Meteorological Extreme events and their Evaluation Based on Climate Change Scenario

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Abstract

Extreme meteorological events are present in the downstream of Drini River. Regarding to the climate change scenario for Albania which leads to an increase of these extreme meteorological elements, review existing information is evaluated.
Trend of occurrence of meteorological hazardous for the time horizons 2025, 2050, and 2100 are evaluated based on climate change scenario for Albania.
Taking into account the increase of temperature, suggested from scenario, a decrease of number of frozen day <-5°C will occur. (Less than one day/year).An increase of about 10 day/year with the temperature >35°C by 2100 time horizons is expecting.
Another extreme event is drought. It has dramatically increased in the number and intensity in some parts of Balkan Region. Also an increase of the consecutive number of no rainy days is expected. The SPI index for Albania calculated in the frame of the project Drought Management Centre for Southeaster Europe (DMCSEE) financed by European Union through South East Europe Transnational Cooperation Programme shows that the drought is present in 13.5% of the years.
The impact of the meteorological hazardous in some of the key economic sectors is estimated too.

Key words: extreme meteorological elements (heavy rain, extreme temperature, strong wind,), climate change scenario, impact in some of the key economic sectors.

Introduction

The zone under the study lies on the north area of Albania along with the Drini River. The Drini River cascade area is wide spread, from east to west of Albania putting together an interesting topographic diversity such as mountains, gorges, fields, coast, seashore. It originates from Kukës up to the coast, to its delta (Fig. 1).

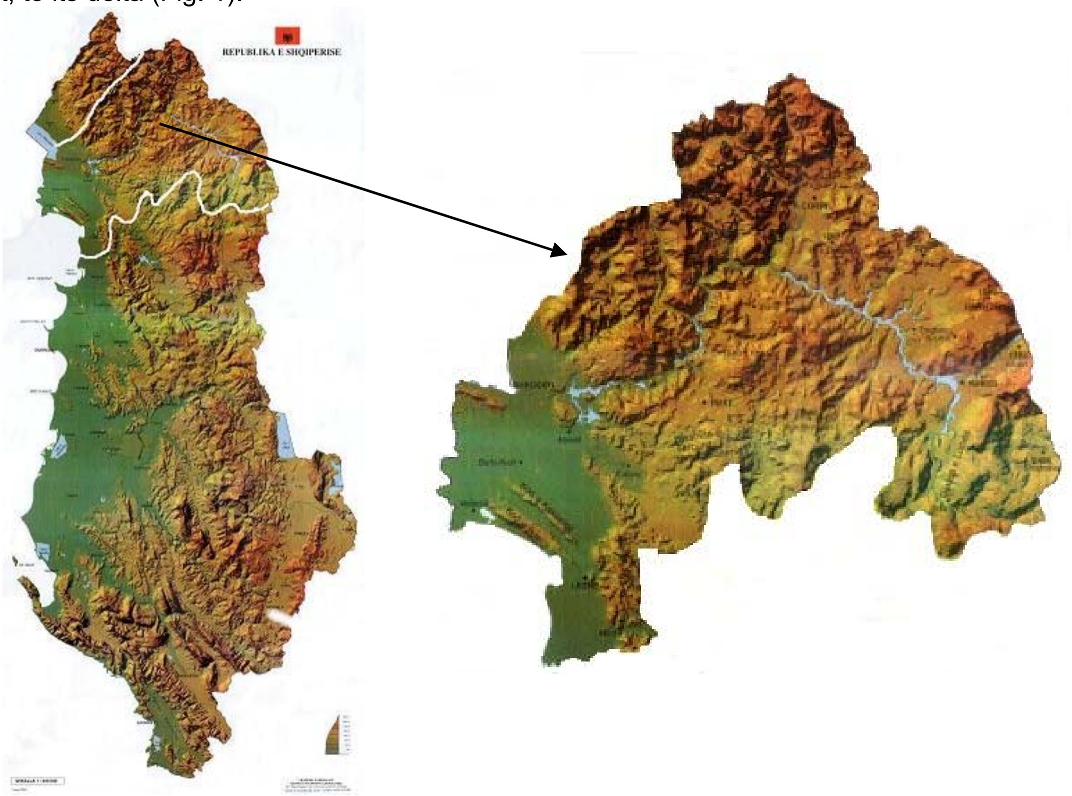

Figure 1: Map of the zone under study

Some climatic zones are included in it referring to the climate classification of Albania: North Mediterranean field and hilly zones, North Mediterranean Pre Mountain and mountain zones and East Mediterranean mountain zone. (IHM. Climate of Albania). The west Albanian Alps are not included in the analyzing of the extreme meteorological elements in this zone.

In despite of its small area a considered variability of climatic elements values does exist inside this zone. There are two main factors that create this variability: altitude over sea level and distance from the sea.

The climatic description is based on the data of all the stations, which are in and around this zone. The data series are as long as they can, starting from the beginning of the observation up to the year 2008

Climate regime

Temperature

The annual mean air temperature profiles a considerable variation. It varies from 8.9°C in inner part of the zone up to 15.4°C in mouth of the Drini River in Lezhe, while on the whole, the mean of this zone is 11.7°C.

To provide an evidence of the temperature variability during for the period 1961-2008, the trend of anomalies related to the respective norms for all stations representing this territory are analyzed.

The trend analysis of anomalies' series for the period 1961-2008 shows that in general annual mean temperature indicates a positive trend especially in the last decade In Figure 2 the yearly anomaly of mean temperature for Lezha station is given.

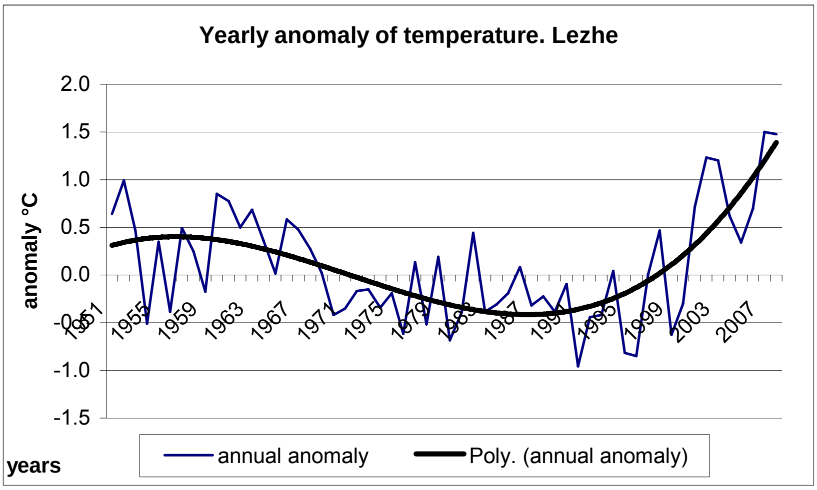

Figure 2: Yearly anomaly and the trend of air temperature (Lezha)

Air temperature extremes.

Meteorological elements and phenomena, according to their nature, may be classified in three groups.

a. The weather elements, which become adverse when they reach extreme values (for example: *maximum and minimum absolute temperature*, pressure).

b. The weather phenomena which occur temporarily and become adverse when their intensity exceeds certain threshold (for example: *amount of precipitation, wind*, drought)

c. The weather phenomena which are always adverse when they occur (for example: hail,)

Air temperature becomes adverse when it reaches extreme values (exceed certain thresholds). The further analysis in this section will be focused to the maximum and minimum temperature regimes.

The maximum air temperature varies from 35°C to 40.0°C in entire zone. The number of days with the air temperature exceeds the threshold 35°C is calculated for each year. The temperature over this threshold influences in the quality of human life as well as in the agriculture and other economy branches.

Taking into consideration the threshold >35°C for the entire zone is found out that the bigger number of such days are observed in the low altitude (up to 9 days/year) and the lower one in the high altitude (1days/year). It is obvious that the number of days with temperature > 35°C is more frequently during the last two decades (Fig 3).

In the fig.3 the polynomial trends is drown whereof we can see the tendency of the number of days with this extreme temperature. It can be seen that up to year 1980 the number of days with temperature>35°C has not been yearly phenomenon while after this year such temperatures are present every year, especially after the year 2000.

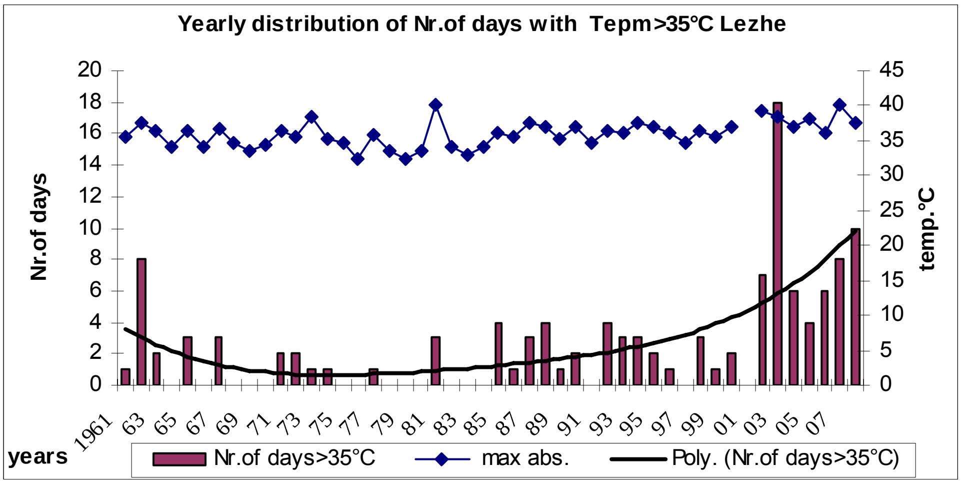

Figure 3: Number of days with temperature >35 ^{0}C and maximum temperature values.

As far minimum temperatures, the absolute value varies from –10°C in the low part up to –24°C in the mountain one. The number of days with minimum temperature ≤-5°C is very low in the lowland, on contrary in high altitude the number of days ≤-5°C is higher, up to 20 days/year. In last decade a lower number with such temperature is observed (Fig. 4).

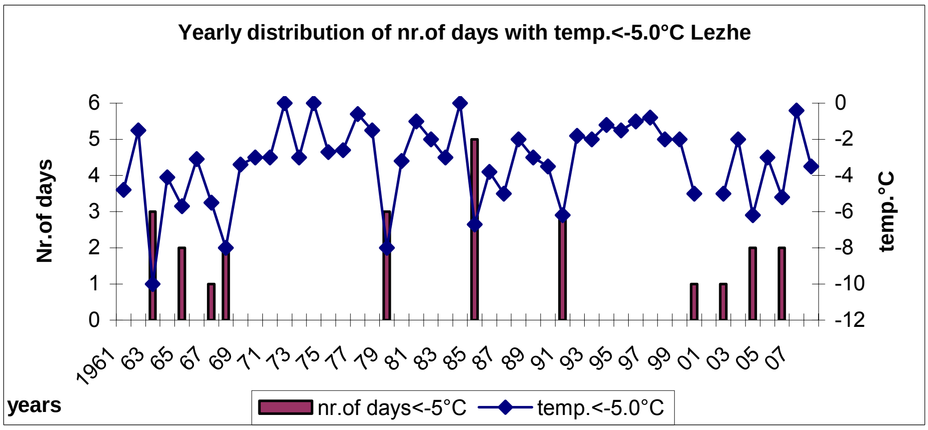

Figure 4: Number of days with temperature ≤ -5 ^{0}C and minimum temperature values.

Precipitation

The amount of precipitation observed in this zone varies in a wide range, from 910 mm in eastern part Kukes up to 2260 mm in the Iballe, while in the whole zone, the average precipitation is 1630 mm per year.

By precipitation anomaly (Figure 5) there are two different periods: the period 1951 – 1980 when predominate positive anomaly and period 1980 – 2008 when predominates negative anomaly. However, since 2000, the precipitation trend has started to increase up to the normal value. It is clear that the region is characterized by climate variability.

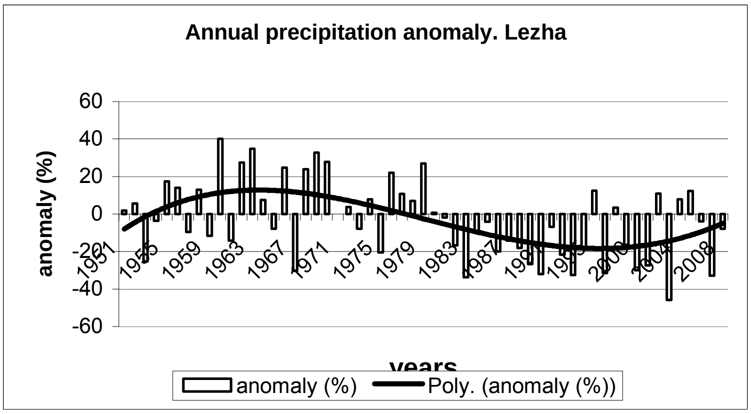

Figure 5: Annual anomaly and the trend of precipitation (Lezha)

Precipitation Extrems

Extreme events such as heavy rains and drought are not rare phenomena for this area. The impact of these phenomenons has significant consequences in all economic sectors and in the human life.

24 hours heavy rain

In general this zone is characterized by heavy rainfall. We can mention some of them as: Heavy rain on 2 October 1946 when in Shkodra region was observed 398.0 mm in 24 hours. This amount of precipitation caused the flooding a part of Shkodra city and the field around it. Other maximum values recorded are: 420 mm in Boge station (Albanian Alps) on 15.12.1963, Iballe 228.9 mm on 19.11.1969, Lezha 220mm 1970 and 219mm, September 2002., Shkodra station (345 mm/24h, 1995).

Referring to **(**Radinović, D. (1997).in climatological practices, the maximum 24 hours precipitation with a return period once in 10 years is considered as a threshold for heavy rain estimation.

Table 1 shows the mean number of days over the respective thresholds for some stations and the 24 hour maximum precipitation for every decade.

Table 1: The mean number of rainy days over the specific threshold & the max. 24h of precipitation.

Thre-shold	Kukes 47mm		Lezhe 77mm		Puke 100mm		B.Curri 80mm		Shkoder 110mm	
Decade	Nr.	Max.	Nr	Max	Nr	Max.	Nr	Max	Nr	Max
51-60	1	76.1	1.1	113.2	0.9	167			1.1	291
61-70	1.4	100	1.5	220	1.4	203.9	0.9	110.2	1.2	206.4
71-80	1.3	91.1	0.8	129.5	0.8	195.8	1.4	180.5	0.9	135
81-90	1	87.5	0.5	152.8	1.1	207	1.6	208.2	1	244.1
91-‘00	1.4	74	0.9	145	1.1	183	0.3	98	0.9	345
2001	0	26	0	66.8	0	67.9	0	66.9	1	120
2002	1	55.6	3	219	1	107.5	0	73	2	190
2003	2	75.2	1	95.4	3	310.7	1	87.3	2	148.5

Taking in consideration the respective thresholds for the entire zone is found out that in the last two decades there is no change in the frequency of heavy rain days.

In the Fig.6 is shown the time series of rainy days >110 mm for Shkodra station.

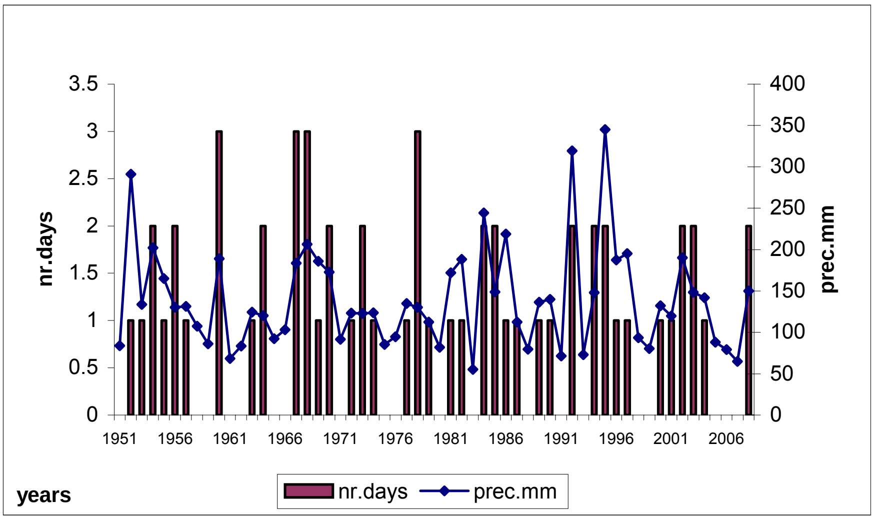

Figure 6: Number of days > 110mm and maximum values

Drought

Drought is a protracted period of deficient precipitation resulting in extensive damage to crops, resulting in loss of yield.

According to the DMCSEE project SPI index is used to evaluate severity of drought in this target zone. The SPI values for 3-months (**SPI**1) are presented in the table 2, based on the drought classification by SPI value. (Lezha city)

Table 2 Classification of Drought based on the SPI values

Classification	Extremely wet	Very wet	Moderate wet	Near normal	Moderate dry	Severe dry	Extremely dry
SPI value	**>+2**	**1.99 -1.5**	**1 - 1.49**	**0.99 -0.99**	**-1 -1.49**	**-1.5 -1.99**	**<-2**
SPI values % Lezha	2.6	4.9	9.8	69.0	6.9	3.3	3.3

As it can be seen from the table 69% of cases is near normal, 6.9% moderate dry, 3.3% severe dry and 3.3% are extremely dry.

The concurrency of cases with SPI3 <-1 (moderate, severe and extremely dry) for every decade is shown in the table 3.

Table 3. The cases of SPI3 <-1

Period	1951-'60	1961-'70	1971-'80	1981-'90	1991-'00	2001-'08
cases	18	7	11	23	19	20

These SPI values calculated for Lezha station point out, that period 1981-1990 has the maximum cases with drought follow by the last period 2001-2008. It can be said that the cases with drought have the increase tendency in the last decades.

In the figure 7 the 3-months SPI index is shown for the period 1951-2008.

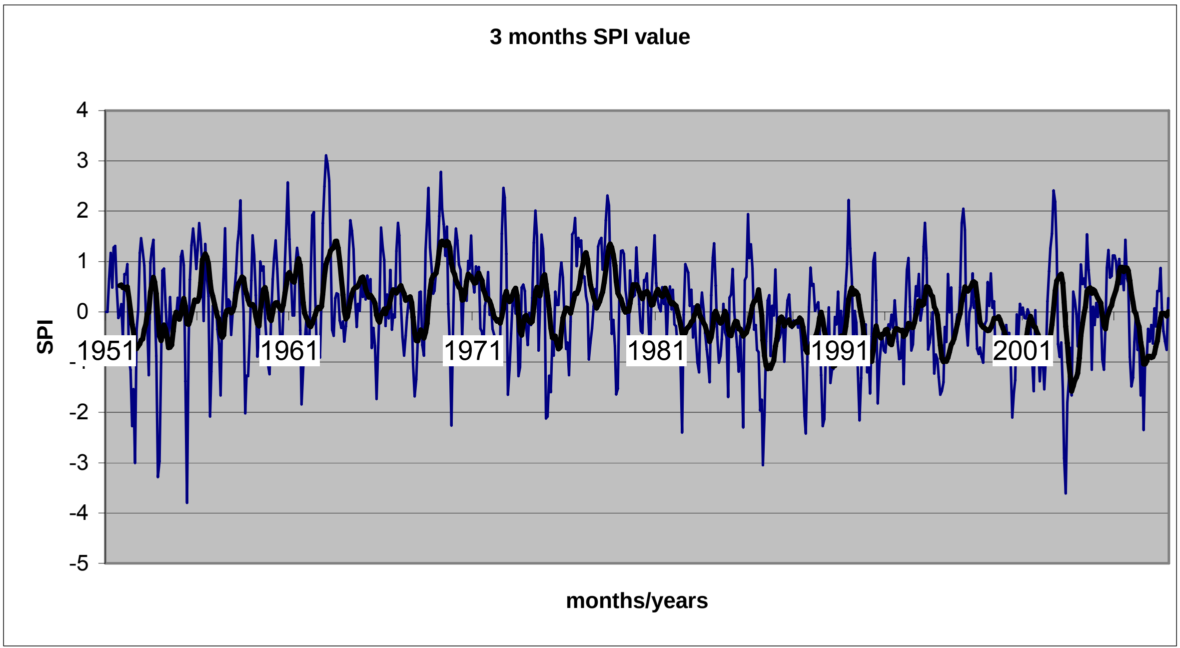

Figure 7. The distribution of 3-months SPI values. Lezhe

In this figure it can be seen clearly the meteorological drought based on the SPI classification index pointed in the tab.2.

There are almost 16 years with extreme dry as: the years 1952, 1953, 1955, 1956, 1958, 1969, 1975, 1982, 2985, 1986, 1989, 1990, 1992, 2000, 2003, 2007

Snow

By analyzing this climatic element it can be say that in the high zone during a year are observed about 21 days of snowfall while in the low part there are observed only 5 days per year.

Based on the statistical method the snow depth over 0.5m is choused as threshold for calling this element dangerous.

In the figure 8 is presented the maximum snow depth and the days with snow depth higher then 0.5m for Kukes station, which represents the inner part of this zone.

It is evident that the courses of maximum snow depth and the number of days with depth higher than 0.5 m have do fit well. By analyzing these figures it can be find out that after 1976 dangerous days almost do not exist as far snow depth is concerned. The year 1985 makes an exception (snow depth reaches about 150 cm and the number of days with depth ≥ 50 cm is about 66 days for the stations under study). Fig.8.

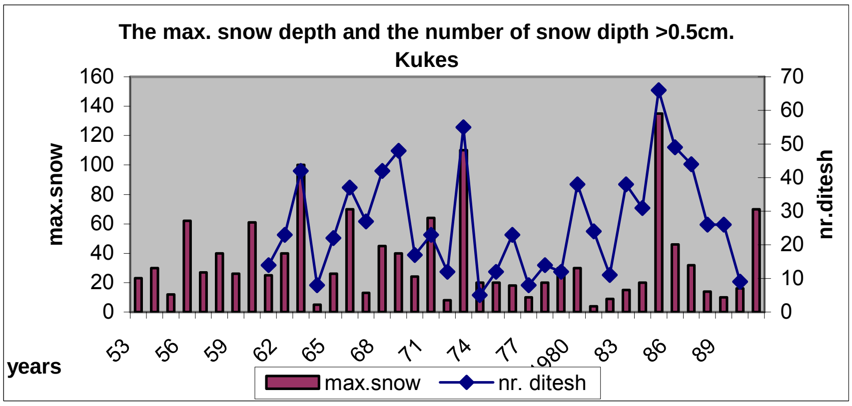

Figure 8: The maximum snow depth & the days with snow depth > 0.5m. Kukes

Expected impacts of climate change in occurrence of extreme events

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC, 2007). The world's average surface temperature has increased by around 0.74°C over the past 100 years (1906 - 2005). A warming of about 0.2°C is projected for each of the next two decades (IPCC, 2007).

Hazard evaluation based on scenario for Albania (Drini river zone)

Based on the scenario we are expecting for the winter months an increase of mean temperature up to 0.8°C, 1.7°C, 3.4°C and for the summer months up to 1.3°C, 2.8°C, 5.6°C for the time horizons 2025, 2050, 2100 respectively. Concerning the amount of annual precipitation, the scenario proposes a decrease up to 3.0, 6.1, and 12.4 % for the time horizons 2025, 2050, 2100 respectively.

Days with minimum of air temperature < -5°C

Taking into account these increases temperature, suggested from scenario, a decrease of number of frozen day will occur. Referring to the number of days <-5°C recording during the period 1951-2000 it is obvious that in the lowland especially in Lezha this number is very low (less than one day/year), while in inner part less than 15 days.

Days with maximum of air temperature >35°C

An increase of days with the maximum temperature >35°C related to the period 1951-2000 is expected to occur for different time horizons. Respectively for the time horizon 2025 is expected an increase of 3 days, for the time horizon 2050 is expected 6 days and 10 days for the time horizon 2100 is expected too.

Number days with intensive rain

Concerning the amount of annual precipitation, the scenario proposes a decrease up to 3.0, 6.1, and 12.4 % for the time horizons 2025, 2050, 2100 respectively.

It is expected an increase of about 1-2 days with intensive rainfall by 2025 time horizons related to 1951-2000, of about 2-3 days by 2050 time horizons, and of about 3-5 days by 2100 time horizons with these hazardous rainfalls.

Cases with Drought

Because of the good relation between drought event and precipitation an increasing of occurrence of severing drought is expected. Respectively by the time horizon 2025 an increasing of 2 cases per decade, by the time horizon 2050 an increasing of 5 cases per decade and by the time horizon 2100 an increasing of 9 cases per decade is expected.

The expected impacts in economy

Water resources

Some of likely impacts of climate changes in water sector are ordered as follows:

- A decrease in the long term mean annual and seasonal runoff for the Drini water basin
- Higher temperatures will shift the snowline upwards; the maximum reduction accounts for 30% and 66% respectively by 2050 and 2100.
- Sea-level rise can cause several direct impacts, including inundation and displacement of wetlands and lowlands, coastal erosion, increased storm flooding and damage, increased salinity in estuaries and coastal aquifers, and rising coastal water tables.
- Reduction in ground water supply in combination with increased salinity of the ground water supply will bring a shortage of drinking water in adequate quality.

Agriculture and Forestry

Climate changes are likely to have a substantial effect on plant growth, and by extension plant productivity. In general, temperature increases in spring and summer will accelerate the course of crop development more crucially on short-cycle crops that are sown in spring than on winter crops.

In forests and pastures, fires would be more frequent and more dangerous; also, many pests that might appear and prosper in the warmer conditions would be too much dangerous for some forest tree species.

Sea level rise

The likely enlargement of the lagoons' area is expected to increase the migratory birds staying capacity and would change their composition. A change in the water fauna and flora, in favor of the species that like more warmth and salinity, is likely as well.

Energy

Climate change could have significant effects on the energy sector. Rising temperatures, changes of the amount of precipitation, and variation in humidity, wind patterns, and the number of sunny days per year could affect both consumption and production of energy in the whole Drini River Area.

Population and tourism

The expected climatic changes (temperature increase), and sea level rise will largely influence the geographical distribution of the residence areas, population, their economic activity in general and tourism in particular (FNC).

- Increased frequency of extraordinary events (heavy rains, strong winds, droughts, flooding) might have a great influence in the settlement and tourists infrastructures.
- Coastal tourism is expected to suffer the vulnerabilities caused by sea level increase. The possibility for new beaches to create (in a natural way) does exist, but building a new tourism infrastructure would require huge investments (FNC).
- Referring to the scenarios for the sea level increase, a likely increase in losses of wetland area (around 1 km^2 by 2100), and as a consequence a decrease in total wetland area are projected.

Conclusions

In this zone the number of days <-5°C is expected to be very low (less than one day/year).

The number of days with the temperature >35°C is more frequently in the last two decades and is expected to increase about 10 days by 2100 time horizons.

An increase of the number of rainy days with hazardous rainfalls, about 3-5 days by 2100 time horizons is expecting.

An increase of occurrence of severe drought is expected by 2100 time horizon

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