Bosnia and Herzegovina National Adaptation Plan – NAP

with proposed measures

Bosnia and Herzegovina National Adaptation Plan – NAP

with proposed measures

September 2021

Development of this publication was supported within the project "Advance the National Adaptation Plan (NAP) process for medium-term investment planning in climate sensitive sectors in Bosnia-Herzegovina (B&H)", funded by the Green Climate Fund (GCF), implemented by UNDP in cooperation with the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, as a UNFCCC focal point for Bosnia and Herzegovina, Ministry of Agriculture, Forestry and Water Management of Republika Srpska, Federal Ministry of Agriculture, Water Management and Forestry and Federal Ministry of Environment and Tourism.

Project board:

Srebrenka Golić, Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska, Chair
Senad Oprašić, Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Zineta Mujaković, Federal Ministry of Environment and Tourism
Marinko Vranić, Ministry of Agriculture, Forestry and Water Management of the Republika Srpska
Suad Skejović, Federal Ministry of Agriculture, Water Management and Forestry
Raduška Cupać, United Nations Development Programme, Bosnia and Herzegovina

Expert team:

Goran Trbić, University of Banja Luka, Faculty of Science, Team Leader, Climate Trends and Modelling
Vladimir Đurđević, University of Belgrade, Faculty of Physics, Climate Modelling
Ružica Stričević, University of Novi Sad, Faculty of Agriculture, Agriculture
Mihajlo Marković, University of Banja Luka, Faculty of Agriculture, Agriculture
Esena Kupusović, Federal Hydrometeorological Institute of Federation BiH Sarajevo, Water Resources
Nijaz Lukovac, HEIS – Institute of Hydraulic Engineering Sarajevo, Water Resources
Radoslav Dekić, University of Banja Luka, Faculty of Science, Biodiversity
Rajko Gnjato, University of Banja Luka, Faculty of Science, Tourism
Zoran Vujković, University of Banja Luka, UCC – Faculty of Medicine, Human Health
Đorđe Markez, University of Banja Luka, Legislative Framework
Samra Prašović, CETEOR – Centre for Economic, Technological and Environmental Development Sarajevo, Energy and Water Management

Table of Contents:

12 **1. Analysis of the current regulatory framework and technical studies**
12 Legislative framework for climate change
14 **2. Methodology**
14 **3. Climate change trends**
16 Expected climate change according to climate scenarios by the end of the 21st century
17 GHG concentration scenarios
19 **4. Future climate projections – global models**
19 Air temperature
21 Precipitation
22 **5. Impact of climate change on sectors**
23 **6. Agriculture**
24 Drainage
25 Drainage in future climatic conditions and recommendations
25 Irrigation
27 Assessment of the possible impact of the RCP8.5 climate scenario on irrigation demand
28 Possible disadvantages and limitations of irrigation
30 Climate change impact on fruit production and viticulture
31 Climate change impact on livestock farming
31 Plant production in future climatic conditions
31 Seasonal weather forecasts in agrometeorology
32 Agroclimatic zoning of BiH, according to the RCP8.5 climate scenario by 2100

34 **7. Water resources**
35 Floods and droughts in recent decades in BiH
38 Analysis of possible impacts on water resources under climate scenarios
45 **8. Forestry and biodiversity**
45 Climate change impact on forest ecosystems in BiH
47 Climate change impact on biodiversity
51 **9. Housing sector**
54 **10. Human health**
57 **11. Tourism**
60 **12. Proposed measures for the most vulnerable sectors**
60 Agriculture
63 Water resources
67 Biodiversity and forestry
71 Human health
74 Tourism
73 **13. Literature and sources**

77 **14. Annex 1: Conceptual framework for monitoring and evaluation of climate change adaptation indicators**
124 **15. Annex 2: Technical guidelines for monitoring and evaluation and capacity building plan**
141 **16. Annex 3: Standard operating procedures for the mechanism of coordination and horizontal and vertical exchange of CCA indicators in Bosnia and Herzegovina**

Acronyms

AVP	Water management agency
BD	Brčko District of Bosnia and Herzegovina
BHAS	Agency for Statistics of Bosnia and Herzegovina
BiH	Bosnia and Herzegovina
CCA	Climate Change Adaptation
COP	Conference of Parties
DNA	Designated National Authority
EEA	European Environment Agency
EE	Energy Efficiency
EU	European Union
EU ETS	EU Emission Trading System
FBiH	Federation of Bosnia and Herzegovina
FBiH MAWMF	Federal Ministry of Agriculture, Water Management and Forestry
FHMZ	Federal Hydrometeorological Institute of Federation BiH
FNC	Fourth National Communication of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GMST	Global Mean Surface Temperature
HPP	Hydroelectric power plant
INC	Initial National Communication of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
MOFTER	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
NAP	Bosnia and Herzegovina’s National Adaptation Plan
NDC	Nationally Determined Contribution
NGO	Non-governmental organization
OSCE	Organization for Security and Co-operation in Europe
PPP	Public-Private Partnership
RCP	Representative Concentration Pathway
RE	Renewable energy
RHMZ	Republic Hydrometeorological Institute of the Republika Srpska
RS	Republika Srpska
RS MAFWM	Ministry of Agriculture, Forestry and Water Management of the Republika Srpska
RS MPPCE	Ministry of Spatial Planning, Construction and Ecology of the Republika Srpska
SCCF	Special Climate Change Fund
SNC	Second National Communication of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change

TNC	Third National Communication of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WBIF	Western Balkans Investment Framework
WHO	World Health Organization
WTTC	World Travel and Tourism Council

1. Analysis of the current regulatory framework and technical studies

United Nations Framework Convention on Climate Change (UNFCCC[1]) recommends that countries develop national adaptation plans in order to facilitate and advance their climate change adaptation planning. The process of developing an adaptation plan is set out in UNFCCC guidelines and manuals. This process should result in an assessment of vulnerabilities and risks arising from climate change and climate extremes as well as offer possible options for adaptation to climate scenarios. The National Adaptation Plan aims to improve existing reporting on the development and implementation of adaptation measures and contribute to the integration of climate change adaptation into relevant social, economic and environmental policies and actions.

The most important technical studies that look at climate change issues included in the Bosnia and Herzegovina National Adaptation Plan (NAP) are: Initial National Communication of Bosnia and Herzegovina under the UNFCCC (INC), Second National Communication of Bosnia and Herzegovina under the UNFCCC (SNC), Third National Communication of Bosnia and Herzegovina under the UNFCCC (TNC) and Climate Change Adaptation and Low-Emission Development Strategy for Bosnia and Herzegovina[2]. The First and Second National Communications laid the foundations for the development of the BiH Initial Climate Change Adaptation Strategy. Currently underway is the preparation of the Fourth National Communication of Bosnia and Herzegovina under the UNFCCC (FNC), the revised Climate Change Adaptation Strategy and the revised NDC that will include a chapter on climate change-induced losses and damages. These documents were used in the preparation of the initial draft of the NAP, while the final NAP document will be aligned with the aforementioned documents once they are adopted.

Legislative framework for climate change

The current legislative framework in Bosnia and Herzegovina does not provide a sufficient basis to adequately address climate change impacts, which further compounds the process of adapting to changing climate. Under the Constitution of Bosnia and Herzegovina, legislative competences in the field of environment belong to the entities in BiH (Republika Srpska and the Federation of Bosnia and Herzegovina) and the Brčko District of BiH. Analysis of the entire legislative framework in BiH shows that all primary and secondary legislation in the country addresses this problem within the broad concept of 'climate', which is certainly insufficient. The only piece of legislation that, in terms of its content, indeed addresses climate change is the *Rules on the manner of preparation, content and formation of spatial planning documents* (2013) in the Republika Srpska, which lays down the methodological approach to drafting spatial planning documents and emphasizes climate change as one of the aspects that must be taken into account in spatial planning and the preparation of spatial documents. Accordingly, the *Law on Spa-*

1 https://unfccc.int/

2 http://www.unfccc.ba/

tial Planning and Construction of the Republika Srpska[3], as a related piece of legislation, also addresses the issue of climate change, but only to a minimal extent.

The existing spatial plans in BiH have not in the least factored in climate change as a dynamic impact factor. Thus, the existing legislation and its accompanying regulatory framework do not contain provisions on – and do not in any way address – the problem of climate change as a dynamic impact factor. To that end, appropriate procedures need to be initiated to amend the current legislation in BiH in such a way as to ensure integration of 'climate change' and 'climate change adaptation' in the most vulnerable sectors. One of the activities in the project 'Integrating Climate Change and Reducing the Risk of Flooding in the Vrbas River Basin,'[4] implemented by the United Nations Development Programme (UNDP) and funded by the GEF, was to propose legislative amendments that will adequately address and integrate climate change into the legislative framework governing the field of spatial planning and development, and into spatial, master and zoning plans.

The proposal contained recommendations that, in addition to analysing climatic conditions, strategic, spatial and master plans should also consider the issues of climate extremes and climate change, and take account of climate change projections. Addressing climate extremes and projected climate change will bring about a shift in the strategic approach to the development of sectors that are vulnerable to climate change impacts in BiH. In that case, the strategic development of such sectors (agriculture, water management, hydropower, etc.) will be accompanied by appropriate measures and plans that will integrate climate change adaptation.

Furthermore, the integration of climate change into strategic and spatial plans at the entity level of Republika Srpska and Federation BiH will also lead to the integration of climate change into master and spatial plans at the municipal level. It is necessary to develop and enact a Law on Climate Change in both entities, of Republika Srpska and Federation BiH, though it is worth noting that the Republika Srpska has already started this process in cooperation with UNDP Bosnia and Herzegovina.

3 https://www.paragraf.ba/propisi/republika-srpska/zakon-o-uredjenju-prostora-i-gradjenju.html

4 https://www.ba.undp.org/content/bosnia_and_herzegovina/bs/home/operations/projects/energija-i-okolis/GoALWaSH1.html

2. Methodology

The NAP development methodology will follow the guidelines laid down by the United Nations Framework Convention on Climate Change (UNFCCC).

The NAP development process should result in an assessment of vulnerabilities and risks arising from climate change and climate extremes as well as offer possible adaptation options, in particular measures to address short-term (2020–2023), medium-term (2023–2027) and long-term needs (2025–2030). The BiH National Adaptation Plan aims to improve existing reporting on the development and implementation of adaptation measures and flow of information as well as contribute to the integration of climate change adaptation into relevant social, economic and environmental policies and actions.

Key guidelines for the development of NAP[5] are set out in the Technical Guidelines for the National Adaptation Plan Process published by the UNFCCC secretariat (UN Climate Change). Additionally, some of the guidelines for the chapter Vulnerability and Adaptation in the National Communications are laid down in the UNFCCC Decision 17/CP.8[6]. Other guidelines and useful recommendations are set out in Decisions: 8/CP.5, 3/CP.8, 8/CP.11, 5/CP.15, 1/CP.16, 2/CP.17, 14/CP.17, 17/CP.18, 18/CP.18, 19/CP.19. Furthermore, Decision 18/CP.19 sets out guidelines for the preparation of National Adaptation Plans[7]. All these decisions are consistent in that they point out that best adaptation is achieved through early and integrated planning and action at all levels. Addressing the issue of climate change adaptation will contribute to achieving long-term sustainable development, i.e. Sustainable Development Goals. Adaptation planning should be a continuous, progressive and iterative process, the implementation of which should be based on clearly defined priorities, including those defined in the country's strategies and plans and aligned with its sustainable development goals, plans, policies and programmes.

3. Climate change trends

Analysis of climate elements for the period 1961–2018 shows that the mean annual temperature maintains a continuous increasing trend throughout the entire country. A positive linear trend in the mean annual temperature was observed, which has been particularly pronounced in the last 40 years. Trends in annual temperatures at all analysed stations are statistically significant, and changes are more pronounced in the continental part. The increase in air temperature on an annual level ranges from 0.4 to 1.2 °C, and during the growing season (April–September) goes up to as much as 1.4 °C. However, temperature increases have been even more pronounced over the last 18 years. In the analysed period, all indices of warm temperature extremes show an upward trend, while those for cold temperature extremes indicate a downward trend. The most significant change in this period is observed in the number

5 United Nations Framework Convention on Climate Change (UNFCCC) Least Developed Countries Expert Group (LEG) UNFCCC; Bonn, Germany: 2012. National adaptation plans: technical guidelines for the national adaptation plan process. Available at: https://unfccc.int/files/adaptation/cancun_adaptation_framework/application/pdf/naptechguidelines_eng_high__res.pdf, accessed on 23 August 2015 [Google Scholar]

6 https://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/dec17-cp.pdf

7 https://unfccc.int/resource/docs/2013/cop19/eng/10a02r01.pdf#page=6

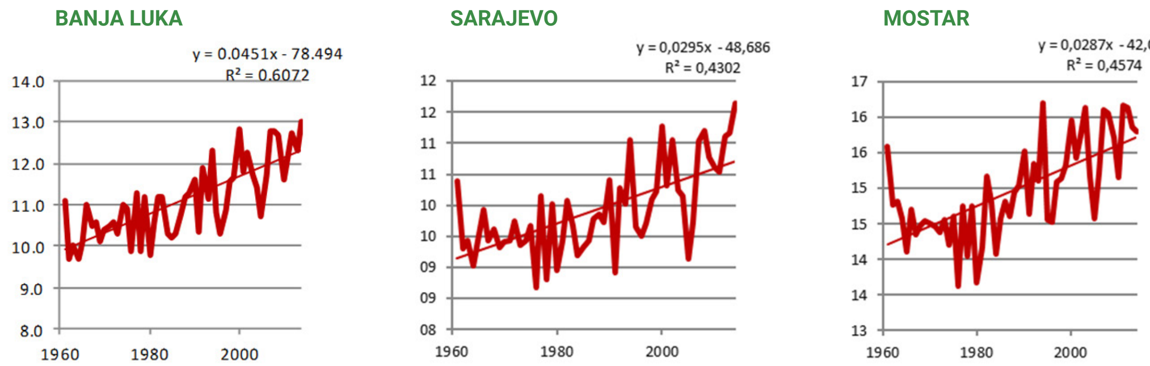


Figure 1.
Air temperature change trends, 1961–2018 (Banja Luka, Sarajevo, Mostar)

of cold and warm days, with the former showing a negative trend at all meteorological stations. In the central mountainous areas, the number of cold days has been reduced by four days in 10 years, while in the south of the country the reduction is somewhat smaller at two days in 10 years. The number of warm days has a positive trend and is statistically significant.

At all meteorological stations in Bosnia and Herzegovina, the coldest month is January, with an average temperature ranging from -3.8 °C in Sokolac to 5.3 °C in Mostar. The average temperature in January in the northern part of the country is in the range of -0.2 °C to 0.2 °C. The warmest month is July, with the highest average air temperature in the eastern and southern parts of the territory (Bijeljina 21.8 °C, Bileća 22.1 °C and Mostar 25.4 °C). The average temperature in July in Banja Luka is 21.4 °C. The mean annual air temperature amplitude in the period 1961–2015 in the north was in the range of 20.2 °C in Tuzla to 21.7 °C in Bijeljina. The largest annual temperature amplitude in the entire research area is in Semberija, which is the most continental part of BiH. Temperature amplitudes are somewhat lower in high Herzegovina (for example, Bileća 18.8 °C) and in Sarajevo (19.9 °C).

Of the ten warmest years in the observed 1961–2015 period, as many as nine were recorded after 2000 (the only other being 1994). Among the warmest years in the analysed period were: 2000, 2007, 2008 and 2014. The warmest year in most of BiH was 2014. In Semberija, the only years warmer than 2014 were 2008 and 2015. In Herzegovina, 2014 was not among the first few warmest years. Mostar was the warmest in 2015, then in 1994, 2011 and 2012 (interestingly, differences in the average annual temperature in Mostar were very small during the ten warmest years). Since 1990, when the warming trend has been more pronounced, only a few years have been colder than the average climate period (1961–1990), namely: 1996 (at all stations except Sokolac), 2005 (in Sanski Most, Prijedor, Doboj, Tuzla), etc. Sarajevo and Bileća), 1995 in Tuzla and Bileća, 1997 in Tuzla, and 1991 and 2006 in Bileća. Since 1990 Sokolac has been warmer than the average standard climate period. Among the coldest years in the period 1961–2015 were 1962, 1964, 1976, 1978 and 1980 (all before 1990). In the northwest of the country, the coldest years were recorded at the beginning of the period under analysis. In Banja Luka and Prijedor the coldest years were 1962 and 1964. In the geographical area between Doboj and Bijeljina the coldest year was 1980, and in the area of Sarajevo and Sokolac, as well as in Herzegovina, 1976.

In the observed period 1961–2018 the entire territory of Bosnia and Herzegovina saw a negative trend in the annual number of frost days, which is statistically significant in almost all parts of the country. The values of the negative trend range from 2.1 to 6.4 days per decade (*Popov, Gnjato, Trbic, 2017*). The trend change is most pronounced in the north-western part of the territory. After 1990, a year with the lowest number of winter days was recorded. There have been very few icy days in the last decade, when global warming was most pronounced.

In the period 1961–2018 a slight increase in annual precipitation was recorded in most parts of the country. Linear trends for the multi-year period 1961–2018 indicate stagnation or a marginal increase in the amount of precipitation in the total geographical area of Bosnia and Herzegovina. Changes in precipitation are more pronounced by seasons than annually. While no significant changes in precipitation have been observed, the pluviometric regime (annual distribution of precipitation) has been greatly affected. Due to the increased intensity and variability of precipitation, as well as the increased share of heavy rains in the total distribution of precipitation, the risk of floods increased, in particular in the central and northern parts of the country, which were hit by the catastrophic May 2014 flood.

Based on previous research on climate and climate change, the biggest changes were identified in the southern, northern and north-western parts of Bosnia and Herzegovina. These include an increase in the intensity and frequency of extreme climate events (floods, droughts, violent windstorms, days with hail, prolonged heat waves, extreme temperatures, etc.). In the last two decades, some of these extremes have occurred each year, and in some places multiple extreme events have occurred. Previous research has shown increasing climate variability in all seasons in the territory of Bosnia and Herzegovina. Rapid and intense changes occur over short periods of time – from extremely cold to warm weather, or from periods of extremely heavy rainfall to very dry spells.

Six of the last 10 years have been very dry to extremely dry, and five years have been marked by extreme flooding. During the last decade (2009–2019), almost all years were marked by extreme weather conditions: floods in 2009, 2010, 2014, 2019, drought and heat waves in 2011, 2012, 2013, 2015, 2016, 2017, 2019; cold snaps in early 2012; windstorms in mid-2012 and late 2017; extremely high number of hail days in 2018 (the entire anti-hail system was in standby mode for 78 days, and the meteorological situation required the deployment of anti-hail rockets for a total of 43 days, twice as much as the annual average).

As mentioned earlier, the southern, northern and north-western parts of the country are hit the hardest by extreme events. If we look at all the extreme weather events that have occurred in the last two decades, the hardest hit town in the south of the country is Trebinje (drought, heat waves, windstorms, heavy precipitation, etc.), in the north Zenica (floods, droughts, heat waves, windstorms, etc.) and in the northwest Laktaši and Sanski Most (drought, heat waves, windstorms, heavy precipitation, hail).

Expected climate change according to climate scenarios by the end of the 21st Century

This report will present the results of future climate projections for Bosnia and Herzegovina, based on different scenarios of future GHG concentrations. The scenarios of future concentrations considered herein are scenarios RCP2.6, RCP4.5, RCP6.0 and RCP8.6, as outlined in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report[8]. Analysis of possible future climate changes will be based on estimates of changes in basic climate variables: mean daily temperatures, minimum daily temperatures, maximum daily temperatures and daily precipitation accumulations, annually and seasonally, for four seasons: December–January–February (DJF), March–April–May (MAM), June–July–August (JJA) and September–October–November (SON). In addition to these results, changes in selected climate indices will be presented, serving as indicators of possible changes in the intensity and frequency of extreme weather and climate events that may adversely affect the functioning of natural ecosystems and various socio-economic sectors such as agriculture, forestry, water resources, human health, biodiversity, ecosystem services, etc. All future changes will be shown for the period from 2016 to 2100, as compared to the reference climate period 1986–2005, which was also used as the reference period in the last IPCC Fifth Assessment Report. Particular focus will be placed on three future twenty-year periods, namely the *near future* 2016–2035, the *mid-twenty-first century* 2046–2065 and t*he end of the twenty-first century* 2081–2100, which were also selected for presenting the results in the IPCC Fifth Report (Djurdjevic, V, 2020).

GHG concentration scenarios

The IPCC Fifth Assessment Report[9] outlines four possible scenarios of future global GHG concentrations (Representative Concentration Pathways – RCPs). These scenarios represent possible changes in GHG concentrations in the atmosphere in the period 2006–2100, which would primarily be a consequence of future global anthropogenic emissions of those gases. As the change in GHG concentrations in the atmosphere leads to the creation of an energy imbalance in the Earth's climate system, a numerical code for the scenario was introduced, indicating the magnitude of this imbalance expressed in W/m^2. Thus, according to the RCP8.5 scenario, the energy imbalance at the end of this century would be 8.5 W/m^2, according to the RCP6.0 scenario, the imbalance would be 6.0 W/m^2, according to the RCP4.5 scenario it would be 4.5 W/m^2 and according to the RCP2.6 scenario 2.6 W/m^2. Scenarios RCP2.6 and RCP4.5 assume that, tentatively speaking, GHG concentrations will stabilize in the future, while according to scenarios RCP8.5 and RCP6.0, the concentrations will continue to grow, or follow the trends observed in the past (Figure 2). Scenario RCP2.6 even assumes that in the second half of this century GHG concentrations could even decrease, requiring that at some point anthropogenic emissions become equal to zero, so potential gas sinks could lead to a decrease in GHG concentration. In this sense, the RCP2.6 scenario can be considered 'optimistic', while, on the other hand, the RCP8.5 scenario, according to which concentrations rise to a value of approximately 1250 ppm (CO2-eq), can be considered 'pessimistic', or as it is colloquially referred to 'business as usual' scenario, since under this scenario the energy policies of individual countries would remain unchanged even in the future, primarily in terms of fossil fuel use. The other two scenarios can be considered options that lie somewhere between these two extremes.

8 https://www.ipcc.ch/assessment-report/ar5/

9 https://www.ipcc.ch/assessment-report/ar5/

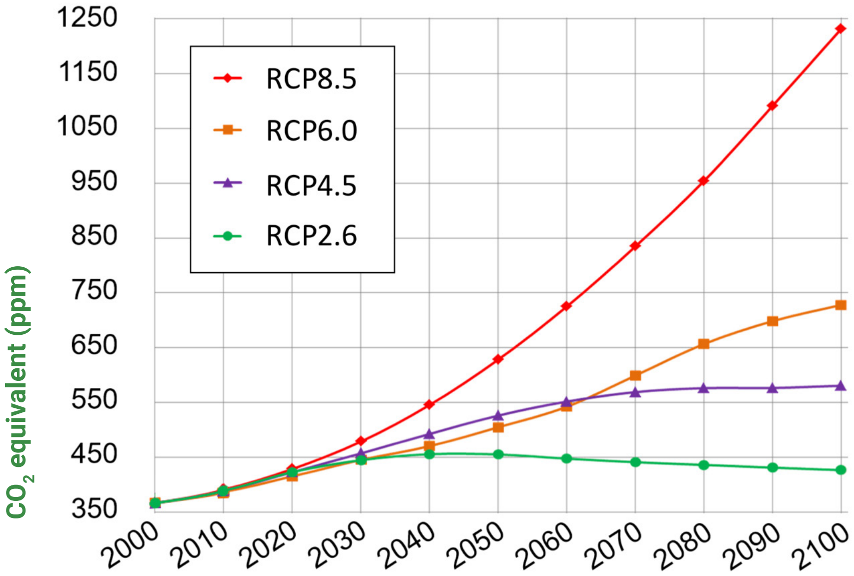


Figure 2.
Future GHG concentrations for four different scenarios

4. Future climate projections – global models

This chapter will present the results of global climate models downloaded from the CMIP5 database[10]. The results shown indicate average changes for the entire territory of Bosnia and Herzegovina for the period 1986–2100, while the period 1985–2006 was used as the reference period against which the deviations of the corresponding magnitudes were calculated.

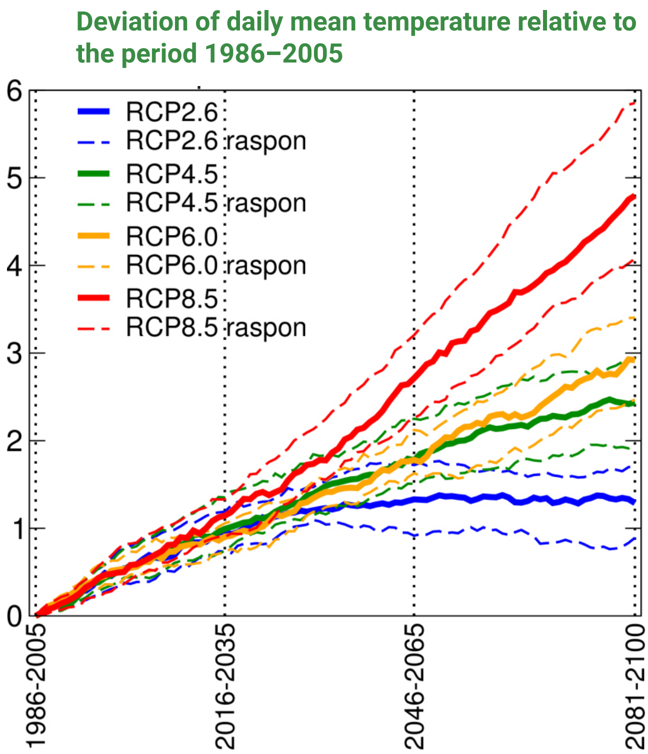
Air temperature

Figure 3 below shows the projections of the average annual value, the daily mean temperature for consecutive 20-year periods, starting from the 20-year period 1986–2005 until 2081–2100, relative to the reference period 1986–2005. The results are shown for four different scenarios – RCP2.6, RCP4.5, RCP6.0 and RCP8.5, where the mean value of the ensemble of different global climate models is represented by the solid line and the range of possible changes is represented by the dashed line, between the 25th and 75th percentiles of the total possible range of the entire ensemble.

According to the RCP8.5 scenario, by the end of this century the expected change in daily mean temperature is the largest in relation to other scenarios, and it is 4.8 °C, with a range from 4 °C to 6 °C relative to the reference period 1986–2005. For the middle of this century, the mean change under this scenario is slightly higher than 2.5 °C, while for the near future (2016–2035) under this scenario the expected change is about 1 °C relative to the value from the reference period 1986–2005. The least change at the end of this century can be expected for the RCP2.6 scenario, according to which the expected change at the end of the century is 1.2 °C, with a range from 0.9 °C to 1.6 °C. Also, according to this scenario, stabilization of temperature and cessation of further rise can be expected in the first half of this century. For the remaining two scenarios, the future temperature change ranges between the results for scenarios RCP2.6 and RCP8.5, with the change being slightly larger at the end of the century for scenario RCP6.0, and the change in the ensemble mean being about 3 °C. In the case of the RCP4.5 scenario, similar as in the case of the RCP2.6 scenario, temperature stabilization is observed, but only in the last decades of the 21st Century. It is also clear that for the near future the change in daily mean temperature does not differ significantly for different scenarios, which is an expected result given that, according to the scenarios, no significant differences in future GHG concentrations are visible until 2040.

10 https://cmip.llnl.gov/cmip5/

Figure 3.
Change in average annual value (in °C), daily mean temperatures, shown as a deviation of the 20-year moving average relative to the reference period 1986–2005, for scenarios RCP2.6, RCP4.5, RCP6.0 and RCP8.5 (solid lines) along with the range (dashed line) between the 25th and 75th percentiles. The three selected 20-year periods: 2016–2035, 2046–2065 and 2081–2100, are specially marked on the figure.



Under the most extreme scenario (RCP8.5), by 2035 the average temperature in Bosnia and Herzegovina will have increased by +0.5 °C to +1.50 °C. For the period 2036–2065, the rise is in the range of 1.5 °C to 3 °C, and for the period 2081–2100 in the range of 2.5 °C to 5 °C. Particularly noteworthy here is the increase in maximum daily temperatures for the June–July–August season, when the temperature increase in most of the country is higher than 5 °C. Temperature changes are bigger in mountainous areas, which is clearly visible in the case of changes in the last period under analysis, namely 2018–2100.

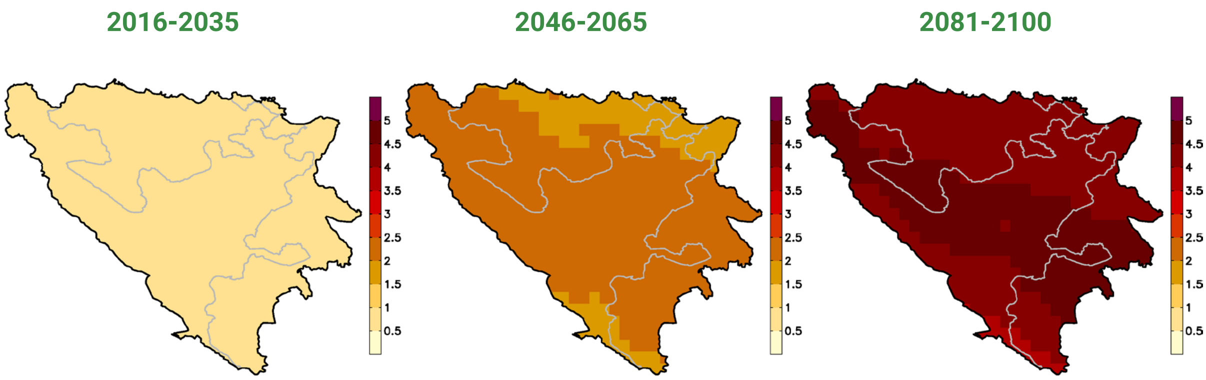


Figure 4.
Change in the daily mean temperature (in °C) relative to the reference period 1986–2005 in the RCP8.5 scenario

By the end of the century, the number of summer days will be increasing in all scenarios. In the RCP8.5 scenario, the change in the number of summer days increases significantly for further time horizons, and for the period 2036–2065 it is up to 40 days more, in some parts up to 50 days more, and the change is most pronounced in the last period with up to 60 days, almost throughout the country.

Precipitation

Figure 5 shows the projections of the average annual value, daily accumulations of precipitation for consecutive 20-year periods, starting from the 20-year period 1986–2005 until 2081–2100, relative to the reference period 1986–2005. Unlike changes in temperature, changes in precipitation show a somewhat more complex structure, with possible both positive and negative changes relative to the reference period, especially for near future, when all four scenarios show that possible changes are in the range of -5 percent to +5 percent relative to the reference period values. The differences between the scenarios become noticeable only in the periods at the end of the 21st Century, with the RCP8.5 scenario standing out, under which the expected change at the end of the century is about -10 percent with a range of -4 percent to -15 percent. On the other hand, according to the RCP2.6 scenario, by the end of this century the possible change in precipitation will remain in the range of -3 percent to +3 percent relative to the reference period value. According to the RCP6.0 scenario, at the end of the century the total range of possible change is negative, similar as in the case of the RCP8.5 scenario, with the values ranging from -1 percent to -5 percent, while the expected value, that is the mean value of the model ensemble, is -3 percent. In the case of the RCP4.5 scenario, the expected value is about -1 percent, and the expected range is +3 percent to -5 percent. According to the results shown, it is only in the RCP8.5 scenario that future changes can be more significant, not least in the second half of the 21st Century, when, according to this scenario, a decrease in total precipitation, as well as change in climate conditions in terms of potential annual precipitation loss, could be expected.

According to the RCP8.5 climate scenario, the change in daily accumulated precipitation at the an-

Deviation of daily precipitation relative to the period 1986–2005

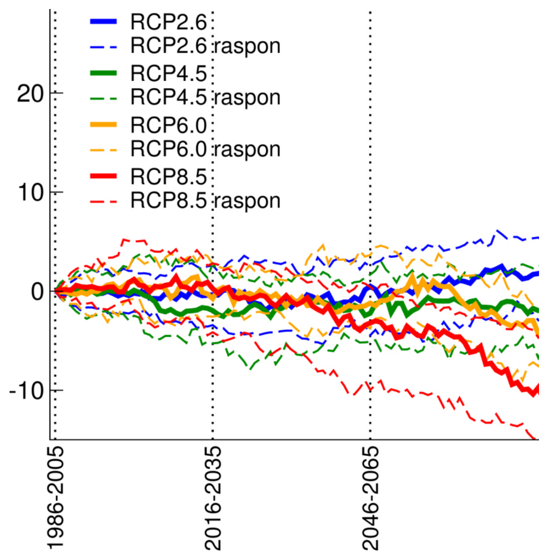


Figure 5.
Change in annual average value (in %) of daily accumulated precipitation, shown as a deviation of the 20-year moving average relative to the reference period 1986–2005, for scenarios RCP2.6, RCP4.5, RCP6.0 and RCP8.5 (solid lines) along with the range (dashed line) between the 25th and 75th percentiles. The three selected 20-year periods: 2016–2035, 2046–2065 and 2081–2100, are specially marked on the figure.

nual level ranges from -5 percent to 5 percent for the first two periods, and is negative for the last period under analysis (2081–2100), and in some parts of the country is less than -10 percent. June–July–August (JJA) is the season with the highest precipitation loss, which is especially pronounced in the RCP8.5 scenario, under which precipitation reduction of less than -30 percent is possible in the south of the country during the last period. This summer precipitation deficit is obviously the main contributor to the negative change in total annual precipitation (Figure 5).

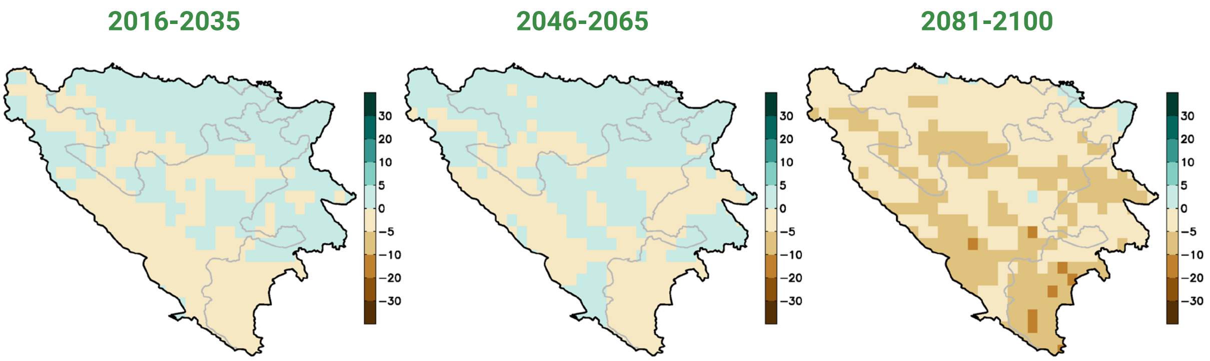


Figure 6.
Change in the daily mean precipitation (in %) relative to the reference period 1986–2005 in the RCP8.5 scenario

The number of days with precipitation exceeding 20 mm will be generally increasing under all scenarios. Changes range from +5 percent to +20 percent (in most parts of Bosnia and Herzegovina where the changes are positive) and up to -5 percent (in the parts where the change is negative). According to the RCP8.5 scenario, this change is somewhat more pronounced in the period 2081–2100 in most of the country at up to +20 percent, and in some smaller areas as much as over +30 percent.

5. Impact of climate change on sectors

The report presents the impacts of climate change on the most vulnerable sectors in Bosnia and Herzegovina. Estimates were made on the basis of available data, scientific and professional literature, and the projections of possible impacts were made on the basis of climate models and scenarios (RCP8.5). So far, climate change in Bosnia and Herzegovina has put the greatest pressure on agriculture and water resources. However, the impact on the energy sector, tourism, public health, forestry, housing, and sensitive plant and animal species is growing. Evidently, climate change needs to be integrated into strategic and planning documents, which will require that certain changes and amendments be made to the current legislative and regulatory frameworks.

6. Agriculture

Climate change is having an increasing impact on the agricultural sector in Bosnia and Herzegovina. These impacts have been particularly pronounced in the 21st Century, and include increasing air temperature, prolonged heat waves, which, coupled with insufficient precipitation, cause droughts, increased number of days with hail clouds and hailstorms, decreasing precipitation during the summer, decreased number of snow days and reduced snow cover retention time. Climate extremes in the form of strong and storm-force winds (affecting fruit production and farming) and heavy precipitation in the form of torrential downpours (causing floods, erosions, etc.) also have a negative impact. The consequences of climate change in the agricultural sector are predominantly negative, and can lead to yield reductions by up to 10 percent (as witnessed in the neighbouring countries of Serbia and Croatia). Due to the marked spatial and temporal variations in precipitation distribution, the need for irrigation of agricultural crops in the country is expected to rise during dry summer periods, when water needs are highest. Irrigation planning needs to respect ecological flows of rivers. According to the IPCC Fifth Report[11] (*AR5, IPCC, 2014*), spring crops can be expected to be at increased risk due to high temperatures and water shortages during the summer months. Also, the yield and quality of pasture and feed (particularly spring crops) are expected to decrease and pastures are likely to deplete. According to the report, by the end of the 21st Century soil erosion processes can be expected to accelerate mainly as a result of increased soil erodibility in the wake of prolonged droughts, increased precipitation intensity and changes in land use patterns.

Climate change is expected to have a positive effect on the yields and quality of winter crops due to the extended growing season. The increasing temperatures and longer growing season may cause fruit and vine cultivation areas to expand (*Trbic et al., 2020*). However, one of the very important features arising from climate change is the frequency and timing of frost days. It follows that the growing season can be expected to become longer, which will directly lead to a decrease in the number of frost days in the country. A decrease in the number of frost days may cause the range for some crops to increase. Furthermore, the reduced number of frost days, in combination with an unstable atmosphere, usually leads to the occurrence of late spring frosts, which have an extremely adverse impact on the fruit production sector. Changes in the frequency and distribution of frost are one of the consequences of global warming. Although the annual number of frost days has decreased, in future frost may have an increasingly detrimental impact on plants due to changed climatic conditions. Research into changes in frost occurrence patterns is particularly important in terms of frost impact on plants. Numerous studies have shown that the increase in air temperature has resulted in changes in plant phenology. In regions with a warming trend, changes in plant phenology were mainly manifested in the earlier occurrence of spring phenophases (e.g. budding, leafing and flowering) and delayed occurrence of autumn phenophases (e.g. leaf colour change and leaf-fall).

According to most climate change models, the risk of negative effects of frost on plants will increase due to their 'premature' development in the spring (caused by the warming climate system), at a time when frost is still likely. For many plant species, the growing period in the spring now begins when the likelihood of frost damage is small. However, climate change can lead to a mismatch between the growing season and a period of low frost risk, so plants can be damaged by late spring frosts more frequently.

11 https://www.ipcc.ch/assessment-report/ar5/

In the observed period 1961–2018, on the entire territory of Bosnia and Herzegovina there was a negative trend in the annual number of frost days, which was statistically significant in almost all areas. The established values of the negative trend range from 2.1 to 6.4 days per decade. The observed trend is most pronounced in the north-western part of the country (especially in Banja Luka), then in Bugojno, Zenica and at the highest station, Bjelašnica. In general, the years with the lowest number of frost days were recorded after 1990, when the warming trend became more pronounced. Extremely few frost days have been recorded over the last decade.

Drainage

Due to the increased frequency of extreme floods and droughts caused by climate change, the need for planned development of irrigation and drainage has increased.

Based on the estimates undertaken by experts from Serbia and the World Bank[15], it is necessary to provide between EUR 5,400 and 8,500 per kilometre for less derelict primary canals, between EUR 9,200 and 16,000 per kilometre for moderately derelict canals, and as much as EUR 35,000 per kilometre for completely degraded large (navigable) canals. Assuming that the canals are moderately derelict, for the specified length of the canal network that needs to be rehabilitated and brought into function, an additional EUR 3 million needs to be provided, plus funds for the rehabilitation of pumping stations and facilities on the network.

Other indirect damages that occur due to poor drainage (e.g. more pronounced waterlogging was observed in Posavina) in temperate climatic conditions are as follows:

- prolonged waterlogging (in spring) hampers farming;
- delayed sowing means that plants can enter a sensitive phenophase in the most unfavourable period (flowering and fruit formation), having a detrimental impact on the yield (regular occurrence in Herzegovina);
- vulnerability of the lowest parts of the field (depression), where water is occasionally retained for a longer or shorter period; due to lack of air plants suffocate and yields are decreased only in those parts;
- irrigation is not possible, preventing two sowings per year;
- it is impossible to sow perennial grasses sensitive to moisture (alfalfa) and winter crops. Instead, summer crops must be used, which is unfavourable from the ecological point of view and, furthermore, they would be especially vulnerable in future climatic conditions due to rising temperatures and intensification of droughts during the summer;
- it is risky, or altogether impossible to plant perennial plants;
- waterlogging near saline ponds or polders (Neretva valley) creates an additional adverse impact on yields.

12 Serbia - Irrigation and drainage rehabilitation project, 2005

http://www.worldbank.org/projects/P087964/irrigation-drainage-rehabilitation-project-serbia?lang=en

Drainage in future climatic conditions and recommendations

Development of agriculture in BiH is inconceivable without a systematic solution to the problem of drainage and irrigation. The Integrated Water Management Strategies in Rrepublika Srpska[13] and Federation BiH[14], which take account of possible impacts change effects, envisage the development of drainage on 158,000 hectares of the highest quality land.

Drainage systems may prove to be particularly important if short-term episodes with heavy precipitation increase in future climatic conditions, as future climate scenarios suggest. Analyses indicate that the climate will be warmer and drier on average, but drainage problems will continue to occur in the colder part of the year (autumn–winter, early spring), so drainage canals should be maintained for exactly these reasons. Even in drier climatic conditions, heavier precipitation can be expected, along with an increased risk of flooding. In the coming period, it is necessary to review the drainage criteria, primarily three-day excess water during the growing season (spring) for multiple years, as well as ways to manage drainage systems in selected localities (e.g. Semberija, where an increasing precipitation trend has been observed, Tuzla, central Posavina, Herzegovinian karst fields) because in many places surplus waters were calculated on the basis of climatic data observed in the 1970s or only empirically. Precipitation in 2010 and 2014 can certainly be of use in revising the drainage criteria. Unfortunately, the requirements of intensive farming and climate change have not been considered so far, necessitating the consideration of new drainage criteria. A good model for that could be the new approach developed by the Dutch government, which has looked at water management in light of climate change, shifting the focus from increasing drainage capacity to "retain, store and only then remove" (*Ritzema H., 2013*). This approach not only reduces peak discharges, but also increases water storage in the soil profile to be used in periods with rainfall deficit. Given the new conditions, novel practices should be introduced to allow certain amounts of water to be retained for irrigation purposes in low-water periods. A study done in the south-eastern part of Serbia[15] has shown that the water intended for use during drought periods (July, August) can only be retained by stopping the operation of water evacuation pumping stations, provided that the water from the canal is captured for irrigation. Naturally, this is only possible in real-time water management conditions and with good connectivity to an early rainfall warning system run by the Hydrometeorological Institutes.

Irrigation

Irrigation is becoming an urgent need in the context of changing climate in BiH. Vegetable crops and modern orchards, such as potatoes, beans, onions as well as apple, pear, peach and berry orchards, especially those raised on shallow to medium-deep soils, will require increased use of irrigation in order to ensure regular yields and good yield quality.

13 http://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mps/Documents/STRATEGIJA%20%20TEKST%20RADNA%20VERZIJA.pdf

14 https://fmpvs.gov.ba/wp-content/uploads/2018/01/Strategija-upravljanja-vodama-FBiH-2010-2022.pdf

15 Group of authors, 2014: Drainage and irrigation systems in Podunavlje, Braničevo, Bor and Zaječar districts and possibilities of their use for irrigating agricultural land. Study, Ed. Faculty of Agriculture, University of Belgrade for the Ministry of Agriculture and Environmental Protection.

There are a total of 2,557,415 hectares of agricultural land in BiH, but not all of that area is suitable for irrigation. Only 46 percent of the land falls under arable land and vegetable gardens. Even most of these areas are not suitable for irrigation. Only 158,000 hectares in the territory of the Republika Srpska is suitable for irrigation[16] (only 23.5 percent of the area), and in Federation BiH[17] 80,800 hectares (17.8 percent).

The total area under irrigation in Republika Srpska currently comprises 2,180 hectares in the Trebišnjica River Basin and 2,604 hectares in the Sava River Basin.

There is no official data on irrigated areas or crops in the territory of the Federation of BiH. According to unofficial data, a total of about 362.5 hectares is irrigated in the Sava River Basin and about 1,250 hectares in the Adriatic Sea Basin. Overall, according to unofficial data, only 1,615.5 hectares, or 0.2 percent of arable land, is under irrigation in Federation BiH.

Although there is no data on irrigated crops, it can be concluded from the bulletin on plant production that the most irrigated crops are vegetables, such as tomatoes, peppers, cucumbers, cabbage and kale, followed by modern orchards (apple, pear orchards, etc. and newly planted raspberry plantations).
In the last 15 years, the territory of BiH has been under the influence of both dry and wet years. Although wet years were predominant, marked by catastrophic floods that caused great damage (2010 and 2014), the impact of droughts is not negligible, with especially dry seasons recorded in 2000, 2003, 2007, 2011 and in particular 2012, which was the driest in terms of intensity and affected area in the last 130 years since the monitoring started. According to estimates by the Association of Farmers, the 2012 drought alone caused damage to the tune of about US$1 billion[18].

Irrigation is very slow to develop, even where conditions for it are favourable. According to strategic water resource management documents, Federation BiH plans to bring its irrigation system to the pre-war level by 2022. This includes reconstruction of existing systems on 7,891 hectares of gross area in Mostarsko polje, Višićka kaseta, Cvilinsko polje, Odžak and Živinice. In the coming period (2015–2024), the plan is to continue revitalizing the irrigation systems at a pace of 500 hectares per year, so that all systems will have been revitalized after 14 years, (on an area of about 7,262 hectares). New systems are planned to be constructed on high quality land at a pace of 4,500 hectares per year, coupled with the consolidation of small systems into larger ones to improve water management. In total, development of irrigation is planned on 72,645 hectares, which is quite ambitious given the amount of necessary funds to be provided. According to the Federation BiH Water Management Strategy, bringing water to some land development areas necessitates the construction of reservorsirs, which greatly increases the costs of the irrigation system.

According to Koç (*Koç, 2011*), the cost of building irrigation systems varies from $2,626 to $11,489 per hectare for gravity fed systems and from $3,471 to $15,373 per hectare for pressurized systems, while cost estimates for two project areas in Serbia are in the range of €3,000 to €5,000 per hectare (*Potkonjak S., T. Zoranovic, 2013*). The lower prices are certainly the result of making use of the already built

16 Study into sustainable irrigation system development in Republika Srpska (2008).

17 Water Management Strategy of the Federation of Bosnia and Herzegovina (2010–2022), Federal Ministry of Agriculture, Water Management and Forestry, 2010

18 Climate Change Adaptation and Low-Emission Development Strategy for Bosnia and Herzegovina 2013, http://www.ba.undp.org/content/bosnia_and_herzegovina/en/home/library/environment_energy/climate-change-adaptation-and-low-emission-development-strategy-.html infrastructure or the fact that no large infrastructure facilities will be built. However, if a dam were to be built to accumulate water for irrigation purposes, the costs would certainly be considerably higher. Analysis of 211 areas in Turkey with irrigation systems in place shows that the average cost of building a pressurized irrigation system is $8,293 per hectare. Taking the average cost of an irrigation system, it is necessary, therefore, to secure about $600 million.

It is necessary to emphasize the efforts of both entity governments (Republika Srpska and Federation BiH) to improve farming and encourage all farmers to develop agriculture. This mainly concerns the provision of incentives from the budget to encourage farming and the development of irrigation systems.

Assessment of the possible impact of the RCP 8.5 climate scenario on irrigation demand

The projected rise in temperature, coupled with changes in rain and evaporation, is likely to have a significant adverse impact on agricultural systems in the country, especially in the Mediterranean areas and in the north. Extreme weather events, such as increased drought intensity, frequency of heat waves and heavy rainfall resulting in floods and landslides, are increasingly occurring and have already caused significant economic losses and environmental degradation (*Žurovec O, et al., 2015*). Adaptation approaches will, therefore, need to focus on improved water management and irrigation, new farming systems suitable for hotter and drier climates, and varietal improvements to local crops, in order to maximize agricultural production under more aridified conditions[19].

Crop yield response to climate change varies greatly depending on species, variety, soil condition, treatment of direct CO_2 effects, water availability and other location-specific factors. Vulnerability of the agricultural sector in BiH is the result of frequent droughts, which can cause a significant loss or reduction in yield. Soil drought and atmospheric drought are highly interrelated[20]. The average decline in yields as a result of drought is about 20 percent in BiH. A study has shown a decrease in yields for the most important crops (e.g. tobacco, peppers, corn, soybeans, potatoes, alfalfa) in the northern part of BiH (*Žurovec O, et al., 2015*). In this situation, irrigation is a measure that can reduce the problem of critical drought periods by improving and stabilizing yields. Due to the documented water shortages and increasing droughts, irrigation should meet about 33 percent of annual water needs for plants in the south, 14 percent in the north and 8 percent in central BiH. Agriculture must be protected not only from average droughts, but also from ones that occur once in ten years.

Owing to existing infrastructure-related constraints, current problems cannot be solved by a reliable irrigation system alone, as agriculture is considered one of the largest consumers of water and appropriate sustainable irrigation practices are rare. Irrigation will certainly be one of the key adaptation mechanisms, as will flood protection, drainage of excess water and regulation of water and air regimes in irrigation systems and/or in the soil. In general, this will be a priority for further development of the agricultural sector in BiH (*Vlahinić M. et al., 2001*). The first step towards meeting the various climate change adaptation measures is an accurate estimate of the reference evapotranspiration (ET0) for the

19 The Council of Ministers of BiH. (2013). Climate Change Adaptation and Low-Emission Development Strategy for Bosnia and Herzegovina. October 2013. PP 1–86p.

20 Vukmir G., Stanišljević Lj., Cero M. et al. (2009). Initial National Communication (INC) of Bosnia and Herzegovina Under the United Nations Framework Convention on Climate Change (UNFCCC), Banja Luka.

entire territory of BiH. Knowing that precipitation does not fully satisfy the water needs of cultivated plants, which negatively affects the yield of most agricultural crops (*Čadro S. et al., 2019*), reference evapotranspiration (ET0) is, in addition to soil and plant characteristics, the main input in any soil balance model and, therefore, constitutes a very important element in estimating the impact of climate change on irrigation needs (*Žurovec J, 2012*). Thus, an accurate estimate of ET0 is crucial for determining net and crop irrigation, irrigation schedule support, irrigation water management, drought and flood analyses, and climate change impact models.

In addition to the effects of drought, negative effects of frost on the agricultural sector have been recorded in BiH. Negative effects of spring frost are similar in all regions, while the increased presence of late crops (most notably fruits) in the southern region is the key reason for damage caused by autumn frosts. These frost-free periods will continue to increase according to future climate projections for BiH, affecting crop production (*Žurovec O, 2019*). For this impact, irrigation needs have to be updated in the same way as the irrigation schedule to cope with frost by creating a protective layer of ice water that keeps soil temperature constant around the crop.

Based on these results, priority areas could be identified for regionally specific adaptation measures, protection against natural hazards (drought, floods, landslides, etc.) and disaster risk reduction actions.

Possible disadvantages and limitations of irrigation

The main causes of the slow increase in areas under irrigation are:

- economic instability (instability of product prices, high bank interest rates, lack of markets, observed reductions in livestock and processing capacity),
- lack of strategy and plan for developing irrigation in agriculture,
- poor infrastructure (inadequate road network and inability to connect irrigation pumps and valves to power network in remote farms),
- state of repair of drainage canals (terrain drainage is an essential condition for irrigation),
- professional/advisory assistance,
- better supply of raw materials (high-yielding varieties and hybrids, mineral fertilizers, plant protection products, manure to repair and preserve soil fertility),
- age structure of farming population,
- EF (ecological flow), where there is no balancing of water with reservoirs.

When developing irrigation, one should take into account possible difficulties that may arise in practice. Thus, if there are not enough farmers interested in irrigation, the problem can be twofold: the cost-effectiveness of bringing water to a plot and the cost-effectiveness of irrigation on the plot. Past research[21] has shown that irrigation can be profitable if at least 60 percent of the total number of owners/users use an irrigation system in one irrigated area. Managing the systems is also one of the potential problems. In many countries, individual irrigation systems are managed by Associations of Water Users. There are examples of good practice in Herzegovina. However, there are also examples of bad practice, where the newly established system management method was sustainable only during the project. In order to prevent such problems from happening again in the future, it is necessary to analyse why the new

21 www.water.worldbank.org/publication/case-studies-participatory-irrigation-management

management method is unsustainable.

The complexity of irrigation is reflected in the fact that the irrigation method needs to be adapted to the given topographic and soil conditions, and the requirements of plants in terms of water and crop rotation. The amount of water available for irrigation determines the possible irrigation area, and water needs to be of certain quality to ensure the production of safe food and long-term sustainability of soil quality. Excessive capturing of fresh groundwater for irrigation can cause secondary salinization, which is currently found to be happening in the Neretva Valley in Herzegovina. If this process is not stopped by using water accumulated in reservoirs instead of groundwater during the winter period, such lands can be permanently degraded and rendered infertile.

In addition to all environmental requirements, economic viability must also be met. Indeed, irrigation enables higher production values, but it also requires increased investment, from 10 to 30 percent[22]. Therefore, an in-depth cost-effectiveness analysis is needed in some areas. Also, it is necessary to identify whether there is infrastructure in place to ensure the supply of raw materials and export of manufactured products, and whether there is a market able to buy and process the entire harvest, which calls for an analysis of the structure of registered farms and analysis of plot size, crop production, processing capacities, etc.

Given that BiH is an exporter of electricity[23], it is assumed that the existing capacities will be able to provide enough energy for the operation of irrigation pumps, but the country will not be able to export it or will do so on a smaller scale, because introducing irrigation requires the construction of further facilities such as cold storage rooms, dryers and other food storage and processing equipment. Based on past analyses, it was estimated that 0.64 kW of power needs to be provided per hectare for pumps only, or a total of 56.2 MW for the planned 87,798 hectares.

From the ecological point of view, when irrigation is employed, it is necessary to provide enough organic matter in order to preserve soil structure, which is the basic precondition for fertility. In irrigation, organic matter in soil undergoes intensive mineralization, leading to soil depletion and desertification. To prevent this, manure needs to be applied. The optimal amount of manure per hectare is provided by two heads of cattle (cattle, horse). The European average is one head, in Federation BiH[24] the average is 1.3, and in Republika Srpska[25] only 0.7 head per hectare. Therefore, in order to preserve the land, in parallel with irrigation, animal husbandry needs to be maintained at the existing level in Federation BiH, and developed (improved) further in the area of Republika Srpska, especially near irrigated fields.

22 Draft Water Management Plan for the Sava River Basin in the Federation of Bosnia and Herzegovina (2016–2021). Capacity building in the water sector. EU IPA project 2011, February 2016

23 Economic accounts and prices in agriculture. Statistical Bulletin no. 1- 6. Republic Bureau of Statistics, Republika Srpska Group of authors 2014 Inventory of agricultural land situation and use in the Herzegovina region, ed. USAID, Mostar BiH.

24 Statistical Yearbook of the Federation of Bosnia and Herzegovina 2015. Federal Bureau of Statistics. FBiH

25 Statistical Yearbook of the Republika Srpska 2015. Republic Bureau of Statistics. Republika Srpska

Climate change impact on fruit production and viticulture

According to statistics, fruit orchards are spread across 97,000 hectares. The most common fruits are plums, followed by apples, pears, walnuts, cherries, sour cherries, apricots, raspberries and strawberries. Based on the number of fruit-bearing trees, it can be concluded that this is largely production on small family farms, in a rather extensive way. However, it should be noted that fruit production is still developing throughout the country. Modern cultivation technologies are applied, especially in Herzegovina[26], which are completely adapted to contemporary climatic requirements and can be applied in future climatic conditions. Orchards will be most affected by climate change due to their long vegetation. Indeed, high temperatures and more intense solar radiation cause burns, affecting the quality and class of fruits. Prolonged dry spells require the use of irrigation, which increases production costs and market competitiveness. On the other hand, heavy rainfall during the flowering and ripening of fruits, especially cherries, sour cherries and berries (strawberries, blackberries, raspberries), causes mould to occur, which either leads to a loss of yield or requires the use of more pesticides, creating a risk of excessive pesticide residue in fruit and inability to sell.

To facilitate recommendation of appropriate measures to mitigate climate change impacts, an analysis of water surpluses and shortages in the areas of Banja Luka, Bijeljina and Mostar was performed. The analysis was done on the basis of the difference between water income (precipitation) and water expenditure (evapotranspiration). Account was taken of the fact that the orchards were mostly grassed in order to prevent erosion on sloping terrains, facilitate movement of farm machinery and ensure integral plant protection. Each fruit species has its own specific water requirements, so before designing a drainage/irrigation system, detailed analyses need to be performed to determine the peak water consumption period in order to be able to ensure adequate supply of water. For the purposes of strategic planning, such calculations give a clear picture of the level of measures that need to be taken in the future.
Analysis of surpluses and shortages of water for fruit crops and perennial grasses clearly shows the periods of excess water in the colder part of the year in all scenarios and time periods (negative values). Excess water is most pronounced in the area of Mostar, i.e. all Herzegovinian karst fields, so maintenance of the drainage network is an essential prerequisite for engaging in any plant production, especially fruit production, which requires much stricter drainage criteria. Maintenance of existing drainage systems or construction of new ones is imperative in these areas as it will make it possible for vegetable crops (lettuce, potatoes, sweet corn, beans, melons, watermelons, etc.) to be sown earlier, which creates advantages such as earlier appearance on the market and better economic effect, and, with irrigation development, two harvests a year.

Another disadvantage is a shortage of water in the summer, in all areas. Looking at the time periods, in the near future situation will be most favourable in the Banja Luka area, especially on deep soils that retain up to 200 mm of water, which greatly mitigates the consequences of drought. On shallower soils orchards will be at greater risk. In the area of Bijeljina, even the water accumulated in the land profile will not be able to compensate for the required amounts of water. Due to the shorter but intense period of drought in the area of Mostar, the water deficit is somewhat smaller than in Bijeljina, but due to the predominantly shallower soils (89 percent), the actual deficit is most pronounced.

Around the middle of the century, higher water deficits are expected, on average up to 30 percent. As a result, orchards and grasslands will also be affected by drought. By the end of the century, water deficits

26 Group of authorsrs (2014) Inventory of agricultural land situation and use in the Herzegovina region. USAID, Mostar, BiH.

could double from their current level.

Climate change impact on livestock farming

Climate change can certainly affect livestock production due to feed shortages, which can reach serious proportions due to drought. Another disadvantage that may occur is the drying out of water sources for livestock watering. The third disadvantage, albeit occurring less frequently, concerns potentially excessive temperatures in stables, barns and poultry houses, necessitating the use of appropriate cooling devices, such as an adapted irrigation system that can create water droplets in the form of mist, which evaporates and lowers the temperature in the building.

Plant production in future climatic conditions

According to the RCP8.5climate scenario, an increase in the number of consecutive dry days can be expected, except in a few smaller parts of the territory of Bosnia and Herzegovina. For the near future period, under all three scenarios the change is from 0 to 5 percent more dry days in most of the country, and only in smaller parts of the country this change is from 0 to -5 percent. For the RCP8.5 scenario, the change in the number of consecutive dry days increases considerably for further weather horizons, and for the period 2036–2065 it amounts to 10 to 20 percent more dry days, while the change is most pronounced during the last period amounting to 20 to 30 percent more dry days in most of the territory of Bosnia and Herzegovina. Finally, the continued rise in temperature will lead to a prolongation of the growing season.

Besides change in the length of the dry season, there will also be an increase in the number of tropical days and tropical waves. Projections of changes in the increase in precipitation accumulation over 20 mm indicate an increase of 20 percent. The growing season is expected to increase from 10 days in the near future to 50 days by the end of the century, and as many as 70 days at higher altitudes. All the above projections of climate indices indicate the need to monitor changes, consider risks and constantly adjust adaptation measures, such as hydrotechnical measures, cropping practices, etc., in order to ensure stable and successful agricultural production.

Seasonal weather forecasts in agrometeorology

Seasonal agrometeorological forecasts are increasingly gaining in importance in the context of a changing climate. Therefore, knowledge of future weather conditions is important in timing farmwork in order to optimize agricultural production and reduce risks, that is, reduce economic losses. In that sense, not only short-term forecasts, but also seasonal weather forecasts (SWFs; so-called long-term forecasts – from several weeks to several months) are of great importance. According to climate change impact studies, extreme weather events and adverse weather conditions can be expected to occur more frequently in the Central European region in the future. Operational use of SWFs can help optimize field operations and applied agricultural management practices and thus reduce risks in crop and livestock production (e.g. early warnings of late spring frosts, droughts, heat waves or high solar radiation). Also, the use of SWFs as input meteorological data in agrometeorological models and crop production models enables the forecast of plant development and yield several weeks or months in advance. In the case of solar radiation, an improved forecast of radiation intensity can help to properly time the removal of leaves in vineyards, release of livestock to pasture and provision of protection, assessment of the impact on plant growth and development, and planning of measures to reduce the risk of leaf damage.

Agroclimatic zoning of BiH, according to the RCP8.5 climate scenario by 2100.

Four distinct agroecological areas can be identified in BiH: the lower Herzegovina area (including the upper Neretva and karst fields), the high karst area with karst fields, the central hilly-cum-mountainous area with river valleys and the lowland hilly area (including serpentine and flysch zones).

High karst area with karst fields – According to the RCP8.5 climate scenario, this agroecological region is particularly exposed to the impact of heavier precipitation and, consequently, greater erosion. Also, forest fires are expected to occur more frequently in this region. As this is a mountainous region, if the changes in climate materialize by the end of the 21st Century as forecasted, forest communities can be expected to come under a considerable impact and their ranges to move up into higher zones.

Lower Herzegovina area (including the upper Neretva and karst fields) – According to the RCP8.5 climate scenario, a more intense increase in temperature and increased water demand are expected during the summer months. Base on the results of this climate scenario, a larger increase in temperatures and a decrease in precipitation are expected, especially in the second half of the century. Also, threats can be posed by heavy rainfall, which is expected to increase in the period 2016–2035 and especially in the period 2081–2100. Apart from the foregoing, the climate scenarios also indicate an increase in the number of hail days and warmer winters with a decrease in snow cover. Based on all the above, the agroecological region of Lower Herzegovina is expected to see further intensification of climate change and, in particular, climate extremes. This calls for better tailored adaptation to the emerging climatic conditions and their impact on the agricultural sector.

Central hilly-cum-mountainous area with river valleys – Compared to others, this agroecological region is under least threat from climate change. The greatest pressure can come from heavy precipitation, which can cause intense erosion and torrential floods, especially in the higher parts of this region. Higher temperatures, milder winters and reduced precipitation can be expected in valleys, which will also cause the occurrence of droughts, especially under the RCP8.5 climate scenario by 2100.

Lowland hilly area, including serpentine and flysch zones – This agroecological region is under quite an impact by climate change. The pressures include an increase in heavy precipitation, which can cause floods and various degrees of excessive wetting, from waterlogging to swamping of lowland arable land, as well as an increase in the intensity and frequency of heat waves, droughts, windstorms and hailstorms. All these are already exerting a damaging impact on the planned development of agriculture. Also, warm winters have a distinctly negative impact, causing atypical blossoming of fruit trees in the winter period and, consequently, poorer yield, in terms of both quantity and quality of fruit produced in the following year. Another serious problem is posed by late spring frosts, which partly or completely destroy fruit trees in bloom, in particular those species and varieties that bloom a little earlier, due to the extended growing season. According to the RCP8.5 climate scenario, by the end of the 21st Century (2100), these climate extremes will be occurring ever more frequently.

7. Water resources

Bosnia and Herzegovina is a country with good availability of water resources, with a dense river network in the Sava River Basin and a less developed network in the Adriatic Sea Basin, and with substantial groundwater resources. One of the basic characteristics of the BiH river network is the large number of watercourses belonging to the category of international watercourses: the northern border of BiH is formed by the Sava River, while the Una River forms a significant part of the border in the west and the Drina River in the east. In BiH, the total annual rainwater resources are 63.9 km^3. The average annual runoff from the Sava River Basin is 722 m^3/s, or 62.5 percent, while the runoff from the Adriatic Sea Basin is 433 m^3/s, or 37.5 percent, from which it follows that the average annual runoff coefficient is about 0.57[27]. An extremely high runoff coefficient indicates that the runoff regimes even in larger rivers are of torrential character with very fast flow concentrations. Another unique feature of the natural hydrological regime in Bosnia and Herzegovina is the extremely unfavourable temporal and spatial distribution of water.

Water management in Bosnia and Herzegovina is governed by the Water Laws of the entities (Federation of BiH and Republika Srpska), which are already largely aligned with the EU Water Framework Directive and the EU Directive on the Assessment and Management of Flood Risks. Water Laws in BiH (jurisdictions of Federation BiH and Brcko District), along with their accompanying implementing regulations, are implemented via three basic branches of water management: water use, water protection and protection against harmful effects of water. Institutionally, the responsibility for water management belongs to the Ministry of Agriculture, Forestry and Water Management in Republika Srpska along with the Public Institution "Vode Srpske" and the Federal Ministry of Agriculture, Water Management and Forestry in the Federation of BiH along with the Sava River Basin Agency and the Adriatic Sea Watershed Agency. The state-level Ministry of Foreign Trade and Economic Relations of BiH has an organizational unit for water, charged with overall coordination at the national and international levels. Strategic documents developed at the level of the entities of Republika Srpska and Federation BiH include the 2010–2022 Water Management Strategy of the Federation of BiH and the 2015–2024 Integrated Water Management Strategy of Republika Srpska. In Federation BiH, the 2016–2021 Water Management Plan (WMP) for the Sava River Basin and the Adriatic Sea Watershed has been prepared.

The development of updated WMPs for the Sava River Basin and the Adriatic Sea Watershed for the period 2022–2027 is underway. At the state level, the BiH 2014–2017 Flood Protection and River Management Action Plan was developed and adopted after the 2014 catastrophic flood. Also, Flood Hazard Maps have been prepared, and the development of the Flood Risk Management Plan is underway. The first River Basin (District) Management Plans for the Sava and Trebišnjica basins were adopted in 2017 and preparation of second plans for both basins is currently underway. The Sava River Basin (District) Management Plan of Republika Srpska (2018–2021) and the Trebišnjica River Basin (District) Management Plan of Republika Srpska (2018–2021) were adopted by the Government of Republika Srpska in 2018 (Official Gazette of Republika Srpska, No. 14/18).

Water systems are expected to be exposed to the impacts associated with climate change, and the projected changes in precipitation and air temperature are expected to adversely affect the current

27 http://www.msb.gov.ba/PDF/PROCJENA_UGRO%C5%BDENOSTI_BIH_07102013.pdf

water resources management system in Bosnia and Herzegovina. The Climate Change Adaptation and Low-Emission Development Strategy for BiH and the Initial, Second and Third National Communications of BiH under the UN Framework Convention on Climate Change were used, in addition to the aforementioned documents, as a basis for developing the climate change adaptation plan for water resources in BiH, while the drafting of the Fourth Communication is currently underway. Also, various reports by domestic and international institutions and organizations, as well as papers and analyses by domestic and international experts, were used as sources of data as and when necessary.

Floods and droughts in recent decades in BiH

In the last two decades, Bosnia and Herzegovina has been hit by several extreme floods. In April 2004 severe floods struck 48 municipalities in the Una, Vrbas, Bosna and Drina river basins. About 20,000 hectares of agricultural land and 300,000 people were under threat from flooding, of whom several hundred families were evacuated. In December 2010, precipitation exceeded the 100-year record, causing floods that were particularly pronounced in the Drina River Basin and eastern Herzegovina. The towns of Goražde, Zvornik and Bijeljina, as well as some smaller communities, were inundated. In Republika Srpska and the Federation of BiH large areas were flooded, of which a large part was agricultural land, and houses, roads and bridges were destroyed or damaged.

In mid-May 2014, BiH and the wider region were hit by extreme floods. The floods followed after several days of rain (the highest precipitation on record since the beginning of organized measurement 120 years ago), which coincided with the melting of snow that contributed to an extreme rise of water levels in a very short time, especially on the rivers Bosna, Sava and Drina and their tributaries. On 17 and 18 May 2014 embankments broke in several places along the Sava River and its main tributaries, causing floods and great material damage in the areas of Central Posavina, Odžačka Posavina and Semberija. Additional damage in the basin was caused by the occurrence of numerous landslides, some of which completely reshaped the environment. Year 2014 was marked by floods, erosion, torrents and landslides. After the May flood, already in July, August and September 2014 heavy rainfall caused new flooding problems in the areas devastated by previous flood.

In addition to the aforementioned major flood events, in the last two decades there have been many situations where rivers burst their banks in places, flooding nearby settlements and roads. Due to the relatively fast reaction of the catchment area to lower intensity precipitation, coupled with the short travel time of flood waves, there are often coincidences of flood waves of Sava tributaries and lower-order tributaries, as well as high Sava waters.

In the Adriatic Sea Watershed (Trebišnjica and Neretva), where there are multi-purpose water management systems in place[28], hydrological regime is more or less influenced by the management of these systems. In December 1999 a large flood wave of the Neretva River caused enormous damage in Mostar, as well as in the entire lower Neretva region. In 2004, when the Sava River Basin in BiH was hit by severe floods, extremely high water levels with occasional overflows were also recorded in the Neretva River Basin.

28 Most of these systems were put in place following the construction of large hydropower facilities.

In recent decades the country has seen an increase in the frequency of extreme droughts (2000, 2003, 2007, 2012 and 2015). The extreme drought of 2000 affected the wider region, causing damage to about 60 percent of agricultural production in BiH. In the spring and summer of 2003, the whole country was hit by a severe drought, with northern BiH being hit harder than three years earlier in 2000. There has been a deficit of precipitation in almost all parts of BiH since February 2003. This deficit is particularly pronounced in the Bijeljina region, which is one of the main production regions in Republika Srpska, where the humidity deficit in the first four months was 49 percent. The lack of precipitation in the summer of 2003 also caused a hydrological drought, resulting in a decrease in surface and groundwater supplies.

Floods and droughts cause great damage in BiH; however, there is a lack of statistics in the entities of Republika Srpska and Federation BiH and at the BiH level on the total annual amounts, as this type of data are still not collected by the entity- and state-level statistical institutions. Table 1 below shows the available data on flood and drought damage in BiH.

Table 1.
Available data on flood and drought damage in BiH

Flood damage

Year/average for the period	Bosnia and Herzegovina	Federation BiH	Republika Srpska	Brčko District
1976	BAM 191,788,328[29]			
1976–1980	BAM 162 million per year (Source:/13/)			
2001		Government of Federation Bosnia and Herzegovina allocated BAM 6,730,178.00 for remedying the consequences, and the damage was to the tune of over BAM 50 million (Source: /13/)		
2004		BAM 23,933,792.86 The flood affected 13,455.95 hectares of agricultural land (Source: /13/)		
2010		Over BAM 87 million (Source: /13/) Over € 50 million Over 140,100 hectares of land flooded, of which about 91,360 hectares of agricultural land (Source: /14/)	Over € 26 million 100,649 hectares of land flooded, 48 buildings destroyed, and 1,513 buildings damaged. 15 bridges destroyed and 40 damaged (Source: /15/)	
2014		BAM 1,083,625,124.20 30,478 ha of agricultural land flooded; 14,415 residential buildings damaged in flooded and landslide-prone areas (Source: /16/)		
2014 Assessment from the RNA document, prepared with EU, UN and WB assistance	Consequences of natural disaster in BiH: 23 casualties, total damage € 2,037 million (Source: /5/)	Total consequences of this natural disaster are € 1,040 million in Federation BiH (Source: /5/)	Total consequences in Republika Srpska amount to €968.30 million (Source: /5/)	Total consequences in BD amount to €29.6 million (Source: /5/)

29 Source: SIZ Vodoprivrede SR BiH – Basic characteristics of water management SR BiH, 1980. Calculated according to exchange rate DEM 100 = 766.47 dinars, as valid on 31 December 1976 – Excerpt from the table of the Association of Yugoslav Banks for the period 1973–1991

Analysis of possible impacts on water resources under climate scenarios

Year/Source	Damage
2000	Worst drought on record in 120 years about 60% of agricultural production affected
2003	€ 200 million
2007	Over 40% of agricultural production destroyed About 250 hectares of land affected
2012	Losses of $1 billion in agricultural production 70% reduced grain and vegetable yields
2015	$176 million

Influence on the hydrological regime – increased variations

Changes in the hydrological regime in recent decades in BiH are seen in the amounts and dynamics of precipitation, as well as water levels and river flows. Under the influence of climate change, growing urbanization and other anthropogenic factors, the adverse consequences of spatial and temporal variations in the hydrological regime can be expected to occur ever more frequently in agriculture, water management, hydropower, and in both urban and rural areas.

In relation to the foregoing, changes can be expected in terms of time of timing, frequency and intensity of extreme events – floods and droughts. The largest increase in air temperature is predicted in the growing season (June, July and August), and a slightly milder increase during March, April and May, which will result in increased evapotranspiration and more pronounced extreme minimums of water levels in watercourses. This will result in a general reduction in the availability of water resources in the growing season, when water demand is the highest in terms of both water quantity and quality, because the risk of water quality degradation increases in low-water periods. A significant increase in air temperature during the winter season (December, January and February) will result in a decrease in snowfall and, consequently, decrease in streamflow in most watercourses in the spring months. On the other hand, the expected increase in the frequency of heavy precipitation will cause sudden swellings, often in the form of floods.

This is especially unfavourable given that the runoff regimes even in larger BiH rivers are of a torrential nature, with very fast flow concentrations.

With the increase in temporal variations, the problems related to pronounced spatial variability are exacerbated too – the poorest in water are the parts of the country with the highest water requirements, valleys with the greatest land potential for intensive agriculture with irrigation and where the population is the largest[30].

30 About 40 percent of the population live in the Bosna River basin, and the Bosna basin accounts for approximately 14 percent of the total available streamflow in BiH.

Impact on water supply

Due to the variations in streamflow, with longer low-water periods, problems can be expected to increase at numerous water supply sources, in terms of both water quantity and quality. Periods of water cuts in water supply systems are increasing in low-water periods throughout the country.

In the Federation of BiH, groundwater makes up 85 percent of the total amount of water abstracted for water supply. Groundwater from fissure-karst environments, which is particularly sensitive to pollution ingress, accounts for 52 percent. Systematic observations of groundwater quality are non-existent, and conclusions about the quality of this water resource can be drawn from water quality data captured for water supply needs of the population, which shows that the quality of groundwater resources is still generally good.

According to the Federation of BiH Water Management Strategy, about 60 percent of the population is covered by public water supply systems (in urban areas the coverage is 94 percent, while in rural areas the coverage is much lower, at about 20 percent)[31].

According to the Republika Srpska 2015–2024 Integrated Water Management Strategy, about 48 percent of the population are connected to the water supply systems of municipal centres, about 12 percent are connected to the water supply systems of local communities, and about 40 percent get their water from individual wells or springs. It follows that about 60 percent of the population of Republika Srpska are supplied with water through organized piped water supply schemes[32]. The ratio of waters abstracted for water supply in Republika Srpska is as follows: 31 percent is abstracted from springs, 46 percent from wells and 23 percent from rivers, lakes and reservoirs. The quality of springs in the river alluvium is under threat in low-water periods, and in some cases in flood situations (the case of Doboj). Water supply in rural areas is very vulnerable to climate change due to the increased risk of water quality and quantity disruption during prolonged droughts, but also periods with floods. Problems in water supply for industries in BiH can be expected to grow in future in terms of reduced amount of available water, which will depend on the growth of industrial production.

Average water losses in water supply systems in Republika Srpska are about 48 percent. According to the data for the Sava River Basin in the Federation of BiH, losses amount to an average of 57 percent of the total quantities of abstracted water, and in some waterworks in Federation BiH up to as much as 80 percent. Based on the above data on water losses in water supply systems in the Federation of BiH and Republika Srpska, it is evident that the growing demand for water in the future stands at odds with the climate-induced reduction in available water. Expanding the capacity of existing water sources or creating new sources to provide extra water is not a sustainable solution to the water supply problem. The current water supply is inefficient and characterized by huge system losses, economically inefficient municipal water rates and poor organization of public water utility companies.

Impact on flood protection

After the 2010 and 2014 floods it has become clear that BiH is in a region that is particularly vulnerable to the effects of climate change: floods that were previously very rare have now become more frequent and devastating.

31 https://fmpvs.gov.ba/wp-content/uploads/2018/01/Strategija-upravljanja-vodama-FBiH-2010-2022.pdf

32 http://www.voders.org/wp-content/uploads/2017/2015-2024.pdf

In areas where the primary purpose of constructing protection facilities was to protect farmland, the most commonly used measure was the construction of embankments, and often hinterland water evacuation facilities were also built as part of the solution to the flood problem. The aforementioned flood protection facilities were used to form polders/cassettes with independent flood protection systems. The Republika Srpska Integrated Water Management Strategy for the period up to 2024 envisages substantial investment in the flood protection sector and rehabilitation of existing and construction of new flood protection facilities. The 2014 flood uncovered serious shortcomings in the existing flood protection system, as well as enormous flood damage. In 2014 and 2015 the Republika Srpska Government took an EIB loan to rehabilitate the existing flood protection facilities, specifically rehabilitation of defensive embankments along the Sava River and cleaning and management of the existing facilities for drainage of highland and hinterland waters. Activities are underway aimed at reconstruction of the existing 19 pumping stations for pumping hinterland waters into recipients. The total value of the investment is €50 million. Also underway is the preparation of technical documentation for the construction of a defensive embankment along the Drina River on the 33-kilometre-long section from the confluence with the Sava River to the settlement of Johovac/Janja. Funding in the total amount of $12 million was secured from a World Bank loan[33].

The northern part of the Federation of BiH is made up of Odžačka Posavina (with an area of 185 square kilometres) and Middle Posavina (area 160 km^2), located in the immediate Sava basin and protected from floods by polders, Sava defensive embankment, embankments along the Bosna River (about 73 km long) and peripheral canals (about 22 km long). Flood protection solutions were implemented in larger settlements along the Bosna River, namely Visoko, Kakanj, Zenica, Zavidovići, Doboj and Odžak. Flood protection facilities were constructed in a piecemeal fashion. Often construction works were done along one bank only and, as a rule, due to lack of funding, along shorter sections, failing to provide requisite levels of protection. Flood risks are present in all karst fields in the Neretva basin. As regards the Drina River, flood protection efforts aimed at stabilization of the Drina riverbed have been done in a piecemeal fashion and are not sufficient to provide safe levels of flood protection[34]. The available hydrological data (historical records of maximum flow rates and water levels) suggest that, on the whole, the highest risk of flooding in the Federation of BiH today is present in the Una River sub-basin.

On the sections of watercourses where these flood protection facilities were constructed to protect urbanized, built-up areas, the solutions were typically designed in such a way as to increase the depth of existing riverbeds and lining the banks with the aim of increasing flow capacity and thus preventing water overflows, while occupying the least possible (urban) area.

Reconstruction and freeboard (superelevation) construction works are underway on sections that do not meet the high-water superelevation criteria. The Sava defensive embankments were designed and built for protection against flood events having a recurrence interval of 100 years (hundred-year floods). It is considered that the reconstruction and construction of a 1.20 m freeboard above the 100-year flood level provides protection from 1000-year floods on the Sava River. However, the actual level of protection remains unknown due to the limited scope and quality of the data used to make size calculations. With the frequent occurrence of extreme streamflow values, the distribution of the probability of occurrence has changed such to necessitate construction of superelevation (higher freeboard) to provide protection against floods with a specific recurrence interval.

33 http://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mps/Documents/STRATEGIJA%20%20TEKST%20RADNA%20VERZIJA.pdf

34 file:///D:/Strategija-upravljanja-vodama-FBiH-2010-2022.pdf

Due to the growing population and larger and more expensive facilities requiring protection, vulnerability is increasing, so flood defence can no longer be implemented successfully by using passive measures only (which include the construction of embankments). Experience has shown that existing passive protection measures increase the risk downstream, indicating the need to focus on active measures by designating areas for reservoirs or retentions. As part of the activities to implement the EU Directive on the Assessment and Management of Flood Risks, a number of important documents have been prepared or are being prepared in BiH, which form the basis for assessing actual and potential damage and preparing flood risk management plans: preliminary flood risk assessments have been made, and projects aimed at the development of hazard maps and risk maps, in accordance with a single methodology adopted for BiH, are in progress. Several projects are underway aimed at putting in place a hydrological flood forecasting and early warning system (Sava Commission project, etc.). Also ongoing is an IPA project for the development of a Flood Risk Management Plan in BiH (of Republika Srpska and Federation BiH and Brčko District) is underway, which will identify priority areas for flood protection interventions to be implemented in the course of the planning cycle.

The occurrence of heavier precipitation will exacerbate flooding problems in cities. This is primarily due to the lack of proper maintenance and, sometimes, the insufficient drainage capacity, when the sewage system cannot receive high amounts of water in a short timespan (example: 102 l/m^2 of rain fell in half an hour on 29 August 2000 in Banja Luka /22/). However, due to the constant increase in the value of urban infrastructure and property of citizens, the damage is growing, that is, vulnerability is increasing along with the growth of the population in cities and river valleys, thus also increasing the need for their protection in the future.

Deforestation and conversion of land without hydrotechnical and other improvement of potential gullies result in increased occurrence of torrents that cause great damage over very short timespans, often in urban areas and on roads.

Climate change impact on the hydropower sector

There is a clear consensus on the impact of conventional fossil fuel energy production on climate change. However, the impact of climate change on the energy sector has remained underestimated until recently. It is only in the last few years that the world has come to realize how and to what extent climate change can affect the operation of existing and future energy production systems. The energy sector is vulnerable to the impact of climate change in a number of ways. Changes in temperature, precipitation and frequency of extreme events affect both the amount of energy produced as well as the amount of energy delivered to and consumed by end users. The impacts of climate change on the energy sector are generally grouped as follows:

- seasonal and daily temperatures and changes in precipitation affect the periods of peak energy demand as well as the magnitude of these peaks;
- prolongation of dry periods leads to reduced availability of water for hydropower plants, thus limiting the capacity to produce electricity;
- changes in temperature and precipitation affect the availability of water needed for cooling in power plants;
- changes in cloud distribution, temperature and air pressure directly affect the yield and reliability of wind and solar sources, which directly brings into question the availability of these renewable sources and their productivity;
- increased intensity and frequency of severe weather events affect the state of repair of the entire

energy infrastructure, including power plants, transmission lines, refineries, pipelines and power lines, resulting in supply disruptions.

Estimates of the possible impacts of the IPCC RCP 8.5 scenario on water resources – level and streamflow trends

Quantifying the future impact of climate change on streamflow is a comprehensive water management task crucial for mitigating this impact. In order to project the effects of climate-change-induced precipitation on runoff and discharges (including peak and dip streamflows), it is necessary to develop databases and model runoff for all basins in BiH. However, some lessons can be learned from already developed studies that have assessed some types of streamflow regimes, such as Flood Hazard and Flood Risk Maps Project in Bosnia and Herzegovina (FHRM BiH)[35].

The FHRM BiH Project has identified the potential impact of heavy precipitation on floods in BiH, using the existing HEC-HMS hydrological model of the Sava River Basin, including its tributaries in BiH. Unfortunately, no corresponding models for the Adriatic Sea Watershed in BiH were available, so estimates of future floods are possible only for BiH tributaries of the Sava River, namely Korana, Glina, Jablanica, Una, smaller rivers that flow directly into the Sava, Vrbas, Bosna and Drina rivers. Hydrological modelling has shown that the upper quarter (75th percentile) of the 100-year daily rainfall value generates an increase of at least 23 percent under RCP 8.5 in the future 100-year peak streamflows of the BiH river by the end of the 21st Century.

Analysis of the possible impacts on the hydropower sector according to climate scenarios

Increase in temperature, as one of the climate change indicators, certainly affects the amount of final energy required by the end user, on the one hand, and the ability to produce electricity and its reliable delivery and transmission, on the other.

- In terms of final consumption, increase in temperature leads to increased energy demand for cooling, which can be more or less significant depending on the climate zone of the given area. It is assumed that an increase in temperature by 1 °C to 2 °C would lead to a three to six percent increase in energy demand for cooling. In parallel with the increase in energy demand for cooling, there is a decrease in energy demand for heating, which also varies depending on the climate zone. Under the climate change scenarios analysed herein, higher winter temperatures could very likely lead to a four to eight percent decrease in energy demand for heating. Such changes in energy demand are very likely to lead to summer peaks in electricity consumption. In order to accommodate such peak demands, investment in new energy infrastructure may be needed in some areas.
- Higher temperatures also lead indirectly to a decrease in the efficiency of thermal power plants that use water for cooling. Namely, colder water means greater efficiency of power production. Thus, higher water and air temperatures also mean lower overall plant efficiency.
- Energy and water systems are generally integrated, so the impact on other sectors extends on the energy sector, too, through increased energy demand for pump operation and distribution and treatment of water and wastewater
- Climate change is further compounding the problems associated with low water levels in rivers. The expected reductions in summer rainfall in inland areas could lead to a drop in electricity generation in hydropower plants, which could in turn jeopardize energy security. Past experience has shown that

35 https://www.voda.ba/mape-rizika

droughts have indeed contributed to reduced electricity generation in hydropower plants. Available analyses show that even a slight decrease in inflow has a significant effect on electricity generation, and that a one-percent reduction in inflow may be responsible for a three-percent reduction in energy generation.

Photo 1.
Bilećko Lake in 2017

Hydrologically, the year 2017 was very unfavourable for the territory of Eastern Herzegovina, that is, the Trebišnjica river basin. As a result, the water level of the Bilećko Lake (Photo 1) was very low, affecting electricity generation in HPP 'Grančarevo'.

Taking into account variations in precipitation and variations in seasonally available and effective inflows, the total reduction in generation can range up to 30 percent. Infrastructure and hydropower generation face an additional problem which may occur in the event of floods: more frequent and heavier rainfall will lead to intense runoff and increased river water levels, when energy generation may not be possible due to potential (or actual) damage to infrastructure. In short, the operation of hydropower plants largely depends on the inflow of water. River water levels in Bosnia and Herzegovina are likely to become increasingly unpredictable, creating significant challenges for the hydropower sector, especially during periods of low water levels. This problem needs to be addressed through improved water resources management at the basin level.

- As has been noted earlier, more frequent and intense heat waves are likely to boost electricity demand, especially in urban areas and industrial centres. At the same time, these areas are likely to experience reductions in water supply due to decreased precipitation and/or increased temperature and evaporation.
- Hydropower plants are sensitive to the amount and timing of inflows. A decrease in inflow, however slight, significantly reduces power generation. In some regions, especially during increased precipitation, hydropower plants will need to adjust their operations to avoid downstream flooding.

Groundwater vulnerability and climate change

Atmospheric composition, air mass movements and anthropic activities might indicate changes in natural regions. Reduction of runoff and pollution of surface waters, depletion of the groundwater table and decrease of the springs discharge are some aspects influenced by the recent climate change (*Mărgărit-Mircea Nistor, 2019*). The impact of climate change on groundwater vulnerability has been assessed in the Pannonian basin over 1961–2070. High-resolution climate models, aquifers composition, land cover and digital elevation model were the main factors that served to perform the spatial analysis using Geographical Information Systems. The analysis presented here focuses on the long-term period, including three temporal time sets: the past period of 1961–1990 (1990s), the present period of 2011–2040 (2020s) and the future period of 2041–2070 (2050s). During the 1990s, the high and very high areas of groundwater vulnerability were identified in all the central, western, eastern, south-eastern and northern sides of the Pannonian basin. In these areas water availability is lower and the Pollution Load Index is high due to agricultural activities. The low and very low vulnerability classes were shown in the south-western part of the basin and at several locations in the peripheral areas, mainly in the north and west. The medium groundwater vulnerability spreads across the Pannonian basin, but is more concentrated in its central, southern and south-western parts.

8. Forestry and biodiversity

As a consequence of global warming, extremes are expected to become more frequent, threatening the functioning of forest ecosystems. Introduction of species from drier and warmer climates is one of the options discussed to ensure that forest ecosystems adapt to these negative effects of climate change. The high genetic diversity of some species, and their consequently wider potential to tolerate climate change provide an indication of what species have priority in terms of adaptive capacity. However, it is necessary to assess the response of different species and their provenances to climate extremes and to identify appropriate populations or ecotypes that are better adapted to projected climate change (*Mataruga, 2015*).

Severe temperatures and climatic conditions, such as frost and heat waves, as well as changes in the form, timing and amount of precipitation (e.g. snow vs. rain, drought vs. flood) can affect some species and the status and levels of forest communities, because these changes may increase susceptibility to pests and pathogens (*Schlyter et al., 2006*). However, in some cases, an increase in carbon dioxide levels stimulates growth only temporarily, while a further increase in CO_2 concentration can even reduce it. Decreased growth can also occur due to increased starch concentration in leaves and decreased photosynthesis (*Wullschleger et al., 1990*).

Due to fragmentation and partial degradation, most forest ecosystems are vulnerable to climate change that will continue in the coming decades. Although there is a possibility that, in the long run, climate change will transform almost all forest ecosystems by shifting the distribution and composition of forest communities, the areas under most threat from climate change have not been identified and there is no in-depth analysis of climate change impacts on individual forest communities and the altitude zones they inhabit. Climate change affects the physiology and relationships between plants, causing changes in their distribution area (range) by increasing or decreasing the range of a species or community and the shift of its range (horizontal and vertical migration).

Climate change impact on forest ecosystems in BiH

Climate change-induced increase in average temperatures and changes in the precipitation regime can affect the structure, distribution and forest cover in BiH. Fir forests in BiH may show a high response to climate change, given that they have a very narrow ecological niche, and may face decline or loss. Due to the fact that firs mainly grow in forests mixed with beech, which has a wider ecological niche and greater adaptability, beech trees are more likely to displace the fir due to changes in humidity and temperature. Species with narrow niches are likely to face decline and loss (*Kirschbaum, 2000*) and may, in the case of BiH, begin to shift the boundaries of their ranges, which show change in vegetation due to climate change, thus making other species more dominant (and potentially causing a decline in the economic value of these forests).

In the area of BiH sub-Mediterranean forests, there is a risk of land structure change. This could cause a decrease in pH values and lead to increased acidity, which will not be acceptable for existing species. Also, it is important to note the vulnerability in the canyon parts of relict-refugial landscapes, where shallow soils are commonly formed, which are susceptible to wind and water erosion. The drying of trees in canyons can result in further soil erosion, leading to higher temperature extremes. This can cause even greater drying of trees and prevent the recovery of refugial forest communities. Some endemic species that are currently found in forest ecosystems can also be expected to disappear. Mountain forests and highland ecosystems are indeed highly endangered due to temperature changes. The biggest threat will be to the species of oak that mostly grow at lower altitudes (pedunculate oak and sessile oak). The threats can undoubtedly cause species migrations.

There is a possibility that climate change will affect BiH forests in a way that could over time transform entire forest systems by shifting their distribution and composition. This carries with it the burden of socio-economic and environmental consequences. The climate change that has taken place will not have the same impact on all forest ecosystems in the country. This claim is supported by the fact that the survival of forest communities is related not only (or exclusively) to the average annual temperature in the area where a given community occurs, which means that an increase in average annual temperature will not be the only factor influencing change. In addition to the average annual temperature, other important elements include the distribution and intensity of precipitation, which needs to be analysed together and in interaction with the increase in average temperature as well as a number of other factors that occur in immeasurable periods and with immeasurable intensity. Given the developed scenarios, it can be stated that changes in the amount of precipitation (+5 to -10 percent) would not have such a drastic impact as is the case with the predicted changes in average annual temperatures.

What has already been proven on the basis of research worldwide is that each region where changes are predicted to occur needs to be analysed individually. This means that it could be expected that in regions where changes are not predicted to occur, there will also be no changes in the structure of forest ecosystems. All communities will not react in the same way (some are found at higher altitudes, deeper pedological profile, higher numbers of species and individuals, some are less sensitive or formed from among more tolerant species, etc.), which suggests that the reaction of each community needs to be analysed separately. Species that are at the centre of their natural distribution will be more tolerant to climate change, while those near the edges (marginal populations) will be very vulnerable. In addition to that, the succession of species (their evolution) and the change in the structure of communities are related to the natural regeneration of forests and are determined by the age of the trees. In some species (such as oaks) this is more than 100 years, and in some it is unrealistic to expect changes in existing vegetation in a period shorter than one century (except in the case of natural disasters). Finally, in all changes and movements of forest communities one must take into account a number of other factors that affect changes in forest ecosystems (changes in soil structure, changes in genetic resources and diversity, adaptability of species, etc.).

In addition to the threats indicated above, another significant threat to forest ecosystems is posed by an increase in the number of forest fires. In some parts of the country, an increased risk of forest fires is expected, caused by rising temperatures and changes in precipitation patterns, which calls for an expansion of fire protection capacity. All the aforementioned aspects (weather, pests, pathogens, fires) can, over a long period of time, lead to reduced productivity and poorer health of forests in BiH.

In conclusion, there is no doubt that the productivity of forests in Bosnia and Herzegovina depends not only on the type and location of the forest, but also temperature and precipitation. Peak temperatures negatively affect productivity, because radical temperatures limit growth. Furthermore, there are certain complex stress agents in forests and forest systems: insects, diseases, droughts, floods, landslides, uncontrolled logging, fires, etc.

Available data and research indicate that climate change is a threat to all four macro-regions in BiH (ecological-vegetation areas according to Stefanović et al.). The Dinarides area, as a very important and rich home ground of endemic species in the Balkans, will be under particular threat. The threats posed to such a rich flora and fauna by a wide range of different anthropogenic activities are numerous. One of the significant effects of global warming on ecosystems will certainly be the shift in water supplies and distribution of pests and diseases. The penetration of non-native species will increase, and more aggressive species can displace indigenous species from their natural habitats. At present, it is not possible to accurately predict the success of adaptation to life in new habitats arising as a result of climate change.

Significant changes are expected in the genera inhabiting the country’s mountainous areas, in particular the migration of some wood species towards northwest along the Dinarides, with possible depletion of flora locally. One can expect a reduction in the number of the herbaceous species with narrow ecological valence in the highest mountain areas, which will not be able to adapt their range quickly enough. The Strategy for Protection of Biological Diversity in Bosnia and Herzegovina (UNEP, 2016) identifies the following landscapes as highly vulnerable to climate change: high mountain landscapes (above 1,600 metres), mountain landscapes (900–1,600 m), sub-Mediterranean landscapes (300–800 m), plateaus (600–900 m), peri-Pannonian landscapes (200–600 m) and Pannonian landscapes (up to 200 m). Available data suggest that climate change threatens all three macro-regions in Bosnia and Herzegovina (Pannonian, mountainous and Mediterranean).

Climate change impact on biodiversity

Climatic conditions have a significant impact on the development of natural systems, with the living world evolving in changing conditions by adapting to these changes. Variability of climatic conditions has contributed to the development of biodiversity, but climate change predicts faster changes that cause changes in biodiversity and inability to adapt.

The effects of climate change on ecosystems are multiple and complex, and can be seen in different segments, from abundance and distribution, to the timing of certain phases of the life cycle, to metabolism, physiological characteristics and, finally, changes in the entire ecosystem.

The survival of many plant and animal species is threatened by various factors (habitat conversion, invasive species, pollution, eutrophication, etc.), with climate change being cited as one of the factors that, in combination with other factors, has significant impacts on ecosystems.

The vulnerability of ecosystems to the effects of climate change has increased precisely because of their degradation, fragmentation and various anthropogenic influences. BiH national reports on climate change and biodiversity protection cite climate change as one of the factors disrupting biodiversity. The impacts of climate change on different ecosystems are manifested through various effects, where interactions are complex and most often in synergy with other factors.

In interaction with other factors, climate change significantly affects the timing and duration of certain seasons, which has a significant effect on the length of the growing period and the timing of certain phenophases. Climate change exerts its effects on plants and plant communities, which are first noticeable as changes in phenophases. Also, it exerts effects on all aspects of biodiversity, which are manifested as changes in the distribution of populations and species, as well as the functioning of ecosystems. According to the First National Communication of BiH (2009), the following vulnerable areas are exposed to strong pressures from changing climate: high mountain ecosystems, mountain ecosystems, ecosystems of sub-Mediterranean forests and shrubs, ecosystems of karst caves, valleys and abysses, ecosystems of hilly areas, ecosystems of the peri-Pannonian area, Pannonian ecosystems.

Also, the Strategy and Action Plan for Protection of Biological Diversity (2014) identifies landscapes, along with their dominant ecosystems that are highly vulnerable to climate change: high mountain landscapes, mountain landscapes, and relict-refugial landscapes.

In addition to the aforementioned, the ecosystems situated in karst landscapes are also vulnerable to climate change and are, at the same time, strongly affected by other anthropogenic pressures. Among these, wetlands in karst fields are particularly sensitive (Strategy and Action Plan for Protection of Biological Diversity, 2014).

A distinctive characteristic of karst areas are endemic species. These are species with a very narrow area of distribution, which, coupled with other factors, is the main reason why they are endangered (*Dekić et al., 2013*).

Climate change is expected to significantly affect biodiversity, with 15–37 percent of land species expected to become extinct over the next 50 years due to climate change (*Thomas et al., 2004*) and the same trend will affect freshwater species (*Xenopoulos, 2005*).

Climate change, in interaction with other factors contributing to the deterioration of biodiversity, is expected to bring about the shifting of vegetation zones, changes in the functioning of ecosystems, habitat fragmentation and the extinction of certain species. The Strategy and Action Plan for Protection of Biological Diversity in Bosnia and Herzegovina (2014) notes that in 2013 intensive dieback of individual spruce, fir, white pine, black pine and juniper trees was observed, even affecting horticultural coniferous species in urban areas, believed to be caused by climate change and other anthropogenic influences. Aquatic ecosystems are very vulnerable to global climate change. Elevated temperatures and prolonged vegetation growth season can lead to increased macrophyte production, elimination of many fish species, and invasion of species that tolerate low oxygen levels in water.

It is thought that species will migrate to higher altitudes and latitudes, depending on their thermal preference.

At the same time, via its impact on ecosystems, climate change exerts various effects on plant and animal populations in these ecosystems, including changes in physiological processes at the level of the organism. Changes in the rate of physiological processes primarily relate to poikilotherms, which do not have the ability to regulate body temperature.

Temperature is one of the most important environmental factors affecting all living beings, and its effect is particularly pronounced in poikilothermic organisms. It affects a number of physiological processes in the body by changing how fast they develop.

Freshwater fish are ectothermic organisms that cannot regulate their body temperature by physiological means (*Moyle and Cech, 2004*) and whose body temperature is identical to or close to the ambient temperature at their specific location. Consequently, physiological reaction rates depend to a great extent on body temperature, as do all aspects of fish physiology, including growth, reproduction, and activity (*Ficke et al., 2005*).

Fish can regulate body temperature only indirectly, by choosing thermally heterogeneous microhabitats (*Brett, 1971*). Therefore, increasing temperatures in freshwater ecosystems will cause changes in their growth, reproduction, metabolism, food consumption, and, generally, their ability to maintain homeostasis. The impact of the changes is species-specific, but it will affect both stenothermal and eurythermal organisms (*Ficke et al., 2007*).

The consequences of increasing water temperature can affect individuals by altering various physiological functions and the ability to maintain internal homeostasis in the face of a variable external environment (*Roessig et al., 2004*).

Factors that cause stress in fish are naturally associated with changes in physical, chemical and biological factors of the aquatic environment, which causes increased susceptibility of fish to disease (*Kubilay, Ulukoy, 2002*). Climate change also leads to the following changes in abiotic factors: increase in water temperature, increase in CO_2 concentration in water, decrease in O_2 concentration in water, acidification of watercourses.

The general impact of climate change on aquatic ecosystems, primarily fish populations, leads to certain changes in several directions:

- Impact on the distribution and abundance of populations,
- Impact on the timing of some life cycles,
- Impact on the organism's metabolism and physiology,
- Disruption in the ecosystem's food chain.

All these possible changes indicate a disturbance of the balance of these ecosystems, where endangered or rare species will be particularly vulnerable to rapid changes, in particular if their distribution is spatially limited and the niche narrowed.

The response of freshwater ecosystems to change needs to allow for interactions between climate change and the many stressors already affecting rivers, lakes and wetlands. These include watercourse management, eutrophication, acidification, toxic substances, hydromorphological change, habitat change and invasive species.

In colder regions expected changes include: productivity increase in response to an increase in the length of the growing season, increase in nutrient release from the soil, population decline of stenothermic species, and changes in trophic structure. In temperate and warm regions, an increase in problems of eutrophication is expected. Lakes most often experience algal blooms, longer periods of summer stratification with greater oxygen depletion in the hypolimnion and increased release of phosphorus from sediments. An increase in temperature will have a particularly negative effect on salmonid fishes (*Heino et al., 2009*).

Climate change is one of the main factors affecting fish populations in freshwater streams. Changes at the population level in ecologically and economically important species caused by climate change are manifested as changes at the individual level (changes in growth, reproductive success, mortality rate). Furthermore, expansions or contractions in the distribution of fish species lead to changes in spawning grounds and break contact between individuals at different stages of development. Each stage of the development cycle requires specific microhabitat conditions, so there usually exists a spatial separation of different developmental forms. However, one of the essential preconditions for maintaining a population is the existence of communication between different developmental stages.

Adaptations to changing conditions include changes in phenology, ecology (migration, spawning) and physiology (*Beamish et al., 2010*). Decreased fish weight and changes in genetic structure are also associated with changes in temperature. It is thought that changes in water temperatures will cause species to migrate further north and to greater depths. The combination of climate change and overfishing poses the greatest threat to fish populations today. Overfishing leads to the elimination of older and larger individuals from the ecosystem, while younger individuals mature earlier and fail to reach full weight. Such populations are much more vulnerable to climate change.

The ability to adapt to changes in the environment is species-specific. In the event of a sudden rise in temperature, there are three possible outcomes for any species: extinction due to thermal stress, a northward shift in geographic range where abiotic and biotic factors allow, and genetic change through accelerated natural selection. All three outcomes are likely to occur, depending on the species. Local extinctions are very difficult to predict without knowledge of key population parameters (fecundity, growth rate, mortality, age structure, etc.). This is typically followed by recolonization depending on river basin characteristics and ecological and historical characteristics. River basins draining to the north allow fish populations to migrate northwards, while in those draining to the east or west, temperature changes will possibly be compensated for by altitudinal shifts. Lake populations will be forced to retreat to the hypolimnion during the summer months. Shallow littoral zones are particularly exposed to negative influences, with consequent effects on trophic dynamics. One of the important items is the change in species dominance, which is a consequence of the adaptation of species to specific spatial, thermal and temporal characteristics.

Potential consequences of climate change also include a shift in the spawning season and earlier hatching. For example, the European perch (*Perca fluviatilis*) would most likely spawn as much as a month earlier during the spring, leaving juvenile individuals with an extended growing season. It is very likely that elevated incubation temperatures will cause larvae to be smaller in size and have smaller yolk sacs and increased metabolic rates.

This further means that small larvae are more vulnerable to predators, have higher metabolic rates, and less time to adapt to feeding in the external environment. Higher winter survival rates lead to greater prey demand, so most scientists agree that fish will significantly shrink in body size.

The zander (*Sander lucioperca*) is a eurythermal species widespread in Europe, whose growth and reproductive success depends on water temperature. Its current geographic range is likely to shift northwards. Increases in abundance will cause changes in the competitiveness of fishes resident in northern habitats because it remains unclear whether watercourses will be productive enough to yield sufficient food for newly arrived populations of the *Percidae* family (*Wrona et al., 2010*).

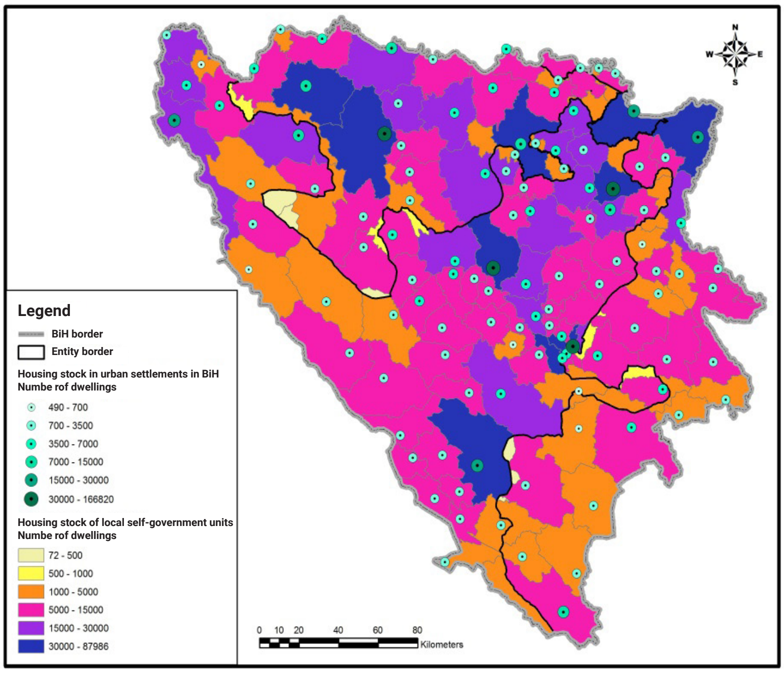
Effects of climate change in synergy with other factors are also impacting the endemic ichthyofauna. Some fish species, such as minnow, are endemic to karst areas. The term minnow encompasses several fish species inhabiting waters in karst areas. They have a specific way of life in that they spend part of their life cycle in underground lakes of karst caves and appear in surface waters when underground water overflows into floodplains in certain hydrological stages. In the waters of Eastern Herzegovina in BiH, the presence of the following species of minnow has been established: *Telestes metohiensis* (*Steindachner, 1901*), *Telestes dabar* (*Bogutskaya, Zupančič, Bogut, Naseka, 2012*) and *Delminichthys ghetaldii* (*Steindachner, 1882*).

These species are on the Red List of Threatened Species of Republika Srpska, and, according to the IUCN, *Telestes metohiensis* and *Delminichthys ghetaldii* are categorized as vulnerable (VU). In addition to those mentioned above, other endemic fish species can be found in BiH waters.

9. Housing sector

According to the preliminary results of the 2013 census of population, households and dwellings, a total of 1,617,308 housing units were registered in Bosnia and Herzegovina, which is an increase of about 25 percent compared to 1991. Therefore, this sector can be said to have fully recovered from the effects of the 1992–1995 war. Currently, 61.3 percent of the housing units (dwellings) in BiH are located in the Federation of BiH, 36.37 percent in Republika Srpska, and 2.33 percent in Brčko District. The largest number of dwellings are located in settlements, of which there are a total of 6,152 in BiH. Of this number, 574 settlements are without dwellings or with fewer than four dwellings. In general, the housing stock in BiH is predominantly located in urban settlements (44.33 percent). The largest number of dwellings are located in the urban settlements of Sarajevo and Banja Luka (14.29 percent of the total housing stock in Bosnia and Herzegovina).

Figure 7.
Housing stock in Bosnia and Herzegovina in 2013 (by urban settlements and local self-government units – LGUs)



The impact of climate change on the housing sector in Bosnia and Herzegovina is manifested in two ways:

- Directly (construction and use/exploitation);
- Indirectly (indirect impact of natural disasters).

Direct impact of climate change on the housing sector in BiH can be felt in housing construction, and particularly in the use/exploitation of housing units.

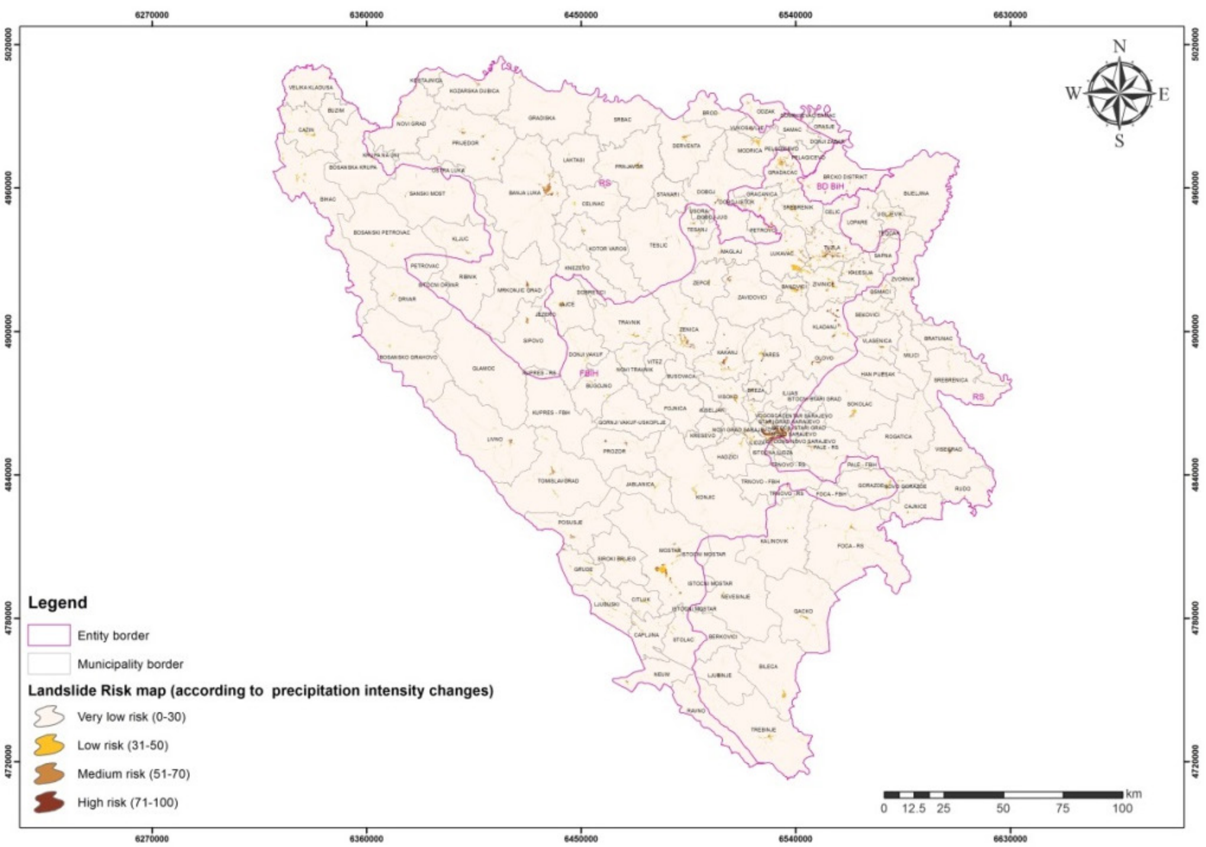
Thus, higher temperatures and increased rainfall during the construction season (May–November) can make construction more difficult and delay completion of works. Increase in the number of days with precipitation exceeding 20 mm may raise the likelihood of the foundation pit on a construction site filling with rainwater, increasing the risk of collapse of the foundation pit. The higher frequency of extreme weather events (windstorms, hail, thunder) can cause various types of damage to residential buildings under construction (primarily roof structure) and equipment on construction sites.

Another form of direct impact of climate change on the housing sector concerns the use/exploitation of housing units. The increased frequency of weather disasters can lead to direct damage to existing residential buildings (primarily roof structure, façade and exterior carpentry). Also, during the use of a residential building, climate-induced increase summer temperatures may lead to higher electricity demand for cooling. On the other hand, increased winter temperatures reduce consumption of energy sources (wood, coal, gas, fuel oil, electricity, etc.) used to heat residential buildings.

The indirect impact of climate change on the housing sector in BiH primarily concerns natural disasters, resulting from changes in climate elements, especially the increased frequency of extreme weather events – weather disasters. The increasing frequency of heavy precipitation results in two types of natural disasters in particular – floods and landslides.

The May 2014 floods and landslides were simultaneously triggered by heavy rainfall due to Cyclone Tamara, but massive landslides were further caused by cumulative rainfall. Therefore, the main causative factor of all landslides was extreme cumulative precipitation during the months of May and April 2014, with the main trigger being extremely heavy rainfall (over 50 mm/day). The following map from the Flood and Landslide Risk Assessment Study for the Housing Sector in Bosnia and Herzegovina shows the risk of landslides in urban areas of BiH by changes in precipitation intensity.

Figure 8.
Map of landslide risk in urban areas of BiH by changes in precipitation intensity



The Flood and Landslide Risk Assessment Study for the Housing Sector in Bosnia and Herzegovina is a document that shows a link between climate change and landslide risk in urban areas of BiH. The urban areas in question cover 60–70 percent of the BiH housing stock.

According to the Study, the following municipalities have the highest landslide risk indices: Tuzla, Sarajevo, Kladanj, Mostar, Zenica, Vogošća, Kakanj, Šipovo and Banja Luka, as indicated in the risk map.

Regarding floods, according to the Study, the highest risk indices are mainly found in municipalities in the north – Bijeljina, Orašje, Brod, Šamac, Laktaši, Maglaj and Doboj.

In terms of the combined risk of these two types of natural disasters, the following municipalities are most vulnerable: Doboj, Sarajevo, Bijeljina, Tuzla, Orašje, Prijedor, Šamac and Brod.

10. Human health

Climate change has become a reality in Bosnia and Herzegovina and is having an increasing impact on human health. This impact is predominantly manifested through sudden changes in extreme weather conditions. These changes are closely associated with blood pressure oscillations and cardiovascular and neurological problems, especially in vulnerable groups (chronic patients, the elderly, etc.). Moreover, extreme events such as floods may cause the spread of water-borne diseases. Climate change is certainly one of the biggest challenges today, but will also continue to be a very serious problem in the future.

The deleterious effects of climate change on human health are likely to intensify in the future, especially in developing countries, where the ability to adapt is constrained by limited resources and technologies. Therefore, there is an urgent need to identify new approaches and methods and develop new tools to increase the resilience of human health to climate-induced risks. If the current climate change trends continue, as indicated by climate models and scenarios, we can expect unforeseen climate conditions resulting in diverse and destructive phenomena. Human health is directly related to the environment. Climate change interferes directly on the conditions of human life, affecting economic development, food production, water quality, agriculture, itd. (*Menne et al., 2005; Smith et al., 2014*). The deterioration of some of these conditions will have adverse effects on the health of populations.

In Bosnia and Herzegovina there is very little research on the impact of climate change on human health, and whatever little there is has been mainly conducted at the local level. There are no regular health statistics on the impact of climate change on human health and no evidence available from multi-year scientific research in the country. While it is not possible to precisely determine the connection between weather conditions (i.e. biometeorological phases) and the incidence of chronic non-communicable diseases, primarily diseases of the circulatory and respiratory systems as well as some infectious diseases, it can be argued with certitude that climate change has a strong impact on human health. Society is undeniably very much concerned about the general state of health, but involving the general public in addressing these problems is crucial if effective adaptation responses to extreme climate change are to be found. A well-informed and educated general public, who are also aware of the dangers of extreme weather conditions, can take appropriate measures to reduce their negative consequences.

Extreme climatic conditions may lead to more frequent changes and worsening of the health situation, especially in patients suffering from severe conditions (heart patients, people with hypertension, kidney and lung patients), but also in other vulnerable groups (children, pregnant women, the elderly, people prone to allergies, etc.). Of all extreme weather events, heat waves are most commonly associated with population morbidity, but also with a high mortality rate, posing an important and global public health problem. Intense heat waves may cause serious conditions such as heatstroke. Heat waves have a very harmful effect on heart patients, but young and healthy people can also feel the consequences of extreme heat. Other health problems can occur as well, such as food-borne and waterborne illnesses and diseases transmitted by mosquitoes, ticks, rodents and birds (vector-borne diseases).

The interaction between climate change and human health affects the general socio-economic situation and standard of living of the people in Bosnia and Herzegovina, especially those with lower incomes. Hardest hit are underdeveloped and small local communities without adequate primary health care facilities. While there are no precise indicators as to the impact of climate change on people's health, any investment in adaptation to climate change can be assumed to be prudent and highly profitable from both an economic and humane point of view. Much more funding needs to be directed into the prevention of heat strokes, public awareness and monitoring accompanied by scientific research. At a later stage, it will be necessary to make detailed cost-benefit analyses, because it is indisputable that human lives are worth the most. If the mortality from certain diseases in extreme climatic situations is reduced by only 10 percent, investment in adaptation measures will pay off many times over.

The impact of climate change on human health has not been sufficiently investigated. There are studies indicating an increased number of cardiovascular diseases during climatic extremes. The Third National Communication found that there was an increase in the number of strokes by type of bleeding in some municipalities in July and August. This is probably the population that works in the field and is directly exposed to sun's UV rays. Based on this finding, recommendations can be produced for that population. However, no research has been done to look at the link between climatic extremes and other diseases.

Future studies should examine the link between climatic extremes and heart attack, chronic obstructive pulmonary disease, arrhythmias and respiratory diseases in Bosnia and Herzegovina. To that end, it would be necessary to conduct a population study to collect data on general and specific morbidity and mortality rates during climate extremes. Analysis of the collected data could help identify the disease that shows the largest increase in these indicators in the country.

The findings of such research would help produce better recommendations for adaptation of population to climate extremes. Furthermore, these adaptation measures would be targeted at specific population groups (e.g. people with chronic obstructive pulmonary disease or those engaged in outdoor farm work) and recommendations would be used to inform the development of legislation regulating working hours and work during climate extremes.

Research in the region indicates that climate change will lead to a change in the prevalence and frequency of vector-borne infectious diseases (malaria, dengue fever, West Nile virus, zika virus, etc.) and the spread of water-borne infectious diseases.

According to research and reports conducted by the Banja Luka-based "Vaso Butozan" Veterinary Institute, in summer 2015 the Asian tiger mosquito (*Aedes albopictus*) was found at five locations in Republika Srpska: Laktaši, Bijeljina, Brod, Gradiška and Banja Luka. In Laktaši and Bijeljina, the adults and larvae of this mosquito were found at two tyre repair shops. Eggs and larvae of the tiger mosquito were found in oviposition traps set at border crossings. Also, an adult tiger mosquito was found in a flat in Jovana Dučića Street in Banja Luka. This species of mosquito is known to play an important role as a vector for microorganisms that cause viral infectious diseases such as dengue fever, chikungunya and West Nile fever. This species had been, prior to that, detected in some neighbouring European countries. In Republika Srpska and BiH, some other species and genera of mosquitoes that affect human health have been detected, too. A larger population of these mosquitoes was found in the areas of Gradiška, Brod, Srbac and Kozarska Dubica.

It is well known that climate change is already having a measurable impact on weather conditions in Europe in the form of increasing average values and changes in precipitation, and more frequent heat waves, droughts and floods are expected as a result. One of the consequences of climate change is its impact on the occurrence, prevalence and seasonal variations of infectious human diseases. This includes the occurrence and spread of already existing infectious diseases in areas where they did not exist before, as well as the occurrence of new infectious diseases.

Climate change has the greatest impact on vector-borne infectious diseases. These are diseases whose causative agent spends some time in a vector (mosquitoes, ticks and various other types of insects) before entering the host's body. Vectors are organisms that do not have mechanisms to maintain body temperature, so they directly depend on the outside temperature. Appropriate temperature and humidity are the basic precondition for the development of eggs and larvae into adult insects, so in conditions with high temperature and high humidity their number can increase severalfold. It is estimated that an increase in air temperature by 0.1 degrees Celsius expands the mosquito's range by up to 150 kilometres northwards. Of the vector-borne infectious diseases in the territory of Republika Srpska, cases of Lyme borreliosis and a few cases of imported malaria are registered annually, but in 2014 ten probable cases of West Nile fever were also recorded.

Greater synergy is needed between institutions responsible for the early warning system (HydroMet institutes) and those in charge of public health (public health institutes and medical institutions) in the face of increasingly frequent climate events (extreme temperatures, floods, air pollution, etc.).

One of the key problems is the limited accessibility of data and lack of research in certain branches of medicine where a significant impact of climate change is expected (cardiology, pulmonology, etc.). It is necessary to keep the public continuously informed about the possible impact of climate change on human health, especially in extreme weather and climate conditions.

In the near future, it will be necessary to functionally adapt the country's public health system to climate change. This includes ensuring better prevention and increased efficiency of the health care system in responding to ever more frequent and extreme climate events. Priority interventions include better management of environmental determinants of health (such as water supply and sanitation), monitoring of existing and new infectious diseases and increasing the resilience of health systems to extreme weather and climate events. Also, poverty reduction and socio-economic development is a necessary precondition to successful adaptation. Climate models and scenarios suggest that constraints to health-related adaptation will become increasingly complex. For example, projections about warming and temperature increase are expected to materialize by the end of the 21st Century under all four climate scenarios (RCP8.5, RCP6.0, RCP4.5, RCP2.5). This increase suggests that temperatures that exceed physiological limits may occur during the year, making it impossible to work or perform other physical activities outdoors. Furthermore, higher temperatures are expected to result in increased pressure on water resources, which in the long run can also cause pressure on drinking water sources.

It is necessary to continue further research and keep the public informed about the possible effects of climate change on human health.

11. Tourism

For a long time global climate change has been manifested through rising average and extreme air temperatures, changing thermal regimes, shifting thermal zones, changing precipitation regimes and territorial distribution, etc., and its negative consequences are manifested in disruptions, changed composition and options for evaluation of all natural ecosystems, obstacles to the development of all types of tourism, and modified and generally adverse conditions for the development of agriculture. Climate change, caused by extreme weather conditions, extreme temperatures, excessive precipitation, hurricane winds, etc., is the underlying cause of increasingly frequent geohazards (landslides, devastating floods, huge fires, catastrophic tidal waves, etc.).

Climate change, especially insofar as it results in the increasing occurrence of extreme temperatures, low snowfall and extreme weather conditions in the atmosphere, has an increasing (adverse) impact on the development of tourism, in particular winter tourism. A trend of reduced snowfall and decreased number of snow days was observed in the late 1980s in the Alps. It was accompanied by problems related to reduced income from winter tourism, increased investment activities, increased employment in tourism, etc. (*Elsasser & Messerli, 2001*). For these reasons, "in the early 1990s, along with climate studies on global warming, there emerged sectoral and regional studies on the impact of climate change on winter tourism, covering almost all mountain tourist areas" (*Budović, Mimić, Ratkaj, 2015*). Various studies have shown that "the reliability of snow conditions in tourist destinations is directly proportional to the increase in altitude, where the number of tourist destinations with reliable snowfall will trend downwards as a result of climate change-induced increase in average air temperatures". Burki et al. (2003) believe that, by 2030/2050, winter tourist destinations at altitudes below 1500 m will not be able to rely on snowfall and that by the end of the century the snowline could rise to 1800 m (*ibidem, p. 380*). In the tourist offer of Bosnia and Herzegovina climate is a significant development factor, especially considering that most tourist activities take place in the open air and tourists count on clear and sunny weather during summer holidays and enough snowfall in the mountains during the winter season. Attractive tourist destinations are also protected natural areas, associated with outdoor tourist activities. In this regard, domestic tourist destinations are vulnerable to climate change, especially changing temperatures and precipitation.

Past research has helped determine the character of global climate change, and practice has shown a direct interdependence of climate and tourism. The biggest and growing danger is to be faced by winter tourism as a result of reduced snowfall and fewer snow days. The consequences of this trend include a shorter winter tourist season, fewer visitors in winter resorts, and a decline in tourism turnover.

In line with the general, that is, global climate change trends, some studies have shown a congruence of changes in climate elements at regional levels, too. Thus, regional climate models and scenarios show a continuous increase in temperature, of varying intensity in certain periods, for the area of Bosnia and Herzegovina: between +1.6 °C and +2.0 °C in the period 2011–2040, between +3.0 °C and +3.4 °C in the period 2041–2070 and between +5.2 °C and +5.6 °C in the period 2071–2100 (*Trbić, 2011*). According to previous studies, done on the basis of the same scenario, a five-percent increase in precipitation is expected relative to the reference period 1971–2000. However, a decrease in annual precipitation is expected in the vicinity of Klekovača for the periods 2041–2070 and 2071–2100, by 10 percent and 20 percent respectively. It is quite certain that the general trend of climate change in the previously examined area will reflect the trend of climate change in the entire area of Republika Srpska and the Federation of BiH.

The impact of climate change on the tourism sector may also have wider implications for the entire economy of Republika Srpska and the Federation of BiH. Fewer tourists in mountain resorts as a result of reduced snowfall during the winter tourist season will initially be felt most by hotels, catering establishments and owners of rental holiday homes, which will in turn impact negatively on the local and, by extension, domestic economy. The negative impacts of climate change on other sectors also bear on tourism. Thus, lower yields and losses in the agricultural sector and higher food prices have a negative impact on the price of tourist services. However, some impacts of climate change, such as the extension of the tourist season and the development of new tourist products, can be regarded as positive.
In order to address the problem of vulnerability of the tourism sector, it is necessary to invest in research and put in place a system whereby all stakeholders in tourism will be kept informed about climate change and its impacts. The efforts and cooperation of the entity authorities of Republika Srpska and Federation BiH are key in formulating strategies and measures to facilitate adaptation to climate change in the tourism sector.

In recent years BiH has seen a significant increase in tourist numbers and, consequently, in revenues and employment in the tourism sector. Since BiH is a predominantly hilly-cum-mountainous country, winter mountain tourist destinations have a particularly important role in the tourism sector, and will also have a role to play during summer. In addition to mountain tourism, which is dominated by the winter tourist season, a significant part of the tourist offer consists of urban and religious tourism destinations, followed by tourist activities associated with rivers and lakes in summer, and tourism in protected natural areas.

In 2018 Bosnia and Herzegovina was visited by 1,550,796 tourists, which is an 18.6-percent increase on the preceding year, generating a total of 3,206,336 overnight stays, 19.7 percent more than in 2017. In 2018 there were 1,101,317 foreign arrivals, generating 2,266,037 overnight stays. Although the statistics show a steady growth in the number of tourists and overnight stays in BiH since 2014, due to grey economy, poor legislation, insufficient in-country coordination and investment, BiH tourism has not yet reached its full potential and remains lagging behind the region. Also, according to the World Economic Forum's Travel & Tourism Competitiveness Report[36], out of 136 countries surveyed, BiH was ranked 113th, making it the lowest ranked country in Southeast Europe.

Globally, tourism is one of the fastest growing economic sectors. According to the annual report of the World Travel and Tourism Council (WTTC), in 2018 this sector employed about 319 million people and accounted for 10.4 percent of global GDP. According to this report, in 2018 in BiH there were 93,500 people employed in tourism and associated sectors, making up 11.7 percent of total people employed. By 2028 the tourism sector in BiH is predicted to employ, directly and/or indirectly, about 113,900 people and direct contribution of tourism to GDP will be to the tune of BAM 1.41 billion, or 3.4 percent of GDP.

Spending by foreign tourists who visited BiH for rest and recreation in 2018 made up 71 percent of the total direct contribution of tourism to GDP, while the rest accounts for business visits. Also, foreign tourists are much bigger spenders than domestic tourists (63 percent of total spending). Based on financial reports and estimates by economic analysts, contributions from tourism and the entire travel industry in the period 2018–2028 will increase 5.3 percent annually, and earnings from tourism are expected to make up over 12.6 percent of GDP. In the same period, investments in tourism are expected to grow to more than BAM 575 million.

36 The Travel & Tourism Competitiveness Report 2017, available at:
http://www3.weforum.org/docs/WEF_TTCR_2017_web_0401.pdf

However, as holds true of other economic sectors in BiH, climate change is becoming one of the key issues affecting the development and management of the tourism sector too. In this regard, winter mountain tourism is directly vulnerable to the impacts of climate change, given the relatively low altitudes of domestic ski resorts and the preponderant share of the winter tourist season.

The reduced snowfall and milder winters are causing a decrease in tourist numbers during the winter tourist season, resulting in poor business performance of mountain resorts. In the face of these negative implications for the winter tourist season, due to higher daily temperatures on the Mediterranean coast, mountain resorts can be advertized as new destinations to visit during the summer tourist season.

12. Proposed measures for the most vulnerable sectors[37]

The measures proposed below were drawn up on the basis of estimated climate change threats to individual sectors, as well as on the basis of climate models and expected climate change by the end of the 21st Century.

Agriculture

Measure	Indicators	Responsible institutions	Necessary funds (BAM)	Time frame	Note
Switch to more resistant varieties; Introduction of more tolerant species, varieties and hybrids; Proper selection of varieties; Rational fertilization; Changes in the timing and density of sowing; Increasing the share of winter crops	Increased incidence of droughts; Altered precipitation regime; Extended growing season; Late spring frosts	Natural persons (farmers); Legal persons Extension Services	1,500,000	2021–2025	Current incentives; Grants

37 These proposed measures are indicative and new proposals and amendments are expected from relevant line ministries and stakeholders, which will be considered and included in the final NAP.

Improving disease and pest monitoring;	Emergence of new invasive species in areas where they were not present before climate change	Natural persons (farmers); Legal persons Extension Services; Scientific institutions	800,000	2021–2025	Funding for Extension Services and scientific institutions needs to be increased; Republika Srpska and Federation BiH entity budgets; Grants
Improving cultivation techniques; Conservation agriculture and agroforestry, Ecosystem-based Approaches (EbAs); Crop rotation adjustment	Heavy precipitation, increased incidence of spring and summer droughts, occurrence of extreme climatic phenomena	Natural persons (farmers); Legal persons Extension Services	1,000,000 up to BAM 1000 per hectare	2021–2023	Increased incentives; Grants
Selection, breeding and creation of tolerant genotypes	Climatic extremes	Scientific institutions	1,800,000	2021–2023	Budget increase for research, Grants;
Change of plant species (growing modern orchards, vineyards)	Increase in temperature and extension of the growing season; Possibility of two harvests of vegetables	Natural persons (farmers); Legal persons Extension Services; Scientific institutions	6,000,000 (BAM 20,000–40,000 per hectare)	2021–2025	50% of the value of investment in new plantations
Reconstruction, construction and maintenance of drainage systems	Occurrences of episodes of heavy rainfall in May and June	Natural persons (farmers); Legal persons in possession; Extension services	BAM 6,000,000	2021–2030	Government of Republika Srpska, Government of Federation BiH; Grants; Donations
Reconstruction, construction (development) and maintenance of irrigation systems	Increased incidence of droughts; longer periods without rain; increase in high temperatures during summer	Ministry of Agriculture, Forestry and Water Management of Republika Srpska; Ministry of Agriculture,Water Management and Forestry of Federation BiH; Public Institution "Vode Srpske"; Natural persons (farmers); Legal persons in possession; Extension services	Up to BAM 7,000 per hectare if the water intake is near the field. BAM 14,500 per hectare for remote springs.	2021–2030	Detailed assessment of water availability and quality, source yield, facility stability, etc. is required
Development of an early warning system for meteorological and climatic extremes	Increased incidence of climatic extremes	Republic Hydrometeorological Institute and Federal Hydrometeorological Institute; Scientific institutions; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	1,000,000	2021–2025	Current projects; (CBIT); Green Climate Fund; Grants

Development of an anti-hail protection system	More frequent atmospheric instability and the occurrence of hail and hail clouds	Hail prevention system of Republika Srpska, Ministry of Agriculture, Forestry and Water Management of Republika Srpska; Ministry of Agriculture,Water Management and Forestry of Federation BiH	1,000,000	2021–2025	Grants; Loans. Some items already realized
Development of climate data collection software	No software has been developed	Republic Hydrometeorological Institute, Federal Hydrometeorological Institute; Scientific institutions; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	1,000,000	2021–2024	Grants; Funds from international organizations
Increased scientific research on climate change, as well as the need and measures (ways) to adapt to climate change	Limited awareness of climate change	Scientific institutions; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Media	500,000 (25 local communities)	2021–2030	Government of Republika Srpska, Government of Federation BiH; Grants; Donations
Awareness raising and education on the need to adapt to climate change	Limited awareness of climate change	Scientific institutions; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Media	500,000 (25 local communities)	2021–2030	Grants; Funds from international organizations

Water resources

Measure	Indicators	Responsible institutions	Necessary funds (BAM)	Time frame	Note
Water management (improving riverbeds, cleaning canals, capturing springs, making studies...)	Increased pressure on water resources; Occurrence of more intense droughts and floods	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watershed Agency	198,000,000	2021–2030	Current incentives, Grants; Loans
Alignment of the BiH flood protection system with the EU Directive 2007/60/EC on the Assessment and Management of Flood Risks (Update flood hazard maps and flood risk maps; Develop and adopt Flood Risk Management Plans)	Increased intensity and incidence of floods	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Ministry of Agriculture, Forestry and Water Management of Republika Srpska; Ministry of Agriculture,Water Management and Forestry of Federation BiHPublic Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Cantons; Local communities; Scientific institutions	11,000,000	2022–2027	Current Incentives, Grants; Loans
Make a feasibility study for retentions and reservoirs	Increase in heavy rainfall and flooding	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency	3,000,000	2022–2024	Grants; Budgets; Loans

Adoption and analysis of implementation of new technical solutions for protection from floods, erosion and torrents, including Environment Based Solutions (EBS), for settlements and cities that did not have protective water management facilities in place and construction of new facilities	Increase in heavy precipitation and flooding	Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Institutions responsible for forestry; Cantons; Local communities; Scientific institutions	11,500,000	2021–2025	Grants; Budgets; Loans
Preparation (of five) studies to reduce erosion in the basin through development of anti-erosion measures (torrent barriers, etc.); Sava River Basin (Brcko District, Federation BiH,) and the Adriatic Watershed (Federation BiH and)	Increase in the intensity and frequency of erosions	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Ministry of Agriculture, Forestry and Water Management of Republika Srpska; Ministry of Agriculture,Water Management and Forestry of Federation BiH, and Forestry Project Implementation Units	1,000,000	2023–2025	Grants; Budgets; Loans
Upgrading the hydrological forecasting system	The existing hydrological forecasting system is not sufficient	Republic Hydrometeorological Institute, Federal Hydrometeorological Institute; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District;; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Cantons; Local communities; Scientific institutions	15,000,000	2021–2025	Funds partially provided, through several ongoing projects
Study the possible impacts of the "living with floods" concept in BiH; open up a discussion on this topic among stakeholders from different secto and from different levels of government	Number of studies done; number of workshop participants	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Cantons; Local communities; Scientific institutions	2,000,000	2023–2025	Funds partially provided, through several ongoing projects

Surface water quality and quantity monitoring	Impaired surface water quality indicated	Brčko District Government; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Cantons; Local communities; Scientific institutions	5,000,000	2021–2025	Grants; Funds, Water Agencies; Some funds are already operational and are being used to implement this measure
Water quality monitoring of groundwater bodies	Impaired quality of groundwater bodies indicated	Brčko District Government; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Cantons; Local communities; Scientific institutions	5,000,000	2021–2025	Grants; Funds, Water Agencies;
Reduction of water losses in water supply systems (Phase I of study preparation)	High water loss (Reduce water losses by 50%)	Public water utilities (Waterworks) and local communities	500,000	2021–2030	Grants; Funds, Utility companies; Local communities
Build reservoirs for multipurpose use, redistribution of large and small waters – flood protection, irrigation; hydropower as a renewable energy source, quality protection in low-water periods		Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Public Institution "Vode Srpske", Sava River Basin Agency (Federation BiH), Adriatic Sea Watehed Agency; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Cantons; Local communities	7,000,000,000	2021–2030	Grants; Funds, Budgets; Green Climate Fund, Loans
Making a study into the impact of climate change on water resources (water supply, floods, etc.)	Increased pressure on water resources due to pronounced climatic extremes	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Cantons; Local communities; Scientific institutions	500,000	2021–2024	Grants; Funds, Budgets; Green Climate Fund

Biodiversity and forestry

Measure	Indicators	Responsible institutions	Necessary funds (BAM)	Time frame	Note
Making a study into the impact of climate change on biodiversity and forestry	Increased pressure on flora and fauna	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; (in line with statutory competences) Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Scientific institutions	900,000	2021–2024	Current incentives; Grants; Loans
GIS mapping of forest areas	There is a need for GIS mapping of forest areas	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; (in line with statutory competences) Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Scientific institutions	2,000,000	2021–2024	Current incentives; Grants; Loans. Part of the project is already being implemented
Afforestation with native and fast-growing species	There is a need for afforestation with native and fast-growing species	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Company "Šume Republike Srpske", Federal Forestry Administration of Federation BiH; Forest companies; Scientific institutions	10,000,000	2021–2030	Grants; Budgets; Loans. Part of the project is already being implemented

Tree health survey and replacement of damaged trees in urban areas	Increased number of diseased and damaged trees	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Company "Šume Republike Srpske", Federal Forestry Administration of Federation BiH; Forest companies; Scientific institutions; Local communities	2,000,000	2021–2030	Grants; Budgets; Loans. Part of the project is already being implemented
Development of a system to monitor the impact of climate change on biodiversity	There is no monitoring system in place	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District;Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Company "Šume Republike Srpske", Federal Forestry Administration of Federation BiH; Scientific institutions; Republic Hydrometeorological Institute, Federal Hydrometeorological Institute; Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska	1,500,000	2021–2025	Grants; Budgets; Funds; Loans
Revision of Red Lists with field research	Existing Red Lists need to be updated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska; Public Company "Šume Republike Srpske"; Federal Forestry Administration of Federation BiH; Forest companies; Scientific institutions	1,000,000	2021–2025	Grants; Budgets; Funds; Loans

Examining the impact of climate change on mountain lakes and ecosystems	Disruptions to mountain lakes and ecosystems indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska; Scientific institutions	800,000	2021–2025	Grants; Funds, Water agencies; Some funds are already operational and are being used to implement this measure
Increasing thepro-tected areas	Increases in protected area	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska; Public Company "Šume Republike Srpske"; Federal Forestry Administration of Federation BiH; Forest companies; Scientific institutions	1,000,000	2021–2025	Grants; Funds, Water Agencies; Additional research needed; Increasing areas under a specific protection regime; Conservation of biodiversity and genetic resources in BiH forests
Examining the impact of climate change on the endemic fauna of karst areas	Impact of climate change on endemic fauna indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska; Scientific institutions	500,000	2022–2025	Grants; Funds

Development of pilot studies and installation of "green roofs"	Rising temperatures reduce climate comfort in residential and commercial buildings. One way to reduce that impact is to build green roofs.	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Company "Šume Republike Srpske", Federal Forestry Administration of Federation BiH; Forest companies; Scientific institutions; Cantons; Local communities	3,000,000 (Production of 300 pilot roofs)	2021–2030	Grants; Funds; Budgets; Green Climate Fund, Loans
Making a study into forest fires and mapping of burned areas in BiH	Increase in forest fires indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Company "Šume Republike Srpske", Federal Forestry Administration of Federation BiH; Cantons; Local communities; Scientific institutions	600,000	2021–2024	Grants; Funds; Budgets

Human health

Measure	Indicators	Responsible institutions	Necessary funds (BAM)	Time frame	Note
Development of legislation on work in extreme climatic conditions	Increase in temperature and impact of heat waves on human health	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	150,000	2021–2023	Grants; Projects; Budgets; Loans
Establishing effective statistical monitoring of climate change-related pathologies (with prior training of staff)	Statistical monitoring established	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	400,000	2021–2023	Grants; Loans. Part of the project is already being implemented.
Building the capacity of public health institutes and emergency departments	Strengthening mobile teams and building technical capacity of emergency departments	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	10,000,000	2021–2030	Grants; Budgets; Loans

Raising awareness and informing the population about the impact of climate change on human health	Increased number of informed and educated population	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	300,000	2021–2030	Grants; Budgets; Loans
Making a study into new diseases caused by climate change	New diseases are indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	250,000	2021–2022	Grants; Budgets; Funds; Projects
Monitoring of the quality of drinking water in rural areas	Impaired quality of drinking water in rural areas is indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	3,000,000	2021–2024	Grants; Budgets; Funds; Loans
Examining bioclimatic impacts on human health	Increased bioclimatic impact on human health is indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	600,000	2021–2022	Grants; Budgets; Funds. Projects in progress

Examining the impact of allergens on human health	An increase in allergens (e.g. ragweed pollen) is indicated	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Public Health Institute of Republika Srpska; Public Health Institute of Federation BiH; Scientific institutions	400,000	2021–2023	Grants; Funds; Water Agencies

Tourism

Measure	Indicators	Responsible institutions	Necessary funds (BAM)	Time frame	Note
Snowmaking on ski slopes	Reduced number of snow days and warmer winters necessitate snowmaking on ski slopes. Longer ski season	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Olympic centres; Companies; Scientific institutions	20,000,000	2021–2025	Grants; Loans
Promoting the summer tourist season	The increase in summer temperatures will cause the summer season to be more attractive in the mountains	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Olympic centres; Companies; Scientific institutions	1,500,000	2021–2025	Grants; Funds; Olympic centres
Promotion of ecotourism	Great potentials for ecotourism development	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Companies; Cantons, Local communities; Scientific institutions	500,000	2021–2025	Grants; Budgets; Projects in progress

Promotion and development of agritourism	Climate change has a positive effect on agritourism	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Companies; Tourist associations and organizations; Cantons, Local communities; Scientific institutions	800,000	2021–2023	Grants; Budgets; Loans
Mapping and development of hiking trails	Increased number of mapped and developed hiking trails	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Companies; Tourist associations and organizations; Cantons, Local communities; Scientific institutions	3,000,000	2021–2025	Grants; Budgets; Loans
Development of bike trails	The development of recreational cycling is trending globally. In BiH, there are great potentials for developing bike trails	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Companies; Tourist associations and organizations; Cantons, Local communities; Scientific institutions	2,500,000 (50 bike trails developed)	2021–2030	Grants; Budgets; Loans; Tourist organizations; Local communities

Development of tourism and recreation on rivers and lakes	Great potentials for the development of recreation and tourism on rivers and lakes (rafting, white-water rafting, calm water kayaking, etc.)	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Companies; Tourist associations and organizations; Cantons, Local communities; Scientific institutions	4,000,000	2021–2025	Grants; Funds, Water Agencies; Tourist organizations; Local communities
Promotion of healthy lifestyles outdoors and in the mountains	Great potentials for the development of this type of tourism and recreation	Ministry of Foreign Trade and Economic Relations of Bosnia and Hercegovina-coordination; Government of Republika Srpska, Government of Federation BiH; Government of Brčko District; Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; Companies; Tourist associations and organizations; Cantons, Local communities; Scientific institutions	300,000	2021–2030	Grants; Funds, Water Agencies; Tourist organizations; Local communities

13. Literature and sources:

1. IPCC (2007). Climate Change 2007: Synthesis Report. The Intergovernmental Panel on Climate Change (IPCC), Geneva, 104 p.
2. WMO (2012). Frequently Asked Questions (FAQs). The World Meteorological Organization (WMO). Available at: http://www.wmo.int/pages/prog/wcp/ccl/faqs.html, July 22, 2012.
3. INCBH (2009). Initial National Communication of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change. Ministry of Environmental and Spatial Planning.
4. Trbic G., Bajic D., Djurdjevic V., Ducic V., Cupac R., Markez Đ., Vukmir G., Dekić R., Popov T. (2016). Limits to Adaptation on Climate Change in Bosnia and Herzegovina: Insights and Experiences. Chapter book, Springer-Climate Change Management Series.
5. Žurovec O,. Vedeld P.O,. Situala B.K. (2015). Agricultural Sector of Bosnia and Herzegovina and Climate Change—Challenges and Opportunities. Agriculture 2015, 5, 245–266; doi:10.3390/agriculture5020245 (https://www.mdpi.com/journal/agriculture)
6. TNC (2016). Third National Communication and second biennial update report on greenhouse gas emissions of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change, July 2016
7. Čadro S., Berjan S., El Bilali H., Žurovec O., Simić J. and Rajčević B. (2012). Governance of Adaptation To And Mitigation of Climate Change on Agricultural, Forest and Water Resources in Bosnia. Third International Scientific Symposium "Agrosym Jahorina 2012", Jahorina
8. SNC (2013). Second National Communication of Bosnia and Herzegovina under the United Nations Framework Convention on Climate Change, June 2013.
9. United Nations (2012). United Nations Framework Convention on Climate Change. http://unfccc.int/resource/docs/convkp/conveng.pdf, July 20, 2012.
10. Vlahinić, M. (2000). Hydro accumulation, agriculture, and land and water management in Bosnia and Herzegovina. Voda i mi No. 27, 26–37.
11. Čadro S., ŽurivecJ., Mrkulić A., Šehić D., Šero A., & Mićić G. (2016). Effect of Climate Change on Agro-Hydrological Balance for Some Regions in Bosnia and Herzegovina. Paper presented at the VII International Scientific Agricultural Symposium "Agrosym2016", Jahorina.
12. Vukmir G., Stanišljević Lj., Cero M. et al. (2009). Initial National Communication (INC) of Bosnia and Herzegovina Under the United Nations Framework Convention on Climate Change (UNFCCC). Banja Luka.
13. Drešković N. & Mirić R. (2013).Klimatski tipovi u Bosni i Hercegovini. Zbornik radova trećeg kongresa geografa Bosne i Hercegovine (Geografsko društvo u Federaciji BiH).
14. Popov T., Gnjato S., Trbic G. (2018). Changes in temperature extremes in Bosnia and Herzegovina: a fixed thresholds-based index analysis. Journal of the Geographical Institute „Jovan Cvijic", SASA 2018 Volume 68, Issue 1, pp: 17–33. DOI: https://doi.org/10.2298/IJGI1801017P
15. Spasova D., Trbic G., Majstorovic Z., Trkulja V. (2017). Study for Climate Change Impact Assessment on Agriculture and Adaptations Strategy Development in BIH, Report of Government of Republika Srpska, Ministry of Spatial Planning, Civil Engineering and Ecology, Regional Environmental Center, Banja Luka, 2007.
16. RKPŠV (1986). Uređenje Zemljišta s Posebnim Prilozima o Uređenju zemljišta na Društvenim gazdinstvima, u Periodu od 1986. do 2000. / Land Reclamation with a Special Annexes for the Landscaping at State Farms, for a Period 1986 – 2000.
17. Čadro S., Žurovec J., Cherni-Čadro S. (2017). Severity, Magnitude and Duration of Droughts in Bosnia and Herzegovina Using Standardized Precipitation Evapotranspiration Index (SPEI). Agriculture & Forestry, 63(3), 199–206. doi: DOI: 10.17707/AgricultForest.63.3.20

18. Vlahinić, M., Čustović, H., Alagić, E. 2001. Situation of Drought in Bosnia and Herzegovina (BIH)
19. Hodžić S., Marković M., Čustović H. (2013) Drought Conditions and Management. Strategies in Bosnia and Herzegovina – Concise Country Report. UNW-DPC Proceedings No. 11. 1st Regional Workshop on Capacity Development to Support National Drought Management Policies.
20. Cherni-Čadro, S., Mujić, F., Nedić, B., Jabučar, D. (2020): Sensitivity of the Flood Risk Maps to the Different Digital Elevation Model's Resolutions. Agriculture and Forest, 66 (2):225 – 234.
21. European Comission (EC). Bosnia and Herzegovina recovery needs assessment, floods 14–19 May https://reliefweb.int/sites/reliefweb.int/files/resources/delegacijaEU_2014070913592248eng.pdf
22. UNDP, Bosnia and Herzegovina floods 2014, Recovery needs assessment, 2014, pp 1–302.
23. The Council of Ministers of BIH. (2013). Climate Change Adaptation and Low-Emission Development Strategy for Bosnia and Herzegovina. October 2013. PP 1– 86p.
24. Žurovec J., Čadro, S. (2010). Climate Changes: The Need and Importance of Crop Irrigation in Northeastern Bosnia and Herzegovina. 21st Scientific-Expert Conference in Agriculture and Food Industry, Neum.
25. Radusin, S., Medić, V., Cero, M., Abdurahmanović, I., Avdić, S., Oprašić, S., . . . Trbić, G. (2016). Third National Communication and Second Biennial Update Report on Greenhouse Gas Emissions of Bosnia And Herzegovina under the United Nations Framework Convention on Climate Change. Retrieved from Sarajevo.
26. Čadro, S., Cherni-Čadro, S., Marković, M., Žurovec, J. (2019). A reference evapotranspiration map for Bosnia and Herzegovina. International Soil and Water Conservation Research, 7(1), 89–101. doi: 10.1016/j.iswcr.2018.11.002
27. Žurovec, J. (2012). Melioracije I uređenje poljoprivrednog zemljišta. Sarajevo: Univerzitet u Sarajevu, Poljoprivredno-prehrambeni fakultet http://refhub.elsevier.com/S2095-6339(18)30071-6/sbref93
28. Žurovec O,. Vedeld P.O. (2019). Rural livelihoods and climate changes adaptation in laggard transitional economies: A case from Bosnia and Herzegovina. Sustainability 2019, 11(21), 6079; https://doi.org/10.3390/su11216079
29. Žurovec O., Čadro S., Sitaula B.K. (2017). Quantitative assessment of vulnerability to climate change in rural municipalities of Bosnia and Herzegovina. Sustainability, 9(7), http://dx.doi.org/10.3390/Su9071208.
30. World Bank. (2010). Agricultural Sector Policy Note for Bosnia and Herzegovina. Trade and Integration Policy Notes – Poverty Reduction and Economic Management Unit, May 2010.
31. Žurovec J., Čadro S. (2015). Temporal Drought and Soil Moisture Variability in the Arable Land of Spreča Valley. 26th International Scientific expert Conference in Agriculture and Food Industry, Ilidža, Sarajevo.
32. Čustović H., Tais M., Hodžić S., Ljuša M. (2013). Assessment of the climate change impact on agriculture in bosnia and herzegovina, vulnerability and adaptation measures. 24th International Scientific-Expert-Conference of Agriculture and Food Industry, Sarajevo, Bosnia and Herzegovina, 25–28 September 2013. Sarajevo, Bosnia and Herzegovina
33. Grupa autora (2013) Procjena ugroženosti od elementarne nepogode i druge nesreće. R. Srpska http://www.vladars.net/sr-SP-Cyrl/Documents/Procjena%20ugro%C5%BEenosti%20Repulike%20Srpske-Prijedlog.pdf
34. Strategija integralnog upravljanja vodama Republike Srpske 2015–2024. Vlada Republike Srpske, Banjaluka 2015.
35. Plan upravljanja oblasnim riječnim slivom rijeke Save Republike Srpske 2017–2021. JU "Vode Srpske", 2017. http://www.voders.org/dokumentacija/2017-2021.pdf
36. Plan upravljanja oblasnim riječnim slivom rijeke Trebišnjice Republike Srpske 2017–2021. JU „Vode Srpske", 2017. http://www.voders.org/dokumentacija202017-2021.pdf
37. Sistem zaštite od poplava u Republici Srpskoj.

38. Serbia – Irrigation and drainage rehabilitation project. 2005 http://www.worldbank.org/projects/P087964/irrigation-drainage-rehabilitation-project-serbia?lang=en

39. Procjena potreba za oporavkom i obnovom u Bosni i Hercegovini. Vlada BiH, EU i World bank Group. http://ec.europa.eu/enlargement/pdf/press_corner/floods/procjena-potreba-za-oporavkom-i-obnovom-sazetak-u-eur.pdf

40. Akcioni plan za zaštitu od poplava i upravljanje rijekama u BiH 2014–2017. AVP rijeke Save.

41. Preliminarna procjena poplavnog rizika na vodotocima I kategorije u FBiH. Knjiga 1. AVP rijeke Save i AVP Jadranskog mora, 2013.

42. Nacrt plana upravljanja vodama za vodno područje rijeke Save u Federaciji Bosne i Hercegovine (2016–2021). Jačanje kapaciteta u sektoru voda. IPA projekat EU 2011, februar 2016.

43. Strategija upravljanja vodama Federacije Bosne i Hercegovine (2010–2022), Federalno Ministarstvo poljoprivrede, šumarstva i vodoprivrede, 2010.

44. Ritzema H., 2013: Land use, climate change and drainage criteria in the Netherlands. Does climate change demand a new approach to drainage design? Sarpsborg, Norway, 23–25 September 2013. Ed. Nordic Association of Agricultural Scientists. Book of abstracts. p.19.

45. Grupa autora, 2014: Sistemi za odvodnjavanje, navodnjavanje u Podunavskom, Braničevskom, Borskom i Zaječarskom okrugu i mogućnosti njihovog korišćenja za navodnjavanje poljoprivrednog zemljišta. Studija, Izd. Poljoprivredni fakultet, Univerzitet u Beogradu za Ministarstvo poljoprivrede i zaštite životne sredine.

46. Studija održivog razvoja irigacionih sistema na području RS (2008).

47. Osnova zaštite, korišćenja i uređenja poljoprivrednog zemljišta Republike Srpske kao komponente procesa planiranja korišćenja zemljišta (2009). Vlada Republike Srpske, Ministarstvo poljoprivrede, šumarstva i vodoprivrede, Republike Srpske.

48. Biljna proizvodnja Federacije Bosne i Hercegovine. Statistički bilten br. 138, 150, 166, 180, 197, 213, 230, 2008, 2009.

49. Baza podataka. Republički zavod za statistiku, Republika Srpska http://www3.rzs.rs.ba/rzs/faces/indicators.xhtml

50. Ekonomski računi i cijene u poljoprivredi. Statistički bilten br. 1– 6. Republički zavod za statistiku, Republika Srpska Grupa autora 2014 Inventar stanja poljoprivrednog zemljišta i njegovog korišćenja u regiji Hercegovine, ed. USAID, Mostar BiH.

51. Strategija prilagođavanja na klimatske promjene i niskoemisionog razvoja za Bosnu i Hercegovinu. 2013, http://www.ba.undp.org/content/bosnia_and_herzegovina/en/home/library/environment_energy/climate-change-adaptation-and-low-emission-development-strategy-.html

52. Avakumović D., Stričević R., Đurović N., i sar., 2005: Savremena analiza potrebnih količina vode za navodnjavanje Vodoprivreda, 350 -0519, 37 p.11–20.

53. Žurovec J., S.čadro (2011). Smanjenje prinosa poljoprivrednih kultura u uvjetima bez navodnjavanja na području sjeveroistočne Bosne. Proceedings. 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia (760–764).

54. ĆOTA J., ŠILJ M., (2012) Dutch early potato varieties in bosnia and herzegovina Third International Scientific Symposium “Agrosym Jahorina 2012” Proceedings, p.167–172.

55. Govedarica B., I. Đurđić, V. Milić. (2016) Stanje proizvodnje krompira u Republici srpskoj. XXI Savetovanje o biotehnologiji. Zbornik radova, Vol. 21.(23), 2016. P. 137–142.

56. Memišević S. 2015. Izvoz krompira poreklom iz Bosne i Hercegovine u Evropsku uniju. Informativni članak. http://www.dei.gov.ba/dei/dokumenti/informativni_clanci/default.aspx?id=15790&langTag=bs-BA

57. Koç, C. (2011) A study on construction costs per unit area of irrigation projects.Irrigation and Drainage Systems 25.4 255–263.

58. Potkonjak S., T. Zoranovic, 2013: Investments and costs of irrigation in function of agricultural sustainable development. Intern. Sci. Meeting. Sustainable Agriculture and Rural Development in

Terms of the Republic of Serbia. Strategic Goals Realization within the Danube Region, Preservation of Rural Values. Thematic Proceedings, December 6–8, 2012 Tara, Serbia 2013 pp. 627–644
59. www.water.worldbank.org/publication/case-studies-participatory-irrigation-management
60. Odluka o stopama posebnih vodnih naknada. (2011). Službeni glasnik Republike Srpske, str. 860.
61. Zoranović Tihomir, Mačkić Ksenija, Potkonjak Svetlana (2015): Economics of agricultural production in irrigation conditions on the area of regional hydrosistem Danube-Tisa-Danube. Book of abstracts of the 2nd International Symposium for Agriculture and Food, 7–9 October, Ohrid, Republic of Macedonia, 85. Izdavač: Faculty of agricultural sciences and food, Skopje ISBN 978-9989-845-90-1.
62. Berbel J., J. Calatrava, A. Garrido, 2007: Water pricing and irrigation: a review of the European experience. Irrigation Water pricing Policy: The Gap Between Theory and Practice. CABI, IWMI (2007): 295–327.
63. Organization for the Development of Western Crete (O.A.DY.K.) http://www.uni-muenster.de/Umweltforschung/medis/restricted/3OADYK.PDF
64. Nacionalni adaptacioni plan R. Srbije. Radna verzija, 2015.
65. Statistički godišnjak Republike srpske 2015. Republički zavod za statistiku. Republika Srpska.
66. Statistički godišnjak Federacije Bosne i Hercegovine 2015. Federalni zavod za statistiku. FBiH.
67. Djurdjevic, V., Rajkovic, B. (2008): Verification of a coupled atmosphere-ocean model using satellite observations over the Adriatic Sea. Annals of Geophysics 26:1935–1954.
68. Gualdi, S., Rajkovic, B., Djurdjevic, V., Castellari, S., Scoccimarro, E., Navarra, A., Dacic, M. (2008): Simulations of climate change in the Mediterranean Area, Final Scientific Report. [32] http://www.earth-prints.org/bitstream/ 2122/4675/1/SINTA Final Science Report October 2008.pdf.
69. Roeckner, E., Bäuml, G., Bonaventur, L., Brokopf, R., Esch, M., Giorgetta, M., Hagemann, S., Kirchner, I., Kornblueh, L., Manzini, E., Rhodin, A., Schlese, U., Schulzweida, U., Tompkins, A. (2003): The atmospheric general circulation model ECHAM 5. Part I: Model description, MPI-Report No 349.
70. Steduto P., T. Hsiao, E. Fereres, D. Raes. (2012) The yield response to water. The original FAO water production function. In: Crop yield response to water. Irrigation and drainage paper 66. FAO rome, fao 66.
71. Stojakovic, N., R. Stricevic, M. Vujadinovic-Mandic, M. Todorovic, 2015: Impact of climate change on water requirements and yield of maize grown under different pedo-climatic conditions in Bosnia and Herzegovina. Proceedings – Book of abstracts of International Conference on “Modern technologies, strategies and tools for sustainable irrigation management and governance in Mediterranean agriculture” (Eds. F.F. Montesano, A. Parente, N. Lamaddalena, M. Todorovic, L. Trotta), 23–25 September 2015, Valenzano (Bari), Italy, ISBN 2-85352-549-X, 97–98.
72. Biancalani R., T. Predić, M. Leko, E. Bukalo, M. Ljuša. (2004) Učešće u razvoju načina korištenja zemljišta na općinskom nivou u Bosni i Hercegovini (LUT). Projekat GCP/BIH/002/ITA, FAO, Rome.
73. Grupa autora (2014) Inventar stanja poljoprivrednog zemljišta i njegovog korištenja u regiji Hercegovine. USAID, Mostar, BiH.
74. Fenološki godišnjak, Federalni hidrometeorološki zavod, 2004–2014.
75. Bird, D.N., Benabdallah, S., Gouda, N., Hummel, F., Koeberl, J., La Jeunesse, I., Meyer, S., Prettenthaler, F., Soddu, A. and Woess-Gallasch, S., 2016. Modelling climate change impacts on and adaptation strategies for agriculture in Sardinia and Tunisia using AquaCrop and value-at-risk. Science of The Total Environment, 543, pp.1019–1027.
76. Linker, R., Ioslovich, I., Sylaios, G., Plauborg, F. and Battilani, A., 2016. Optimal model-based deficit irrigation scheduling using AquaCrop: A simulation study with cotton, potato and tomato. Agricultural Water Management, 163, pp.236–243.
77. Panković L. M. Malešević (2005). Uticaj roka setve i nivoa đubrenja azotom na prinose strnih žita u periodu 2000–2004. Godine. Zbornik radova Instituta za ratarstvo i povrtarstvo. sveska 41 str. 499 – 506.

14. Annex 1:

CONCEPTUAL FRAMEWORK FOR MONITORING AND EVALUATION OF CLIMATE CHANGE ADAPTATION INDICATORS

September, 2021

GREEN CLIMATE FUND

U N D P

Development of this publication was supported within the project "Advance the National Adaptation Plan (NAP) process for medium-term investment planning in climate sensitive secto in Bosnia-Herzegovina (B&H)", funded by the Green Climate Fund (GCF), implemented by UNDP in cooperation with the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, as a UNFCCC focal point for Bosnia and Herzegovina, Ministry of Agriculture, Forestry and Water Management of Republika Srpska, Federal Ministry of Agriculture, Water Management and Forestry and Federal Ministry of Environment and Tourism.

Expert team:

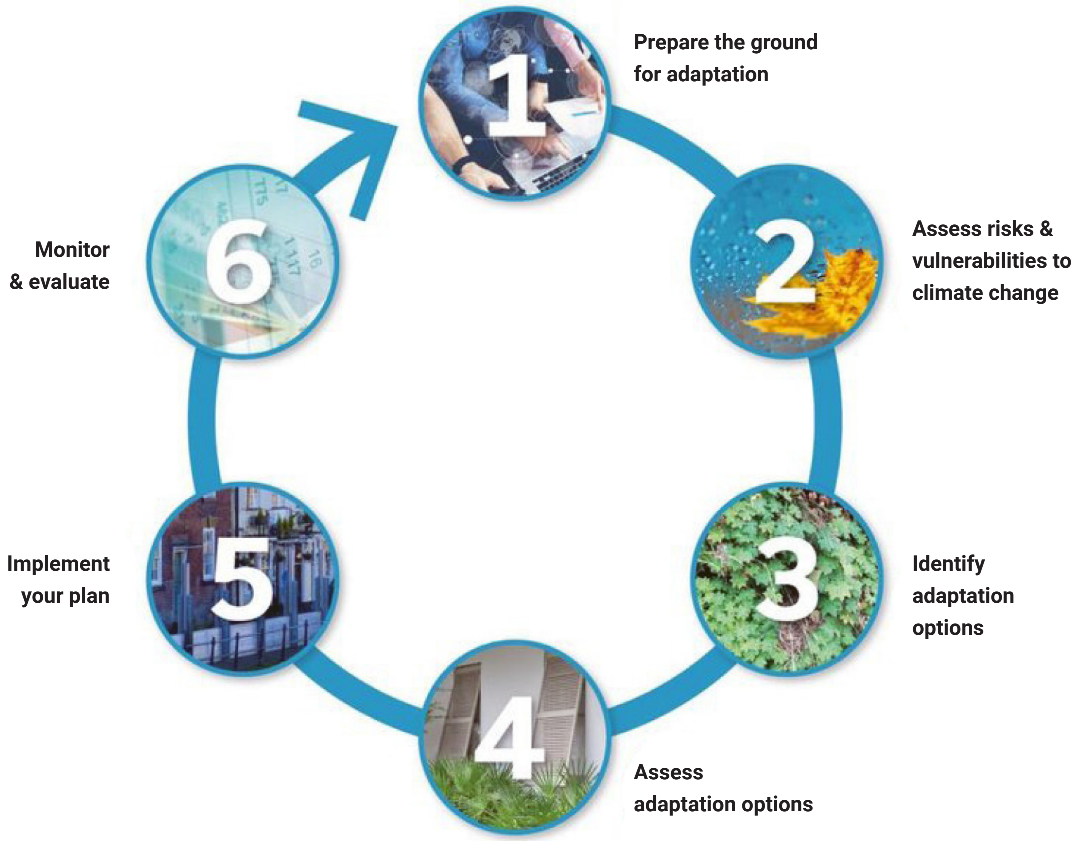
Danijela Božanić, Monitoring and Evaluation expert

Table of contents:

79 **1. Key assumptions**
83 **2. Indicators, data, sources and methodologies**
97 **3. Data processing and quality control model(s), i.e. roles and responsibilities of entities in charge of implementing, measuring, reporting and verifying CCA activities in relevant sectors**
97 3.1. Responsibility for the M&E system
99 3.2. Responsibility for data collection, data flow and availability
102 3.3. Legal basis for responsibilities and data exchange
103 **4. Governance structure – procedures for reporting and collecting data on performance indicators and for communication and dissemination of data**
104 4.1 Climate Change Committees (CCCs)
105 4.2 Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Protection Fund of Federation BiH and Department of Agriculture, Forestry and Water Management
106 **5. Data flows**
106 5.1 Local-level data
107 5.2 Data exchange and dissemination
107 5.3 Legal basis
109 **6. Costs/needs of the M&E system**
110 **7. Summary of recommendations**
111 **8. Annex 1: EEA methodologies for calculating indicators**
115 **9. Annex 2: List of potential indicators, by sector, based on international experiences and practices**

1. Key assumptions

Climate change adaptation (CCA) is a fundamental means of coping with the inevitable impacts of climate change. It is a mechanism for managing risks and adapting economic activity with a view to reducing vulnerabilities and improving business security. Rather than being an outcome, it is a process that requires planning and implementation (Figure 1).



Picture 1:
Phases in the adaptation cycle,
http://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool

In the IPCC Fourth Assessment Report (AR 4), vulnerability is a key concept, while four key components that determine whether and to what extent the system is vulnerable to climate change are: *exposure, sensitivity, potential impact and adaptive capacity*.

Exposure is directly linked to changes in climate parameters (temperature, precipitation, evapotranspiration and climatic water balance, as well as extreme events such as heavy rain, meteorological droughts, etc.). Sensitivity determines the degree to which a system is susceptible to climate change, and these two in combination determine the *potential impact* of climate change (Figure 2).

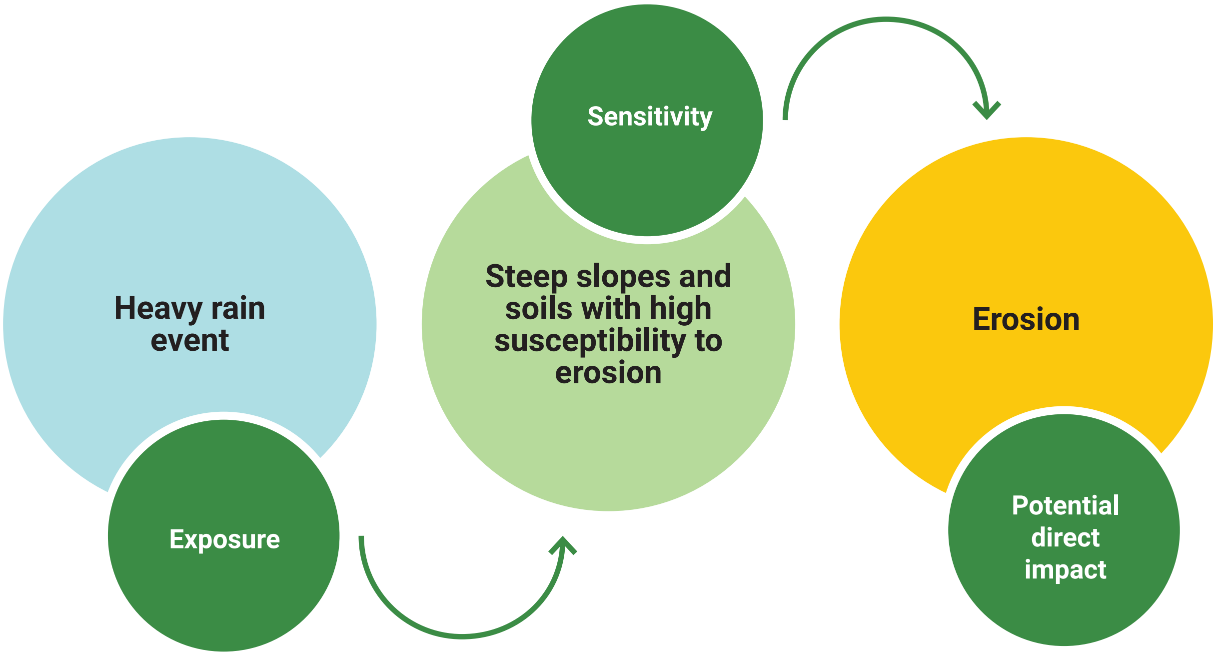


Figure 2.
Components of vulnerability to climate change – an example

Impacts can be direct (e.g. erosion) or indirect (e.g. reduction in yield, loss of income), stretching from biophysical to societal. *Adaptive capacity* refers to 'the ability of a system to adjust to climate change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.'[38]

However, the Fifth Assessment Report (AR5) replaced the concept of vulnerability with the concept of risk from climate change impacts. This concept of risk was taken over from the community-based Disaster Risk Reduction (DRR) risk assessment approach and practice. The AR5 risk concept focuses on assessing the risk of climate impacts that could harm the system. Risk is described as the result of the interaction of *vulnerability, exposure and hazard*.

Vulnerability and climate risk assessment is therefore a central component of any adaptation action. These assessments are used to identify the main risks and impacts on people, regions and sectors and, based on that, to formulate adaptation policies and projects. Also, they form a reference point by which to monitor the effectiveness of adaptation policies and projects.

Monitoring and evaluation (M&E) play a central role in monitoring progress towards adaptation. The overall goal of the CCA monitoring and evaluation system is to provide tools for decision makers to monitor and quantify adaptation progress and demonstrate the success/failure and effectiveness of adaptation measures.

38 Adaptation Support Tool, Climate – EU ADAPT,
https://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool/step-2-4

The BiH monitoring and evaluation system may refer specifically to the process of monitoring and evaluation of the implementation of a national adaptation strategy or plan (NAS/NAP) and related actions, or may have a broader meaning, where the aim is to understand changes in vulnerability and risk levels across the country. Where there is no national adaptation strategy or plan in place, as is the case with BiH, only the latter option is feasible.

The BiH CCA monitoring and evaluation systems usually collect data from several units, namely sectors and sub-national levels.

Monitoring – continuous and systematic collection of information that enables stakeholders to check whether an intervention is 'on track' or achieving set objectives.

Evaluation – systematic assessment of the worth or utility of an intervention at a specific point in time, e.g. whether a policy has been effective in achieving set objectives.

Thus, an M&E system may aggregate data collection:

1) Horizontally, across thematic areas and sectors. Priority sectors may be identified in a policy or plan, in National Communications to the UNFCCC and/or in sectoral assessments or evaluations.
2) Vertically, across geographic scales, which is necessary where a system needs to take into account data that exist at more local scales, e.g. from municipal governments, communities or adaptation projects.

The M&E system in BiH obviously needs to incorporate both dimensions, which, *inter alia*, define the scope of the conceptual framework.

In general, most countries have focused their efforts on CCA monitoring and reporting. The development of specific evaluation activities is still at an early stage, even in countries with relatively more experience in implementing CCA policies. It is therefore obvious that **monitoring and reporting should be a central part of the M&E system in BiH during the first phase.**

The aim of the M&E system is to monitor and quantify progress towards adaptation against the national CCA strategy or plan, based on vulnerability/risk assessment and prioritization of CCA measures and activities. Similarly, certain parts of the M&E system provide the data and information needed to assess risk/vulnerability. Given the current state of play regarding adaptation to climate change in BiH, **the M&E system should be developed with emphasis on the need to assess vulnerability/risk to climate change beyond those provided for in the National Communications to the UNFCCC.**

Some of the methodologies and examples of vulnerability/risk assessment options and adaptation options are provided at the following link: https://www.ipcc.ch/report/ipcc-technical-guidelines-for-assessing-climate-change-impacts-and-adaptations-2/, which could serve as a useful starting point for domestic NAP experts in BiH.

The M&E system is defined as a system of indicators used for systematic analysis of the results and impact of adaptation measures, as well as for feedback on the effectiveness of decision-making. However, there are also a number of indicators that are important for risk and vulnerability assessments, as a starting point for the adaptation cycle.

Indicators can be divided into four categories:

1) **Climate parameters** – observed and projected climate parameters (temperature, precipitation, extreme events) that give a picture of expected climatic conditions within which adaptation measures will be implemented;
2) **Climate impacts** – information about the impacts that the climate parameters have and could have on socio-economic and ecological systems, e.g. areas affected by forest fires or the number of people displaced because of them. They serve to measure the effects of changing climate on population and nature.
3) **Adaptation actions** – measures to implement an adaptation strategy, such as the number of sectoral laws that include adaptation considerations or the percentage of building codes updated.
4) **Adaptation results** – expected outcomes of adaptation measures, such as the number of cubic metres of water conserved or the number of motorways built using updated building codes.

Annex 2 provides a list of potential indicators by sector, based on the analysis of CCA monitoring and evaluations systems in selected countries (Morocco, Kenya, South Africa, Nigeria, Mexico, Germany, United Kingdom[39], etc.).

CCA indicators are defined for any sector potentially affected by climate change, namely: agriculture, biodiversity, building sector, coastal zones, energy, forestry, fishery, telecommunications, infrastructure, human health, information & communication, tourism, trade & industry, transport, urban areas, water resources, etc.

However, the establishment of a M&E system should start with the sectors identified as most affected by climate change or which are a priority for adaptation to climate change. In the case of **Bosnia and Herzegovina, focus will be on the sectors considered in National Communications to the UNFCCC.**

Women commonly face higher risks and greater burdens from the impacts of climate change in situations of poverty, and the majority of the world's poor are women. Women participate unequally in decision-making processes, although they can play a critical role in response to climate change. Therefore, it is important to include gender indicators in the M&E system, where two approaches could be applied:

1. Disaggregation of existing data; and or
2. Use of General Data/Indicators (e.g. maternal mortality, share of seats in parliament, proportion of women with at least some secondary education, labour force participation rate, etc). These data form the Gender Inequality Index (GII), which is important for vulnerability/risk assessment.

Given the current state of play regarding data collection and exchange in BiH, **it is recommended that existing gender indicators should be used and correlated with climate change. While disaggregation of data by gender is time-consuming, it is also recommended.**

39 For EU Member States, the indicators are mainly those of the European Environment Agency

2. Indicators, data, sources and methodologies

Considering that the scope of this project is the drafting of the **BiH National Adaptation Plan, this phase will focus on the first two categories of indicators (climate parameters and climate impacts), which could simultaneously contribute to the monitoring and evaluation of CCA activities and results**. Furthermore, as part of the preparation of the Bosnia and Herzegovina Adaptation Plan (AP), activity indicators will be identified and included in the Adaptation Plan. In general, the adaptation action in the Adaptation Plan could be formulated as required by the Modalities, Procedures and Guidelines (the legal document laying down the obligations under the Paris Agreement) and its sections defining the content and monitoring of NDCs. They will be discussed in the Conceptual Framework, which is the subject of this report.

In addition to the above, it is necessary to establish an initial set of CCA indicators based on:

1) context-specific needs at the national or sub-national levels;
2) the availability of basic data;
3) the capacity of data holders;

which will also be the main driver of the proposed BiH Conceptual Framework for Indicators.

Therefore, this report focuses on **agriculture, water management, forestry, human health and biodiversity**, as established in the National Communications, climate parameters and climate impacts, while special attention will be given to gender indicators. Finally, it is proposed that the European Environment Agency's set of CCA indicatorsrs should be the starting point in the context of Bosnia and Herzegovina's accession to the EU.

The aim is to start setting up the M&E system using a smaller number of indicatorsrs and to add further indicatorsrs over time, as the country is still gaining experience with M&E and CCA activities.

Table 1 below lists the broader range of proposed indicators (as a medium-term objective), the current availability of country-level data, the availability of trends and projections (other than those provided in NatComm) for each indicator as well as the institutions responsible for indicators and for data production/collection. However, the list of priority indicators will be indicated in the Report "TECHNICAL GUIDELINES FOR MONITORING AND EVALUATION AND CAPACITY BUILDING PLAN", based on international experiences and on the results of consultations among BiH stakeholders (within the project). The methodology for calculating specific indicators is described in Annex 1. Another source of methodologies is the IPCC.

The use of EEA indicators and methodologies is recommended[40].

Table 1:
List of indicators, data availability and data sources for indicators, and institutions responsible[41] for data collection and indicators

Sector: All sectors
Climate parameters – observed and projected climate parameters

Indicator	Data available YES/NO)	Data source	Trends and projections for BiH	Responsible institution	
				Indicator	Data collection
Change in annual temperature[42]	Y	Hydrometeorological institutes Republika Srpska https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/[43] FBiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php Indicator KP9 on the List of selected environmental indicators for BiH[44]	EEA: Trends in annual temperature across Europe between 1960 and 2018 https://www.eea.europa.eu/data-and-maps/figures/decadal-average-trends-in-mean-9 EEA: Projected changes in annual, summer and winter temperature https://www.eea.europa.eu/data-and-maps/figures/projected-changes-in-annual-summer-1	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Mean monthly temperature	Y	Hydrometeorological institutes Republika Srpska https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ FBiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-mjesec.php	N/A	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Number of hot days/Number of extreme heat waves	Y	Hydrometeorological institutes Republika Srpska: https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php	EEA: Number of extreme heat waves in future climates https://www.eea.europa.eu/data-and-maps/figures/number-of-extreme-heat-waves-1	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute

40 https://www.eea.europa.eu/data-and-maps/indicators#c0=10&c5=climate-change-adaptation&b_start=0&c12=climate-change-adaptation
https://www.eea.europa.eu/themes/climate-change-adaptation/intro#:~:text=The%20European%20Climate%20Adaptation%20Platform,Adaptation%20(ETC%2FCCA)
https://climate-adapt.eea.europa.eu/

41 Recommended based on current situation and capacity. Alternatively, this role could be assigned to the Environmental Funds

42 Grey boxes represent a priority indicator (initial set of indicators)

43 Annual climate reports for 2016 and 2017 are available

44 The list of selected environmental indicators for BiH was prepared under the UNEP/GEF project “Capacity Development for the integration of Global Environmental Commitments into National Policies and Development Decision Making in Bosnia and Herzegovina”

Change in annual precipitation	Y	Hydrometeorological institutes Republika Srpska: https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php Indicator KP10 on the List of selected environmental indicators for BiH	EEA: Trends in annual and summer precipitation across Europe between 1960 and 2015 https://www.eea.europa.eu/data-and-maps/indicators/european-precipitation-2/assessment EEA: Projected changes in annual and summer precipitation https://www.eea.europa.eu/data-and-maps/figures/projected-changes-in-annual-and-/.5	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Monthly precipitation	Y	Hydrometeorological institutes Republika Srpska: https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-mjesec.php	N/A	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Extreme precipitation /Heavy precipitation[45]	Y	Hydrometeorological institutes Republika Srpska: https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php	EEA: Observed trends in maximum annual five-day consecutive precipitation in winter and summer (1960–2015) EEA: Projected changes in heavy precipitation (in %) in winter and summer from 1971–2000 to 2071–2100 for the RCP8.5 scenario https://www.eea.europa.eu/data-and-maps/indicators/precipitation-extremes-in-europe-3/assessment-1	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute

45 Heavy precipitation is defined as the maximum annual five-day consecutive precipitation.

Meteorological droughts (precipitation deficit) and hydrological droughts (minimum river flow)[46]	Y/N	Hydrometeorological institutes For meteorological drought – SPI (standard precipitation index) Republika Srpska: https://rhmzrs.com/meteorologija/agrometeorologija/uslovi-vlaznosti/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/AGRO/SPI-prognoza.php Indicator KP11 on the List of selected environmental indicators for Bosnia and Herzegovina. For hydrological drought – a set of observations of river flows – an incomplete set of data is available (in terms of stations and years covered). Federation of BiH: http://www.fhmzbih.gov.ba/latinica/HIDRO/godisnjaci.php# Republika Srpska: Not available on the RHMZ website (some data are available in the Statistical Yearbook https://www.rzs.rs.ba/front/category/8/)	Trend in the frequency of meteorological droughts in Europe (1950–2015) Trend in runoff during the driest month of the year in Europe (1950–2015) Projected change in meteorological drought frequency between the present (1981–2010) and the mid-century 21st century (2041–2070) in Europe, under two emissions scenarios Projected change in 10-year river water deficit between the present (1981–2010) and the end of the 21st century (2071–2100) in Europe, under two emissions scenarios https://www.eea.europa.eu/data-and-maps/indicators/river-flow-drought-3/assessment	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Hail events and wind storms[47]	Y/N	Hydrometeorological institutes The Potential Hail Index (PHI), which quantifies the atmospheric potential for hailstorms, is derived from atmospheric numerical models. Current weather observations are used as input for numerical computer models. Republika Srpska: https://rhmzrs.com/meteorologija/meteorolosko-bdenje/aktuelni-podaci/podaci/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/AKTUELNO/BosniaHerzegovina.php There are no historical data on hailstorms and/or windstorms	Observed annual median and trend of the Mean Potential Hail Index (PHI) over the period 1951–2010 https://www.eea.europa.eu/data-and-maps/figures/observed-median-annual-and-trend Wind storms – data for BiH are not included in the EEA indicators.	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute

46 The update will be performed in January 2020

47 Extreme wind speed (98th percentile of daily maximum wind speed)

Snow cover extent and snow mass	Y/N	Hydrometeorological institutes Limited data are available for maximum snow depth Republika Srpska: https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php	Snow cover data are available for the northern hemisphere and the whole of Europe	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Heating and cooling degree days	Y	Systematized data are not available	Data for EU available at: https://www.eea.europa.eu/data-and-maps/figures/trend-in-heating-and-cooling-1		

Sector: Water management
Climate impacts – impacts that climate parameters have and may have on socio-economic and ecological systems

Indicator	Data available YES/NO)	Data source	Trends and projections for BiH	Responsible institution	
				Indicator	Data collection
River flows	Y/N	Hydrometeorological institutes/ Statistical Offices Incomplete data set available (in terms of stations and years covered) Federation of BiH: http://www.fhmzbih.gov.ba/latinica/HIDRO/godisnjaci.php# Republika Srpska: Not available on the RHMZ website (some data are available in the Statistical Yearbook https://www.rzs.rs.ba/front/category/8/)	Model-based estimate of past change in annual river flows https://www.eea.europa.eu/data-and-maps/figures/model-based-estimate-of-past Projections have been made for 12 rivers, including the Danube in Romania. Data for BiH are not included in the EEA indicators	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute or Sava River Basin Agency, Adriatic Sea Watershed Agency/ Public Institution “Vode Srpske” Bijeljina	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute or Sava River Basin Agency, Adriatic Sea Watershed Agency/ Public Institution “Vode Srpske” Bijeljina
River and lake water temperature	Y/N	Hydrometeorological institutes/ Statistical Bureaus Incomplete data set available (in terms of stations and years covered) Federation of BiH: http://www.fhmzbih.gov.ba/latinica/HIDRO/godisnjaci.php# Republika Srpska: Although some measurements are carried out, systematic data on water temperature are not available on the RHMZ website	Water temperature trends of major European rivers and lakes, including the Danube in Vienna. Data for BiH are not included in the EEA indicators	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute	Federal Hydrometeorological Institute, Republic Hydrometeorological Institute

River floods	N	Republic Civil Protection Administration: Census of Disasters https://ruczrs.org/en/%d0%b4%d0%be%d0%ba%d1%83%d0%bc%d0%b5%d0%bd%d1%82%d0%b8/, data limited Federation BiH Civil Protection Administration: http://www.fucz.gov.ba/category/brosure/ (unclear whether data are available)	Observed regional trends in annual river flood discharges in Europe (1960–2010) https://www.eea.europa.eu/data-and-maps/figures/observed-regional-trends-of-annual Projected change in 100-year river floods for two global warming levels. BiH is not included in the geographical coverage	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Republic Civil Protection Administration/ Federal Civil Protection Administration

Sector: Agriculture
Climate impacts – impacts that climate parameters have and may have on socio-economic and ecological systems

Indicator	Data available YES/NO)	Data source	Trends and projections for BiH	Responsible institution	
				Indicator	Data collection
Water-limited crop yield	N	Data not available	Projected change in mean water-limited yield of winter wheat by 2030 https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-mean-water Projected changes in water-limited crop yield (for 2050s) https://www.eea.europa.eu/data-and-maps/figures/projected-changes-in-water-limited Probability of the occurrence of adverse agroclimatic conditions for wheat under baseline and projected climate – Data for BiH are not included.		Agricultural Institute of Republika Srpska / Federation BiH Agricultural Institute or Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Agrophenology/Seasonal cycle of agricultural crops	Y	Hydrometeorological institutes RS: https://rhmzrs.com/meteorologija/agrometeorologija/fenologija/ratarske-i-povrtarske-kulture/ https://rhmzrs.com/meteorologija/agrometeorologija/fenologija/vocarski-radovi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/FENO/godisnjaci.php	Trend in flowering date of winter wheat https://www.eea.europa.eu/data-and-maps/figures/change-of-flowering-date-for-2	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Agricultural Institute of Republika Srpska / Federal Agricultural Institute or Federal Hydrometeorological Institute, Republic Hydrometeorological Institute

Crop water demand	N	Data not available Agricultural Institute (as part of its activities): Therefore, due to the increased frequency of drought in the region, indicating a great need to study maize resistance to drought as a complex phenomenon, which refers to: study of resistance to high temperatures, study of resistance to water scarcity. Similar data are not available on the website of the Federal Institute of Agriculture.	Trend in crop water deficit of grain maize during the growing season https://www.eea.europa.eu/data-and-maps/indicators/water-requirement-2/assessment Projected annual rate of change of the crop water deficit of grain maize during the growing season in Europe for the period 2015–2045 for two climate scenarios https://www.eea.europa.eu/data-and-maps/figures/projected-annual-rate-of-change	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Agricultural Institute of Republika Srpska / Federal Agricultural Institute or Federal Hydrometeorological Institute, Republic Hydrometeorological Institute
Growing season of agricultural crops	Y	Hydrometeorological institutes Republika Srpska: https://rhmzrs.com/meteorologija/klimatologija/mjesecni-pregledi/ Federation of BiH: http://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php	Trend in the number of frost-free days https://www.eea.europa.eu/data-and-maps/figures/rate-of-change-of-frost-1	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Agricultural Institute of Republika Srpska / Federal Agricultural Institute or Federal Hydrometeorological Institute, Republic Hydrometeorological Institute

Sector: Forestry
Climate impacts – impacts that climate parameters have and may have on socio-economic and ecological systems

Indicator	Data available YES/NO)	Data source	Trends and projections for BiH	Responsible institution	
				Indicator	Data collection
Burnt area due to forest fires (hectares)	Y	Bureau of Statistics of Republika Srpska https://www.rzs.rs.ba/front/category/20/144/?&add=None (statistics on damage to forests, including fires and insects, and statistics on the number of fires in privately and state-owned forests) Federation BiH Bureau of Statistics http://fzs.ba/index.php/publikacije/godisnji-bilteni/sumarstvo/ (statistics on fire and insect damage, including gypsy moth and bark beetle, and statistics on the number of fires and causes) Indicator Š3 on the List of selected environmental indicators for BiH Hydrometeorological institutes – FORECASTED INDEX OF FOREST FIRE RISK (FWI) Federation of BiH: http://www.fhmzbih.gov.ba/latinica/AGRO/pozar.php Republika Srpska: https://rhmzrs.com/meteorologija/meteorolosko-bdenje/prognoza/prognoza-uslova-za-izbijanje-pozara/	Burnt area in European countries, data for BiH are not included. Forest fire danger in the present climate and projected changes under two climate change scenarios, data for BiH are not included.	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Bureau of Statistics of Republika Srpska / Federal Bureau of Statistics
Forest composition and distribution	Y	Bureau of Statistics of Republika Srpska https://www.rzs.rs.ba/front/category/20/144/?&add=None Federation BiH Bureau of Statistics http://fzs.ba/index.php/publikacije/godisnji-bilteni/sumarstvo/ Indicator Š1 on the List of selected environmental indicators for Bosnia and Herzegovina	Projected changes in climatic suitability for broadleaf and needleleaf trees https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-climatic-suitability	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Federal Forestry Administration[48] / Ministry of Agriculture, Forestry and Water Management of Republika Srpska; Ministry of Agriculture, Water Management and Forestry of Federation and Forest Agency of Republika Srpska

Sector: Human health
Climate impacts – impacts that climate parameters have and may have on socio-economic and ecological systems

Indicator	Data available YES/NO)	Data source	Trends and projections for BiH	Responsible institution	
				Indicator	Data collection
Deaths related to flooding	N	Bureau of Statistics of Republika Srpska / Federation BiH Bureau of Statistics Republika Srpska: https://www.rzs.rs.ba/front/category/8/?left_mi=287&add=287 (Chapter 5 – Violent deaths by sex, age and external cause of death – deaths attributed to accidental drowning) Federation of BiH: Not available	Deaths related to flooding https://www.eea.europa.eu/data-and-maps/indicators/floods-and-health-1/assessment	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Republic Civil Protection Administration / Federal Civil Protection Administration or Bureau of Statistics Republika Srpska / Federal Bureau of Statistics
Mortality due to extreme temperatures	N	Not available	Associations between temperature and mortality in four European cities; BiH is not included. https://www.eea.europa.eu/data-and-maps/indicators/heat-and-health-2/assessment Some figures can be found for European or EU countries: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Public Health Institute of Republika Srpska / Federal Public Health Institute, Bureau of Statistics Republika Srpska / Federal Bureau of Statistics

48 Based on data from:
KJP GDŠ “Sarajevo šume” doo Sarajevo
JP “Šumsko-privredno društvo Zeničko-dobojskog kantona” doo Zavidovići
ŠGD “Hercegbosanske šume” doo Kupres
“Šumsko-gospodarsko društvo Županije Zapadnohercegovačke” doo Posušje
JP “Šume Tuzlanskog kantona” dd Kladanj
JP “Unsko-sanske šume” doo Bosanska Krupa
JP “Bosansko-podrinjske šume” doo Goražde
ŠGD “Šume Središnje Bosne/ ŠPD Srednjobosanske šume/ ŠPD Srednjobosanske šume” doo Donji Vakuf
JP “Šume Hercegovačko-neretvanske” doo Mostar

Number of people requiring interventions against neglected tropical diseases	Y	Bureau of Statistics of Republika Srpska /Federation BiH Bureau of Statistics Public Health Institute of Republika Srpska / Federation BiH Public Health Institute Republika Srpska https://www.rzs.rs.ba/front/category/8/?left_mi=287&add=287 (Chapter 28 – Reported cases of communicable diseases) Republika Srpska: https://phi.rs.ba/index.php?view=publikacije&id=publikacije Federation of BiH: https://www.zzjzFBIH.ba/statisticki-godisnjaci/ (Diseases, conditions and injuries from Public Health in Federation BiH; Diseases, conditions and injuries from the women's health services in Federation BiH)	Some figures can be found for European or EU countries: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Public Health Institute of Republika Srpska / Federal Public Health Institute
Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease	Y	Bureau of Statistics of Republika Srpska / Federation BiH Public Health Institute Republika Srpska: https://www.rzs.rs.ba/front/category/8/?left_mi=287&add=287 (Chapter 5 – Deaths by sex and cause of death) Federation of BiH: https://www.zzjzFBIH.ba/statisticki-godisnjaci/ (Deaths by cause of death, sex and age in Federation BiH, Leading causes of death in Federation BiH by sex, Leading diagnosis among malignant neoplasms as a cause of death in Federation BiH population)	Some figures can be found for European or EU countries: https://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Public Health Institute of Republika Srpska / Federal Public Health Institute

Vector-borne disease – Prevalence: *Ixodes ricinus* ticks, *Aedes albopictus*, West Nile Virus infections, Chikungunya transmission	N	Not available	Current European distribution of *Ixodes ricinus* ticks (there are no field studies in BiH); Known distribution of the tiger mosquito in Europe (*Aedes albopictus*), BiH included in the analysis (data for BiH partially available) https://www.eea.europa.eu/data-and-maps/figures/european-distribution-of-borrelia-burgdorferi-1 https://www.eea.europa.eu/data-and-maps/figures/presence-of-aedes-albopictus-the-tiger-mosquito-in-europe-in-january-3 Projected change in the climatic suitability for Chikungunya transmission https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-the-climatic Projected future distribution of West Nile Virus infections https://www.eea.europa.eu/data-and-maps/figures/projected-future-distribution-of-west-1	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Public Health Institute of Republika Srpska / Federal Public Health Institute
Time series of vibriosis infections (Salmonella, Norovirus, Campylobacter, Cryptosporidium, Vibrio species (except cholera)	Y	Limited data are available Bureau of Statistics of Republika Srpska / Federation BiH Bureau of Statistics Republika Srpska: https://www.rzs.rs.ba/front/category/8/?left_mi=287&add=287 (Chapter 28 – Reported cases of communicable diseases) Federation BiH: Not specified https://www.zzjzFBIH.ba/statisticki-godisnjaci/ (Leading infectious and parasitic diseases in Federation BiH)	Not available (Baltic region only)	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Public Health Institute of Republika Srpska / Federal Public Health Institute

Sector: Biodiversity
Climate impacts – impacts that climate parameters have and may have on socio-economic and ecological systems

Indicator	Data available YES/NO)	Data source	Trends and projections for BiH	Responsible institution	
				Indicator	Data collection
Impact of climate change on bird populations	N	Not available	Climate change impact indicator for European birds Weighted population trend of species predicted to lose range in response to climatic change (92 species) Weighted population index of species predicted to gain range in response to climatic change (30 species) Data for BiH are not included https://www.eea.europa.eu/data-and-maps/indicators/impact-of-climate-change-on/impact-of-climate-change-on	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska / Federal Ministry of Environment and Tourism
Distribution shifts of plant and animal species Trend in thermophilic species in bird and butterfly communities Projected change in climatically suitable areas for bumblebees	N	Not available	European variations in the temporal trend of bird and butterfly community temperature index, data for BiH are not included Projected change in climatically suitable areas for bumblebees; data for BiH are not included	Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Republic Institute for Protection of cultural, historical and nature heritage of Republika Srpska / Federal Ministry of Environment and Tourism

The institutions responsible for indicators, as proposed in Table 1, are the result of analyses presented in Report 1 and review of existing frameworks, procedures and competences, while the final decision remains subject to agreement at the national level.

In order to monitor the indicators in a meaningful way, it is necessary to have reference data (data for calculating indicators during the reference/specific time period). Therefore, it is recommended that the following indicators be used initially:

Sector: All sectors
Adaptation results – expected outcomes of adaptation measures[49]

Economic losses from climate-related extremes	N	Not available For the period 1980–2017 and the EU: https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2		Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Republic Civil Protection Administration / Federal Civil Protection Administration
Climate-related economic losses by type of event	N	Not available For EU available at: https://ec.europa.eu/eurostat/web/products-datasets/product?code=cli_iad_loss		Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina	Republic Civil Protection Administration / Federal Civil Protection Administration

Table 2:
A set of initial climate change adaptation indicators – recommended for monitoring and reporting

Indicators to be included in the first phase of the M&E system

1.	Change in annual temperature
	Mean monthly temperature
	Number of hot days/Number of extreme heat waves
	Change in annual precipitation
	Monthly precipitation
	Extreme precipitation events/Heavy precipitation events[50]
	Heating and cooling degree days
2.	Agrophenology/Seasonal cycle of agricultural crops
	Growing season of agricultural crops
3.	River flows
	River and lake water temperature
4.	Burnt area due to forest fires (hectares)
	Forest composition and distribution
5.	Deaths related to flooding
	Mortality due to extreme temperatures
	Number of people requiring interventions against neglected tropical diseases
	Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease

49 For most adaptation activities, these two could be an indicator. Also, they can serve as a basis for accessing climate funds. In addition, collection of data on losses and damages is required under the Sendai Framework, so they could be a good starting point for ensuring the necessary link between DRR and CCA.

50 Heavy precipitation is defined as the maximum annual five-day consecutive precipitation.

Table 3.
Gender indicators – recommended for monitoring and reporting

Climate impacts - related to gender

Health sector indicators (No. 5, Table 2) can be classified and used as gender indicators. Furthermore, existing general indicators:

- Deaths by cause of death and sex[51] [52]
- Percentage of women in innovation[53]
- Patients treated in hospitals by disease group and sex could be a starting point for including gender in climate change adaptation, contrasting their correlation with climate conditions.

After consultations among BiH stakeholders (within the project), the list will be revised and the competent institution of the Brčko District will be confirmed (in the report "TECHNICAL GUIDELINES FOR MONITORING AND EVALUATION AND CAPACITY BUILDING PLAN").

Furthermore, taking account of Articles 9–11 of the Paris Agreement, the funds should, in the future, initiate activities aimed at systematization and collection of information on the necessary and received financial and technological support, as well as support in building CCA capacity. This could, as a minimum, be achieved by using the data presented in the BiH AP, National Communications and Biennial Transparency Reports, as well as by collecting information on the support received from donors.

51 http://www3.rzs.rs.ba:8080/rzs/faces/indicators.xhtml

52 http://www3.rzs.rs.ba:8080/rzs/faces/indicators.xhtml

53 https://www.rzs.rs.ba/front/category/26/108/?left_mi=39&up_mi=12&add=39

3. Data processing and quality control model(s), i.e. roles and responsibilities of entities (Republika Srpska and Federation BiH) in charge of implementing, measuring, reporting and verifying CCA activities in relevant sectors

In order to operationalize the system of indicators (which measure the reduction of identified risks/vulnerabilities and the effectiveness of CCA activities), it is important to define the following:

1. Who is responsible for the monitoring system and who ensures the performance of the main cross-sectoral functions (planning, coordination, quality assurance, documentation, etc.)?
2. What data should be collected for the purpose of indicators?
3. Who collects, processes and analyses data and how?
4. Who bears the costs?

3.1. Responsibility for the M&E system

Based on Table 1 and Table 2, the **Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina**; and the Brčko District Department of Agriculture, Forestry and Water Management (hereinafter: the Department) will be the entities responsible for the monitoring and reporting/evaluation system and performing the main cross-sectoral functions (planning, coordination, quality assurance, documentation, etc.).

Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; and Brčko District Department of Agriculture, Forestry and Water Management should provide resources to cover the costs of setting up and operating a CCA monitoring and evaluation system, including data collection and sharing, as well as public disclosure of data within their purview.

Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; and the Brcko District Department of Agriculture, Forestry and Water Management will be responsible for providing indicators and data related to them, which does not necessarily mean that these institutions will be responsible for collecting data and "calculating" the indicators. Rather, their responsibility will entail presenting meteorological, hydrological, socio-economic and other data through the climate change lens, e.g. collecting and providing data on air temperature and mean annual temperature is the responsibility of the HydroMet Institutes. However, when it comes to expressing trends and comparing current values at baseline, if it is not done by the HydroMet Institutes, then it will be done by the Funds/Department, while the calculation, given the current capacity of the environmental funds, will initially be done by external experts (with activities being entrusted to the HydroMet Institutes or some other experienced institution/expert). Once the Funds have built up their capacity, the performance of this function will be entrusted to them.

During the first phase, the Funds will use existing data (Table 2). In parallel, the Funds need to start setting up a framework for collecting and systematizing data for a wider range of indicators.

Existing laws do not specify who is responsible for making projections of climate parameters and climate impacts. HydroMet Institutes are responsible for monitoring climate parameters, but not for making future projections of these data, which are needed for vulnerability assessment and adaptation planning; water management agencies monitor water flow data and have historical data, but are not responsible for making future projections for this parameter. Therefore, the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina; and the Brcko District Department of Agriculture, Forestry and Water Management will ensure the existence of climate change projections and all selected indicato (externalized in accordance with IPCC and EEA methodologies, such as those given in Annex I Table 1). Most countries, including EU member states, entrust such tasks to institutes and univeities, e.g. the Austrian Environmental Protection Agency, which is a professional organization and a limited liability company partially funded by the Government, or CITEPA, which is entrusted with calculating, interpreting and disseminating information on reliable emissions data for decision make and experts in France and abroad. CITEPA is a non-profit organization and a state operator for the French Ministry of the Environment, which meets the requirements for reporting air pollutants and GHG emissions from France in various inventory formats, such as UNFCCC, EMEP, Kyoto Protocol and UNECE inventories.

Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and the Brcko District Department of Agriculture, Forestry and Water Management will establish an electronic system (web application and platform for climate change vulnerability assessment and adaptation), in the form of an interactive web application and platform with consolidated climate data and observations (or data derived from observations, climate model projections, indicato and their projections, financial resources provided for CCA and CCA needs), which are accessible to all provide of data relevant to indicato.

The electronic system will also be used by the other operational body Ministry of Foreign Trade and Economic Relations BiH that coordinates and shares data and information between the entities Republika Srpska and Federation BiH. Data sharing arrangements should be agreed at the entity/state level, based on good practice (e.g. in the water sector), and defined by a legal document or MoU on data and information sharing.

3.2. Responsibility for data collection, data flow and availability

Institutional analysis has identified government and other institutions responsible for producing data relevant to indicato (either through observations or from observational data) in the Federation of BiH, Republika Srpska and Brčko District. A more detailed analysis of proposed indicato is given in Table 1, based on the recommendations from Table 2. List of institutions responsible for **data development in Republika Srpska and Federation of Bosnia and Herzegovina**:

1) Ministry of Agriculture, Forestry and Water Management of Republika Srpska/ Ministry of Agriculture, Water Management and Forestry of Federation Bosnia and Herzegovina– for data related to forestry;
2) Ministry of Spatial Planning, Construction and Ecology of Republika Srpska/ Federal Ministry of Environment and Tourism – for data related to environmental protection;
3) Ministry of Spatial Planning, Construction and Ecology of Republika Srpska /Ministry of Spatial Planning of Federation Bosnia and Herzegovina – for data related to spatial planning;
4) Republic Hydrometeorological Institute and Federal Hydrometeorological Institute – for climate paramete
5) Republic Hydrometeorological Institute and Federal Hydrometeorological Institute and the Sava River Basin Agency, the Adriatic Sea Watehed Agency, the Public Institution "Vode Srpske" Bijeljina – for hydrological paramete
6) Agricultural Institute of Republika Srpska, Institute for Genetic Resources /Federal Institute of Agri cultural Pedology – for data related to agriculture
7) Forest Agency of Republika Srpske and Federal Forestry Administration (Forest Agency) – for data on forests
8) Republic Civil Protection Administration/Federal Civil Protection Administration – for losses and damages
9) Public Health Institute of Republika Srpska, Ministry of Health and Social Welfare of Republika Srpska, Public Health Institute of Federation BiH (Public Health Institutes) and Ministry of Health of Federation BiH – for data related to health
10) Institute for the Protection of Cultural, Historical and Natural Heritage of Republika Srpska /Federal Ministry of Environment and Tourism (Institutes for Nature Protection) – for data on biodiversity.

At the level of the Brčko District, the relevant units are:

1) Department of Agriculture, Forestry and Water Management, and
2) Department for Spatial Planning and Property Affairs

A more exhaustive list of institutions will be drawn up following a consultation process and will be included in the Standard Operating Procedures for Coordination and Exchange of Climate Change Adaptation Indicators to be developed within the project.

The institution identified in Table 1 as responsible for data collection shall furnish data to the body responsible for indicators. Once produced, the indicator is submitted to the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Protection Fund of Federation BiH and the Brčko District Department of Agriculture, Forestry and Water Management, which will share it via the web application and platform. Indicators and supporting data are stored in a common database and are thus made available to all stakeholders in the process. In addition to indicators, methodologies and other relevant details should be published and securely archived so as to enable the monitoring of changes and progress towards improving the quality of data and procedures.

This system will be an integral part of the Environmental Information System.

Furthermore, due to the institutional and operational arrangements at the level of BiH, it is important to ensure the involvement of and sharing of data with the BiH Ministry of Foreign Trade and Economic Relations.

In the context of climate change adaptation, it is obvious that hydrometeorological institutes (HMZs) are crucial stakeholders in planning the development of BiH in almost all sectors. More about their importance and role can be found at: https://library.wmo.int/doc_num.php?explnum_id=7936

So, **all HMZ data must be publicly available, free of charge and in a format suitable for climatological and other modelling**. If this is the case, EU data and globally available data (historical and projected) could be used and brought down to BiH and entity levels of Republika Srpska and Federation BiH and be made available to the public. The CCA monitoring and evaluation system will provide climate data, which the Funds could also make available on their websites.

Furthermore, under the Paris Agreement, information about national CCA actions can be reported through the Biennial Transparency Report (every two years). Precise reporting guidelines under Article 15 of the MMR are available at: http://cdr.eionet.europa.eu/help/2019_MMR_reporting_guidance_adaptation.pdf[54] and their use as reporting guidelines is recommended. According to the MMR, every four years (every two years after 2021), aligned with the timings for reporting to the UNFCCC, Member States shall report to the Commission information on their national adaptation planning and strategies, outlining their implemented or planned actions to facilitate adaptation to climate change.

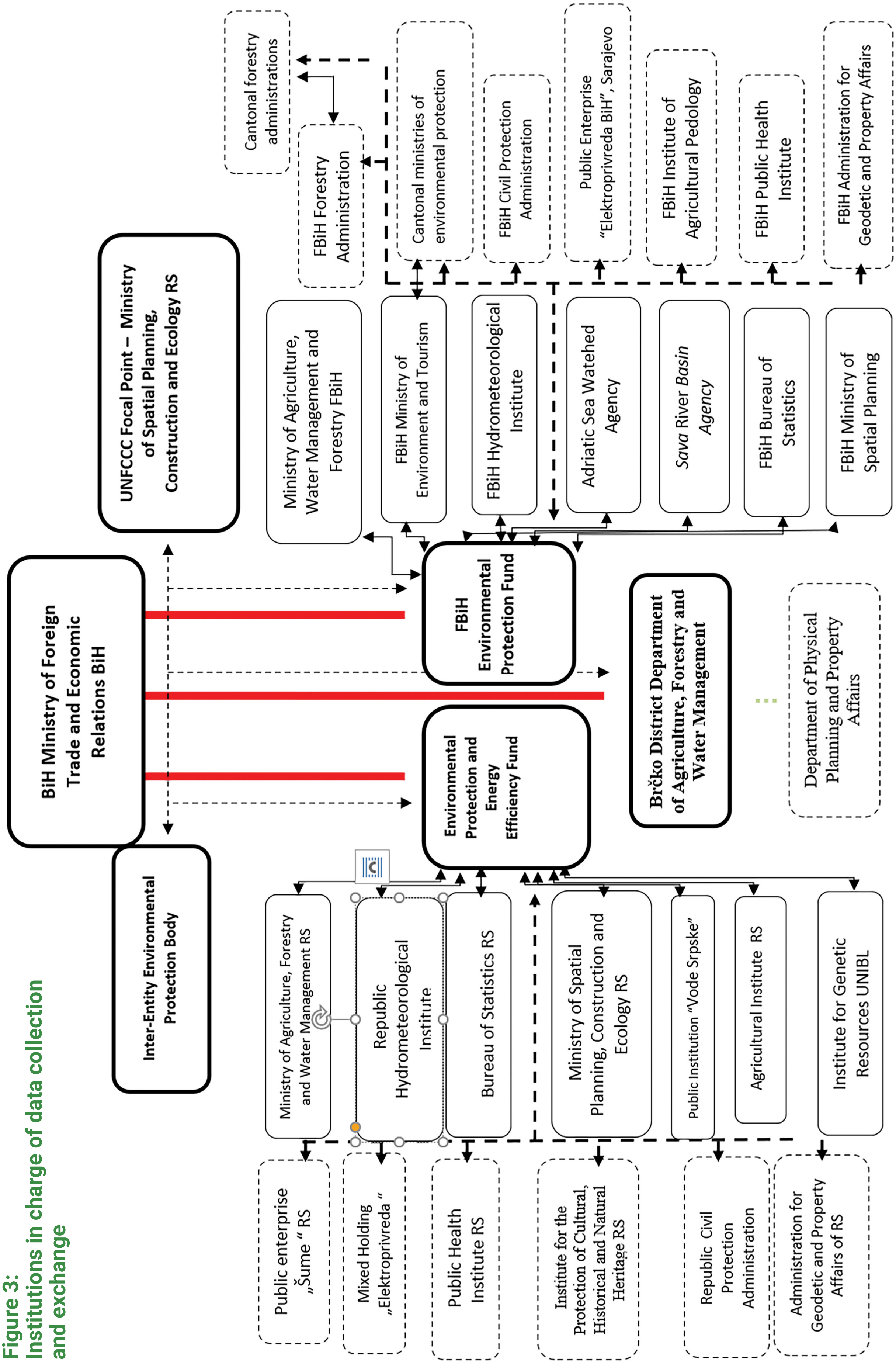
Therefore, **indicators and supporting data must be collected and prepared on an annual basis**.

In Bosnia and Herzegovina, the preparation of the National Adaptation Plan is underway, so it is not possible to make recommendations for the roles and responsibilities of the entities of Republika Srpska and Federation BiH in charge of implementing adaptation activities in specific sectors. Responsibilities and roles directly depend on the type and scope of action; therefore, these could be defined once the National Adaptation Plan has been completed.

In general, line ministries are responsible for the situation in respective sectors, and the main goal of climate change adaptation is the integration of CCA considerations into sectoral policies and actions. Therefore, line ministries are considered to have the overall responsibility for climate change adaptation activities in their respective sectors.

54 Regulation (EU) No. 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, OJ L 165, 18 June 2013, p. 13.

Figure 3: Institutions in charge of data collection and exchange



3.3. Legal basis for responsibilities and data exchange

It is recommended that responsibilities, roles, deadlines and data availability formats should be prescribed by the **Law on Climate Change and accompanying implementing regulations, in accordance with the current legal and legislative frameworks**.

It is generally recommended that the following should be introduced:

- responsibilities and obligations for collecting missing climate-related inputs, definition and monitoring of indicators, projections of inputs and indicators, establishment and maintenance of a database of both Funds, namely the Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH;
- data sharing obligations and institutions responsible for specific climate-related inputs;
- deadlines for submission of data/indicators to the Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH the Brcko District Department of Agriculture, Forestry and Water Management;
- deadline for submission of data/indicators to the BiH Ministry of Foreign Trade and Economic Relations;
- lists of indicators; and
- provisions related to the development of climate change adaptation strategies/plans.

The Law on Climate Change should contain references and requirements regarding climate change mitigation, GHG inventories, technologies, capacity building needs, climate change research and financing, and monitoring, reporting and verification in general (as defined in the Modalities, Procedures and Guidelines).

For more technical data, it is recommended that information and requirements should be included in implementing regulations and memoranda of understanding/cooperation protocols, due to frequent changes at international and EU levels.

Also, requirements relevant to CCA indicators could be included in the legal act regulating the environmental information system.

Until this complex system has been legally defined and put in place, data sharing and exchange could be regulated by bilateral memoranda of understanding/Standard operating procedures/cooperation protocols between the data holders and the indicator holders, which should as a minimum include the following:

• Deadlines, timeframes and formats according to which the data holder/collector will provide data to the institution responsible for the indicators;
• Deadlines, timeframes and formats according to which the institutions responsible for the indicators are obliged to send data to the Funds;
• Deadlines, timeframes and formats according to which the Environmental Protection and Energy Efficiency Fund of Republika Srpska, the Environmental Protection Fund of Federation BiH and Brcko District Department of Agriculture, Forestry and Water Management will publish the indicators;
• Institutions responsible for the data and the list of data that are their responsibility.

In the absence of government institutions that could collect data, this activity could be entrusted to one of the institutes or faculties. In this case, this should be done over a longer period of time (e.g. 10 years), to ensure consistency of data and because of requirements for climate change datasets over a longer period.

Climate change laws must contain the requirements of the UNFCCC, the Paris Agreement and the EU *acquis*.

4. Governance structure – procedures for reporting and collecting data on performance indicators and for communication and dissemination of data

Resilience building requires the development and implementation of effective climate-related policies and laws, which rely on the availability and quality of a range of long-term climate data/climate indicators relevant to decision making, as well as their monitoring and evaluation. Although the aim here is to establish a CCA monitoring and evaluation system/governance structure, this should be part of the broader picture of resilience building in BiH. Therefore, the governance structure will include institutions **prescribed by law**, with their responsibilities, rules and processes that will ensure:

1. Assessment of climate change, and its impacts and vulnerabilities;
2. Identification of priority sectors and adaptation measures;
3. Development, monitoring and revision of policies and laws, including NAPs and NDCs;
4. Participant engagement;
5. Information transparency and sharing.

Secondly, this structure should ensure reporting to the UNFCCC every two years (from 2021 onwards) on:

(a) Domestic priorities and progress towards those priorities;
(b) Adaptation challenges and gaps, and barriers to adaptation[55].

Regarding monitoring and evaluation, the following information is provided:

(a) Achievements, impacts, resilience, review, effectiveness and results;
(b) Approaches and systems used and their outputs;
(c) Assessment of and indicators for:
   (i) How adaptation increased resilience and reduced impacts;
   (ii) When adaptation is not sufficient to avert impacts;

55 18/CMA.1 - Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement

(iii) How effective implemented adaptation measures are;

(d) Implementation, in particular on:

(i) transparency of planning and implementation;

(ii) how support programmes meet specific vulnerabilities and adaptation needs;

(iii) how adaptation actions influence other development goals;

(iv) good practices, experience and lessons learned from policy and regulatory changes, actions and coordination mechanisms.

In the EU, information about national adaptation actions will be reported as required by the Regulation on the Governance of the Energy Union and Climate Action, also known as the “Governance Regulation” (EU, 2018b, Article 19 and Part 1 of Annex VIII).

According to Article 19: By 15 March 2021, and every two years thereafter, Member States shall report to the Commission information on their national climate change adaptation planning and strategies, outlining their implemented and planned actions to facilitate adaptation to climate change.
Both documents and their requirements may be relevant for BiH.

The establishment of the system begins with the establishment of an institutional structure needed to monitor and report on a number of indicators (relevant for assessing climate change, its impacts and vulnerabilities, and adaptation planning), while indicators for assessing the effectiveness of adaptation measures will be included in the AP.

Based on the climate parameters and climate impacts, it is obvious that the institutions shown in Table 1 and Figure 3 are among the relevant CCA stakeholders, i.e. the institutions of the CCA governance structure. However, the final list of stakeholders is subject to the decision on key indicators (indicators that will be collected from the beginning for the entire territory of BiH) and the responsible institutions.

The CCA monitoring, reporting and assessment structure must be operational and include both entities, Republika Srpska and Federation BiH in BiH and the Brčko District of BiH in the process. In accordance with the existing structures and competences, the **Ministry of Foreign Trade and Economic Relations** of Bosnia and Herzegovina clearly has the key role in ensuring the sharing and exchange of data and information between the entities, Republika Srpska and Federation BiH.

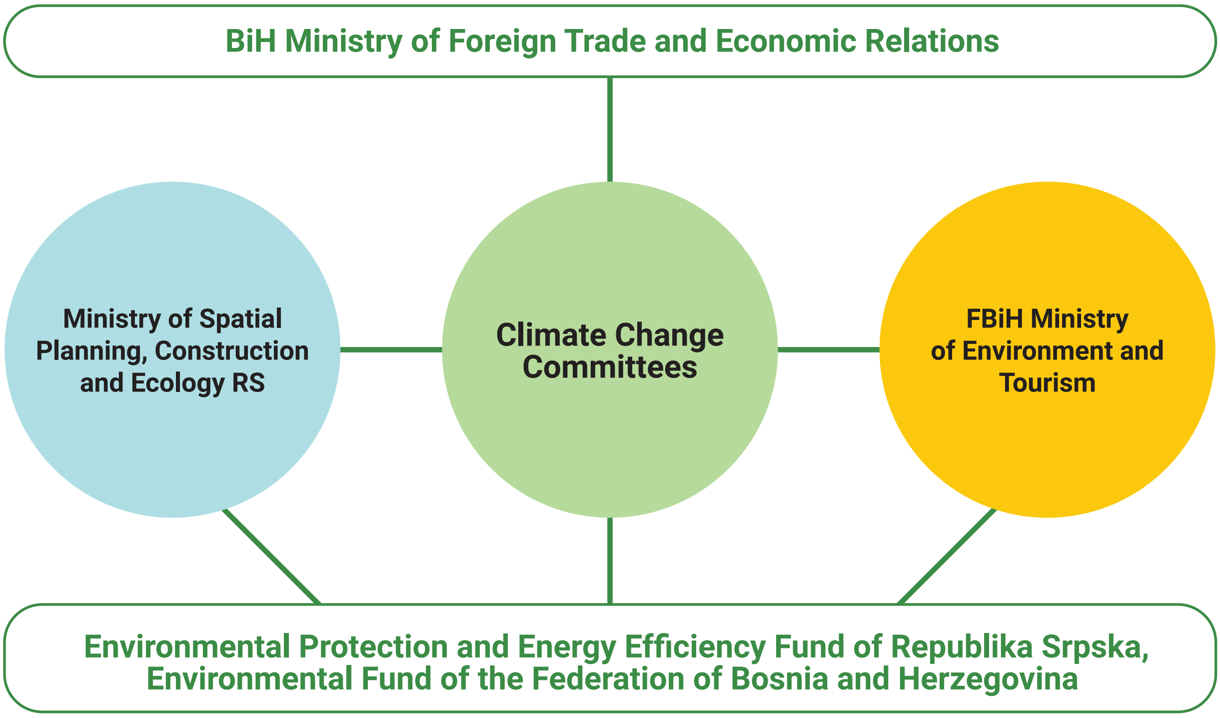
The Ministry of Spatial Planning, Construction and Ecology of Republika Srpska and the Federal Ministry of Environment and Tourism once a year submit to the **Ministry of Foreign Trade and Economic Relations** of Bosnia and Herzegovina a Report on implemented activities, collected data, constraints and gaps, as well as recommendations for improving data collection and data quality.

4.1 Climate Change Committees (CCCs)

It is recommended that Climate Change Committees (CCCs) of Republika Srpska and Federation BiH should be established, which will include representatives of institutions involved in monitoring and evaluation, those responsible for climate-sensitive sectors, and measures and actions under the National Adaptation Plan of Bosnia and Herzegovina, as well as relevant local communities, and representatives of academia and CSOs. CCCs monitor progress on implementation of the BiH National Adaptation Plan (BiH AP), discuss implementation gaps and challenges and identify solutions to address them, and ensure data exchange and presentation of results to participants. Republika Srpska and Federation BiH

CCCs will be a kind of control mechanisms for transparency of the process and improvement of cooperation between state institutions and other participants. They are established by law as a control body. CCCs and the department report to the ministries of Republika Srpska and Federation BiH in charge of climate change and inform the Inter-Entity Environment Body.

The Ministry of Spatial Planning, Construction and Ecology of Republika Srpska and the Federal Ministry of Environment and Tourism will coordinate the work of the CCCs, with the support of the Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation.



4.2 Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and Brcko District Department of Agriculture, Forestry and Water Management

Indicators, supporting data and information will be included in the databases of the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and the Brčko District Department of Agriculture, Forestry and Water Management, as institutions responsible for the M&E system. Databases must be compatible and linked to existing databases.

These institutions will be responsible for making indicator projections, which includes provision of resources and appropriate experts or professional institutions (described in Chapter 3.1).

All institutions involved in data collection and exchange, in cooperation with the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and the Brčko District Department of Agriculture, Forestry and Water Management, will be responsible for data quality assurance and control (QA/QC).

5. Data flows

The institutions responsible for data collection shall submit data and information no later than 15 January of the current year x for year x-1 or x-2 to the Funds/Department, which shall prepare all relevant information and a draft report for the Reports to the MOFTER by 15 March. Data are collected and indicators are calculated and/or monitored on an annual basis.

Information on the implementation of actions under the BiH National Adaptation Plan will be prepared every two years and submitted to the UNFCCC, upon completion of the official procedure.

The deadlines and use of the template as provided for in the Standard Operating Procedures (SOPs) will be prescribed by law.

In all institutions involved in the CCA monitoring and evaluation system, which are to be finally identified in the project consultation process (and in Report 3), the responsible person and deputies will be officially appointed as members of the of Republika Srpska and Federation BiH CCCs. They will act as coordinators in their institutions and be in charge of ensuring timely delivery of data and information.

If the competent institutions fail to submit indicators, data and/or information, the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and the BD Department of Agriculture, Forestry and Water Management will define alternative data collection methods (e.g. fax, e-mail, letter, etc.).

In the absence of specific data for a specific year or time period, the responsible institutions should explain the reasons for this and outline the activities that have been implemented or planned to overcome the data gaps. Also, they are expected to indicate the period within which the complete set of data will be provided, as well as the requirements for that, if applicable.

5.1 Local-level data

It is important to keep in mind that CCA activities may take place at the local level. Therefore, data disaggregation and/or collection at the local level could significantly contribute to effective adaptation to climate change.

Therefore, the SOP documents will propose the disaggregation of data at the local level, if possible, as well as the appropriate methodology. A similar approach will be applied to gender data. This task could also be outsourced, as needed, similar to data projections (expected future values).

5.2 Data exchange and dissemination

It is recommended that an electronic exchange of indicators and accompanying data/information should be put in place, ensuring direct access for competent institutions/appointed representatives for data collection and indicators (Table 1).

This data could be linked to a publicly available platform, displaying indicators, data and information free of charge and in simple formats, as part of the websites of the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and the BD Department of Agriculture, Forestry and Water Management. This will ensure communication and dissemination of CCA data and information to participants and the general public. Furthermore, this will also ensure that the same input data are used for CCA activities.

Databases maintained by the Environmental Protection and Energy Efficiency Fund of Republika Srpska, Environmental Fund of the Federation of Bosnia and Herzegovina and the BD Department of Agriculture, Forestry and Water Management will be linked, comparable and harmonized. Therefore, it is highly recommended that persons responsible for monitoring and evaluation of CCA activities should be appointed in all institutions. They will evaluate the results and define development, priorities and joint work in the short and medium term (in the next five years).

These databases will be available to MOFTER as well as the Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, as the UNFCCC Focal Point for BiH, for the purposes of preparing Biennial Transparency Report (BTR), as well as to other ministries for the purpose of fulfilling international and domestic obligations.

In the context of available data, the Environmental Protection and Energy Efficiency Fund Republika Srpska, the Environmental Protection Fund Federation BiH and the BD Department of Agriculture, Forestry and Water Management will support the preparation of national communications under the UNFCCC.

5.3 Legal basis

It is recommended that the responsibilities, roles, deadlines and formats for collecting and reporting on data that form the basis of a functional CCA planning and evaluation system (including monitoring and reporting) should be legally prescribed (**Law on Climate Change and accompanying implementing regulations**) in accordance with the current legal and legislative frameworks.

As has been mentioned earlier, the implementation of CCA happens at the local level and it could therefore be important to legally introduce the obligation for local communities to report on the implementation of CCA actions.

The Law on Climate Change would prescribe the development of NAPs, as well as their preparation at the entity level, of Republika Srpska and Federation BiH. This could include specific CCA actions, which are described in detail in Table 4 below.

Table 4:
CCA action form – example

Name of the CCA action		
Description		
Implementation time frame		
Type of measure	Regulatory	
	Financial	
	Technological/Technical/Infrastructural	
	Informative/Educational	
	Organizational/Managerial/Institutional	
Climate change impact(s) addressed by the action		
Objectives		
Institution(s) responsible for planning and implementation		
Description of participant engagement		
Territorial coverage	National coverage	
	Regional/local coverage (specify)	
Estimated cost (explain period)		
Source of financing, amount, status (already secured, in negotiations, potential) and type (loan, donation, concession)	State budget	
	Private financing	
	International source	
	Other (specify)	
Additional benefits associated with the action	Provides additional benefits beyond addressing the targeted climate change impact (briefly describe)	
Impact on GHG emissions	The action may increase GHG emissions	
	The action can reduce GHG emissions (briefly describe)	
Legal basis		
Additional needs		
Key obstacles		
Monitoring indicator(s)	Baseline value	
	Current value	
	Target value	
Institutions responsible for monitoring and reporting		

6. Costs/needs of the M&E system

The costs of the M&E system depend on the scope and status of CCA monitoring and evaluation, as well as on plans and deadlines related to collection, analysis, reporting, capacity, etc. However, based on the examples of France and Serbia, certain needs estimates are made:

A. Initial costs – are estimated as the time required to establish a CCA monitoring and evaluation system.

Initial costs arise after establishment of a new system that entails the creation of new outputs such as reports, indicators and new information systems.

Here, the estimate is based on the assumption that an information system is created and the projections of indicators in Table 2, as well as the works, are entrusted to experienced companies.

It is estimated that the establishment of the system in BiH would require about 115 days (1 working day = 8 working hours) per competent entity (Environmental Protection and Energy Efficiency Fund Republika Srpska and Environmental Protection Fund Federation BiH), assuming that all data will be publicly accessible and exchanged.

B. Running costs for maintenance and regular updates once the system becomes fully operational and only minor adjustments are needed as required, are estimated at between 0.5 and 1 FTE[56] mainly under the responsibility of the administration (data holders and indicator holders).

The operation of the M&E system will require new skills and capacities of civil servants, which will be achieved through training and other types of learning. However, these specific needs could be assessed only after completion of the list of indicators for the first phase, development of an action plan to increase the number of indicators, confirmation by the competent institutions on systematic and systematized data collection, their continuity and quality for indicators in Table 2, and capacity assessment in the relevant institution.

56 Full-time equivalent and does not necessarily mean one full-time expert in one institution

7. Summary of recommendations

Based on the foregoing, the following recommendations are made:

1. The Environmental Protection and Energy Efficiency Fund of Republika Srpska, the Environmental Protection Fund Federation BiH and the Brcko District Department of Agriculture, Forestry and Water Management have the main responsibility for the CCA monitoring and evaluation system;
2. Responsibility of the entity funds (Republika Srpska and Federation BiH) for the environmental information system, including CCA indicators, should be legally defined;
3. The collection of data and indicators will be legally defined, which implies
    3.1. Entering CCA-related data into the environmental information systems of Republika Srpska and Federation BiH;
4. Databases maintained by the Environmental Protection and Energy Efficiency Fund of Republika Srpska, the Environmental Protection Fund Federation BiH and the Brcko District Department of Agriculture, Forestry and Water Management will be linked, comparable and harmonized.
5. Draft climate change laws to ensure regular and effective reporting under the UNFCCC and the Paris Agreement, which will include all climate issues;
6. Sign an Agreement on the exchange of CCA data;
7. Ensure the availability of CCA data and indicators in an easy-to-use format according to the scheme in Figure 3 (at the level of institutions of Republika Srpska and Federation BiH, Brčko District and state institutions);
8. Develop electronic exchange of indicators and basic data and information, providing direct access to the responsible institutions/designated representative for the purpose of collecting data and indicators;
9. Assess all proposed indicators and potential responsible institutions during project consultations and include those selected for this process in the Standard Operating Procedures for Coordination and Exchange of Climate Change Adaptation Indicators to be developed under the project.

8. Annex 1: EEA methodologies for calculating indicators

Meteorology/hydrology

Indicator	EEA data for BiH	EEA methodology for calculating indicators[57]
Temperature	Trends in annual temperature across Europe between 1960 and 2018 Projected changes in annual, summer and winter temperature	Different data sets on global and European temperature trends were used for this indicator. Projected changes in annual, summer and winter near-surface air temperature (°C) in the period 2071–2100, compared with the baseline period 1971–2000 for the forcing scenarios RCP 4.5 and RCP 8.5
Mean precipitation	Trends in annual and summer precipitation across Europe between 1960 and 2015 Projected changes in annual and summer precipitation	Precipitation trends in Europe are obtained using data from the **E-OBS database**. E-OBS is a daily gridded observational dataset for precipitation, temperature and sea level pressure in Europe based on ECA&D data. Projected changes in annual (left) and summer (right) precipitation (%) in the period 2071–2100 compared to the baseline period 1971–2000 for the forcing scenario RCP 8.5. Model simulations are based on the multi-model ensemble average of RCM simulations from the EURO-CORDEX initiative.
Heavy precipitation[58]	Observed trends in maximum annual five-day consecutive precipitation in winter and summer (1960–2015)	Observed heavy precipitation is defined as the maximum annual 5-day consecutive precipitation (Px5d). An ensemble of Regional Climate Models driven by different Global Climate Models, using the RCP8.5 scenario, was utilized to calculate changes in heavy precipitation and prolonged droughts. Trends are calculated using the median of the dual-slope algorithm.
Hail events and wind storms[59]	Observed annual median and trend of the Mean Potential Hail Index (PHI) over the period 1951–2010	Hail forms within deep convective clouds with observations recorded only by ground-based hail pad networks. Proxies for hail events can be also derived from satellite temperature imagery and radar reflectivity.
Heat waves	Number of extreme heat waves in future climates	Number of projected heat waves in a multi-model ensemble of the near future (2020–2052) and the latter half of the century (2068–2100) under the RCP4.5 and RCP8.5 scenarios. The Heat Wave Magnitude Index (HWMI) takes into account both the duration and intensity of the heat wave. HWMI is defined as the maximum magnitude of the heat waves in a year, where heat wave is the period ≥ 3 consecutive days with maximum temperature above the daily threshold for the reference period 1981–2010. The threshold is defined as the 90th percentile of daily maxima, centred on a 31-day window. ≤1 Normal <2≤ Moderate <3≤ Severe <4≤ Extreme <8≤ Very Extreme <16≤ Super Extreme <32≤ Ultra Extreme.

57 Available at: https://www.eea.europa.eu/data-and-maps/indicators/#c0=30&c12-operator=or&b_start=0&c12=climate-change-adaptation

58 Heavy precipitation is defined as the maximum annual five-day consecutive precipitation.

59 Extreme wind speed (98th percentile of daily maximum wind speed); Wind storms – data for BiH are not included in EEA indicators

Meteorological droughts (precipitation deficit) and hydrological droughts (minimum river flow)[60]	Trend in the frequency of meteorological droughts in Europe (1950–2015) Trend in runoff during the driest month of the year in Europe (1950–2015) Projected change in meteorological drought frequency between the present (1981–2010) and the mid-century 21st century (2041–2070) in Europe, under two emissions scenarios Projected change in 10-year river water deficit between the present (1981–2010) and the end of the 21st century (2071–2100) in Europe, under two emissions scenarios	Meteorological droughts are based on the Standardized Precipitation Index for three months (SPI-3). Past trends are based on precipitation data from the E-OBS gridded dataset, whereas projections are based on a model ensemble from the EURO-CORDEX project for two emissions scenarios. Trends in hydrological droughts are calculated based on the runoff during the driest month in the E-RUN dataset. The E-RUN dataset employed a statistical model to estimate runoff across Europe based on the largest database of streamflow observations and the E-OBS dataset. Hydrological drought projections are based on the 10-year river water deficit, as calculated by the LISFLOOD hydrological model forced by a model ensemble from the EURO-CORDEX project for two emissions scenarios
River flows	Model-based estimate of past change in annual river flows Projections have been made for 12 rivers, including the Danube in Romania. Data for BiH are not included in the EEA indicators.	An inventory of river flows in Europe was produced by combining over 400 time series (from 1962 to 2004) of river catchments with near-natural flow conditions for Europe and an ensemble of eight large-scale hydrological models.
River and lake water temperature	Water temperature trends of major European rivers and lakes, including the Danube in Vienna. Data for BiH are not included in the EEA indicators.	Measurement of river water temperature in time series 1901–2014.
Snow cover extent and snow mass	Snow cover data are available for the Northern Hemisphere and the whole of Europe.	The data represent satellite-derived time series of snow cover extent for the period 1967–2015 over the Northern Hemisphere (left) and Europe (right). The time series for the Northern Hemisphere is extended back to 1922 by including reconstructed historical estimates.
Frost-free days	Trend in the number of frost-free days	The annual rate of change of frost-free days represents the trend coefficient for long-term changes in the annual number of days with a minimum daily temperature above 0 °C. For example, a value of 1 indicates that the number of frost-free days has increased on average by 1 day per year in last 30 years (period 1985–2014). The analysis is based on the JRC-MARS gridded meteorological data at 25 km resolution.
Heating and cooling degree days	Observed trend in heating and cooling degree days (1981–2017) Projected linear trend in heating (HDD) and cooling degree days (CDD) over the period 1981-2100 under two scenarios	HDDs and CDDs are defined relative to a base temperature — the outside temperature — below which a building is assumed to need heating or cooling. The baseline temperatures for HDDs and CDDs are 15.5 °C and 22 °C, respectively.
River floods; Economic losses from climate-related extremes, including deaths, missing persons and directly affected people attributed to disasters per 100,000 inhabitants (starting with: deaths related to flooding)	Observed regional trends in annual river flood discharges in Europe (1960–2010) Projected change in 100-year river floods for two global warming levels. BiH is not included in the geographical coverage Data on economic losses from climate-related extremes for BiH are not included (not available) Deaths related to flooding	Trends in river floods are calculated based on the annual flood discharge of all rivers included in the European Flood Database. Future changes in the risk of river floods in Europe have been simulated using the hydrological model LISIFLOOD, driven by an ensemble of climate simulations. The European Commission is working with Member States, ISDR and other international organizations to improve disaster loss data. The Joint Research Centre has prepared a guidance for recording and sharing disaster damage and loss data, an overview of the current status and best practices for disaster loss data recording in EU member states, and recommendations for a European approach to recording disaster losses. Data on deaths related to flooding were taken from the EM-DAT database.

60 The update will be performed in January 2020.

Burnt area due to forest fires (hectares)	Burnt area in European countries, data for BiH are not included. Forest fire danger in the present climate and projected changes under two climate change scenarios, data for BiH are not included.	Historical fire data series are available in Europe and regularly updated by EFFIS. EFFIS addresses forest fires in Europe in a comprehensive way, providing EU-level assessments from pre-fire to post-fire phases, thus supporting fire prevention, preparedness, fire-fighting and post-fire evaluations. To complement the data, information from past forest fires is routinely used to rate fire potential due to weather conditions. The Canadian FWI is used by EFFIS to rate daily fire danger conditions in Europe.
Forest composition and distribution	Projected changes in climatic suitability for broadleaf and needleleaf trees.	The projected change in climatic suitability for broadleaf and needleleaf trees has been simulated using species distribution models (or climate envelope models) for major tree species in Europe in order to assess what the consequences of climate change on the habitat suitability of these tree species might be.
- Mortality due to extreme temperatures **- Number of people requiring interventions against neglected tropical diseases** **- Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease** **- Vector-borne disease** **- Distribution: *Ixodes Ricinus* ticks, *Aedes albopictus*, West Nile virus infections, Chikungunya transmission** **- Time series of vibriosis infections (Salmonella, Norovirus, Campylobacter, Cryptosporidium, Vibrio species (except cholera))**	- Associations between temperature and mortality in four European cities; BiH is not included. - Not available - Not available - Current European distribution of *Ixodes ricinus* ticks (there are no field studies in BiH); Known distribution of the tiger mosquito in Europe (*Aedes albopictus*), BiH included in the analysis (data for BiH partially available) Projected change in the climatic suitability for Chikungunya transmission Projected future distribution of West Nile Virus infections - Not available (Baltic region only)	Daily temperature and mortality data for four locations in Europe from the period 1985–2012 have been used to fit a standard time-series Poisson model for each location, controlling for trends and day of the week. Tick and *Aedes* mosquito distribution maps are the outcome of collaborative work of the VectorNet network and are based on collecting existing data by the network members. VectorNet is a joint initiative of the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC). The risk for Chikungunya transmission in Europe was assessed by combining temperature requirements of the Chikungunya virus with the climatic suitability of the vector *Aedes albopictus*. Projections for different time-frames are based on projections by the regional climate model COSMO-CLM for two emission scenarios (A1B, a medium scenario and B1, a low scenario). The “current situation” refers to the 1960–1990 baseline climate. The West Nile virus risk in Europe has been projected into 2025 and 2050 based on July temperature projections under a medium emissions scenario (A1B), keeping other variables constant (e.g. state of vegetation, water bodies and bird migratory routes).
Water-limited crop yield	Projected change in mean water-limited yield of winter wheat by 2030 Projected changes in water-limited crop yield (for 2050s)	Simulated change in mean water-limited crop yield of winter wheat between the baseline period around year 2000 and 2030. The four simulations are a combination of two climate models (HadGEM2 and MIROC) and the crop model WOFOST at 25 km spatial resolution, with and without taking into account the effect of CO_2 fertilization. The indicator represents expected changes in crop yields across Europe for the 2050s (compared with 1961–1990). The simulations by the ClimateCrop model are based on an ensemble of 12 GCMs under the A1B emission scenario. They include effects of changes in temperature, precipitation and CO_2 concentration on crop yields of three main crops assuming current irrigated area.
Agrophenology/Seasonal cycle of agricultural crops	Trend in flowering date of winter wheat	The annual rate of change of the flowering date represents the trend coefficient for long-term changes in the occurrence of flowering of winter wheat in Europe. For example, a value -0.6 indicates that in last 30 years the winter wheat flowering date has been anticipated on average by 0.6 days per year (6 days in 10 years). The flowering date is derived from crop growth models simulating crop development of winter wheat as a function of the temperature sum. The simulation is based on the JRC-MARS gridded meteorological data at 25 km resolution.

Crop water demand	Trend in crop water deficit of grain maize during the growing season Projected annual rate of change of the crop water deficit of grain maize during the growing season in Europe for the period 2015–2045 for two climate scenarios.	Annual rate of change of the crop water deficit of grain maize during the growing season for the period 1985–2014 in Europe. The crop water deficit is the difference between the crop-specific water requirement (in this case grain maize) and available water through precipitation. The simulation is based on the JRC-MARS gridded meteorological data at 25 km resolution. Projected annual rate of change of the crop water deficit of grain maize during the growing season in Europe for the period 2015–2045 for two climate scenarios. The climate forcing of the two simulations is based on the two global climate models HadGEM2 and MIROC. Crop model simulations have been done with the crop model WOFOST at 25 km resolution.
Growing season of agricultural crops	Trend in the number of frost-free days	The annual rate of change of frost-free days represents the trend coefficient for long-term changes in the annual number of days with a minimum daily temperature above 0 °C. For example, a value of 1 indicates that the number of frost-free days has increased on average by 1 day per year in last 30 years (period 1985–2014). The analysis is based on the JRC-MARS gridded meteorological data at 25 km resolution.
Distribution shifts of plant and animal species Trend in thermophilic species in bird and butterfly communities Projected change in climatically suitable areas for bumblebees	European variations in the temporal trend of bird and butterfly community temperature index, data for BiH are not included. Projected change in climatically suitable areas for bumblebees; data for BiH are not included.	The Community Temperature Index (CTI) measures the rate of change in community composition in response to temperature change. Observations and species distribution models (also known as habitat models, niche models or envelope models) were used to calculate the indicators.
Impact of climate change on bird populations	Climate change impact indicator for European birds Weighted population trend of species predicted to lose range in response to climatic change (92 species) Weighted population index of species predicted to gain range in response to climatic change (30 species) Data for BiH are not included	The Climate impact Indicator (CII) measures the divergence between the population trends of bird species projected to expand their range and those predicted to shrink their range due to climate change. The indicator is based on a combination of observed population trends monitored from 122 common bird species in 20 European countries over 26 years, and projected potential shrinkage, or expansion, of range size for each of these species at the end of this century (~2070–2099), derived from climatic envelope models. The ensemble in this case is the average climate envelope forecast based on six differing future scenarios.

9. Annex 2: List of potential indicators, by sector, based on international experiences and practices

1. Agriculture

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of households affected by drought Percentage of total livestock killed by drought Number of surface water areas subject to declining water quality due to extreme tempera-tures Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Shift of agrophenological phases of cultivated plants Losses of GDP in percentage per year due to extreme rainfall
Adaptation action	Percentage of farmers and fisher folk with access to financial services Total sum of investments in programmes for the protection of livestock Number of inventories of climate change impacts on biodiversity Uptake of soil conservation measures Percentage of treated wastewater Percentage of agricultural land with improved irrigation Number of farmers involved in pilot irrigation messaging projects Number of women organized in agricultural cooperatives Cultivation of varieties of red wine that need warmth
Adaptation results	Percentage of poor people in drought-prone areas with access to safe and reliable water Number of cubic metres of water conserved Percentage of water demand being met by existing supply Percentage of livestock insured against death due to extreme and slow-onset weather events Percentage of farmland covered by crop insurance Percentage of additional fodder for grazing livestock Increase in agricultural productivity through irrigation of harvested land Increase in percentage of climate-resilient crops being used Percentage of cultivated surface cultivated with drought-resistant varieties Turnover generated by agricultural cooperatives

2. Biodiversity

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of surface water areas subject to declining water quality due to extreme temperatures Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Distribution of climate sensitive species Acidification of marine water Decline in fish habitats due to temperature change Decreased annual average fish catch as a result of temperature change
Adaptation action	Percentage of farmers and fisherfolk with access to financial services Number of inventories of climate change impacts on biodiversity Uptake of soil conservation measures Percentage of climate resilient trees Area of land under 'landscape scale' conservation Percentage of treated wastewater Percentage of coastline under marine protection Number of firebreaks constructed Compliance with fishing quota
Adaptation results	Percentage of cultivated surface cultivated with drought resistant varieties

3. Building sector

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of people living in flood prone areas Number of properties flooded per year Number of properties located in river/coastal floodplain Number of properties lost due to coastal erosion per year Total length of sewerage and drainage network at risk from climate hazards Losses of GDP in percentage per year due to extreme rainfall Financial losses to businesses due to extreme weather events Number of people permanently displaced from homes as a result of flood, drought or sea-level rise

Adaptation action	Number of methodological guides produced to assess impacts of extreme weather events on transport systems Number of urban adaptation best practices disseminated Percentage of population living in flood and/or drought-prone areas with access to rainfall forecasts Funding for climate-adapted construction and refurbishment Percentage of transport infrastructure standards revised Green label for neighbourhoods requiring climate change vulnerability assessments established Number of properties with retrofitted flood resilience measures; water meters; water efficiency measures; cooling measures
Adaptation results	Percentage of households at reduced flood risk due to construction of new or enhanced defences Reduction of flood damage and disaster relief costs in cities due to increased standards for flood protection and improved flood emergency preparedness Number of new major infrastructure projects located in areas at risk

4. Coastal zones

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of people living in flood prone areas Number of properties flooded per year Number of businesses located in areas of flood/coastal erosion risk Number of households within most deprived communities located in areas of flood/coastal erosion risk Number of properties lost due to coastal erosion per year Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Acidification of marine water Distribution of warmth-adapted marine species Decreased annual average fish catch as a result of temperature change Number of people permanently displaced from homes as a result of flood, drought or sea-level rise
Adaptation action	Percentage of population living in flood and/or drought-prone areas with access to rainfall forecasts Percentage of farmers and fisherfolk with access to financial services Number of inventories of climate change impacts on biodiversity Number of wave recorders installed along coastal areas Climate change vulnerability maps of coastal zone developed Uptake of riparian tree planting Percentage of treated wastewater Percentage of coastline under marine protection
Adaptation results	Percentage of households at reduced flood risk due to construction of new or enhanced defences Number of new major infrastructure projects located in areas at risk

5. Energy

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation
Climate impacts	Weather-related disruption of electricity supply Losses of GDP in percentage per year due to extreme rainfall
Adaptation action	Percentage of new hydroelectric projects that consider future climate risks Number of water efficiency measures used in energy generation/extraction Energy Storage Capacity
Adaptation results	Number of new major infrastructure projects located in areas at risk

6. Forestry

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of surface water areas subject to declining water quality due to extreme temperatures Percentage of area of ecosystem that has been disturbed or damaged Total forest area impacted by wildfire per year Annual timber losses from pests and pathogens Areas covered by vegetation affected by plagues or fires
Adaptation action	Number of inventories of climate change impacts on biodiversity Conservation of forest genetic resources Uptake of soil conservation measures Percentage of climate resilient trees Proportion of forest managers taking action on adaptation Number of firebreaks constructed

7. Human health

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of households affected by drought Number of surface water areas subject to declining water quality due to extreme temperatures Urban Heat Island Effect in summer Number of people at high risk of heat stress Reduced work productivity due to heat stress Number of hospitals located in areas at risk from flooding/coastal erosion Number of households within most deprived communities located in areas of flood/coastal erosion risk Areas covered by vegetation affected by plagues or fires Acidification of marine water Number of cases of water-borne diseases
Adaptation action	Number of businesses that have changed their working hours Uptake of early warning systems (UV and air/water quality) Uptake of measures to reduce air pollution Percentage of treated wastewater
Adaptation results	Percentage of poor people in drought-prone areas with access to safe and reliable water Percentage of urban households with access to piped water Percentage of water demand being met by existing supply

8. Tourism

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of surface water areas subject to declining water quality due to extreme temperatures Percentage of area of ecosystem that has been disturbed or damaged Total forest area impacted by wildfire per year Areas covered by vegetation affected by plagues or fires Acidification of marine water Losses of GDP in percentage per year due to extreme rainfall
Adaptation action	Uptake of measures to reduce air pollution Percentage of coastline under marine protection
Adaptation results	Volume of water consumed by tourist facilities Number of new major infrastructure projects located in areas at risk

9. Trade and industry

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Reduced work productivity due to heat stress Number of properties flooded per year Number of properties located in river/coastal floodplain Number of businesses located in areas of flood/coastal erosion risk Number of properties lost due to coastal erosion per year Annual timber losses from pests and pathogens Total length of sewerage and drainage network at risk from climate hazards Losses of GDP in percentage per year due to extreme rainfall Financial losses to businesses due to extreme weather events
Adaptation action	Number of methodological guides produced to assess impacts of extreme weather events on transport systems Percentage of trade and industry chambers using and distributing climate information Percentage of new hydroelectric projects that consider future climate risks Number of businesses with risk management plans considering climate change aspects/ or adaptation options Percentage of transport infrastructure standards revised Number of properties with retrofitted flood resilience measures; water meters; water efficiency measures; cooling measures Number of water efficiency measures used in energy generation/extraction Number of water companies rationing water during droughts Number of businesses that have changed their working hours Uptake of early warning systems (UV and air/water quality) Uptake of measures to reduce air pollution Number of businesses with insurance for extreme weather events Percentage of companies assessing risks and opportunities from extreme weather and reduced water availability to their supply chains Percentage of treated wastewater Number of women organized in agricultural cooperatives
Adaptation results	Percentage of climate resilient roads in the country Percentage of poor people in drought-prone areas with access to safe and reliable water Percentage of urban households with access to piped water Number of cubic metres of water conserved Percentage of water demand being met by existing supply Number of new major infrastructure projects located in areas at risk Percentage of livestock insured against death due to extreme and slow-onset weather events Increase in agricultural productivity through irrigation of harvested land Turnover generated by agricultural cooperatives

10. Transport

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of hectares of productive land lost to soil erosion Losses of GDP in percentage per year due to extreme rainfall Financial losses to businesses due to extreme weather events Number of people permanently displaced from homes as a result of flood, drought or sea-level rise
Adaptation action	Number of methodological guides produced to assess impacts of extreme weather events on transport systems Percentage of transport infrastructure standards revised
Adaptation results	Percentage of climate resilient roads in the country Number of new major infrastructure projects located in areas at risk

11. Urban areas

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Urban Heat Island Effect in summer Number of properties located in river/coastal floodplain Number of hectares of productive land lost to soil erosion Total length of sewerage and drainage network at risk from climate hazards Number of people permanently displaced from homes as a result of flood, drought or sea-level rise
Adaptation action	Number of urban adaptation best practices disseminated Percentage of population living in flood and/or drought-prone areas with access to rainfall forecasts Percentage of municipalities with local regulations considering adaptation and vulnerability assessment results Funding for climate-adapted construction and refurbishment Green label for neighbourhoods requiring climate change vulnerability assessments established Uptake of riparian tree planting Percentage of treated wastewater

Adaptation results	Priority areas for precautionary flood protection Percentage of poor people in drought-prone areas with access to safe and reliable water Percentage of urban households with access to piped water Number of cubic metres of water conserved Percentage of water demand being met by existing supply Reduction of flood damage and disaster relief costs in cities due to increased standards for flood protection and improved flood emergency preparedness Number of new major infrastructure projects located in areas at risk

12. Water resources

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of households affected by drought Percentage of total livestock killed by drought Number of surface water areas subject to declining water quality due to extreme temperatures Number of properties flooded per year Number of properties located in river/coastal floodplain Number of businesses located in areas of flood/coastal erosion risk Number of hospitals located in areas at risk from flooding/coastal erosion Number of households within most deprived communities located in areas of flood/coastal erosion risk Number of properties lost due to coastal erosion per year Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Acidification of marine water Distribution of warmth-adapted marine species Total length of sewerage and drainage network at risk from climate hazards Number of cases of water-borne diseases Number of people permanently displaced from homes as a result of flood, drought or sea-level rise
Adaptation action	Number of public awareness campaigns on water efficiency Percentage of population living in flood and/or drought-prone areas with access to rainfall forecasts Percentage of new hydroelectric projects that consider future climate risks Number of inventories of climate change impacts on biodiversity Number of water efficiency measures used in energy generation/extraction Number of water companies rationing water during droughts Uptake of riparian tree planting Percentage of treated wastewater Percentage of agricultural land with improved irrigation Percentage of coastline under marine protection Number of farmers involved in pilot irrigation messaging projects Priority areas for precautionary flood protection

Adaptation results	Percentage of poor people in drought-prone areas with access to safe and reliable water Percentage of urban households with access to piped water Number of cubic metres of water conserved Volume of water consumed by tourist facilities Percentage of water demand being met by existing supply Percentage of households at reduced flood risk due to construction of new or enhanced defences Number of new major infrastructure projects located in areas at risk Increase in agricultural productivity through irrigation of harvested land Percentage of cultivated surface cultivated with drought resistant varieties

13. Capacity building & mainstreaming

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Adaptation action	Number of climate responsive tools developed and tested Number of vulnerable stakeholders using climate responsive tools to respond to climate variability or climate change Number of communication tools that incorporate climate change adaptation Percentage of trade and industry chambers using and distributing climate information Number of government staff that have received training on adaptation Degree of integration of climate change into development planning Number of policies and coordination mechanisms explicitly addressing climate change and resilience Number of policies, plans or programmes introduced or adjusted that mainstream climate risks Percentage of municipalities with local regulations considering adaptation and vulnerability assessment results Existence of interministerial/intersectoral commissions working on adaptation Number of people supported to cope with the effects of climate change through the availability of a service or facility Number of existing meteorological stations per territorial unit Number of farmers involved in pilot irrigation messaging projects Number of women organized in agricultural cooperatives
Adaptation results	Number of people with diversified income

15. Annex 2:

TECHNICAL GUIDELINES FOR MONITORING AND EVALUATION AND CAPACITY BUILDING PLAN

September, 2021

Development of this publication was supported within the project "Advance the National Adaptation Plan (NAP) process for medium-term investment planning in climate sensitive secto in Bosnia-Herzegovina (B&H)", funded by the Green Climate Fund (GCF), implemented by UNDP in cooperation with the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, as a UNFCCC focal point for Bosnia and Herzegovina, Ministry of Agriculture, Forestry and Water Management of Republika Srpska, Federal Ministry of Agriculture, Water Management and Forestry and Federal Ministry of Environment and Tourism.

Expert team:

Danijela Božanić, Monitoring and Evaluation expert

Table of contents:

126 **1. Introduction**
127 **2. Standard/key indicators**
129 **3. Monitoring and evaluation for integrated water and climate change management**
129 3.1 Guidelines for the key indicator
132 3.2 Guidelines for monitoring and evaluation of adaptation projects
138 **4. Capacity development needs and activities**

1. Introduction

Climate Change Adaptation (CCA) refers to how people and systems adjust to the actual or expected effects of climate change. Adaptation is a process of continual adjustment which, if successful, will enable socio-economic or environmental goals to be achieved despite a changing climate context. Monitoring and Evaluation (M&E) play a central role in assessing the effectiveness of climate change adaptation.

The M&E system actually includes monitoring, reporting and evaluation (MRE) and refers to: systems and approaches designed to monitor, report and evaluate adaptation progress (whether adaptation goals are sufficient and how they contribute to reducing vulnerability to climate change), and helps identify key challenges and opportunities resulting from climate change.

The M&E system is defined as an indicator system used for:

- *systematic analysis of the results and impacts of adaptation interventions;*
- *risk and vulnerability assessment (as a starting point of the adaptation cycle).*

Therefore, indicators could be divided into four types as shown in Table 1 below.

Table 1:
Types of indicators

Type of indicator	Description
Climate parameters	Observed and projected climate parameters (temperature, precipitation, extreme events) that give a picture of expected climatic conditions within which adaptation measures will be implemented.
Climate impacts	Information about the impacts that the climate parameters have and could have on socio-economic and ecological systems, e.g. forest areas impacted by wildfires or the number of people displaced because of wildfires. They serve to measure the effects of changing climate on population and nature.
Adaptation action	Measure of implementation of an adaptation strategy, such as the number of sectoral laws that include adaptation considerations or the percentage of building codes updated.
Adaptation results	Expected outcomes of adaptation measures, such as the number of cubic metres of water conserved or the number of motorways built using updated building codes.

It is important to ensure that gender indicators are included in the MRE/M&E system.

Since the preparation of the BiH National Adaptation Plan is still underway, the focus in the first phase will be on climate parameters and climate impacts, whereas indicators for specific actions and the institutions responsible for their monitoring and reporting will be defined in the BiH National Adaptation Plan (NAP). A list of potential NAP indicators, shown by sector and compiled on the basis of international practices, is available in Annex II to the Report “*CONCEPTUAL FRAMEWORK FOR MONITORING AND EVALUATION OF CLIMATE CHANGE ADAPTATION INDICATORS*”.

2. Standard/key indicators

Compliance with the Modalities, Procedures and Guidelines (Decision 18/CMA.1 – Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement lays down modalities, procedures and guidelines for measurement, reporting and verification) and preparation for implementation of relevant EU legislation is the starting point for establishing/improving the measurement, reporting and verification system (including indicators) in BiH. A complete list of recommended indicators, recommended initial indicators and gender indicators is elaborated at length in the Report "*CONCEPTUAL FRAMEWORK FOR MONITORING AND EVALUATION OF CLIMATE CHANGE ADAPTATION INDICATORS*".

Based on the foregoing, the indicators included in the Standard Operating Procedures for the Coordination and Exchange of Climate Change Adaptation Indicators (SOPs) and the definitions for three-phased establishment of a complete CCA M&E system, the following conclusions can be drawn:

1) The key indicators are those included in phase 1 of the SOP document;
2) Preparations for phase 2 should begin immediately;
3) Projections for key indicators should be made without delay.

Furthermore, if there is a system in place for collecting data on losses and damages under the Sendai Framework for Disaster Risk Reduction (2015–2030), it is recommended that the CCA M&E/MRV system should be linked to it. Economic losses from climate-related extreme events, including the number of deaths and total and insured economic losses from weather and climate events, are among the best adaptation action evaluation indicators.

Past changes/trends (observed/measured values) and expected future values and trends (projected values) are estimated for all data/indicators. Methodologies, procedures and other information relevant to the calculation of indicators are described in the SOP documents developed separately for the most vulnerable sectors in BiH, whereas the recommended methodologies and projection models are described in Annex I to the Report "*CONCEPTUAL FRAMEWORK FOR MONITORING AND EVALUATION OF CLIMATE CHANGE ADAPTATION INDICATORS*". These methodologies are also available online at: https://www.eea.europa.eu/data-and-maps/indicators/#c0=30&c12-operator=or&b_start=0.

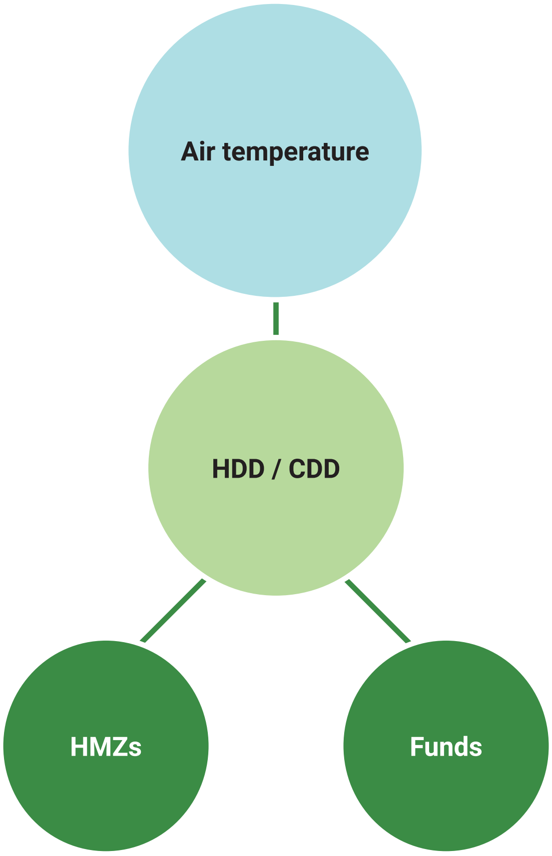
The Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH will be responsible for preparing trends and projections. This responsibility means ensuring availability, whereas data collection and evaluation of derived value indicators can be outsourced to government institutions (as shown in Table I.1 of Annex I) or to scientific and other entities. Responsibility for specific indicators will be assigned based on the capacity of institutions and the discussions between data providers and the Environmental Protection and Energy Efficiency Fund of Republika Srpska / Environmental Fund of Federation BiH.

Using the example: heating (HDD) and cooling degree days (CDD)[61]

HDD and CDD are derived from outdoor air temperature measurements.

Hydrometeorological services (HMZs) are responsible for measuring air temperature. Ensuring HDD and CDD can be the responsibility of HMZs or the Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH, depending on the capacity and agreement among these institutions.

In addition to current data, projections will be prepared.



Even though most of the key indicators are made up of climate parameters (which cannot be used to measure the effectiveness of adaptation actions), there are a number of adaptation result indicators, and monitoring of some key indicators ensures evaluation of adaptation actions (Table 2).

61 Heating (HDD) and cooling degree days (CDD) reflect the amount of energy needed to heat or cool residential or commercial buildings.

Table 2:
Potential adaptation options and their correlation with key indicators

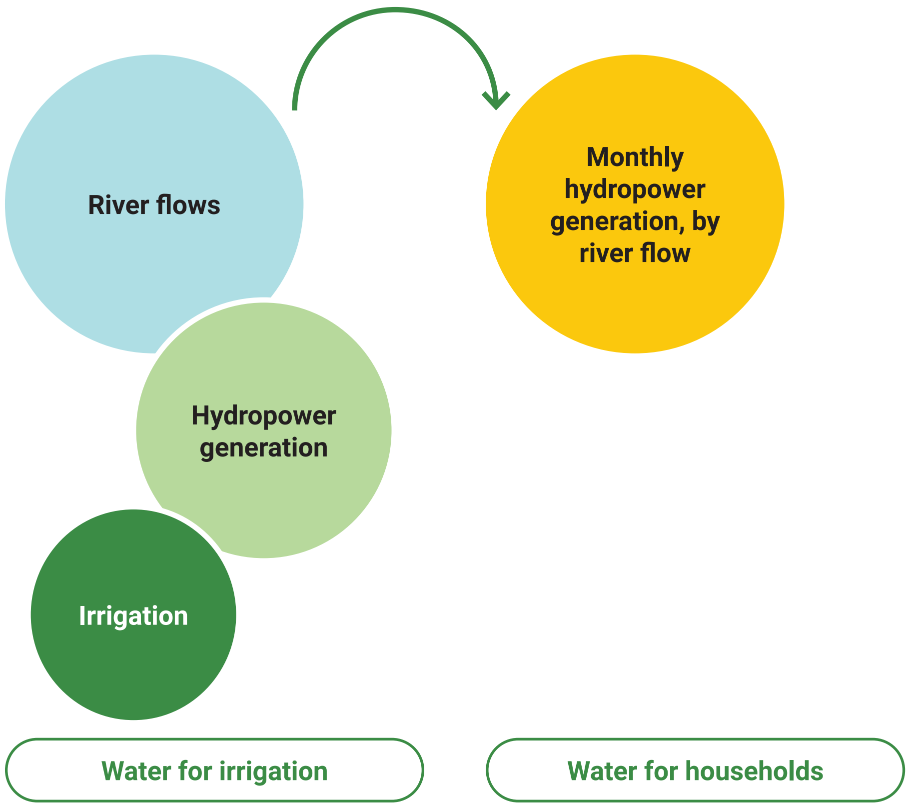
Adaptation action	NAP indicator	Key indicator
Sowing crops that are more resilient to drought	Drought resilient crop covers X ha up to year Z	Agrophenology/Seasonal cycle of agricultural crops
Changing the sowing date (earlier planting time)	Earlier sowing on X ha up to year Y X farmers, which is 10% of all farmers, plant maize Y days earlier Maize yield increased by X% compared to year Y	Growing season – change in the beginning of the growing season
Improving the irrigation system	Expansion of irrigated area by X ha up to year Y Water savings of 20–25% in the existing irrigation system	Water used for irrigation
Increasing the share of hydropower in the energy mix	X% of new hydroelectric projects that take into account future climate risks	Hydropower production
Establishment of a real-time early warning system for wildfire areas	System established on X ha of forest up to Y year Losses and damages from wildfires reduced by X% per year	Burnt area due to wildfires (ha)
Selection of appropriate tree species, sources, populations and genotypes	Appropriate tree species planted on X ha	Forest type and area
Introduction of adaptive forest management and adaptive forest resource management practices	X employees trained in application of adaptive practices Adaptive practices applied to X ha of forest	Forest vitality

Additional guidelines for data collection, monitoring, reporting and evaluation as part of the monitoring, evaluation, measurement, reporting and verification system are presented below using the example of the water management sector.

3. Monitoring and evaluation for integrated water and climate change management

3.1 Guidelines for the key indicator

Based on the SOPs and considering the need for a common set of indicators for Federation BiH, Republika Srpska and Brcko District BiH, key indicators for water management, including electricity generation from hydropower, include data and derived values as follows:



The monitoring, reporting and evaluation system in the water management sector starts with:

1) River flow – represents an indicator for phase 2. Monitoring of these data provides an assessment of direct impacts of climate change on water resources.

This indicator monitors:

- observed trends in river flood discharges;
- projected changes in river floods with a return period of 100 years;
- a change in flow indicating changes in the amount of water.

The indicator is expressed as % and % change per decade.

Based on this indicator, the following will be monitored:

(1) number of severe floods;
(2) trends in river flows;
(3) changes in mean annual river discharge;
(4) timing of annual floods; and
(5) changes in annual flood levels.

Webpage https://www.eea.europa.eu/data-and-maps/indicators/river-floods-3/assessment\ presents results including trends in mean annual river flood discharge in medium and large catchments in Europe over the period 1960–2010 and projected changes in the discharge of a once-in-a-century (Q100) river flood between the reference period (1981–2010) and two levels of global warming (1.5 and 3 °C). It is important that the publicly available hydrological model LISFLOOD was used for these projections. Also, the use of this model is recommended so as to enable comparability with the results for most of the European continent. The necessary data are collected by the river basin agencies. However, these data will be subject to checks in terms of their quality and the period for which they exist. If the data have already been submitted to the competent ministry, there are two possible options:

1. River basin agencies submit data to the competent ministry and the Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH
2. Upon receiving data from the river basin agency, the ministry submits them to the Environmental Protection and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH.

Regardless of which option is chosen, data exchange will be easier once an Environmental Information System has been set up that includes CCA-related data and is linked to a database that already contains data and information relevant to water management and flood protection. In order to obtain Monthly hydropower generation by river flow, in addition to river flow, it is necessary to have data on hydropower generation.

There is no modelling methodology for such an indicator, but monitoring changes in the monthly hydropower output could provide a good basis for estimating vulnerability of the energy sector and economic losses due to climate change impacts on energy production. This could contribute to better planning in the energy sector and electricity generating companies.

2) Hydropower generation

The measurement, reporting and verification system includes data on hydropower generation according to indicators developed within the SOPs, based on data collected by hydropower producers or the ministry responsible for energy/institution responsible for preparing energy balances.

As in the case of river flow, there are two possible options for submitting data to the Funds.

All data and trends will be compared with data and trends of relevant climate parameters (temperature and precipitation) in order to associate the change in indicators with climate change.

Climate parameters are relevant for all sectors and need to be publicly available in easy-to-use formats. This will ensure that scientific institutions can use these data to make estimates relevant for policy making and adaptation planning. Also, analysis will draw upon the same database, thus increasing data interaction and consistency.

Obviously, there is a requirement for data on average monthly river flow and hydropower generation. This does not explicitly mean collection on a monthly basis; rather, it means the availability of data on daily production for at least the last five years (e.g. LISFLOOD model requires daily production). Also, it is important to set up a measurement, reporting and verification system for the collection of river flow data that are relevant to the specific hydro power plant(s).

Furthermore, the irrigation water use indicator will be considered very important for integrated water management.

If data on irrigation (area under irrigation, number of farmers using irrigation systems) are available, the opportunity for improvements will be assessed by collecting data on water use for irrigation. This indicator is also important for the agricultural sector. In addition, as shown below, the example of this indicator indicates the need for the NEXUS approach in a large number of sectors and situations.

Water, energy and agriculture exhibit interlinkages as follows:

Water <-> Energy:	Water plays a key role in energy production, e.g. in hydroelectric power plants, for cooling thermal power plants and in growing plants for biofuels. Conversely, energy is required to process and distribute water, to treat wastewater, to pump groundwater and to desalinate seawater.
Water <-> Food:	Water is the keystone for the entire agro-food supply chain. Conversely, agricultural intensification impacts water quality.
Food <-> Energy:	Energy is an essential input throughout the entire agro-food supply chain, from pumping water to processing, transporting and refrigerating food. Conflicts around land use for food production may arise in the case of biofuels or extended solar installations.

Under a traditional sectoral approach, attempting to achieve resource security solely for the needs of one sector often endangers sustainability and security in other sectors that use the same resource. Under the Nexus approach, interlinkages, synergies and trade-offs of the sector are analysed, with the aim of identifying solutions that will, in this case, foster the security and efficiency of the water, food and energy sectors and reduce impact and risks on water-dependent ecosystems. Therefore, the Nexus approach allows the analysis of interlinkages between sectors in order to reap positive synergies and to effectively manage trade-offs that enable these sectors to function in the most sustainable and optimal way. This is achieved by adopting an integrated and coordinated approach across sectors, with the aim of reconciling potentially conflicting interests, as sectors compete for the same scarce resources, all the while capturing existing opportunities and exploring emerging ones.

3.2 Guidelines for monitoring and evaluation of adaptation projects

Monitoring and evaluation of adaptation actions and results requires specific indicators for individual actions/measures/results as explained in Table 4. Therefore, without these actions/measures/results it is not possible to define indicators or the responsible institution. In the BiH National Adaptation Plan, a specific action will have an indicator that will measure the effectiveness of actions and the Adaptation Plan as a whole in an easy, transparent and qualitative way.

There are two ways in which climate change is relevant to actions/projects (e.g. planning and construction of roads, buildings, farming practices, etc.). First of all, projects may be vulnerable to the impacts of climate change (e.g. floods or sea-level rise damaging infrastructure). Second, actions/projects may increase or decrease the vulnerability of natural and human systems to climate change. Both of these aspects need to be considered.

The vulnerability of a project activity to the impacts of climate change may be direct (e.g. irrigation facilities are affected by changes in runoff as well as changes in demand for irrigation) or indirect if the area in which a project is established undergoes significant socio-economic modifications as a result of climate change. Infrastructure activities and projects in climate hazard areas, or hydropower and irrigation projects that depend upon the reliability of future water supply, may be very vulnerable to climate change. In between these examples is a wide array of potential project activities where climate change may be relevant but in ways that are not so immediately self-evident. The assessment of climate risks will enable the identification of those projects that are vulnerable and those that are not. In addition, there may be possibilities to modify certain projects to take advantage of potential opportunities that may arise from climate change.

Alignment of Environmental Impact Assessment (EIA) legislation in BiH with the EU legislation, specifically the Directive on Environmental Impact Assessment (2014/52/EU), may provide an opportunity for including climate change issues into national legislation.

Directive 2014/52/EU makes clear references to 'climate change' and 'greenhouse gases.' It provides a detailed description of climate change issues to be addressed as part of the screening criteria for Annex II projects:

a) impacts of the project on climate change (in terms of greenhouse gas emissions including from land use, land-use change and forestry);
b) contribution of the project to an improved resilience;
c) the impacts of climate change on the project.

Furthermore, the Directive also makes a clear reference to disaster risk management, most notably in Article 3 and Annexes III and IV.

The requirements that need to be met in order for climate change to be properly integrated into the EIA processes are as follows:

a) available data on climate change (observed and projected), as a minimum;
b) practitioners who have knowledge of climate change projections (in order to include them and understand them when they are included);
c) assessments of climate change risks and identification of appropriate adaptation measures to be included in the design; and
d) a competent authority that recognizes the importance of such integration.

In practice, CCA incorporation in EIA means clarification of future weather variability and presentations of how adversely it affects project infrastructure and how projects/PPs have been designed to be resilient to these changes.

In terms of specific measures and actions, M&E for identified adaptation actions/interventions (e.g. irrigation system improvement) includes the following steps:

In the planning phase:

1) Is the adaptation action included in the nationally determined contributions adaptation (NDC) component;
2) Determining the period over which it will be implemented (e.g. until 2030);
3) Determining the scope to be covered by that year;
4) Definition of indicators (e.g. 100 km of new irrigation system built annually, 10 percent of farmers included in the new irrigation system in 2030);
5) Required funds.

Once the reporting starts:

6) Methodology used for monitoring;
7) Implementation status (indicator of 100 km of the new irrigation system built annually);
8) Share of expenditure used to support the action and resources.

Therefore, in addition to the indicators assumed under the SOPs, potential indicators (by category and by sector) for the monitoring and evaluation of specific actions identified in the BiH Action Plan may include the following:

1. Agriculture

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of households affected by drought Percentage of total livestock killed by drought Number of surface water areas subject to declining water quality due to extreme temperatures Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Shift of agrophenological phases of cultivated plants Losses of GDP in percentage per year due to extreme rainfall
Adaptation action	Number of farmers choosing more adaptable crops Number of farmers who changed planting dates Uptake of soil conservation measures Percentage of agricultural land with improved irrigation Number of farmers involved in irrigation projects Number of women organized in agricultural cooperatives
Adaptation results	Percentage of poor people in drought-prone areas with access to safe and reliable water Number of cubic metres of water conserved Percentage of water demand being met by existing supply Percentage of livestock insured against death due to extreme and slow-onset weather events Percentage of farmland covered by crop insurance Percentage of additional fodder for grazing livestock Increase in agricultural productivity through irrigation of harvested land Increase in percentage of climate-resilient crops being used Percentage of cultivated surface cultivated with drought-resistant varieties Turnover generated by agricultural cooperatives

2. Biodiversity and forestry

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of surface water areas subject to declining water quality due to extreme temperatures Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Distribution of climate sensitive species Acidification of marine water Decline in fish habitats due to temperature change Decreased annual average fish catch as a result of temperature change
Adaptation action	Number of inventories of climate change impacts on biodiversity Total forest area impacted by wildfire per year Annual timber losses from pests and pathogens Uptake of soil conservation measures Percentage of climate resilient trees Area of land under 'landscape scale' conservation Percentage of treated wastewater Percentage of coastline under marine protection Proportion of forest managers taking action on adaptation Number of firebreaks constructed
Adaptation results	Percentage of cultivated surface cultivated with drought resistant varieties

3. Human health

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of households affected by drought Number of surface water areas subject to declining water quality due to extreme temperatures Urban Heat Island Effect in summer Number of people at high risk of heat stress Reduced work productivity due to heat stress Number of hospitals located in areas at risk from flooding/coastal erosion Number of households within most deprived communities located in areas of flood/coastal erosion risk Areas covered by vegetation affected by plagues or fires Number of cases of water-borne diseases

Adaptation action	Number of businesses that have changed their working hours Uptake of early warning systems Uptake of measures to reduce air pollution Percentage of treated wastewater
Adaptation results	Percentage of poor people in drought-prone areas with access to safe and reliable water Percentage of poor people in drought-prone areas with access to energy Percentage of urban households with access to piped water Percentage of water demand being met by existing supply

4. Tourism

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events
Climate impacts	Number of surface water areas subject to declining water quality due to extreme temperatures Percentage of area of ecosystem that has been disturbed or damaged Total forest area impacted by wildfire per year Areas covered by vegetation affected by plagues or fires Acidification of marine water Losses of GDP in percentage per year due to extreme rainfall
Adaptation action	Uptake of measures to reduce air pollution Percentage of coastline under marine protection
Adaptation results	Volume of water consumed by tourist facilities Number of new major infrastructure projects located in areas at risk

5. Water resources

Indicator category	Potential indicators
Climate parameters	Change in annual temperature Mean monthly temperature Number of hot days Change in annual precipitation Monthly precipitation Extreme precipitation events

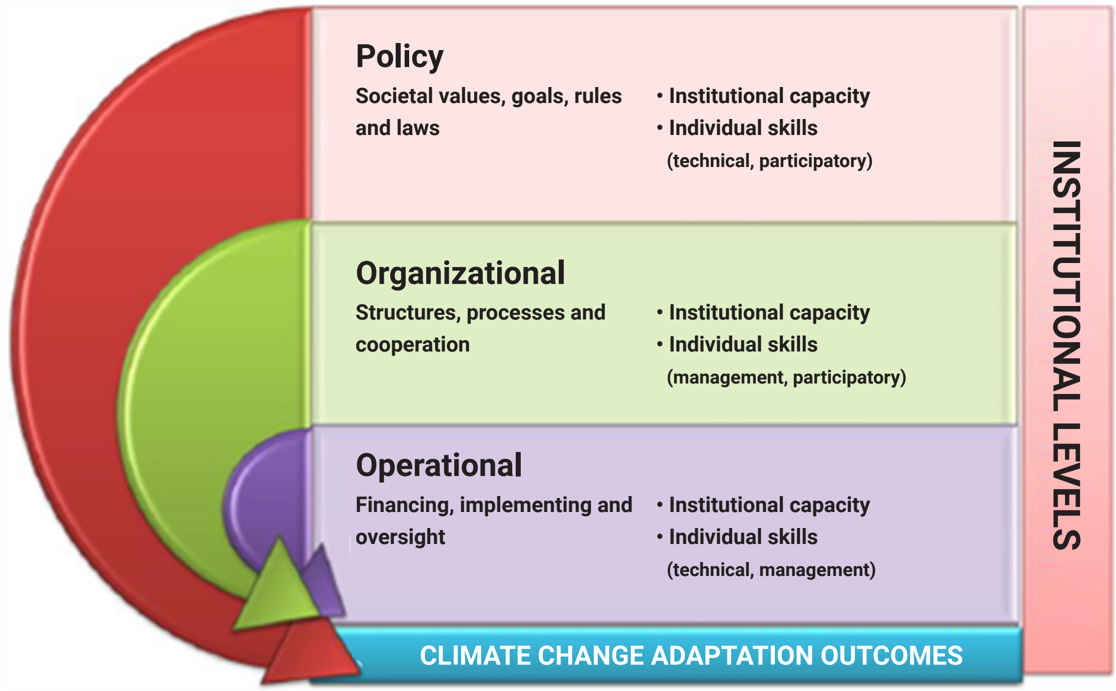
Climate impacts	Number of households affected by drought Percentage of total livestock killed by drought Number of surface water areas subject to declining water quality due to extreme temperatures Number of properties flooded per year Number of properties located in river/coastal floodplain Number of businesses located in areas of flood/coastal erosion risk Number of hospitals located in areas at risk from flooding/coastal erosion Number of households within most deprived communities located in areas of flood/coastal erosion risk Number of properties lost due to coastal erosion per year Number of hectares of productive land lost to soil erosion Percentage of area of ecosystem that has been disturbed or damaged Areas covered by vegetation affected by plagues or fires Acidification of marine water Distribution of warmth-adapted marine species Total length of sewerage and drainage network at risk from climate hazards Number of cases of water-borne diseases Number of people permanently displaced from homes as a result of flood, drought or sea-level rise
Adaptation action	Number of public awareness campaigns on water efficiency Percentage of population living in flood and/or drought-prone areas with access to rainfall forecasts Percentage of new hydroelectric projects that consider future climate risks Number of inventories of climate change impacts on biodiversity Number of water efficiency measures used in energy generation/extraction Number of water companies rationing water during droughts Uptake of riparian tree planting Percentage of treated wastewater Percentage of agricultural land with improved irrigation Percentage of coastline under marine protection Number of farmers involved in pilot irrigation messaging projects Priority areas for precautionary flood protection
Adaptation results	Percentage of poor people in drought-prone areas with access to safe and reliable water Percentage of urban households with access to piped water Number of cubic metres of water conserved Volume of water consumed by tourist facilities Percentage of water demand being met by existing supply Percentage of households at reduced flood risk due to construction of new or enhanced defences Number of new major infrastructure projects located in areas at risk Increase in agricultural productivity through irrigation of harvested land Percentage of cultivated surface cultivated with drought resistant varieties

Additionally, the Annex to the report provides a list of indicators used in several EU countries. However, the SOP document provides relevant information for monitoring and reporting on indicators selected by national institutions.

4. Capacity development needs and activities

The entire NAP process requires comprehensive capacity development in the country, both at the state and entity levels. Capacity development approaches include the following elements:

- Human resource development: Women and men in different organizations should be trained to perform required tasks in the NAP process.
- Organizational development: Organizations should function in such a way as to ensure that adaptation processes are planned, implemented, and monitored successfully.
- Institutional development: Legal frameworks, rules, codes of operation and other institutional setups should enable successful NAP processes.
- Cooperation and network development: NAP processes require successfully operating net works among stakeholders and organizations.



Concept of capacity development (source: UNDP Capacity Development Framework, 2008)

Capacity development for reporting, monitoring and evaluation should be considered part of the overall NAP process and as a process in general. Therefore, in addition to the responsibility for developing and maintaining an M&E system, the Environmental and Energy Efficiency Fund of Republika Srpska and the Environmental Protection Fund of Federation BiH should have a capacity development programme in place to ensure that all partners involved improve the quality and quantity of data and results.

1. It is recommended that a final consultative meeting should be organized with

- Republika Srpska Bureau of Statistics;
- Federation BiH Bureau of Statistics; and
- Bosnia and Herzegovina Agency for Statistics

to present identified indicators, phases of their inclusion, gaps, key indicators and assumed roles and responsibilities.

The aim is to assess together with the Republika Srpska Bureau of Statistics and the Federation BiH Bureau of Statistics whether there are indicators that will be obtained directly from them, as well as to agree on the deadlines for data submission by data providers.

2. Introductory training to provide an overview of the current results of the NAP process, gaps in adaptation planning and in legislative and institutional arrangements, SOPs and indicators identified as key indicators for high-level decision makers in relevant institutions, including representatives of:

a) Environmental Protection and Energy Efficiency Fund of Republika Srpska;
b) Environmental Protection Fund of Federation BiH; and
c) Ministries of Republika Srpska and Federation BiH with mandates for climate change and Ministry of Foreign Trade and Economic Relation Bosnia and Herzegovina.

The aim of this session is to present climate change adaptation, current legislative and institutional setups, identified indicators and phases of their inclusion in M&E, gaps, key indicators, quality assurance and control, roles and responsibilities.

The purpose of this event is to ensure better coordination and exchange of information right from the outset.

3. Training for bodies responsible for data submission, as set out in the SOP document, as well as for those responsible for relevant activities under government laws.

Training for data providers should include two phases:

- Phase I – Training for key indicators;
- Phase II – Training for other indicators.

Phase I is crucial for the establishment and operation of the M&E system.

The aim of the Phase I training is to ensure that all stakeholders understand the importance of the NAP process in general and the related CCA M&E activities, as well as the role they play in organizing a successful CCA M&E system.

The first two-hour workshop will be organized for all attendees and will concern the list of indicators, phases in improving the number of indicators, responsibilities and other general issues. Attendees will receive information on the process of developing a CCA M&E system at the national and project levels.

Based on the SOP development process and existing data in official databases, as well as their availability, the focus will be on:

- Data quality;
- Data projections (values in the future);
- Methodologies to be used for harmonization in different entities.

After this general workshop, it is necessary to organize alternating training sessions for specific key indicators. The aim is to present data collection methods and indicator assessment and projection methodologies.

The final part of the training will comprise an interactive training session on how to complete indicator reporting forms. Training in the use of the interactive IT data exchange tool will be organized once the tool has been developed and launched.

The overarching aim of these training sessions is to confirm the current data collection practice and identify gaps, opportunities and capacities for making projections, quality assurance and control procedures to be established at the data collection level, and data exchange protocol mechanisms.

The training will be organized as a joint session for both entities (Republika Srpka and Federation BiH). All data producers should participate, as should also the Environmental Protection and Energy Efficiency Fund of Republika Srpska, the Environmental Protection Fund of Federation BiH and Ministry of Foreign Trade and Economic Relation Bosnia and Herzegovina.

It is recommended that experts from the EU and/or EU Member States with hands-on experience in implementing M&E systems should be engaged. A useful opportunity could be close cooperation with the ongoing multi-country project TRATLOW: EU Support for Climate Action in IPA II beneficiaries – Transition towards the low emissions and climate-resilient economy.

16. Annex 3:

STANDARD OPERATING PROCEDURES FOR THE MECHANISM OF COORDINATION AND HORIZONTAL AND VERTICAL EXCHANGE OF CCA INDICATORS IN BOSNIA AND HERZEGOVINA

September, 2021

This publication was prepared within the project “Advance the National Adaptation Plan (NAP) process for medium-term investment planning in climate sensitive sectors in Bosnia-Herzegovina (B&H)”, funded by the Green Climate Fund (GCF), implemented by UNDP in cooperation with the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry of Spatial Planning, Construction and Ecology of Republika Srpska, as a UNFCCC focal point for Bosnia and Herzegovina, Ministry of Agriculture, Forestry and Water Management of Republika Srpska, Federal Ministry of Agriculture, Water Management and Forestry and Federal Ministry of Environment and Tourism.

List of experts:

Zoran Lukač, Team leader
Vujadin Blagojević, Water management RS
Alma Bibović, Water management FBiH
Nedeljko Sudar, Hydropower RS
Faruk Serdarević, Hydropower FBiH
Lejla Hajro, Spatial planning FBiH
Branimir Gojković, Spatial planning RS
Đorđe Vojinović, Environment RS
Melisa Ljuša, Environment FBiH
Hamid Čustović, Agriculture FBiH
Mihajlo Marković, Agriculture RS
Besim Balić, Forestry FBiH
Milan Mataruga, Forestry RS
Đorđe Markez, Legal expert
Edin Zahirović, Economist
Danijela Božanić, M&E expert

Table of contents:

144 **1. Introduction**
145 **2. Purpose of standard operating procedures**
146 **3. Who are the sops intended for**
146 **4. International legal framework and domestic legislation**
148 **5. SOP structure**
148 5.1. Title of the procedure
148 5.2. Type of CCA indicator
148 5.3. Geographical area
148 5.4. Title of the indicator
148 5.5. Date of submission of the form to the central processing unit (CPU)
148 5.6. Year and relevant period
149 5.7. Missing data
149 5.8. Name of the institution completing and submitting the form, contact information and registered office
149 5.9. Number of protocol of the institution submitting the form
149 5.10. Quality assurance and control
149 5.11. Procedure version number / year of adoption of the procedure
149 5.12. General statement on the procedure
150 5.13. Scope of application
150 5.14. Description of the procedure
150 5.15. Adoption of the procedure
151 5.16. Full name of the cpu and the electronic address of the recipie**nt**
151 **6. Review of the procedure**
152 **7. Introduction of a new procedure and new indicators**
154 **8. Overview of the institutional horizontal and vertical exchange of information concerning CCA mnitoring in Bosnia and Herzegovina**
154 8.1 Additional recommendations concerning horizontal and vertical flow of information and intersectoral coordination
156 **9. Overview of joint indicators**
157 **10. List of indicators divided by area and possibility of phased submission of data and trends from relevant institutions of the Republika Srpska and the Federation of BiH**
157 8.1. Area - Water management
159 8.2. Area - Hydropower
159 8.3. Area - Agriculture
160 8.4. Area - Forestry
162 8.5. Area - Environment
163 8.6. Area - Spatial planning
164 8.7. Area - Economic aspects of climate change adaptation
164 8.8. Area - Human health

1. Introduction

As a party to the *United Nations Framework Convention on Climate Change (UNFCCC), Bosnia and Herzegovina has taken important steps towards understanding and solving the issue of climate change. The relevant authorities and the scientific community increasingly recognize that climate change is a matter of key strategic importance. BiH has put great emphasis on climate change as one of the most significant development challenges faced by the country.*

The importance of Climate Change Adaptation (CCA) is strongly emphasized in the *Second National Climate Change Adaptation and Low-Emission Development Strategy for BiH (CCA LED)*, adopted in 2013. In 2015, BiH submitted its *Intended Nationally Determined Contribution (INDC) Report*, as part of the negotiations that led to the historical Paris Agreement, which was signed in April 2016.

The relevant authorities in Bosnia and Herzegovina and the key domestic actors see climate change as a rising threat to the development of the country and the need to adapt all sectoral policies and measures to climate change, in order to avoid or minimize their negative effects.

One of the most important aspects in fulfilling the assumed international obligations of Bosnia and Herzegovina in the field of climate change adaptation is mutual coordination of all activities and measures of the key institutions at all levels of government in Bosnia and Herzegovina. Without a coordinated approach, the efficiency of fulfilment of the assumed international obligations and the implementation of the intended strategic objectives will not reach a satisfactory level. In order to overcome all challenges and problems in this field, it is necessary to establish a mechanism of efficient coordination and intersectoral horizontal and vertical cooperation in all sectors that are 'sensitive' and vulnerable to climate change, such as: water management, agriculture, forestry, hydropower, spatial planning, environmental protection and other related fields.

Horizontal cooperation means a set of measures and activities concerning mutual exchange of information and data on the CCA activities between the key institutions at the entity level of Republika Srpska and Federation BiH and at the level of the Brčko District of BiH (BDBiH). Vertical cooperation encompasses a set of measures and activities concerning exchange of information and data on the CCA activities between the institutions at the of Republika Srpska and Federation BiH /Brcko District BiH level and the key institutions at the level of BiH.

In order to establish a mechanism of efficient horizontal and vertical communication, and unimpeded exchange of information in the field of monitoring of measures and CCA activities, it is necessary to take into consideration the complex constitutional arrangement of Bosnia and Herzegovina in the first place, as well as the legally defined responsibilities of the key institutions at the level of BiH, Entity level of Republika Srpska and Federation BiH (taking into consideration the responsibilities of the Cantons within the Federation BiH as well), and at the level of the Brčko District of BiH. Such a situation poses an additional challenge to the creation of a mechanism of coordination and exchange of information in the field of CCA monitoring.

Standard Operating Procedures for the mechanism of coordination and horizontal and vertical exchange of CCA indicators in BiH is a document developed with the financial assistance provided by the UNDP, and with active participation of all key institutions in Bosnia and Herzegovina that are responsible for the implementation of CCA monitoring and reporting activities.

2. Purpose of standard operating procedures

Standard Operating Procedures (SOPs) represent a set of written instructions (step-by-step instructions) for particular, recurring, business processes or activities carried out within an organization.
The SOPs ensure that all institutions and all employees carry out the same procedures in the same manner.

The development and use of the SOPs are an integral part of a successful quality system, because they provide individuals and institutions with information for proper performance and facilitate consistency in reaching the end result.

The aim of the *SOPs for the mechanism of coordination and horizontal and vertical exchange of CCA indicators in BiH* is to:

1) identify the key institutions in Bosnia and Herzegovina (at the state level of BiH, Republika Srpska, Federation BiH and Brcko District BiH) that are responsible for CCA monitoring and collection and processing of data for the corresponding CCA indicators,
2) establish a clear and efficient framework for coordination of CCA activities between climate-vulnerable sectors, such as water management, agriculture, forestry, spatial planning, environmental protection and hydropower,
3) establish an efficient mechanism of intersectoral horizontal and vertical cooperation and exchange of information at the level of the entities of Republika Srpska, Federation BiH and the Brcko District BiH, as well as cooperation and exchange of information with relevant authorities at the level of BiH with a view to fulfilling the assumed international obligations,
4) to serve as a reliable and solid basis for the establishment of the Monitoring and Evaluation Framework for climate change adaptation activities in Bosnia and Herzegovina (M&E Framework for CCA). The M&E as an information system has to monitor and quantify the progress in climate change adaptation, as an obligation under the UNFCCC / Paris Agreement.

In each of the observed sectors, the SOPs need to provide very precise answers to the following questions:

1) WHO is responsible for a particular procedure (institution, sector, department);
2) WHO is preparing information about the CCA indicator (responsible person);
3) WHO is collecting and processing data on the CCA indicator;
4) WHO is authorizing and archiving the collected indicators;
5) WHAT/WHICH activities and procedures are carried out;
6) WHEN, in which period/interval are the target activities carried out;
7) HOW are the target activities carried out;
8) HOW do relevant stakeholders cooperate and communicate.

3. Who are the SOPs intended for

The SOPs for the mechanism of coordination and horizontal and vertical exchange of CCA indicators in BiH are intended for all institutions (ministries, agencies, administrative structures, institutes, bureaus, public enterprises, etc.) that are competent and responsible for creation, implementation and analysis of sectoral policies and measures for the climate change adaptation activities in Bosnia and Herzegovina, pursuant to laws, regulations and/or strategic documents. In that regard, it has to be taken into consideration that the institutional framework comprises the levels of BiH, Republika Srpska, Federation of Bosnia and Herzegovina and Brčko District of BiH.

This SOPs are particularly focused on the institutions that are directly or indirectly involved in the CCA monitoring mechanism in BiH, and whose regular activities encompass collection, processing, archiving and publication of data identified as indicators for climate change adaptation measures, which includes:

1) Climate parameters – observed and projected climate parameters (temperature, precipitation, extreme events) which give a picture of the expected climate conditions in which the adaptation measures will be carried out;
2) Climate impacts – information on the effects which climate parameters have or could have on socio-environmental systems. They are used for measuring the climate change effects on population and nature;
3) Adaptation action – measure of implementation of the adaptation strategy, such as the number of sectoral laws which include adaptation considerations or the percentage of updated sectoral laws;
4) Adaptation results – outcomes of the adaptation measures.

4. International legal framework and domestic legislation

Climate change adaptation activities in BiH will be implemented taking into consideration the following international conventions and EU directives:

1) United Nations Framework Convention on Climate Change (UNFCCC), https://unfccc.int/
2) Kyoto Protocol from 1997 (entered into force in 2005), https://unfccc.int/kyoto-protocol-html-version
3) United Nations Convention to Combat Desertification (UNCCD), https://www.unccd.int/
4) United Nations Convention on Biological Diversity (UNCBD), https://www.cbd.int/
5) A policy framework for climate and energy in the period from 2020 to 2030;
6) GREEN PAPER A 2030 framework for climate and energy policies;
7) Proposal for a DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/EC /* COM/2014/020 final – 2014/0011 (COD)
8) DIRECTIVE 2012/27/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
9) DECISION No 406/2009/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

10) DIRECTIVE 2009/29/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

The SOP document is based on the following laws in BiH:

1) Law on Ministries and other Administrative Authorities of Bosnia and Herzegovina (Official Gazette of BiH, 5/03, 42/03, 26/04, 42/04, 45/06, 88/07, 35/09, 59/09, 103/09, 87/12, 6/13, 19/16 and 83/17)
2) Law on the of Republika Srpska Administration (Official Gazette of Republika Srpska, 115/18)
3) Law on Waters (Official Gazette of Republika Srpska, 50/06, 92/09, 121/12 and 74/17)
4) Law on Agricultural Land (Official Gazette of Republika Srpska, 93/06, 86/07, 14/10, 5/12, 58/19)
5) Law on Spatial Planning and Construction (Official Gazette of Republika Srpska, 40/13, 2/15, 106/15, 3/16, 84/19)
6) Rules on the manner of preparation, content and formation of spatial planning documents (Official Gazette of Republika Srpska, 69/13)
7) Law on Environmental Protection (Official Gazette of Republika Srpska, 71/12, 79/15 and 70/20)
8) Law on Nature Protection (Official Gazette of Republika Srpska, 20/14)
9) Law on the Meteorological and Hydrological Activity (Official Gazette of Republika Srpska, 20/20)
10) Law on Forests (Official Gazette of Republika Srpska, 75/08, 60/13 and 70/20)
11) Law on Federation BiH Ministries and other Federation BiH Administrative Authorities (Official Gazette of Federation BiH, 58/02, 19/03, 38/05, 2/06, 8/06, 61/06 and 48/11)
12) Law on Waters (Official Gazette of Federation BiH, 70/06)
13) Law on Agricultural Land (Official Gazette of Federation BiH, 52/09)
14) Law on Environmental Protection (Official Gazette of Federation BiH, 33/03 and 38/09)
15) Law on Nature Protection (Official Gazette of Federation BiH, 66/13)
16) Law on Spatial Planning and the Use of Land at the level of the Federation of Bosnia and Herzegovina (Official Gazette of Federation BiH, 2/06, 72/07, 32/08, 4/10, 13/10, 45/10)
17) Cantonal laws on forests (9 Cantonal laws):
   1. Law on Forests of the Sarajevo Canton (Official Gazette of the Sarajevo Canton, 5/13)
   2. Law on Forests (Official Gazette of the Una-Sana Canton, 22/12, 16/16, 12/17, 25/17 and 4/19)
   3. Law on Forests (Official Gazette of the Tuzla Canton, 7/17 and 8/20)
   4. Law on Forests (Official Gazette of the Zenica-Doboj Canton, 8/13 and 1/15)
   5. Law on Forests (Official Gazette of the West Herzegovina Canton, 8/13, 11/17 and 6/20)
   6. Law on Forests (Official Gazette of the Posavina Canton, 9/13)
   7. Law on Forests (Official Gazette of the Central Bosnia Canton, 5/14)
   8. Law on Forests (Official Gazette of the Bosnian Podrinje Canton, 4/13 and 05/13)
   9. Law on Forests of the Canton 10 (Official Gazette of the Canton 10, 4/14)

18) Law on the Protection of Waters (Official Gazette of the Brčko District of BiH, 25/04, 1/05, 19/07 and 9/09)
19) Law on Environmental Protection (Official Gazette of the Brčko District of BiH, 24/04, 1/05, 19/07 and 9/09)
20) Law on Agricultural Land of the Brčko District of BiH (Official Gazette of the Brčko District of BiH, 32/04, 20/06, 10/07 and 19/07)
21) Law on Forests of the Brčko District of BiH (Official Gazette of the Brčko District of BiH, 14/10, 26/16)
22) Law on Nature Protection of the Brčko District of BiH (Official Gazette of the Brčko District of BiH, 24/04, 1/05, 19/07 and 9/09)
23) Law on the Hydrometeorological Matters of Interest to the Republika (Official Gazette of the SFRY, 10/76) – pursuant to Article IX. 5. (1) of the Constitution of the Federation of Bosnia and Herzegovina, it is applied as an Federation BiH law;

24) Law on Spatial Planning and the Use of Land at the level of the Federation BIH (Official Gazette of Federation BiH, 2/06, 72/07, 32/08, 4/10, 13/10 and 45/10);
25) Law on Agriculture (Official Gazette of the Federation of BiH, 88/07)

5. SOP structure

INTEGRAL PARTS OF THE SOPs

HEADING – in the form of a table with basic information

5.1. Title of the procedure

Indicate the procedure and the area to which the processed indicator belongs.

5.2. Type of CCA indicator

In this field, write one of the following acronyms, which corresponds to the type of indicator:

KP = CLIMATE PARAMETER
KU = CLIMATE EFFECT
AA = ADAPTATION ACTIVITIES
RA = ADAPTATION RESULT

5.3. Geographical area

5.4. Title of the indicator

Use the same terminology in all three competent units (Republika Srpska, Federation of BiH, BDBiH). For that purpose, two CPUs will agree on all terminological entries for the CCA indicators processed by the competent authorities in BiH.

5.4.1. Data used for obtaining indicators

5.5. Date of submission of the form to the central processing unit (CPU)

5.6. Year and relevant period

5.7. Missing data

5.8. Name of the institution completing and submitting the form, contact information and registered office

Full name of the institution, contact information (telephone, fax, e-mail, postal address) and registered office.

5.9. Number of protocol of the institution submitting the form

5.10. Quality assurance and control

5.10.1. Procedure

Indicate here whether quality control has been performed for data and procedures, as well as the act prescribing the rules of quality control in the reporting period.

5.10.2. Responsible person(s)

5.10.3. Improvement plan

Indicate the period and planned steps in improving the quality of data, as well as what is needed for their implementation (necessary funds, equipment, etc.).

5.10.4. Data used

Indicate which data and which institutions were used for the calculation.

5.11. Procedure version number / year of adoption of the procedure

Write the number of versions of the adopted procedure / year of adoption of the procedure in the form.

5.12. General statement on the procedure

This statement should highlight in brief the importance and reasons for the procedure, as well as its relation to the type and category of cca indicator.

5.13. Scope of application

Indicate the territorial jurisdiction (republika srpska, federation of bih, brčko district of bih) and the specific area of categorization of the indicator (e.g. water, air, temperature, etc.).

5.13.1. Legal basis for the procedure

For the level of horizontal exchange of data and coordination of the institutions from the Republika Srpska, refer to the appropriate sectoral law (see Chapter 4 of this document) and Article 115a of the Law on Amendments to the Law on Environmental Protection.

For the level of horizontal exchange of data and coordination of the institutions from the Federation of BiH, refer to the appropriate sectoral law from the Federation BiH (see Chapter 4 of this document) and the Conclusion of the Government of the Federation of BiH no. 146/2018 of 1 February 2018.

For the level of horizontal exchange of data and coordination of the institutions from the BDBiH, refer to the appropriate sectoral law from the BDBiH (see Chapter 4 of this document).

5.14. Description of the procedure

Describe in brief all the steps in the process of collection, processing, archiving and submission of data on the CCA indicator, persons responsible for the implementation of activities, time and manner of the implementation of activities, etc.

If possible, explain the methodological procedure for preparation of the CCA indicator, such as: source of information; manner of collection and processing; instrumental method, etc.

If the institution submitting the completed form uses an inadequate methodological procedure or a non-verified instrumental method, and, as a result, inadequate data on the indicator, the CPU will contact the institution which has submitted the form with a view to harmonizing the procedure or correcting the methodological procedure.

5.15. Adoption of the procedure

At the end of the procedure, indicate the names:

- name and signature of the person who has prepared the data, and the title of the post,
- name and signature of the person responsible who has given consent to the implementation of the procedure and who has verified the entered data,
- name and signature of the director/manager of the institution submitting the data on the CCA indicator,
- date of authentication of the entered data,
- stamp of the institution (for the printed version of the document).

Note: the document is also sent in an electronic form, in the MS OFFICE EXCEL format.

5.16. Full name of the cpu and the electronic address of the recipient

1) Environmental Protection and Energy Efficiency Fund (for the institutions in the territory of the Republika Srpska)
2) Environmental Protection Fund of Federation BiH (for the institutions in the territory of the Federation of Bosnia and Herzegovina)
3) Institutions in the territory of the Brčko District of Bosnia and Herzegovina

6. Review of the procedure

The procedure of review of the compliance with the international standards is conducted every two years, and this is recorded at the end of the procedure.

An unscheduled review procedure may be conducted even earlier in the event of:

- any amendment to the piece of legislation that is related to the procedure of submission of CCA indicators or regulates the sectoral area of CCA indicators;
- any change of the jurisdiction and the scope of activity of the institution preparing data on the indicator;
- any change in the internal organization of work;
- introduction of equipment or a working method;
- other (specify).

As regards a previously reviewed procedure, it is necessary to indicate the month and year of review and any previous reviews of the procedure.

In the event of initiation of an unscheduled or regular review procedure, the relevant CPU has to be informed thereof both in writing and in an electronic form.

7. Introduction of a new procedure and new indicators

If the institution intends, on the basis of an amendment to the law, a regulation or an internal act, or on the basis of the annual work plan:

- to introduce a new instrumental method,
- or if it will be able to collect new parameters on the CCA indicator,
- or if it introduces a new procedure which will modify the approach to the analysis of the existing CCA indicator,
- or if it will be able to collect parameters on a new CCA indicator,
- or if it will be able to monitor new sectoral adaptation measures,
- or in any other case indicating a new approach of the procedure or encompassing a new indicator,

it will be obliged, at least six months prior to the introduction of the procedure/indicator, to notify its CPU in writing and via electronic mail and seek their opinion on the introduction thereof. In addition to the notification, the institution is obliged to send a completed SOP form for the proposed procedure/indicator.

After obtaining the written consent, the institution will start with the implementation of the new procedure/indicator under these SOPs.

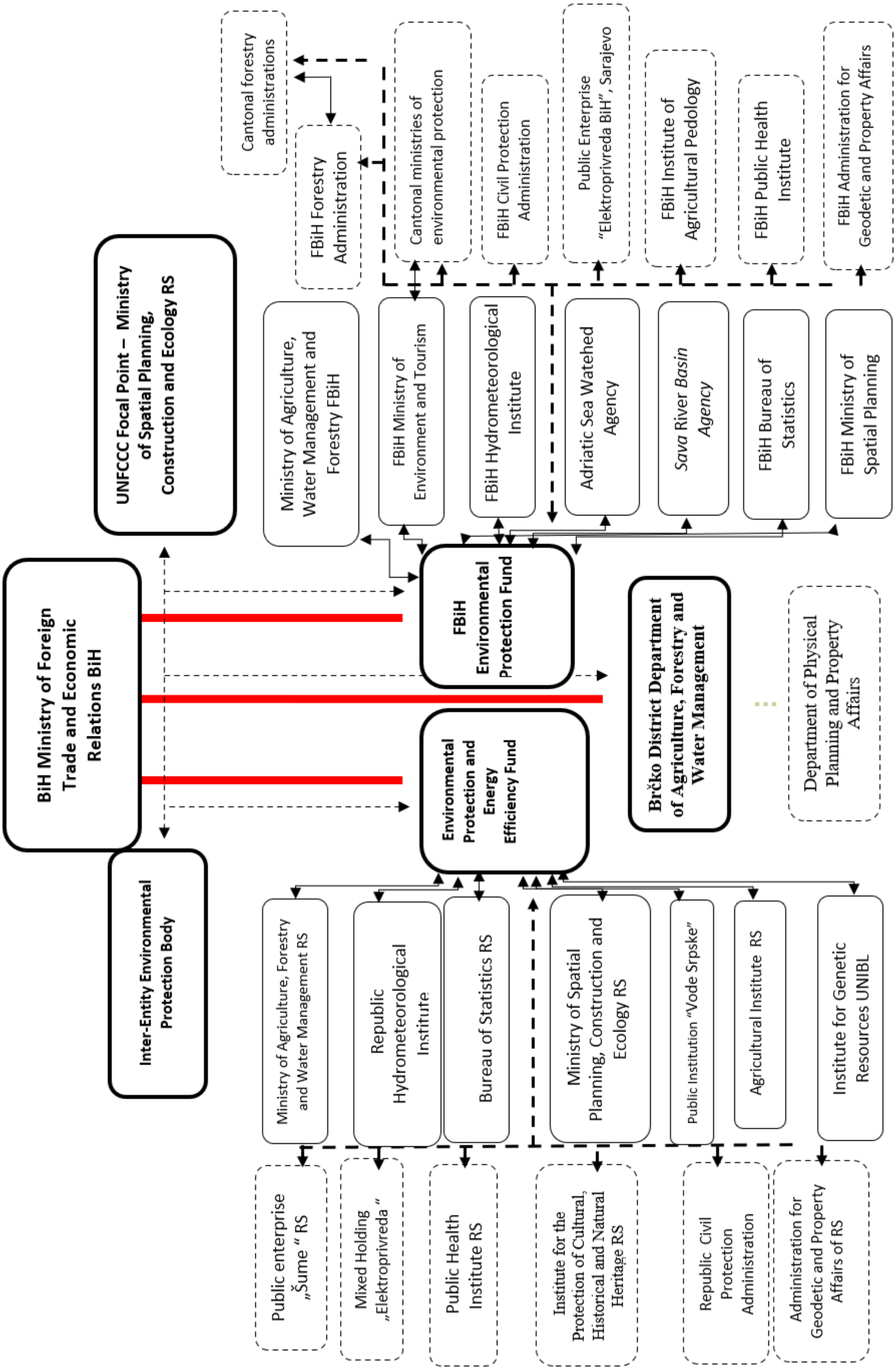
CCA indicator submission form

6.1.	TITLE OF THE PROCEDURE: AREA:		Form 1.1
6.2.	TYPE OF INDICATOR (use the acronym)		
6.3.	GEOGRAPHICAL AREA FOR WHICH THE INDICATOR IS RELEVANT		
6.4.	TITLE OF INDICATOR		
6.5.	DATE OF SUBMISSION OF THE FORM TO THE CPU		
6.6.	YEAR AND RELEVANT PERIOD		
6.7.	MISSING DATA		
6.8.	NAME OF THE INSTITUTION SUBMITTING THE FORM		
	CONTACT INFORMATION AND REGISTERED OFFICE		
6.9.	PROTOCOL NUMBER:		
6.10.	QUALITY ASSURANCE AND CONTROL		
6.10.1.	PROCEDURE		
6.10.2.	RESPONSIBLE PERSON(S)		
6.10.3.	IMPROVEMENT PLAN		
6.10.4.	DATA USED		
6.11.	PROCEDURE VERSION NUMBER / YEAR OF ADOPTION		
6.12.	GENERAL STATEMENT ON THE PROCEDURE		
6.13.	SCOPE OF APPLICATION		
6.13.1.	Legal basis for the procedure		
6.14.	DESCRIPTION OF THE PROCEDURE		
6.15.	ADOPTION OF THE PROCEDURE		
	Name and signature of the person who has prepared the data, and the title of the post		
	Name and signature of the person responsible who has given consent to the implementation of the procedure and who has verified the entered data		
	Name and signature of the director/manager of the institution submitting the data on the CCA indicator		
	Date:	L.S.	
6.16.	FULL NAME OF THE CPU		
	ELECTRONIC ADDRESS OF THE RECIPIENT		
7.	REVIEW OF THE PROCEDURE		
8.	INTRODUCTION OF A NEW PROCEDURE AND NEW INDICATORS		

8. Overview of the institutional horizontal and vertical exchange of information concerning CCA monitoring in Bosnia and Herzegovina

8.1. Additional recommendations concerning horizontal and vertical flow of information and intersectoral coordination

1. It is recommended to the Government of Republika Srpska to adopt a piece of legislation to regulate the content, the manner of data collection, the structure and category of data, and the administration of a single information system for environmental protection of the RS, thereby regulating additionally the manner of submission of periodical CCA monitoring data and indicators to the relevant institutions and bodies at the level of BiH.
2. It is recommended to the Federation BiH Government to amend the Law on Nature Protection with a view to granting permanent jurisdiction over the administration of a single environmental information system to the Environmental Protection Fund of Federation BiH.
3. It is recommended to the Government of Republika Srpska, Government of Federation BiH and the Government of the Brčko District of BiH to sign an agreement on cooperation and understanding in the area of exchange of data and CCA monitoring within the Inter-Entity Environmental Protection Body, which will define all details of cooperation between the two Entity Funds and the Department of Agriculture, Forestry and Water Management of the Brčko District of BiH towards the MoFTER in terms of data protocols and the mechanism of vertical coordination.
4. It is recommended to the Federal Ministry of Environment and Tourism to conclude an additional protocol, a cooperation agreement or a similar document with the Cantonal ministries of environmental protection, which will define the manner and scope of exchange of the necessary data in the area of CCA monitoring, the time frame and the types of data.
5. It is recommended to the Ministry of Agriculture, Water Management and Forestry of Federation BiH and the Federation BiH Forestry Administration to conclude an additional protocol, a cooperation agreement or a similar document with the Cantonal forestry administrations, which will define the manner and scope of exchange of the necessary data in the area of CCA monitoring, the time frame and the types of data.


BiH Ministry of Foreign Trade and Economic Relations BiH
UNFCCC Focal Point – Ministry of Spatial Planning, Construction and Ecology RS
Inter-Entity Environmental Protection Body
FBiH Environmental Protection Fund
Environmental Protection and Energy Efficiency Fund
Brčko District Department of Agriculture, Forestry and Water Management
Department of Physical Planning and Property Affairs
Ministry of Agriculture, Water Management and Forestry FBiH
FBiH Ministry of Environment and Tourism
FBiH Hydrometeorological Institute
Adriatic Sea Watehed Agency
Sava River Basin Agency
FBiH Bureau of Statistics
FBiH Ministry of Spatial Planning
Cantonal forestry administrations
FBiH Forestry Administration
Cantonal ministries of environmental protection
FBiH Civil Protection Administration
Public Enterprise "Elektroprivreda BiH", Sarajevo
FBiH Institute of Agricultural Pedology
FBiH Public Health Institute
FBiH Administration for Geodetic and Property Affairs
Ministry of Agriculture, Forestry and Water Management RS
Republic Hydrometeorological Institute
Bureau of Statistics RS
Ministry of Spatial Planning, Construction and Ecology RS
Public Institution "Vode Srpske"
Agricultural Institute RS
Institute for Genetic Resources UNIBL
Public enterprise „Šume " RS
Mixed Holding „Elektroprivreda "
Public Health Institute RS
Institute for the Protection of Cultural, Historical and Natural Heritage RS
Republic Civil Protection Administration
Administration for Geodetic and Property Affairs of RS

9. Overview of joint indicators

No.	Indicator code	Indicator title	Water management	Agriculture	Environment	Economic aspects
1.	КП6	Emissions of CH_4 (direct greenhouse gas)		√	√	
2.	КП7	Emissions of N_2O (direct greenhouse gas)		√	√	
3.	КП8	Projections of greenhouse gas emissions and sinks with a policy and measures		√	√	
4.	КП9	Trends in mean air temperature / Change in mean annual temperature	√	√	√	
5.	КП10	Atmospheric precipitation trends / Change in the total annual precipitation	√	√	√	
6.	КП11	Standardized Precipitation Index (SPI)	√	√	√	
7.	КП12	Aridity index	√		√	
8.	КП13	Number of hail days / Frequency of hail events	√	√	√	
9.	КП14	Number of snow days / Snow depth	√	√	√	
10.	КП15	Number of hot days	√	√	√	
11.	КП16	Number of extreme heat waves	√	√	√	
12.	КП17	Change in mean monthly air temperatures / Mean monthly temperature	√	√		
13.	КП18	Change in the total monthly precipitation	√	√		
14.	КП19	Extreme precipitation	√	√	√	
15.	КП20	Precipitation deficit / Meteorological droughts	√	√		
16.	СД1	Household water usage	√			√
17.	П4	Irrigation water usage / Increase in area under irrigation	√	√		√

10. List of indicators divided by area and possibility of phased submission of data and trends from relevant institutions of the Republika Srpska and the Federation of BiH

List of indicators divided by area and possibility of phased submission of data and trends from relevant institutions of the Republika Srpska and the Federation of BiH

10.1. Area - Water management

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	1.1	KP9 Change in the average annual temperature	•	•
	1.2	KP17 Mean monthly temperature	•	•
	1.3	KP15/KP16 Number of hot days / Number of extreme heat waves	•	•
	1.4	Pgod Change in the annual precipitation	•	•
	1.5	KP18 Monthly precipitation	•	•
	1.6	KP19 Extreme precipitation events / Heavy precipitation	•	•
	1.7	KP20 Meteorological droughts / Precipitation deficit	•	•
	1.8	KP13/OV Hail events	•	•
	1.9	KP14 Snow depth	•	•
	1.10	OV Wind storms		
	1.11	SM Snow mass	•	•
PHASE II – PARTIALLY ESTABLISHED INDICATORS	2.1	Qsr Streamflows	•	•
	2.2	KP10 Atmospheric precipitation trends	•	•
	2.3	BDGH Number of days when heating or cooling is necessary	•	•
	2.4	KPQSR Change in the mean annual streamflow	•	•

PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS	**3.1**	KP12 Aridity index	•	•
	3.2	KP11 Standardized Precipitation Index (SPI)	•	•
	3.3	RJTSR Mean annual temperature of water in rivers and lakes	•	•
	3.4	RP River floods	•	•
	3.5	KAV1 Amount of nutrients in rivers and lakes	•	•
	3.6	ME1 Analysis of the amount of nutrients in coastal and sea waters		•
	3.7	PP Municipal wastewater treatment plants	•	•
	3.8	BR12 Number of fish ponds	•	•
	3.9	P4 Irrigation water usage	•	•
	3.10	SD1 Household water usage		•

Note:

- Indicator – Amount of nutrients in coastal and sea waters is only done for the territory of the Federation of BiH,
- Indicator – River floods; in the coming phases, it is necessary to define the manner of reporting on this indicator,
- The indicators in the area of water management may overlap with the indicators in the other sectors (since the collection of these indicators is the responsibility of water management institutions, if the same indicator appears in the other sectors, it is necessary to indicate that it is collected by water management institutions).
- The indicators which have already been established are listed in Phase I,
- The indicators which are in the development stage (collection of a sufficient set of data or those which require human and material resources for the development of trends) may be established in Phase II,
- The indicators established in Phase III are those requiring establishment or evaluation of monitoring and development of human and material resources for projections of trends, or those that are not directly related to CCA activities.

10.2. Area - Hydropower

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	1.1	HE1 Ratio of the monthly generation of electricity to the installed power	•	•
PHASE II – PARTIALLY ESTABLISHED INDICATORS	2.1	HE2 Ratio of the monthly generation of electricity to the streamflow	•	•
PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS	3.1	HE3 Change in the mean streamflow on the profile of hydroelectric power stations or on the profile of a water meter station (VS) representing the profile of hydroelectric power stations	•	

10.3. Area - Agriculture

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	1.1	KP9 Change in the mean annual air temperatures / Trends in the mean annual air temperature	•	•
	1.2	KP10 Change in the total annual precipitation / Atmospheric precipitation trends	•	•
	1.3	KP11 Standardized Precipitation Index (SPI)	•	
	1.4	KP13 Frequency of hail events / Number of hail days	•	
	1.5	KP14 Snow depth / Number of snow days	•	
	1.6	KP15 Number of hot days	•	•
	1.7	KP16 Number of extreme heat waves	•	
	1.8	KP17 Change in the mean monthly air temperatures	•	•
	1.9	KP18 Change in the total monthly precipitation	•	•
	1.10	KP19 Extreme precipitation	•	•
	1.11	KP20 Precipitation deficit	•	•
	1.12	KP21 Number of frost days	•	
	1.13	KP22 Number of rural households affected by drought	•	
	1.14	P7 Occurrence of diseases and pests on plants and animals		•

PHASE II – PARTIALLY ESTABLISHED INDICATORS	**2.1**	P4 Increase in area under irrigation / Irrigation water usage	•	•
	2.2	P5 Growing season of crops	•	•
	2.3	P6 Agrophenology	•	•
	2.4	P7 Occurrence of diseases and pests on plants and animals	•	
	2.5	TP5 Change in soil organic carbon content	•	•
	2.6	TP6 Change in PH land/soil reaction	•	•
PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS	**3.1**	KP6 Emissions of CH_4 (direct greenhouse gas)		•
	3.2	KP7 Emissions of N_2O (direct greenhouse gas)		•
		KP8 Projections of greenhouse gas emissions and sinks with a policy and measures		•
	3.3	KP19 Extreme precipitation		•
	3.4	P8 Crop water demand	•	•
		P9 Change in the crop yield / **Water-limited crop yield**	•	•
	3.5	P10 Share of agricultural land used for a productive and sustainable agricultural activity	•	•
	3.6	P11 Irrigation pressure on renewable water resources on Earth		•

10.4. Area - Forestry

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	**1.1**	Š1 Forest and forest land area	•	•
	1.2	Š2 Total logging volume and afforestation	•	•
	1.3	Š3 Burnt forest land	•	•
	1.4	Š4 Sustainably managed areas (international certificate)	•	•
	1.5	Š5 Salvage logging ('incidental harvest')	•	
	1.6	Š6 Forest health	•	
PHASE II – PARTIALLY ESTABLISHED INDICATORS	**2.1**	Š5 Salvage logging ('incidental harvest')		•
	2.2	Š6 Forest health		•
PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS				

Note:

- Indicator no. 2.5 – Salvage logging ('incidental harvest') is collected and reported on for the territory of the Federation of BiH, and for the Republika Srpska. However, in order to assess the degree of vulnerability of particular tree species in the Federation BiH due to the impact of climate change, and to get a clear picture of why a tree was removed from the forest as 'incidental harvest', it is necessary to keep a record of the causes of withering or damage to trees (wind breakage, snow breakage, damage to the crown and trunk of a tree due to the cutting of adjacent trees, due to diseases or pests, damage caused by wild animals, as a result of drought or natural death due to competitive relationships and a lack of light, or for other unknown reasons). Since the foregoing record has not been kept yet, this indicator has been moved to the group of partially established indicators – Phase II.
- **Recommendation:** The responsible Cantonal forestry companies which manage forests and forest land should keep a record of the causes of 'incidental harvest' and send reports to the relevant Cantonal and Federation BiH forestry administrations.
- Indicator no. 2.6 – Forest health is monitored in the territory of the Federation BiH as well. However, in order to ensure continuous monitoring of the forest health and vitality, primarily for the purposes of assessment of defoliation and discolouration, it is necessary to join the *International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests in accordance with the Convention* on Long-range Transboundary Air Pollution – ICP Forests Monitoring, which is implemented in 46 European countries. The Federation of BiH has not yet established the Coordination Centre for Forest Health Monitoring, which would be responsible for assessing the level of damage to forest ecosystems in accordance with the *ICP Forests Monitoring* methods and criteria. This process has been permanently carried out in the Republika Srpska in the last 5–6 years.
- **Recommendation:** It is necessary, as soon as possible, to start developing a single application at the state level for the admittance to the ICP Forests network (*International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests*). *The application should be prepared by the relevant Entity ministries of agriculture, water management and forestry of Republika Srpska and Federation BiH*.

10.5. Area - Environment

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	1.1	KP5 Emissions and sinks of CO_2 (direct greenhouse gas)	•	
	1.2	KP6 Emissions of CH_4 (direct greenhouse gas)	•	
	1.3	KP7 Emissions of N_2O (direct greenhouse gas)	•	
	1.4	KP8 Projections of greenhouse gas emissions and sinks with a policy and measures	•	
	1.5	KP9 Trends in mean annual air temperature	•	•
	1.6	KP10 Atmospheric precipitation trends	•	•
	1.7	KP11 Standardized Precipitation Index (SPI)	•	•
	1.8	KP12 Aridity index	•	•
	1.9	KP13 Number of hail days	•	•
	1.10	KP14 Snow cover, number of snow days	•	•
	1.11	KP15 Number of hot days / heat waves	•	•
	1.12	KP16 Number of extreme heat waves	•	•
	1.13	BR1 Public environmental awareness	•	•
	1.14	BR8 Area under protection	•	•
	1.15	BR11 Trends in density of populations of economically important fish species in watercourses		•
	1.16	Emissions of pollutants in the air (CO_2, NO_x, SO_2 and PM_x)		
PHASE II – PARTIALLY ESTABLISHED INDICATORS	2.1	BR2 Endangered and protected species	•	•
	2.2	BR3 Condition and index of endangered and protected species	•	•
	2.3	BR4 Population trends of selected species in protected areas		•
	2.4	BR6 Invasive alien species		•
	2.5	BR10 Genetic resources	•	•
	2.6	TP1 Land-use change	•	•
	2.7	TP3 Status of land cover	•	•
	2.8	TP4 Soil erosion risk		•
	2.9	TP5 Change in soil organic carbon content		•
	2.10	TP10 Land productivity		•

PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS	**3.1**	KP5 Emissions and sinks of CO_2 (direct greenhouse gas)		•
	3.2	KP6 Emissions of CH_4 (direct greenhouse gas)		•
	3.3	KP7 Emissions of N_2O (direct greenhouse gas)		•
	3.4	KP8 Projections of greenhouse gas emissions and sinks with a policy and measures		•
	3.5	KP19 Extreme precipitation	•	•
	3.6	BR14 Distribution shifts of selected plant and animal species	•	•
	3.7	BR15 Impact of climate change on bird populations	•	•
	3.8	BR16 Phenology of plant and animal species	•	•
	3.9	BR17 Vector-borne diseases	•	•

10.6. Area - Spatial planning

Indicator establishment phases	**No.**	**Title of indicator**	**Entity level of establishment of the Indicators**	
			Republika Srpska	**Federation of BiH**
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	**1.1**	PP1 **Number of spatial plans drafted taking into consideration the need for climate change adaptation**	•	•
PHASE II – PARTIALLY ESTABLISHED INDICATORS	**2.1**	PP2 **Change in the manner of use of land**	•	•
PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS				

10.7. Area - Economic aspects of climate change adaptation

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	1.1	SD1 Household water usage	•	•
PHASE II – PARTIALLY ESTABLISHED INDICATORS	2.1	BR9 Financing biodiversity protection and conservation	•	•
	2.2	TP8 Number of landslides	•	•
	2.3	P4 Irrigation water usage	•	•
	2.4	EA1 Number of households affected by floods	•	•
	2.5	EA2 Number of businesses affected by floods	•	•
	2.6	EA3 Economic damage due to floods as a percentage of the GDP	•	•
PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS	3.1	EA4 Economic damage due to droughts as a percentage of the GDP	•	•

10.8. Area - Human health

Indicator establishment phases	No.	Title of indicator	Entity level of establishment of the Indicators	
			Republika Srpska	Federation of BiH
PHASE I – PREVIOUSLY ESTABLISHED INDICATORS	1.1	LJZ1 Number of deaths (men/women) related to flooding	•	•
PHASE II – PARTIALLY ESTABLISHED INDICATORS	2.1	LJZ2 Number of deaths (men/women) related to excessive natural heat and cold	•	•
PHASE III – RECOMMENDATION FOR THE ESTABLISHMENT OF INDICATORS	3.1	LJZ3 Number of people (men/women) infected with contagious diseases related to climate change	•	•

UNDP in Bosnia and Herzegovina
Zmaja od Bosne bb
71000 Sarajevo
Bosnia and Herzegovina

Tel: +387 (33) 293 400
Fax: +387 (33) 552 330

ba.undp.org

@UNDPBIH

U N
D P

GREEN
CLIMATE
FUND