for children aged under 5 years; the central estimate is the mean of the probability density function of impact estimates; the uncertainty interval is mean ± 1 standard deviation of the probability density function

c Diarrheal disease estimates are for children aged under 15 years; estimates are based on median temperature across the five global climate model runs, with the central estimate based on the mid-estimate of the temperature/diarrhea coefficient, and the range based on the low and high coefficient estimates

d Heat estimates are for people aged over 65 years; results assume 50% adaptation

e Undernutrition estimate for Andean Latin America and tropical Latin America combined

f Undernutrition estimate for central Latin America and Caribbean combined

5.2. GIS mapping of the climate change impact on the health sector in Montenegro

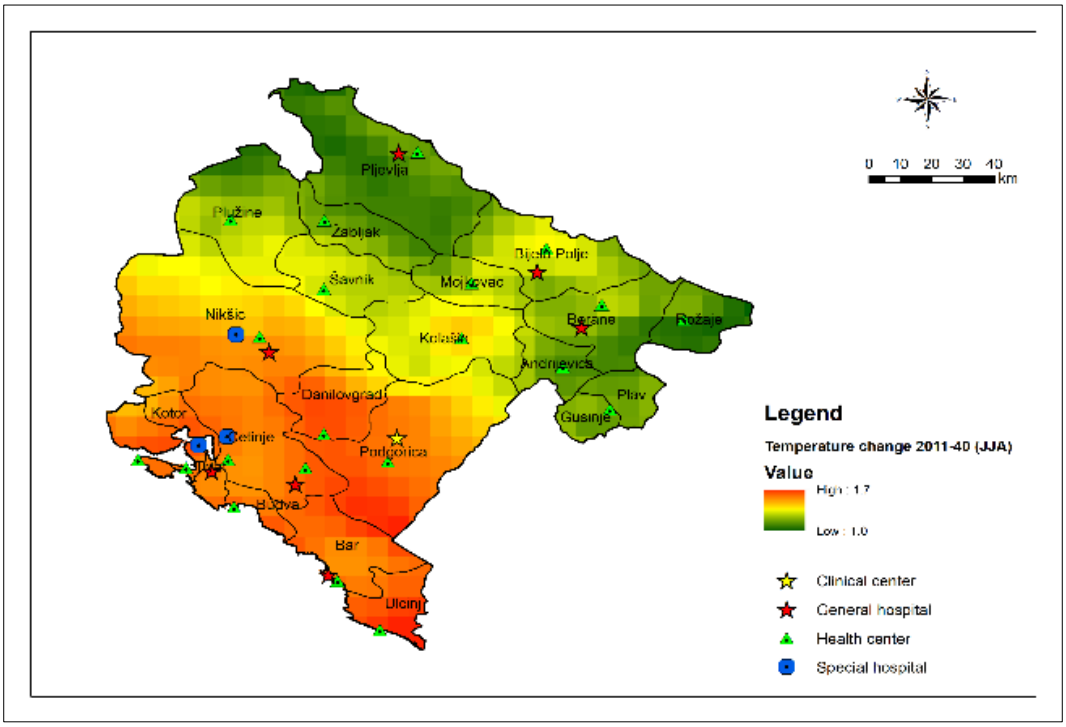
The creation of climate health risk maps is a complex process that needs applying a specific methodology and using a wide number of vulnerability and exposure metric data for any region (or settlement) in the country. In the absence of very accurate and properly disaggregated demographic, socio-economic data, and some exposure data in Montenegro, the following maps have been produced as an attempt to initiate the real process of mapping the climate health risks in Montenegro and inform the health authorities about the approach that could be used during the prioritization process of climate adaptation actions.

Namely, we have used the climate projections maps of some climate extremes (exposure metrics) like high temperature, heat waves, tropical nights, and days with or without rain[77]. The map of the distribution of the health care institutions is used as a vulnerability metric. For some regions and /or cities some additional data should be used to enhance the level of assessment of the health risk (like at-risk poverty ratio, illiteracy rate, and the share of people over 60) which are not available for all regions in a detailed form. Accordingly, in chapter 1.3. it was documented that the **northern region** of the country has many additional vulnerability factors like the highest % of people over the age of 60, highest at poverty risk ratio and illiteracy rate, as well problems with the accessibility of the health care services in some settlements together with a lower number of health care specialists. As described in 4.1 some cities in the region (especially Bijelo Polje and Plevlja) have a higher level of air pollution as an additional exposure factor. All of this makes the climate health risk level of this region higher than in other regions despite the actual risk from the climate extremes registered or projected for the region. Other cities with high air pollution (as an additional exposure factor) like Nikšić and Podgorica are also assessed with higher health risks than the others. In the climate projections we have used, the future climate change is primarily characterized by a further increase in the temperature, which will also cause changes in extreme weather and climate anomalies, so that we can expect a decrease in the number of temperature extremes with low temperatures and an increase

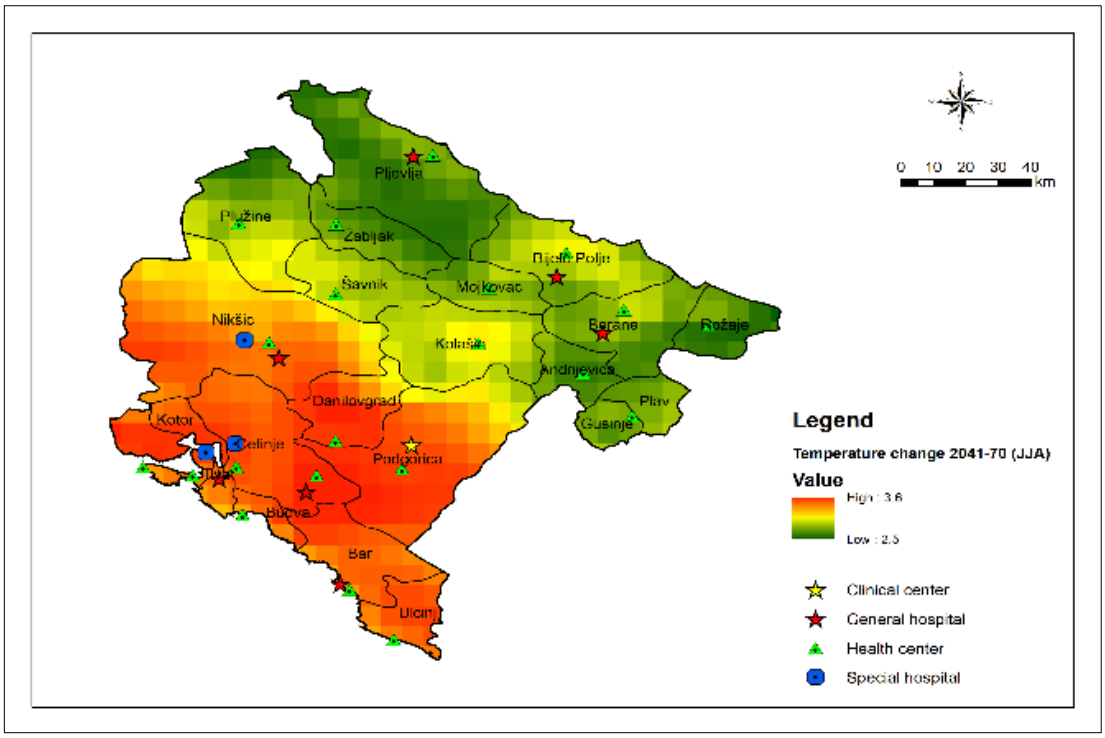
[77] *Third National Report of Montenegro on Climate Changes according to UNFCC, Gjurgjevic, V. Report on future climate projections and analysis of changes in extreme weather and climate events, 2018*

in the number of warm extremes, i.e., a significant increase in very hot days and an extended duration and increased frequency of heat waves.

Changes in Temperature – health risks



Map 1 Level of health risk related to temperature change 2011-2040

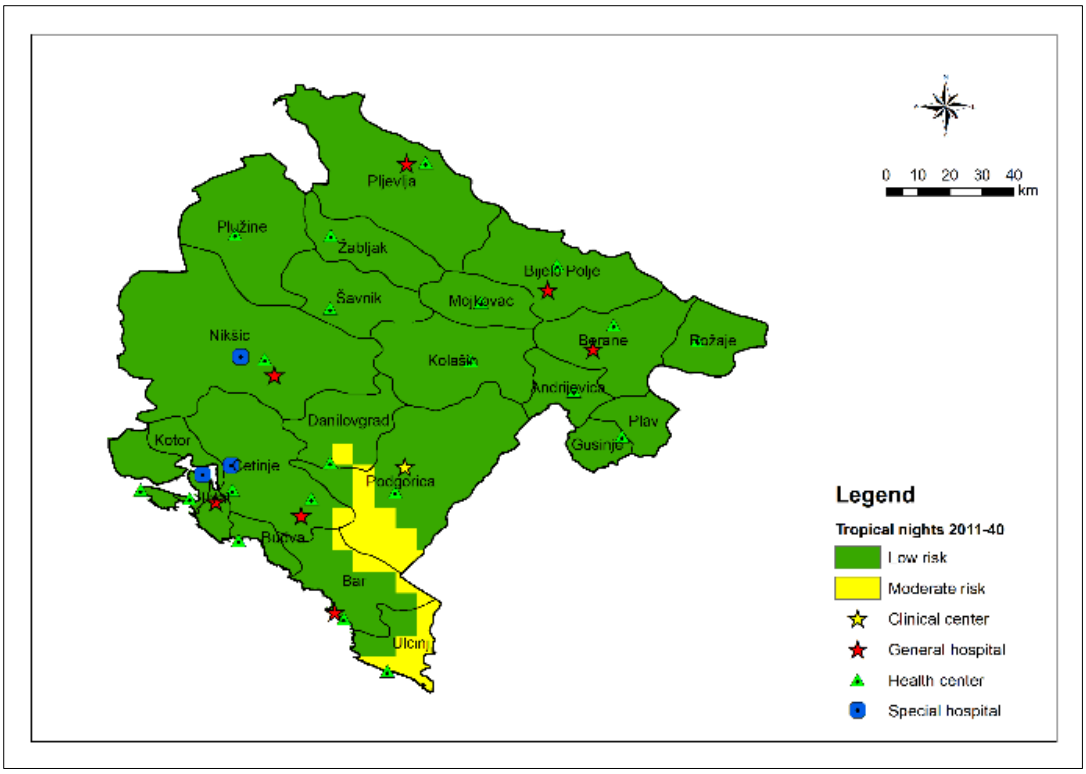


Map 2 Level of health risk related to temperature change 2041-2070

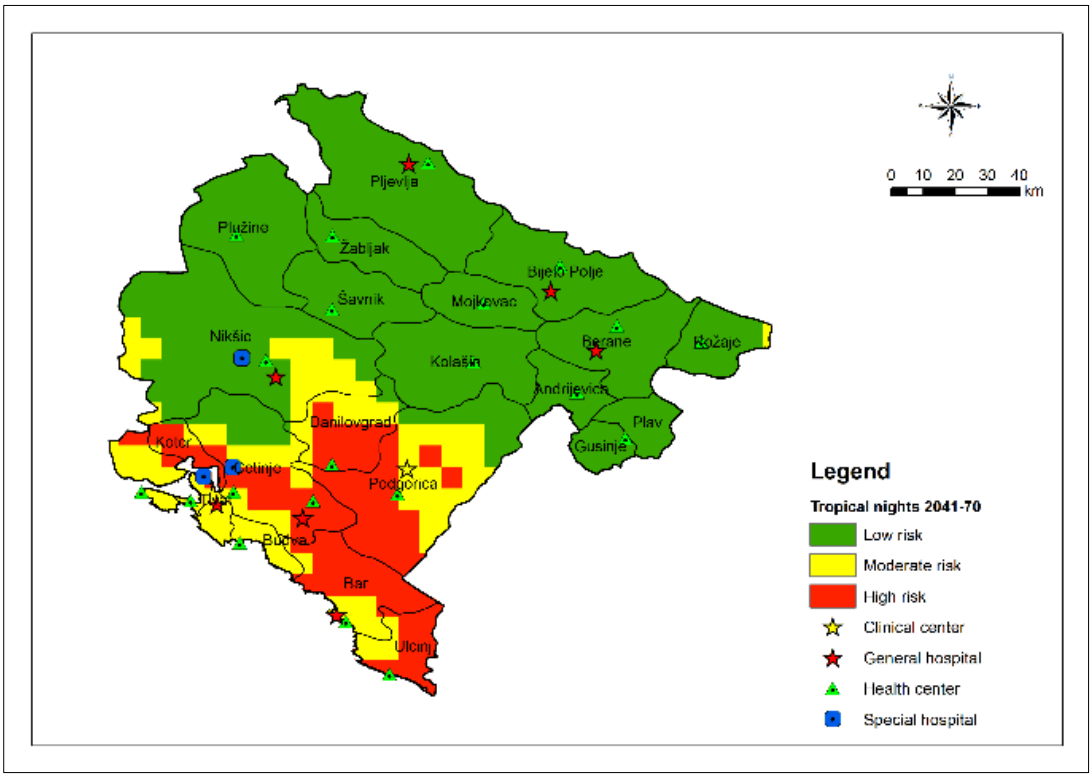
For the future period 2011–2040. the deviation of mean annual temperatures in relation to the reference transition according to this scenario amounts to 1.5 to 2 °C. The deviations for the summer season (June, July and august) for the entire territory are on average around 2 °C (Map 1,2). For the period 2041–2070. the deviations of the mean annual temperature are from 2.5 to 3 °C, with the fact that for the winter season the deviations are greater in the north of the country, while for the summer season on the south.

Health risk: The population of the coastal region (Ulcinj, Bar, Budva) and partly the central region (the urban areas of Podgorica and Danilovgrad) will be at the highest health risk (Map 1,2). The capacities and medical staff in the general hospitals, medical centers, and emergency care services in these regions must be well prepared for dealing with and providing services during periods of high-temperature extremes, especially for vulnerable population groups. As health consequences, we can expect increased rates of deaths, heat stress, and diseases, or worsening chronic conditions such as cardiovascular , cerebrovascular and respiratory diseases. People over 65 are the most vulnerable to heat-related illnesses, as well chronically ill people, outdoor workers (including touristic, agricultural and construction workers), homeless and socially disadvantaged people. An extended pollen season and more days with high pollen concentrations are also expected in those regions.

Tropical nights



Map 3 Level of health risk during tropical nights 2011-2040



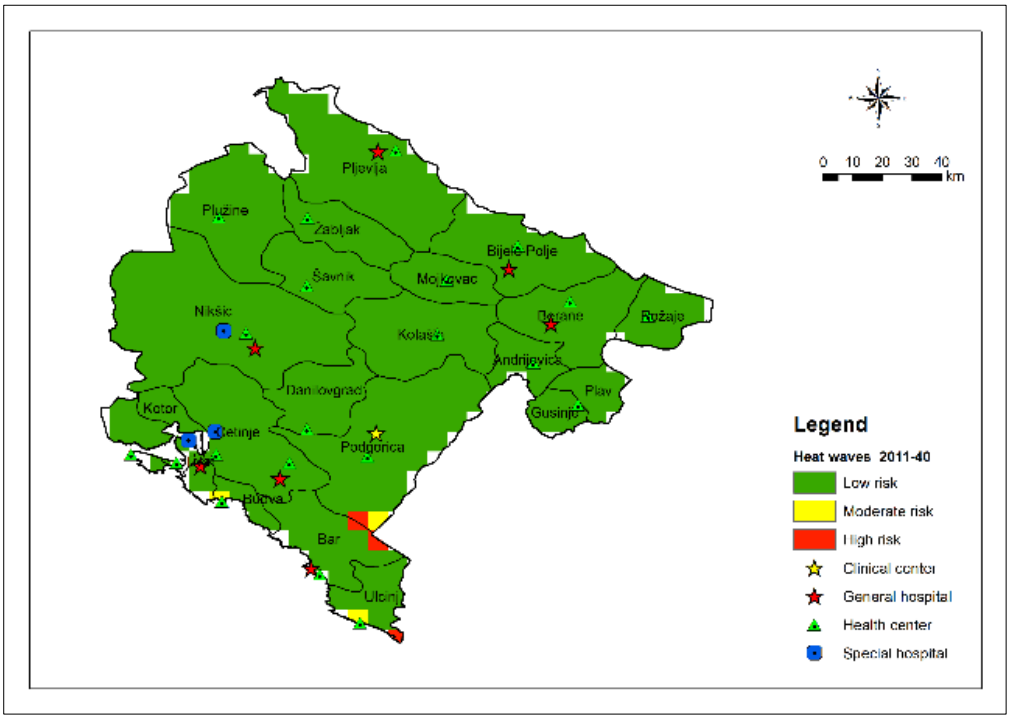
Map 4 Level of health risk during tropical nights 2041-2070

During the period from 2011 to 2040, an increase in the level of tropical nights will be expected in the entire territory and an increase in the number of tropical nights in most of the country's territory of

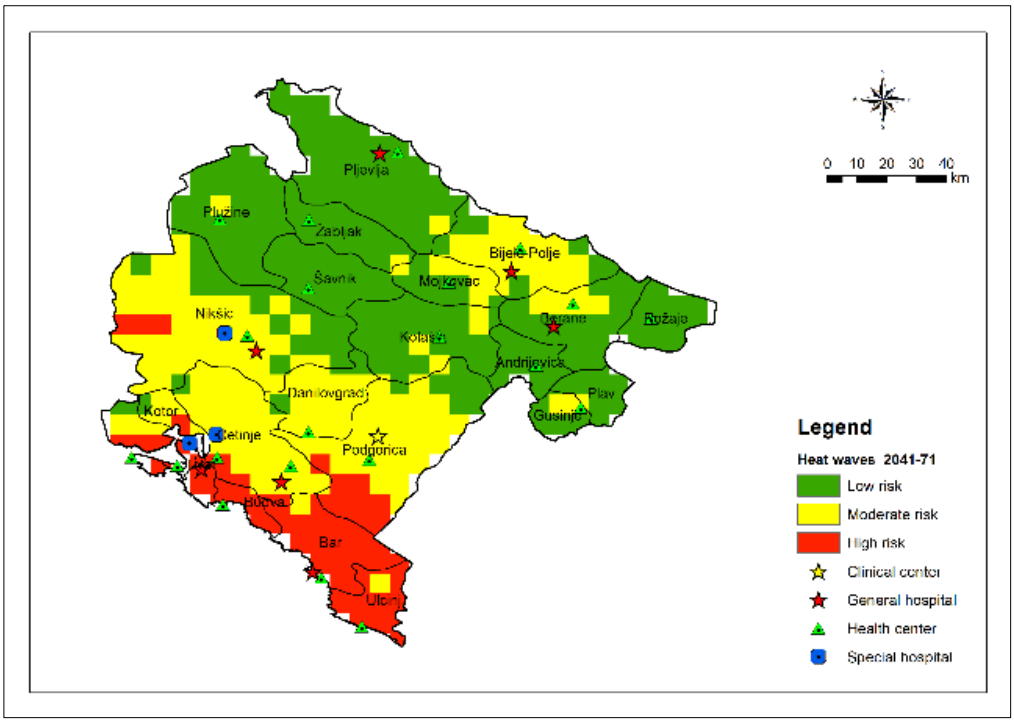
about 50%, while in the **southeast** a change of up to 100% is possible, i.e., twice the number of these nights in relation to their number during the period 1971–2000. The situation will be even worse in the period of 2041-2070 with some cities exposed to high climate health risks like Ulcinj, Bar, Kotor, Podgorica and other neighbouring cities.

Health risks especially to older people and chronically ill patients will be extremely high and the capacities and medical staff in the health care services including emergency care must be well prepared to work in climate extreme circumstances according to the findings from the vulnerability checklist.

Heat waves



Map 5 Mapping health risks from heat waves in Montenegro, 2011-2040



Map 6 Mapping health risks from heat waves in Montenegro, 2041-2070

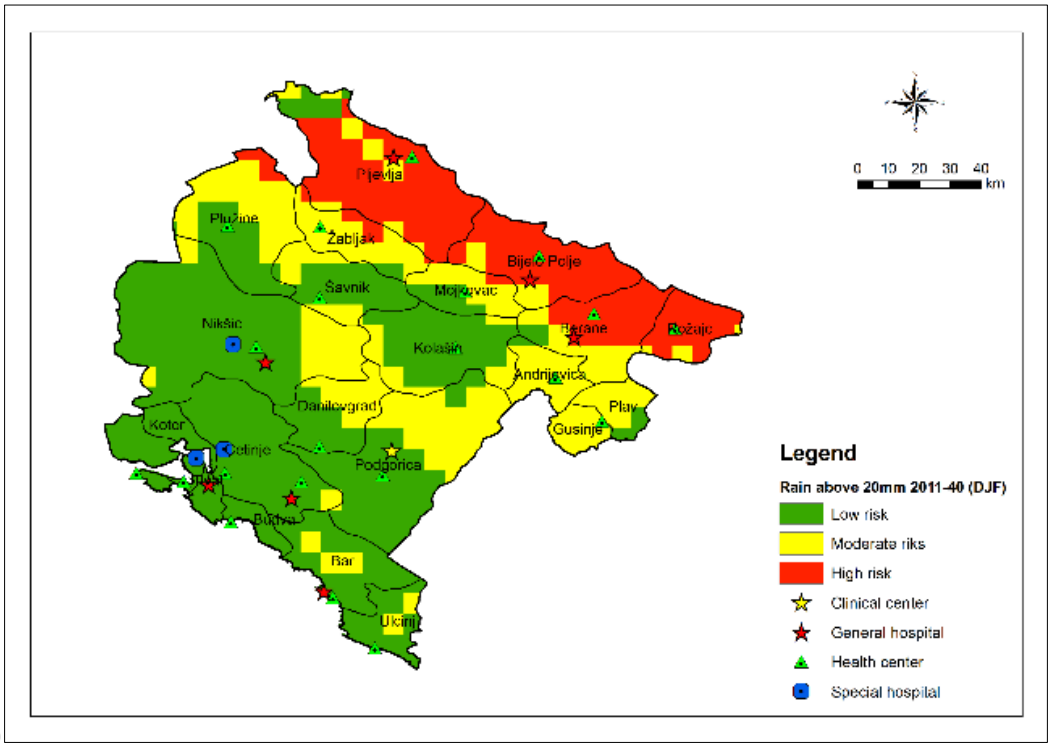
The total length and number of heat waves in Montenegro will continue to increase until the end of this century. During the period from 2011 to 2040, an increase in their number is expected to be from 200% to 400% (that is, 3-5 times more heat waves), with an increase in the duration of about 100% (on average twice as long), in relation to their average duration during the period 1971–2000. In the coastal areas, somewhat more pronounced changes can be expected compared to the other part of the territory. During the period 2041–2070. an increase in their number can be expected to be from 400% to 700% (that is, 5-8 times more heat waves) with an increase in the duration of 300% to 500%, whereby the change is more pronounced in the **southern and coastal part** of the country (Maps 5,6).

Health risks during the heat waves and the vulnerable groups are the same as during extremely high-temperature periods - people over 65, chronically ill people, outdoor workers (including touristic, agricultural and construction workers), homeless and socially disadvantaged people. The highest burden will be on the health care services (Clinical center, general and special hospitals and medical centers in the areas marked with yellow and red on the maps). For the reasons explained above, Northern regions of the country and cities with heavy polluted air will have even higher level of health risk than presented from the mapping of the results.

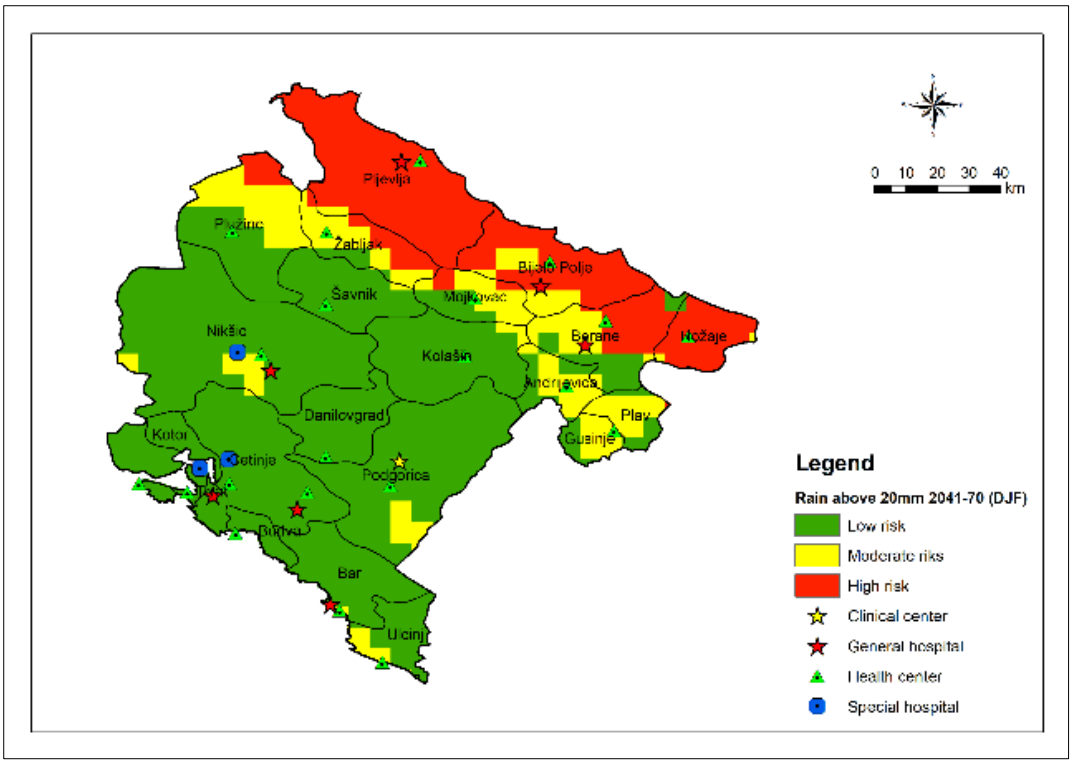
Days with rains more than 20 mm and flood risk in regions in the country

The main characteristic of this change is that for most of the season, and all three future periods, an increase in the number of these days can be expected in the **far north of the country**, with maximum values exceeding 80%. The only season that deviates from this rule is the summer season for all three RCP periods (Maps 7,8). On the other side according to historic data and strategic documents data, the flood risk regions in the country are distributed in parts of the northern and central regions like

along the edge of Skadar Lake, in the zone of the lower flow of Moraca, as well as along the Bojana River. This includes the urban areas from Sutomore and Virpazar, the old town of Kotor, Sutorina, Herceg Novi, and Crkvica. In addition, we should not neglect the flood risk to the karst fields of Niksic and Cetinje (Map 9).

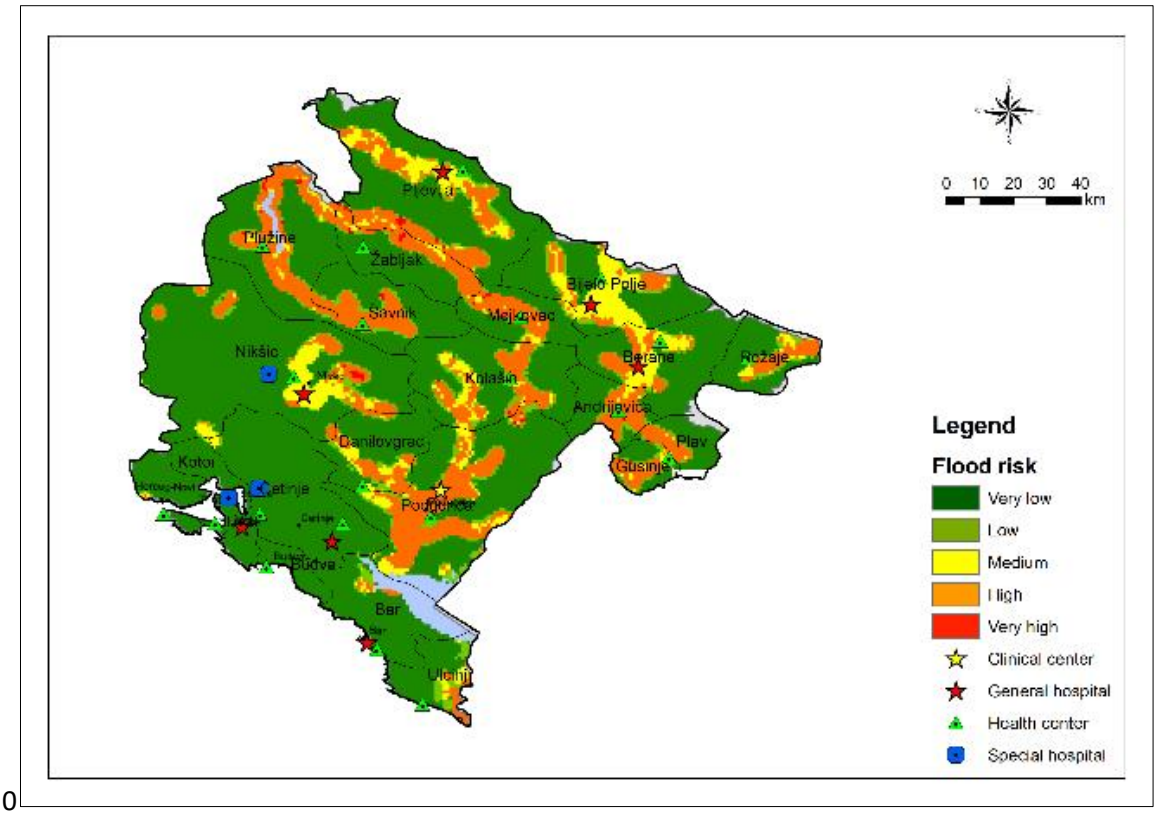


Map 7 Mapping health risks from higher precipitations in Montenegro 2011-2040



Map 8 Mapping health risks from higher precipitations in Montenegro 2041-2070

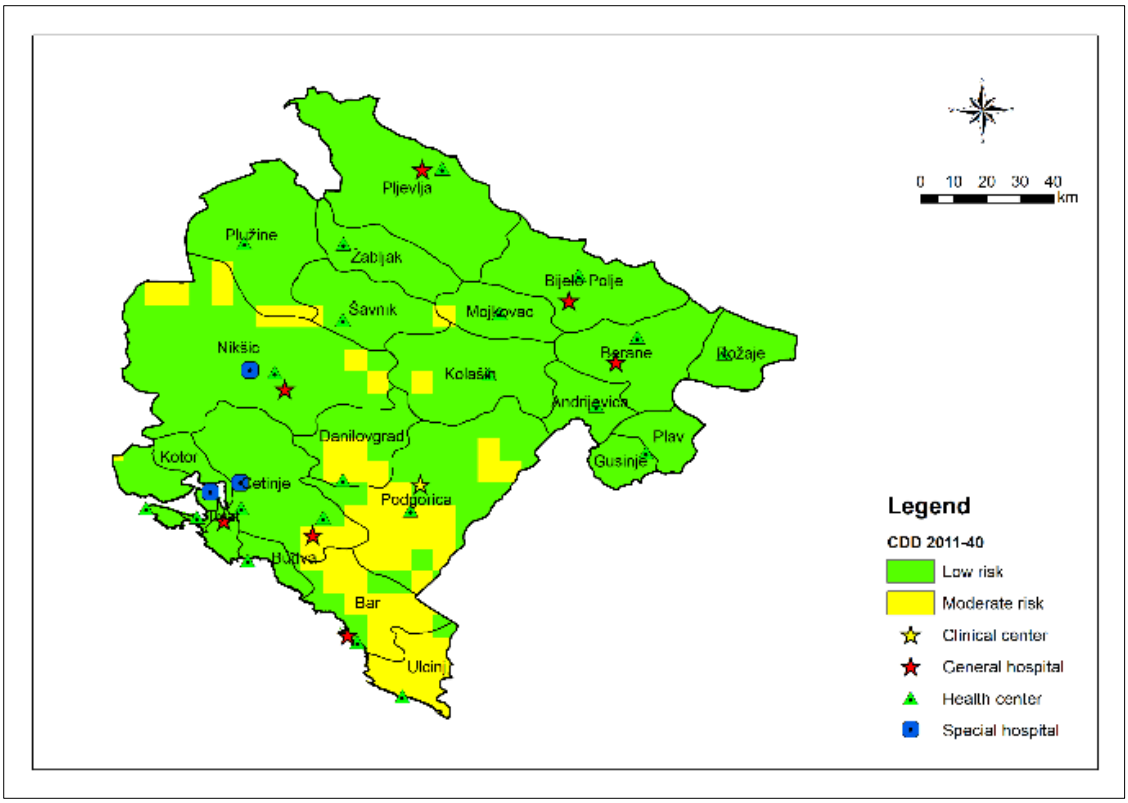
Health risks: in the regions with an increasing number of rainy days and floods it is expected to have frequent outbreaks of water-related infectious diseases, an increment in some intestinal water and food-borne diseases, and deterioration of the drinking water quality. Since the **northern region** already has a lot of other vulnerable factors and a large population group of people over 60, as well as people living in remote areas and villages, this region will be again at the highest health risk. This makes this region also highly prioritized when planning the enhancement of the health care services well prepared to work in climate extremes. The regions that will have at the same period higher temperature and higher precipitation or floods, will be exposed to more other health risks like the increased prevalence of infectious transmissive diseases and survival of certain arthropods such ticks, and mosquitos, as well as lower productivity in agriculture, lower quality of food, and increased risk from undernutrition. There is also a significant risk of injuries or drownings and major deterioration of the public infrastructure which will disable the efficacy in providing urgent medical services. According to this, the health care institutions in all regions should be well prepared to adapt to the flood risks.



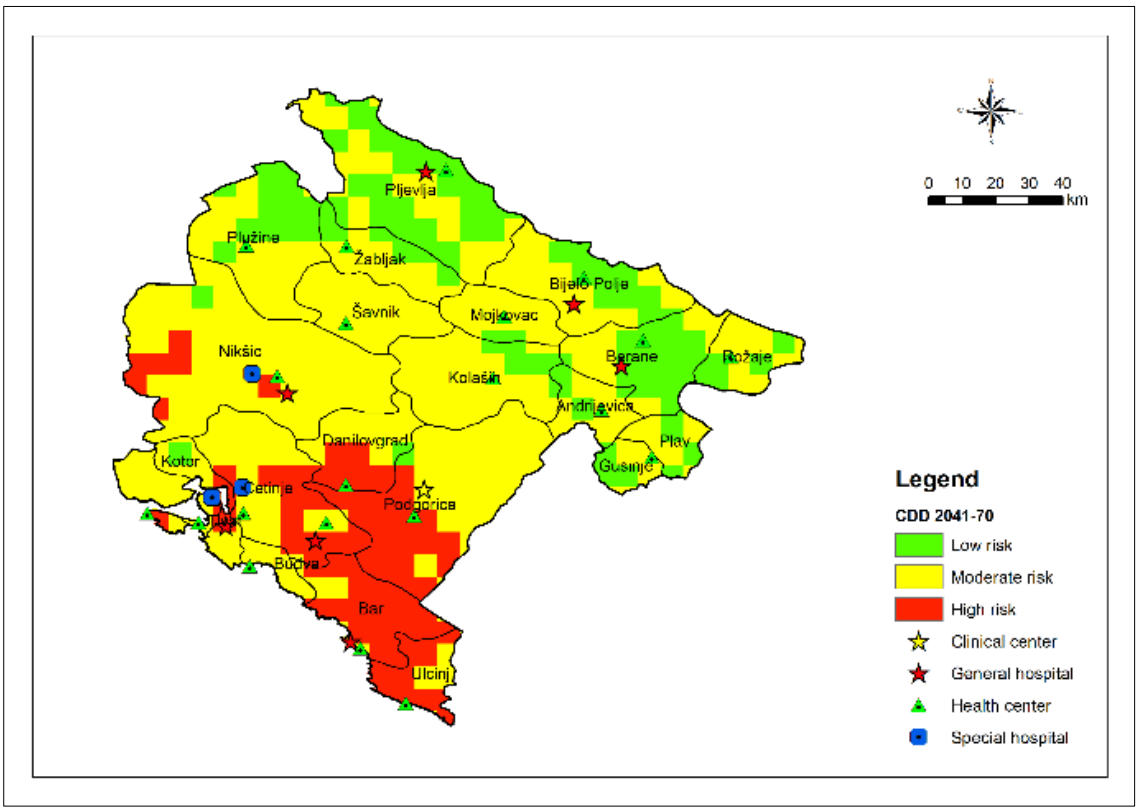
Map 9 Flood hazard distribution map of Montenegro (WHO 2010)

Consecutive days without rainfall and droughts

For the period 2011–2040. in the north of the country, the change in this index is low (around –5%) both in the case of the summer (June, July, August) season and in the case of the annual change. The positive change in the **south eastern part** of the country is slightly higher for the summer season compared to the annual change and the maximum value is around 30%. For the remaining two analysed periods, 2041–2070. and 2071–2100, an increase in the number of consecutive days without precipitation dominates in the entire territory.



Map 10 Mapping health risks in the period of consecutive days without rainfall, 2011--2040



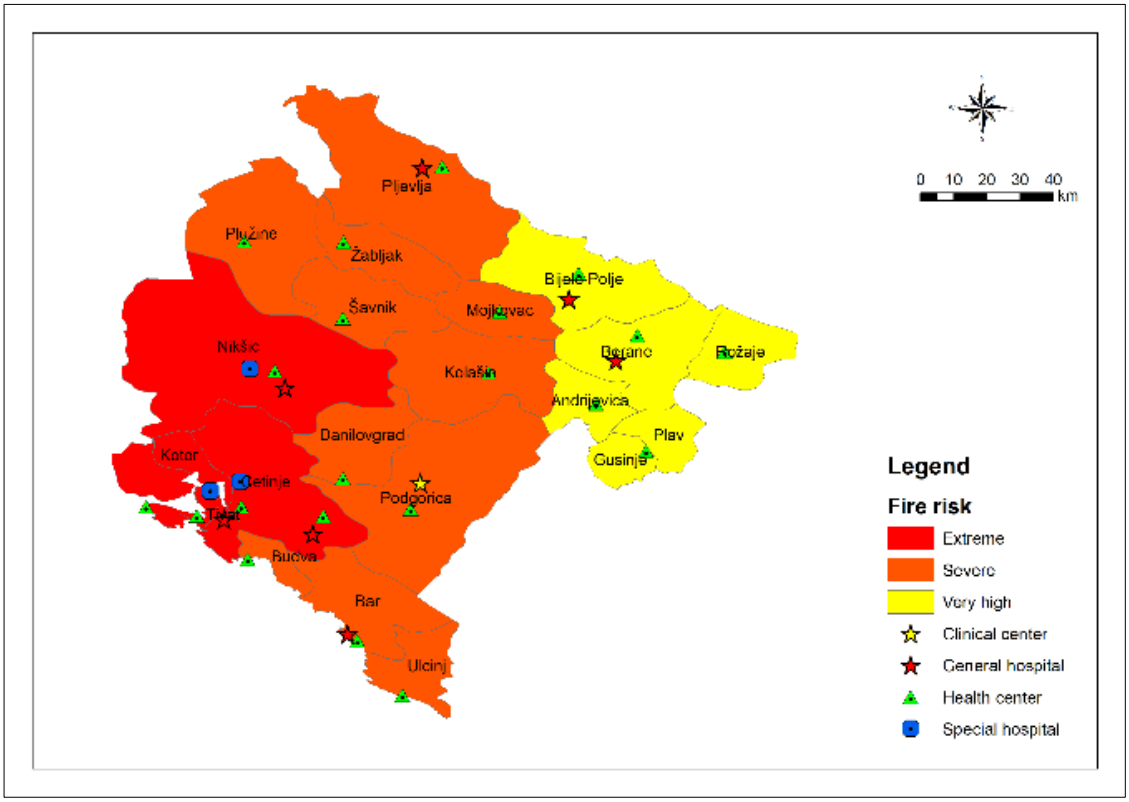
Map 11 Mapping health risks in the period of consecutive days without rainfall, 2041-2070

Health risks: There is an indirect health impact on the population in these regions through decreased water availability, water supply safety, food safety and undernutrition, and forest fires risks. Remoted and socially deprived population groups especially in rural areas are at higher risk (people dependant on their personal agricultural products, Roma population included). Health care institutions especially in these regions should be prepared to work in such conditions.

Forest fires

Forest fires (and wildfires) can also have a negative impact among others on the public health in Montenegro. The region of Nikšić, Cetinje and part of the coastal areas are estimated to be at extreme risk to forest fires. A large part of the rest of the country is also at serious risk (the northern part) (Map 13) .

Health risks : besides destroying huge areas of forest and wood mass, the fires emit fine particles and ozone precursors and can increase the risk of premature deaths and adverse chronic and acute cardiovascular and respiratory health outcomes. The water resources, infrastructure, traffic, and accessibility to health and emergency care will be also threatened. Elderly and patients with chronic diseases, remoted and socially deprived population groups, especially in rural areas (Roma population included) are at the highest risk.



Map 12 Forest fires affected regions in Montenegro in 2012

6. Economic impact assessment of the climate change impact on the health sector

In Montenegro, as in the region, there is no officially defined methodology on the procedure and manner of determining the damage caused by climate change, as well as the methodology for assessing future harmful economic impacts caused by climate change. The activities so far in assessing these damages are mainly based on the activities of concrete assessment of material damage, due to certain emergency events, which are a consequence of changed climate.

The task defined within the scope of this document, is to assess future adverse economic impacts caused by climate change over a longer time period.

Methodologically, it was perhaps the most difficult to assess the negative economic impacts of climate change in the **health sector**. Although the health effects of climate change are obvious or proven, it is not easy to establish a clear correlation between climate change and specific diseases where, thereby official statistical data on that are nowhere to be found. For this reason, when assessing the negative impacts for this area, the focus was exclusively on direct death cases, which will occur due to climate change. This assessment required to:

- Collect relevant statistics on the number of deaths caused by climate change;
- Process and analyse collected data, as a basis for further projections;
- Project the future number of deaths caused by climate change;
- Perform an analysis of the value of statistical life (VSL - Value of Statistical Life) in Montenegro and in the world and determine future values, as a basis for damage assessment;
- Based on previously collected and processed data, calculate and project the economic damage caused by climate change in this sector.

Defining the time frame for observation/analysis was the next important step. Climate change is a phenomenon that occurs slowly and not so noticeably, so its consequences, namely negative effects, cannot be adequately assessed for shorter periods of time (e.g., up to 20 years), which is common for different types of economic analysis. For this reason, and based on research and recommendations from numerous documents, especially the document "IPCC Special Report, Emission Scenarios" (Intergovernmental Panel on Climate Change, WMO and UNEP, 2000) it was decided to assess economic damage as a consequence of climate change for:

- The period of the near future, until 2050 (Near Future) and
- The period of the distant future, up to 2100 (Far Future).

In the scope of the further analysis, and due to the impossibility to precisely define at this moment the extent of impact on the climate which will occur in these defined periods, and therefore what negative consequences these changes will cause, it was decided to observe two scenarios - more favourable and less favourable, within each period. The number of scenarios can certainly be higher, but it is estimated that for the sake of clarity of the analysis, and also its objective (to determine the preliminary approximate level of considered adverse effects), this number of scenarios is sufficient.

Ideally, further analysis would imply that within each considered sector, adverse effects are quantified by defined categories of analysis, for both time frames and for both climate scenarios. Given that this

is very difficult at the moment, since adequate statistical data and scientifically proven research data are scarce, the experiences in analysis and research in Europe and the world were considered. Data and assumptions in these sources may vary, so only those which served to define the criteria for this analysis are presented below.

Within the document *"The Economic Impact of Climate Change in Montenegro"*(UNDP, 2010), the assessment of economic damage for individual sectors was performed based on the following assumptions:

- For the period up to 2050, 2 scenarios: losses of 3% and 8%;
- For the period up to 2100, 2 scenarios: losses of 8% and 15%

Research abroad have mainly focused on predicting adverse effects on the total national GDPs as a result of climate change. Thus, for example, in a document prepared by the Swiss Re Institute, *"The Economics of Climate Change: No Action not an Option"* (April 2021) the expected impact on global GDP by 2050 was presented, according to four different scenarios, as compared to the world "without climate change". Those are the following scenarios for Europe:

- Decrease of GDP of 2.8%, if the goals of the Paris Agreement are achieved (increase in temperature well below 2 ° C);
- Decrease of GDP of 7.7%, if further mitigation measures are taken (temperature increase of 2 ° C);
- Decrease of GDP of 8.1%, if some mitigation measures are taken (2.6 ° C increase in temperature);
- Decrease of GDP of 10.5%, if mitigation measures are not taken (temperature increase of 3.2 ° C).

As it can be seen, harmful effects by 2050 are estimated in the range from about 3% to approximately 10% for the period until 2050.

The third document that served as a basis for further analysis is the official document of the International Monetary Fund from 2019, *"Long-Term Macroeconomic Effects of Climate Change: A Cross-Country Analysis"* (International Monetary Fund, 2019). In this document, there is analysis of negative impact of climate change on GDP, by countries, grouped in relation to their geographical location and economic situation. The analysis showed that these damages, for a group of countries including Montenegro, would be the following:

- for the period up to 2050: losses of 2.18% and 3.11%;
- for the period up to 2100: losses of 6.05% and 8.25%

It is obvious that the predicted adverse effects within this document are somewhat lower than in the previous ones, which only confirms the view that their prognosis is not simple and depends on numerous input assumptions. Therefore, to cover the broader framework of analysis and future estimates, within this document the analysis was performed for all considered sectors with the **following scenarios**:

1. Near future, damage level by 2050 5% (Near Future 1, NF1),
2. Near Future, damage level by 2050 10% (Near Future 2, NF2),
3. Far future, damage level by 2100 10% (Far Future 1, FF1),
4. Far Future, damage level by 2100 15% (Near Future 1, FF2).

Projections of individual economic categories are made relying on certain growth rates based ither on historical data, or on the fluctuations of a certain category in the past period, or using official GDP growth rates, or certain sectoral rates or a combination of all mentioned above with appropriate estimates of sectorial experts.

In this particular case, some historical rates are not fully relevant due to the atypical 2020. This also applies to the GDP growth rate, which dropped significantly in 2020. For that reason, it was decided to follow the precautionary principle with moderate growth rates, in relation to the initial state. For health sector we decide to consider 1% per year.

As already mentioned, in sectors of Agriculture and Water Resources, growth rates are lower, due to real capacity, which is limited. Significantly higher growth rates have been considered in the sector of tourism until 2020, while in the health sector the benchmark was the target number of deaths in the aforementioned "Program for adapting the health system to climate change in Montenegro for the period 2020-2022"[78]

Climate change is one of the greatest threats to human health and health workers around the world are already responding to the damage to health caused by this evolving crisis. The following can be expected in the near future:

- economic, social and health consequences of loss of ability to work and reduced productivity;
- increasing the incidence of respiratory diseases due to higher concentrations of ground-level ozone and particulate matter in urban areas, related to climate change;
- increased risk of illness and death caused by more intense heat and extreme heat waves and higher risk of injury and death from multiple fires;
- increasing the impact of floods on health due to heavy rainfall;
- increased number of infectious diseases through ticks, mosquitoes, rodents and tropical and foodborne diseases;
- increasing the number of water-borne diseases in populations where water, sanitation and personal hygiene standards are low

Vulnerability to weather and climate change depends on people's levels of exposure, their personal characteristics, and their access to resources. The following population groups are particularly vulnerable: the elderly, chronically ill people, children, exposed workers, socially vulneraable and homeless people.

Older people are particularly vulnerable, and their vulnerability stems from a complex mix of factors such as: multiple chronic diseases, poverty, isolation, lack of access to transportation, etc.

Children are particularly vulnerable because of their physiological and cognitive abilities of immaturity and their greater potential for long-term exposure.

[78] https://wapi.gov.me/download/6982b1d9-5fb9-40bb-b8e6-dedefd8b2ead?version=1.0

Some workers are at particular risk at the place of their occupation. Heat exhaustion and heat stroke are the main health effects associated with heat, which pose a risk to outdoor workers and outdoor occupations. The health risks associated with heat increase with the level of physical strain. Agricultural and construction workers are therefore among the most exposed, but heat stress is also a problem for those who work indoors, in environments that are not under temperature control. Here we should also mention the outdoor workers who are working in the tourism sector, as well as food and beverage servers and supporting personnel.

In evaluating the impact on health, there are three elements to consider when assessing the overall effects of the impact on the well-being of society. These elements are:

- Resource costs, i.e. medical expenses;
- Opportunity costs, i.e. costs in terms of lost productivity, and
- Lost enjoyment of life by to premature mortality, plus the pain and suffering of the loved ones.

6.1. Calculating economic costs from premature deaths from Climate Change

Considering that in Montenegro, but also in Europe, there is not enough input data and clear principles and methodologies to determine the correlation between these cost categories and climate change, an assessment of economic damage caused by premature mortality due to the effects of climate change was made in this document.

The cost of premature mortality was calculated based on projections of the additional number of deaths due to climate change and the established Value of Statistical Life (VSL).

According to the data from the "Program for adapting the health system to climate change in Montenegro for the period 2020-2022, in the baseline scenario it was determined annual mortality of 55 deaths caused by high temperatures.

Projections of the number of deaths caused by climate change (baseline scenario) are shown in the following table:

Table 15 Projections of the number of deaths caused by climate change (baseline scenario)

Year	Number of deaths
2025	57
2030	60
2035	63
2040	66
2045	69
2050	73

2055	76
2060	80
2065	84
2070	89
2075	93
2080	98
2085	103
2090	108
2095	114
2100	120

After that, an expert assessment of the impact of climate change on the number of premature deaths was performed, for different projected time periods, as well as for the corresponding climate scenarios. Four scenarios were considered:

1. Near future, an increase in the number of deaths by 2050 by 5% (NF1),

2. Near future, an increase in the number of deaths by 2050 by 10% (NF2),

3. Far future, an increase in the number of deaths by 2100 by 10% (FF1),

4. Far Future, an increase in the number of deaths by 2100 by 15% (FF2).

The projection of the additional number of premature deaths caused by climate change is shown in the following table:

Table 16 Projection of the additional number of premature deaths caused by climate change

Year	NF1	NF2	FF1	FF2
2025	0	1	0	0
2030	1	2	1	1
2035	1	3	1	1
2040	2	4	1	2
2045	3	6	2	3

2050	4	7	3	4
2055			3	5
2060			4	6
2065			5	7
2070			5	8
2075			6	9
2080			7	11
2085			8	12
2090			9	14
2095			11	16
2100			12	18
Total	**48**	**95**	**367**	**546**

In the next step of the analysis, it is necessary to determine the Value of Statistical Life (VSL) for Montenegro. The value of statistical life (VSL) is the rate of local compromise between the risk of death and money. When compromise values are performed in market contexts, VSL serves both as a measure of the willingness of the population to pay for risk reduction, but also as a marginal cost of increasing security. Given its fundamental economic role, analysts have adopted VSL as an economically sound measure of the benefits that individuals derive from improving their health and safety. Estimates of VSL values vary by country, given the positive elasticity of VSL to GDP. Due to the emphasis on reducing the risk of mortality, as a justification for a particular measure, VSL is also used as an essential component in cost-benefit analyses. VSL is also fundamentally related to the concepts of statistical age valuesand statistical injury values, which also permeate the literature on occupational and health economics.

There are no special studies conducted in Montenegro to determine the VSL. However, authors used EU methodologies and relevant publications which describe the procedures of determining this value.

Unit values of VSL were determined on the basis of two models from the professional literature. The first model is from the document "Handbook on the External Costs of Transport - 2019", which defines these values for the EU28 average, and then proposes their correction for each country in accordance with the relationship between GDP per capita. The second model is based on the document "The true cost of road crashes - valuing life and the cost of a serious injury-IRAP", which provides recommendations for determining these values based on a comprehensive analysis and on an established formula correlated with GDP per capita.

These values are presented in the following table:

Table 17 Determined Values of Statistical Life in Montenegro

Description/Source	IRAP[79]	Handbook[80]
Value of Statistical Life – VSL	542.010	630.206

Estimates of economic damage of premature mortality due to the effects of climate change are shown in the following tables:

Table 18 Estimates of economic damage of premature mortality due to the effects of climate change in EUR, (VSL – IRAP),

Year	NF1	NF2	FF1	FF2
2025	160.978	315.251	112.797	165.546
2030	453.144	891.126	317.103	466.060
2035	777.309	1.535.030	543.238	799.564
2040	1.136.135	2.253.104	792.970	1.168.810
2045	1.532.482	3.051.983	1.068.197	1.576.752
2050	1.969.421	3.938.841	1.370.951	2.026.566
2055			1.703.411	2.521.661
2060			2.067.913	3.065.698
2065			2.466.958	3.662.605
2070			2.903.222	4.316.598
2075			3.379.575	5.032.200
2080			3.899.086	5.814.261
2085			4.465.039	6.667.984
2090			5.080.950	7.598.945
2095			5.750.577	8.613.120
2100			6.477.943	9.716.915

[79] International Road Assesment Programme, The true cost of road crashes-valuing life and the cost of a serious injury, 2016

[80] EU Handbook on the External Costs of Transport, Version 2019-1.1.

Cumulative Total 2025-2050/2100	**25.972.704**	**51.573.065**	**198.703.933**	**296.118.329**

Table 19 Estimates of economic damage of premature mortality due to the effects of climate change, in EUR (VSL – Handbook)

Year	NF1	NF2	FF1	FF2
2025	187.172	366.548	131.151	192.483
2030	526.879	1.036.130	368.702	541.897
2035	903.793	1.784.811	631.633	929.670
2040	1.321.008	2.619.729	922.002	1.358.999
2045	1.781.848	3.548.603	1.242.014	1.833.322
2050	2.289.885	4.579.770	1.594.032	2.356.330
2055			1.980.591	2.931.987
2060			2.404.405	3.564.549
2065			2.868.382	4.258.585
2070			3.375.636	5.018.996
2075			3.929.501	5.851.041
2080			4.533.546	6.760.359
2085			5.191.592	7.753.000
2090			5.907.723	8.835.447
2095			6.686.313	10.014.649
2100			7.532.036	11.298.054
Cumulative Total 2025-2050/2100	**30.198.988**	**59.965.047**	**231.037.086**	**344.302.776**

The economic damage of premature mortality due to the effects of climate change could be significant. In the first variant of the VSL value, in the near future scenarios, these damages could be around EUR 2 to 4 million per year in the final year of observation, which would be cumulatively

around EUR 25 to 50 million for the total observed period. In the distant future, these damages in the final years would be from about 6.5 to about 10 million EUR per year, so the cumulative amount of these damages for the total period up to 2100 would be from about 200 to 300 million EUR. In the second variant of the VSL value, the amount of these damages is proportionally higher and can reach a cumulative level of around EUR 350 million.

6.2. Expenditures for treating diseases related to Climate Change

In order to carry out a more accurate assessment of the costs of treating diseases caused by climate change, it is necessary to have reliable data on the types and additional number of certain diseases that are a direct consequence of climate change, as well as on the cost of their treatment. There are no records of this kind in Montenegro, and no analyses and research have been carried out, so the next part presents an analysis of international experiences (primarily from the USA, which mostly dealt with this issue), which can roughly be the basis for showing how big the potential costs could be.

Costs of Lyme disease treatment

Lyme disease patients not only suffer from debilitating symptoms, but also have to pay significant amounts of medical bills. Lyme disease can take a heavy damage on patients and their families because in addition to struggling with symptoms, there are financial costs that come with this diagnosis.

If a patient is lucky enough to receive immediate treatment for early-diagnosed Lyme disease, these negative economic effects may affect them in just a few weeks. But for many patients with Lyme disease, the situation is not simple. Approximately 40% of cases are not diagnosed until the later stage of the disease, and 10-20% of those diagnosed early continue to experience persistent symptoms, so the way to recovery is long and circuitous[81]. In these cases, patients can suffer for years and the financial impact can be severe.

Research by the Johns Hopkins Bloomberg School of Public Health (Johns Hopkins University Bloomberg School of Public Health) revealed that Lyme disease costs the US health care system between $712 million and $1.3 billion annually, or nearly $3,000 per patient, on average. The stated amount includes only direct medical costs (costs of treatment, therapy, etc.), and in addition to them, indirect non-medical costs (for example, travel costs, etc.), as well as costs of loss of work ability and productivity, often occur. Some Lyme disease patients are forced to spend their life savings to cover medical expenses. These costs can be especially difficult to cover when patients are too ill to work. In a 2015 study on Lyme disease of more than 6,000 patients with chronic Lyme disease, 42% said they had to quit or cut reduce its work.

Malaria treatment costs

Malaria is a potentially life-threatening infectious disease, because if not treated within 24 hours, it can progress to a severe disease and can be fatal. In children, severe malaria may include symptoms

[81] Recent Progress in Lyme Disease and Remaining Challenges. Frontiers in Medicine, 8, 666554–666554. https://doi.org/10.3389/fmed.2021.666554

such as severe anemia or convulsions and coma in cases of cerebral malaria. Long-term neurological abnormalities such as ataxia, paralysis, speech impairment, deafness, and blindness may persist after cerebral malaria, especially in children. Despite increased prevention and control methods, malaria remains a major public health burden in sub-Saharan Africa, being among the top three causes of childhood death.

If the disease is treated on time and complications are avoided, the treatment costs are not excessively high. Seven studies estimated the cost of malaria treatment to health systems, which ranged from $1.94-$31.53 for outpatient cases to $20-$136 for inpatient cases[82].

Costs of leishmaniasis treatment

Leishmaniasis is a disease caused by a protozoan parasite from the genus Leishmania that is transmitted to humans through the bite of sand flies. The most severe form of this disease is fatal in a large number of cases if it is not adequately treated.

Initial treatment is expensive and must be administered by administering appropriate injections. The costs of this treatment cycle range from 30 to 150 dollars. In case of relapse, patients need to be treated with far more expensive second-line drugs, so the treatment costs can range up to 1,500 dollars[83].

According to WHO data, the average cost of treating leishmaniasis is around 600 USD.[84]

Costs of salmonellosis treatment

Salmonella are rod-shaped bacteria that cause infections in the gastrointestinal tract in humans and animals and can often be fatal. Salmonella belongs to the group of food-borne infections and enters the human body by consuming animal products, such as meat, eggs or dairy products. Since salmonella bacteria can survive outside the body for weeks, poor hygiene during processing (no hand washing) and transmission via cutting boards and knives, for example, can also be a reason for infection.

The Economic Research Service (ERS) of the USDA (US Department of Agriculture) estimates that salmonella infections from all sources cost Americans $2.65 billion annually. This figure is based on the Centers for Disease Control and Prevention's (CDC) estimate of nearly 1.4 million cases of

[82] Economic and Resource Use Associated With Management of Malaria in Children Aged <5 Years in Sub-Saharan Africa: A Systematic Literature Review, Amira El-Houderi, Joëlle Constantin, Emanuela Castelnuovo, First Published December 21, 2019 Research Article Find in PubMed, https://doi.org/10.1177/2381468319893986

[83] Control of leishmaniasis, Report by the Secretariat-WHO, Sixtieth World Health Assembly A60/10, Provisional agenda item 12.3 22

[84] Costs of medicines in current use for the treatment of leishmaniasis, World Health Organization

salmonella annually. The estimated average cost of treatment per case was determined to be $1,893[85].

More than 350,000 human cases of salmonellosis are reported in the European Union each year, but the actual number is probably higher. The European Food Safety Authority (EFSA) estimates that salmonella in humans could cost the EU economy in total (direct medical costs, indirect medical costs and lost productivity costs) up to 3 billion euros per year[86].

Costs of treating infections caused by Dengue virus

The dengue virus is transmitted to humans by the bite of infected mosquitoes, and almost half of the world's population, about 4 billion people, live in dengue risk areas. Every year, about 400 million people become infected with this virus.

For people who get dengue, symptoms can be mild or severe. Severe dengue fever can be life-threatening within hours and often requires hospital care.

The direct and indirect medical costs of dengue disease range from $421 to $571 on average per case, up to a total of $992[87], including lost productivity.

Costs of treating infections caused by West Nile virus

West Nile virus infection is an infection transmitted by certain types of infected mosquitoes. Thanks to the high invasiveness of the mosquito species that transmit it, today this disease is not exclusively a tropical infection, but an increase in cases is recorded from year to year in areas with a moderate continental climate, which is present in most of Europe.

Approximately 80% of infected people do not have any symptoms. Up to 20% of infected people develop fever, while a severe clinical picture, involving the central nervous system and inflammation of the meninges (meningitis) or brain tissue itself (encephalitis) occurs in less than 1% of those infected[88].

[85] Economic Research Service, U.S. Department of Agriculture, https://www.ers.usda.gov/

[86] Study: Salmonella causes damage worth billions of euros, European Food Safety Authority

[87] A Prospective Study on the Impact and Out-of-Pocket Costs of Dengue Illness in International Travelers

[88] https://www.ijzcg.me/me/groznica-zapadnog-nila-pitanja-i-odgovori

Total treatment costs (direct and indirect medical costs, lost productivity costs), per case, range from $10,556 to $25,117.[89]

Costs of treatment of acute respiratory infections

Acute respiratory infections (ARI), i.e. acute inflammatory diseases of the respiratory system, are the most common infections of modern man, as they account for two thirds of all infections. Thus, ARI are the most common human diseases in general. An adult gets sick on average 3 to 5 times a year.

To assess the economic impact of respiratory tract infections in the United States, national survey data were used to estimate direct and indirect economic costs. Respiratory infections are estimated to be responsible for as much as $15 billion in direct and indirect medical treatment costs. Physician costs account for about half, and hospital care accounts for approximately one quarter of these costs. It is estimated that 1.25 million patients are hospitalized annually due to respiratory tract infections, and the cost of their care is estimated at about 4 billion dollars. It is not possible to calculate the full size of the indirect costs of respiratory infections, but it is estimated that the loss of income of employees who are absent from work due to infection is more than 9 billion dollars annually[90].

Based on these data, it can be concluded that the total costs of treatment (direct and indirect medical costs, costs of lost productivity), per case, are around USD 19,200.

The costs of treating allergies caused by pollen

Although a number of economic analyses of the consequences of allergic rhinitis have been published, there are relatively few empirically based studies, especially outside the US. Estimates of the annual medical costs (direct and indirect) of allergic rhinitis range from 2 to 5 billion USD[91]. The wide range of estimates may be attributed to differences in the identification of patients with allergic rhinitis, differences in cost allocation, limitations associated with available data, and difficulties in determining the indirect costs of allergic rhinitis.

To date, the medical literature lacks a comprehensive economic evaluation of the consequences of the treatment of allergic rhinitis.

[89] Initial and Long-Term Costs of Patients Hospitalized with West Nile Virus Disease, J. Erin Staples, Manjunath B. Shankar, James J. Sejvar, Martin I. Meltzer, and Marc Fischer

[90] Economic costs of respiratory tract infections in the United States, R E Dixon

[91] The Economic Burden of Allergic Rhinitis: A Critical Evaluation of the Literature, PharmacoEconomics 22(6):345-61, Shelby D Reed, Duke University Medical Center, Todd A Lee, University of Illinois at Chicago, Douglas Mccrory, Duke University

7. Priority actions that address climate-driven vulnerabilities and gender disaggregated impacts

Based upon the main findings (and/or predictions) of the climate change impacts and vulnerability assessment of the health and health sector in Montenegro, we can draft and prioritize a list of actions to be taken to address them in the process of climate change adaptation

The main criteria that should be applied in drafting the actions[92] to be taken are:

- Feasibility,
- The cost-effectiveness to reduce the defined health risks,
- Availability of human resources, and
- The positive impact of the measure on the health sector resilience, technical and financial capacities.

Main areas for intervention for addressing the gender driven climate related vulnerabilities of the health sector of Montenegro are:

a. Policy level – planning, monitoring, financing

- Define, legally regulate and institutionalise the national climate adaptation planning processes.
- Develop a Long-Term Strategy on Climate Action which is inline with the EU requirements and prospects for climate action until 2050.
- Prepare and adopt a comprehensive and cross-sectorial National Health Climate Change Adaptation Strategy and Action Plan.
- Introducing evidence-based heat protection action plans
- Development and constant promotion of general guidelines for the population during heat waves and extremes.
- Establish an intersectoral body and process to monitor the impact of climate change on the health sector and the human health in general, as well as to monitor the development and implementation of the relevant national policy documents
- To establish an integrated (intersectoral) information system, with timely, spatially and gender (where applicable) disaggregated data/information of all cause and cause specific mortality, climate sensitive health outcomes and, hospital admissions, environment, water and food safety and security, social issues and disaster risk data etc.
- Introducing of a special fund for dealing with climate change and climate extremes.
- Develop gender responsive, cross-sectorial and coherent policies relevant for the health sector and its climate adaptation.

[92] WHO. 2021. Quality Criteria For Health National Adaptation Plans, Available on https://www4.unfccc.int/sites/NAPC/Documents/Supplements/WHO%20Criteria%20for%20quality%20NAPs.pdf:

b. Health care infrastucture and health protection

- To enhance the regular public health related climate actions (heat and cold waves and warnings, air quality, pollen concentration in air, transmissive diseases vectors distribution, water and food security and safety etc);
- To introduce an Early warning system during the weather extremes and prepare the health sector for appropriate response;
- To enhance the knowledge and the skills of the health sector policy making level regarding the climate change health impact/risks.
- To enhance knowledge and skills of the human resources in the health care facilities to deal with various climate extremes and climate impacts.
- To provide the health care system in the country with essential medical products, service delivery, technologies, and health care infrastructure for climate adaptation and resilience
- Urgently invest in measures for disaster risk mitigation for all eath facilities in the country
- Conduct as many as possible climate change and health field research studies on prioritized health risks per specific regions and micro locations (heat, flood, drought, wildfires) with aim to assess the level of risk and impact and future impact
- Enhancing of the capacities of the health care facilities to deal with health risks from climate change,
- Providing healthy and safe working conditions and enough health workers who are well trained, informed, and knowledgeable to respond to climate risks and minimize environmental threats resulting from the operation of the health care facility.
- Enhanced monitoring and assessment:
    - The healthcare facilities should have sufficient information regarding water, sanitation, chemical use, healthcare waste management, and energy services considering climate resilience and environmental sustainability.
    - The health sector should be capable to assess and manage the water safety and security, sanitation, chemicals, and health care waste and energy-related risks to workers, patients and served communities, by including assessments of climate resilience and environmental sustainability in responding to hazards and identifying and reducing exposures and vulnerabilities[93].
- Water safety and security, sanitation, chemical safety and health care waste regulations should be designed and implemented taking into consideration climate change variability and impact over time, as well as environmental sustainability.
- Activities should be introduced for adaptation of the current systems and infrastructures through building regulations implemented in the construction and retrofitting of health care facilities to ensure climate resilience and environmental sustainability.
- New digital technologies should be promoted to enhance the capacities of the heath sector and their outreach to the general population related aspects related to climate adaptation

[93] https://www.mdpi.com/1660-4601/17/23/8849

- Facilities should have established a special procedures and budget for emergency preparedness and response to climate hazard

c. Specific actions for monitoring and addresing climate-driven vulnerabilities and gender and solcially disaggregated impacts:

- Setting up procedures, legal and institutional mechanisms for systematic collection of the following data:
  - Daily or monthly morbidity and mortality data (with causes of death), hospital bad occupancy with proper sex and age disaggregation
  - Incidence of food, water-borne, vector-borne diseases, pollen allergies, number of office/clinic visits on monthly /daily level for last 10 years; the causes of disease/visit, emergency care calls with sex disaggregation
  - Health workers sex disaggregated at national and municipality level
  - Food safety data
  - Long-term health and social care data (for the vulnerable groups) and
  - Epidemiological and/or research data-evidence on direct or indirect impact of climate change on health on general or vulnerable group of population in MNE as well on health care system in general (including facilities).
- Setting up an institutional and operational structure (procedures) for gender mainstreaming (collecting sex-disaggregated data, provision of a systematic gender analysis, ensuring gender-responsive policy design, monitoring and reporting)
- Gender-responsive budgeting to support adaptation measures targeted to address the gender-based vulnerabilities.
- Collection of sex-disaggregated data on policy, program, project level in the health sector related to gender-based vulnerability assessment in terms of creation of gender-responsive adaptive solutions;
- Analysis of sex-disaggregated data in corelation with other types of vulnerabilities in relation to heat waves, droughts, food, nutrition, water sufficiency and management, adaptive food related practices, indoor and ambient pollution and health risks, which are a combination of psychological, biological, behavioural, and social factor.
- Field research on homelessness in the country (in line with the National strategy to fight homelessness and housing exclusion of Montenegro).
- Preventive and protection activities of mortality attributed to household air pollution and energy poverty, such as financial support (subvention for purchasing energy efficient sources of heating and cooking) and other types of informative actions. These actions should be targeted, especially towards most vulnerable groups: female owners of households facing material deprivations, single parents etc.
- Design of gender responsible adaptation measures attributed to heatwaves and floods;
- Design of gender responsible adaptation measures for owners and workers in agricultural holdings and unpaid labour force;
- Design and implementation of measures for preventing health hazards by the water consumption and water usage;
- Design and implementation of measures related to humidity and temperature rise and reproductive health.