PONDS AND CLIMATE, THE GEOGRAPHICAL ASCENDANCY RELATIONSHIP ("LA BRENNE" CASE STUDY, FRANCE)

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ABSTRACT. Ponds and climate, the geographical ascendancy relationship ("La Brenne" case study, France). The climate influences markedly the volume of water ponds and lakes. However, the role and the influence of "small" water areas, and areas of ponds on the local climate remain poorly understood. Scientific studies for the Great Lakes have been made. Moreover, scientific studies on «small» water areas and areas of ponds do not exist until today. A first approach to study the area of ponds of "La Brenne" (Central Region, France) was performed. The monthly climate data from some meteorological stations, with the reference station of "Issoudun", located away from areas of ponds, were the basis of our analysis. The study focuses on the most representative climatic parameters. These are the temperature, precipitation and relative humidity. This first approach is used to distinguish and clarify the most important cases and relevant parameters in order to achieve a typology of criteria. Our results will be used for further study and quantify the real influence of "small" water areas and areas of ponds on the elements of the local climate.

Key-words: Geography, limnoclimate, ponds, water, influence.

1. INTRODUCTION: "LA BRENNE" A REGION OF NUMEROUS PONDS

The climatic effect of the Great water area in particular the very Great world lakes was studied for a long time. It is especially about Great lakes such as, Michigan, Erie, Baikal, etc. (Derecki, 1976, Fuller, 1995, Touchart, 1998). Apart from some old papers on the influence of the regions of ponds on the climate, the small water area and these regions of ponds did not interest many researchers of the various scientific domains and even less the geographers. Also, these papers were often a part of the researches which were interested in the other aspects related to ponds. Therefore, the researches contained assertions and ideas, without having made recourse to analyses related to the climate or to the limnoclimate[4] but contented themselves preliminary observations. These works often remind that the lowering in the temperatures and the increase of the precipitation result from the

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[4] Limnoclimat is defined as a local climate influenced by a Great water area or a region of numerous small water areas (territory of ponds).

presence of ponds and from the Great areas of water (Magnin, 1876). In terms of the climate, water areas in general and Great lakes in particular have a regulating effect on the climate while considering that the presence of a sufficient water volume regularizes the temperatures and the relative humidity. Moreover, the researchers interested in the Great lakes considered that the medium and the small water area contain an insufficient water volume to modify in a considerable way the temperature and the climatic parameters (Escourrou, 1980). However, many of the other cultural misconceptions exist in the literature and are based on a supposed negative influence of water areas. Many researches in geography-climatology are often limited to Great lakes or to big water reservoirs (Baikal, Michigan, Erie). This paper is interested in the effect of the water areas of lesser importance and small size on the climate. It is based specifically on a region of small water areas, namely the ponds of "La Brenne". The approach highlighted is based on the data processing of climatic parameters registered in some meteorological stations.

Our ground of study forms part of the territory of the "Region Centre". It is about "La Brenne" and more specifically about "Grande Brenne" which is situated in the South of the Region in the department of the "Indre". La Brenne which is also a Regional Natural Reserve (PNR) is characterized by a strong presence of ponds and figure among the Great zones of ponds of France (more than 4300, oral communication, 2012, new data Bartout). We are in front of a wetland of international importance; La Brenne is one of the biggest French continental zones of this type. Its poor clayey-arenaceous soils explain the creation of ponds (all artificial) (Web site of the PNR). This aspect makes the study of this region as a test case for this type of water areas.

To analyze the limnoclimate, it is necessary to make at first a small reminder of the general climate of the study area. Indeed, the region is located in an area characterized by a slightly degraded oceanic climate. This type of climate affects the whole Paris Basin with an extension to the south. The climate remains oceanic but with slightly damages. The temperatures are intermediate (approximately 11°C on average annual, between 8 and 14 days with a lower temperature in-5°C). The precipitation are low (less than 700 mm of annual accumulation), especially in summer, but rains fall on average on 12 days in January and on 8 in July, mean values were reported to the French's Territory. The inter-annual rainfall variability is minimal whereas that of the temperatures is high (Joly *et al*. 2010).

2. METHOD: MEASUREMENTS OF METEOROLOGICAL, CLIMATOLOGICAL PARAMETERS AND GEOGRAPHICAL MODELLING

The methodology is established on the data processing "Météo-France" with a statistical treatment based on certain climatic parameters considered as parameters influenced by the water reservoirs (Escourrou, on 1980), namely, the precipitation, the temperature and the relative humidity. For this fact, three

meteorological stations were chosen according to their places in relation to the area of ponds of La Brenne (fig. 1). One station is located in the south boundary of the region of the water area of Grande Brenne (Blan-Arci). The second is inside this zone (Rosnay) and the third station in the north of the region of ponds (Murs). These various places of stations will allow us to estimate the effects of ponds on the "local climate ". Also, another referential station (Issoudun) situated outside of the study area, in the same type of climate, has been selected to compare the results of the analyses of these stations (fig. 1). This last one is situated in a zone where ponds make rare even non-existent, in approximately 43 km east of La Brenne. The data processing of chosen stations will allow us afterwards to widen the study towards other stations in the Natural Reserve to further study and encircle it while specifying real climatic factors and their degree of influence. All these stations are located in altitudes close to each other. It is about 108 m above the sea for the station of Blanc-Arci, 109 m for Rosnay, 148 m for Murs and 138 m for Issoudun. The size of water areas will have no importance in our current analysis because we work on the scale of a region of ponds: in this study we will focus on the influence of the whole region.

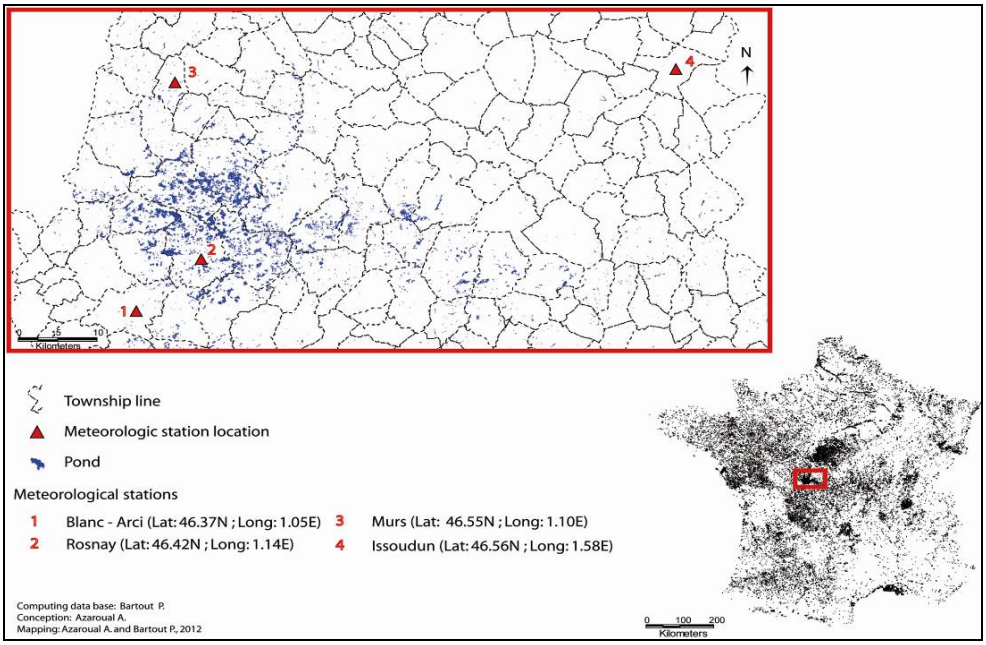

Fig. 1. ***General map of the study area and the location of the meteorological stations***

The analytical work is based on the modeling of the climatic parameters previously presented. To represent the climate of a station, several types of diagram are used. The simplest are ombro-thermal diagrams and climographs, two types of figures showing the monthly average of temperatures and precipitation (Beltrando, 2004, p. 124). In our current study we opted for the creation of the ombro-thermal diagrams by using the relationship of scale proposed by Gaussen (P=2T) from the

statistics and monthly averages registered in the meteorological stations taken into account. The choice of this type of diagram is based on its adaptation to the climate of the region of study (Charre, 1997) and he allows a simplified and relevant comparison between the data of every station with a partial synthesis but relatively synthetic (Beltrando, 2004).

The relative humidity, from its meaning in the parameters of influence, was taken into account in our analysis and modeled in order to compare its evolution in each station. It is expressed in percentage and corresponds to the relationship between the really contained quantity and the one witch would saturate the same air in the same temperature (Vigneau, 2000). For a relative humidity of 0 %, the air is absolutely dry. The air saturated in water vapor presents by definition a relative humidity of 100 %.

The evolution of the relative humidity is largely connected to those of the anomalies of precipitation and temperatures with different variants. The quantity of water that the atmosphere in the form of vapor can absorb depends strongly on its temperature. More the air is warm, more it is absorbent, under condition, of the existence of a sufficient source of humidity at the level of the substratum (sea, lakes, ponds, etc.) and also of a source of energy necessary for the transformation of the liquid water in water vapor (Pagney, 2007).

In regard to the temporal analysis, the accent was put on the choice of a small period of data in the climatic scale. As it is about a study which leaves of the general to retail, and of the small scale towards the large scale in a multi-scalar approach, the monthly data were privileged to be able to raise the first general results of analysis. These data spreads out over a recent period of four years (2008-2011).

3. RESULTS: THE IMPACT OF PONDS ON CLIMATE OR LIMNOCLIMATE STUDY

The series of the precipitation and the air temperature, presented in this paper, is extracts monthly analyses. A simple comparison between the various graphs of each station shows that the stations which are in the middle or at the edge of ponds register an interesting stability and moderation during the year in terms of precipitation and temperature (fig. 2 and fig. 3). Thus, three stations register the ranges less important than the station of Issoudun in particular at the level of the average of the precipitation. The differences enter the wettest and the driest month of the average of four years (2008-2011) are 54.9 mm for the station of Murs, 56.5 mm for the station of Rosnay, 59.6 mm for the station of Blanc-Arci while it amounts to 64.2 mm for the referential station of Issoudun. On the other hand and contrary to the fact that we can think, the highest mean value is registered in the station of Issoudun and which is 97.9 mm during December. It is the same month which registers the highest averages of the other stations. It is 83.2 mm for the station of Rosnay, 86.4 mm for Blanc-Arci and 90 mm for the station of Murs.

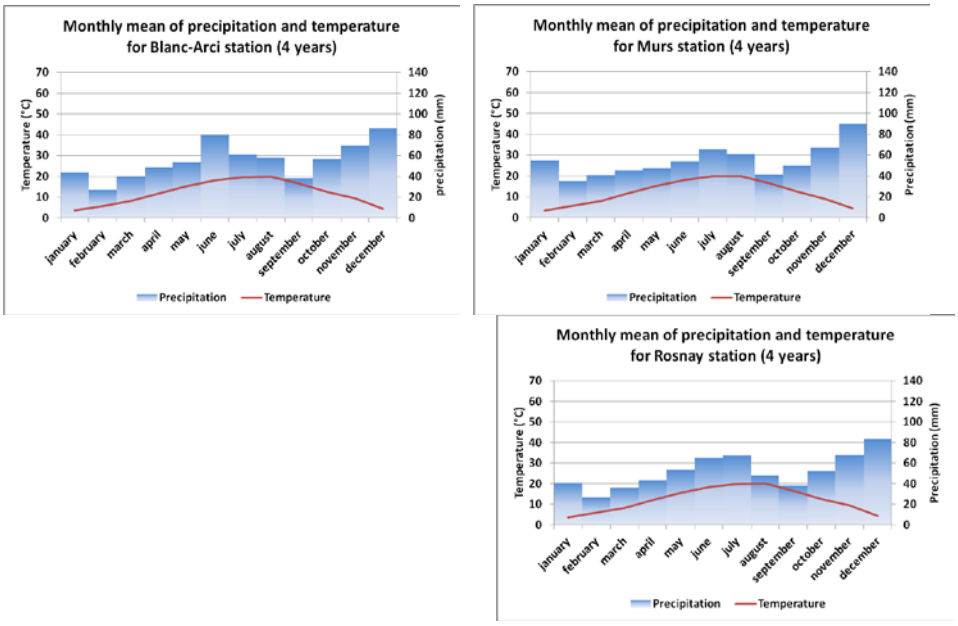

Fig. 2. ***Monthly mean of precipitaion and temperature for the Blan-Arci, Musr and Rosnay stations***

Concerning the temperatures, even if the mean value is less important, we register a slight difference between the ranges of each station. It is (the thermal amplitude of four years of study) 16.3 °C for the station of Blanc-Arci, 16.4 °C for the station of Rosnay, 16.5 °C for the station of Murs and 16.8 °C for the referential station of Issoudun.

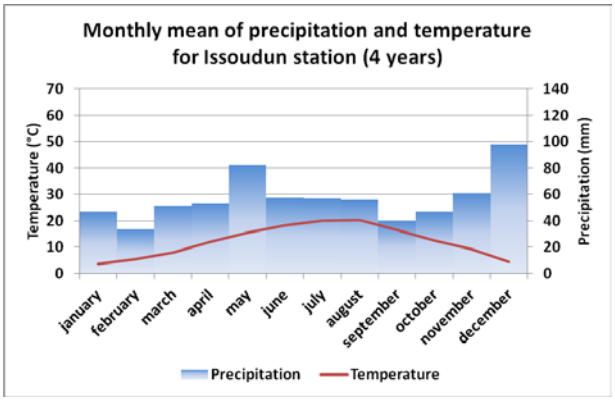

Fig. 3. ***Monthly men of precipitation and temperature for referential station of Issoudun***

The curves of evolution of the average temperatures of three stations near to the area of ponds know almost all the same evolution and overlap during most of

the months of the year. For the station of Issoudun, the evolution is often higher and crosses itself with the curves of the other stations only during the winter seasons. In other words, the average temperature of the station of Issoudun is often superior to that of the other stations during all year. Thus, the most mattering range between three stations and referential station is noticed during summer and it attains 0.3 °C in August (fig. 4).

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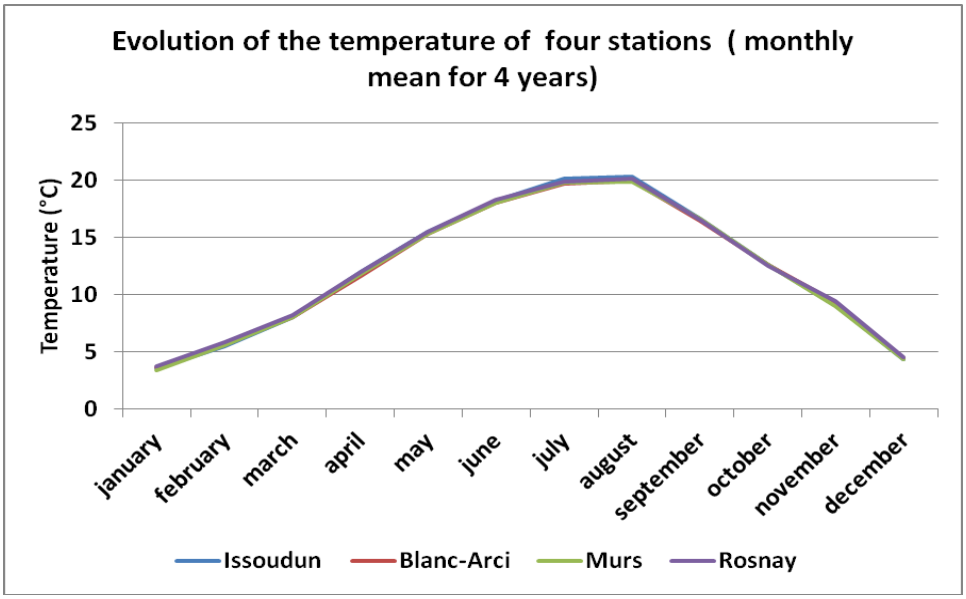

Fig. 4. ***Evolution of the temperature of four stations***

What was said on the temperature and the precipitation can be also said for the relative humidity. The data of the stations near or inside the zone of the presence of ponds show regularity between years and a moderation between the months of the year in term of humidity of the air. Thus, the stations of Rosnay, Murs and this of Blanc-Arci know a remarkable stability with fluctuations less important than that registered in the station of Issoudun. The range of the mean values of four years consideration in this study is more important for the station of Issoudun because it reaches 26 while there are only of 20 for Rosnay, 22 for Blanc-Arci and 25 for the station of Murs.

The curves of evolution of the relative humidity for three stations near to the region of ponds are very close and overlap by moment in particular during summer even if the curve of the station of Murs registers a slight superiority during winter. However, the curve of evolution of the relative humidity of the referential station of Issoudun is characterized by important fluctuations and crosses itself with the other curves of the other stations only during winter. The range the most mattering between three stations and station of Issoudun intervenes during summer because the relative humidity touches the 60 % for the station of Issoudun (fig. 5).

These results confirm the influence of ponds on the local climate or at least on the variations of the local climatic data at first. This aspect is asserted by the data of the station of Issoudun where the temperatures and the precipitations know important variations during the year and irregularities between one year and the other one. The relative humidity confirms this report by registering important fluctuations enter the stations which are located near of the region of ponds and the station of Issoudun.

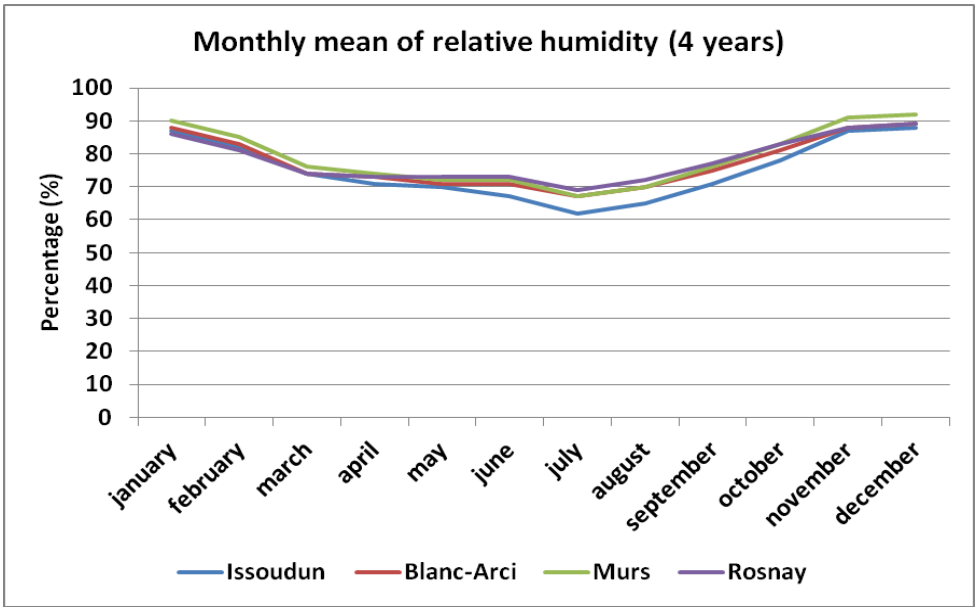

Fig. 5. ***Monthly mean of relative humidity for four stations***

4. DISCUSSION AND CONCLUSIONS

The comparative approach used here being very simple, the results are uncertain and require an in-depth study based on finer analyses and over longer periods, but we applied a statistical approach which allows us to have significant results. A slight variation in the temperatures and in the precipitations, for example, confirms the influence of ponds on the local climate with peaks of similar temperature for three stations being situated near the region of ponds and a peak slightly more raised for the referential station of Issoudun. The method exposed in this paper considers the average of the various climatic characteristics of each month without going farther to details to have a first approach of the results of this influence. It leaves a simple base which advances the comparison which allows distinguishing clearly the station the best represented for the temperatures or the precipitation even for the relative humidity. This station is not other one than that of Rosnay who is in the middle of the region of ponds of La Brenne. It is the station which registers a more remarkable stability with less important variations.

This will facilitate the choice and the characterization of the climatic parameters for each month of the year and for each station to define, afterward, the degree of influence of every parameter.

The limno-climatic research concerning the small-sized water area and limnic wetlands regions based on the analysis of meteorological data and measures of ground is still in a launch phase. The results proposed in this article are limited by the rarity of the documentation being directly interested in this subject of study and treating water areas of medium size and small size or regions of ponds. Nevertheless, the documentation concerning the climate and the influence of the Great lakes is considerable, and can allow loosening multiple avenues of research to define the degrees of influence of ponds and the significant periods of analysis. However, these data offer the other teachings because; they allow us to make a first report and to assert the existence of an influence even if it remains small and without a precise temporal and spatial scale.

The overall results of these analyses constitutes an indispensable stage to introduce these researches by basing itself on a multi-scalar approach starting from the general to the detail to establish a starting point for these researches and climatic indicators in particular. It would mean setting up a typology of water areas by using an approach based on the size and the time to establish if there is a real correlation between the size of water area and the local climate.

We can regret that the limnoclimatical study presented in this paper is based only on averages because they limit a little the synthetic reach and a frequency analysis of rains, temperatures and other parameters would bring a complementary support of a big utility and a deeper comparison. In other words, it would be interesting that in these graphs of averages can be added in the future, analyses on edges of smaller periods and the more synthetic data. Their elaboration does not present considerable theoretical difficulties but requires a rather long statistical study. Decadal statistics even daily can be the base of this study. Thus, the consideration of the new climatic parameters and the other meteorological stations prove to be indispensable in the studies to come.

To conclude, we can assert that the presence of the water and “limnical area” influence the “local climate”. This influence, as show it analyses made in this paper, does not intervene in the increase of the precipitation or at the level of the decrease of the temperatures but it intervenes in particular in the regularity and moderation of the climatic aspects. It is about the humidity, about the temperature and about the precipitation. Besides, it should be noted that this study concerned only recent periods and remains very general because it is based on monthly averages. Stations close to the region of pond register a slight increase of the averages of precipitation. However, and contrary to generally accepted ideas, the temperature of four stations taken into account in our analysis registers very close mean values even if a slight difference appears during summer for the referential station of Issoudun. The averages of the relative humidity register a remarkable stability for stations close to the area of ponds of La Brenne and to the important fluctuations for the referential station of Issoudun.

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