A STUDY OF THE REFERENCE CLIMATIC PARAMETERS AND THEIR IMPACT UPON THE HYDROLOGICAL REGIME. CASE STUDY: IALOMITA HYDROGRAPHIC BASIN

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Abstract. The paper provides an analysis for the evolution and spatio-temporal variation of two climatic parameters (precipitation and evapotranspiration) and one hydrological parameter (the flown water volume) over a common period of time (1970-2007) in Ialomita Hydrographical Basin which has been recently affected by extended periods of drought. In achieving this aim we started our analysis from the equation of the water balance in a large hydrographical basin over a long period of time. Among the elements of this equation the amount of rainfall (precipitation) and evapotranspiration are further called the reference climatic parameters since they are the ones that influence the volume of the surface run-off. The evolution of the above mentioned parameters has been accomplished by taking into account the recorded data from 6 meteorological and hydrological posts that can be considered characteristic for Ialomita River Basin. They have been used to identify the tendency of these reference climatic parameters and establish their influence upon the hydrological regime. The parallel study of these three parameters may offer valuable data upon their tight connection in a regional context.We often use the air temperature as an indicator of how comfortable we will feel when we are involved in sports or other physical activities. However, the air temperature is only one factor in the assessment of thermal stress. Human thermal comfort depends on environmental and personal factors. The four environmental factors are: airflow (wind), air temperature, air humidity, and radiation from the sun and nearby hot surfaces. The personal factors are the clothing being worn and the person's level of physical activity.

Introduction

Ialomita River Basin is located in south-east Romania, between 44°32' N and 45°32' N, 25°40' E and 27°09' E. The basin has an elongated north-west –

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south-east shape, an area of 10350 sq km and a total length of 417 km (Atlasul Cadastrului Apelor din Romania, 1992). Ialomita River Basin displays a large variety of landforms, starting from the high altitude peaks of the Transylvanian Alps to the flat areas of the Baragan Plain.

The watershed with the neighbouring river basins (Arges, Olt and Buzau) crosses the peaks of the Leaota, Bucegi and Clabucet Massives, the Sub-Carpathian heights around the town of Targoviste, the elevated areas of Vlasia and Mostistea Plains towards west and south, the Istrita Hill and the low-lying flat lands of the Baragan Plain northwards (Ujvari, 1972).

So far, the most recent studies and interpretations show that the forecasts regarding the water resources in this river basin are far from optimistic.

Other researches that have been carried out upon the variations in time of the meteorological and hydrological data series (Adler and others, 1997) (Carbonnel and others, 1997) (Mares and Mares, 1991) (Iliescu and Tuinea, 1991) (Busuioc, 1991) exhibit certain tendencies that could reflect the effect of the present climate changes.

1. Data and methods

We have based our analysis on the equation of the water balance $x= y + z \pm \Delta U$, where X is the total amount of rainfall, Y is the surface run-off volume carried towards the neighbouring areas, z stands for the evapotranspiration and ΔU represents the variation of the water reserve.

In order to carry this analysis we have based our study on recorded data regarding the total amount of rainfall, the evapotranspiration and the mean monthly values of the surface liquid run-off from 3 hydrological posts (Campina located on Prahova River, Moara Domneasca on Teleajen River and Slobozia on Ialomita River) and their corresponding weather stations (Campina, Ploiesti and Urziceni weather stations) for the 1970-2007 period.

The hydrogeological studies show that the phreatic water reserve is almost constant, being held in a relative equilibrium, which allows us to consider that for a large area and over a long period of time the contribution of the phreatic reserves upon the surface run-off is very low.

Of the 3 elements that are encompassed in the equation of the water balance the total amount of rainfall and the evapotranspiration are of climatic origin, being called the reference climatic parameters, since they represent the reference elements to which the total amount of surface liquid run-off must be related to. Any change in their regime affects directly and immediately the quantity of water carried out by the surface liquid network.

The area that we have focused on has been affected by long repeated periods of drought that have occurred mainly in the high-sun season and that is why we have chosen this geographical space to study.

Since in the southern part of the country we have found weather stations with continuous and long series of recordings we appreciate that the analysis of the phenomena is concluding and trustworthy.

2. Incomes

2.1. The rainfall. The recent tendency in the evolution of rainfall has been of great concern throughout researchers all over the world, mainly because a small change in the global climate may have serious effects upon any environmental component.

We have taken into consideration the time lapse of 1970-2007 and compared the statistical data to the climatological average established by NAM (the National Administration of Meteorology) for each weather station located in Ialomita River Basin.

To provide a brief analysis of the rainfall regime throughout Ialomita River Basin we have selected the following weather stations: Campina, Ploiesti and Urziceni. For each weather station we have compared the recorded amounts of yearly rainfall to the mean value of the 1970-2007 period, we have tried to establish the general tendency (increase or decrease of amounts) and also the variability of the gliding mean value (the gliding step has been considered to be 5 years).

The results of the calculations are shown in figures 1-4.

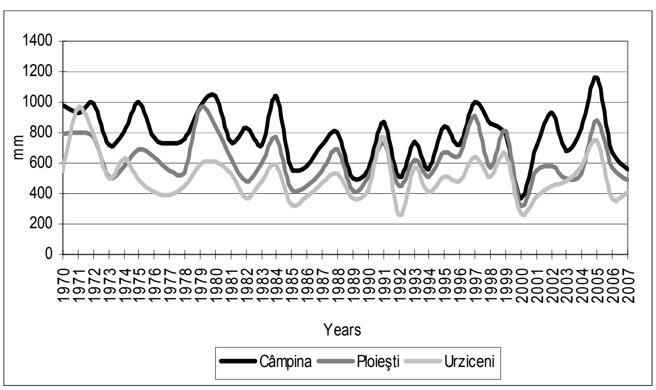


Fig. 1 - The multiannual variation of the rainfall amounts and their evolution trend in the period 1970-2007 at Campina, Ploiesti and Urziceni weather stations

Fig. 2 - The deviation of the annual amounts of rainfall as compared to the multiannual average (1970-2007) and their gliding average (every 5 years) at Campina, Ploiesti and Urziceni weather stations

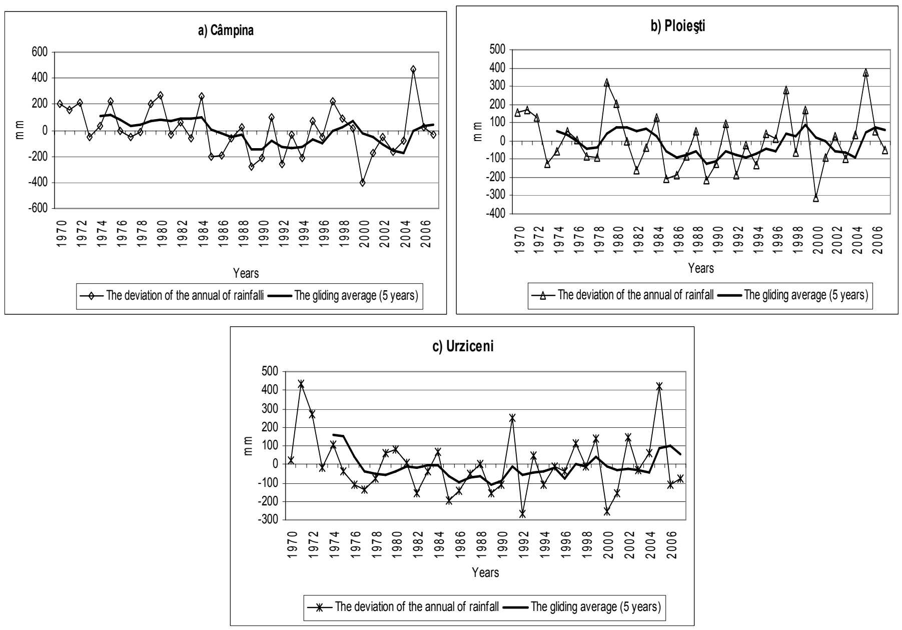


Figure 2 shows which have been the rainy years of this period in which the processes of land modeling have been very active. These rainy years have totalized considerably higher amounts of rainfall than the mean annual value for this interval (in some cases over 50% higher).

Thus we can easily observe that the dry periods (1985 – 1991, 1998 – 2003, 2006 -2007) are followed by excessively rainy periods.

We could state that the analyzed weather stations show some similarities which refer especially to the fact that the years tend to group themselves in a few very well defined periods (judging by the gliding average), either dry or wet, the magnitude of these periods being the one that somehow differs from one station to another.

The gliding average, also called the mobile average is used when the stream of data is very long and characterized by sudden changes and deep fluctuations that make hard the determination of a certain trend. One can assume that the gliding average corresponds to the middle of the synthetic interval. It is obtained by averaging 3 to 5 consequent values.

In order to obtain the gliding average for these stations we have taken into account 5 consequent years (values) since this interval can diminish the importance of some exceptional events but still keeps the general trend of the data stream.

Thus every mean annual value is transformed in a 5-year mean value, the first two being prior to the average itself and the next two after it. In this way, we have eliminated the fluctuating trend from one year to another and we have focused on the general synthetic evolution trend.

The trend of these gliding averages for the three analyzed weather stations can be seen in fig.2 where we have compared it to the multiannual mean value.

2.2. Evapotranspiration. Evapotranspiration represents the total loss of water through evaporation from the surface of the planet (lands and oceans), through the evaporation of rainfall and also from the physiological processes of transpiration that are proper to all living organisms.

Evapotranspiration is the second element that plays an active role in the equation of water balance.

Evapotranspiration may be either potential or real. The real evapotranspiration (RET), an index established by Thornthwaite, represents the amount of water that the soil, covered with vegetation and periodically supplied with water, loses by means of evaporation and transpiration. Potential evapotranspiration (PET) is the quantity of water that may evaporate from the same surface, under the same atmospheric conditions, lest the available water resource would be a limitative factor.

The determination of the RET can be achieved either by direct recordings from the evaporimetrical stations or by calculations. The Turc, Penman and Kotodo formula are the ones that best fit the conditions of our country.

For establishing the values of the PET in Ialomita River Basin we have used the FAO modified Penman equation. Thus we have obtained values that are similar to those recorded at the evaporimetrical stations placed throughout this river basin.

Based on the available weather data from the period 1970 - 2007 and making use of the Daily ET computing programme, we have successfully managed to determine the PET values for the three weather stations that we took into account, Campina, Ploiesti and Urziceni.

The data we have gathered have been analyzed to see which the multiannual variation of the evolution trend might be and also we have compared them to the climatological average for our reference period, 1970-2007 (fig.3).

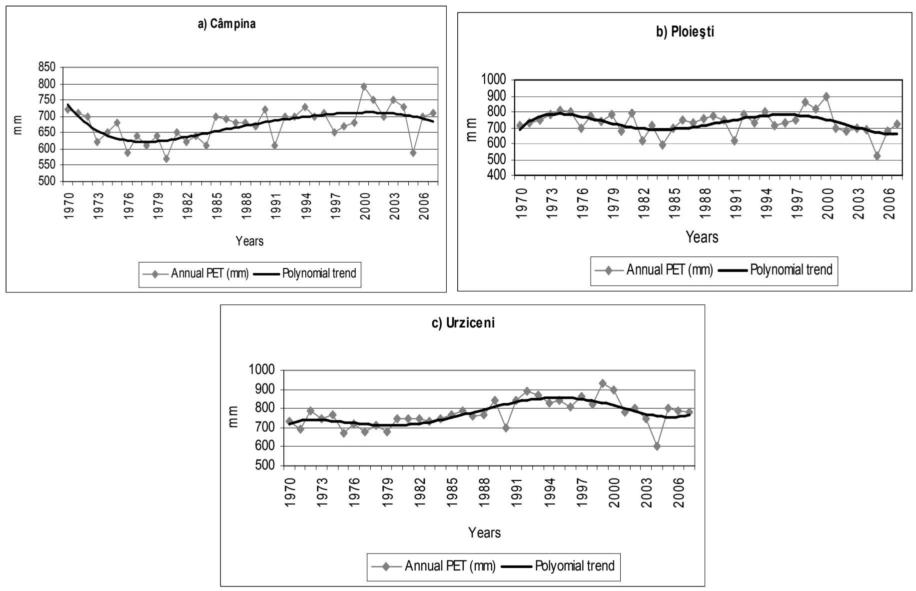


Fig. 3 - The multiannual variation and the evolution trend of the potential evapotranspiration (PET) for the weather stations

The PET variation is very much connected to the altitude of the weather station. We can easily observe that for Campina weather station, which is quite close to the mountains, the PET variation is extremely low, with mean annual values between 590 and 750 mm. On the other hand, at Urziceni weather station, located at a lower altitude, the interval is somehow larger, between 600 and 930mm. Evapotranspiration is an extremely complex phenomenon. The charts in fig. 3 show very high levels of PET for the periods of 1970-1972 and 1985-1992 followed by lower values during the intervals of 1973-1984, 1993-1999 and 2001-2005, which have recorded higher amounts of rainfall. The oscillation of the PET values is extremely high, especially for the low altitude areas (peripheral hills and plains).

Usually the trend exhibited by the PET is opposite to the trend exhibited by rainfall. Therefore we can state that wet years show low variations in PET. But this is not always valid. For example the year 1983 had high amounts of rainfall but also showed significant variations in the levels of PET. This again certifies the aleatory character of PET and the importance it has when discussing the annual balance of run-off.

2.3. The hydrological regime. The analysis of the hydrological regime has been accomplished, as well as the analysis of the precipitation and evapotranspiration regimes, taking into account recorded data from the three main hydrometrical stations that represent the Ialomita River Basin.

We present now the hydrometrical stations we have selected and their corresponding weather stations:

- Campina hydrometrical station on Prahova River (Campina weather station)
- Moara Domneasca hydrometrical station on Teleajen River (Ploiesti weather station)
- Slobozia hydrometrical station on Ialomita River (Urziceni weather station).

The analysis that we have carried upon the hydrological regime of Ialomita River Basin is similar to those that we have carried upon the other two parameters mentioned so far rainfall and evapotranspiration. By saying this, we mean that we used the same methods applied upon statistical recorded data. We tried to establish the general trend of evolution, we compared the data to the mean multiannual average for the period 1970-2007 and we aimed at showing how the gliding average (5-year gliding step) varies for each of the three hydrometrical stations that we focused on. Fig. 4 shows the outcomes of this analysis.

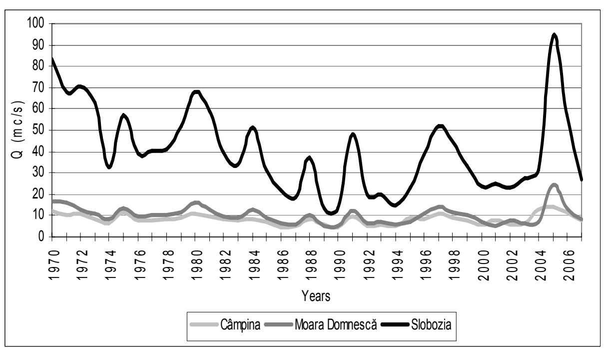


Fig.4 - The multiannual variation of the water discharges and their evolution trend from 1970 to 2007 for Campina, Moara Domneasca and Slobozia hydrometrical stations

We could state that there is a relative correspondence between the variation of the annual amounts of rainfall and the mean annual liquid discharges. The range of this variation is different according to various landforms. Thus for Slobozia hydrometrical station, located in a low-lying flat plain, the amplitude of the variation of annual water discharges is similar to that of the annual amount of rainfall. We can also observe important variations at Moara Domneasca and

Campina hydrometrical stations, compared to Ploiesti and Campina weather stations.

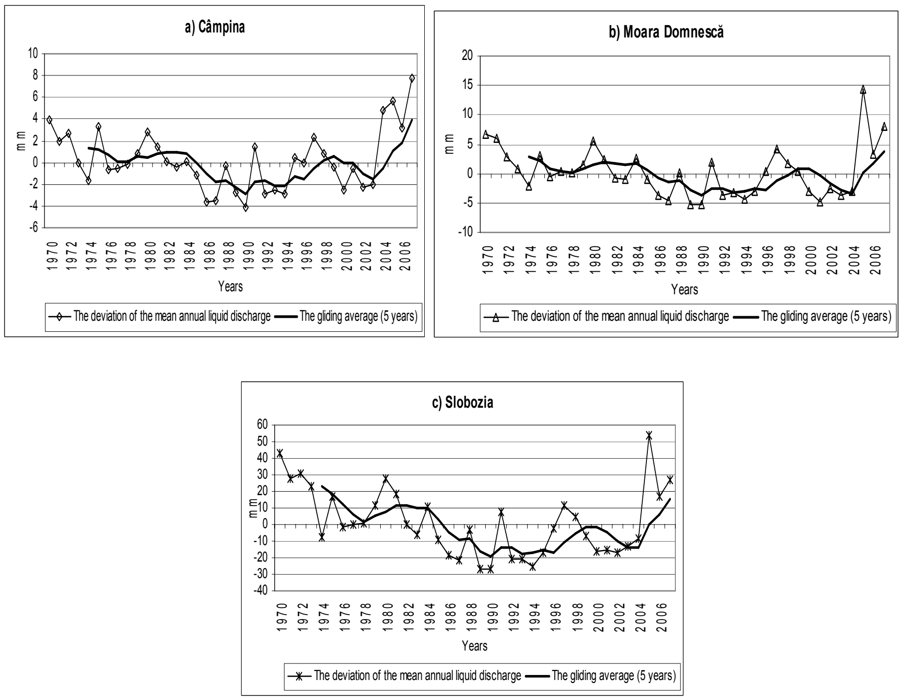


Fig.5 - The deviation of the liquid discharges annual values from the mean value of the 1970-2007 period and their gliding average (5-years gliding step) for the a) Câmpina, b) Moara Domnească,c) Slobozia hydrometrical stations.

The year 1976, for example, has been a wet one, judging by the amount of rainfall that it had, instead it exhibits a modest liquid run-off, with around-the-average values of the water discharges (as fig.5 shows).

3. Outcomes

We hereby present a synthesized image of the way in which the three water balance components vary: (fig.6).

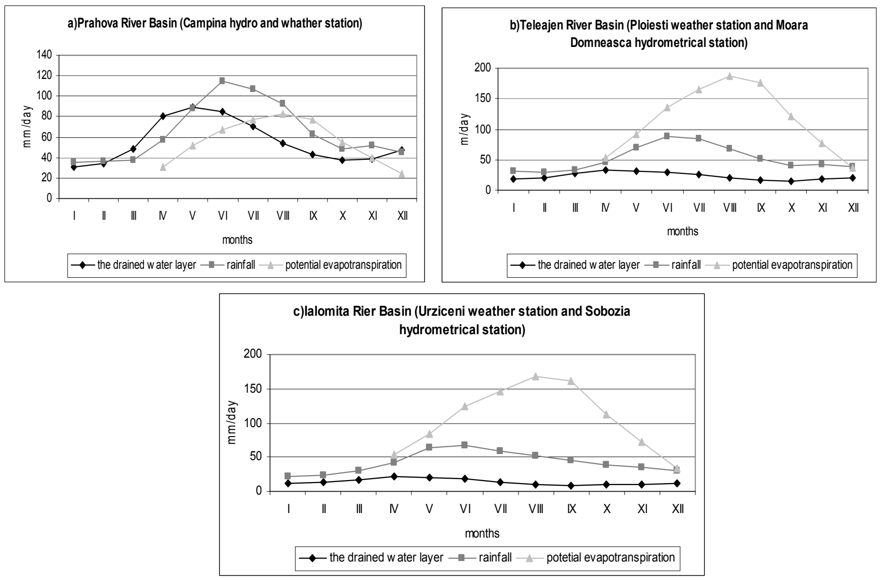


Fig.6 - The mean monthly values of the drained water layer, rainfall and potential evapotranspiration in Ialomita River Basin

We have attempted at a common period analysis of all these three elements, that is the 1970-2007 interval.

We have determined for this interval the multiannual monthly values of the three parameters and the results we have obtained were then transformed into values of the drained water layer that is mm/day for each day of the year.

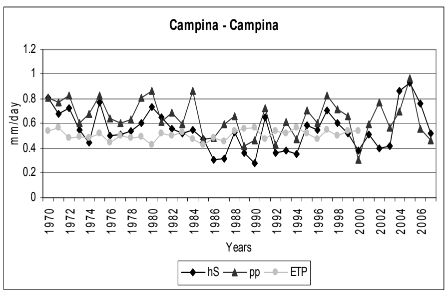
We can easily observe from this charts that the ratio between the three components of the water balance equation varies and changes as the mean altitude of the river basin they represent also changes from one station to another.

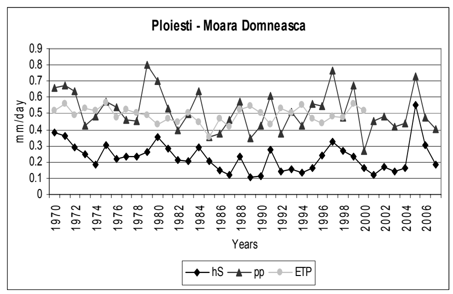
One can observe that for Campina weather and hydro stations, located in a sub-carpathian area, the amounts of rainfall and the values of the potential evapotranspiration follow the same trend, especially in the warm season of the year, when the liquid run-off also has some noticeable levels. The differences tend to increase during the cold season, when the PET decreases towards 0, while the amounts of rainfall remain at approximately high levels, owing that to the influence of snowfalls.

The situation changes radically for the low-lying areas, where the potential evapotranspiration has some very high values over the summer season, while the rainfall amounts are particularly low.

The drained water layer has insignificant values at these hydrometrical stations not only because of the low quantities of rainfall but also because it refers to the entire river basin located upstream from the station itself, a huge land area that cannot be represented by only one weather station.

We believe that a comparative analysis of the annual values of these three components is even more eloquent, as shown by the charts below:





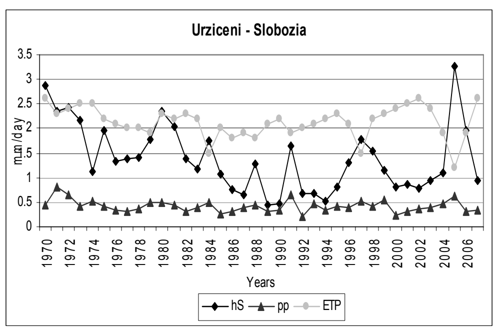


Fig.7 - The variation of the annual values of the drained water layer (hs), of rainfall (pp) and of the potential evapotranspiration (PET) for Ialomita River Basin as according to the data recorded by Campina, Ploiesti and Urziceni weather stations and Campina, Moara Domneasca and Slobozia hydrometrical stations

We can observe the different share of these three elements according to the different levels of altitude that the corresponding hydrographical basins have.

The situation is pretty different in the mountainous and hilly areas where the interconnection between PET, rainfall and surface liquid run-off is more complex and sharply changes from one year to another. In the sub-Carpathian area the amount of rainfall usually exceeds the values of the potential evapotranspiration with the exception of the dry years (such as 1990 or 1992) in which the surface liquid flow too shows significant decreases.

The drought that has been recorded over the last two decades has been the most severe. The driest ever recorded years for the weather stations we have taken into consideration were 1985, 1986, 1989, 1992 and 2000.

From a hydrological point of view the situation presents itself as slightly different, since the hydrometrical stations usually represent the entire river basin situated upstream from them, which often means a large area of land, while the weather stations usually offer „spot" information, applicable only for the very proximity of the station itself. Therefore, the meteorologically dry years are also hydrologically dry, meaning that the surface liquid run-off is poor, but an exact correspondence is hard and difficult to find.

Conclusions

The comparative analysis of the three parameters may offer valuable data upon the tight interconnection in a regional context.

The three elements show ample variations in both time (throughout the year and over several years) and space, even for stations or river basins located in similar geographical setting.

Such situations, developed in a regional or national context, prove that the surface liquid run-off regime has changed a lot and this has happened mainly because of the immense changes that affected all climatic parameters in recent times.

One can observe that the hydrological drought is not always triggered by the simple lack of precipitation, but also by high levels of PET, which, for the southern part of the country exceeds the amounts of rainfall, especially during the warm part of the year.

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