

The Effects of Climate Change on Water Resources in Spain

In order to achieve appropriate hydrological planning, it is necessary to take into account two important aspects, which are, on the one hand, assessing the available water resources, especially the renewable ones, and on the other, estimating the demands of the different water use sectors, both present and future. Currently in Spain, the Ministry of Environmental and Marine and Rural Affairs is in the process of developing hydrological plans containing the different river basin districts. These documents establish the distribution of the water resources for the different uses in the coming years (urban supply, agriculture, industry, etc.), with the above-mentioned issues being essential to their correct elaboration.

River basin districts



The first aspect, the available water resources, is an essential element in establishing the total water volume available. We find that, according to the data from the Ministry of Environment and Marine and Rural Affairs listed in the following table, the input to the rivers has been reduced by about 15% between 1996 and 2005 with regard to the average values obtained during the 1940-1995 period.

<i>Mean annual water input (Hm³/year)</i>			
<i>District</i>	Mean input Period 1940-1995	Mean input period 1996-2005	Reduction of the water input in the 1996-2005 period with regard to the 1940-1995 period
<i>North</i>	43.494	38.573	-11,3 %
<i>Duero</i>	13.861	11.729	-15,4 %
<i>Tajo</i>	10.533	9.012	-14,4 %
<i>Guadiana</i>	5.464	4.391	-19,6 %
<i>Guadalquivir</i>	8.770	8.113	- 7,5 %
<i>Mediterranean-Andalucian Basin</i>	2.446	2.101	- 14,1 %
<i>Segura</i>	817	505	- 38,2 %
<i>Júcar</i>	3.493	3.057	- 12,5 %
<i>Ebro</i>	17.189	13.555	- 21,1 %
<i>Internal Basins of Cataluña</i>	2.742	2.196	- 19,9 %
<i>Total</i>	109.948	93.763	- 14,7 %

Source: Ministry of Environment, Marine and Rural Affairs.

The reduction in the input of water to the rivers has occurred in an uneven way, both across basins in general and even within each basin. However, all of them have had their resources diminished dramatically. This reduction has been especially severe in the

Segura basin, around 40%, as well as those of the Guadiana, especially at its source, the Ebro and internal basins of Cataluña, which have lost about one-fifth of their input over a period of only 10 years.

Ten years could be considered a relatively short period of time; however, it should be kept in mind that, within the 1996-2005 period, there were only two years of drought, while in some years the precipitation was much higher than the average. On the other hand, the 1940-1945 period includes the two most severe droughts suffered in our country in the twentieth century, the ones that occurred in 1940-1945 and 1990-1995. In summary, with a precipitation level that could be considered normal, or even slightly higher than the average during the twentieth century, we find that the water input to the rivers during this period has fallen sharply. Thus, lack of precipitation should be ruled out as the cause of this important reduction in water input. To conclude, in spite of a normal level of precipitation, the input of the water resources to the rivers fell by 15% over a period of 10 years (1996-2005).

Once precipitation has been ruled out as the cause of the diminishing water resources, there are other factors that are being considered, and it is quite possible that the cause lies in a combination of them.

One possible reason could be the over-exploitation of the aquifers in vast areas of our country, which might prevent the water from reaching the rivers. However, in a large number of aquifers the connection with the rivers is not fast and direct enough to produce such an important reduction. Besides, the drop in the water input has also occurred to almost the same extent in basins and sub-basins where there are few aquifers or they are very limited.

Another possible reason could be the expansion of the forestry regions which, due to the retention of rainwater in leaves of trees (interception coefficient), promotes later evaporation, causing the runoff to be reduced. However, although it is true that the forest land has been increasing in Spain in the last few decades as a result of the progressive abandonment of some of the crop land, this extension of the forests has been very slow, which contrasts with the dramatic reduction in the water input. Furthermore, as occurred in the case mentioned above, in those basins and sub-basins where the increase in forest land is quite limited or even non-existent, the water input to the rivers has experienced a reduction similar to that of the rest of the basins and sub-basins.

The third possible reason would be the increase in temperatures that the Iberian Peninsula is experiencing, which produces more direct evaporation of water, especially before reaching the rivers, as well as greater consumption and evapo-transpiration of water by plants.

According to the State Meteorology Agency (AEMET), which depends on the Ministry of Environmental and Marine and Rural Affairs, during the 1973-2005 period both the mean temperatures and the maximum and minimum temperatures increased greatly.

<i>Annual and seasonal increase in daily temperatures . Period 1973-2005 (in °C/decade)</i>			
<i>Periods</i>	Maximum daily temperatures	Minimum daily temperatures	Mean daily temperatures
<i>Annual</i>	0,51	0,47	0,48
<i>Winter</i>	0,35	0,06	0,27
<i>Spring</i>	0,82	0,66	0,77
<i>Summer</i>	0,73	0,62	0,67
<i>Autumn</i>	0,13	0,43	0,29

Source: Meteorology State Agency (AEMET)

For the 1980-2006 period, the State Meteorology Agency (Service of Meteorological Developments) has produced a list with the mean annual temperatures of the Spanish peninsula and the Balearic Islands (based on data from 40 meteorological stations). This list shows an upward tendency of 3.7°C/100 years. The five warmest years were, with the mean estimated temperature in parentheses: 2006 (15.87°C), 1995 (15.81°C), 1997 (15.75°C), 2003 (15.73°C) and 1989 (15.65°C).

As can be observed, the temperature increase experienced in recent decades is evident. Moreover, as shown in the table above, the greatest increases are occurring during the spring months, which is the time of year when the country receives much of its rainfall and the consumption of water by most of the vegetation is greater. Hence, it is predictable that the loss of water due to the increase in evaporation and evapotranspiration would be more pronounced than at any other time of year.

Therefore, it seems obvious that the temperature increase experienced in Spain in the last few years is causing an important rise in the direct evaporation and evapotranspiration coefficients, which undoubtedly means a decrease in the runoff coefficient.

In short, the conclusion can be reached that the main cause of the dramatic reduction in the water input to the rivers experienced in recent years in our country is the increase in temperatures that is taking place due to climate change. Moreover, given the established tendency, it is foreseeable that the 15% reduction obtained in the 1996-2005 period, with regard to the 1940-1995 period, will also increase sharply in the coming decades.

However, and in spite of the decrease in the available water resources, water consumption in Spain continues to increase. The amount of irrigation continues to rise in the basins of the Ebro River, where the crops are high water consumers, and in the basins of the Guadalquivir River, mainly due to the irrigation of tens of thousands of hectares of olive trees and vineyards. Water consumption also continues to rise in the basins of the Duero, Tajo, Guadiana and Jucar rivers, in the latter two also due to the irrigation of vineyards.

With regard to the consumption for urban distribution, it has increased considerably in all the basins, being especially important in those basins in the Mediterranean area. Moreover, in these Mediterranean basins the urban growth is characterised by its relationship with tourism, including a large number of swimming pools, gardens and golf courses, which have a lower water return (less than 50%) than the conventional urban supply (80%), significantly increasing the effect on the final volume of the water resources available.

Diminishing water resources and water consumption that increases every year point to a situation of greater hydrological and, therefore, environmental unsustainability. Thus, while in 1990 it was thought that the Segura was the only basin with a structural deficit (demands exceeding natural input), currently it is assumed that prior to 2010 this will be the situation in the basins of the Júcar and Guadalquivir rivers, the Internal basins of Cataluña, a part of the Guadiana, and the Mediterranean-Andalusian basins, encompassing, in all, one-third of the peninsular surface.

As mentioned above, the Ministry of Environmental and Marine and Rural Affairs, through the hydrographical confederations, is developing the hydrological plans for the river basin districts. In these documents, the assumption is that there will be a 7 % reduction in the resources available, with regard to those theoretically existing in the early 90's, a figure that is lower than the true one. Given that these documents contain the hydrological plans for the coming years, Ecologistas en Acción considers that, not only should the already confirmed reductions of over 15% be contemplated, but the expected pattern for the coming years should also be included. Otherwise, we fear that the demands established in these planning documents will not be satisfied by the water resources that will actually be available, with the resulting harm to the environment, the society and the economy.

Ecologistas en Acción considers that the only solution to this problem is to adopt measures to recover the lost hydrological balance in each basin and sub-basin. Specifically, this can be achieved by means of increasing the efficiency of water use when possible, and by reducing the demands of those activities that consume the most. To do so, it is necessary to completely stop the development of new irrigation lands, as well as eliminating part of the existing irrigation crops, on the order of a few hundred thousand hectares, establishing a maximum of irrigated land in Spain of 3 million hectares. Likewise, water extraction from those aquifers that are suffering over-exploitation should be stopped at once, except for urban supply and when there is no alternative.

It would also be necessary to implement measures restricting the increase in water consumption in the urban and tourism sectors on the Mediterranean coast. Although their development has slowed down due to the recent crash in the housing market, these sectors continue to be big consumers and destroyers of natural resources, including water.

The reduction in the water input to the rivers in the Iberian Peninsula is a very serious environmental concern whose main origin can be found in climate change and, therefore, human action, and which leads to serious environmental, social and economic problems. For this reason, the public administrations should act immediately, on the one hand, by implementing the necessary policies to stop climate change and, on the other, by adjusting the current and future water demands to the resources available, which, following the current trend, will be increasingly scarce.

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