Chapter 2

Site description

The Ebro basin stretches from Spain's intermediate mediterranean coast to the north of the Iberian peninsula. Its area occupies approximately 17% of the total of the Iberian surface. Further information can be represented in a listing form as seen in [27].

- Length of the reach: 928 km
- Basin surface: 85820 km^2
- Average flow at Miranda: 82 m^3/s
- Average flow in Tortosa: 319 m^3/s

Geographical data can be downloaded freely from the website of the CHE [8]. In order to illustrate the magnitude of the installations present that are going to be described in the next section, some of the data has been visualized as seen in figure 2.1.

2.1 Installations

To describe the basic principles of water use, the basin has been divided into three parts according to their functions [4].

1. Up to Miranda de Ebro
2. From Miranda de Ebro to Mequinenza
3. From Mequinenza to the delta

Apart from a few small irrigation and drinking water extractions up to Miranda de Ebro no reasonable water consumption can be accounted for. Downstream though, large irrigation projects have been implemented with the construction of the Ebro dam in 1945 with a capacity of 540 hm^3. This reservoir regulates water which is derived downstream towards the canal Lodosa and partly to the canal Imperial de Aragón and canal de Tauste. The Ebro reservoir feeds a minimum flow of 1 m^3/s. Apart from other water uses hydropower generation takes place here. Especially mentioned shall be the hydroworks of Sobrón with a concessionary flow of 80 m^3/s and the one at Puentelará with 55 m^3/s. Further-on the following power plants can be found up to Mequinenza.

- Cereceda reservoir, constructed in 1947 with a capacity of 1,2 hm^3.
- Cillaperlata reservoir, constructed in 1956 with a capacity of 0,6 hm^3.
- Puentelará reservoir, constructed in 1968 with a volume of 1,5 hm^3.
- Sobrón reservoir, constructed in 1960 with a volume of 20 hm^3.

Finally there is the water transfer which connects the Ebro reservoir to the Saja-Besaya basin. Works were started in 1982 in order to guarantee the resources for domestic and industrial water supply of the Torralavega region. The water transfer is reversible and has a capacity of 4 m^3/s, whereas the annual volume transported amounts to 49,9 hm^3/a to Torrelavega and 23,7 hm^3/a into the Ebro reservoir. In the streak reaching from Miranda de Ebro to the Mequinenza reservoir major water abstractions can be found. Apart from the major ones the following canals divert:

- Londosa canal, which derives its waters from the Mártires de Lodosa dam following the right waterside of the Ebro for 127 km feeding between Mallén and Gallur. Its main application is for the irrigation of 32,868 ha of land. Its flow is regulated from the Ebro reservoir.
- Tauste canal, which takes its waters in Fontellar and continues on the left waterside for 44 km. It disembogues into the Ebro in Cabañas de Ebro. Its major use is for the irrigation of 8,845 ha of land. It is being regulated from the Ebro reservoir, although it also benefits from the regulation of the Aragón river.

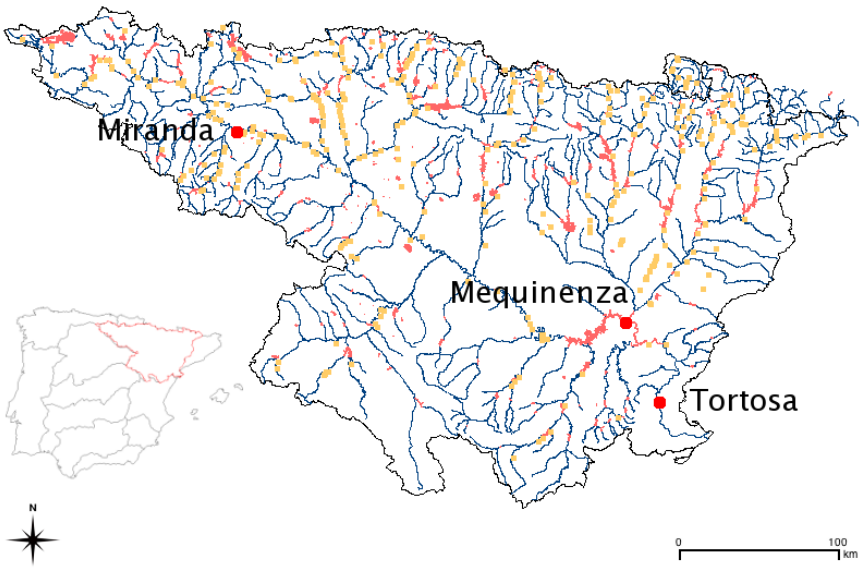

Figure 2.1: *Ebro basin illustrated using data from the CHE. The Ebro river and its effluents are marked in blue, hydropower stations can be seen in yellow and reservoirs are illustrated in red.*

- Imperial canal of Aragón, takes its waters in Fontellar and from the reservoir abstraction weir in Pignatelli. It follows the right Ebro waterside for 105 km up to the border of the ”Burgo de Ebro district”, ”Términos del Burgo de Ebro” and Ebro Springs. With its water 25,800 ha are being irrigated and Zaragoza (100 hm^3/a) and 16 cities more are supplied for domestic as well as for industrial use. The discharges are regulated from the Ebro reservoir and the Aragón river.

Further-on there exist some 50,000 ha of smaller irrigation patches, representing the most significant infrastructure draining from Pina, the elevation of Quinto, draining from the Ebro in Alfaro, Pradejón and the river Nuevo de Mendavia.

Also there exist several hydropower stations. Special emphasis is put to the Mequinenza reservoir. It was constructed in 1966 and disposes over a capacity of 1534 hm^3 mainly assigned for hydropower use with a concessionary discharge of 900 m^3/s. In the section downstream from Mequinenza to the estuary, apart from the Mequinenza reservoir, the following two important reservoirs can be found:

- Ribarroja reservoir, constructed in 1961 with a capacity of 210 hm^3.
- Flix reservoir which was constructed in 1948 with a capacity of 11 hm^3.

The Ribarroja power station disposes of a concessionary discharge of 900 m^3/s, the one at Mequinenza over 600 m^3/s and the one at Flix over 80 m^3/s.

The employment of those power stations ought to follow discharge demands of 72 m^3/s at the nuclear power plant at Ascó, which went into production in 1983. Further discharge demands have been assigned to the currently static ecologic inflow requirement for the Ebro delta with 100 m^3/s.

For its agriculture exist two major canals, also called the Delta canals which derive their water from the Xerta canal intake weir and serve for land irrigation along the attaching areas in the final Ebro segment, mainly corresponding to the delta. The two canals are:

- Right canal with a length of 51,5 km and an irrigation surface of 12,000 ha.
- Left canal with a length off 51 km and an irrigation surface of 12,691 ha

Both canals dispose over weirs deriving water for the Ebro-Campo of Tarragona diversion, which are dimensioned for 70 hm^3/a. Developments of reservoir volume have been illustrated with data from [27] in figure 2.2.

2.2 Ecologic division

The CHE has launched a campaign [7] to develop a regional breakup of the Ebro basin watershed with the objective to separate biologically similar habitats. In order to achieve a satisfactory result, characteristic chemo-physical and biological regional data has been used as input information. The following variables have been used to circumcise in a statistically significant manner regions mentioned below.

- Altitude of observation station

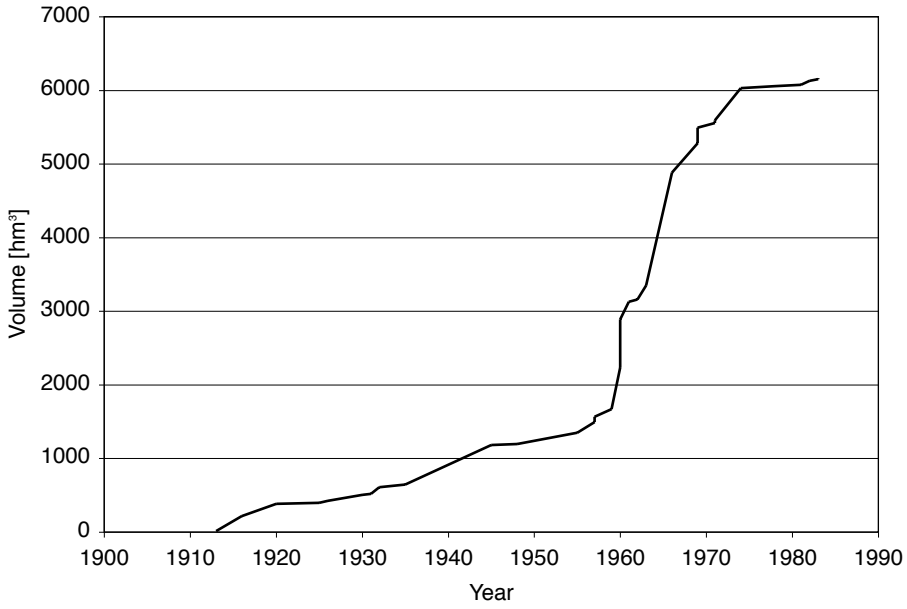

Figure 2.2: *Reservoir constructions in the Ebro basin as seen with [27]. Illustrated is the cumulative reservoir volume over time. The sharp increase during 1960-1970 is caused by the employment of the Ribarroja and Mequinenza dam.*

- Environmental temperature
- Annual precipitation
- Annual discharge
- River number according to Strahler
- Slope of sub-basin
- Percentage of silicious rock material present in sub-basin
- Percentage of limestone material present in sub-basin
- Percentage of silicon-carbonous rock material in the sub-basin

Biological parameters have been grouped by the abundance of macroinvertebrae families in combination with its respective abundance. Since species are quite numerous they will not be cited in this work, but can be looked up in [7]. Applying chemo-physical and biological parameters six regions have been defined. A tabular listing with its regional characteristics can be found in figure 2.3.

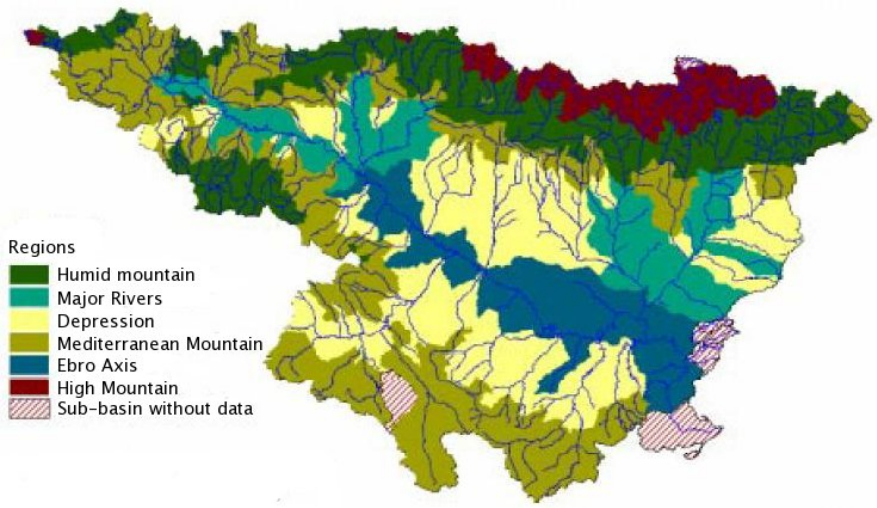

Figure 2.3: *Ecologic regions in the Ebro basin according to CHE studies [7]. Illustrated are the six ecologic regions as detailed in A.1. Since the Ebro Delta represents a unique ecosystem, it is not being included in the Ebro Axis region.*

2.3 Conclusion

The reader has been presented with an overview of the present installations and the different definitions of division. In order to apply the anticipated models for instream flow evaluation, a gauging station with long-term records is indispensable. Also the discharges ought not to be influenced by downstream water retainment as for example a

reservoir, in order to fully observe the upstream reservoir impacts. Thus the reach of interest lies downstream of the last large dam at Flix. Long-term recordings downstream of Flix are only given at Tortosa gauging station, thus the section in focus is located between Flix and Tortosa (see also figure 2.4). For reasons of anticipated model architecture the final focus will be put on the reach Tortosa-Xerta.

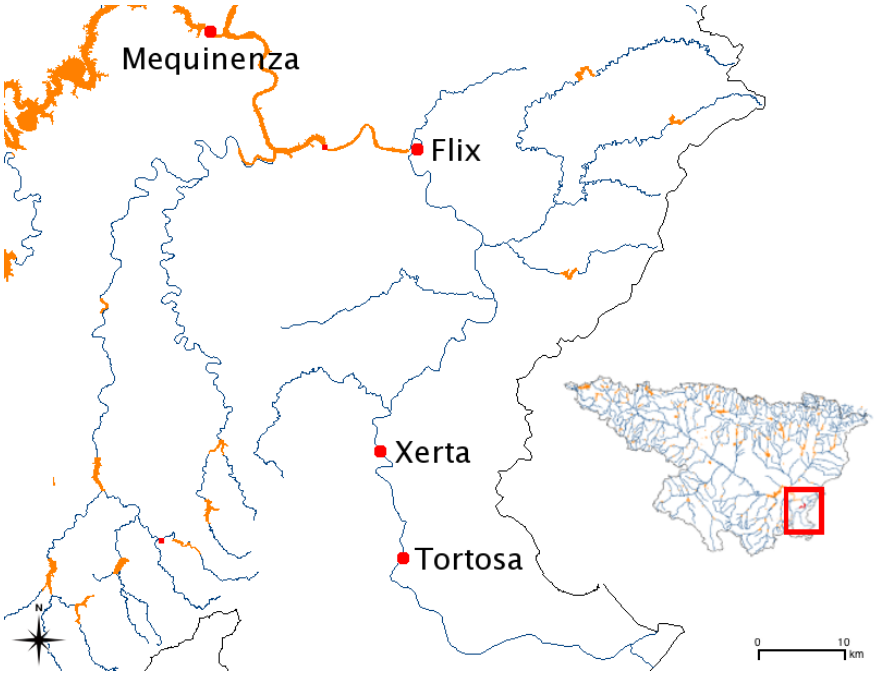

Figure 2.4: *View of study site. Reservoirs are marked in orange, whereas dams respectively power-stations are marked in red. The study-site is located between Xerta and Tortosa.*