

SPAIN

INTRODUCTION

Constitutionally, Spain is a bicameral Parliamentary Monarchy, the Chef d'Etat being the King, with a Central Government chaired by a Prime Minister, or Government President. Administratively, Spanish insular and continental territories are divided into 17 Autonomous Communities (15 continental and 2 insular: the Canary and the Balearic islands), governed by their respective Regional Governments, endowed with wide powers within their Regions but subject to the State's Central Government for basic issues of statal scope at national level, affecting the general governance (planning in different fields, finances, public works, justice, health, education, etc.), as well as international affairs, relations with the European Union, etc.

1. PHISIOGRAPHY

Spain occupies about 85 per cent of the Iberian Peninsula; it is situated on the extreme south-west of Europe, lying between the latitudes 36° N and 43° 47' N and between the longitudes 3° 20' E and 9° 30' W. It is bounded on the north by the Bay Biscay and France from which it is separated by the Pyrenean Range of Mountains; on the east and south by the Mediterranean Sea and the Atlantic Ocean; and on the west by Portugal and the Atlantic Ocean.

Physiographically, Spain consists of an ancient crystalline block with Alpine Mountain ranges of the Tertiary period to the north (the Pyrenees and Cantabric Mountains) and to the south-east (the Penebetic Mountains). Between the Central Plateau and the north-eastern range of mountains there is a tectonic basin, the Aragon Lowland, through which the Ebro River flows, whilst between the plateau and the southern mountains there is another structural basin occupied by the Guadalquivir River. The Ebro River rises in the north-west and flows east and southwards, eventually cutting its way through the Catalanian Range to the Mediterranean.

More than half of the Spanish peninsular territory is occupied by the Central Plateau, which is an ancient earth block consisting mostly of flat-lying strata, broken and eroded, and reduced in large part to a state of peneplain. The Plateau slopes gradually south-eastwards, its average altitude being about 600 m over sea level. A number of smaller parts of the Plateau itself make local mountain ranges, such as the Sierra de Guadarrama (Guadarrama Range) with peaks over 2,100 m, separating the basins of the Old and the New Castile, and the Montes de Toledo (Toledo Mountains) to the south-west. Several large rivers (Duero, Tagus and Guadiana) originate in the eastern part of the Central Plateau and flow westwards across it to the Atlantic.

The Montes de Toledo are a series of Sierras, or Mountain Ranges that form a denuded high land of relatively low elevations and are separated from the Iberian Chain of Mountains by a wide plain of the Plateau known as La Mancha. Their highest point is Las Villuercas (1,420 m) in Sierra de Guadalupe. Their westwards extension into Portugal is known as the Montanhas do Alentejo. The Sierra Morena is an even less continuous range than the Montes de Toledo. Its westerly extension into Portugal ends at the rocky headland of the Cape St. Vincent.

South-west of the Central Plateau is the Betic or Andalusian Lowland, a long syncline running north-east from the Gulf of Cadiz. Like the Aragon Lowland, the depression was occupied during the Tertiary period by an arm of the sea, and the underlying rock is predominantly Tertiary. Much of the ground today, however, is covered by recent alluvial deposits, making the area extremely fertile. The Guadalquivir River flows through the depression to empty into the Gulf of Cadiz. Near the delta is an extensive area of marshes known as Las Marismas.

Extending south-westwards from the eastern end of the Pyrenees are the low Catalonian Mountains, with elevations from 1,000 m to 1,200 m which run parallel to the Mediterranean coast for about 400 km and effectively shut off the Aragon Lowland from the sea. A narrow but fertile plain follows the Mediterranean coast north of the Cape Palos.

In the south-eastern part of the country is the Penebetic Mountain chain, over 3,000 m culminating in the Mount Mulhacen (3,426 m), the highest peak on the Iberian peninsula.

2. CLIMATE AND RAINFALL

The climate of Spain may be divided into three types; the temperate mean climate of the north-west and the north with moderate temperature and ample year-round precipitation; the Mediterranean climate of the south and the east coast with mild moist winters and hot dry summers; and the arid continental climate of the interior with its cold winters and hot and dry summers.

The total average annual rainfall over the whole country is 684 mm; however, excluding the northern slopes of the Cantabric Mountains that occupy 10.7 per cent of the national territory and receives 22 per cent of the total rainfall, and some specific small areas in the South, where high precipitations are caused by the moisture-bearing winds blowing from the Atlantic, the average annual rainfall over the rest of the country comes down to 578 mm. being indeed a great variation of rainfall from one basin to another. The average annual precipitation ranges from over 1,500 mm in the north-west (Galicia) and on the western slopes of the Pyrenees to less than 250 mm in the Aragon Lowland and La Mancha plain in the centre of Spain. The province of Almeria, in the south-east coast of the Mediterranean, has only an average annual rainfall of 150 mm which has urged the development of an extra intensive agriculture under plastic and greenhouses, taking advantage of the favourable climate and the existing aquifers, to produce early crops for both national and international markets.

The climate and rainfall conditions of the country make irrigation necessary on the whole territory (excepting the north and north-western humid regions), and particularly along much of the eastern and south-eastern coasts, in the Aragon Lowland and over a large part of the Central Plateau, most areas occupied by the Communities of Castilla y León, Castilla-La Mancha, Extremadura and Andalusia. Drainage facilities are required and do actually exist in many irrigation systems and have been built for the reclamation of extensive marshy areas at the mouths of the Guadalquivir and Ebro rivers.

3. POPULATION AND SIZE OF HOLDINGS

During the last 30 years the population in Spain has evolved as shown on Table 1:

Table 1. Demographic evolution in Spain from 1970 to 1999

{PRIVATE }POPULATION	1970	1999	Increase
A - Total	33,615,000	39,699,394	+ 17.89 %
B - Total economically active	11,742,000	16,121,000	+ 46.71 %
C - Percent B over A	34.93 %	40.61 %	
D - Engaged in Agriculture	3,052,000	1,216,300	- 45.44 %
E - Percent D over B	25.99 %	7.5 %	
F - Engaged in irrigation	No data availab.	550,000	
G - Percent F over D	No data availab.	43.85 %	

It can be noted the important increase of economically active population (from 34.93% to 40.61%) and the drastic decrease of economically active persons engaged in agriculture (from 25.99% to 7.78%),

whilst almost 44 % are engaged in irrigation, all this placing Spain in the group of advanced developed countries.

Until the mid of 19th Century, large holdings were in possession of the Church or the nobles for centuries. Cultivation, particularly in the central provinces, was sacrificed for large-scale sheep farming. During the first half of the 19th century, extensive areas of common land were purchased by the middle classes. Estimates made in 1930 revealed that in Extremadura, Andalusia and La Mancha about 7,000 land proprietors (most of them absentees) owned about 2,400,000 ha. Living conditions for the tenant farmers and the land less labourers (often unemployed) were precarious. In attempting to redress this the Government met strong opposition and little improvement could be made prior to the outbreak of the Civil War (1936-1939). Soon after the Civil War, the new regime set about to improve agriculture by the establishment, in October 1939, of the National Institute of Colonisation (INC), a successor to the Republic's Institute of Agrarian Reforms. Subsequent legislation led to the 1939 Act for Colonisation and effecting redistribution in irrigation.

At the time of the 1949 legislation, land was divided too unequally (about 45 per cent of farming land occupied by farms of more than 100 ha and 30 per cent by farms of less than 5 ha and dependence for successful agriculture was mainly on casual labour). Most small farms were uneconomical and the rate of agricultural employment was high (permanent workers were about 8 per cent).

The 1949 legislation empowered the National Institute of Colonisation (INC), under the Ministry of Agriculture, to buy (or to expropriate, if necessary), develop and break up among small holders the large and unproductive estates, to select certain areas for irrigation, drainage and general development, to reorganise and combine existing agricultural organisations and to introduce a more helpful system of loans and credits and promote technical agricultural training.

The INC exercised its authority also in the numerous acquired farms to permit access to the property by the agricultural workers and the small tenants or co-workers. Those properties were transformed by voluntary sale by their owners, or by expropriation in cases where necessary to solve social problems. (According to the law on forced expropriation in the social interest, the INC recommended and the Government declared the social interest applying to the acquisition of each property by means of a Decree.)

When in actual possession of the land, the settlers contributed 20 per cent of its value, paying the balance subsequently by annuities computed over a period of 20-25 years.

Those settled on the farms acquired by the INC by way of expropriation, and those who did not possess the necessary means to pay the initial 20 per cent or the basic capital required for the development of the land, were made to pass through a period called "the period of tutelage" during which the INC provided them with the lands and means for their permanent improvements, farm cattle, agricultural machinery, seeds, fodder and fertilizers, besides paying the taxes on the property. Thus, the settler was fully established and guided in the first steps of his new profession as an agricultural farmer without any more on his part than could be expected of him, namely normal intelligence and effort on the land. The contributions made by the INC were reimbursed by the beneficiaries by cultivating the allotted land in partnership with the INC during the five years of period of tutelage, and by delivering the products in the quantity necessary to refund the advances received, i.e., the net capital, cattle and machine

The INC constructed, as a part of its activities, villages for the settlers, schools, churches, agricultural centres, etc.

The holdings allotted, per family by the INC varied from 4 to 5 ha in the Badajoz Project area and 7 to 10 ha in the Monegros and the Flumen irrigated areas. This size was deemed economical to ensure a

reasonable standard of living for the farmer but new considerations are taken into account for enlarging the average irrigated farms to 16 ha.

According with the last Yearbook of Agriculture and Food Statistics of the Ministry of Agriculture, Fisheries and Food the present number of land holdings is 1,264,527, covering a useable surface of 25,230,338 ha, which represents an average of some 20 ha per holding. However the existance of large holdings, mainly in areas of the Centre, West and South of Spain distorsions greatly the effective average holdings surface of small farmers.

4. LAND RESOURCES

The total area of Spain is 506,009 km² (50,600,900 ha) out of which land area is 499,540 km². The land-use statistics are as follows :

Arable land	14,284,700 ha
Permanent crops	4,774,000 ha
Natural Pastures	6,600,000 ha
Forest and Wood-land	16,206.100 ha
Other land	8,736,100 ha

A variety of broad soil regions are available in Spain : (1) atlantic podsol, (2) brunisolic, (3) mediterranean cinnamonic, (4) arid cinnamonic; (5) high latitude humid mountains, (6) mediterranean mountains. A brief description of soil types follows:

- (1) In the atlantic podsol region the principal soils are : brun acide; podsols, and grey-brown podsolic.
- (2) The principal soils in the brunisolic region are : braunerde, lithosols and grey-brown podsolic.
- (3) The mediterranean cinnamonic region's principal soils are : alluvial, cinnamonic brown; cinnamonic; terra rossa; reddish brown; aeolian sands; lithosols; and darm clays.
- (4) The arid cinnamonic region's principal soils are : alluvial; reddish brown; terra rossa; lithosols; and serozems.
- (5) In the high latitude humid mountains the principal soils are : brun acide, podsols, grey-brown podsolic and lithosols.
- (6) Mediterranean mountains have principal soils as : cinnamonic; reddish brown; lithosols; and podsols.

5. WATER RESOURCES

5.1. Surface water resources

Hydrographically Spain (continental) is divided into 10 drainage basins, namely Northern coast, Duero, Ebro, Pyrenness Oriental, Tagus, Jucar, Guadiana, Segura, Guadalquivir and the Southern coast. The Spanish rivers are extremely irregular and their natural flows cannot be taken to be directly usable resources. Over 18 years, the average ratio of the maximum and minimum flow varies from 2 to 8, but usually the differences are much larger. To give an idea of the extreme variability of the ratio of the maximum and minimum flow, records can be reported on several southern Spanish brooks in which, after heavy showers, the flow per second registered has been larger than the average flow per hour

measured during the year. During one hour, the total discharge has been larger than the mean registered for a week, and the total discharge during a week has been larger than the annual average of the same stream.

Presently, the average annual runoff of the country (continent and insular) (see Table 3) is about 111,116 Mm³, being the average natural and artificial regulations 8,927 Mm³/yr and 39,175 Mm³/yr, respectively. Artificial regulation can be achieved thanks to the 1023 large dams and their total storage capacity 56,063 Mm³.

Although the main river of the Northern coast is the Miño river (274 km) which in its tail reach forms the boundary between Spain and Portugal this basin consists of many minor short rivers as the Nalon, Navia, Narcea, Miera, Deva, Besaya, Nervión, etc. etc., all of them flowing into the Cantabric Sea. This special feature has forced for managerial reasons to divide the "basin" into four "sub-basins", named North I, North II, North III and Galicia Coast. The average annual runoff of the basin is 44,157 Mm³.

The present regulated flow is 17,388 Mm³/yr, the future estimated regulated flow being 26,250 Mm³/yr while the forecast of future demand is 1,306 Mm³/yr, which shows for this basin a likely surplus of 24,944 Mm³/yr.

The main river of the Duero basin is the Duero river, which, after traversing almost the middle of the Basin turns south-west forming the boundary with Portugal for some distance where after it turns west and runs through Portugal emptying into the Atlantic Ocean. Its total length is 744 km. The total natural flow of this basin is 13,660 Mm³/yr, of which 6,095 Mm³/yr are regulated. Future regulation is estimated to reach 9,143 Mm³/yr against a forecast total demand of 6,763 Mm³/yr. According to these figures, the basin will have a likely water surplus of 2,380 Mm³/yr.

The main river of the Tagus basin is the Tagus river with its tributaries the rivers Alberche, Tietar and Arrago. The Tagus river is 906 km long and after traversing through Spain flows through Portugal into the Atlantic Ocean in Lisbon. The total average natural flow of this basin is 10,883 Mm³/yr, of which 5,845 Mm³/yr is now regulated. The future regulated flow of the whole basin is estimated to be 8,303 Mm³/yr, against an expected demand of 4,295 Mm³/yr, which means a likely surplus of 4,008 Mm³/yr.

The Guadiana river along with its main tributaries the Jabalón, Zancara, Cigüela and Zújar rivers compose the hydrographic network of the Guadiana basin. The Guadiana itself, near Badajoz turns southwards to serve as boundary of Spain and Portugal, then flows through Portugal to become again in the last stretches the boundary between the two countries. It is 824 km long. The total average annual runoff of this basin is 5,475 Mm³/yr, of which 2,150 Mm³/yr are regulated today. The future regulated flow is estimated to be 3,486 Mm³/yr while the estimated total future demand is 2,360 Mm³/yr, which will leave a surplus of 1,126 Mm³/yr.

The Guadalquivir basin has its river the Guadalquivir, 500 km long, with its tributaries the Genil, the Bembezar and the Viar rivers. The Guadalquivir river solely lies in Spain. The average annual runoff of its basin is 8,601 Mm³/yr, of which 2,819 Mm³/yr are presently regulated. The future regulated flow will be 5,016 Mm³/yr, against a future estimated demand of 5,720 Mm³/yr, thus, resulting a deficit of 704 Mm³/yr of water in this basin.

The South of Spain basin comprises three main rivers, the Guadalhorce, the Guadalfeo and the Almanzora rivers along with several other minor rivers. All of them flow within the territory of Spain. The average annual runoff of the basin is 2,351 Mm³/yr of which 359 Mm³/yr are currently regulated. The future regulated flow will be 1,828 Mm³/yr while the total forecast demand is 1,795 Mm³/yr. This leaves a small surplus of 33 Mm³/yr.

The Segura basin has its main river, the Segura, with an average annual runoff of 803 Mm³. The present regulated flow is 626 Mm³/yr with an estimated future regulation of 801 Mm³/yr, the estimated total future demand being 3,270 Mm³/yr, thus meaning a foreseeable significant structural deficit of 2,469 Mm³/yr in this basin.

The Júcar basin has two main rivers, the Júcar and the Turia rivers. Its joint average annual runoff is 3,432 Mm³, of which 2,095 Mm³ is the present regulated flow. The future estimated regulated flow is 2,714 Mm³/yr against an estimated total future demand of 3,950 Mm³, thus, showing a foreseeable deficit of 1,236 Mm³/yr to meet the whole water requirements of the basin users.

The Ebro basin has its principal river, the Ebro, 768 km long, with its main tributaries, the Aragon, Gallego, Cinca and Segre rivers by the right bank, and the Najerilla, Jalon and Guadalupe rivers by the left. The total average annual runoff of the basin is 17,967 Mm³ of which 11,012 Mm³ is the present the regulated. The future regulation estimates to be 14,964 Mm³/yr against a total future demand of 9,603 Mm³/yr which would leave a surplus of 5,361 Mm³/yr of water in this basin.

The Eastern Pyrenees or Internal Catalanian Basins, have two main rivers: the Ter and the Llobregat. The average total annual runoff of the basin is 2,787 Mm³ of which 791 Mm³/yr are currently regulated. While the estimated future regulated flow is 1,411 Mm³/yr the total future estimated demand is 3,145 Mm³/yr, hence a deficit of 1,734 Mm³/yr in this basin is foreseeable.

It will be seen that out of the ten basins, six are in excess and four show a deficit in potential water supplies to meet the aggregate future demands. On the whole, the country has a surplus flow of 31,709 Mm³/yr. This will call for inter-basin transfer of water in the future for full utilisation of nation's water resources.

According with the White Book of Water the present status of water resources and of regulation structures (reservoirs), and estimated future demands are as shown on Table 2

Table 2. Natural runoff, natural and artificially regulated volumes
(in millions of cubic meters per year)

{PRIVATE } Basin	Natural runoff	Total storage capacity	Natural regulation	Per cent natural regulation	Regulated variable demand	Per cent regul. unif. demand
North (4 sub-basins)	44,157	4,409	3,119	7.06 %	7,383	16.72%
Duero	13,660	7,667	892	6.53 %	6,095	44.61 %
Tagus	10,883	11,135	605	5.56 %	5,845	53.74 %
Guadiana (2 sub-bas.)	5,475	9,619	36	1 %	2,150	39.26 %
Guadalquivir	8,601	8,867	132	1.5 %	2,819	32.78 %
South	2,351	1,319	16	1 %	359	15.27 %
Segura	803	1,223	225	28.0 %	626	77.96 %
Júcar	3,432	3,349	924	26.9 %	2,095	60.51 %
Ebro	17,967	7,702	2,795	15.6 %	11,012	61.29 %
Pyrenees-Catalonia	2,787	772	177	6.4 %	791	28.38 %
CONTINENTAL SPAIN	110,116	56,063	8,927	8.1 %	39,175	35.58 %

Although the annual total runoff in continental Spain is computed to be 110,116 Mm³, the assessed useable annual runoff is 95,451 Mm³, thus being the annual regulated flows according to the variable demand along the year of 41.04 per cent. Likewise the effective useable storage capacity is estimated to be 47,591 Mm³, against the 56,063 Mm³ shown on Table 2.

Table 3. Estimated current demands for domestic supply, and agricultural and industrial uses
(Source : White Book of Water in Spain)

{PRIVATE } BASIN	Annual Runoff	Present Demands, Mm ³ /year			Average irrigation duty, m ³ /ha
		Supplies	Industry	Agriculture	
NORTH (I,II,III)	31,907	568	527	532	7,589
Galicia Coast	12,250	262	53	532	8,337
DUERO	13,660	243	10	3,603	6,547
TAGUS	10,883	851	25	1,875	8,127
GUADIANA (I, II)	5,475	174	84	2,285	6,701
GUADALQUIVIR	8,601	583	88	3,140	6,499
SOUTH	2,351	283	32	1,070	6,704
SEGURA	803	180	23	1,639	6,162
JUCAR	3,432	613	80	2,284	6,173
EBRO	17,967	338	415	6,310	8,049
PYRENEES-CATALONIA	2,787	791	296	371	5,752
BALEARIC ISLES	661	114	4	189	7,862
CANARY ISLES	409	347	10	264	8,800
TOTAL SPAIN	111,186	5,3471,647	24,094	7,010

5.2. Groundwater resources

The increasing pressure on the water resources during the last decades to satisfy the increasing demands of the growing population, both in number and in life quality, the expansion of irrigated areas and of new industries, the need to allocate to the water related ecosystems and wetlands the volumes required for their maintenance, as well as a variety of other activities that require water for their accomplishment, has made to pay a special attention in Spain to groundwater development, particularly because very frequently, areas that only occasionally used in the past their groundwater resources have become dependant on these resources and are overexploiting their aquifers thus endangering their sustainability and their quality.

Water abstractions are specially important in the Islands (Balearic and Canary) and in the Eastern and South-eastern coastal areas of the peninsula, where pumping levels are well below sea level, thus producing seawater irreversible intrusion problems. In central Spain, overexploitation of aquifers results in lowering the water table, raising pumping costs, and reducing water quality. In particular, the Canary and the Balearic archipelagos, have very little surface water resources and the needs of both domestic

supplies and irrigation shall be met from groundwater or, as we will explain later in this text, from other non conventional resources. These islands, along with the Mediterranean coastal areas, have the added pressure of a powerful touristic industry, which is very important to the Spanish economy.

Latest field surveys estimate that 942,244 ha are irrigated using groundwaters, and the most recent studies say that there are in Spain 422 aquifers, with an assessed capacity of 180,000 Mm³, the annual extractions being as much as 5,532 Mm³/yr, against an estimated natural recharge of 29.908 Mm³/yr; 51 of these aquifers are considered to be overexploited, having a total reserve of 27,423 Mm³ and presenting a deficit of 663.34 Mm³/yr.

5.3. Alternative non conventional resources

During the last years increasingly more attention as been given to the use of non conventional water resources as a means to cope with the scarcity of water for basic uses, mainly domestic, in areas suffering of structural deficit of water resources, or where the human pressure force the water managers to find solutions to the problem.

Basically non conventional water resources are the urban effluents and waste waters, saline and brackish waters and return flows from agricultural runoffs. All of them are more and more being used once conveniently subject to a purifying treatment to guarantee the health quality minimizing the hazards for human use nor for the environment.

Progressively there is an increased use of treated waste waters from urban effluents for uses not requiring a high quality level, as is the case of agriculture. Presently the contribution of treated waste waters to the ensemble of water resources is estimated to be some 230 Mm³/yr, 89 % of which are used for irrigated agriculture, 6 % for recreational purposes, 2 % for municipal uses, 2 % to satisfy environmental requirements and 1 % for the industry.

There is also a very efficient reuse of runoffs in irrigated areas where, for centuries the water running off from a field is used to irrigate another fields at lower level, and so on up to three times. This is a common practice in the Segura plain where water has traditionally been very scarce and farmers have learned to optimize its use.

The desalination of sea and brackish waters entails a contribution to the hydrological cycle of 222 Mm³/yr, placing Spain in the first position in Europe with 30% of all desalting plants of this old continent. According to the White Book of Water, the distribution of desalted water is as follows:

Sea water:	Urban use	90 Mm ³ /yr
	Agriculture, irrigation	5 Mm ³ /yr
Brackish water:	Urban and touristic use	29 Mm ³ /yr
	Industrial use	40 Mm ³ /yr
	Agriculture, irrigation	58 Mm ³ /yr

6. BRIEF HISTORY OF IRRIGATION AND DRAINAGE

6.1. General Overview

Spain is a country with a long and glorious history of irrigation development. The Cornalvo Dam, 23.2 m, was built during the Roman times and is still in use. The importance of water for irrigation was recognised as early as the second half of the 7th century when Fuego Juzgo (the promulgated Spanish Code) described water as the very "blood and life" of the fields of Spain. The first systematic irrigation

projects were carried out in Valencia and Granada in the 11th century, during the period of Caliph Alhaken II, the Arabic ruler. The Catholic Monarchs in the 15th century also established systems in the Eciija and the Segura basins. Emperor Charles I, in the 16th century, began the Imperial Canal of Aragon, but it was King Charles III, in the 18th century, who realized the need to optimize the use of the water resources of the country by setting up irrigation systems in the dry zones. The Almansa Dam, 13.5 m high, was built during the 14th century and rised to 23 m one hundred years later; it is the first known arch dam. The Tibi

In 1900, the area under irrigation in Spain was about 1,000,000 ha.

M. Gasset gave official status to the First Hydraulic Plan (1902) which aimed at irrigating 1.5 million ha of land.

Since the preparation of the Plan in 1902, five national irrigation congresses were held to spread the objectives of the plan among the beneficiaries - the first at Zaragoza in 1913, the second in Seville in 1918, the third in Valencia in 1921, the fourth in Barcelona in 1927, and the fifth in Valladolid in 1934. By 1920 the irrigated area rose to 1,200,000 ha.

It was, however, not until 1926, when the Hydrographic Confederations were created under the Ministry of Public Works that the plan could be implemented in right earnest, when at the same time a new plan was formulated envisaging the irrigation of an area of 790,000 ha more than the area of the 1902 Plan. These Confederations, ten a number, covering the ten hydrologic basins of the country, are semi-autonomous organizations. The important projects in some of these basins constructed during the period preceding the Civil War were :

Eastern Pyrenees basin (today Internal Catalanian basins) - The Riudecañas Dam, 35.5 m high, completed in 1918 and the Foix Dam, 38 m high, completed in 1927.

Ebro basin - The Alloz Dam on the Salado, 61 m high, completed in 1930; Pena Dam on the Pena, 41 m high, completed in 1913 and enlarged in 1930; the Ardisa Dam, 51 m high, completed in 1932.

Northern coast - The Castadon Dam across the Lona, 23.7 m high, completed in 1929.

Duero basin - The Camporredondo Dam across the Carrion, 75.5 m high, completed in 1930; the Ricobayo Dam across the Elsa, 99.4 m high, completed in 1934.

Tagus basin - The Burguillo Dam across the Alberche, 90 m high, completed in 1931; the Charco del Cura Dam across the Alberche, 50 m high, completed in 1931.

Guadalquivir basin - The Guadalcacin Dam on the Majaceite, 34 m high, completed in 1917. The Guadalmellato Dam across the Guadalmellato river, 64 m high, completed in 1928; The Jándula Dam across the Jandula, 87.5 m high completed in 1932; La Breña Dam across the Guadiato, 56 m high, completed in 1935.

Segura basin - La Cierva Dam across the Mula, 51 m high, completed in 1929, and the Fuensanta Dam across of Segura, 74.85 m high, completed in 1933.

Some of these works were disrupted by Spanish Civil War (1936-1939) after which plans were drawn up for the improvement of the economic value of agriculture with the general resurgence of the country. The planned economy was based on the principle of a maximum of State control in the spheres of economy for the quickest possible attainment of the objectives pursued, namely, national recovery and a more equitable distribution of wealth. The economic and social trend in the agrarian policy was

embodied in the Large Area Settlement Act of December 26, 1939, and later, in the Act of April 21, 1949, on settlement and distribution of property in irrigable areas. Both Acts were markedly interventional in character and provided for Government action in agricultural transformation. This has been, and is being, achieved by the joint efforts of the INC and Ministry of Public Works as indicated under Section 3 above.

The developments from 1939-1949 were modest, but with a sound basis for organised planning and execution in the future. The irrigated area, which was about 1,300,000 ha in 1940, rose to about 1,500,000 ha in 1949. The important projects executed include La Lobrega Dam across the Rumblar in the Guadalquivir basin, 66.5 m high, completed in 1941; El Tranco de Beas across the Guadalquivir, 93 m high, completed in 1945; the Guadalhorce Dam across the Turon in the South basin, 74.1 m high, completed in 1947; and El Pintado Dam across the Viar in Guadalquivir basin, 86.5 m high, completed in 1948.

Development since 1949 has been more rapid. The area irrigated rose to about 1,800,000 ha in 1959 and to 2,100,000 ha in 1965. Several projects were executed during the period in all the ten hydrographic basins, the most important among them being the Badajoz Multipurpose Project, the extension of irrigation on the Monegros and Flumen Area in the Ebro basins, the Los Peares and El Romeral Dams across the Miño and the Sil in the North basin (completed in 1955), the Entrepeñas-Buendía Dams in the Tagus basin (completed in 1956), the Salime Dam across the Navia in the Northern Coast (completed in 1956), the Saucelle Dam across the Duero in the Duero basin (completed in 1956), the Montijo Dam across the Guadiana in the Guadiana basin (completed in 1958), the Rosarito Dam across the Tietar in the Tagus basin (completed in 1958), the Canelles Dams across the Noguera (completed in 1960), and the Alarcón Dam, across the Júcar river, completed in 1955.

After 1960, until today, the following important large Dams were built:

North basins: Eume (103 m, built in 1960); Belesar (129 m, in 1963); Portodemouros (91 m, in 1967) and Las Portas (141 m, in 1967)

Duero basin: Compuerto (78 m, built in 1960); Santa Teresa (59 m, in 1960); Aldeadávila (140 m, in 1963); Porma (78 m, in 1968); Almendra (202 m, in 1970); Riaño (101 m, in 1985)

Tagus basin: Gabriel y Galán (73 m, built in 1961); Valdecañas (98 m, in 1964); Oriol-Alcántara (130 m, in 1969); Atazar (134 m, in 1972)

Guadiana basins: Orellana (63 m, built in 1961); García de Sola (65 m, in 1962); Zújar (61 m, in 1964); Chanza (80 m, in 1986); Alange (70 m, in 1989); La Serena (90 m, in 1990, with a storage capacity of 3,232 hm³)

Guadalquivir basin: Bembezar (99 m, built in 1963); Iznájar (122 m, in 1969); Quentar (133 m, in 1975); Negratín (75 m, in 1983); Guadalcacín (75 m, in 1991); Giribaile (90 m, in 1998)

Sur basin: Guadalhorce-Guadalteba (75 m, built in 1973); Rules (130 m, under construction)

Segura basin: Cenajo (102 m, built in 1960); Puentes (80 m, in 1999)

Júcar basin: Contreras (129 m, built in 1975); Tous (130 m, in 1995)

Ebro basin: Canelas (150 m, built in 1960); Yesa (78 m, in 1960); Mequinenza (81 m, in 1966); El Grado (130 m, in 1969); El Mediano (91 m, in 1974); Itoiz (128 m, in 1998); Rialb (100 m, in 1999); Val (95 m, in 1999)

Catalonia Internal basins: Sau (84 m, built in 1963); Susqueda (135 m, in 1968); Baells (102 m, in 1976); La Llosa del Cavall (122 m, in 1998)

Summarizing, irrigation in Spain has evolved as follows: At the turn of the 19th century there were some 1,000,000 ha irrigated. By 1920 there were 1,200,000 ha, which rose to 1,300,000 in 1940, and to 1,500,000 in 1949. In 1960 the irrigated area extended to 1,828,000 ha, reaching 2,100,000 ha in 1965 and 2,379,000 ha in 1970. In 1980 the irrigated area was 3,029,000 ha that increased to 3,370,000 ha in 1990 arriving to be about 3,440,000 ha equipped for irrigation in 1997.

6.2. Water-related legislation

Water resources in Spain have been governed for more than one Century by the Water Act of 1879. The changes in the use of water as a result of the increasing demand of different economically expanding sectors urged the promulgation of the Water Law 29/1985 of 2 August. A few years later, however, coinciding with the incorporation of Spain to the European Union, as well as the appearance of new concepts arisen from the more and more demanding activities, which developed ideas such as to consider water as an economical good, thus opening the possibility to trade with it (more precisely allow transfers of water rights use with the permission of the Administration), or the need to look for private financing for hydraulic works or for improving irrigation systems, made it again necessary to modify the 1985 Water Act, adapting some Articles to meet the new requirements, and so, a new Bill (46/1999 of 13 December), modifying the Water Bill of 1985 was approved by the Spanish Parliament.

Parallel to this improvement of the legislative bodies, it was deemed necessary to planify the water resources in order to improve its management, making serious and reliable studies of the true status in order to know, basin by basin, their respective resources, the future estimated demands for the environment, for domestic supplies, for agriculture, for the industry, etc. These studies composed the so called River Basin Hydrological Plans (RBHP), that were finally approved in 1998. A National Hydrological Plan (NHP), based on the RBHP, is now in the process to being finalized and approved in the next months. In the meanwhile, the Ministry of the Environment, responsible of the Hydrulic Policy, issued in December, 1998 the White Book of Water, in which, the Water Authority presents the framework that will lead the future water policy.

The Irrigation National Plan (INP), drawn up by the Ministry of Agriculture, Fisheries and Food, and already formally presented by the Minister of that Department, is a basic and fundamental document that shall complement the National Hydrological Plan so that the NHP can take into account the water requirements for irrigation proposed by Agriculture and allow both Ministries (Agriculture and Environment) to take coordinated decisions in the field of new areas to be put under irrigation. The INP presents the foreseeable policy on consolidation, modernization and improvement of existing irrigation systems, and shows the Government's criteria to put new areas under irrigation until the year 2008 and its possible expansion in the following years, according and subject to the European Union Common Agricultural Policy, the international trade agreements, the regional interests to be decided by the Autonomous Governments, etc.

7. GENERAL STATISTICS ON AGRICULTURE, IRRIGATION AND DRAINAGE

Spain's total area (continental and insular), 506,009 km²

G.N.P., 525,334 Million US \$

Per capita income, 13,280 US \$

Land area: 49,944,000 ha

Arable & Permanent crops: 19,164,000 ha (38.4 % of land area)

Arable land: 14,344,000 ha

Permanent crops: 4,820,000 ha
 Non arable & non permanent crops: 30,780,000 ha
 Area cropped under dry/rain-fed farming, 15,570,300 ha (87 % of UA)
 Area under irrigation (equipped), 3,440,000 ha
 Area effectively irrigated (AEI) (average), 3,344,637 ha (13 % of UA)

by gravity:	1,980,838 ha (59.23 % of AEI)	
by sprinkling:	800,945 ha (23.94 % of AEI)	
by micro-irrigation:	562,854 ha (16.83 % of AEI)	
with surface waters:	2,263,000 ha	
water from large systems (dams and reservoirs):		1,051,000 ha
water concessions from rivers (collective irrigations):		772,000 ha
water concessions from rivers (individual farmers):		440,000 ha
with groundwaters:	942,244 ha	
with water from transfers:	98,483 ha	
with return flows:	23,799 ha	
with treated and desalinated water:	17,208 ha	

Final agrarian production (constant peseta value of 1996), 2,582 Milliard pesetas
 Final production of dry/rain-fed agriculture, 1,162 Milliard pta (45 %)
 Final production of irrigation, 1,420 Milliard pta (55 %)
 Total water volume used for irrigation, 24,094 hm³/yr
 Average irrigation duty, 7,204 m³/yr
 Total volume of water for domestic supply, 4,667 hm³/yr
 Total volume of water for industry: 1,647 hm³/yr
 Hydro-power installed: 17,000 MW
 Average Hidro-electric power produced: 30,000 GWh/yr
 Hidro-electric power used for irrigation: 2,867 GWh/yr
 Primary power consumed by irrigation: 1,261 Ktep (fuel plus electricity)