ASSESSMENT OF CLIMAT CHANGE IMPACTS ON WATER RESOURCES IN THE VJOSA BASIN

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Projects in Albania concerning the impact of climate change on the hydrological cycle :

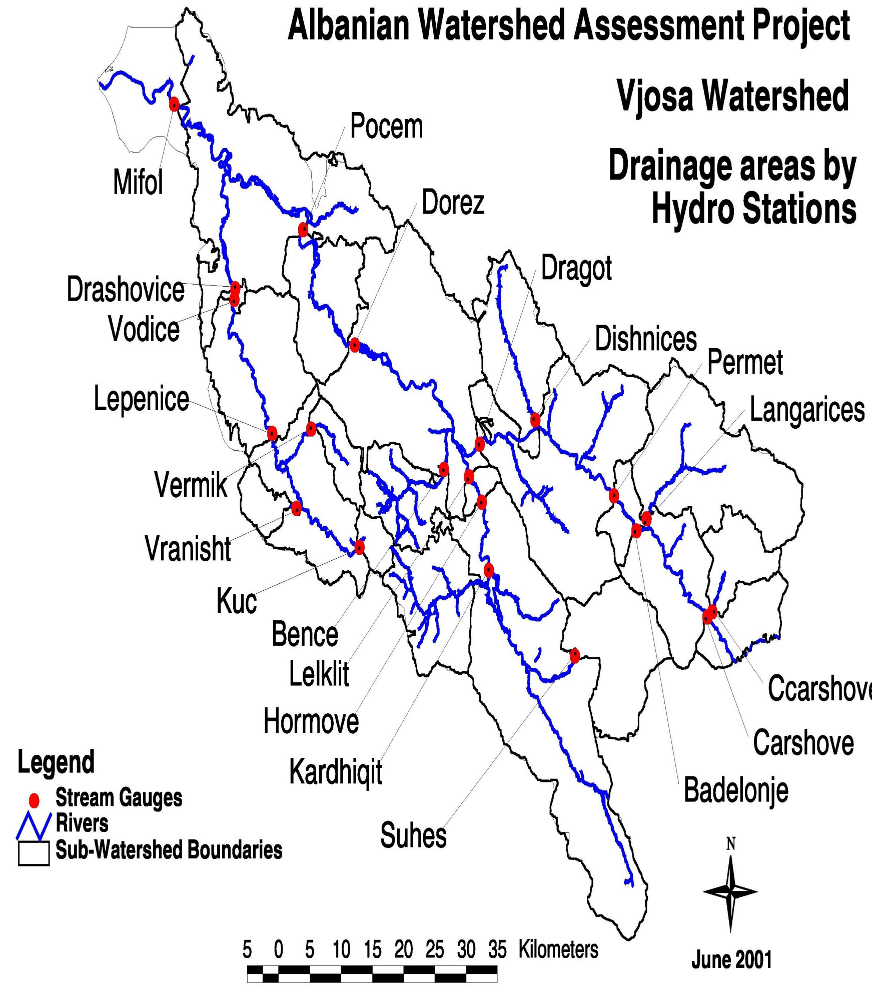
- ***Implications of climate change for the Albanian coast (*****MAP Technical Reports Series No. 98, UNEP, 1996*****);***

- ***Vulnerability assessment of climate change and adaptation options*** **(ALB/96/G32/A/1G/99)**

- **Assessment, of Climate Change impact on the Hydrological Cycle Elements in the South Eastern European Countries. UNESCO 2006**

Vjosa River basin

- The total area is about 8.100km²
- The Albanian part is of 6.706 km and a length of 272km from which only 2/3 of the entire basi is situated in the territory of Albania,the rest belongs to Greece.
- The largest tributary is the Drino river; a catchment's area of 1.320 km² of which 256 km² are situated in Greece
- The presence of deep karst aquifers, which assure an abundant underground supply during the dry season.



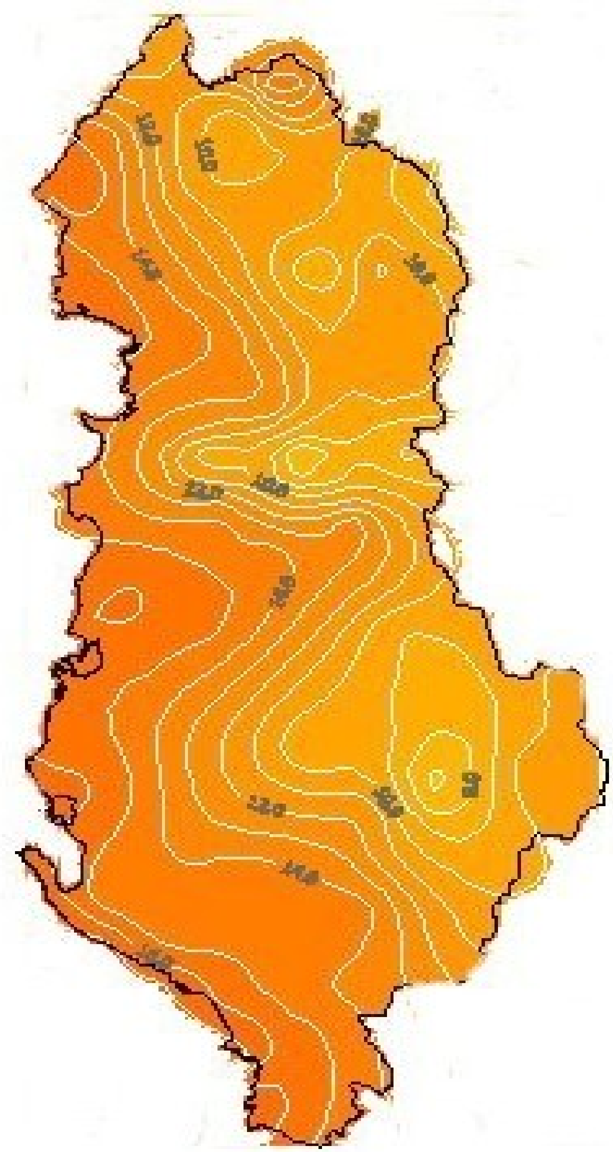
Present climate

A wide variation over the territory

- In the lower part the mean annual temp. varies from 15-16°C : July 23-24°C and January 6-9°C.
- Up to 500m a.s.l the annual temp. 12-14°C: July 20-24°C and January 6-9°C.
- Over 500m a.s.l. the mean annual temp 8-10°C: July 20°C and January 1-2°C.

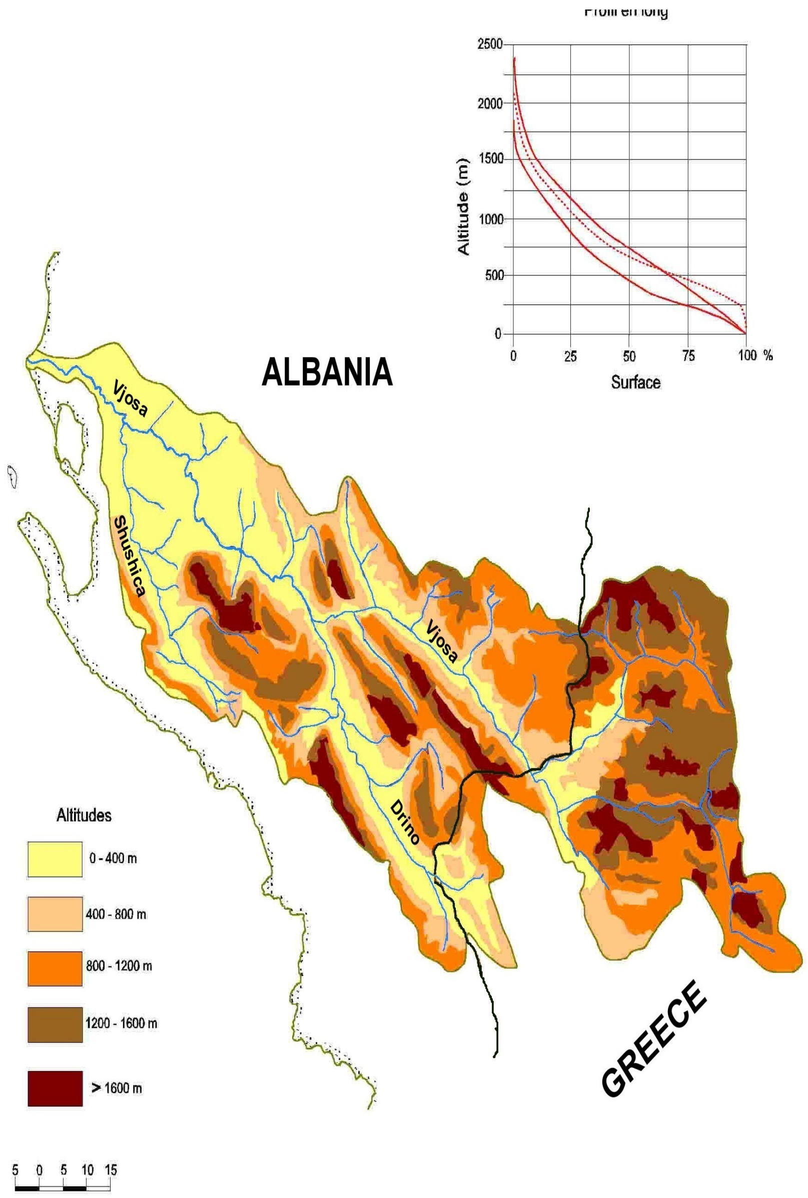
-The mean annual temp. varies from 7°C over the highest zones up to 15°C on the coastal zone;

-July 20°-24°C and January 1-2°C to 6-9°C



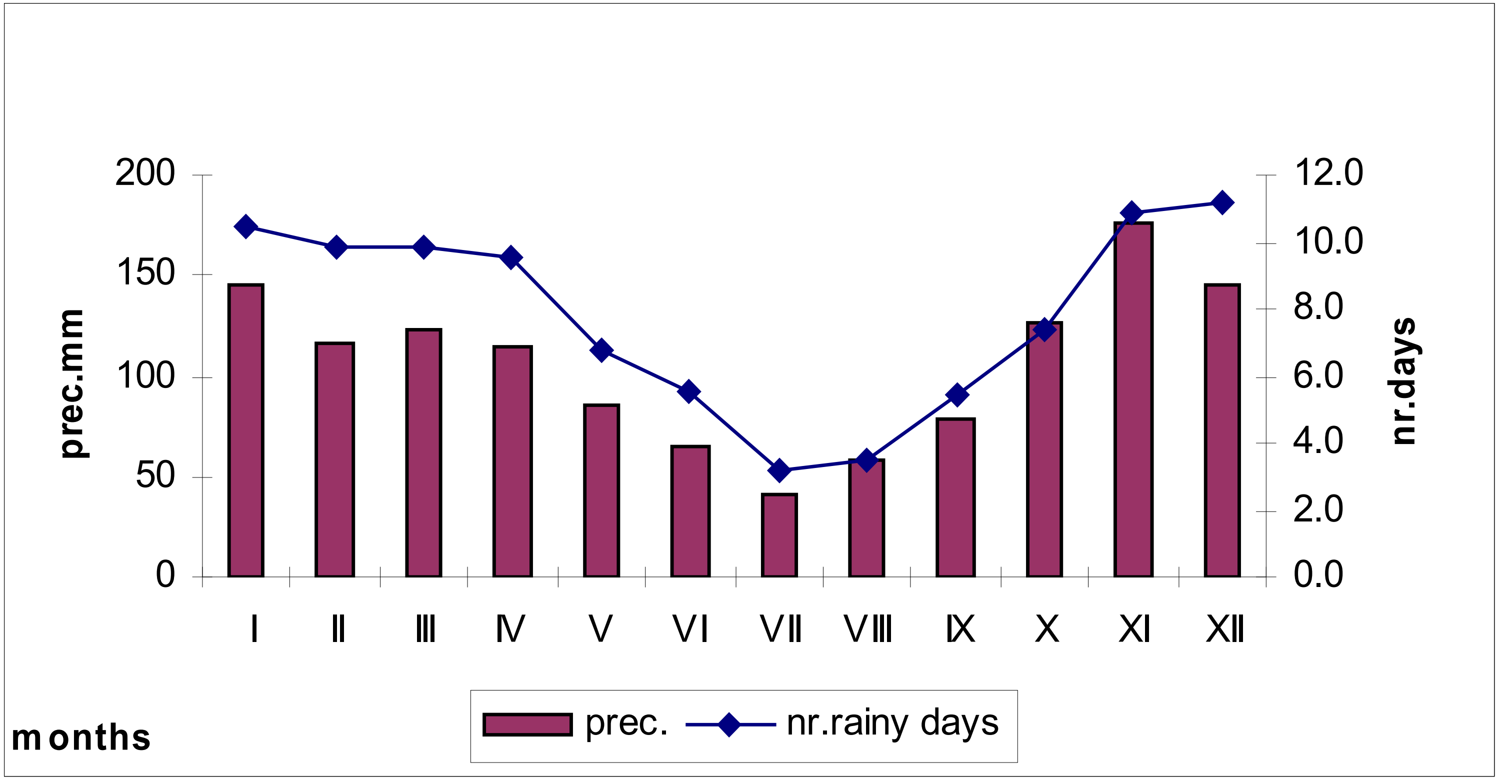
Present climate

- The Vjosa basin receives a big amount of precipitation, the highest in all the south Albania.
  - In the upper part of the basin this amount is 1387 mm, and during the summer, around 106 mm.
  - The mountains receive over 2500mm of precip. and these part of the basins have a significant influence in water flow and in its water regime.



Distribution of total precipitation and the number of days with precipitation

- During the summer 7 to 10% of the A.A and during the winter more than 50% of it.
- The precipitation during the winter time is in the form of snow.
- The annual precipitation on the basin is estimated to be around 1670 mm.



Hydrographic characteristics

- Annual discharge volume: 5,550 million m^3
- Specific discharge: 26 $l/s.km^2$
- Ratio wettest month (February) to driest month (August-September): 7.3, a low value for a river without regulating structure One in 10 year high flow: about 21 times the river module
- In this hydrographic basin there are a big number of springs some of them with a very strong impact in the water resources of the basin.

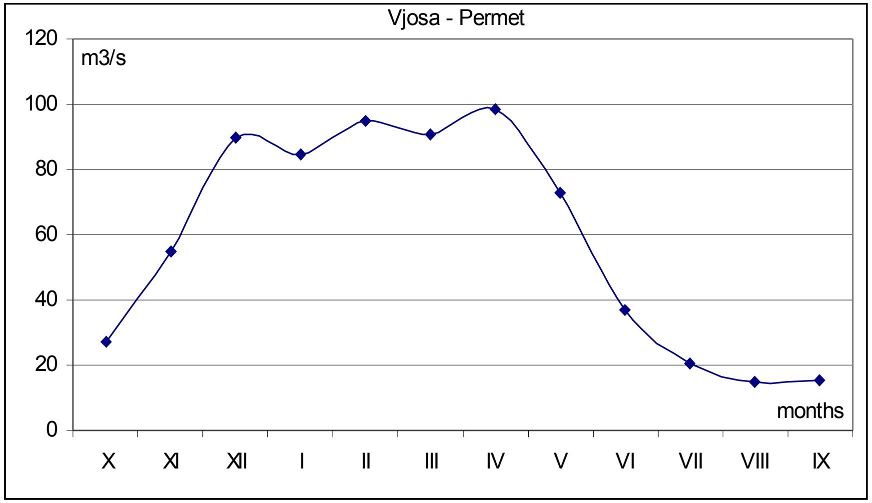
Hydrographic characteristics

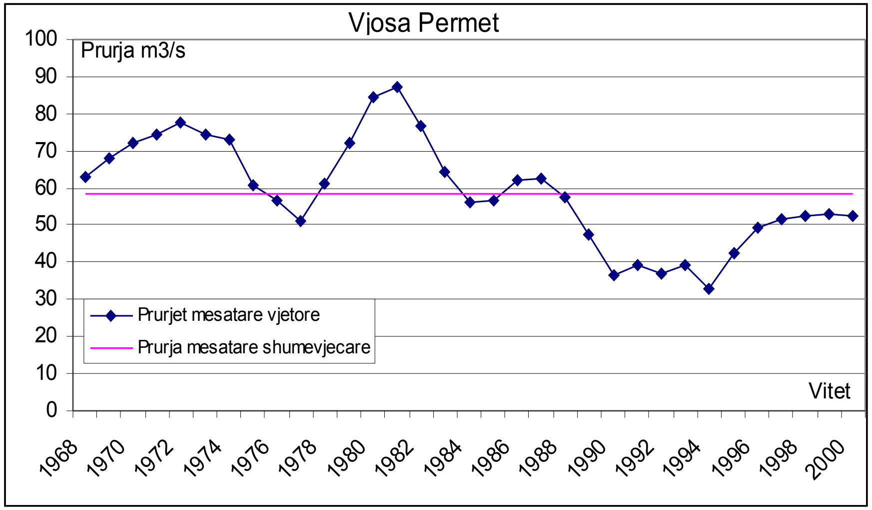
- Vjosa enter Albanian territory with a mean discharge of 53 m^3/s discharging into the sea a mean of 200 m^3/sec.

- In the upper zone of the basin the water modules varies from 26.5 to 26.7 $l/s/km^2$. After Drino flow to Vjosa this module has the value of 28.6 $l/s/km^2$, and 26.6 $l/s/km^2$ in Mifol.

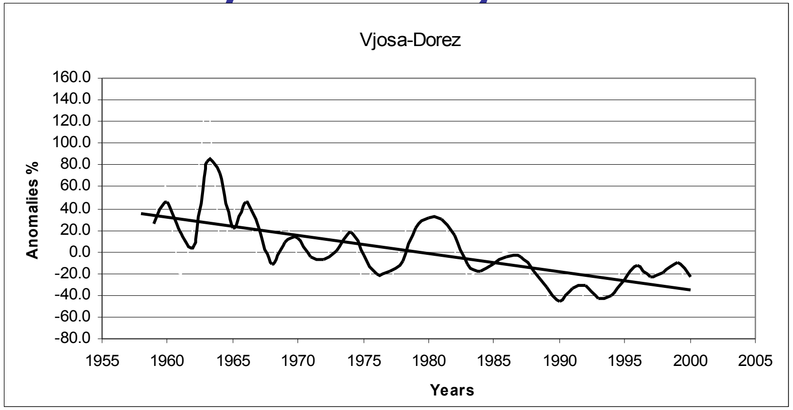
Water regime

- **The water flow** - seasonal and monthly variation. The river flow process, follow the precipitation process.
- **regime** : Vjosa has a nivo-pluvial regime two phases - November to May contribute for the wet period and July- September belong to the dry period.
- **maximum discharge** : with two maximums: one in the winter (December) and another in at the end of the spring (april-may) and only one minimum at the end of summer (august).

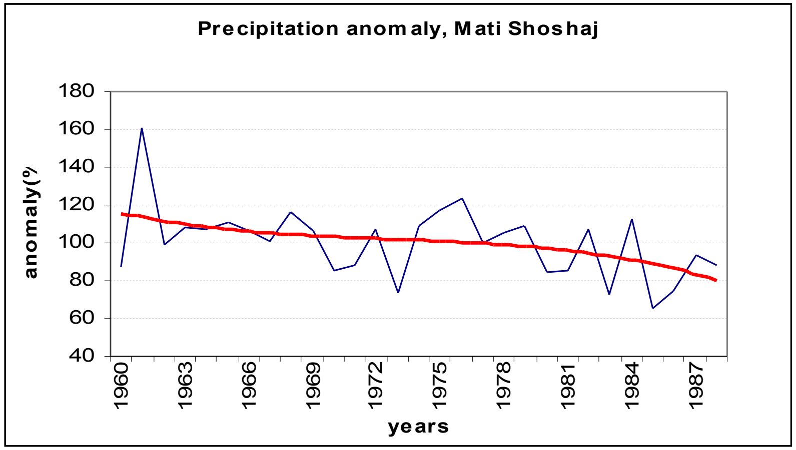




- Up to 1980 there are cycles with low and with high waters. This is a typical hydrologic periodicity always with a positive tendency.
- After the 1980 there are regular consecutive cycles with high and low water but now the tendency is a negative one.



- In this period there are more consecutive years with low water (more than three) so the dry period is more extended than before.
- In these graphics the discharges are calculated as the moving average values.



- All profiles show **decreasing trends in the last** years.

Trend in observed streamflow

- The method: Peak-Over-Threshold approach (POT) : Peak over threshold (POT) series consist of a series of independent monthly maximum river flow that exceed a certain threshold.
- The use of POT series allows an estimation of the trend in the frequency of floods, rather just their magnitude.
- The data to be use are these of maximum monthly river flow in Vjosa river basin and are selected to be free of human influence.

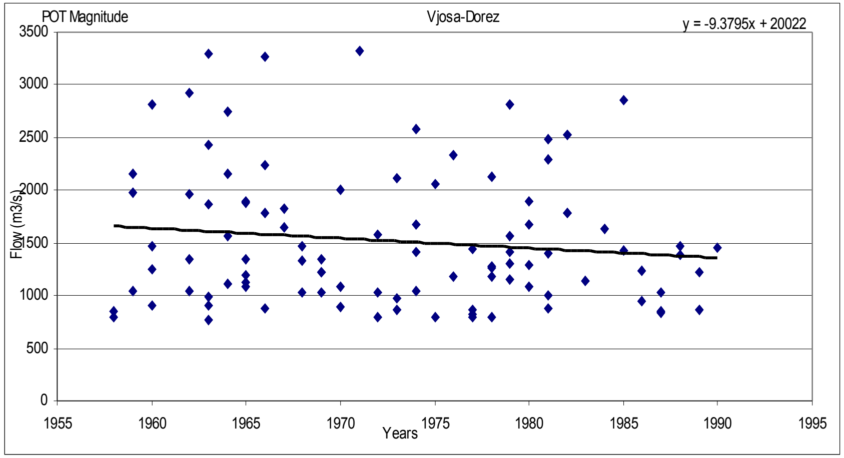
Trend in observed streamflow

- The first indices is the annual maximum daily river flow (Ann.Max).
- Two POT indices describing flood magnitude were use: the POT 1 Magnitude (POT 1 Mag.) and POT 2 magnitude (POT 2 Mag.)

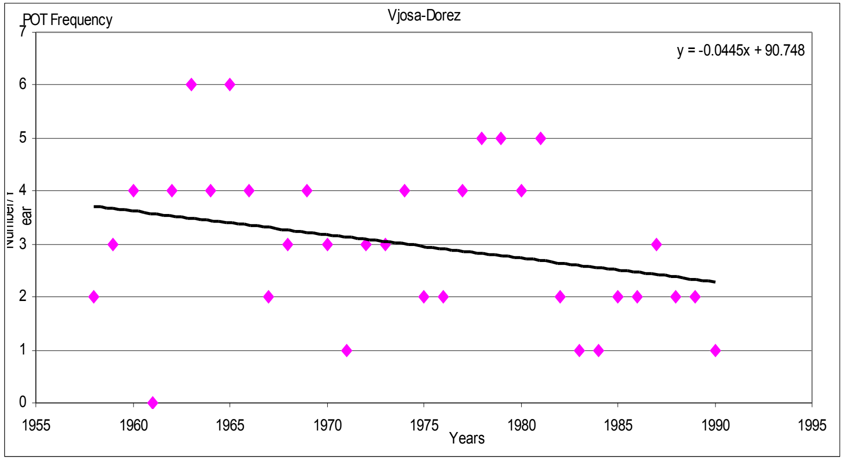
  -As the threshold for the POT1 Mag. was selected the smallest annual flood for the whole period

  -For the POT 2 Mag as the threshold was selected the mean of the maximum annual series.
- The Ann.Max series describe the magnitude and frequency of the most extreme floods, whereas POT 1 and POT 2 series characterize the behavior also of the more moderately sized floods.

- The method used to estimate whether is a significant positive or negative trend in flood magnitude and frequency is the linear regression.



- For all the flood index series (magnitude and frequency and Ann.Max) the stations of Vjosa River are showing negative trend.

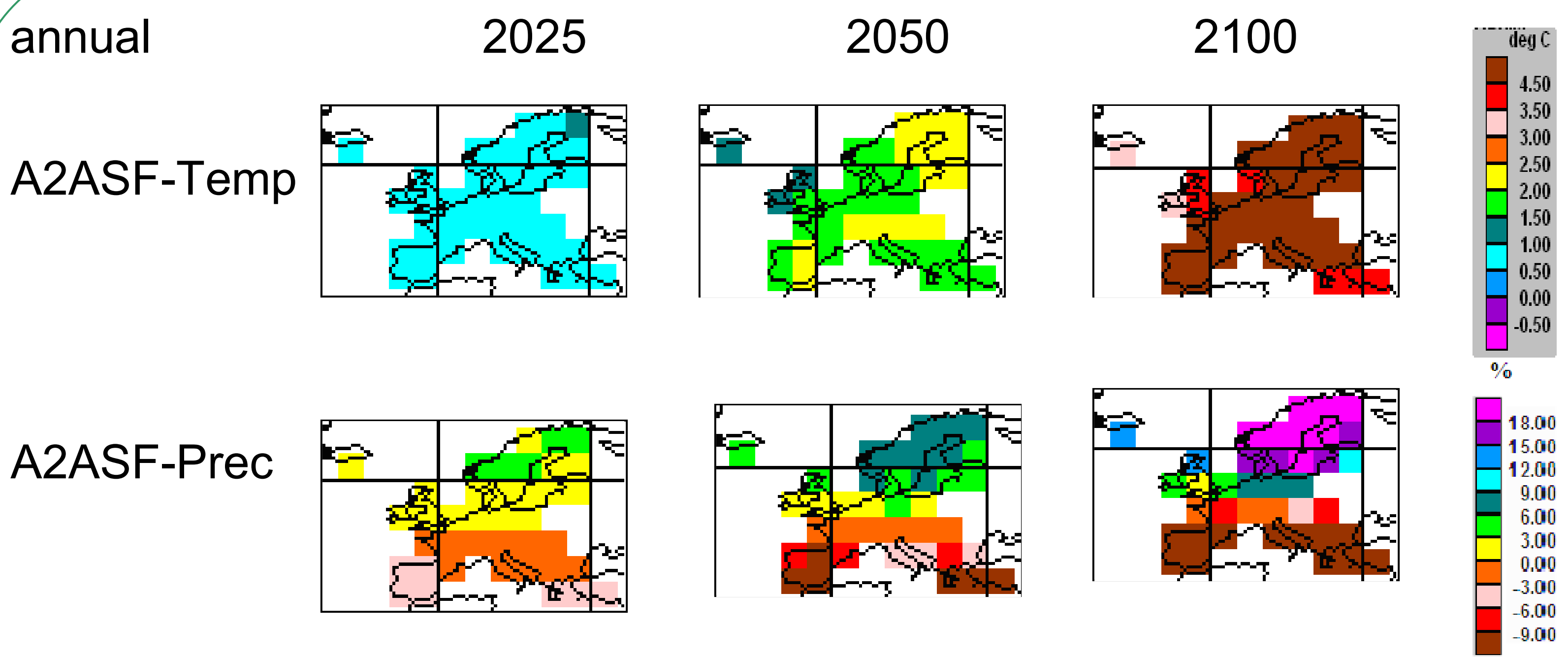


Expected climate changes

- Climate change scenarios are prepared by using the updated version of *MAGICC/SCENGEN* (version 4.1). *MAGICC – **M**odel for the **A**ssessment of **G**reenhouse-gas **I**nduced **C**limate **C**hange* is run by using the following scenarios from different SRES families: A1BAIM, A2ASF, B1IMA, and B2MES. They are markers of respective families (SRES A1, SRES A2, SRES B1, and SRES B2). *calculates the global temperature, sea-level and atmospheric CO2 concentration, between the years 1990 and 2100*
- To develop the climate scenarios, the change fields are used, scaled in *SCENGEN – a global and regional SCENario GENerator-* by the global-mean temperature change derived from MAGICC.

    The temperature and precipitation changes are generated for each emission scenario for years 2025, 2050 and 2100.

Expected climate changes

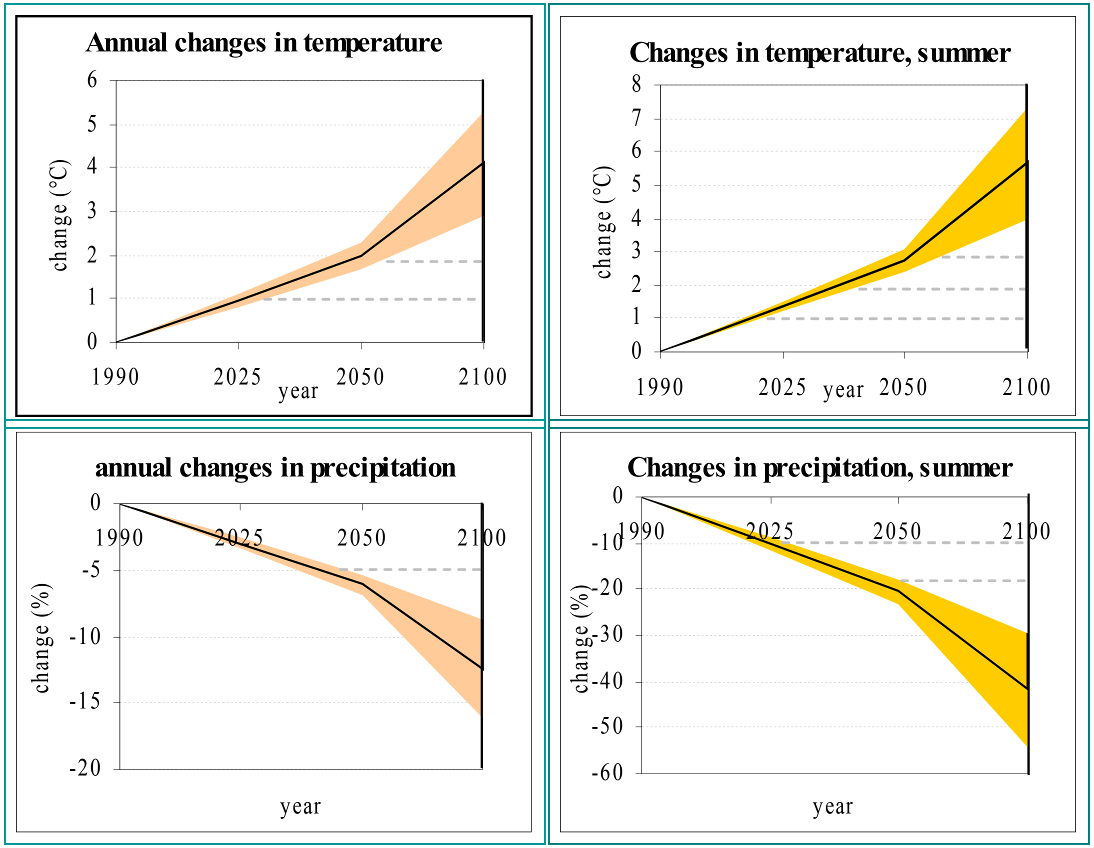


MAGICC/ SCENGEN (v.4.1)- scenarios from different SRES families (Third Assessment Report of IPCC):

A1BAIM, **A2ASF**, **B1IMA**, **B2MES** (SRES A1, SRES A2, SRES B1, SRES B2)

The GCMs: CSM_98, ECH395, ECH498, GFDL90, HAD295, HAD300 .

Expected climate changes



!!!! Increase in temperature and decrease in precipitation !!!!

The annual increase in temperature : 1.0, 2.0 and 4.1°C respectively by 2025, 2050 and 2100

Decrease in annual precipitation: up to 3.0%, 6.1% and 12.4% respectively by 2025, 2050 and 2100

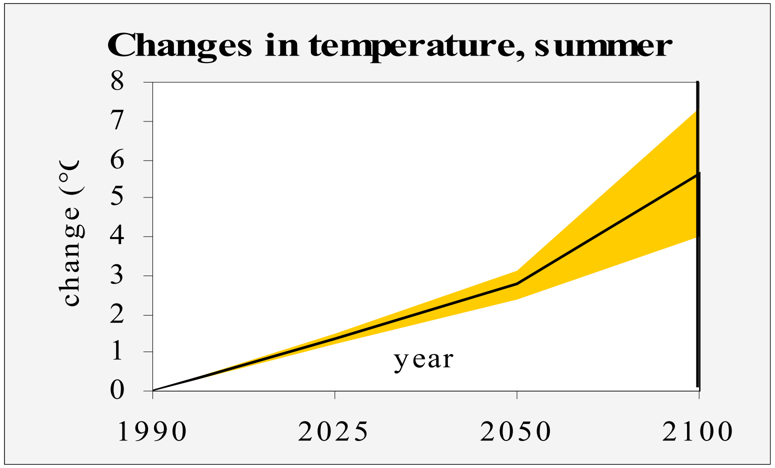
!!!! may expect: <u>milder winter, warmer springs, hotter and drier summers and autumn.</u>

Expected climate changes

Scenarios for Albania		Time horizon		
		2025	2050	2100
Annual	temperature (°C)	0.8 to 1.1	1.7 to 2.3	2.9 to 5.3
	precipitation (%)	-3.4 to -2.6	-6.9 to -5.3	-16.2 to -8.8
Winter	temperature (°C)	0.7 to 0.9	1.5 to 1.9	2.4 to 4.5
	precipitation (%)	-1.8 to -1.3	-3.6 to -2.8	-8.4 to -4.6
Spring	temperature (°C)	0.7 to 0.9	1.4 to 1.8	2.3 to 4.2
	precipitation (%)	-1.2 to -0.9	-2.5 to -1.9	-5.8 to -3.2
Summer	temperature (°C)	1.2 to 1.5	2.4 to 3.1	4.0 to 7.3
	precipitation (%)	-11.5 to -8.7	-23.2 to -17.8	-54.1 to -29.5
Autumn	temperature (°C)	0.8 to 1.1	1.7 to 2.2	2.9 to 5.2
	precipitation (%)	-3.0 to -2.3	-6.1 to -4.7	-14.2 to -7.7

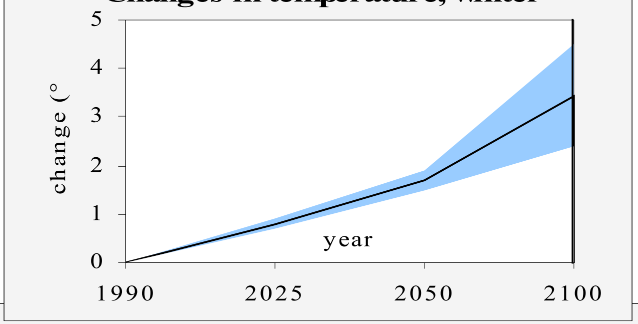
Expected climate changes

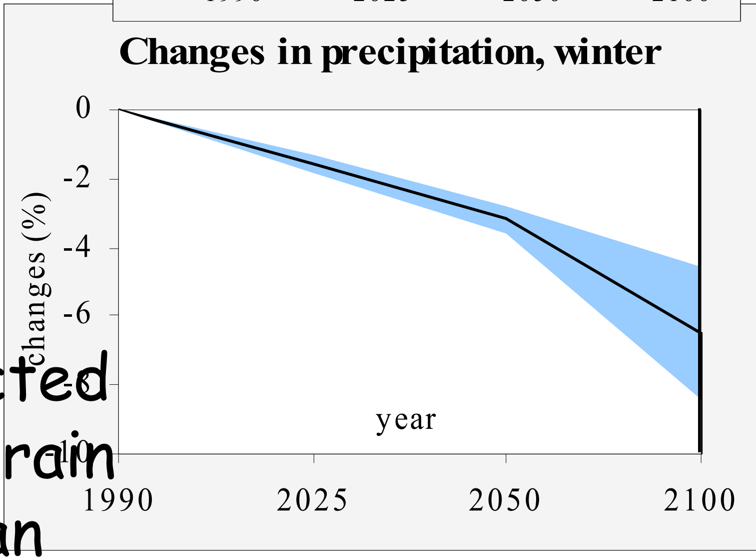
The extreme high increase in summer temperatures is likely to result in increases in the frequency or intensity of extreme weather events (heat waves).



The analysis shows the number of days with the temperature ≥35°C is likely to increase by about 1-2 days by 2025, and about 3-4 days by 2050. There is also an expected increase in value for this indicator by 2100 (about 5-6 days over the mountainous part, and up to 8 days on the lowland areas).

Expected climate changes





- With expected higher average temperatures in winter, more precipitation is likely to fall in the form of rain rather than snow, which will increase both soil moisture and run-off.

- Although total precipitation is expected to decrease, an increase of intensive rain episodes is likely. So, we can expect an increase in the number of hazardous rainy days of about 1-2 days by 2025 as compared to 1951-2000, of about 2-3 days by 2050, and of about 3-5 days by 2100. This is likely to have great consequences, especially on agriculture. This may induce greater risks of soil erosion, depending on the intensity of rain episodes.

Effects of Climate Change on River Flow

- To evaluate the effects of Climate Change on Vjosa River flow, a hydrological rainfall – runoff model was applied.
- The precipitation and temperature input into the model was spatially averaged over the basin using Thisean method for precipitation and arithmetic mean for temperature.
- The model was calibrated with data for standard period 1961-2000.
- The Equations used are as follow:
- For the evaporation

  EPI = a1+b1*T+c1*T2+d1*T3

  where: T (^{0}C) - mean seasonal air temperature
- and for runoff:

  R = a + b*P + c*EPI

where:

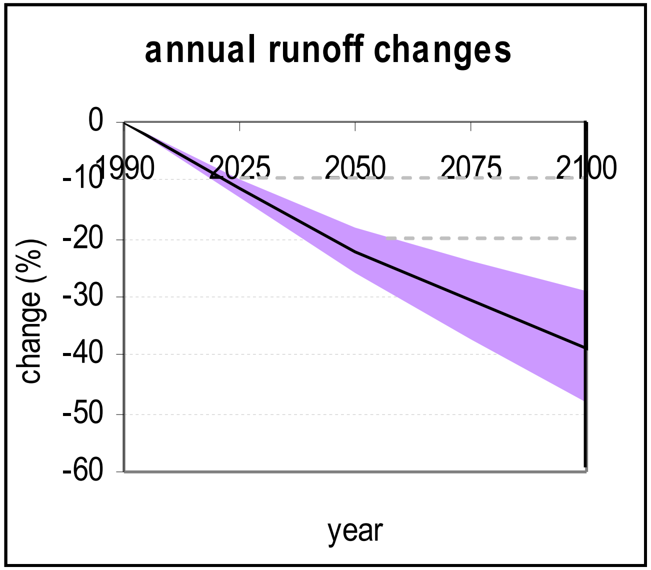
R (mm) - mean seasonal runoff;

P (mm) - seasonal sum of precipitation;

EPI (mm) - index value of the seasonal evapotranspiration,

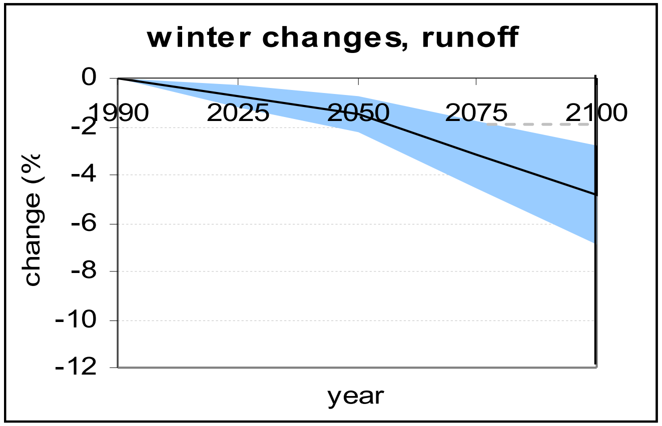
Effects of Climate Change on River Flow

- A decrease in the long term mean annual and seasonal runoff
- The decrease in discharges can be expected for all the time horizons.
- Even within each time horizons there are oscillations because they express the change of runoff as a result of the different extreme possibilities of climate change.
- **Less river flow**



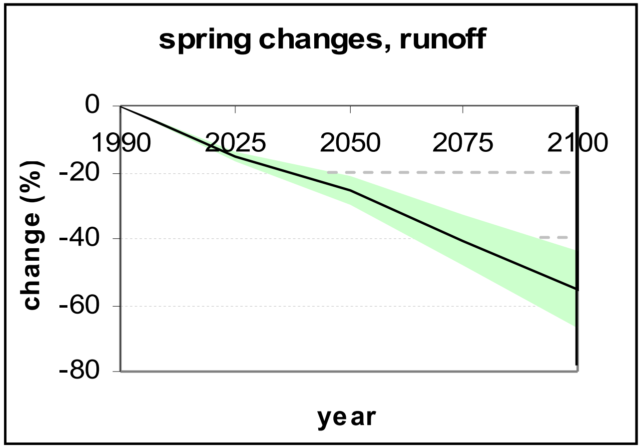
Effects of Climate Change on River Flows

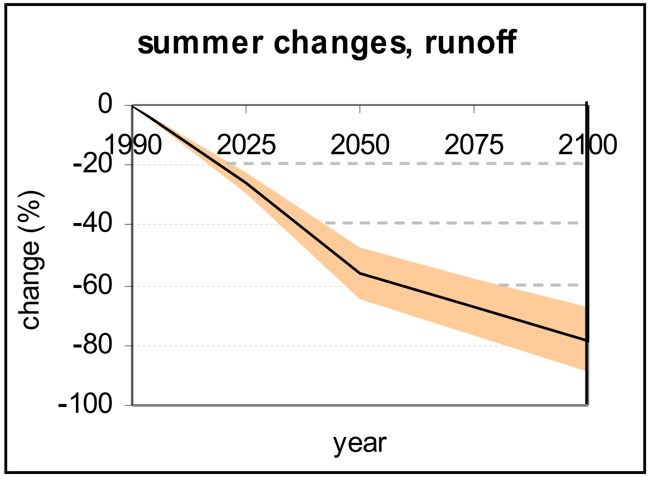
- A more detailed analysis shows that there are no significant changes for the winter for all time horizons. It is expected to reduce up to maximum 7% by 2100.
- The floods will still occurred during the winter season,
- and for the reasons we mention above even the flood of spring time, will shift toward the winter.



Effects of Climate Change on River Flows

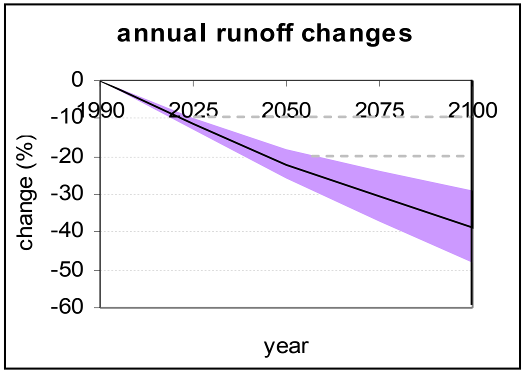
- Higher temperatures will shift the snowline upwards;
- The seasonal patterns of snowfall are likely to change with the snow season beginning later and ending earlier.
- So, the spring runoff is expected to reduce noticeably . The maximum reduction accounts for 30% and 66% respectively by 2050 and 2100.
- Water supply system, Agriculture and Hydropower industry must take into consideration the expected runoff reduction. (Albania is dependent on hydropower)



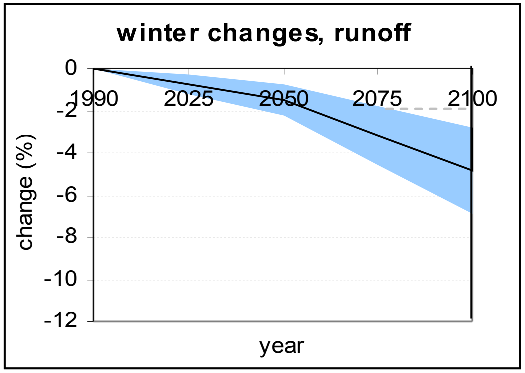


Some likely impacts

- Decrease in runoff, both annual and seasonal



- Because of the reduction of stream flows in the wetlands, western part of Albania would experience both increasing demands for water and reduced supply of water, which would decrease wetland area.



- A decrease of 20% in runoff ⇨ a reduction of 60% in power generation

Expected climate changes

- Increase in the frequency of extreme events (heavy rains, potential flood risk, strong winds, droughts)

- not only changes in total water amount and levels, but also erosion of riverbeds, and modification of turbidity and sediment load.

- Sealevel rise, by directly influencing the increase in the ground-water levels and composition, would

  limit the growing of some species that do not like the moisture and salt along the Adriatic coast

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n, Porto Romano, 2003

Conclusions and further considerations

- The government of Albania has not been considering climate change impact and risks in its long term investment plan in different sectors. The study focused on the VRCA shows that there is a significant need to support well informed decision making for long term development planning by sensitizing the investment scheme to climate change risks.
- There is a significant need for pilot projects aimed at the implementation of the measures identified in such a study after their refinement and an in-depth review. This might be done through an intervention enabled through projects aiming to raise awareness and support decision makers in all sectors to address climate impact and risk in the planning process. The projects will have both short/medium and long term implications on the development agenda of the country.

Thank you!