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TREND OF THE RAINFALLS AND TEMPERATURES IN A SMALL FLUVIAL BASIN OF PENINSULAR SEMIARID SOUTH-EAST

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I. INTRODUCTION AND JUSTIFICATION

The global change is understood as the interrelationship of changes induced by the natural processes and by the human action in the global environment, and their implications in the operation of natural ecosystems, and in society. This complex process includes many factors heavily interrelated which highlights the alterations in the climate, presently known as climate change. The changes in climate seems to affect, so important, ecosystems and in particular to the semi-arid systems mediterranean with a accentuation of water stress and increase the aridity. By this and other reasons the need to know and deepen the climate variability in scenarios vulnerable and uncertainty as are the river basins mediterranean and in particular the Southeast Spain.

New environmental and social challenges, and others related to the management of the territory and resources, arise due to the environmental deterioration prompted by the man and the real threats of climate change, which according to experts will have different consequences in each climatic zone. Climate change is a matter of a passionate scientific debate and poses a sharp uncertainty about weather, zones and its magnitude. However, there is an important consensus in its veracity and in the consequences that will increasingly become apparent in ecosystems and economic systems

II. OBJECTIVE

This work aims to contribute to the knowledge of the climate variability, in the framework of global change, in a small river basin in the semi-arid Southeast of the Iberian Peninsula, the river Quípar one, through the study of the evolution of the precipitation and temperature, analysing the possible patterns of change and, in turn, conclude the most direct impact that the climatic variation can have on the population and its activities.

III. AREA OF STUDY

The field of study is the River Quípar basin, located in the North-West of the Region of Murcia, in the Spanish Southeast, where the climatic aridity is one of the main defining characteristics. The total area of the basin is 826.4 Km . Its altitude ranges between 200 and 1,900 m, though, 50 % of its surface is above the 800 m. The basin of this river is an anthropized space, where the agricultural techniques and traditional uses of the territory are of great importance, emphasizing dry-farm crops and the limited irrigated land in fluvial terraces

The climate, its geology, its geomorphology and the soils determine the biophysical particularities of the territory. Aridity is the main climatic trait, the geology is dominated by the characteristics of the morpho-structures of the Betic Ranges and geomorphology manifests itself in some processes of erosion and accumulation that have caused a set of specific geoforms (karst, talus, alluvial fans , glacis, gullies, fluvial terraces, etc.)

The climate of the area under study is identified as humid temperate with dry summers, also known as Mediterranean climate. Nevertheless, it is necessary to clarify that in the north and northwest area of the basin, where there are territories of higher altitude, the Mediterranean influence is attenuated, and the relief determines the decrease in temperatures and an increase in rainfalls. in these mountain scenarios, the dominant winds from the West generate a certain foëhn effect evident in the fact that the slopes orientated towards the Western part receive more rainfalls than those placed in the Eastern part. The importance and orientation of the relief shows itself as one of the most important factors that determine the climatic characteristics in the basin.

The rainfalls in the area under study tend to be scarce and quite irregular in time. the total number of the hydrological year often records rainfall averages between 300 - 400 mm, with two maximum of rain, spring and autumn, more accentuated the second one because of the phenomena of DANA (isolated depression at high levels in the atmosphere).

The annual average temperature is around the 16 ºC, with a thermal swing of about 12 ºC, which impregnates the climate with a certain continental character. The winters are relatively cold, with an average temperature of 9 ºC. The spring has a soft character, with a few averages values of temperature of 17 ºC. The summers range between moderate and warm with a temperature around 23 ºC. Finally, autumn is fresh with a few values of 12 ºC.

IV. METHODOLOGY

The climate characterization of the basin is done through four weather observatories distributed through the territory. The methodology is based on the treatment of the data of the climatic series coming from the state agency of meteorology (aemet). The available series present gaps in data in some variables and temporary moments. in order to solve this error, known univariate and multivarientes methods are applied. The former has been used when the lack of data was produced at a time with values in other stations, while the univariate methods have been applied when the gap did not have this type of correlation.

it has been used the univariate method «approach of the differences», which is consists of replacing the lack of a monthly record with the value of the previous month, adding the average value of the differences between the previous month, and the month in question. this method is expected to be valid for series which have a high autocorrelation, so that it is not very appropriate for the precipitation variable.

The multivariate method is the «Weighted Linear Combination» (CLP). It consist of replacing the lack of data with data of neighboring series, in such a way, that each incomplete piece of information is obtained by means of the weighted linear combination of data of the series that will be used for the completion. Such data have, a burden in the CLP which is proportional to the coefficient of correlation of Pearson with the incomplete series, provided that this is higher than an acceptable critical value.

Once the complete climatic series is obtained, an analysis is carried out based in the interpretation of the trends followed by the precipitation and temperature. Due to the marked seasonal nature of the climate in the basin, the implications of the changes and trends will be different depending on the season. So, a seasonal analysis is made related to the changes in climatic variables. This analysis is based on the observation of the variations in the seasonal concentration of precipitation and temperature as well as on the analysis of trends of precipitation and temperature through its calculation by means of a linear regression. But given the wide dispersion of data that the variables studied show, the linear regression presents a very low goodness of fit, so that it may be valid to give a general idea of the tendency of the data, but not to illustrate periods or specific cycles. This type of information is offered by the polynomial regressions, which show a high correlation with the reality and which make possible to observe different moments or trends over the series.

On the other hand, an assessment of the variability in the course of the period under study has been made, calculating the coefficient of variation on moving 10-year averages, accumulating the values annually. In addition, it is established a classification of the seasons of the year on the basis of the direction and magnitude of the termopluviometric anomalies.

In the analysis of the data of each observatory, all operations are carried out both for the annual average, as for each time of year. In addition, with the complete series of rainfall available, IT is attributed to each monthly data the percentage value on the annual total, and so with all the years, for the final establish an average, the percentage weight that each month has on the annual value. Finally, it is estimated that average for the last 25 years, in this way, it is possible to appreciate if i know this changing the regime of rainfall.

V. RESULTS, AND DISCUSSION

1. Annual values of precipitation and temperature

The evolution of the annual rainfall in the basin, follows a slightly declining trend, but with some differences. Although these differences reflect the extent of the period of data and its weight, they have the various wet or dry periods in the linear regression. In any case, the extent of the series of rainfall in the observatory of Alfonso XIII seems adequately to describe the rainfall pattern, which keeps on registering wet and dry periods not as sharp as before 1950.

The annual temperatures present a slight tendency to increase, being very frequent the values higher than the average in the last two decades. However, in the last five years annual values of temperature below the average are detected.

With regard to the moving average, there are cycles of 20 years in precipitation, evident in all seasons. In the case of the temperatures, the less availability of data makes difficult a similar reading, nevertheless, it is also noted a certain bidecadal periodicity. So, there is a great correspondence between humid and fresh periods and dry and hot periods, especially since 1960, which makes droughts and affections in natural and human systems much more severed.

A special attention must be paid to the analysis of the evolution of the moving bidecadales averages. They show that the temperature record a marked increase over the whole period, and this rise presents significant cycles. On the other hand, rainfall seem to be more stable. In this way, there seems to be some stability in the rainfall pattern, with the exception of wet and dry cycles at the beginning and half of the period respectively. For that reason it cannot be stated that there is clear increase or decrease in the annual rainfall. Nevertheless, the linear trend shows an average downward bias of more than 30 mm total accumulated.

2. Values and seasonal trends of precipitation and temperature

The annual average hinder the study of the relationship between rainfall and temperature, and the perception of the implications which the changes in the main climatic variables have on the ecosystems and the population. That is why there is a need in carrying out a seasonal study.

To star with, in winter there is no significant trend in its development, although the winters in recent decades are considerably warmer. The winter rains show some increase so that its weight in the total annual has increased.

Spring shows the same pattern than winters, being quite significant a slight reduction in precipitation.

In summer, temperatures are stable but with an upward bias. The most remarkable issue is the sharp downward trend in the rainfall, which poses a significant decline in the summer rains, with the consequent impact associated with it.

Autumn seems to be the most stable season of all, both in terms of the rainfall or temperatures, since both variables appear apparently stable over the time. However, this stability or slight increase means that in a widespread context of decline of rainfall, autumn increases its importance as the rainiest season.

3. Variability and seasonality of thermal and rainfall anomalies

There seems to be a decline of the variability in temperatures, so that, in the last ten years more than 40 percent of the seasons are considered as very close to the average, which is higher than any other previous decade. There is no clear evidence of an increase of frequency of hot or cold seasons, but it is noteworthy the fact that the linear annual trend shows (very cold, cold, normal, warm and very warm), a slight increase towards warmer values, especially in winter, in accordance with the rest of the analysis carried out.

Regarding the precipitation, there is no clear sign of a tendency towards a greater or lesser humidity, although it is true that the trend here also coincides with the other analysis, appearing a clear bias towards the increase in dry or very dry years. These values coincide with the expected seasonal pattern, more regular and humid winters and autumns and irregular and dry summers, characterized by a strong humid tension, marked low water levels and some intermittent storms.

4. Evolution of the pluviometric seasonal variability

The analysis of the seasonal variability is essential for the study of the water availability and to predict risks associated with the recurrence of periods of drought and intensity of torrential rains. In this regard, it is apparent that contrary to some predictions and studies about the Spanish Mediterranean domain, in the river Quípar is taking place a clear reduction of the variability of rainfall on moving 10-year averages. Seasonally, the greatest reduction takes place in summer, followed by spring and winter; on the contrary this variability increases in Autumn. In this way, in outline it seems that rainfall are more stable in the basin, presenting annual values which are closer to the average, falling in this way the aggressiveness of major droughts and also of the torrential episodes.

The greater autumnal variability is even more significant than the trends in the rest of stations, as it is the rainiest season, with more than one third of the total of rainfall. So, this increase in the variability could well be due to a more irregular interanual pattern in the episodes of DANA, with a greater activity of these.

This decrease of variability on moving averages is likely to lead to a reduction in water availability in Quípar River Basin, verified on the other hand taking into account the 1980s, a period in which there is a marked reduction in the flows of the major rivers and springs in the Segura Basin. It is also important to note that it is precisely from this period on, when a more evident decrease of variability starts.

5. Changes in the precipitation and temperature regime

In the last 25 years there has been a percentage decrease of rainfall in the summer months, during which the highest temperatures and the water tension become more pronounced. The rainfall increase in the months of February, May and September but they decrease in April.

In line with this, temperatures, in the same period of time, show stability or rise in every month compared to the average values, highlighting that this rise is greater in the central months of the year, especially in summer. In the basin studied, it is confirmed the fact known in the Mediterranean area related to the existence of an inverse relationship between the rainfall and temperature.

VI. CONCLUSIONS

The previous results involve some implications, both for the natural environment as for the social environment. On the one hand, it cannot be found a clear variation in temperature and precipitation in the territory related to the total values, although it can be

seen a significant downward trend in the summer precipitation, followed by a slight rise in temperatures, as well as a change in the seasonal regime of these variables, in addition to a significant reduction in the variability on moving 10-year averages. It should be added that, all the analysis about trends show that the temperatures are experiencing an upward trend whereas precipitation are downward.

These changes become evident by analysing the seasonal pattern of climate which proves that there is a marked reduction of rainfall at the end of spring and early summer, and a moderate rise in temperatures. These phenomena are verified by other studies and areas of the Spanish interior and by climatic models where the greater reduction is expected in Spring.

On the other hand, in the rainfall pattern and temperatures in the Quípar Basin, it can be observed that when warm periods occur, the precipitation decrease and during colder periods rainfall increase, which causes more severe droughts. In addition, the decline in the variability coefficient, especially pronounced in summer, expresses a less severity in droughts or in torrential rain.

This climate pattern has a series of implications, such as the alteration in the hydrological cycle, changes in land use, impact on the dry farming, rise in demands for water for irrigated agriculture and supply to populations, etc. For water resources, the first impact is a reduction of the flows of rivers and springs, of the contribution of the course of water, of a lesser availability of stagnant water and therefore a widespread decline in the availability of water. Before the likelihood that the precipitation decrease significantly and the temperatures rise, as it is showed, among others, in the IPCC reports (2008) and the AEMET (2010), both the uses of the soil as the population should get adapted to the new climate scenarios that will be emerging in the coming decades. In short, the recent changes in the regime of precipitation and temperatures in the Basin of the River Quípar, pose new challenges of adaptation of the natural and socio-economic systems to new conditions, in the framework of global change.

VII. REFERENCES

AEMET. Clivar España. Red Temática, (2010): *Clima en España: Pasado, presente y futuro. Informe de Evaluación del Cambio Climático Regional*. F.F. Pérez y R. Bocolo (Eds)., 85 pp.

IPCC, (2008): *Fourth Assessment Report: Climate Change* 2007 /AR4) *Synthesis Report,* 114 pp