UN environment programme

Mediterranean Action Plan
Barcelona Convention

PAP/RAC

Strategic Guidelines for the Adaptation to Climate Change in the Neum Municipality

Coastal Area and Backland of the Neum Municipality

UNEP/MAP PAP/RAC
January 2022

CAMP
BOSNIA and
HERZEGOVINA

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Project: Coastal Area Management Programme – CAMP for Bosnia and Herzegovina

Document: Strategic Orientation for Adaptation to Climate change of the Neum Municipality

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Place and date: Sarajevo, January 2022

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GDP – Gross Domestic Product
GHG – Greenhouse gases
IPCC – Intergovernmental Panel on Climate Change
RCP – Representative Concentration Pathway

1. INTRODUCTION

Climate change is a major challenge faced by the mankind because they affect all aspects of environment and economy and threaten the sustainable development of the society. It is more recognized a fact that climate change affects the frequency and intensity of extreme events. The so far research has proven that the climate variability is more present in all seasons. Rapid and intensive changes occur in short time intervals – extremely cold weather followed by hot weather or extreme precipitation followed by drought periods. The adoption of a number of international resolutions and treaties confirms the scientific and political consensus that the climate change is taking place by far and large.

According to the data of the report by the Intergovernmental Panel on Climate Change *(IPCC*) from 2019, the global trend of temperature rise is by + 1.1 °C and if the greenhouse gas concentration continues to increase by current rate, the global warming is likely to reach 1.5 °C between 2030 and 2052.

The first consequences of the climate change are already visible in Europe and the world, and it is estimated that such consequences will intensify in the decades to come. Therefore, the climate change are not only a future problem, but something taking place now, which affects the traditional models of development and has serious economic effects. The new development model has emerged to help the eradication of poverty and sustainable economic growth, strengthening of social inclusion, improvement of human welfare and creating of employment opportunities, while maintaining the healthy functioning of the ecosystem of Planet Earth. At UN Conference on sustainable development which took place in Rio de Janeiro, Brazil, on 6 June 2012, the world leaders recognized the models defined by the term 'green economies'. Within the context of the climate change, the 'green economy' is seen as a concept based on the introduction of the following:

- measure of adaptation to climate change, including the preparation for adverse effects and using of possibilities which emerged as a consequence of climate variability and unavoidable climate change;
- measure of mitigation of climate change, reducing greenhouse gas emissions by improving energy and material efficiency and by introducing of renewable energy sources.

In Bosnia and Herzegovina (BiH) six of 10 recent years were very dry to extremely dry, and five years were characterized by extreme floods. In the period 2009-2018, almost every year had extreme weather conditions: floods in 2009, 2010, 2014, drought and heat waves in 2011, 2012, 2013, 2015, 2016 and 2017., waves of cold in early 2012, strong wind in mid-2012 and end 2017; extremely high number of days with hail in 2018. (the anti-hail system was on stand-by during 78 days, and during 43 days meteorological situation required the use of anti-hail shells, which is twice the average).

The climate change intensifies a series of other existing threats thus affecting the activities related to livelihood, infrastructure and economic activity. In broader development context, natural disasters mainly affect the vulnerable and marginalized groups. In summer 2012, intensive drought which affected BiH and generally Balkans, caused the drop of world production of crops, which led to soaring crops prices. In May 2014, catastrophic floods hit BiH. Although the events which led to the said disasters and catastrophes were mainly unpreventable, it is evident that good adaptation to climate change can largely reduce their effects. The focus of the management of natural disasters is the reduction of the risk of catastrophic consequences, and climate change should be incorporated into the processes of risk assessment and planning of risk reduction in BiH, with special emphasis on management of watercourses and building of multi-purpose accumulations, which would help the flood and drought management with the strengthening of capacities for early prevention and fire-fighting.

Climate change intensifies the need to effectively integrate the risk management into the development strategies. Economic implications, in combination with the risk of natural disasters caused by climate change, require the development of the effective strategy for the risk reduction and management. Without such strategy, climate change will directly affect the food production and safety, energy supply and household welfare. Climate change in BiH mostly affects agriculture and water resources, and the possibilities of adaptation are intertwined.

Adverse effects of climate change are already visible in BiH despite its slight contribution to global causes of climate change. Per capita emissions are equivalent to 7.25 t of carbon-dioxide per person (CO_2eq/per person) in 2014, which is by 17% less than the average of the countries of the European Union (EU). However, if compared to the relative wealth, emissions in BiH are almost four-fold higher than in the EU. In 2014, the greenhouse gas emissions per GDP unit in BiH were kg equivalent to 1.85 CO_2 per one Euro, while the EU average was equivalent to 0.39 kg CO_2 per one Euro. These statistical data illustrate the economic and social situation in BiH: caught in poverty trap, with relatively low GHG emission value, and even lower gross domestic product per capita, indicating the irrational use of the resources, first of all of energy.

Unlike many other problems in the area of environmental protection, the effect of climate change is not geographically connected with its causes. Therefore, although BiH is amongst the countries which have one of the lowest values of greenhouse gas emissions per capita in Europe, climate change has already been observed. BiH is especially sensitive to climate change due to its geographic position, economic importance of the sector of agriculture and forestry, and its limited capacity to adapt to climate change.

Therefore, it is of crucial importance to establish the effect of the climate change in BiH, the level of vulnerability and determine the action measures. In other words, it is necessary to strategically approach the process of adaptation to climate change and use the opportunity for application of innovative solutions for sustainable development. At the same time, transition towards low-emission development ensures the opportunities related to 'green economy', as well as mobilization and attraction of domestic and foreign investment in energy efficiency and renewable energy sources.

According to all climate scenarios, the number of hot summer days will increase by the end of this century. For the scenario called RCP8.5 the change of number of hot summer days significantly increases by further time horizons and for the period 2036-2065, it is up to 40 days more, in some parts 50 days more, while for the last period the change is most noticeable and equals 60 days, almost in the entire territory of our country.

According to all climate scenarios, the number of days with precipitation higher than 20 mm will mostly increase. The change ranges between +5 to +20% in the period 2036-2065 (in the majority of the territory of BiH where the change is positive) and up to -5% (in the parts where the change is negative). In case of scenario RCP8.5, for the period 2081-2100, this change is somewhat more prominent in the major part of the territory and equals to +20%, and in some smaller areas even more than +30%.

The number of successive dry days will mainly increase, except in some smaller areas of the territory of BiH. In near future (until 2036) the change according to all three scenarios of climate change in the majority of the territory is from 0 to 5% more of such days, while only in smaller areas the change is from 0 to -5%. For the scenario RCP8.5 the change of successive dry days will significantly increase for further time horizons for the period 2036-2065 and equals 10 to 20% more of such days, while for the last period this change is the most prominent and equals 20 to 30% more of such days, in the majority of the territory of the country.

Heat stress is the major problem in agriculture, especially in sub Mediterranean part of BiH. The problem is especially prominent in the last two decades and is most noticeable in the production of fruit, grape vine and most recently in the production of olives.

In 2013, the European Commission adopted the EU Strategy on Adaptation to Climate Change. The Strategy's goal is to make Europe more resilient to climate change. By application of the coherent approach and improvement of coordination, the intention is to enhance readiness and capacity of all administration levels to respond to impact of climate change.

The EU Strategy on Adaptation to Climate Change focuses on three key goals:

- Promotion of action of member states: the Commission encourages all member states to adopt comprehensive adaptation strategies and ensures financial resources to help them enhance adaptive capacity and undertake actions. It also supports adaptation in cities through the Covenant of Mayors for climate and energy.
- Measures of adaptation to climate change at the EU level by further encouraging of adaptation in the key vulnerable sectors, including agriculture, fishery and cohesion policy, while ensuring that the European infrastructure is made more resilient and promoting the use of insurance against natural disasters and disasters caused by human activity.
- Better informed decision making by filling the gaps in knowledge about adaptation and further development of the European Platform for Adaptation to Climate Change (Climate-ADAPT).

2. POSITION, BIODIVERSITY, RESOURCES, CLIMATE AND DEMOGRAPHIC DATA FOR NEUM

2.1. General spatial data

In the south, Bosnia and Herzegovina has a coast on the Adriatic Sea, surrounding the Neum-Klek bay. The coast is about 26 km long. The Adriatic Sea is a body of water separating the Balkan and Apennine Peninsula. The Adriatic Sea depression extends from the southeast to the northwest. The Adriatic Sea spans from the Strait of Otranto to the Gulf of Trieste encompassing 783 km of length, and from 87 to 210 km of width. In the southern Adriatic depression, where the Adriatic is widest, the sea is deepest and the maximum depth is about 1.330 m. At the far northwest, near the Gulf of Trieste, the sea depth is only 23 m. In general, the sea depth rises from the northwest to the southeast, which indicates the relief of the bottom of the Adriatic basin.

The area of the Neum municipality is 225 km^2 and is among the smaller administrative units in BiH. On the north, the Neum municipality borders with the Stolac municipality, on the west with the Čapljina municipality, and on the east Ljubinje and Ravno, while on the south it border with the Republic of Croatia and has access to the Adriatic Sea. As an administrative unit, the Neum municipality belongs to the Herzegovina-Neretva Canton. The position of the Neum municipality in BiH is presented in Figure 1. The Neum municipality is situated about 70 km on the south from Mostar and is the only town with the access to the sea in BiH. Regarding its geographic position, it has significant touristic value, as well as political significance since the coastline of more than 20 km in length makes BiH a maritime country.

Figure 1 Position of the Neum municipality in Bosnia and Herzegovina

The Neum municipality consists of 5 communities: Donje Hrasno, Gornje Hrasno, Gradac, Hutovo and Neum as the most populated one. Neum is an administrative buffer zone dividing the Republic of Croatia since 17th century as a result of the then political agreements. Within a bigger Mali Ston Bay, closed by the peninsula Klek, there is a Neum Bay. It belongs to the Adriatic Sea and is the only access of BiH to the sea. The Bay is 6 km long and 1.2 km wide. Neum has two border crossings with Croatia at D8 state road connecting the northern and southern Adriatic. The crossing "Neum 1" borders with Klek, and "Neum 2" with the place Zaton Doli. The European route E65 runs through Neum.

2.2. Climate Characteristics

Climate Characteristics in Bosnia and Herzegovina and Federation of Bosnia and Herzegovina

There are three different climate areas in BiH with more or less prominent boundaries, including:

- on the north – moderate continental, or Central European Climate
- in central part – continental mountainous, or alpine-like climate and
- on the southwest – Mediterranean or maritime climate.

The climate varies from moderate continental on the north with quite sharp winters and hot summers but, compared to alpine strip, the temperature range is lower between winter and summer temperatures. The central part of BiH is dominated by continental mountainous climate or alpine-like climate. The basic characteristic of this climate is sharp winter (absolute minimum temperatures are very low), while summer is hot. On the south of BiH, because of the vicinity of the Adriatic Sea, mean temperature January is relatively high (from 3.0 to 5.0 °C).

Depending on the altitude, there are transitional climate zones between the above main climate zones. Thus, from south to north, with increasing altitude, there are transitional zones, or altered Mediterranean climate, Mediterranean climate of foothills, or further to north, moderate continental foothills climate.

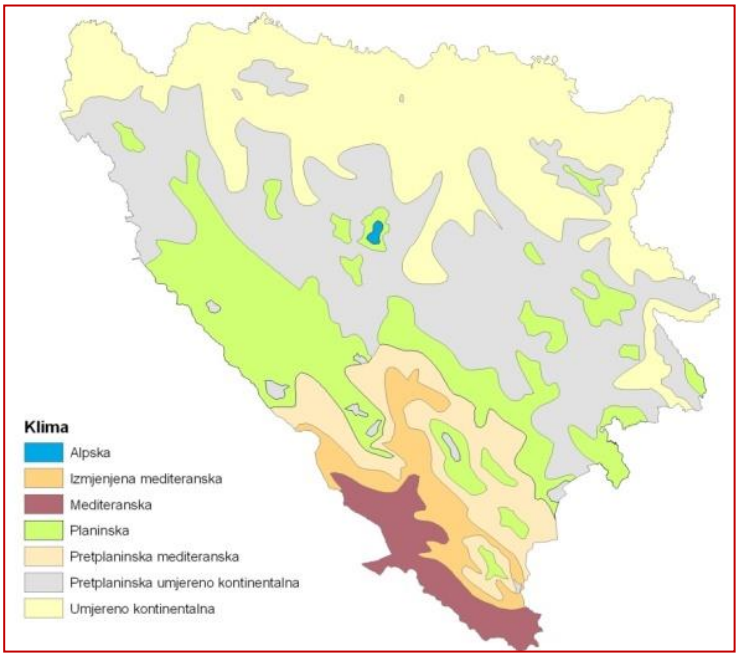


Figure 2 Climate zones in BiH

Climate Characteristics of the Neum Municipality

The climate in Neum is Mediterranean, with long, hot summers and short mild winters. Mean annual temperature is 16 °C. Neum is the warmest town in BiH alongside Trebinje and Mostar. Show is rare. Neum has about 260 sunny days in a year.

Typical climate conditions in Neum include long and warm summers and short and mild winters. Neum has a high number of sunny days which opens a possibility for investment in solar power plants. An average sea

temperature in winter is 13 °C, while in summer it reaches 32 °C on the surface. Favourable climate characteristics make the tourist season longer in Neum than that of the average coastal season.

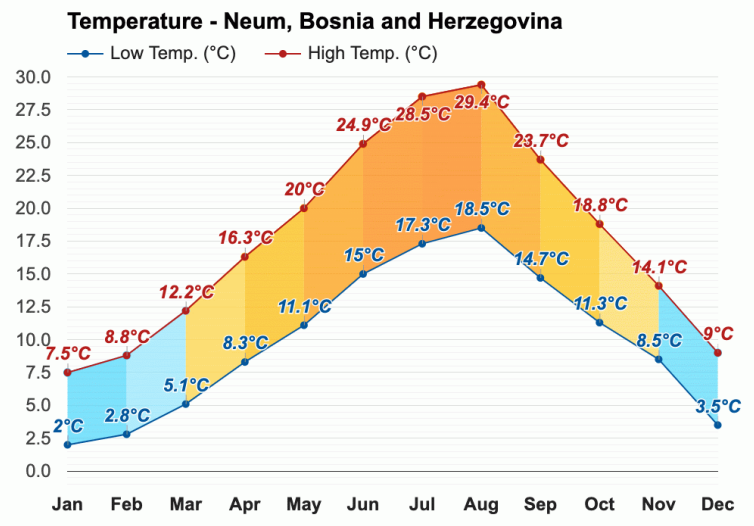


Figure 3 Chart of average air temperature for Neum

The warmest month is August with average maximum temperature 29.4 ^{0}C, and the month with the lowest temperature is January with the average maximum temperature 7.5 ^{0}C.

2.3. Population

According to the data of the 2013 Census of population, households and apartments in Bosnia and Herzegovina – Preliminary Results, the population of the Neum municipality is 4,960, which is about 2% of the population of the Herzegovina-Neretva Canton. According to the estimate of the Neum municipality for 2020, the population of Neum is 3,426. There is a total of 27 statistically registered settlements in the municipality, while the population of the centre of the Neum municipality as the only settlement with urban characteristics and on the coast is 3,013 in 2013 and 2,800 according to the 2020 estimate, while the remaining 26 settlements belong to the backland of the municipality.

The density of the Neum municipality (22 st/km^2) is very low compared to the average in the Federation BiH (92 st/km^2), or entire BiH (75 st/km^2).

Despite the developed tourism and recent favourable population trends, the Neum municipality has been depopulated like major part of BiH. According to the 1991 FBiH census, the population of the municipality was 4,325, and according to the 2013 census, the population was 4,653, and according to the 2020 estimate of the Neum municipality, the population was only 3,426. It should be borne in mind that the 2013 census data are not entirely reliable, since according to the information from the municipality, a lot of people resided in the Neum municipality during the census, although their real residence address was elsewhere. It is especially true about the rural backland of the municipality, where a lot of persons included in the 2013 census *de facto* lived in a settlement of Neum, in other parts of BiH or in Croatia due to the possibility of double citizenship.

2.4. Tourism

The development of tourism in BiH was connected to favourable climate conditions, and even now, the climate has a key role in the positioning of BiH in the world tourism market. Therefore, in BiH the climate is of great significance for the tourism because of the structure of the touristic offer, i.e. because most of the tourism flows take place in summer months when the greatest change and the longest sunlight periods are expected. In that context, the change of increasing frequency may seriously affect the development of tourism in BiH, especially the territory of the Neum municipality. Also, with adequate adaptation measures, such change may have positive effect.

Table 1 provides the number of overnight stays in the territory of the Neum municipality. The Table indicates the rapid trend of growth of the number of arrivals. In the period 2015 to 2019, the number of arrivals increased even by 63.9%. The share of international tourists had a somewhat higher growth rate. However, such growth does not follow the growth of the average duration of stay. Therefore, the frequency of tourists increases, which especially burdens the traffic infrastructure.

Table 1 Number of arrivals and overnight stays in Neum from 2015 to 2019

year	arrivals		overnight stays		% of foreign tourists		average duration of stay	
	total	foreign	total	foreign	arrivals	overnight stays	total	foreign
2015	81,000	68,000	218,000	181,000	84.0	83.0	2.8	2.7
2016	96,000	81,000	228,000	190,000	84.4	83.3	2.5	2.3
2017	113,000	97,000	265,000	223,000	85.8	84.2	2.6	2.3
2018	118,000	102,000	288,000	245,000	86.4	85.1	2.7	2.4
2019	132,760	115,913	292,773	247,976	87.3	84.7	2.7	2.1
growth 2015 - 2019 %	63.9%	70.5%	34.3%	37.0%				

Sources: For period 2015-2018. FBiH Institute for statistics, Federation BiH, for 2019, Report on work of the Tourism Association of the Herzegovina-Neretva Canton for 2021

According to the number of tourists and overnight stays, the Neum municipality is the second strongest tourist destination in BiH, right after the capital Sarajevo. According to the data from the Municipality, in 2019 there were 30 facilities of hotel type in Neum, including three major hotels of capacity of about 200 beds, and 198 private facilities offering the accommodation. The number of hotel beds was 3,186, and private accommodation beds 1,970, while the data are not available for other types of accommodation. Amongst the hotels, 7 hotels with 1,379 beds were 4-star hotels, 11 hotels with 1,425 beds were 3-star hotels, and the remaining 12 facilities with only 326 beds were facilities with two or less stars.

On the basis of the accommodation capacity and estimate of their occupancy rate, it is concluded that in high season the number of persons in Neum is more than three-fold. At the same time, day tourists are not taken into account. Such change imposes a big burden for the infrastructure, especially water and electricity supply and traffic infrastructure.

The tourism resources are defined as means of usefulness in the tourism of an area, and they are generally divided into natural and social tourism resources. The current situation of the tourism in Neum is characterized by the switch from domestic demand from former Yugoslavia to mainly foreign demand in the 21st century. Thus, before 1990, the share of foreign tourists and overnight stays was less than 30%, while in

2019, the share of overnight stays of foreign tourists in the registered facilities was 84%, and that of their arrivals was 87%. However, the share of domestic tourists and tourists from former Yugoslavia would be even higher if all overnight stays were registered, since the estimate is that due to language similarity and the same guests who come regularly for years in the same facilities, there are many more overnight stays which have not been statistically registered.

Table 2 Facilities for rest and relaxation in the Neum municipality according to the distance from the owner's residence in 2019

NASELJA / SETTLEMENTS	do100 km / up to 100 km	100-250 km	preko 250 km / over 200 km	UKUPNO / TOTAL
Urbana (grad Neum) / Urban (Neum itself)	135 (43,8 %)	114 (37,0 %)	59 (19,2 %)	308 (100,0 %)
Ruralna / Rural	85 (79,4 %)	4 (3,7 %)	18 (16,9 %)	107 (100,0 %)
Općina Neum / Municipality Neum	**220 (53,0 %)**	**118 (28,4 %)**	**77 (18,6 %)**	**415 (100,0 %)**

Source: FBiH Administration (2019); JP EP HZ HB (2019); Neum Municipality (2019)

Table 2 shows that the majority (about 56%) of facilities for rest and relaxation in the urban part of the Neum Municipality, or at coastal area, are owned by persons whose residence is at distance of more than 100 km. in the context of climate change, it is an additional challenge. Due to higher frequency of climate phenomena the maintenance of such facilities will be more demanding outside the touristic season. On the other hand, the period of use can be extended to the period after usual owners' vacation period.

The slowing of expansion of the constructing of "weekend houses" in the town of Neum, especially on the most attractive sunny coastal locations, can have positive effect on the development of the secondary housing in the rural backland.

2.5. Biodiversity of the Adriatic Sea

The Adriatic Sea is characterized by high biodiversity, including the outstanding biodiversity, many endemic species and specific habitats. Aquatorium of the Neum Bay is a segment of the overall Adriatic Sea, characterized by a certain biodiversity of habitats which enables the development of the diverse flora and fauna. With the maximum depth of 27 m, aquatorium in BiH is characterized by habitats with mainly sludgy and sandy type of bottom (Gajić & Lelo, 2014). The relief of the marine bottom in the part of the sea of Bosnia and Herzegovina is very dynamic.

According to the Guideline for types of habitats (2015), in the marine part of BiH, the following exists:

- Shallow sandy sea bottom always covered with water, existing in the northern coastal line of the Neum-Klek Bay.
- Big shallow bays and inlets. This habitat is the major part of the marine aquatorium in BiH. The only exception is the shallow sea coastal zones
- Rocky and stony Mediterranean coasts with endemic species of genus Limonium. This habitat exists along almost the entire coast, except in urban zones, where the original form of relief was anthropogenically changed and adapted to human needs.

Figure 4 Neum coastal area

The research of the marine part of BiH has shown that diverse flora and fauna lives in this part of the Adriatic Sea, although some of the research is incomplete and sporadic. Recently, a number of data emerged about the biodiversity of the marine part of BiH. Water quality, shelter from strong storms and specific combination of dissolved salts, conditioned the development of the outstanding biodiversity. Neum aquatorium is the adaptive zone with a significant number of marine invertebrates: molluscs, echinoderms, arthropods and Cnidaria (Gajić % sar., 2014). Also, data show that in this part of the Adriatic Sea, 414 species of diatoms live and are divided into 92 genes, of which 72 from the Pennales order, and 20 from the Centrales order (Hafner i sar., 2013). The data on species of cartilaginous fish which exist in this part are also complemented with the data on new species which have been registered.

Gajić (2012) says that the area of the Neum aquatorium is the ecological niche for some cartilaginous fish, including seven species of sharks and 5 species of ray fish and that it is an adaptive zone for 20 species of cartilaginous fish. In 2015, the first trawling research was conducted in order to learn about the biodiversity of the Adriatic Sea in the area of the Neum Bay. Also, in this part of the Adriatic Sea various species of fish and shellfish are farmed.

In addition to the above marine habitats, of high importance are the habitats which exist in the broader area of the Neum backland. According to the environmental impact assessment of the Klepovice-Neum area, the vegetation consists of the low shrub land of evergreen oak, Fraxino orni – Quercetum ilicis; maquis and gariggue, with many societies of the order Cisto ericetalia, which maintain the erosion level of the soil. Individual trees of Quercus ilexa exist in the southern parts closing the vegetation EU Mediterranean zone along with the ecosystems of the order of sand bluestem and butcher's broom (Cymbopogo – Brachypodietalia), typical for EU Mediterranean zone, going slightly towards the sub-Mediterranean zone, characterized by forests of downy oak and hornbeam. This type of forest shows a number of geographic variations in the form of low shrub land, low forest, underbrush, shrubs, dry lawns and rocky pastures. The fauna mostly consists of small and medium-sized game, and many birds which live in this area seasonally, and a significant number of birds which live here throughout the year.

Figure 5 Neum backland

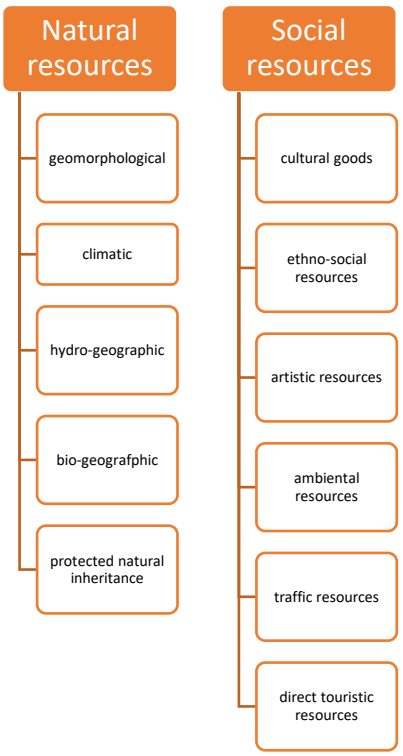


Figure 6 Division of touristic resources

Figure 6 presents the division of touristic resources. Neum is currently dominated by climate-related and direct touristic resources. Therefore, the adaptation to climate change is significant, but also the strengthening of other touristic resources in order to mitigate the potential loss of climate resources and achieve the synergy of various touristic resources.

2.6. Water

The Neum municipality is supplied with drinking water by the regional water supply system *Gabela –Hutovo-Neum*. When the system was designed in mid-1970s, the basis for the planning of the necessary quantity and the dimensioning itself was the plan of development envisaging a strong expansion of the so called "mass tourism" and construction of the large touristic complexes on the Klek peninsula and broader area of the Dubrovnik backland. The regional system *Gabela – Hutovo – Neum* is deigned in a way to supply water to the parts of the Čapljina municipality (settlement Dračevo, Gabela, Višići and other so called water supply system *Dolina Neretve*), settlement in Popovo Polje, today's Ravno municipality, part of the settlement in the backland of the Dubrovnik coastal line, Croatia – settlements Bistrina, Smokovljani, Visočani, Čepikuće etc., and the town Neum and all settlements of the Neum municipality. The system itself is one of the most complex systems of water supply in BiH, and beyond and it was planned to be able to supply at the end of the planned period Q=238 l/s of water for all above consumers[1].

Due to huge problems of the regional water supply system, the source Blace has been activated for the needs of Neum. This is the spring of small abundance with Q_{min}=15-20 l/s.

Due to lack of maintenance because of the insufficient resources, the regional water supply system *Gabela-Hutovo-Neum* is in quite bad condition and more resources are needed for its repair and proper functioning.

In summer months, during high season, the town Neum has an increased need for water. The study paper developed in 2011 envisaged that the maximum necessary daily water quantity in the water tank V. Neum 1 outside the touristic season in 2035 would be Q_{max}=28.55 l/s. The same study paper says that during the peak touristic season in 2020, the need for water will be 77.8 l/s, while by the end of the planned period, in 2035, the envisaged need is Q_{max}=101,55 l/s (Džeba, 2014). Therefore, during the peak touristic season the need for water is almost 4 times higher. It is a huge burden for the system in a sense of system capacity and management. The maximum need is in the period when the quantity of precipitation is lowest, i.e. in dry period, which further worsens the situation and creates the need for big accumulation of drinking water.

Table 3 provides data on invoiced water consumption in 2021. The difference between consumption in January and August is more than 7-fold.

Table 3 Water consumption by months – invoiced in 2021

Jan	Feb	March	Apr	May	June	July	August	Sept	Oct	Nov	Dec
m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
15,645	**16,655**	**16,409**	**23,777**	**29,200**	**64,890**	**94,841**	**117,254**	**57,524**	**30,715**	**17,019**	**21,392**

The populated places in the backland through which the regional water supply system *Gabela-Hutovo-Neum* is running, are connected to the same. The places through which the system is not running and which are not connected to the water supply system are the settlements Hrasno and Gornje Hrasno, Hotanj, Žukovice, Drijen, Cerovo, Borut, Kolojanj, Radež, Klek.

The number of connections or water meters registered in the system to which the invoices are issued is 2,220 (168 companies + 2052 private connections). It should be taken into account that sometimes the consumption from one connection/water meter e.g. in a condominium is shared by several consumers and several invoices are issued to the addresses of consumers/users, therefore their number increases. On the other hand, it can happen that one company, e.g. hotel has several connections at various locations (main

[1] O nama – J.P. KOMUNALNO NEUM (komunalno-neum.com)

water meter, garage, shower, sprinklers, offices, etc.) and is issued with several invoices for respective water meters.

Water supply disruptions occur sporadically when the pipeline accidentally breaks due to the network being worn out or when the foreseen repair is conducted. Then, if possible, the water supply is redirected from one reservoir to another in order to shorten the disruption period. The estimated losses in the system are about 70%. The Public Utility Company *Komunalno Neum* d.o.o. (Ltd.) has the regular monthly water analyses conducted by the Institute for public health of HNC. Two locations with two different reservoirs are sampled and bacteriological and chemical analysis is conducted. Analysis results show that water satisfies the parameters of drinking water. In case water fails to satisfy the parameters, additional chlorination is conducted and the system is further checked.

3. CLIMATE CHANGE IN NEUM

Climate change is defined as a status of climate characterized by changes of the mean value and/or variability of its features which persist for a while, usually for one decade or longer. Climate variability is defined as a variation of mean values of the status of climate in shorter intervals like months, years, or even decades. Most often, climate variability is attributed to natural phenomena, like for example El Nino and La Nina. However, even that definition started to change over time and the climate variability is more considered as a phenomenon related to climate change, or as a consequence of the anthropogenic activities.

The water of the Adriatic Sea is very movable. Warm sea currents penetrate from the Ionic Sea through Strait of Otranto. They move along the coast of Montenegro, Croatia and BiH, at speed of 7 km per day. The same currents return along the Italian coast, at speed of 14 km per day as cold currents.

Due to relatively small area, waves are lower on the Adriatic Sea than on the Atlantic for example. Bora and scirocco create biggest waves, while mistral creates smaller waves. Bora creates short and relatively high waves, up to 3.5 m, which makes the sailing quite difficult. Scirocco blows at lower speed compared to bora, but creates higher waves of 5 m. Because of their length of up to 30 m, these waves do not disrupt sailing.

Figure 7 Bay Neum-Klek, Bosnia and Herzegovina access to sea

Tide and ebb on the Adriatic Sea is not high and ranges from 30 cm in the southeast, or 85 cm in the northwest. The sea temperature is quite high. Therefore, the Adriatic Sea is one of the warmest seas. Surface layers of the sea water in autumn and winter are warmer than air above the water, while they are cooler in spring and summer. Summer temperature of the Adriatic Sea ranges between 23 and 32 ^{o}C, and winter temperature ranges between 11 and 13 ^{o}C. The Adriatic Sea is clear and transparent. The transparency is most prominent in the southern Adriatic, where the sea is deepest and least prominent in the northern part where it is reduced to 20 m.

The colour of the Adriatic Sea is intensive blue in the southern part, and light blue in the northern part. The Adriatic Sea has high salinity, up to 38‰ in the southern part, and up to 35‰ in the northern part. Sea water is more salty at open sea because of the distance of the confluence of big rivers.

The Adriatic Sea has enormous economic significance for BiH. The sea has important functions including: touristic, maritime, fishery-related, etc. In addition, the sea is an important political strategic factor. The most prominent manifestations of the climate change in the Neum municipality are:

1. Rising sea level,
2. Air temperature increase,
3. Changes in precipitation patterns,
4. Changes in wind patterns,
5. Increased sea salinity.

3.1. Scenario of rising sea level

The Second national report on climate change for BiH gives the framework assessment that the sea level of the Mediterranean will rise by the interval of 34 to 52 cm by the end of the 21st century. This rise would significantly threaten low coastal areas, i.e. estuaries, habitats and coastal sand. It has been determined that changes can be expected in physical, hydrodynamic, biological and chemical parameters. It has been emphasized that serious consequences on biocenosis of freshwater can cause warming of the surface water layer and deeper penetration of the low-salinity water into estuaries. It has been concluded that damage or extinction of certain coastal species can be expected due to erosion, and that the direction of change and impact on certain taxonomic groups is unpredictable. After the adoption of the Second national report, no detailed research has been conducted about the potential impact of climate change on the BiH marine coastal line.

The IPCC Fifth Assessment Report of the intergovernmental panel for climate change defines the new climate models and scenarios which treat potential rise in sea level by the end of this century. For each scenario, a certain regional scenario of rising sea level is determined. The results are based on scenarios published in the scientific paper Hinkel et al. (2014). These results take a wider range of uncertainties of ice melting than that in AR5, which led to somewhat higher projections of the increase of sea level compared to the IPCC Fifth Assessment Report. According to IPCC AR5 projections, it is estimated that the global sea level will rise by up to 0.98 m in the period 1986-2005 until 2100, according to the climate scenario RCP8. On the basis of this scenario, the air temperature, quantity of precipitation and intensive precipitation projections are made by the end of 21st century for the territory of BiH.

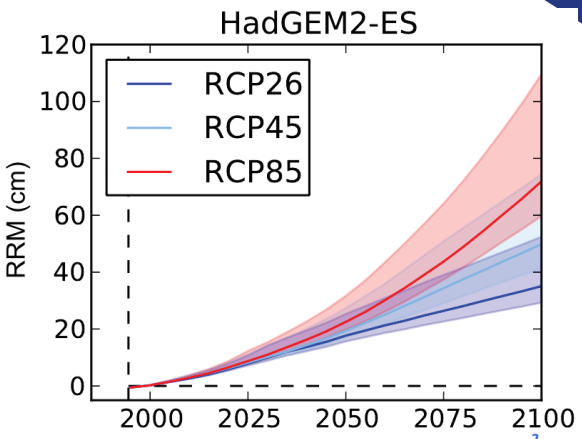


Figure 8 Designed increase of the global sea level[2]

According to Hinkel et al., a slightly higher increase of the sea level can be expected in relation to the IPCC planned projections. The research has been conducted for the area of the Croatian coast, and three climate scenarios were used for the potential increase of the Adriatic Sea level. The lowest scenario is -RCP2.8, in combination with the percentile 5% projection of ice melting (called low). The medium scenario is -RCP4.5 in combination with the median (called medium) and the highest scenario RCP8.5 in combination with the percentile 95% (called high).

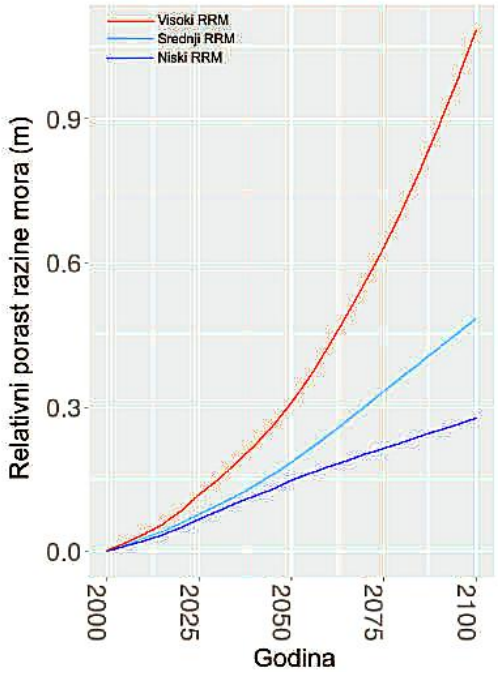


Figure 9 Average rise of the Adriatic Sea level for the three scenarios[3]

The highest rise of the seal level according to the most extreme scenario RCP8.5, may reach up to 1.1 m by the end of the 21st century. The same author did not take into consideration the natural depositing and increased depositing caused by the anthropogenic activities and ice melting. It is considered that the expected difference in the rise of the sea level, with the natural and increased depositing included, may

[2] Prema RCP8.5 scenariju (IPCC, AR5)
[3] Prema Hinkelu

range from 1.2 to 1.5 cm. Various degrees of ice melting may cause an additional rise of the seal level from 28 cm to 120 cm.

Table 4 Rise of the Adriatic Sea level, according to Hinkel, by 2050 and by 2100

Scenario	Rise of the Adriatic Sea level by 2050	Rise of the Adriatic Sea level by 2100
Low RRM	0,15 m	0,28 m
Medium RRM	0,19 m	0,49 m
High RRM	0,31 m	1,08 m

3.2. Scenario of increase of air temperature

The increase of air temperature will cause the decline of activities in the area during the warmest month, which may have impact on the tourism. The number of visitors may drop in high season due to heat waves and drought, while the climate in pre-season and post-season could become more attractive, which can have positive impact on the length of the touristic season. However, the increase of air temperature high season (July and August) will cause the overload of the infrastructure. This will be especially evident in electricity supply due to increased need for cooling. The water-supply system will also be overloaded due to increased need for water. In the backland, the increase of air temperature in combination with dry periods will increase the risk of fire. Therefore, the early fire alarm system needs to be constructed, as well as fire roads and fire-fighting equipment purchased along with the strengthening of human capacities.

3.3. Changes in precipitation patterns

Climate risks include torrent floods, coastal floods, droughts, heat waves, etc. Therefore, capacities for timely intervention and mitigation of damage should be ensured as well as the space for the accumulation of drinking water and fire-extinguishing water. Also, other infrastructure necessary for the adaptation to the changes of the precipitation patterns should be built. A heavy rainfall in a short period of time is also a characteristic of the climate change. The ground water drainage system often cannot receive all the amount of precipitation, so the roads are flooded and torrents pose risk to people's safety and may cause huge material damage.

3.4. Changes in wind patterns

Increased frequency and intensity of storms followed by thunderstorms with heavy, intensive precipitation and hail, often causes huge damage to property, agricultural and other civil facilities, traffic, and threatens human life. This change in itself is not so significant in Neum. However, in combination with other changes like heat waves and dry periods, it may have catastrophic consequences.

3.5. Increase in sea salinity

The Adriatic Sea has a high level of salinity, being 38‰ in the southern part, and 35‰ in the northern part. The level of salinity is higher at open sea due to distance of the confluence of big rivers. Due to accelerated circulation of water caused by climate change, the level of salinity will rise. With other factors, like rising sea level and increased intensity of winds, the coastal infrastructure will be more exposed to salty water. Such phenomena may cause the corrosion on metal parts of the infrastructure and consequently lead to higher costs for its maintenance and shorter life span.

3.6. Climate change impact on biodiversity

In addition to changes of the sea level, other phenomena may emerge due to climate change and may have direct or indirect impact on biodiversity. These primarily include the change of temperature and amount of precipitation, as well as the change of the salinity level. All these parameters have a significant impact on flora and fauna, spread of invasive species, fisheries and mariculture, while the consequences of such impact are difficult to establish. Disorders and long-term change have impact on biocenosis of the sea bottom and water bottom, thus disrupting biodiversity, especially in areas where the anthropogenic impact is high.

The complex impact of the climate change on the marine ecosystems is of special significance because it can be both positive and negative. On one hand, this change may bring about the arrival of new species in this area, which in economic terms can be positive, while on the other hand such species may occupy the ecological niches and their competition may pose threat to indigenous species. This may lead to changes in the composition of species and bring about the increase of the invasive species. Also, in synergy with environmental changes, this impact may bring about changes in migrations of the marine organisms, seasons and life cycles, growth rate and reaching full maturity.

Generally, changes of basic environmental parameters induced by climate change have the impacts on aquatic organisms regarding the following: number and distribution of organisms, time of certain life cycles, physiology and metabolism of an individual and food chain which has the direct effect on the trophic structure. This causes the changes of the time and place of migration of the sea fish, as well as the reproduction and development forms. The fluctuation of the number of sea fish is observed, which makes it difficult to plan the fishing (Dulčić et al., 2012). The same authors claim that in the Adriatic Sea the level of biodiversity of fish is increased from the north to south, while some species which populated the south move towards north, and temperature is claimed to be one of the factors.

The climate change is also related to the prolongation of the spawning period of the sardines, and the new locations of spawning which were not known before.

This is an indication that fish can evidence the on-going changes because the changing of their species distribution, the populating of the new habitats and the emerging of the new species are reliable indicators of the environmental changes, and together with climate change, they have such effect.

Accordingly, the spread of certain species towards north and increase of number of the southern species develop in several phases. First, adults appear. Then, spawn is reproduced, followed by the populating of an area (Glamuzina, 2010).

Thus, the increase of temperature is deemed to have significant effect on the increase of the population of some fish species – gilt in the Mali Ston Bay and bluefish at the Neretva confluence. Gilt causes damage to shellfish farmers, as they feed on mussels and oysters from the farm. Bluefish appeared at the Neretva confluence in the last 5-6 years, mainly feeds on mullet and significantly reduces the local fishermen catch and destroys the existing fishing tools. An increased number of these species is the direct consequence of the sea warming, which enables the migration of new fish species, prolongs the spawn period of the old warm-water species and better renewal of the offspring (Glamuzina and Dulčić, 2008).

Furthermore, the climate change causes the spread of various invasive species which emerge in the Adriatic Sea where they interact with the indigenous species.

Given the increasing number of the invasive species from the different system groups of organisms found in the Adriatic Sea, it is expected that some of these species enter the sea of the Neum Bay. Their rapid spread

in the Adriatic Sea and sudden increase of the population in the areas they entered could have certain impacts on the populations of the local organisms. The consequences of the entering of the invasive species could be serious and imply the reduction of the biodiversity and dysfunction of the food chain and entire ecosystems. Climate or sea temperature change is one of the reasons why some species managed to populate the places which are not their natural habitat.

It is worth noting that in addition to climate change, there are many other factors with synergy effect. These primarily include the irrational use of the living resources and non-compliance with laws, waste disposal, embankments and construction undertakings on the coast, pollution by wastewater, petrol and heavy metals.

3.7. Impact of climate change on mariculture

Climate change has enormous impact on mariculture, as one of the changing parameters is the water temperature. It is one of the factors which affect the physiological characteristics of fish, their metabolism and possibility of the adequate growth.

For species which have broader ecological valence, the rise of temperature will have positive effect including the prolongation of the growth season and reduction of the breeding cycle. According to Glamuzina (2010), this scenario relates to gilt (Sparus aurata) and Mediterranean mussel (Mytilus galloprovincialis). These two species are better adapted to higher temperatures and they favour the temperature of the Adriatic water. The only potential problem may emerge during the spawning period of the mussel, when lower level salinity is needed for the successful spawning, which could be limited due to lower level of precipitation in this area and the change of the inflow (Glamuzina, 2010).

Unlike the above species, the species which prefer colder water or have no possibility of adaptation to the increased temperature like the sea bass (Dicentrarchus labrax) and European flat oyster (Ostrea eduls), will face the problem in their breeding cycle due to the increase of water temperature. There is an organized farming of various fish and shellfish species in the Neum Bay, and it could be similarly affected.

4. VULNERABILITY OF THE AREA OF THE NEUM MUNICIPALITY TO CLIMATE CHANGE

The coastal area of the Neum municipality is the area with complex structure which is exposed to adverse effects of natural events like climate change and socio-economic events which significantly contribute to its vulnerability. The coastal area is mainly rocky and steep, thus mitigating the effect of the climate change. The coast is not exposed to high waves as it is sheltered from the open sea. The biggest part of the coast is occupied or planned for construction of residential facilities or economic activities which considerably increases its vulnerability. There are no sensitive constructions on the coast like cultural and historic buildings under protection, etc. The backland of Neum abounds with olive and vine plantations and is ideal for the development of agritourism.

The Second national report on climate change in BiH (2013) provides a rough estimate that the sea level of the Mediterranean will increase by the interval of 34 to 52 cm by the end of the 21st century. This increase would significantly threaten the low coastal area, including the estuaries, habitats and coastal sand.

It was concluded that certain coastal species could be damaged or exterminated due to erosion and that the direction of change and impact on certain taxonomic groups is unpredictable.

The fifth report by the Intergovernmental Panel on Climate Change (AR5 IPCC, 2013) defines the new climate models and scenarios which treat the potential increase of the sea level by the end of this century. Each scenario is followed by the corresponding regional scenario of the increase of the sea level.

In addition to changes of the sea level, other climate change induced phenomena may emerge which have direct or indirect impact on biodiversity (change of temperature and amount of precipitation which affects the salinity level). These parameters have significant impact on flora (low forests, underbrush, shrubs and dry lawns and rocky pastures), fauna (small and medium large game, many birds which live in this area seasonally, and many species which live in the area throughout the year), spread of invasive species, fisheries and mariculture.

The arrival of new species in this area due to climate change can be positive in economic terms, while on the other hand, such species may occupy the ecological niches and their competition may pose threat to indigenous species. This may lead to changes in the composition of species and bring about the increase of the invasive species.

In the backland of the Neum municipality, the most vulnerable activity is agriculture given the change of the precipitation pattern throughout the year. Such change may cause long-term drought and heavy rainfall in a short period. Due to the increase of the air temperature, the complete vegetation in the Neum backland is highly vulnerable.

5. SPATIAL AND DEVELOPMENT PLANNING FOR BETTER ADAPTATION TO CLIMATE CHANGE

The issue of overconsumption and irrational use of space is not a novice and is seen as one of the most serious issues of the system. This section provides a brief analysis of the degree to which the spatial planning system ensures conditions for a sustainable spatial development. Specifically, the following aspects of the functioning of the system will be analysed:

- Quality of the construction,
- Urban-planning processes and vulnerability of the coastal space,
- Spatial development planning.

Urban-planning processes and vulnerability of the coastal landscape: A lot of space between the construction zones of various purposes has a value and potential that is insufficiently recognized in the formal protection regimes or spatial plans. The preservation and shaping of this space is highly significant for the appearance of the coastal area and its touristic attractiveness. Inadequate use of this space, e.g. inadequate undertakings outside the construction area, will directly affect the quality of the touristic development and touristic positioning of the municipality in the tourism market in future.

Quality of the construction: The equipment and quality of numerous recently constructed buildings along the coast is unsatisfactory. Many parts of coastal settlements were constructed in accordance with the plan, but their content, form and equipment are unsatisfactory. The major cause for that, especially with respect to insufficient public space and content in the municipality, seems to be the lack of the land policy instrument. Another problem is the illegal construction, incompliant with the spatial plans, which devastated some of the most valuable coastal sites in the municipality.

Spatial development planning: Scattered economic structure in the municipality is the consequence of the insufficient capacities for the designing and implementing of the modern development strategy which would activate the available resources and space, thus unburdening the narrowest coastal area and enriching some of the backland. A rational development strategy, given the dependence on tourism and its activities, should emphasize the promotion of the preservation of the tourism attraction basis and its rational utilisation. The same applies to the preservation of land for the quality tourism projects, especially multipurpose hotels and touristic resorts. By better management of the economic tools, the development planning should facilitate the spatial planning decisions and resolutions related to the optimization of the quality locations for various human activities. This is particularly related to the valuing of the economic effects of various purposes of the space, especially from the aspect of the public interest (jobs, tax revenues, use of resources).

<u>Loss of beaches because of the urbanization of the coast</u>

The loss of beaches and coast is also the consequence of the changed dynamics of the sediment inflow from the coastal area/slopes. Rain and sunshine cause erosion on the coastal hilly areas. The erosion material, which emerges during heavy rainfall, together with water courses and torrents, moves towards the coast, thus making embankments and naturally renewing coasts and beaches. The intensive coastal urbanization, redirecting and regulating the torrents, construction of houses and other facilities on the coastal area, often reduces or completely stops this process. Thus, the natural transport of the material towards the coast is stopped; the balance of material/sediments is distorted on the coast and beaches gradually disappear.

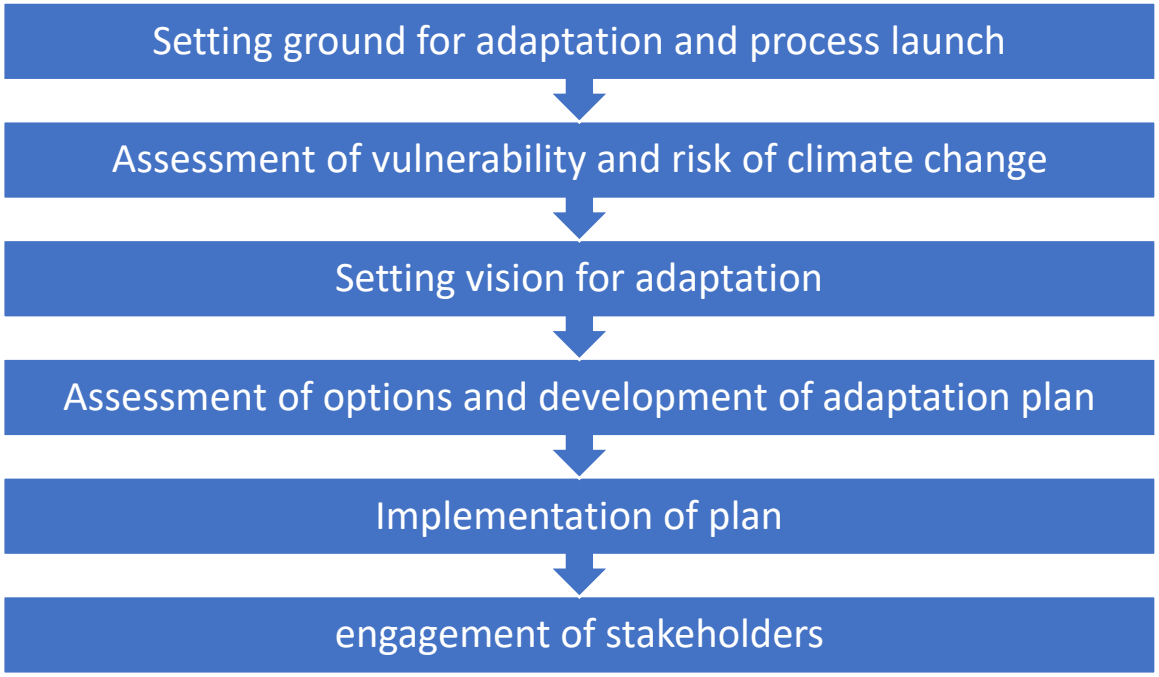
More intensive erosion on the coastal slopes is expected due to climate change because of the increased temperature and rainfall in shorter time periods. Therefore, the transport of sediments towards the coast will be potentially higher as well as the possibility of the natural renewal of the coast and beaches which get smaller due to the rise of the sea level and coastal processes. Of course, the transport of sediments will occur only if the sediment can be naturally (by water) transported to the coast. Sadly, the urban construction in the coastal line prevents these processes and prevents the movement of sediments towards the coast. Instead, the sediment is stopped at the edge of the coastal settlements and causes huge problems and damage there. Drain ditches get embanked due to rainfall, roads and urban areas get flooded and water drainage to the sea is slowed down. The consequential floods in the coastal urban areas cause huge damage in the settlements. The deposited sediment needs to be cleaned up and transported outside the settlement which incurs additional costs. Ideally, the deposited sediment should be transported to the coast where it should be. Thus, the material for the renewal of beaches would be on the coast after huge damage and high costs. The adequate solution of the drainage of mountain waters in the backland settlements could significantly eliminate these negative processes and enable the sediment to naturally reach the coast. As already said, the beaches should also be renewed in order to stop the natural processes of the transport of material towards the coast. Therefore, in this case the renewal of beaches is necessary due to intensive urbanization and climate change.

Until recently, the green areas in cities had mainly aesthetic role. The natural appearance and other positive impacts on humans and natural environment were not taken care of. The role of greenery in cities has not been considered so far from the aspect of the need for countering thermal islands, air pollution or floods. Nowadays, the role of the greenery has to be reconsidered in the cities. The vegetation is key for the maintenance of the moisture level, oxygen and carbon-dioxide balance in the atmosphere and basis for the development of fauna. Urban green infrastructure should consist of already natural and constructed areas, planned and maintained in a way that the entire infrastructure offers high quality in a sense of usefulness, biodiversity and appearance, while providing many services of the ecosystem. Regardless of the ownership or origin, all types of locations and individual elements characterized by the vegetation or water may become part of the green infrastructure (PAP/RAC, 2021).

The adaptation measures relate to the protection of nature and sustainable development of the society and economy, making economy, society and nature compatible in a country. The key role includes the directing of the development towards sustainability by means of economic subsidies, provided by state or otherwise (e.g., ecological fund, investment banks funding) leading to the possibility that the developed countries may fulfil some of their commitments by reduction of greenhouse gas emissions in other countries, countries which are not members of the Annex I of the Convention on Climate Change, through the clean development mechanism. BiH is very vulnerable to climate change and will be considerably exposed to threats of the climate change. BiH is also highly sensitive to these threats because of the economic role of the climate sensitive sectors like agriculture and tourism (and the role of hydro-power plants in the energy sector to a lesser degree) with significant secondary impact.

6. MEASURES OF ADAPTATION TO CLIMATE CHANGE

The high priority should be to launch the social process of accepting the concept of adaptation to climate change, establish the effects of the climate change and the level of vulnerability and set the priority action measures. In other words, a strategic approach to the process of adaptation to the climate change reality is necessary. Also, opportunities of the climate change should be used through the development and implementation of the innovative solutions for the sustainable development. The 2019 EU Green Deal sets the strategic approach to the resolving of issues of the climate change impact by adopting the new EU Strategy on Adaptation to Climate Change. It is important to ensure that the measures of adaptation to climate change also contribute to the greenhouse gas emissions. The measures of adaptation to climate change in the Neum municipality mostly relate to the economic sectors for the purpose of strengthening of economy due to the challenges caused by the climate change. The economic and other specificities should be taken into consideration while adapting to the climate change. The goal of the coastal plan of adaptation to the climate change is the synergy of the concept of development of new green deals and economy and the concept of circular economy in which the resources should be used to the maximum.



The coastal plan of adaptation to the climate change is structured as follows:

1. Identification of priorities – defined in 4 areas – with respective policies,
2. General measures for the territory of the Neum municipality – the measures mostly relate to the infrastructure and economic sectors in order to strengthen their resilience to challenges caused by the climate change,
3. Proposal of the coastal area management system from the aspect of adaptation to climate change.

Identification of priorities – four respective policies

The strategic guidelines for the adaptation to climate change in the Neum municipality determines the relationship between the policies and measures. Policy is defined as a certain guideline for the implementation of certain goals, i.e. set of actions for the implementation of such goals. The following four policies are proposed for the needs of this plan of adaptation to climate change:

1. Policy for sustainable spatial development,
2. Policy for sustainable economic development,
3. Policy for management of water resources,
4. Policy for strengthening resilience of the coastal area.

6.1. Plan of adaptation to climate change of the coastal area of the Neum municipality

Policy for sustainable spatial development

In the situation of deep social and economic crisis under pressure and when the practices of uncontrolled exploitation of space flourish, especially in certain construction areas, it is necessary to ensure that the utilization of space and its resources complies with the fundamental principle of sustainable development, and that future generations learn about and use in a sustainable fashion the inherited resources.

- Preservation of inherited natural, cultural, historical, aesthetic and other values,
- Preservation of heritage for the purpose of tourism development,
- Raising awareness about the importance of this area and diversity, especially among companies
- Operative plans of protection (fire protection, protection and rescue , environmental protection) should include the protection of landscape,
- Improve the quality of the existing construction.

Policy for sustainable economic development

- Strengthen resilience of the local economy to climate variability and change, or conditions of increased uncertainty.

Hot and dry summers will affect the attractiveness of the Neum area during the hottest month, which has the consequence on tourism. The number of visitors may drop in high season, while the climate in pre-season and post-season could become more attractive. That would mean that the touristic capacities would be better occupied during a year, and the employment would be prolonged. Proactive action in a sense of enriching the offer in pre-season and post-season should become one of the primary goals. It should be borne in mind that hot and dry summers will cause additional demand for water and electricity for the tourism sector. Also, more electricity will be demanded for the transport in the context of the increasing number of electric cars. As the touristic centre, Neum must work on the building of infrastructure for electric cars. The highest demand for electricity will coincide with the high season which will additionally burden the electricity supply system. In order to resolve that and to reduce congestion, reduce environmental impact, etc., it is necessary to develop public transport and infrastructure for non-motorized means of transport (walking, cycling, etc.).

Policy for management of water resources

- Water intended for water supply (water supply system) (irrigation, industrial needs, fire protection) should be efficiently distributed and used.

The public should be involved in the development of plans of adaptation to climate change. The protection of environment should be well-measured and should not jeopardize other water demands, especially the demand of the population and tourists. Therefore, the fire-fighting services, irrigation systems, etc. should develop tools for the efficient responding to the climate change. The efficient utilization of water in the touristic facilities should also be taken care of. Potential measures include efficient consumption of water by use of water-saving shower heads, system for monitoring of consumption and ranking of the hotel capacities according to their respective water consumption (e.g. water consumption per overnight stays). The municipality and other services must work in the field with farmers in order to demonstrate the efficient irrigation.

Policy for strengthening resilience of the coastal area

- Increase resilience, i.e. reduce vulnerability of settlements to extreme climate risks.

Climate risks include the rising sea level, torrent floods, coastal floods, drought, heat waves, fires, etc. of these the biggest threat is posed by forest fires, drought and heat waves. The interpolation of these three risks is the biggest risk because high temperature and dry periods increase the dryness of the fuel mass and reduce the relative air humidity, which worsens the fire damage. Therefore, the capacities for timely intervention and damage mitigation should be adjusted. These primarily include the intervention units (fire-fighters, rescue services, emergency medical service, etc.) tasked to act in case of risk. The development plans need to envisage the reconstruction of the coastal infrastructure and integral systems of drainage in urbanized areas under threat of torrent floods and coastal floods, in a way to adapt to the increased load they will face in future.

Table 5 Vulnerability and measures of adaptation to climate changes of the coastal area

	Tourism	Energy	Coastal area	Water management	Land
Aspects of impact	Reduction of potential/number of tourists in high season due to high temperature; increase of touristic potential during other periods	Changes in the pattern of the seasonal demand of electricity	Risk of erosion and soil deficiency due to rising sea level; increase of sea water temperature	Difficulties in water supply; changes of annual precipitation pattern, torrents	Failure of some ecosystems and species to adapt to rapid climate change; soil degradation due to changes of precipitation pattern, fires and torrent floods
Primary measures	Promotion of tourism development during entire year; introduction of the new content which is not exclusively related to marine summer tourism	Development of the renewable energy sources (production of electricity and heat); promotion of energy efficiency in buildings (especially energy necessary for cooling); strengthening the capacity of distribution of electrical energy in order to prevent the congestion and overload	Involvement in the programmes of coastal zone management in Croatia, building of infrastructure taking into account the expected rise of the sea level	Training in efficient water consumption and reduction of losses in the water supply system; building of water accumulation for water supply and agriculture; promotion of efficient water consumption (especially in the touristic facilities)	Implementation of the measures of nature protection in the entire territory; building of capacity for fire fighting, installation of early fire alarm system; strengthening of infrastructure for drainage Application of the conservation measures of land farming and proper use of Fertilizers in order to enhance land fertility and humidity conservation for better resilience of the cultivated plants to climate change
Secondary measures	Providing information to entrepreneurs in the tourism industry about expected climate change	Inclusion of the effects of the expected climate change during the development of annual and seasonal energy balances; installation of chargers for electric cars powered by solar plants with batteries	Reduction of anthropogenic impacts in coastal and marine areas	Strengthening the system of monitoring of water consumption and planning of available water quantity	Improvement of the legal system and implementation in the area of protection of nature, awareness raising

Table 6 Measures of adaptation to climate change of the Neum coastal area

Tourism
• Strengthening of the touristic offer beyond summer season • Strengthening of the offer beyond the segment "sunshine-sea" • Planning of energy demand in tourism in the conditions of the increase of temperature • Planning of water demand in tourism in the conditions of the increase of temperature • Designing special offer during the warmest period of day, e.g. ensuring shade on the beaches, squares, streets, etc. • Strengthening of health-care teams in the periods of heat waves • Promotion of measures of energy efficiency in the building and renewal of the touristic facilities • Introduction of the certification of the touristic capacities with respect to energy and water consumption • Adaptation of the stakeholders in the sectors related to tourism • Education and awareness raising about the importance of the sustainable tourism and adaptation to the climate change (media campaigns, workshops, panels, scientific-professional conferences) • Public awareness raising campaigns about climate change and public health, e.g. heat waves (big media campaign – TV, Internet, posters)
Energy industry
• Planning of energy system through assessment of the increased demand, and encouraging the local production given the oscillations caused by the climate variability and change • Continuous communication with the intersectoral coordination course, and reporting about the consumption and production of the electrical energy, especially in emergencies (heat waves, thunderstorms, etc.) • Promotion and development of the local energy production from renewable sources (on the distribution network), and energy efficiency measures • Checking of the energy distribution infrastructure, and stress testing during natural disasters
Water management
• Adjustment of the existing coastal facilities, breakwaters to the future rising sea level and extreme weather conditions, especially for the planned construction • Adjustment of the coastal urban infrastructure (roads, pipes, cables, etc.) to the future rising sea level and extreme weather conditions • Improvement of the drainage, treatment and wastewater discharge system, in accordance with the expected increase of temperature, precipitation and sea level, especially coastal discharge • Planning of the construction and renewal of the urban water infrastructure in accordance with the cumulative impact of the sea and local precipitation, in accordance with the expected increase of extreme weather conditions and sea level. • Drainage of the rainfall in urban areas, water retention and natural purification, makeover of brooks which retain water longer in the environment and retaining of the water wave of the mountain torrents with barriers or solid accumulations. • Defining the concept of management of urban rainfall water by imitating the natural hydrological cycle in the environment with constructions • Reduce water losses in the water supply system to the optimum level with the analysis of the possibility of the increase of the capacity of the water accumulation (water supply system reservoirs)

- Renewal and promotion of the use of traditional water supply systems (e.g. use of rainfall) where it is acceptable economically, socially and environmentally
- Implementation of the measures of the protection of environmental, coastal sea and people against pollution generated from the coastal settlements and areas, especially measures to respond in situations like flood or extreme sea condition
- Ensuring that waters inflowing from the urban water system (rainfall and wastewater and backland water) do not deteriorate the quality of the sea water and eco system in settlements
- Implementation of the energy efficiency measures of saving, and other activities in order to reduce the greenhouse gas emission generated by the urban water system and infrastructure
- Establishment of the local integral system of forecast, early alert, and assistance in protection against extreme weather, sea condition

Coastal area – terrain

- Construction at low parts of the coast, especially lower than 2 m, can be allowed only exceptionally, only on the basis of the analysis of the vulnerability of the specific location and by respecting specific conditions of the construction, and application of the measures of protection against the sea flooding and other disasters related to the rising sea level and extreme weather conditions
- Makeover and adjustment of the coastal line, beaches and walking trails to the future rising sea level and extreme weather conditions and waves
- Implementation of the measures (plan-related, operative, infrastructural) of sustainable use and protection of the coastal sea in order to reduce the adverse effect on the sea appearance and biodiversity (anchorage, berths, fishing, mariculture, recreation, navigable route, etc.)
- Ensuring sustainable use of the coastal natural resources by proper planning of development and implementation of the measures of supervision and offer
- Implementation of the measures aimed at protecting the natural coastal processes of erosion and transport of sediments, thus maintaining the environmental natural features of the coast and beaches
- Prohibition of constructing and modifying the coastal line which would alter the hydrodynamic features of the coastal sea, processes and features of the coastal ecosystems, especially in conditions of the expected change of sea level and storms
- Development of the cadastre of the coastal infrastructure

Spatial planning

- Preservation of the environmental heritage and open areas as key development resources and impeller of the present and future development, especially tourism
- Elaboration of the additional spatial and planning criteria and methods for a more active control of consumption of the coastal land for the urbanization, especially at locations of the increased vulnerability to climate change
- More active management of the spatial development, especially by control of expansion of the construction areas into the areas subject to restrictions (remote construction area outside the settlement) and expansion along the narrowest coastal line
- Establishment of the systems of measureable, quantifiable indicators for the strict monitoring of the consumption of the coastal land and coast, applicable at different levels of plans
- Establishment of the system of monitoring and evaluation of conditions and processes in the space and implementation of the planning documents, primarily for the coastal area of the municipality, by

the use of indicators and improvement of the IT support and IT systems

- Strengthening of competencies and capacities of the staff of the municipality and cantonal authorities which participate in the preparation, development and enactment of plans (programmes of professional development),
- Establishment of the additional coordination of the spatial planning and regional development system at cantonal level, by formulating common strategic development topics, objectives and solutions, resulting from the integral, multisectoral perception

6.2. Plan of adaptation to the climate change of the Neum municipality backland

Policy for the maintenance of the spatial development

- Create pre-conditions for the more efficient implementation of the spatial development at municipality level with a special emphasis on the monitoring and evaluation of the condition of the space and successfulness of the implementation of the spatial planning measures,
- The operative plans of protection (fire protection, protection and rescue, environmental protection) need to include the landscape protection,
- Improve the quality of the areas with the existing construction.

It is necessary to monitor and evaluate the condition and processes in the space and implementation of the planning documents (improvement of the IT support and IT systems). The strengthening of the capacities of the staff of the local authorities who participate in the development and enactment of the plans and awareness raising of all stakeholders should be a continuous process.

Policy for sustainable economic development

- Establish measures necessary for the preservation of biodiversity in the backland,
- Strengthen resilience of the local economy to climate variability and change, i.e. to conditions of growing uncertainty.

The protection measures should primarily include the constant monitoring of the quantitative and qualitative features of biodiversity in the backland. The loss of biodiversity is often irreversible process with adverse effect on the relationships in the ecosystem and individual industries.

Policy for water resources management

- The planning of investments and ensuring of funds for the investments in irrigation and drainage systems,
- Water intended for the use outside the water resources (irrigation, water supply, tourism, industry) should be distributed efficiently,
- The planning of investments in risk management regarding the protection against floods and drought
- The planning of investments in rarely populated and rural areas.

The goal of the water management is to establish the system of management and use of underground and ground waters, in order to reach the economic, social and ecological objectives.

Strengthening of the capacity of returning to original status

- Establish horizontal and vertical system to be able to respond to any risk posed to this area with a special emphasis on fires which threaten life of humans, property and landscape.

This group includes the measures for the spatial planning first of all by means of legal solutions which will encompass heliport, evacuation routes, fire evacuation and roads, natural and artificial accumulations and water sources. It is necessary to establish the surveillance system (video surveillance and observatory with the human crew) and alarm and provide the training of all protection system staff and raise awareness about the climate change and fires.

Table 7 Vulnerability and measures of adaptation to climate change in the Neum backland

	Tourism	Energy	Forestry	Agriculture	Water management	Land
Impact aspects	Reduction of potential in high season due to high temperature, and prolongation of season	Changes in the pattern of seasonal electricity demand	Loss of biodiversity due to climate change; increased risk of fire	Changes in the precipitation pattern. Changes in the seasonal air temperatures	Difficulties in water supply; changes in the annual precipitation pattern	Incapacity of some ecosystems and species to adapt to climate changes; degradation of the soil due to drought, erosion and fire
Primary measures	Promotion of tourism development throughout the year (e.g. cycling tourism)	Development of renewable energy sources for household own needs, promotion of energy efficiency, increase of resilience of the energy infrastructure to climate change (lines and transformer stations)	Conducting a detailed forest mapping; improved protection of forests against pests and plant diseases; construction and maintenance of the fire roads and strengthening of capacities (construction of heliport, purchase of equipment, etc.)	Inclusion of agriculture in the programmes of water management; construction of accumulations for the need of agriculture; use of modern irrigation techniques (drop by drop), application of land cultivation techniques with minimized humidity loss	Training of end users to efficiently use water and reduction of losses in the water supply system; construction of accumulations for fire extinguishing and agriculture (rainfall and torrents); training on land cultivation techniques with minimized humidity loss	Implementation of the nature protection measures across the territory
Secondary measures	Providing of information to entrepreneurs about the tourism industry regarding the expected climate change	Inclusion of effects of the expected climate change during the development of the annual and seasonal energy balances	High level of concern for the protection of biodiversity; Improvement of the fire protection system (early warning system)	Training of farmers on new technologies of land cultivation and irrigation; training on protection of goods against extreme heat; assistance to farmers to cover costs of insurance policies in case of weather-related disasters	Improvement of the water consumption management system; use of solar energy for limited pumping of underground waters for agriculture; development of the system for hydrological information	Improvement of the legislative system and its implementation in the area of nature protection

Table 8 Measures of adaptation to climate change in the Neum backland

Tourism
• Inventing the touristic offer in the backland (preferably beyond the touristic season "summer-sea") • Planning of energy demand in tourism in conditions of rising temperature and drought • Planning of water demand in tourism in conditions of rising air temperature and drought • Designing special offer during the warmest period of day, e.g. ensuring shade in the resorts and drinking water • Promotion of measures of energy efficiency in the building of the touristic facilities • Development of non-invasive tourism, makeover of the walking trails and bike paths in nature • Education and awareness raising about the importance of the sustainable tourism and adaptation to the climate change (media campaigns, workshops, panels, scientific-professional conferences) • Public awareness raising campaigns about climate change and public health, e.g. heat waves (big media campaign – TV, Internet, posters)
Energy industry
• Planning of energy system by estimating the increase of demand, and promotion of the local production given the oscillations caused by climate variability and change • Monitoring and reporting about the consumption and production of the electrical energy, especially in emergencies (heat waves, etc.) • Promotion and development of the local energy production from renewable sources, and energy efficiency measures • Improvement of resilience of the infrastructure for the electricity distribution (storms, torrent, etc.), and stress testing during the natural disasters
Forestry
• Inclusion of measures in the spatial planning and civil protection including the heliports, evacuation roads, fire roads, natural and artificial accumulations and water sources, access roads to critical infrastructure and forest complexes, etc. • Inclusion of preventive measures in the spatial planning in a sense of environmental protection, or impact of fires on environment, in documents, for the purpose of fire protection (type of vegetation, infrastructure and roads affecting fires and development of fires, forests and other open areas after fire and environment, standards on minimum area determined by fire roads, which forests and other open areas would be a priority for fire fighting and why • Establishment of the surveillance (video surveillance and observatory with the human crew) and alarm system • Education of all stakeholders of the protection system and awareness raising on climate change and fires, with a special emphasis on rural population and youth and the training of the command staff and local officials • Timely development and updating of the plans at all levels and operative documents to be followed by the operative teams according to the operative needs • Relevant inspections and other services (communal monitors, fire fighters,..) authorized to propose solutions in the field should strictly control the actions within their responsibility (fire roads, cleaning of the fire-protection line, readiness in days of high risk of fire, control of hydrants, prohibition of lighting fires, etc.)

- In accordance with legal obligations, found and train operative teams to respond in crisis situations
- Establish the way of financing the system necessary for every community, more including the touristic sector, in addition to other sectors, in the financing of the fire protection at the local level
- Exchange experience, skills and knowledge with other similar and related surrounding in Croatia and EU;
- Improving the system by joint applying for EU projects intended to improve the quality of prevention and operation

Agriculture

- Ensuring the resources and infrastructure for the irrigation of the farms
- Systematic monitoring of the changes in agriculture caused by climate change
- Networking of farmers and building of partnerships among farmers and scientists in order to ensure the continuous and easily available professional and scientific support to farmers in order to improve the resilience of the agriculture
- Encouraging the association of producers and institutional purchase of the locally produced food
- Ensuring the early warning system for farmers
- Preparation of plans for the rotation of crops due to climate change
- Promotion of insurance for farmers
- Protection of the agricultural land in the region and development of the local food production in order to reduce emissions caused by transport, and achieving the local food production independence
- Creating the bank of native seeds
- Forming the specialized programmes of education for the ecological agriculture
- International networking with the regions which implement good practices
- Introduce new agricultural practices adapted to climate change from the aspect of selection of species, varieties in order to improve the resilience of farms to climate extremes
- Educate farmers and official representatives of the agricultural institutions about mitigation and adaptation measures to climate change with the focus on floods and drought

Water management

- Improvement of the system of drainage, treatment and discharge of utility wastewater in accordance with the expected increase of the air temperature and change of precipitation pattern
- Planning of construction or reconstruction of the water infrastructure in accordance with the cumulative impact of local precipitation, all in accordance with the expected increase of extreme weather conditions
- Reduce water losses in the water supply systems to the optimum level
- Renewal and promotion of the use of traditional water supply systems (e.g. use of rainfall) where it is acceptable economically, socially and environmentally
- In the settlement makeover plans include the water sensitive designs
- Encourage the use of purified wastewater for the irrigation, watering, street washing, energy production by heat pumps and other purposes
- Ensure that water inflowing from the water system (rainfall and wastewater) does not deteriorate the quality of the coastal sea and ecosystems in settlements

- Application of energy efficiency measures, and other activities in order to reduce the discharge of greenhouse gases generated by the water system
- Establishment of the local integral forecast system, early warning system and assistance in protection against extreme weather conditions.

Other

- Preservation of the environmental heritage and open areas as key development resources and impeller of the present and future development, especially tourism
- Raising awareness about the importance of environmental values and diversity, especially among companies
- Improvement of the coordination of the spatial and development planning in order to improve the balanced spatial development of all parts of the municipality
- Strengthening of competencies and capacities of the staff of the municipality and cantonal authorities which participate in the preparation, development and enactment of plans (programmes of professional development),
- Establishment of the additional coordination of the spatial planning and regional development system at cantonal level, by formulating common strategic development topics, objectives and solutions, resulting from the integral, multisectoral perception

7. COST AND BENEFIT ANALYSIS OF THE ADAPTATION MEASURES

IPCC defines the costs of the adaptation to climate change which include the costs of planning, preparation, management and implementation of the adaptation measures, and transition costs. It also defines the benefits in a sense of avoided costs of damage or accrued fees after the adoption and implementation of the adaptation measures. In order to evaluate the benefits of the adaptation measures in relation to the baseline scenario, the expected climate change and costs of various options of the implementation of the measures are analysed. The adaptation measures usually do not completely eliminate the adverse effect of the climate change. Therefore, the costs of the remaining damage after the implementation of the adaptation measures should also be taken into account. After comparing options of certain measures, the options with the highest net benefits are chosen. For example, a fire protection measure can be implemented in different ways. Several options can be analysed for the construction of forest roads, purchase of certain equipment, training of people, accessibility of the extinguishing water, etc. The scope of the selected measure depends on the risk faced by an area and the magnitude of consequences that may emerge in case of an analysed event like fire, drought, electricity supply disruption, etc. It should be emphasized that measures are never implemented in order to reduce the damage risk to zero, since that would require enormous material resources.

Table 9 provides the cost and benefit analysis for the preparation and implementation of the most important measures of adaptation to climate change in the area of the Neum municipality. The costs are based on average unit costs of the measures and number of such units to be implemented. For example, the costs of installation of equipment for the collection of rainfall are estimated on the basis of the unit price of the system (household) and assumption that in the next 10 years in 500 households such system will be installed. The period of implementation of such demanding measures is 10 years, so the estimated costs should be taken for the same period. The costs include the costs of implementation, encompassing the phase of preparation, promotion and education of the target groups, and excluding the costs of system maintenance and control.

It should be noted that these are the rough costs and a detailed analysis of the baseline status should be developed for each measure and then determine the scope of the implementation of respective measures.

The total estimated costs are 17.25 million KM (for 10-year period). The costs can be financed from the municipality budget. The municipality budget should co-finance the said measures, and the basic financing tool should be the earmarked international funds for the adaptation to climate change. In that context, it is essential for the Municipality to cooperate with the higher levels of authority.

The implementation of the measures from Table 7 would considerably reduce the risks of climate change, i.e. the damage caused by extreme weather conditions and their direct consequences. The level of damage reduction compared to the scenario without the implementation of the said measures depends on the frequency and intensity of the extreme weather conditions. Therefore, their assessment is challenging.

Table 9 Analysis of costs and benefits of the most important measures of adaptation to climate change for the Neum municipality

	measure	description	benefits estimate	costs estimate (KM)
1	Reduction of losses in the water supply system	average water losses about 50%; first step detailed screening of water losses, based on GIS losses display, develop and implement the plan of replacement of critical parts of pipeline, installation of leak detection system, decrease of pressure, etc.	reduction of water losses to 30%, saving from water intake about 295.000 m3/y; saving of electricity about 600 MWh/god; reduction of the drainage and wastewater treatment system load; availability of water for other purposes	3,000,000
2	Improvement of rainfall management	reduction of status and capacity of drainage on critical spots, i.e. spots of local flooding during intensive precipitation, separating of the system of drainage of rainwater and wastewater where it has not been done, implementation of green infrastructure measures	improvement of safety, esp. in transport; reduction of damage, torrents and local flooding	1,000,000
3	Installation of equipment for rainwater collection	installation of equipment for rainwater collection in 500 households with water tanks on the coast and in the backland	collected amount of water 100 m3/y or 65 l/(st/y), reduction of water consumption from the water supply system esp. for farming needs	750,000
4	Strengthening capacities for fire protection	construction of fire protection routes and roads (costs about 50.000 KM/km), purchase of equipment for early detection, purchase of equipment for fire extinguishing	improved safety of the population, reduction of damage caused by fire, preservation of biodiversity, reduction of water consumption	2,500,000
5	Local production of electrical and heat energy	promotion and construction of solar plants(electricity) and solar collectors for heating sanitary water; development of study for entire municipality and audits of big touristic facilities; construction of chargers for electric cars with solar plants and batteries	reduction of peak load of electrical energy network, reduction of energy costs, more renewable energy sources and reduction of indirect greenhouse gas emissions	3,000,000
6	Improvement of efficiency of energy and water use, public transport development	promotion and implementation of measures of efficient energy and water use esp. in touristic facilities; use of efficient heat pumps for heating and cooling (based on use of wastewater), water-saving shower heads, etc.; ranking of touristic facilities with respect to carbon footprint	reduction of peak load of electrical energy network, reduction of energy costs, reduction of indirect greenhouse gas emissions	5,000,000
7	Improvement of the irrigation system in the backland	promotion and implementation of modular systems for irrigation powered by solar energy; rational water use (use of rainwater and used water); water tanks; education of farmers about the land cultivation with minimum loss of moisture and efficient irrigation	reduction of damage in agriculture due to drought with improvement of agricultural production, protection of biodiversity	2,000,000

8. GOVERNANCE

Governance encompasses the relationships among the institutions, processes and customs which determine in what manner the authority is implemented, decisions on topics of public and private interest are made, and how citizens and other stakeholders cast votes. Or in short – governance determines who has power, who decides, what other players do to make their voice heard and how the effects of the implemented decisions are assessed. Governance also includes the question how decisions are implemented, or tangible and intangible ways and processes necessary for the governance to be operative. In its essence, governance is also made of various committees and councils since they facilitate governance. The reality of governance is also a complex network of local conditions, understanding and disagreements, good and bad communication, with (good and bad) allocation of power and resources – which together make success and failure between policies and practice. Governance definitely isn't a short-term project. Namely, governance implies a long-term context; building of trust, rapport, support by local community, realization of agreed 18 plans and action programmes, and the existence of the consensual style of governance, which further evolved, beyond the political changes, a common and stable platform for building trust and partnership. Strengthening of governance for the climate action is the task which transcends the government structures and is intended to broad social partnership (PAP/RAC 2021).

The systematic approach of adaptation to the climate change includes the appropriate governance by the local and state level. The competencies for the adaptation to climate change in BiH have not been clearly and completely defined since the law on climate change has not been adopted yet. However, the Ministry of Foreign Trade and Economic Relations of BiH (MoFTER) is responsible for the affairs related to climate change at state level. MoFTER is responsible for tasks and assignments at BiH level of government related to defining of policies, basic principles, coordinating of activities and harmonizing of plans of the entity government bodies and international institutions in the area of energy, climate change and air quality.

The MoFTER Department for environmental protection within the Division for water resources, tourism and environmental protection performs the legal, analytical, expert-operative and IT-documentation tasks in the area of proposing of policies, basic principles, coordination and harmonization of plans of the entity and Brčko District tasks, and performs the coordination at international level in the area of environmental protection for BiH. The Department for environmental protection manages the activities related to the ratification of a number of conventions, agreements and protocols in the area of environmental protection and climate change.

The ministries responsible for environment are competent for this area at the level of cantons and FBiH.

The climate change is the issue which a government should not and cannot resolve on its own. The success of the 2020 – 2030 Strategy for adaptation to climate change and low-emission development of Bosnia and Herzegovina will depend on organizations, local communities and corporate sector which will get ready for the climate change and implementation of an adequate response. Government levels in BiH must cope with this problem, ensure leadership and support and a conducive environment and essentially cooperate with the partners in the local community, state authorities, and with international partners.

International experience has shown that development and implementation of strategies of adaptation to climate change is often restricted by a number of institutional complexities and horizontal issues. Government institutions were established at the time when the issue of climate change was of little importance. Due to its complex nature, the adaptation to climate change does not always fit in different

divisions, departments or ministries. In Bosnia and Herzegovina, the issue of climate change is still marginal for most of the institutions.

Institutions in BiH (and in other countries) face the challenges which reduce capacities of adaptation and possibility of implementation and further development of the adaptation strategy. The key problems are contradictory and duplicated mandates, poor coordination and lack of effective response. Below is the table of the system of governance related to climate change in BiH.

Administrative level/competence	Institutions
State level	
Participation in the work of the UN Framework Convention on Climate Change	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Umbrella coordination of activities of adaptation and measures of mitigation of climate change with potential donors and investors	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Submission of activities of the Nationally Appropriate Mitigation Actions (NAMAs) to register, reporting on NAMAs activities of adaptation and measures of mitigation of climate change	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry for Spatial Planning, Construction and Ecology RS
Statistics of greenhouse gases	Agency for Statistics of Bosnia and Herzegovina
Reporting according to UN Framework Convention on Climate Change UNFCCC and European Energy Efficiency Fund and EEA	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, Ministry for Spatial Planning, Construction and Ecology RS
Analysis of advancement of the Strategy and its updating	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
Entity level	
Integration of objectives of adaptation to climate change and mitigation of climate change into the development policies	Government of Republika Srpska, Government of Federation of Bosnia and Herzegovina and Government of Brčko District
Transposition of legal regulations and standards of the European Union	Ministry for Spatial Planning, Construction and Ecology of Republika Srpska Federation Ministry of Environment and Tourism Ministry of Energy and Mining of Republika Srpska Federation Ministry of Energy and Mining and Industry
Promotion of energy efficiency through energy efficiency agencies - EEA	Ministry of Energy and Mining of Republika Srpska Federation Ministry of Energy and Mining and Industry Government of Brčko District
Submission and coordination of activities of adaptation and measures of mitigation of climate change with potential donors and investors	Ministry for Spatial Planning, Construction and Ecology of Republika Srpska Federation Ministry of Environment and Tourism Federation Ministry of Spatial Planning Ministry of Energy and Mining of Republika Srpska Federation Ministry of Energy and Mining and Industry Ministry of Agriculture, Forestry and Water Management of Republika Srpska Federation Ministry of Agriculture, Water Management and Forestry Government of Brčko District Other relevant ministries
Monitoring, reporting and checking of the results of activities of adaptation and measures of mitigation of climate change - NAMAs	Ministry for Spatial Planning, Construction and Ecology of Republika Srpska Federation Ministry of Environment and Tourism

Administrative level/competence	Institutions
Management of the implementation of the activities of adaptation and measures of mitigation of climate change through appropriate institutes and organizations	Relevant entity ministries and departments in the Government of Brčko District Relevant entity agencies Eco funds
Regional, local and corporate level	
Development and implementation of the activities of adaptation and measures of mitigation of climate change NAMAs	Cantons, municipalities, agencies, public undertakings, companies, NGO
Integration of the objectives of mitigation of climate change into other activities and development plans (strategies of local development, LEAP, SEAP, etc.)	Cantons, municipalities
Promotion of energy efficiency	Cantons, municipalities, agencies for energy efficiency, public undertakings, companies, NGO

In order to facilitate the adaptation to climate change, the Neum municipality should integrate all aspects of adaptation in its development plans and clearly define measures. On the basis of that, it can request assistance from the higher levels for the financing, strengthening of capacities, promotion of best practice, etc. an important precondition for that is the designation of a department as a holder of the activity related to the adaptation to climate change.

9. CONCLUSION

The adaptation to climate change is a process of adjustment in response to expected long-term changes. Decisions on adaptation to climate change are not easily made due to the fact that climate change has a long-term impact, and the response is already due. However, the implementation of these decisions must commence long before the impact of climate change becomes clearly visible. This incongruence may adversely affect the decision making process, especially at local level, where the public opinion is often divided about the legitimacy of such decisions. Proposed policies include all main aspects of adaptation with recommendation that implementation of the decisions should start as soon as possible in order for their effects to be timely visible.

Climate variability is on the rise in the area of the Mediterranean, and its consequence is the increased number and intensity of unexpected weather events, for which the response readiness needs to be strengthened by an appropriate policy.

The most prominent impact of climate change in the territory of the Neum municipality is the rising sea level, increase of air temperature, change of precipitation patterns, change of wind patterns and increase of the sea salinity level. The above changes cause more frequent heat waves, drought, torrents, and fire and have adverse impct on biodiversity. Such phenomena put pressure on the existing water supply systems, health care, electricity supply system, etc. Therefore, climate change affects all elements of a society. Some of the recommended measures of adaptation to climate change of the coastal area and backland are:

- promotion of tourism throughout the year,
- adaptation of the construction on the coast taking into account the expected rise of the sea level,
- reduction of losses in the water supply system and encouraging of the rational water consumption by all consumers,
- increase of the capacity of drainage of rainwater and wastewater (especially on critical spots),
- installation of the early warning system for extreme weather conditions and fires in addition to the strengthening of the fire protection capacities (equipment and fire evacuation routes),
- construction of the system for irrigation and accumulation of water for agriculture,
- strengthening of the electricity distribution system in addition to promotion of the local production of electricity and heat with enhanced energy efficiency (especially in the touristic facilities).

The above policies and the corresponding measures aim at improving resilience of the coastal settlements and backland to both predictable effects of climate change and consequences of the unpredictable weather events and other adverse situations (floods, fires, drought, storms), which caused considerable damage in the Neum municipality in recent years. Also, it should be emphasized that this municipality is one of those areas which may expect the most severe consequences of climate variability and change. The improvement of the resilience of the coastal settlements and backland implies the improvement of resilience of both coastal and marine ecosystems and their ability to quickly revert to the original state after harmful events.

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