The Climatic Change Impact in Water Potential Processe on the Albanian Hydrographic River Network

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Abstract: The general cascade impt of climatic change on the water potential processe in the Albanian hydrographic river network is presented in this paper. Hydrological change impact in the sediment regime of the Albanian river system as an important part of the paper is present. The climatic change impact has been analysed in two principal aspects. Firstly by evaluation of the global water potential of the Albanian river system and secondly, by the influence of the climatic change in the multi-annual variation of this potential in the territory catchment area of this system.The climatic change impact processes in the Albanian hydrographic river network is analysed in the last part of the paper.The impact for two type climatic characteristics years, wet and dry years, are analysed.

Keywords: Temperature, climate change, sediment discharge, load discharge, water potential.

1. Introduction

The catchment area of Albanian hydrographical network is 43 305km^2, where 28 500km^2 is inside the Albanian state territory and the rest outside of it. This area is one of the most complicated natural areas in Europe because of its physic-geographical conditions: a mountainous region, a particular land cover with small vegetation and important flysch formation presence, a typical Mediterranean climatic regime with intensive precipitation, a hydrological regime with intensive surface flow, etc.
Many hydrological studies have been carried out to evaluate the climate change in the Albanian territory (, Frasheri A et al. 2002, etc.). At the same time other studies have been carried out to evaluate suspended and load sediment discharge of the Albanian river system (Pano N., 1984, 1995, 1998, Pano et al. 1984, 2002, Saraçi R. 2002, etc.). In this paper it is attempted to present the evaluation of this cascade impact of climate change water potential process on the Albanian hydrographic river network.

2. Method and materials

Climate change are analyzed in two directions: firstly by temperature record in the deep wells and shallow boreholes, and secondly by the meteorological observations data. The ground surface temperature reconstruction for long period, about 5 centuries, has been performed by estimation of the ground surface temperature changes at the past, according to the present-day distribution of the temperature at the depth, recorded in the borehole. The study of geothermal field of Albania has been carried out based on the temperature logging in the wells and boreholes. Six thermoplots were used for inversion of the ground surface temperature history which are located at the plane region in the west of Central Albania and in the mountainous region of the northeast of the Albania .
Air and ground temperatures, total annual rainfall quantity, wind speed and wetness, which are analyzed by records in Meteorological Stations. These stations are located in different

plane regions (Shkodra, Tirana, Kuçova and Fier) and in a mountainous region of Albani (Kukes), where the investigated wells are situated (Albanian Climate, Meteorological Bulletin for the 1931-2001 Years, the data for 1985-2000).

In the Albanian hydrographical network there are 11 principal rivers together their numerous branches such as Buna River with catchment area of the F=5 750km^2, Drini River -F=14 173km^2, Vjosa River-F=6706 km^2, Semani River-F=5649 km^2, etc. There are 125 other rivers with a small catchment area F>50 km^2 (Pano N., Avdyli B. 1985, Pano N., 1995).

Water potential evaluation was carried out based on the multi-annual archival data. Albanian monitoring system consists of more then 220 meteorological stations and 175 hydrometric stations in a period of 15-50 years. These stations are located all over the territory.

Water potential of this system has been evaluated by a specific way, because this system is very complicated. This system is generally a mountainous hydrographic network with an average altitude of 785m. Part of the system is Prespa-Ohri and Scutary lakes, with a surface of 270-305 km^2 and with a very intensive karstic phenomenon in the limestone formation. In these conditions the estimation of run-off discharge is carried out for two categories of river basins, with different hydrographical and hydraulically natural conditions:

Firstly, for river systems where the run-off discharge is computed as function of the altitude of water level (Q'_0=f (H). Secondly, for the water system of Scutary Lake- Drini River-Buna River, which is very complicated and is unique in the Mediterranean hydrography. This particularity has made particular modeling for the estimation of the water discharge of Buna River (Q_2) necessary (Pano N. 1995):

$$Q_2 = 0,025.[H_2 - Q_2^2/(0,0073.H_2^{1.61413})^2]^{1.85} - Q4 \qquad (1)$$

There are their discharge of the Buna river that flows away from the Skutary Lake, have been calculated in dependence of the lake water level (H_2) and the Drini River discharge (Q_1) in to Buna River. Parameters of the water river discharge probability distribution (Q_0, C_V, C_S) for the Albanian river system are calculated. Graphic-analytic relation are also compiled according to these forms:$Q_0=f(x_0)$,$Q_0=(x_0,t_0)$ and $Q_0=f(F)$ where: Q_0- is water discharge, X_0-precipitation, t_0- temperature, F –catchment area surface were determined. Calculating and examining much annual archival data for the period 7-30 years analyze erosion process evaluation in this network (Pano N. and Avdyli B., 2002, Pano N. and Frasheri A. 2002, Saraci R., 2002). Sediment samples are taken in 70 cross-sections in the river system. After determining respective samples with observed data of the solid discharges, statistical analyze of this samples is made. Parameters of the suspend loads discharge probability distribution (R_0, C_V, C_S) for Albanian river system are calculated. For these rivers graphic-analytic relations are also compiled as forms:$R_0=f(Q_0)$, R_0, p%=f(Q_0,p%) and R_0=f(F),(where:R_0- is solid suspend discharge) were determined (Pano N., 1984, 1998).

3. Analyze of the results

The ground surface temperature reconstruction of the thermoplots of Kolonja-10 and Arza-31 deep wells, which are located at coastal plane region of western Albania, are shown in fig.2. As it is seen in this figure, the GST history yielded by tighter inversion of Ko-10, presents a gradual cooling of 0.6 K, before a middle of the 19th century. Later followed by 0.6 K warming, with a gradient 5.4 mK/years, that seems quite reasonable and is consistent with generally accepted ideas about the climate of the last 2-3 centuries. On the contrary, the paleothermal history, obtained from Arza-31 well, presents a monotone warming of 1,7 K, by a gradient 5.7 mK/year, during the 17th and 19th centuries. This trend of the warming has only explanation caused by a deforestation of the area and presence of the paleo-swamp.

Fig. 3 shows a GST history of Vl-1127, Gurth-595, Krasta-1 and Ragam-168 boreholes, which are located in the mountainous regions of Northeast Albania. Some changes are observed in these regions as to the cooling of 0.2 K during the 19th century. Later, the warming trend of 0.6 K during the 20th century is observed, by a gradient 6.7 mK/year. Warming gradient increasing at mountainous regions, in comparison with coastal areas, is caused by intensive deforestation during the last half of 20th century.
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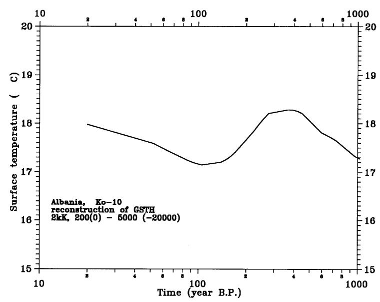
Climate changes in Albania are observed also by the hydrometeorological studies. Fig. 4 presents graphics of yearly average temperature of the air in Tirana Meteorological Station, for the period from 1931 to 2004. Fig. 5 presents graphics of yearly average temperature of the air in Tirana, Kukesi, Shkodra and Vlora Meteorological Stations, for the period from 1951 to 2004. Meteorological stations are located in plane regions, as Tirana, Shkodra and Vlora, also in mountains regions, Kukesi.. In general, the end of first observes half 20th century, a warming of climate more 1°C. Thirty quarter of 20th century is characterized by a cooling of 0.6°C, and later, up to present a warming of 2°C.



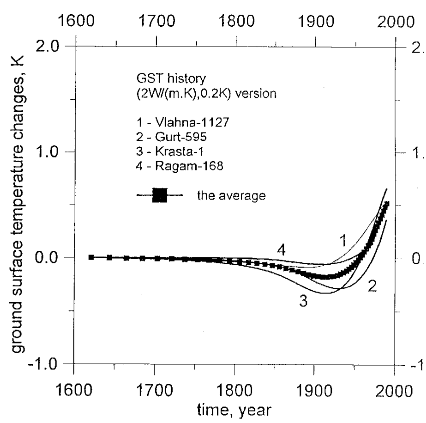


Figure. 1. Ground surface temperature history according to thermoplot of Ko-10deep well(According to the Safanda, J. calculations).

Figure. 2. GST history of Vl-1127, Gurth-595, Krasta-1 and Ragam-168 boreholes (According to the Safanda, J. calculations).

The cross correlation coefficient is $C_c = 0.78$ between variation curves of the average annual temperatures of both of these stations. Warming trend of maximum 1.2°C, in particular after seventy years, is observed in all Albanian territory. There are good cross correlation between variation curves of the average annual temperatures of Shkodra, Tirana and Kukesi, respectively C_c = 0.78 and 0.79 (Fig. 5).

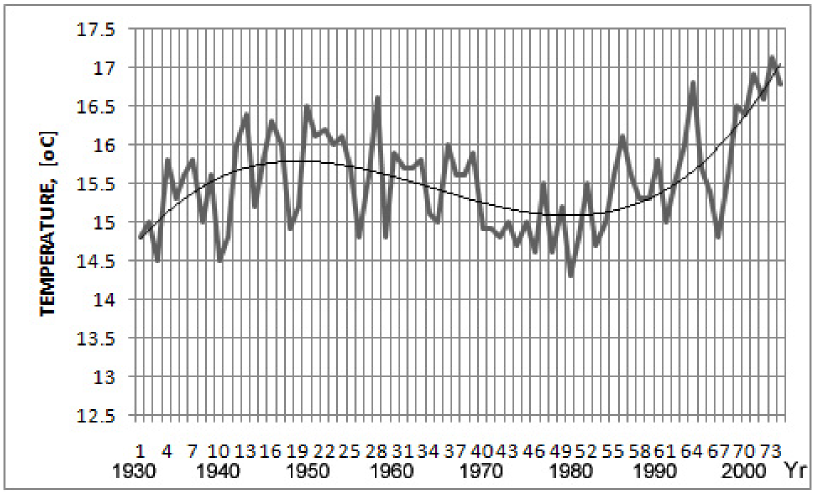


Fig.3. Air Average Annual Temperature Variation at Tirana Meteorological Stations (Period 1931-2004).

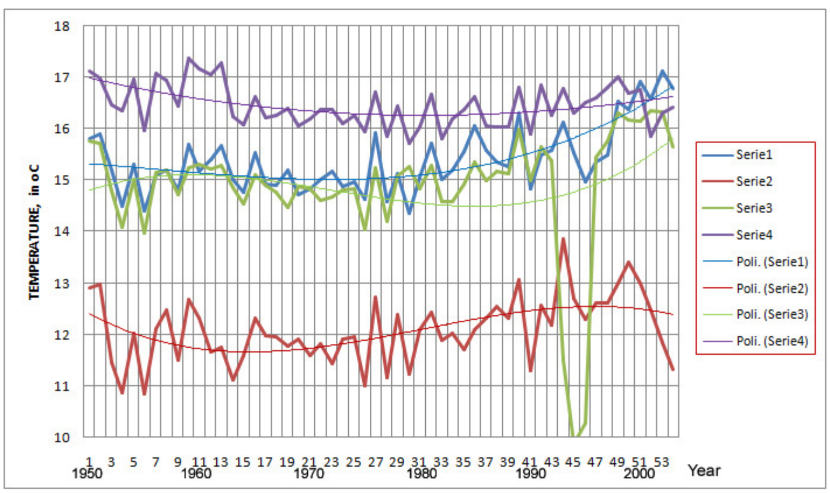
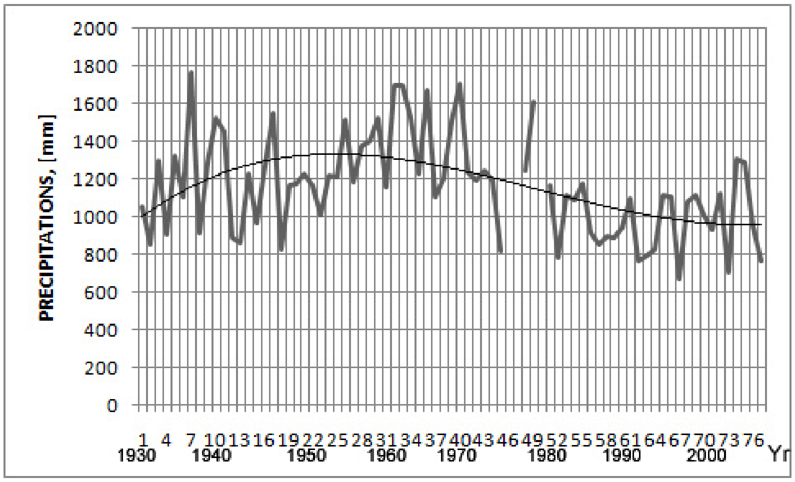


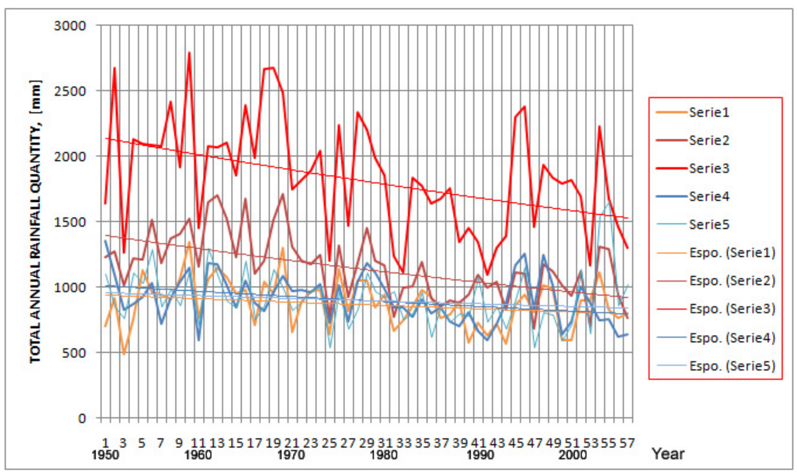
Fig. 4 Correlation between variation curves of the average annual temperatures of Shkodra, Tirana Kukesi and Kuçova cities (Period 1951-2004).
Series: 1- Tirana; 2- Kukesi; 3- Shkodra; 4- Vlora

The meteorological data shows that the warming trend is not a monotone one. In short intervals are observed cooling and warming (Fig. 3, 4).

The warming period in Albania is accompanied with changes of the rainfall regime., wind speed and wetness. There are observed a decreasing of the total year rainfall quantity, for about 200-400 mm. (Fig. 5). In the dependence of the geographical location of the areas changes the cross correlation of the rainfall quantity: Tirana area with Shkodra area C_c=0.62, with Korça C_c=0.81, Kuçova C_c=0.66, Kukesi C_c=0.88, Gjirokaster C_c=0.88, Vlora C_c=0.53, during the period of 1930-1970. Fig. 7 is presented the difference of the total year rainfall quantity in the most dry and wet years, respectively 1907 and 1960. The warming have accompanied with decreasing of the wind speed about 1.5 m/sec and 5% increasing of the wetness, during the period of 1950-1994.



a)



b)

Figure5. Total year rainfall quantity of the: a) Tirana Meteorological Station (Period 1930-2007); b) Meteorological Station Kukesi (1), Tirana (2), Shkoder (3); Erseke (4); Vlora (5), (Period 1930-2007).

This warming is part of the global Earth warming during the second half of XX century. Its impact has been observed on some directions:

- Country climate,
- Water systems and water resources. The rainfall regime changes have their consequences in the fresh water resources of the country, of surface's and underground waters.
- Inland water resources changes have their impact on the hydrographic regime of the Adriatic Sea.
- Soil erosion intensively, forestry etc.

Water potential of Albania is W_0=38,3.10^9 m^3 that corresponds to a discharge of Q_0=1270 m^3/sec, and a module of q_o=30.1 l/sec.km^2.So Albania is one of the countries of a high specific water potential in Europe.
The hydrographical features of the Albanian catchment area in a tab.1 are presented.
In the Albanian hydrographic network the annual flow distribution is generally characterized by a typical Mediterranean nature with strong flow in winter and weak one in summer. The two characteristics periods are: a) dry water period of the year (VII—IX) and b) wet water period of the year (X-XI). About 20% of the annual flow passes during the dry period, while 80% of it passes during the wet one. Erosion processes in this territory is very intensive especially during the water period.
Water flow of the hydrographic network of Albanian rivers differs in wide limits, not only in different periods of the year, but also in the multi annual cycle because of the of the physic-geographical conditions of the network and especially of the atmospheric precipitation and evotranpiration regime.
To explain the cyclical fluctuations of annual flow of the Albanian river system, have constructed standardized difference-integral curves of module coefficients. The presence of cycles of different duration is characteristic in the fluctuation of river flow.
The value of the coefficient of the water discharge variation is C_v=0.25 of the Drini River, C_v=0.27 of the Mati River, C_v =0.27 of the Ishmi River, C_v=032 of the Vjosa River, etc.
Evaluation of the yearly flow fluctuation of the Albanian rivers was carried for multi annual period. So, during the multi annual cycle the discharge in the Mediterranean Sea varies in very wide limits, from 650-750 m^3/sec for the hydrological years of a low precipitation and from 1800-2200 m^3/sec for the hydrological years of a high precipitation.
Albanian rivers are the most turbid in the Europe. The average suspended load discharge concentration of these rivers is r_0=1660 gr/m^3, the suspended load discharge is R_0=1650 kg/sec (tab. 1). One of the important respective indicators to estimate the integral impact of the natural factors in the erosion process is the specific module of the suspended load discharges-γ_0 (in ton/km^2.years). In the Albanian territory hydrographical catchment area, the average specific module of the suspended load discharges is γ_0= 1 489 ton/km^2.year.

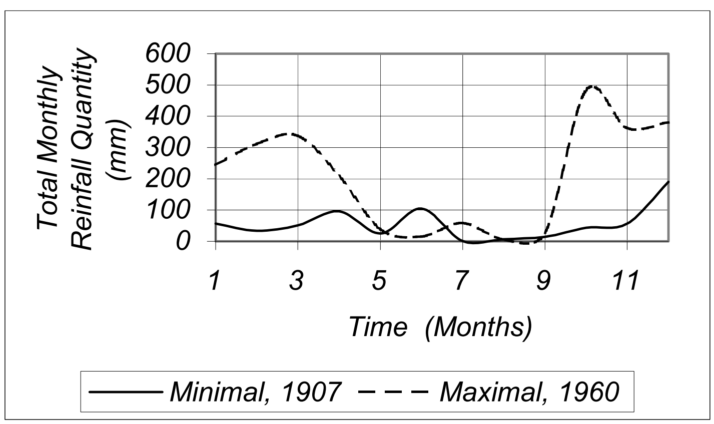


Fig. 6. Total Year Rainfall Quantity in the most dry and wet year, respectively, of the Shkodra Meteorological Station (respectively 1907 and 1960 years).

The average annual sediment discharge into Adriatic and Ionian seas is W_T= 63,34.10^6 ton, from which W =52,24.10^6 ton are suspend sediment and W_F^o= 11,1.10^6 ton are load sediment (tab.1).
The value of the coefficient of the suspended discharges variation coefficient for the Drini River is C_vR_0= 0.46, for Shkumbini River C_vR_0= 0.66, for Vjosa River C_vR_0= 0.69, etc.

According to the multi annual data the total suspend discharge of the Albanian river system in the Mediterranean Sea varies in very wide limits. Minimal suspend discharge is W_p= 30.10^6 ton that correspond a specific module of r_o= 967 ton/km^2 for the hydrological dry years up to maximal values W_F=120.10^6 ton that correspond a specific module of r_o= 3558 ton/$km^2$for the hydrological wet years.
The relation coefficient $\eta_0=C_v^{R0}/C_v^{Q0}$ in the Albanian river system varies from 1.24 to 2.16. In these conditions, the intensity variation of erosion process depends mainly on the variation of the water discharge variation as well as on other general factors such as evotranspiration and temperature that are linked with climate regimeintensity.The relation coefficient η_0 values are presented in thetab. 2.

5. References

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Table 1

The hydrological characteristics of the Albanian principal rivers

Nr	RIVERS	F catchment area surface (km^2)	H average altitude of the basin (m)	Q water discharge (m^3/s)	R suspend load discharge (kg/s)	r_0 Turbidity (gr/m^3)	γ_0 module of solid discharge (Ton/km^2)	W_p suspend load volume (10^3.ton)	W_F bead load volume (10^3.ton)	$W_T = W_p + W_F$ Total aluvion volume (10^3.ton)
9	Catchment Aarea (with lakes)	43306	789	1270	1650	1660	1450	52240	11100	63345

The relation coefficient $\eta_0 = C v^{R0}/Cv^{Q0}$ in the Albanian river system

Tab.2

Nr.	Rivers	F catchment area surface (km^2)	H Average altitude of the basin (m)	Q_0 Water discharge (m^3/s)	C_v^{Q0} Coefficent of variation of the water discharge	R_0 suspend load discharge (kg/s)	$C_v^{R_0}$ is coefficent of variation of the suspend load discharge	$\eta = Cv^{R0}/C_v^{R0}$
10	Catchment area (with lake)	43304	789	1270	0,35	1650	0,58	1.54