United Nations World Water Development Report

World Water Assessment Programme (UNESCO)

The Tagus River Basin District – Portugal

Case Study

Ministério da Agricultura, Mar, Ambiente e Ordenamento do Território

ARH TEJO
Administração da Região Hidrográfica do Tejo I.P.

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CONTENTS

GENERAL CONTEXT

1. Physical Characteristics

The Tagus river has its source in the Sierra de Albarracín (Montes Universales, Spain) at 1,600 m above sea level.The Tagus river basin is an international river basin district shared by Portugal and Spain, encompassing the surface waters, including the transitional and coastal waters, and the groundwaters. The capitals of both countries are located in this river basin which is home to over 9 million people. Both aspects reinforce its socio-political relevance.

The Iberian Peninsula is the westernmost peninsula of Europe and the Tagus river basin district (RBD) covers an area of 81,310 km^2, 25,666 km^2 in Portugal and 55,644 km^2 in Spain. The RBD is 1,100 km long (230 km in Portugal) and has a mean width of 120 km, flowing from ENE to WSW.

Figure 1 – Tagus river basin district (Tagus RBD).

The Tagus river flows into the Tagus estuary, one of the largest estuaries of Western Europe, and due to its great biodiversity and variety of habitats is designated as Special Protected Area under the European Birds Directive and, therefore, is part of Natura 2000[1] network. It is also classified as Nature Reserve under the National legislation (Figure 2).

Figure 2 – Tagus estuary (City of Lisbon and Flamingos (*Phoenicopterus roseus*)).

The main tributaries are located in the Spanish part of the RBD, including the Jarama and its tributaries (11,600 km^2), Alerche (4,100 km^2), Tietar (4,500 km^2), Alagón (5,400km^2), Guadiela and Almonte (3,000 km^2). In the Portuguese territory the main tributaries are the Sorraia (7,611 km^2) and Zêzere (5,029 km^2).

The Tagus RBD covers more than 28 per cent of the Portugal mainland area, encompassing a great diversity of landscapes and ecosystems. A summary of the general characteristics of the Tagus RBD is shown in Table 1.

Table 1 – General characteristics of the Tagus RBD.

Characteristics	Tagus River Basin District
Area	
Total	81,310 km^2
Area in Spain	55,644 km^2
Area in Portugal	25,666 km^2
River length	
Total	1,100 km
Spain	827 km
Portugal	230 km
Population	
Total	9,584,929
Spain	6,099,113
Portugal	3,485,816
Water supply and sewerage	
Water supply coverage	95%
Sewerage coverage	79%

The present case study will only cover the Portuguese part of the Tagus RBD.

[1] Network of nature protection areas established under the Habitats Directive and includes the Special Areas of Conservation (SAC) and the Special Protection Areas (SPAs) designate under the Birds Directive.

1.1. Geology

The Tagus RBD has three hydrogeological units defined in terms of structure, lithology, hydrogeology and geomorphology. These units are shown in Figure 3 and have the following designation:

- Maciço Antigo ou Hespérico – formed by old rocks, eruptive and metamorphic, from Precambic and the Palaeozoic age;
- Orla Ocidental – formed by Mesozoic and cenozoic formations of the west part of Maciço Antigo and modern eruptive rocks, in particular granitic rocky mass range of Sintra from Jurassic Superior and volcanic rocks of the Lisbon region;
- Bacia Terciária Baixo Tejo – formed by tertiary and quaternary deposits that fulfill the area identified as Baixo Tejo.

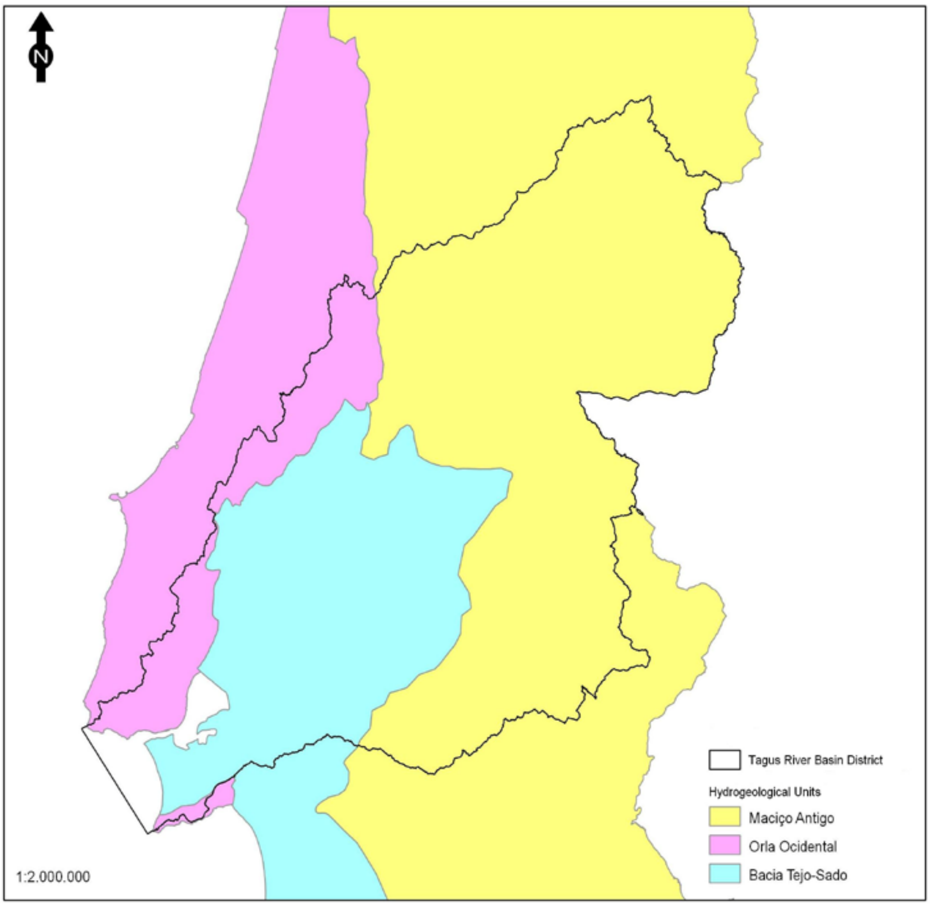


Figure 3 – Hydrogeological units.

Throughout the RBD there is a wide variety of rock types, with predominance of granites and schists in the eastern part, limestone, marl and clay in the western border, and with dominant detrital formations in the central region.

In terms of geomorphology the Tagus RBD establishes the connection of two areas of the country with quite distinct physical characteristics: in the North area higher altitudes are dominant compared to the rugged area in the South. The RDB has also the most extensive sedimentary basin area.

1.2. Protected Areas

The European Water Framework Directive (WFD) and the Portuguese Water Law define Protected Areas as "*areas that require special protection under EU legislation regarding the protection of surface water and groundwater or the conservation of habitats and species directly depending on water*." Accordingly to this definition, Protected Areas include:

- bdies of water used for the abstraction of water intended for human consumption or for the protection of aquatic species of economic interest (Water Framework Directive and Directives on water quality to support fish life and shellfish);
- bodies of water designated as recreational waters, including areas designated as bathing areas (Bathing Water Directive);
- sensitive areas in terms of nutrients, including vulnerable areas (Nitrates Directive) and areas designated as sensitive areas (Urban Waste Water Treatment Directive);
- areas designated for the protection of habitats or species where the status of water is an important factor in their protection, including relevant Natura 2000 sites (Birds and Habitats Directives);
- areas of maximum infiltration.

The number of protected areas identified in the Tagus RBD is 145. In addition to those areas, 9 are classified as sites of interest for nature conservation under the national legislation, and closely linked to aquatic ecosystems protection.

Table 2 – Protected areas.

Protected areas	Legal framework	Areas (no.)	Water bodies (no.)
Water intended for human consumption	Directive 2000/60/EC Directive 98/83/EC	41	41
Fish life	Directive 78/659/EEC	19	64
Bathing waters	Directive 2006/7/EC	57	19

Protected areas	Legal framework	Areas (no.)	Water bodies (no.)
Vulnerable zones	Directive 91/676/EEC	2	2
Sensitive areas	Directive 91/271/EEC	2	2
Special Protection Area	Directive 79/409/EEC	9	42
Special Areas of Conservation Sites of Community Importance	Directive 92/43/EEC	15	86

The Figure 4 shows the sites identified under the Habitats Directive and Birds Directive.

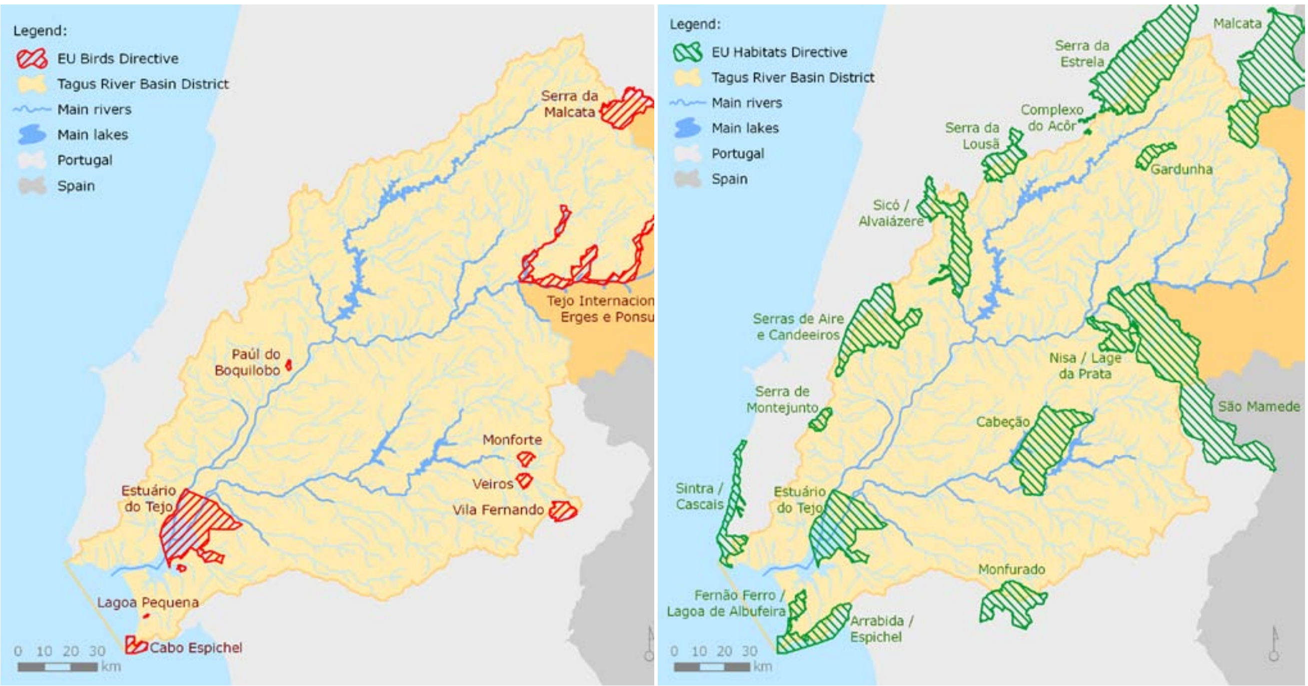


Figure 4 – Natura 2000 sites.

1.3. Water Resources

1.3.1. General Characteristics

The flow regime reflects the rainfall variation both in terms of annual and seasonal values. Therefore, the rivers within the RBD have a quite irregular flow regime. Intense precipitation periods in autumn and winter seasons often cause floods episodes. Through the construction of dams these episodes became less frequent and less intense. In summer, most of the smaller rivers dry as a result of rainfall reduction and evaporation increasement.

The annual precipitation varies between 2,744 mm and 524 mm measured in Penhas da Saúde and Cabo da Roca, respectively.

1.3.2. Climate

The mean annual temperature varies from 7.4 ºC (measured at Lagoa Comprida station at 1,604 m above sea level and, approximately, 100 km from the Atlantic coast) to 16.9 ºC (measured at Cabo Ruivo station at 16 m above sea level and at the Tagus estuary area). The average annual temperature is 14.9 ºC.

The extreme temperature values vary as follows:

- Between -15.0 ºC (measured in December at Penhas da Saúde station) and 0.0 ºC (measured in December and January at Cabo Carvoeiro station);
- Between 30.0 ºC (measured in September at Lagoa Comprida station) and 44.0 ºC (measured in June at Alcácer do Sal station).

1.4. Land Resources

The characterization of the land use within the RBD area is based on CORINE *Land Cover*[2] (CLC), 2006. The three main classes identified in the study area are the following:

- Forest and natural and semi-natural areas – Forest; Scrub and/or herbaceous vegetation associations; Open spaces with little or no vegetation.
- Agricultural areas and Agro-forestry – Arable land; Permanent crops; Pastures; Heterogeneous agricultural areas.
- Artificialised Areas – Urban; Industrial, Commercial and transport units; Artificial, non-agricultural and non-vegetated areas.

In general terms, there is a predominance of forest and natural and semi natural areas, which covers almost 50 per cent of the total area (Figure 5).

[2] Coordination of Information on the Environment (CORINE) is a European programme initiated in 1985 by the European Commission. It aims at gathering information on certain priority topics such as air, water, soil, land cover, coastal erosion, biotopes, etc.

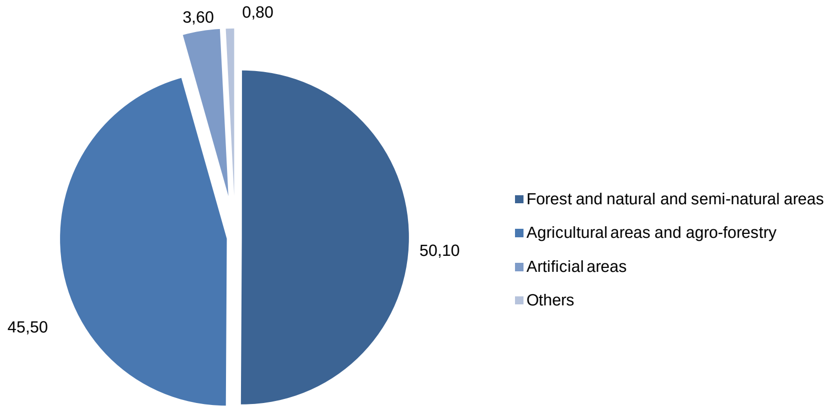
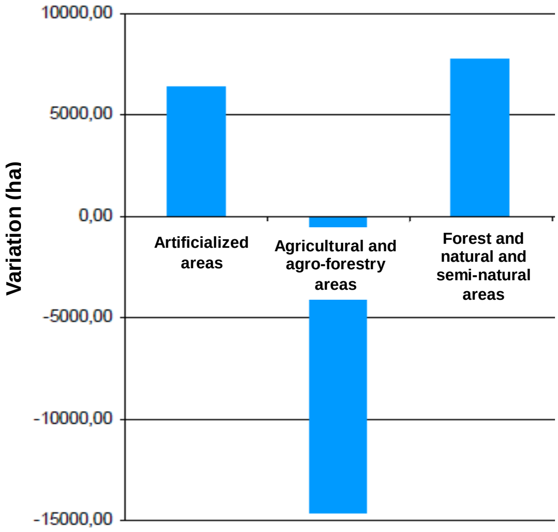


Figure 5 – Land use in the Tagus RBD (CLC, 2006).

The Figure 6 shows the variation in the land use area for the period 2000-2006.



Source: CORINE Land Cover 2000 and 2006

Figure 6 – Variation of the land use between 2000 and 2006.

As expected the sub-basins with a higher proportion of artificialized areas are nearer the Lisbon urban area. It should be highlighted the significant reduction in the areas used for agricultural and agro-forestry activities. On the other hand, there is a significant increase of the forest and natural and semi-natural areas.

2. Main Socioeconomic characteristics

2.1. Demography

In accordance to Portuguese Statistics (INE), the estimated resident population in the study area was 3,485,816 inhabitants in 2008, representing approximately 34 per cent f the total population in Portugal mainland. The population evolution from 2001 to 2008 is presented in Table 3.

Table 3 – Total resident population in 2001 and 2008.

Territorial unit	Total resident population (inhab.)	% Tagus RBD	Total resident population (inhab.)	% Tagus RBD
	2001		2008	
National level *	10,356,117	32.6	10,627,250	32.8
Portugal mainland	9,869,343	34.2	10,135,309	34.4
Tagus RBD	3,372,180	-	3,485,816	-

*Refers to Portugal mainland and the Azores and Madera Islands.

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI); Anuários Estatísticos Regionais, 2008.

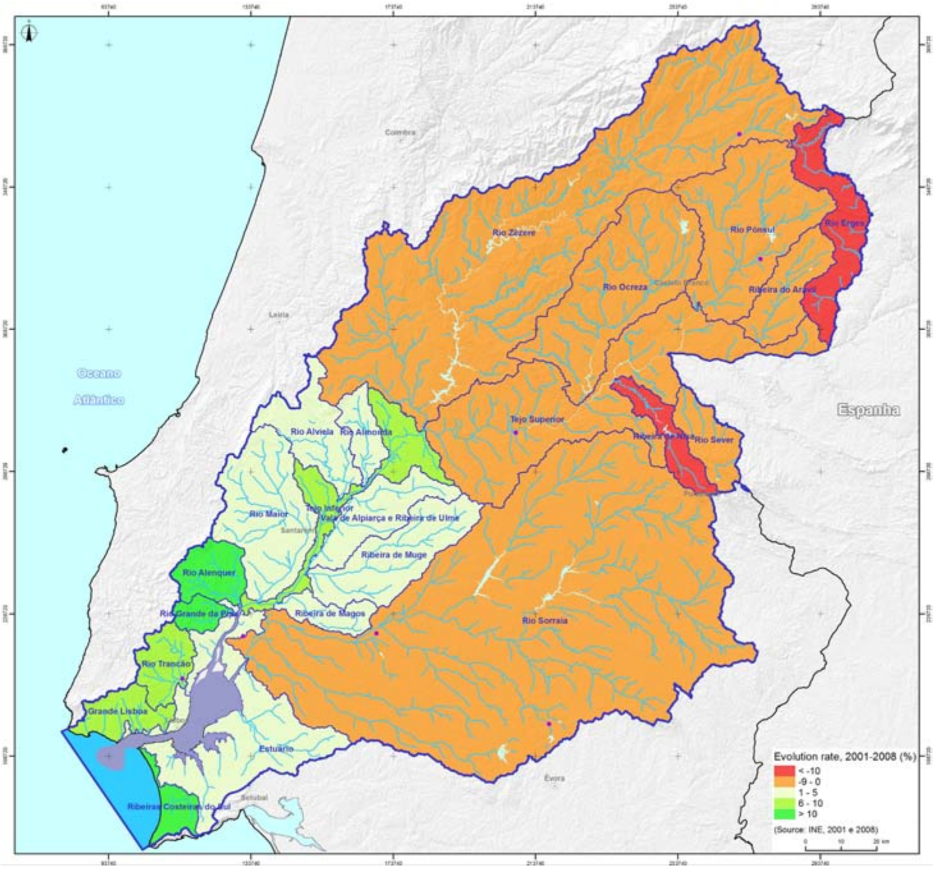
The distribution of the population in each one of the sub-basins within the RBD shows a higher concentration in the areas near Lisbon, in particular the Estuário and Grande Lisboa sub-basins, with 1,176,032 and 931,656 inhabitants in 2001, respectively. Taking also into account the Trancão sub-basin (301,686 inhabitants) these 3 sub-basins together represent 71 per cent of the total RDB population.

The evolution rate of the resident population in the Tagus RBD increased 3.4 per cent between 2001 and 2008, as shown in Table 4. The Figure 7 shows the indicator behaviour in each sub-basin.

Table 4 – Evolution rate of the resident population in 2001 and 2008.

Territorial unit	Evolution rate (%) 2001 - 2008
National level	2.6
Portugal mainland	2.7
Tagus RBD	3.4

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI); Anuários Estatísticos Regionais, 2008.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI); Anuários Estatísticos Regionais, 2008.

Figure 7 – Evolution rate of the resident population per sub-basin (2001 and 2008).

The general pattern of the population distribution shows an increasing concentration nearer the coastal areas and also around the estuary where the economic activity is higher. On the contrary, the upper-part of the RBD shows a decrease on the rates.

Taking into account the figures in 2008, the average population density (people per km^2) in the Tagus RBD is expected to be 139 inhabitants per km^2 which is higher than the values for National and Portugal mainland (Table 5).

Table 5 – Population density in 2001 and 2008.

Territorial Unit	Population density (inhab./km^2)	
	2001	2008
National level	112	115
Portugal mainland	111	114
Tagus RBD	135	139

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI); Anuários Estatísticos Regionais, 2008.

The Ageing index in the Tagus RBD in 2001 is higher compared to the average values for National and Portugal mainland (Table 6).

Table 6 – Ageing Index in 2001.

Territorial Unit	Ageing Index (no. of people aged 65 and over per 100 people aged up to 14)
National Level	102
Portugal mainland	105
Tagus RBD	129

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI).

2.2. Education

The level of Education is strongly affected by the population age structure and existing social conditions. Taking into account the estimates made for the year 2001, half of the RBD population has the Middle School level (52.3 per cent), a slightly lower value compared to the National and Portugal mainland average. The same behaviour is observed in relation to the other education levels (Table 7).

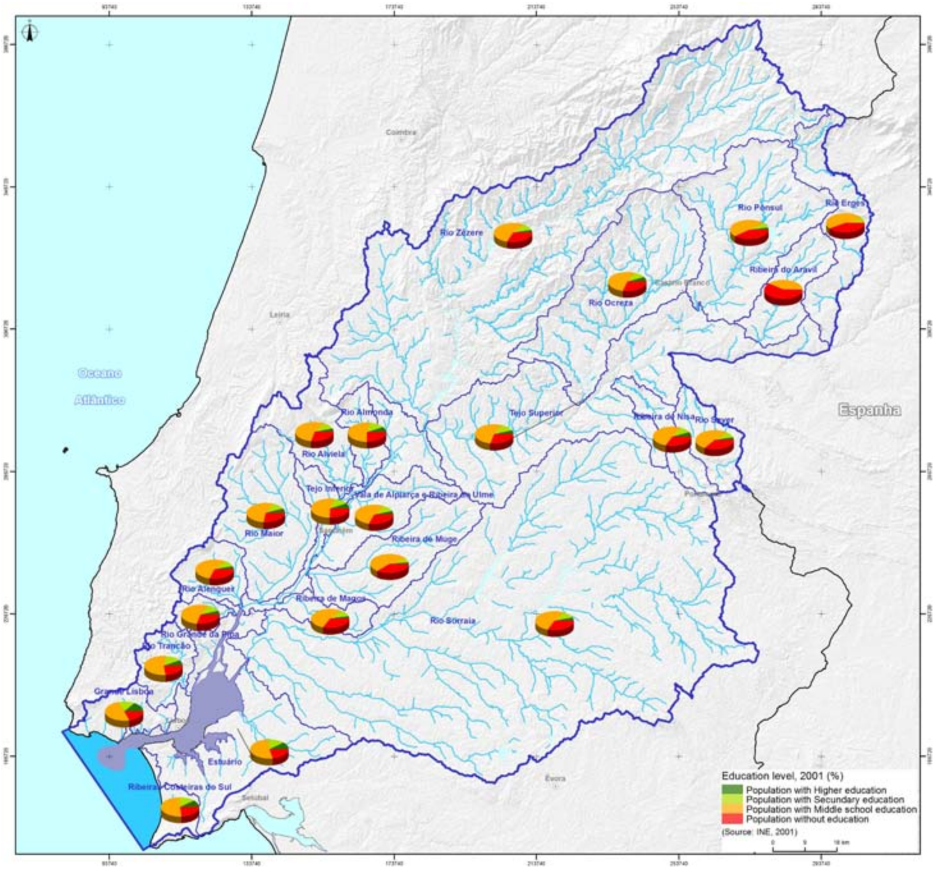
Table 7 – Education level of the resident population in 2001.

Territorial Unit	Education level of the resident population (%)			
	None	Middle School	Secondary	Higher*
	2001			
National level	14.3	58.6	16.4	10.8
Portugal mainland	14.2	58.3	16.6	10.9
Tagus RBD	23.4	52.3	15.2	9.0

* Terciary and above

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI).

Taking into account the investments made in the education sector over the last decade, it is expected a significant improvement on the indicators presented in the Table above. The variation of the education level rates within the RBD is shown in Figure 8.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.
Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI).

Figure 8 – Education level of the resident population in the sub-basins (2001).

2.3. Living standards

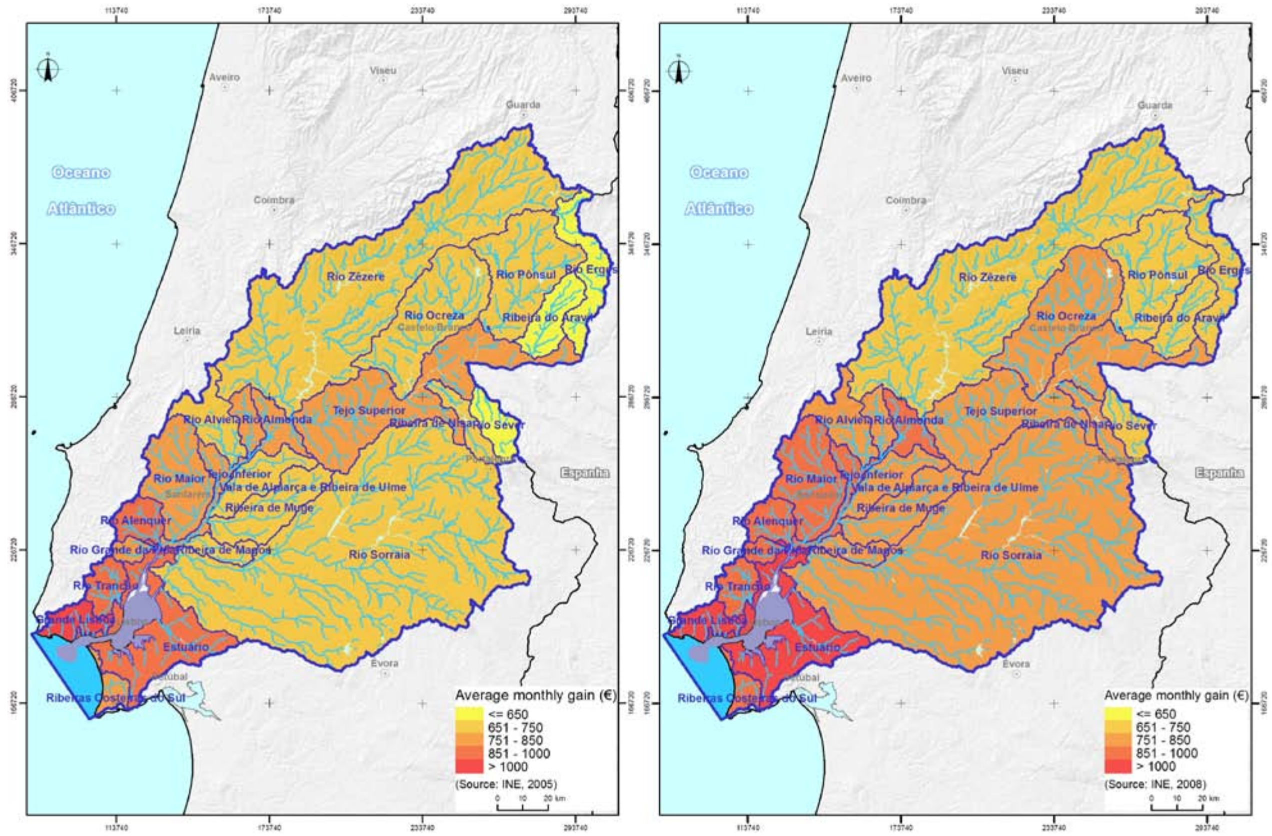
The average monthly earnings of the employees in the Tagus RBD were approximately €1,045.73 in 2007, presenting a considerably higher average than the national and mainland standards and revealing a still higher gap comparing to 2004 value (Table 8).

Table 8 – Average monthly earnings in 2004 and 2007.

Territorial Unit	Average monthly earnings (€)	
	2004	2007
National level	877.50	963.28
Portugal mainland	879.60	965.25
Tagus RBD	920.75	1,045.73

Source: Portugal Statistics (INE) – Anuários Estatísticos Regionais, 2005 e 2008.

The Figure 9 shows the significant variations of the average monthly earnings in the nearer coastal and the upper areas of the RBD. The analysis reflects the differences found in the coastal and inland parts, which varies from €1,217.79 in the Grande Lisboa sub basin to €676.66 in the Rio Erges sub-basin.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.
Source: Portugal Statistics (INE) – Anuários Estatísticos Regionais, 2005 e 2008.

Figure 9 – Average monthly earnings of the employees per sub-basins (2004 and 2007).

As regards the purchasing power per capita the variation is consistent with the one verified to the average monthly earnings. The average purchasing power per capita of the Tagus RBD was 127.07 in 2007. This value is lower compared to the purchasing power verified in 2002 as shown in Table 9.

Table 9 – Purchasing power *per capita* in 2002 and 2007.

Territorial Unit	Purchasing power *per capita* (Portugal = 100)	
	2002	2007
National level	100.00	100.00
Portugal mainland	101.32	100.51
Tagus RBD	129.56	127.07

Source: Portugal Statistics (INE) – Estudo sobre o Poder de Compra Concelhio, 2002 e 2007.

Other representative indicators of the national importance of the Tagus RBD are GDP (Gross Domestic Product) and GVA (Gross Value Added). It is estimated that the Tagus RBD represents almost half of GDP and GVA of Portugal mainland in 2007 (Table 10), respectively 67 and 57 billions of Euro. The GDP *per capita* in Tagus RBD is around 19,3 thousand euros, well above the national and mainland average.

Table 10 – GDP, GVA and GDP *per capita* in 2007.

Territorial Unit	GDP	GVA	GDP *per capita*
	Million Euros	Million Euros	Thousand Euros
	2007	2007	2007
National level	163,119	139,817	15,5
Portugal mainland	154,766	132,657	15,3
Tagus RBD	67,214	57,611	19,3

Source: Portugal Statistics (INE) – Anuários Estatísticos Regionais, 2008.

The economic characterization of the Tagus RBD includes also the analysis of the economic activity rates and the employed population by sector of activity. The Table 11 shows that the overall economic activity rate in the study area is around 50 per cent which is slightly higher compared to National and Portugal mainland results.

Table 11 – Activity rate and employed population by economic activity sector in 2001.

Territorial Unit		Activity Rate (%)	Employed population (no.)			
			Total	Primary Sector	Secondary Sector	Tertiary Sector
		2001				
National level	No.	48.2	4,650,947	231,646	1,632,638	2,786,663
	%		-	5.0	35.1	59.9
Portugal mainland	No.	48.4	4,450,711	211,603	1,581,676	2,657,432
	%		-	4.8	35.5	59.7
Tagus RBD	No.	50.2	1,566,554	43,042	405,493	1,118,018
	%		-	2.7	25.9	71.4

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI).

The Tagus RBD concentrates 20.3 per cent of the total population employed in the primary sector and 25.6 per cent in the secondary sector, which indicates the predominance of the tertiary sector in the this area with 42.1 per cent of the employed population.

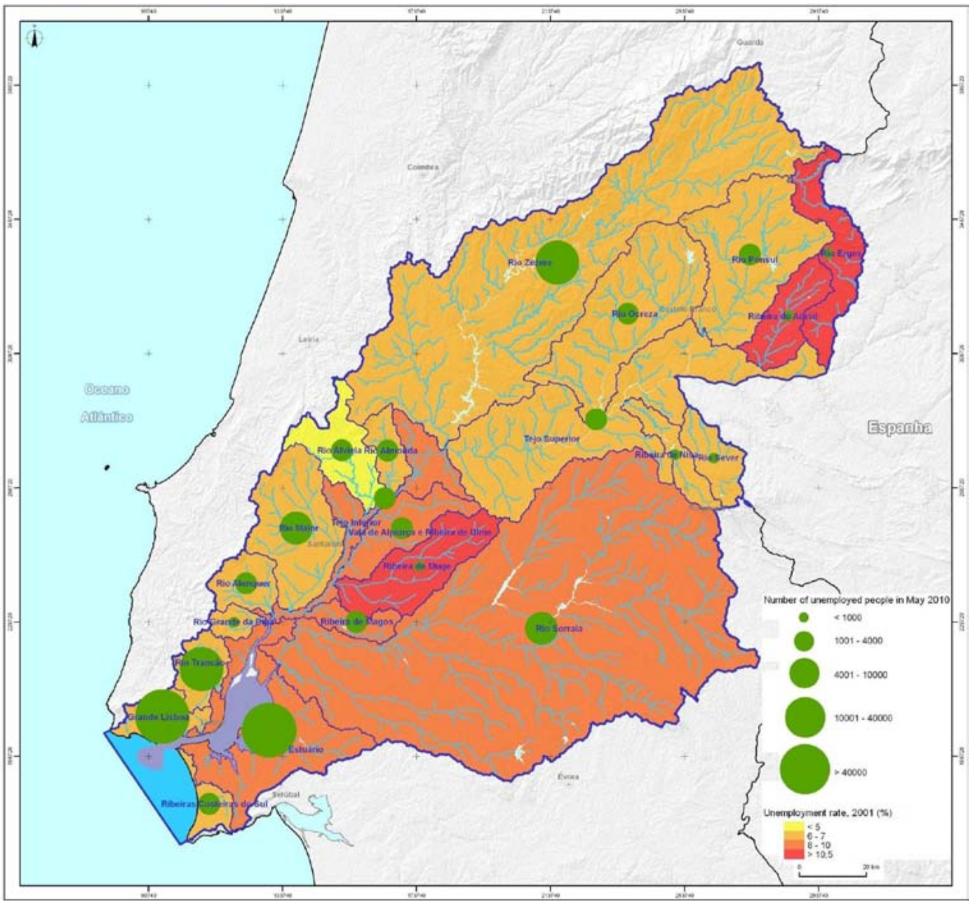
As for the unemployment issue, and according to the latest statistics of May 2010, the number of unemployed people in the Tagus RBD reached 159,739 individuals. This corresponds to an increase of 27.9 per cent in the number of unemployed in relation to 2001, which still below the increase registered in the Portugal mainland (64.9 per cent).

Table 12 – Unemployment rates in 2001 and 2010.

Territorial Unit	Unemployment rate (%)	No. of Unemployed people		Rate of unemployed people 2001-2010 (%)
	2001	2001	2010	2001-2010
National level	6.7	339,261	-	-
Portugal mainland	6.8	327,404	539,957	64.9
Tagus RBD	7.4	124,871	159,739	27.9

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI), IEFP – Concelhos, Estatísitcas Mensais, Maio 2010 (www.iefp.pt)

Taking into account the number of unemployed people in 2010, Figure 10 shows its distribution within the RBD area and the higher numbers are verified around the metropolitan area of Lisbon, particularly in Estuário and Grande Lisboa sub-basins with, respectively, 57,824 and 45,692 people. These two sub-basins account for nearly 65 per cent of the toral number of unemployed people in the whole RBD area.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.

Source: Portugal Statistics (INE) – Recenseamento Geral da População e Habitação, 2001 (BGRI), IEFP – Concelhos, Estatísitcas Mensais, Maio 2010 (www.iefp.pt)

Figure 10 – Unemployment rate (2001) and number of unemployed people (2010).

2.4. Economic Growth

For the period 2002-2007, the number of enterprises has increased 8.0 per cent, 7.1 per cent and 4.9 per cent at National, Portugal mainland and RBD levels, respectively (Table 13).

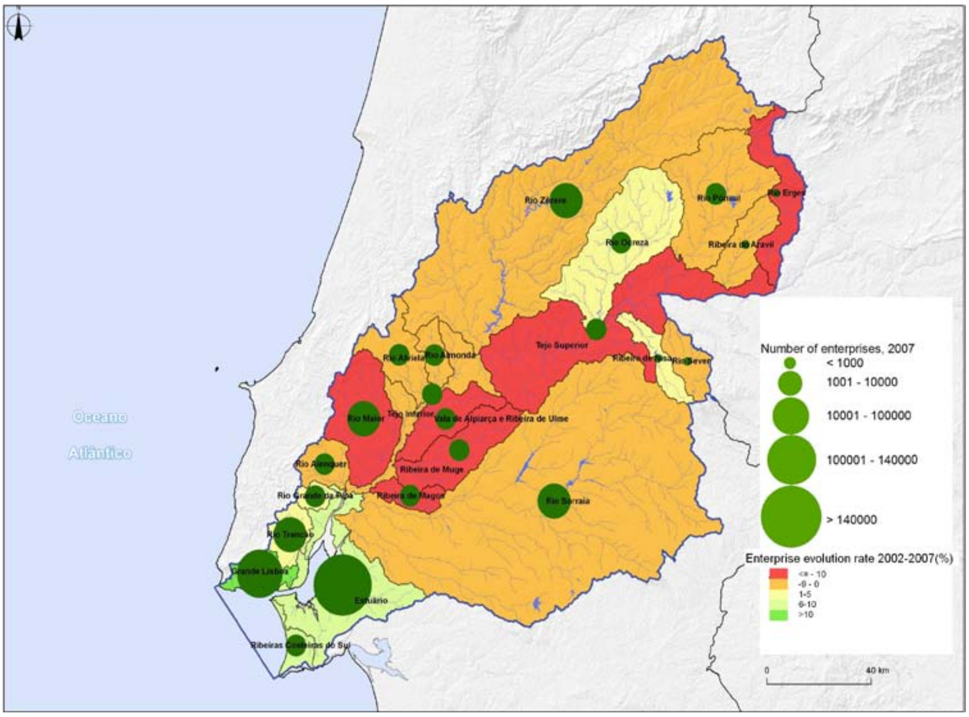
Table 13 – Total number of enterprises in 2007 and evolution rate for the 2002-2007 period.

Territorial Unit	Enterprises (no.)	Evolution rate of total enterprises (%)
	2007*	2002 - 2007
National level	1,172,090	8.0
Portugal mainland	1,123,953	7.1
Tagus RBD	411,627	4.9

* Activities included: agriculture, livestock farming, hunting and forestry.

Source: Portugal Statistics (INE) – Anuários Estatísticos Regionais, 2003, 2007 e 2008.

The Figure 11 shows the number of enterprises in each sub-basin and the respective variation for the time period of analysis (2002-2007). The increase trends are more significant in the areas near Lisbon and the decrease trends are observed in the upper part of the RBD.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.
Source: Portugal Statistics (INE) – Anuários Estatísticos Regionais, 2003, 2007 e 2008.

Figure 11 – Number of enterprises in 2007 and evolution rate for the 2002-2007period in each sub-basin.

The Tagus RBD accounted for 37 per cent of the business in Portugal mainland in 2008. As previously mentioned, the highest concentration of enterprises is located around the Lisbon area, more specifically the Estuário and Grande Lisboa sub-basins, summing up almost 70 per cent of the total number of enterprises in the river basin.

There is a predominance of trade and services throughout the river basin, quite comparable to Portugal mainland pattern. The weight of the Tagus RBD is, in general, remarkable in all sectors of activity. It is estimated that the region represents about 27 per cent of employment and GVA for the agriculture sector, while for the livestock sector the importance exceeds 30 per cent. For other consumptive uses - manufacturing and golf – the significance of the Tagus RBD in relation to Portugal mainland also exceeds 20 per cent. As for tourism indicators, the Tagus RBD offers around 21.6 per cent of the total tourist beds. It follows also a high level of tourism demand, largely due to the attractiveness of the city of Lisbon, as shown by the number of overnight stays in the Estuário and Grande Lisboa sub-basins.

Regarding other economic sectors relevant in the area, the energy sector should be highlighted once it represents in terms of production of hydro and thermal energy, respectively 13 per cent and

40.5 per cent of installed power at Portugal mainland level. Also in the fishery sector, the representativeness of the region, compared to Portugal mainland, exceeds 20 per cent in terms of production value unloaded at the ports in the region, and aquaculture does not exceed the 10 per cent average. The extractive industry, analysed only in terms of extractions directly on water areas, is represented by 140 authorized points, which reached a total volume extracted in 2009 of 650,000 m^3.

In synthesis the Table 14 below shows the main socioeconomic characteristics of the Tagus RBD and Portugal mainland.

Table 14 – Summary of the main socioeconomic characteristics of the Tagus RBD and Portugal mainland.

Major socioeconomics indicators	Portugal Mainland	Tagus RBD
Demography		
Resident Population	10,135,309	3,485,816
Evolution Rate (2001-2008)	2.7%	3.4%
Population density (inhab/km^2)	114	139
Ageing index*	105	129
Education		
Education level		
None	14.2%	23.4%
Middle School	58.3%	52.3%
Secondary	16.6%	15.2%
Higher	10.9%	9.0%
Living standards		
Average monthly earning (2007)	€965,25	€1,046
Purchasing power *per capita* (2007)	100,51	127,07
GDP – Millions Euro (2007)	154,766	67,214
GVA– Millions Euro (2007)	132,657	57,611
GDP *per capita* – Thousands Euro (2007)	15,3	19,3
Activity rate	48.4%	50.2%
Employed population (2001)	4,450,711	1,566,554
People employed in the Primary sector	4.8%	2.7%
People employed in the Secundary sector	35.5%	25.9%
People employed in the Tertiary sector	59.7%	71.4%
Number of Unemployed people (2010)	539,957	159,739
Rate of Unemployement (2001-2010)	64,9	27,9
Economic Growth		
Number of enterprises	1,123,953	411,627
Evolution rate	7.1%	4.9%

* Number of people aged 65 and over per 100 people aged up to 14

3. Water Policy

3.1. Legal Aspects

Under the transposition process of the European Water Framework Directive (Directive 2000/60/CE), into national legislation a new legal framework on water resources management was created through the adoption of the Law no. 58/2005, 29th December, commonly known as Water Law. The Law has a broader scope than the one provided under the WFD as it includes all the elements associated to an integrated water resources management, both quantitative and qualitative aspects, and the extreme events issues.

The Water Law provides the framework for the management of surface waters, including inland waters, transitional and coastal waters, and groundwaters, in order to:

- Prevent further deterioration and protect and enhance the status of aquatic ecosystems as well as terrestrial ecosystems and wetlands dependent on aquatic ecosystems in relation to their water needs;
- Promote a sustainable water use based on long-term protection of available water resources;
- Increase the protection of the aquatic environment through specific measures for the progressive reduction and cessation or phasing out of discharges, emissions and losses of priority substances;
- Ensure the progressive reduction of groundwater pollution and prevent its further degradation;
- Mitigate the effects of floods and droughts;
- Ensure the provision of sufficient water, surface and groundwater, of good quality as required for a sustainable, balanced and equitable water use.

To complete the legal framework on water resources management, several regulations were adopted since 2005, in particular the following:

- Decree-Law 77/2006, 30th March – Complementary norms for the WFD transposition
- Decree-Law 226-A/2007, 31th May – Licensing system of water uses
- Decree-Law 311/2007, 17th September – Multipurpose infrastructures
- Decree-Law 348/2007, 19th October – Water Users Associations
- Decree-Law 97/2008, 11th June – Economic and Financial Regime of Water Resources

The establishment of an economic and financial regime aims at improving the efficiency and sustainability of water use. The regime was established based on the integration of both the social and economic value of water and the environmental aspects of water resources management. Besides the major goal of implementing the polluter-pays and user-pays principles, it also aims at internalising the costs associated with damage to the water status, including environmental and resource costs.

Convention for the Protection and Sustainable Use of Water in the Shared River Basins of Portugal and Spain

In terms of bilateral cooperation in the field of transboundary river basins, significant steps were also taken which culminated in the signing of the Convention for the Protection and Sustainable Use of Water in the Shared River Basins of Portugal and Spain (Albufeira Convention) in 1998 and its entry into force in 2000. The main objectives of the Convention are:

- Coordination of actions to promote and protect the good status of surface waters and groundwaters within the international river basins;
- Coordination of actions aiming at the sustainable use of waters;
- Coordination of actions aiming at contributing to the mitigation of floods and droughts or water scarcity events.

River Basin District Authorities

The Water Law also establishes a new institutional model, based on five River Basin District Administrations and a National Water Authority, which was an aspiration of the technical and the scientific community for almost three decades. The municipalities have also some competencies at local level. Two distinctive types of bodies, the National Water Council and the River Basin District Councils, provide advisory to the Minister responsible for the environment and the River Basin District Administrations, respectively (Figure 12).

The Tagus River Basin District Administration (ARH do Tejo) is one of the five set under the new institutional model. Since 1st October 2008 these authorities became responsible for water resources management at river basin level, in particular for the planning, licensing, infrastructure management, surveillance, monitoring and information/communication activities. ARH do Tejo has a modern matrix-based organizational structure with horizontal and vertical functions. It is also fully committed to fulfil its obligations following a citizen-oriented basis also supported by governance principles such as participation, transparency, coherence, responsiveness and accountability.

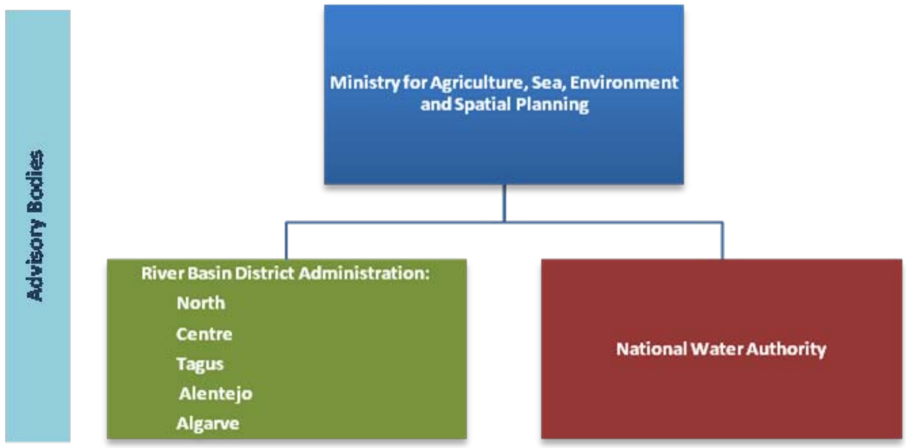


Figure 12 – Institutional model for water resources management.

Besides these competent authorities, there are other organizations with more specific and complementary functions such as the Portuguese Environmental Agency, the Nature Conservation and Biodiversity Institute, the Coordination and Regional Development Commissions and the Municipalities.

The strategic goals set by the ARH do Tejo are the following:

- Increase the level of protection, restoration and valorisation of water resources;
- Increase the level of protection of citizens and assets from risk situations;
- Improve the knowledge and information on water systems;
- Strength the public participation and ensure the involvement of institutions;
- Ensure excellence in the performance of the assigned competencies.

The Tagus River Basin District Council has in its composition a majority of representatives from the economic activities associations and civil society (Figure 13). The main functions of this advisory body include:

- Formulation and appreciation of the proposals on water quality objectives;
- Establishment and analysis of environmental objectives;
- Follow the spatial and water resources planning processes and provide advice on final reports;
- Provision of advice on measures to be taken against pollution;
- Provision of advice on the taxes associated to water uses;
- Provision of advice on the ARH do Tejo Activities Plan and Report and on the investments on the river basin district area.

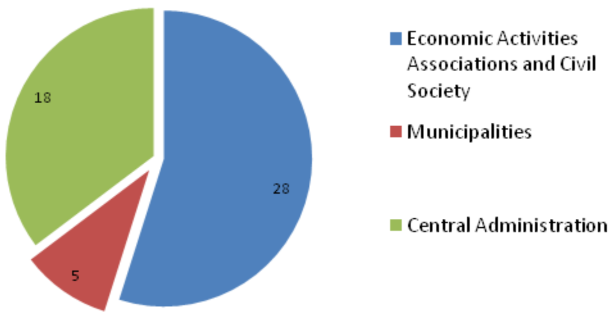
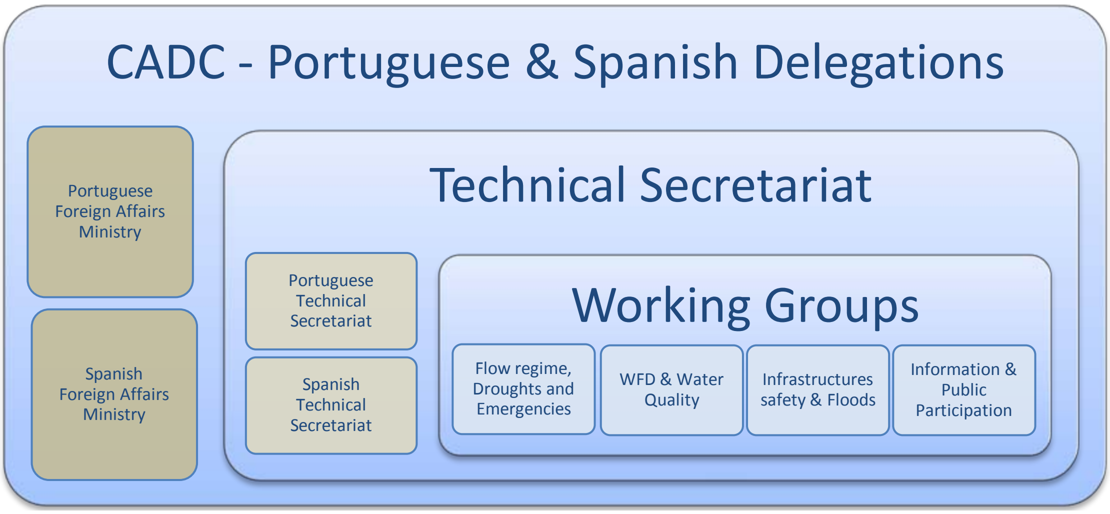


Figure 13 – Membership of the Tagus River Basin District Council.

The implementation of the Albufeira Convention is carried out by the Commission for Implementation and Development of the Convention (CADC), which is coordinated by both ministries for foreign affairs and integrates the technical support from the ministries for environment (Figure 14).



Source: Adaptated from http://www.cadc-albufeira.org/

Figure 14 – Organizational structure of the Commission for the Application and Development of the Albufeira Convention (CADC).

3.2. Water Resources Planning Instruments

The new Water Law establishes a set of planning instruments aiming at achieving the full implementation of a broader and integrated approach to water resources management. The instruments are listed below:

- **Special Land Use Plans**
  - Spatial Plan of Public Water Reservoirs and Lagoons
  - Spatial Plan of Coastal Areas
  - Spatial Plan of Estuaries

- **Water Resources Plans**
  - National Water Plan
  - River Basin Management Plans (RBMP)
  - Specific Water Management Plans

- **Measures for Water Resources Protection and Valorisation**
  - Conservation and rehabilitation of the hydrographic network, the coastal area, estuaries and wetlands
  - Protection of water resources abstractions, areas of maximum infiltration and vulnerable zones
  - Prevention and protection against risks of floods, droughts and serious pollution accidents

During the WFD co-decision procedure (1997-2000), a first generation of water resources planning was taken place in Portugal. As a result of this process, 15 River Basin Plans, 2 Regional Water Plans (Azores and Madera) and 1 National Water Plan were published in the 2001-2002 period (Table 15).

Table 15 – List of river basins and river basin districts.

River Basins (RB)	River Basin Districts (RH)
Minho	RH 1
Lima	
Cávado	RH 2
Ave	
Leça	
Douro	RH 3
Vouga	RH 4
Mondego	
Lis	
Ribeiras do Oeste	
Tejo	RH 5
Sado	RH 6
Mira	
Guadiana	RH 7
Ribeiras do Algarve	RH 8
Total: 15	**8**

River Basin Management Plan (RBMP)

The RBMP is currently being elaborated and the draft report is expected to be published by June 2011. This new plan is an obligation both set in the Community and National legislation and the strategy set for its elaboration is built from previous experience and the need to go beyond the simple production of reports. So, the capacity building and the development of information systems, models and decision support tools are also priorities in order to enable the competent authority to put into practice an integrated water resources management. The general scheme of the planning process is shown in Figure 15.

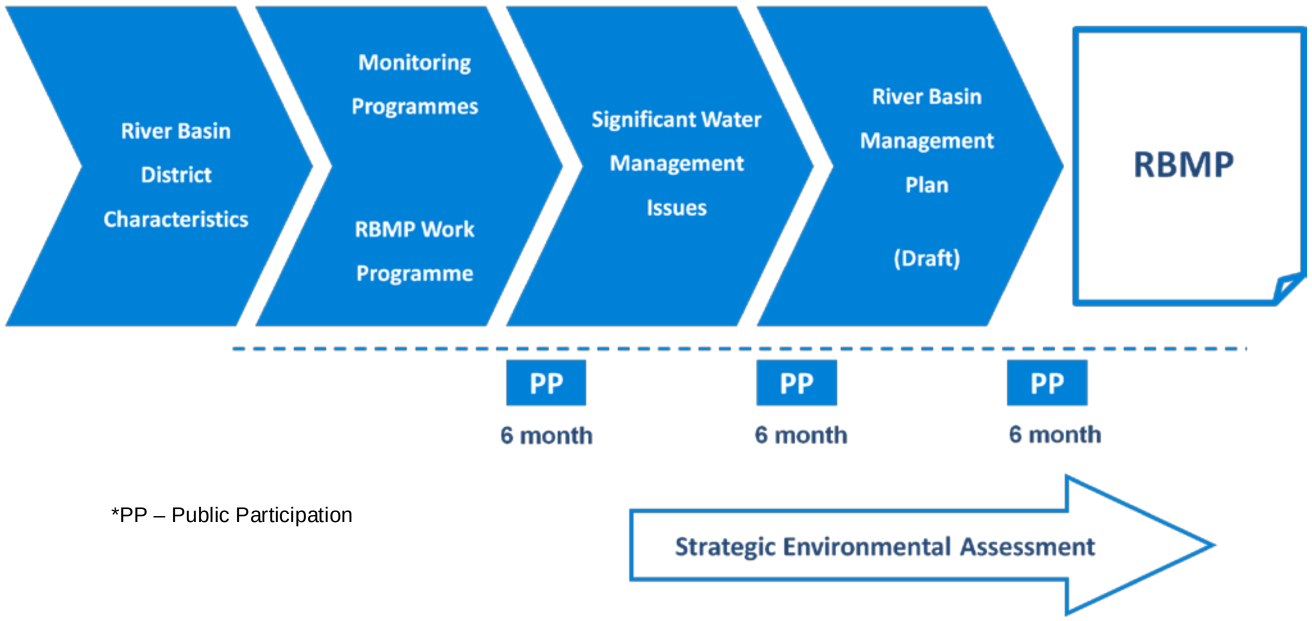


Figure 15 – General scheme of the water resources planning process.

The structure and the contents of the RBMP are set by regulation in order to harmonize as much as possible the documents developed for each RBD (Figure 16). This approach also allows an easier integration of the contents in order to produce national level indicators that will be later on included in the National Water Plan.

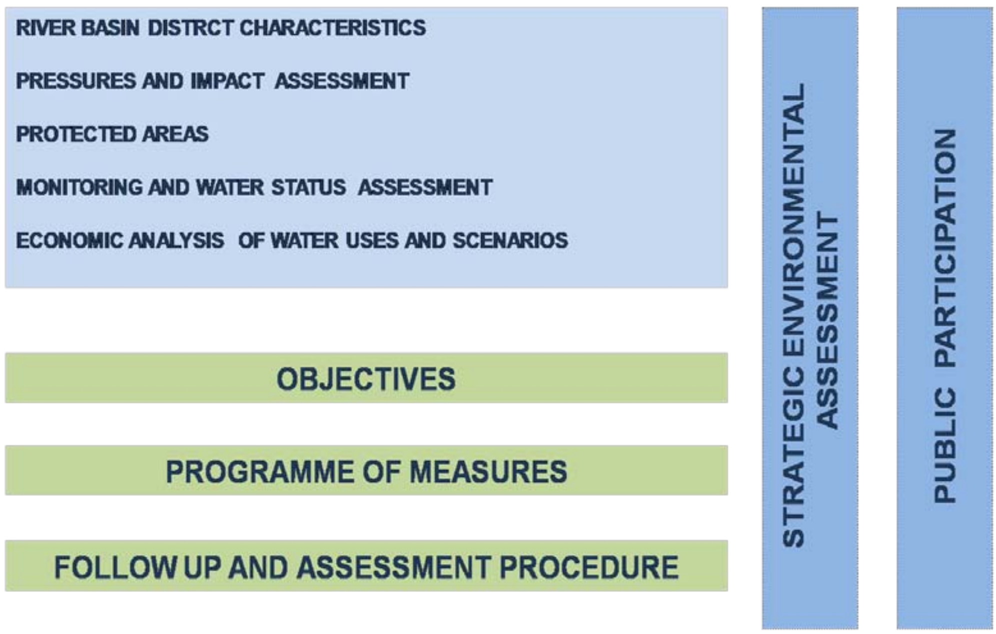


Figure 16 – General contents of the Tagus RBMP and complementary issues.

The Strategic Environmental Assessment (SEA) is mandatory for plans such as the RBMP and therefore the two processes run in parallel. Under the SEA procedure an Environmental Report is prepared taking into account the potential effects on the environment and the alternatives of the proposed plan. The relevant authorities and the public are consulted on both the draft plan and the Environmental Report. As regards the effects on other countries, the SEA procedure follows the same general approach provided under the UNECE Convention on Environmental Impact Assessment in a Transboundary Context.


Castelo de Almourol, Vila Nova da Barquinha

USE OF THE RESOURCE

1. Hydrology

The main tributaries of the Tagus RBD are listed in Table 16. Also, some general characteristics as drainage area and annual runoff are presented.

Table 16 – Main tributaries of the Portuguese part of the Tagus RBD.

River bank	Main Rivers	Drainage Area (km^2)	Annual Runoff (hm^3)
Right	Rio Erges	592	132
	Ribeira do Aravil	427	50
	Rio Pônsul	1,296	288
	Rio Ocreza	1,429	474
	Rio Zêzere	5,029	2,392
	Rio Almonda	213	43
	Rio Alviela	483	125
	Rio Maior	923	236
	Rio Alenquer	287	71
	Rio Grande da Pipa	118	26
	Rio Trancão	279	54
	Grande Lisboa	172	37
Left	Rio Sever	310.0	77
	Ribeira de Nisa	264	65
	Vala de Alpiarça e Ribeira de Ulme	457	79
	Ribeira de Muge	703	130
	Ribeira de Magos	200	32.8
	Rio Sorraia	7,611	1033
	Ribeiras Costeiras do Sul	106	17
Left/Right	Ribeiras Tejo Superior	2,090	372
	Ribeiras Tejo Inferior	546	100
	Estuário	1,227	153
Coastal	Água Costeira do Tejo	153	25

The Tagus RBD is subdivided in 23 sub-basins and three of them are transboundary: Tejo Superior, Erges and Sever (Figure 17).

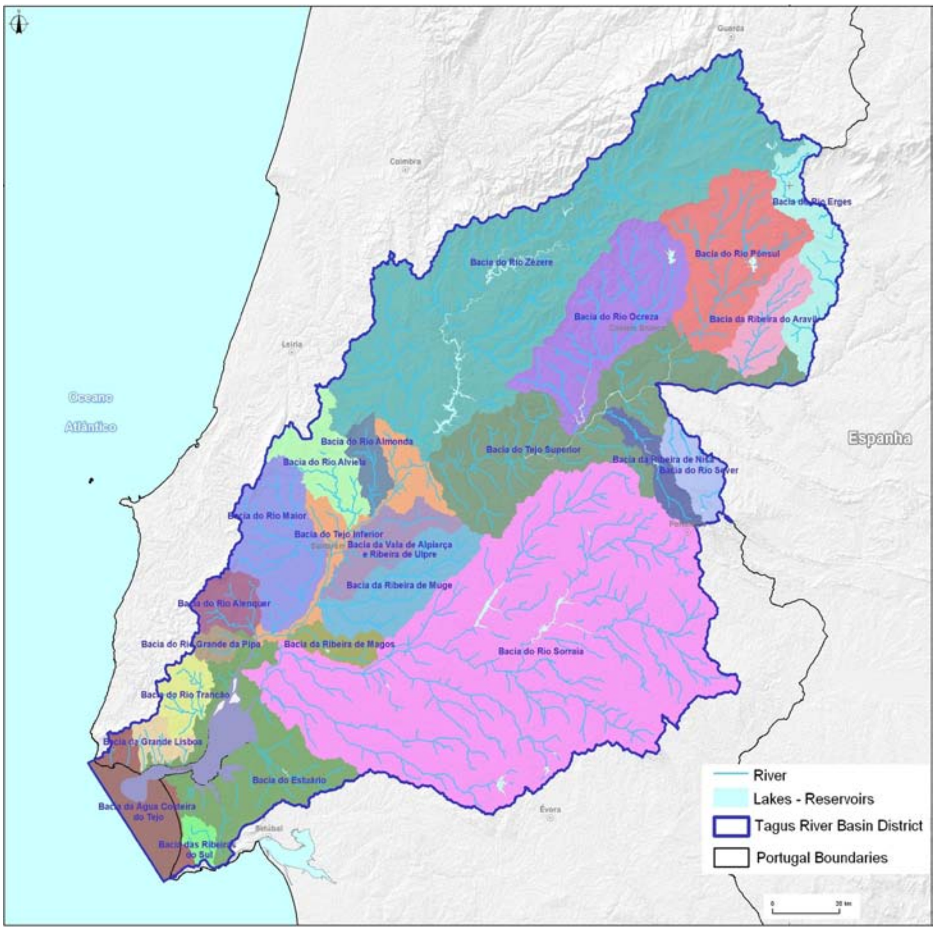


Figure 17 – Sub-basins in the Tagus RBD.

As regards the precipitation distribution, the study area can be subdivided in three regions: right bank of Tagus river (1,100 a 1,600 mm), left bank of Tagus river (590-700 mm) and estuarine/coastal area (700 mm).

In terms of flow regime two areas can be differentiated, the left and the right banks. The existing differences in terms of slope and type of soil have a direct influence on the runoff coefficient and infiltration capacity. The lowest capacity of infiltration and highest runoff coefficient are observed in the right margin rivers.

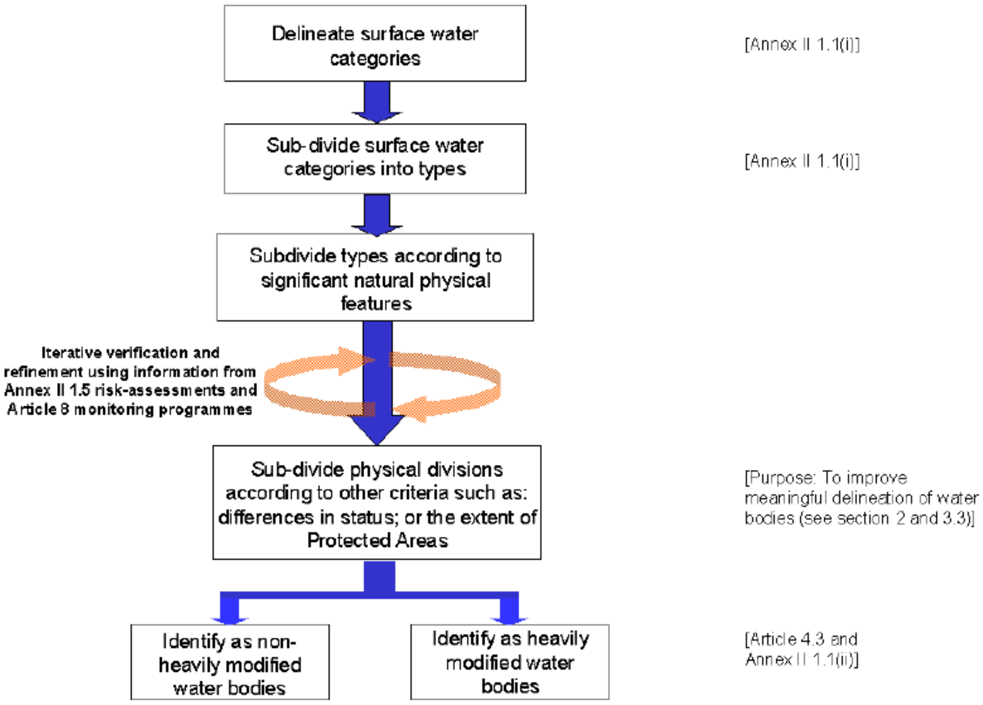
The RBD has a total storage capacity of 2,485 hm^3. The main dams (available storage capacity of 1 hm^3 and higher) are 34 and correspond to 98.5 per cent of the total available storage capacity (Figure 19).

The WFD regulates all waters, including inland waters (surface water and groundwater) and transitional and coastal waters[3]. As regards the chemical status it also includes the territorial waters.

[3] "Coastal waters" means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters.

For the purpose of the implementation of the WFD, the following units should be considered: the river basin, the river basin district, and the "water body". The groundwaters and stretches of coastal waters must be associated with a river basin district.

The environmental objectives are measured by the status of "water bodies"[4]. In Figure 18 the general scheme to delimitate water bodies is shown. The delimitation of the water bodies is a very important task under the WFD implementation process since the number and the carachteristics should be adequate to setting the environmental objectives and not entailing excessive administrative burden.



Source: Adapted from CIS Guidance Document No 2 - Identification of Water Bodies

Figure 18 - Summary of the hierarchical approach to the identification of surface water bodies

[4] "Water bodies" are therefore the units that will be used for reporting and assessing compliance with the Directive's principal environmental objectives. However, it should be emphasised that the identification of a "water body" is a tool not an objective in itself.

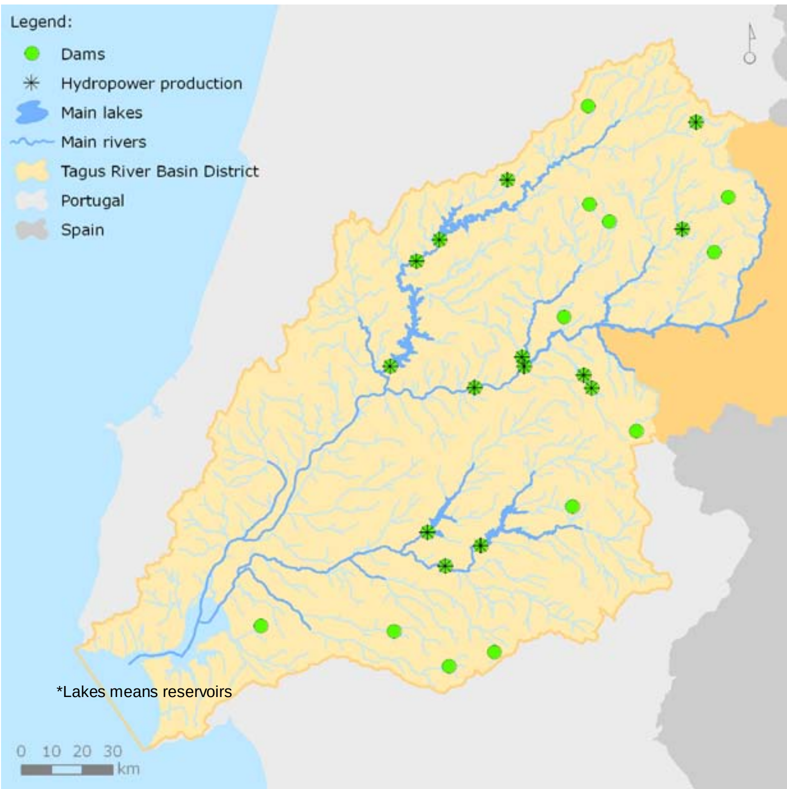


Figure 19 – Main dams in the Tagus RBD.

Under the Albufeira Convention, which entered into force in January 2000, the annual runoff in the Cedillo dam section (Spain) and in the Ponte de Muge gauge station section (Portugal) is 2,700 hm^3 and 1,300 hm^3, respectively, as shown in Table 17.

Table 17 – Flow regime established under the Albufeira Convention for the Tagus RBD.

Cedillo dam downstream section	
Annual runoff	2,700 hm^3
Quarterly runoff	
From 1st October to 31st December	295 hm^3
From 1st January to 31st March	350 hm^3
From 1st April to 30th June	220 hm^3
From 1st July to 30th September	130 hm^3
Weekly runoff	7 hm^3
Ponte de Muge gauge station downstream section	
Annual runoff	1,300 hm^3
Quarterly runoff	
From 1st October to 31st December	150 hm^3
From 1st January to 31st March	180 hm^3
From 1st April to 30th June	110 hm^3
From 1st July to 30th September	60 hm^3
Weekly runoff	3 hm^3

The recharge of groundwater bodies varies accordingly to the geological formations, which determine the type of aquifer. In general, the formations that lead to karst and porous aquifers are those with the highest rates of recharge. An overview of the main aquifers and respective percentage area within the the Tagus RBD is shown in Table 18.

Table 18 – Distribution of lithologies in the Tagus RBD.

Lithology	%
Cleft/Porous	50.6
Porous	38.5
Cleft/Karst/Porous	4.9
Karst	4.8
Cleft/Karst	1.2

The Tagus RBD encompasses 15 groundwater bodies (Figure 20). From these, three are only partially included in the study area and therefore its managemnent should be done in conjunction with other river basins (Penela-Tomar, Sicó-Alvaiázere and Maciço Calcário Estremenho). As for the surface waters, the water body is the conformity checking unit. So, the environmental objectives are set at this scale.

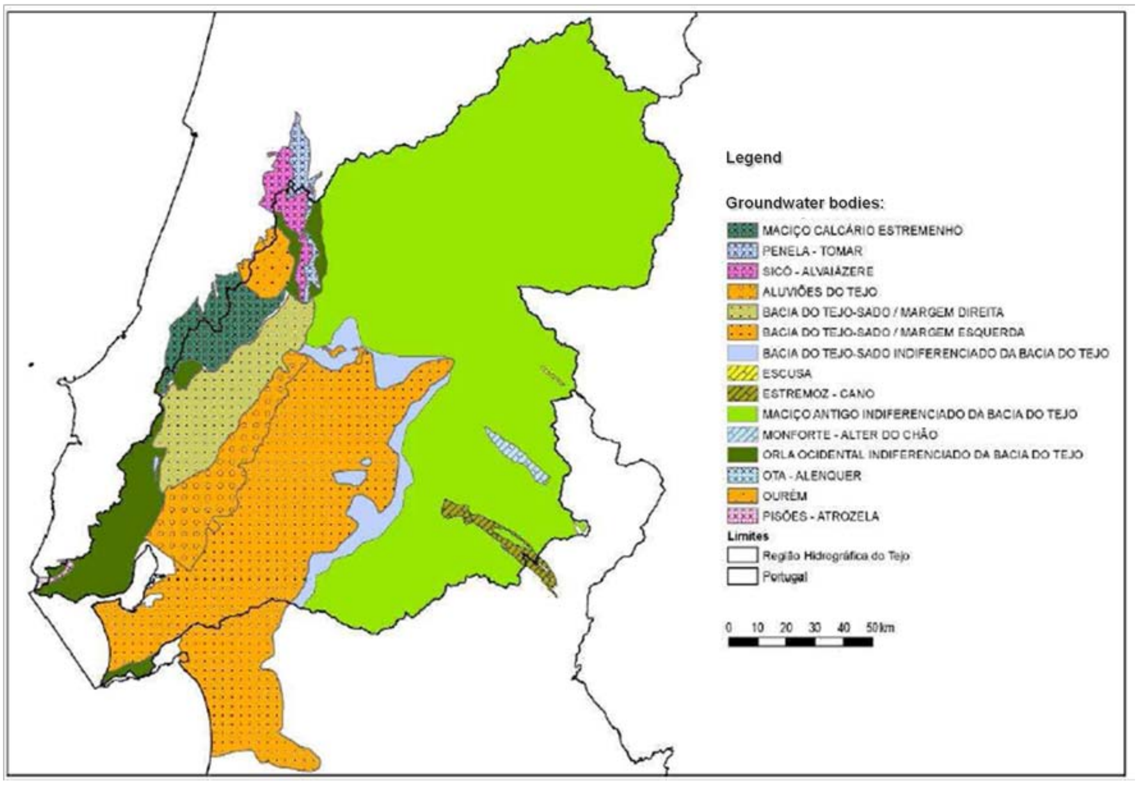


Figure 20 – Groundwater bodies in the Tagus RBD.

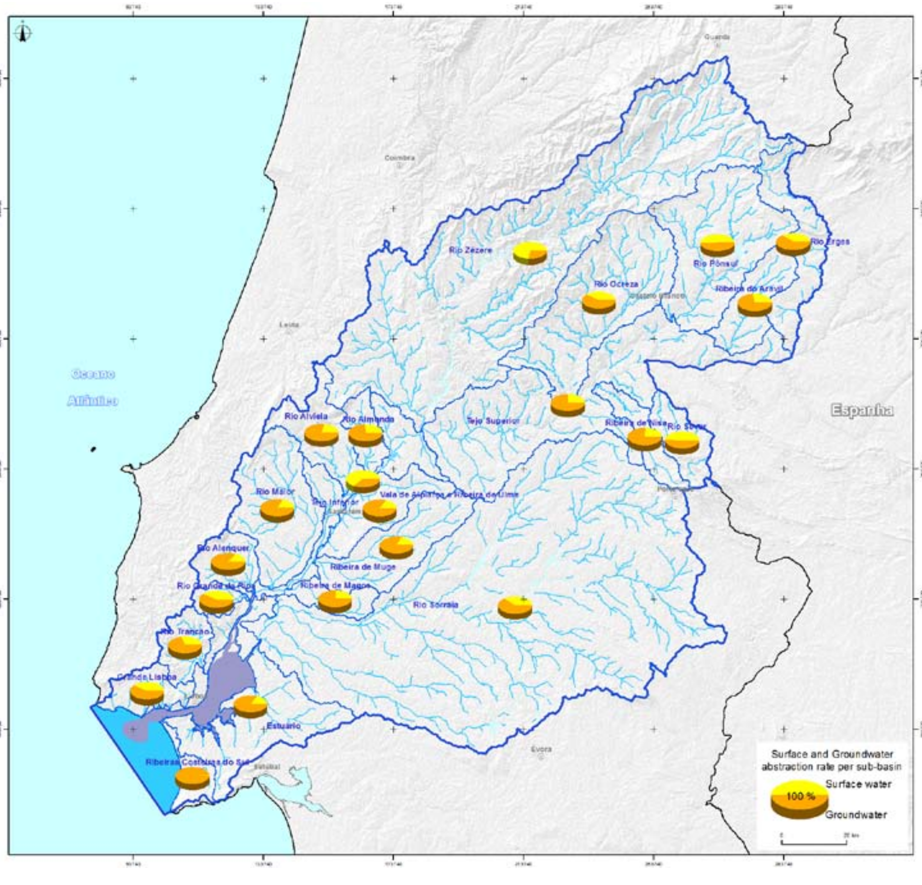
2. Water Availability

The total water availability, including surface and groundwater sources, is over 9,000 hm^3 in an average year (Table 19).

Table 19 –Total water availability per year.

	Surface Water	Groundwater
Climatic Year	**Average**	
Tagus RBD (hm^3/year)	6,300	3,000

The Figure 21 shows the ratio of surface and groundwater abstractions in each sub-basin. The groundwater abstractions are predominant in a large majority of the sub-basins.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.

Figure 21 – Ratio of surface and groundwater abstractions in each sub-basin.

Water Uses

Accordingly to estimates for average years, the water needs in Tagus RBD reach a total volume of 1,452 hm^3. As expected, agriculture is the major user, corresponding to approximately 65 per cent and 68 per cent of the total water needs in average and very dry years, respectively.

The water needs for urban uses correspond to 27 per cent of the total volume and for the industry is around 6 per cent (Figure 22).

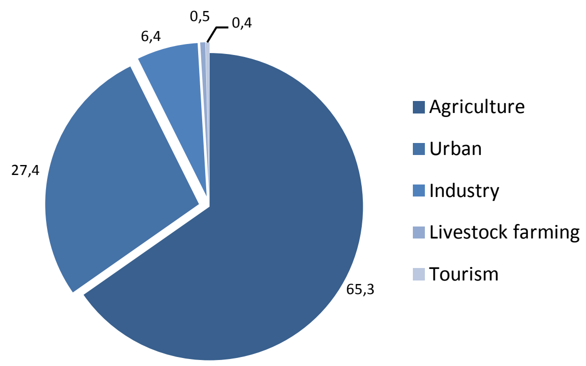


Figure 22 – Total water needs (%) per consumptive uses.

Table 20 –Total water needs per consumptive uses in each sub-basin.

Water needs (hm^3/year)					
Sub-basin	Urban	Industry	Agriculture (average year)	Livestock Farming	Tourism (Golf)
Rio Erges	0.17	0.01	2.15	0.08	-
Ribeira do Aravil	0.12	0.01	16.40	0.08	-
Rio Pônsul	2.30	0.25	59.51	0.21	-
Rio Ocreza	4.05	0.85	18.77	0.17	-
Rio Zêzere	24.78	7.88	91.47	0.65	-
Rio Almonda	3.78	5.94	26.54	0.03	-
Rio Alviela	4.40	3.85	15.18	0.39	-
Rio Maior	9.95	4.22	44.90	0.69	0.35
Rio Alenquer	3.04	3.05	4.60	0.06	-
Rio Grande da Pipa	1.96	0.85	0.82	0.07	-
Rio Trancão	34.51	4.93	8.86	0.12	0.16
Grande Lisboa	87.96	9.76	0.98	0.02	0.389
Rio Sever	0.67	0.41	1.61	0.09	-
Ribeira de Nisa	0.46	0.09	2.82	0.08	-
Vala de Alpiarça e Ribeira de Ulme	3.13	3.73	44.15	0.04	-
Ribeira de Muge	1.25	0.62	29.18	0.14	-
Ribeira de Magos	1.71	0.55	31.77	0.08	-
Rio Sorraia	13.77	9.74	297.49	3.14	0.94
Tejo Superior	5.78	4.32	29.77	0.26	-
Tejo Inferior	5.29	2.08	50.92	0.17	-
Estuário	131.73	21.49	100.33	0.70	1.83
Ribeiras Costeiras do Sul	1.53	0.03	0.67	0.01	-
Água Costeira do Sul	24.3	1.020	1.8	0.01	0.189

The water needs were assigned to the sources of abstraction, that meaning that the point of consumption is where the source of the water catchment is. This has particular importance in the case of urban water supply, since most needs for urban use is from the sub-basin Rio Zêzere (Castelo de Bode dam), the headwaters of the Alviela and the main section of the Tagus in Valada do Ribatejo.These sources are integrated in the EPAL system that supplies the city of Lisbon, and also supply needs from the Ribeiras do Oeste river basin, adjacent in the West of the Tagus RBD.

The estimated total losses in urban systems are approximately 35 per cent.

Overall, the Estuário and Grande Lisboa sub-basins stand out from the others, representing, as a whole, 66 per cent of the total needs of the Tagus RBD, encompassing the counties of densely populated metropolitan area of Lisbon. Also, it's possible to say that Rio Grande Pipa and Ribeira Aravil sub-basins water needs for urban use are totally provided from sources outside the sub-basin.

The Figure below (Figure 23) represents, on average, the source of the water consumption by sector.

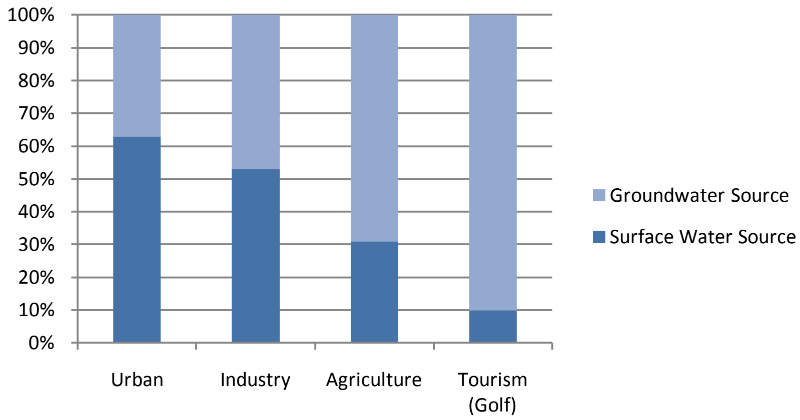
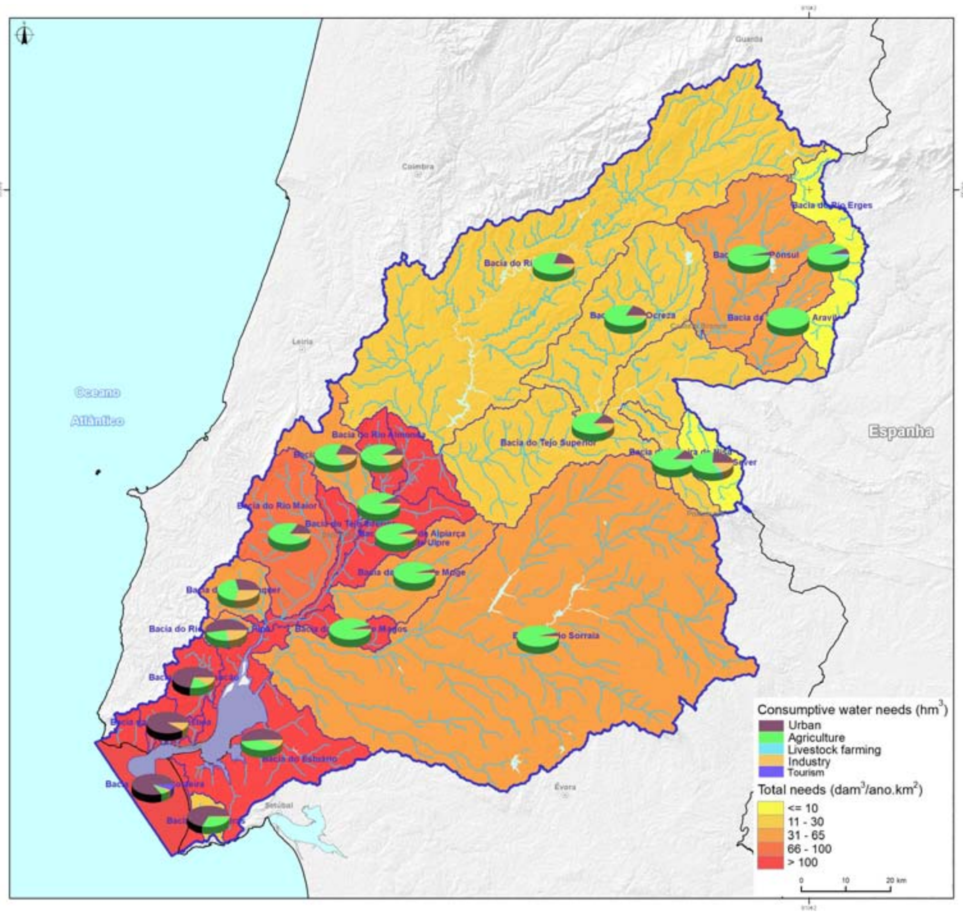


Figure 23 – Water abstraction source per consumptive uses.

The Figure 24 shows the total water needs for each sub-basin and how this volume is distributed among the main consumptive sectors.



* The information regarding the Agua Costeira do Tejo sub-basin is integrated in the Grande Lisboa and Ribeiras Costeiras do Sul sub-basins.

Figure 24 – Total water needs (hm^3) per consumptive uses per sub-basin.

As an overall analysis, the water needs are higher in the sub-basins with more population and where the economic activities are more developed. Additionally, the water supply to the population (urban sector) is provided by a proportion of 60 per cent from surface water and 40 per cent from groundwater.

3. Extreme Events

3.1. Floods

The climatic conditions and rainfall regimes found in Portugal mainland result from the low pressure in the Atlantic associated with moist fronts that move to East, causing periods of intense rainfall.acroos the territory. Another type of weather phenomena is associated with convective atmosphere causing intense precipitation in relatively small areas. In general, these situations lead to excessive rainfall and flash flooding with more severe impacts in smaller river basins.

The identification of the critical points in the Tagus RBD was based on a work developed by the National Water Authority and the analysis of the National Ecological Reserve[5] defined in the Municipal Master Plans[6]. In addition, a filed work was developed to collect all the relevant information regarding historical floods for the entire RBD. At last, the flood peak flows were simulated using the Hydrologic Modeling System (HEC-HMS).

In general, the main gauging stations located in the river Tagus, namely Almourol, Tramagal, Vila Velha de Ródão and Ómnias, registered high flood peak flows for the different return periods ranging from 4,000 to 13,000 m^3/s. The Table 21 shows the flood peak flows estimated by HEC-HMS for a return period 100 years.

Table 21 – Flood peak flows estimated by HEC-HMS (return period 100 years)

Sub-basin	Reference Sections	Area (km^2)	Retention time (h)	Flood peak flow (m^3/s)	Specific peak flow ($m^3/s.km^2$)	Flood volume (hm^3)
Rio Erges	Rio Erges	592	22	663.1	1.12	32,800
Ribeira do Aravil	Ribeira do Aravil	427	11	525.5	1.23	20,830
Rio Pônsul	Pônsul 1	365	11	448.6	1.23	18,640
	Pônsul 2	931	14	1,230.5	1.32	51,304
Rio Ocreza	Rio Ocreza	1,429	24	1,455.3	1.02	124,345
Rio Zêzere	Zêzere 1	2,355	30	2,354.6	1.00	324,107
	Zêzere 2	2,614	25	2,828.5	0.83	174,436
	Agroal	601	12	616.3	1.03	25,703
	Fábrica da Matrena	985	18	954.0	0.97	60,101
Rio Almonda	Rio Almonda	213	14	305.9	1.44	14,890
	Ponte Nova	84	6	245.0	2.93	5,181
Rio Alviela	Rio Alviela	483	14	747.6	1.55	36,381
	Ponte Ribeira de Pernes	104	7	266.0	2.57	6,522
Rio Maior	Rio Maior	923	23	869.6	0.94	65,892
Rio Alenquer	Rio Alenquer	287	11	495.6	1.72	18,463

[5] National Ecological Reserve (REN) is a biophysical structure which integrates areas subject to special protection measures due to their ecological value and sensitivity or susceptibility to natural risks. REN is regulated under Decree-Law 166/2008, 22nd August.

[6] Municipal Master Plan (PDM) is a plan developed for the municipality area and establishes the basic classification and qualification of land and construction rules in accordance with local infrastructures, present and future.

Sub-basin	Reference Sections	Area (km^2)	Retention time (h)	Flood peak flow (m^3/s)	Specific peak flow ($m^3/s.km^2$)	Flood volume (hm^3)
	Ponte de Barnabé	115	6	323.0	2.81	6,791
Rio Grande da Pipa	Rio Grande da Pipa	118	7	298.8	2.52	7,986
Rio Trancão	Rio Trancão	279	9.5	597.6	2.14	19,994
	Ponte Pinhal	78	4	212.0	2.72	4,445
Rio Sever	Rio Sever	423	23	320.9	0.76	25,054
Ribeira de Nisa	Ribeira de Nisa	264	14.5	266.1	1.01	13,810
Vala de Alpiarça e Ribeira de Ulme	Vala de Alpiarça e Ribeira de Ulme	457	22	453.4	0.99	34,159
Ribeira de Muge	Ribeira de Muge	703	23	477.8	0.68	38,995
Ribeira de Magos	Ribeira de Magos	105	17	214.0	2.04	6,643
Rio Sorraia	Sorraia 1	2,282	26	-	-	-
	Sorraia 2	1,181	28	-	-	-
	Sorraia 3	4,147	45	-	-	-
	Monforte	141	6	269.0	1.91	5,498

The flood marks were identified by sub-basin and drainage area of the water bodies, including the register of flood levels. Flood marks are located essentially along the main course of River Tagus and near the Lisbon metropolitan area, in particular in Rio Trancão sub-basin (Figure 25).

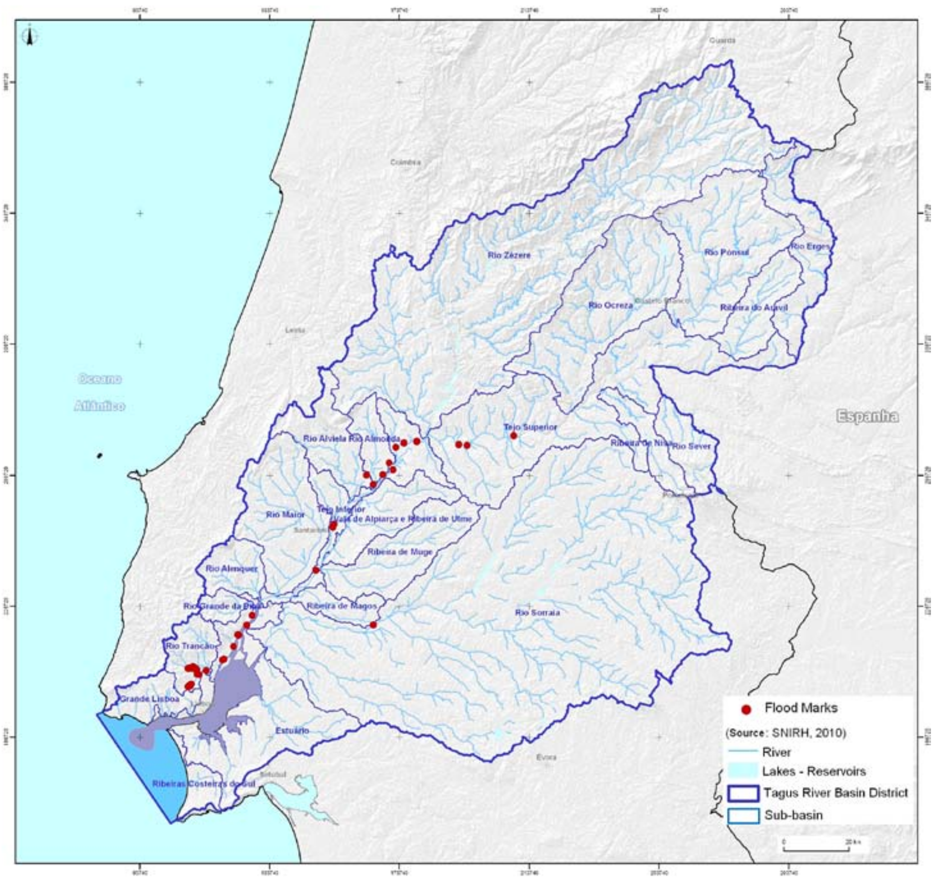


Figure 25 – Flood marks in the Tagus RBD.

The Tagus RBD is usually affected by flooding being the right margin the main area at risk. The valley of the River Tagus, which has has the largest alluvial area in Portugal, was affected by 47 significant flood events since 1739. The biggest flood in the River Tagus occurred in December 1876 and with an estimated peak flow of 16,000 m^3/s. A flood discharge of 10,000 m^3/s usually corresponds to the magnitude of a 20 year flood.

The issue of flooding is of particularl importance in the Tagus RBD not only for the extent of the area affected, but for the relevant urban areas subject to such events. There are two types of flood events: the flash floods that occur mainly in the Metropolitan Area of Lisbon and the river floods that occur in the city of Tomar and Lezíria do Tejo and Médio Tejo areas or in the main course of the rivers Tejo, Sorraia and Ribeira de Muge.

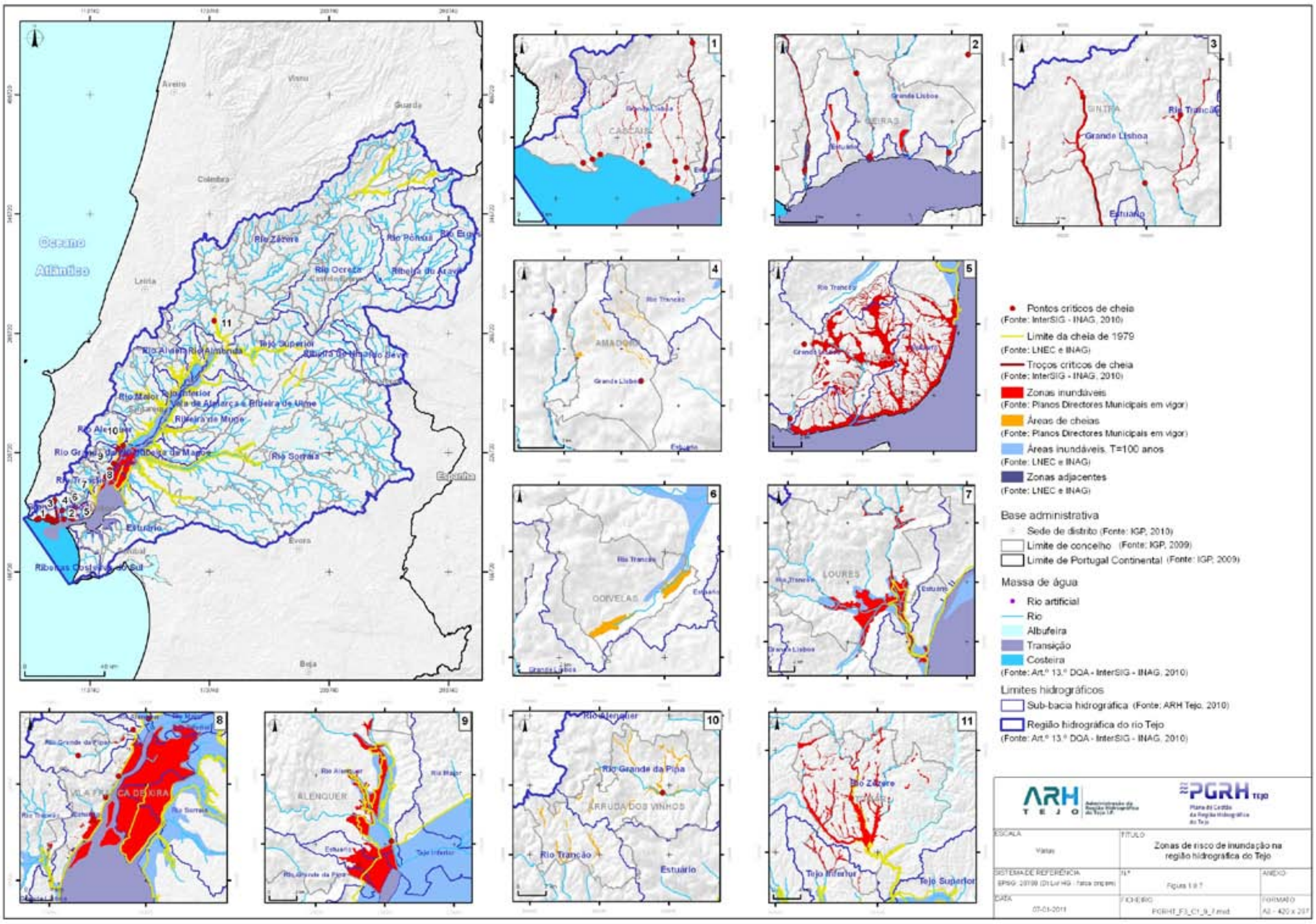


Figure 26 – Major floods events in the Tagus RBD.

Along the years there has been an effort to promote the regularization works of the rivers in order to reduce the frequency and effects of the floods. The construction of dams in the Rio Zêzere, which is the main tributary of the River Tagus, is insufficicietnt to prevent the ocorrunce of floods events in the downstream areas. The reservoir capacity of the Tagus RBD in Spain and the exploration regime of the reservoirs have a direct effect on the frequency and magnitude of the floods in the Portuguese part of the RBD.

In conjunction with more structurall oriented measures, the establishment of protection measures such as spatial planning and early warning systems are of most importance to address the issues related to flooding.

3.2. Drought

For the Tagus RBD, the drought of 1944-1945 is considered the most severe having a significant area of the RBD being designated as in severe/extreme drought for 15 months. It was the second most prolonged drought and it lasted for a period of 29 months.

The most prolonged drought ever started in February 1973 and lasted for 46 months with an average intensity of -0.80. The regional SPI (Standardized Precipitation Index, McKee et al. (1993, 1995) aggregate for the RBD, reached the category of moderate drought after 22 months of abnormally dry conditions.

The last drought event occurred in 2005 at the end of the hydrological year and the entire territory was affected by a long period of continuous dry weather ranging from a classification of moderate to extreme drought: 3 per cent Moderate, 36 per cent Severe and 61 per cent Extreme.

The Figure 27 shows the average duration of droughts in months for each station and using the time series 1941-1999. The SPI index was calculated for each one of the 35 stations across the Tagus RBD.

The main impacts resulting from drought on the economic activities was assessed based on a combined analysis of the intensity and duration of droughts and the land cover. From the analysis, the areas affected with more prolonged droughts are in great part occupied with water-dependent crops but which are at certain level adapted to water scarcity periods. The more resistant areas to water scarcity have proven to be the forests, heterogeneous agricultural areas and olive. In general terms, the agriculture activity needs to focus on irrigation strategies for crop production under water scarcity.

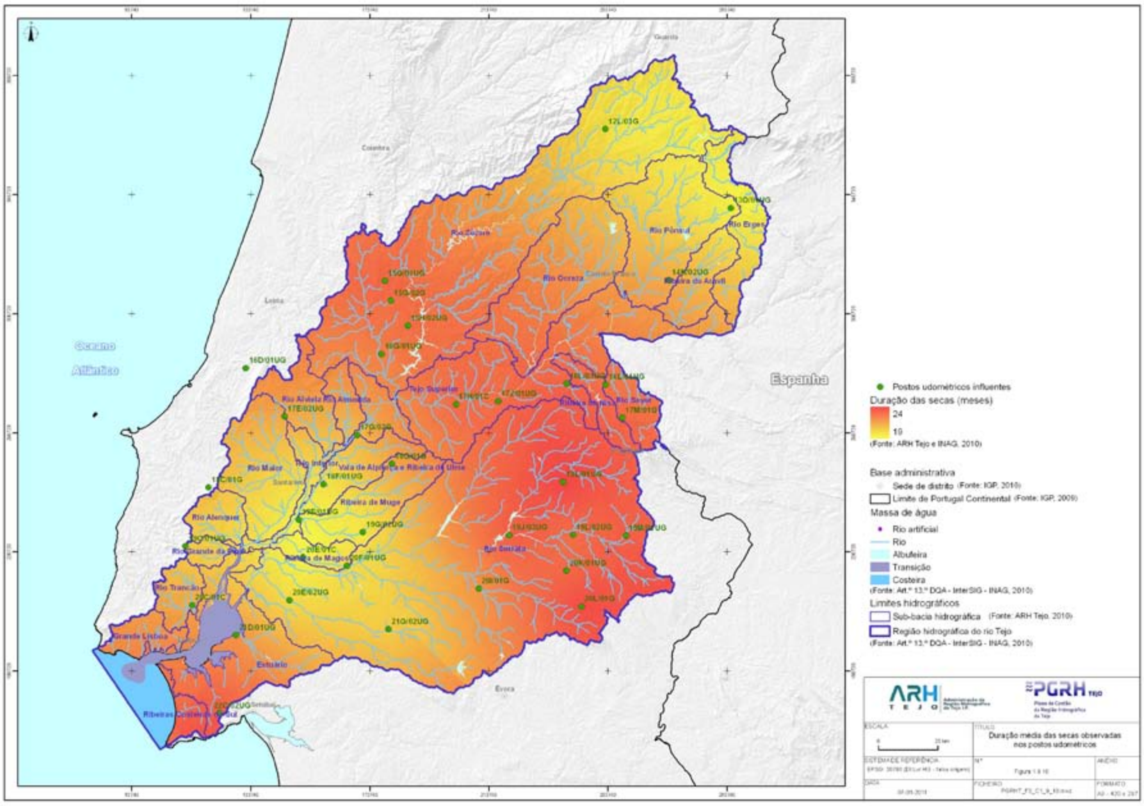


Figure 27 – Average duration of droughts in months (time series 1941-1999).

4. Pressures on Water Resources

The characterization and quantification of anthropogenic pressures on surface water and groundwater bodies take into account the point and diffuse sources, morphological and hydromorphological alterations and water abstraction.

The point sources include the contributions from industries, urban waste water, livestock farming, landfills, power plants and mining industry (Table 22).

Table 22 – Point sources – Number of facilities

Type of Pressure	No. of facilities
Urban	753
Industry	138
Livestock farming	190
Landfill	10
Power Plants	3

The diffuse sources include the contributions from agriculture, forest areas, pastures, artificial areas, shrubs or herbaceous vegetation areas, livestock farming (pig farming, poultry and cattle farming), industries and urban areas (septic tanks). The Table 23 shows the number of facilities regarded as diffuse pollution sources.

Table 23 – Diffuse source – Number of facilities

Type of Pressure	No. of facilities
Urban	340
Industry	337
Livestock farming	1 757

4.1. Surface water

The pollutant loads discharged to surface waters were estimated for both point and diffuse sources (Table 24). In relation to point sources, the estimates were made for the parameters BOD_5, COD, TSS, Nitrogen (N_{Total}) and Phosphorous (P_{Total}). The information is aggregated taking into account the pollution loads from the following sources:

- Urban - includes the urban wastewater treatment plants, septic tanks and urban collectors;
- Livestock - includes the pig farms and poultry;
- Industry - includes all industrial sectors, landfills and power plants.

For diffuse sources, the estimates were made for Nitrogen (N_{Total}) and Phosphorous (P_{Total}) taking into account the contributions from agriculture, forest areas, pastures, artificial and shrubs or herbaceous vegetation areas.

Table 24 – Estimates of pollutant load from point and diffuse sources in the Tagus RBD.

Source	COD (%)	CBO_5 (%)	TSS (%)	N_{Total} (%)	P_{Total} (%)
P - Urban	66.3	73.8	65.4	56.9	70.6
P - Industry	16.5	12.1	8.3	5.4	1.5
P - Livestock farming	17.2	14.1	26.3	9.5	12.9
Diffuse	-	-	-	28.2	15.0

The pollutant load from the urban sector has the highest values in the Água Costeira do Tejo and Estuário sub-basins. These two sub-basins contribute significantly to the total pollutant loads, representing the sum of the two sub-basins almost 55 and 59 per cent of all estimated load in terms of COD and BOD_5, respectively. The N_{Total} and P_{Total} loads from these sub-basins correspond to 53 per cent and 54 per cent of the total values, respectively.

As regards livestock farming the pollutant loads are more significant in the Rio Maior sub-basin followed by Estuário, Rio Zêzere and Rio Sorraia areas.

The pollutant loads from industry are mainly concentrated in the Tejo Superior and Estuário sub-basins. As major contributors, it should be highlighted the pulp industry in the Tejo Superior and the chemical, food and drink industries in the Estuário sub-basin.

As regards diffuse pollution from agricultural sources, the largest contribution in terms of load generated is linked to agricultural areas with annual crops (51 per cent). Heterogeneous and permanent crops agricultural areas represent respectively 35 per cent and 14 per cent of the total contributions from the agriculture sector.

In terms of nutrients, the largest contribution from diffuse sources to the surface water bodies is of N_{Total}, representing approximately 89 per cent of the total nutrients load generated. By the analysis of the data the sub-basins that contribute more with this kind of pollution are Rio Sorraia and Rio Zêzere. These two sub-basins represent almost half of the total estimated load for the whole Tagus RBD.

The characterization of the morphological and hydromorphological alterations includes the identification of the main infrastructures and activities causing physical changes on the water bodies and impacts on the river continuum such as energy production and sediments extraction.

The Table 25 shows the number of dams associated to different purposes.

Table 25 – Number of dams associated to different purposes.

Purpose	Large dams[1]	Dams[2]	Small dams[3]
Irrigation	25	80	1,492
Public Supply	18	3	4
Private provision	-	6	459
Energy	17	2	6
Protection against floods or fires to use	2	2	-
Recreational use	2	1	1
Other	5	2	205

(1) Dams with a height greater than or equal to 15 m measured from the lowest part of the general surface of foundation to the crest or dams with a height exceeding 10 m, whose reservoirs have storage capacity exceeding 1 million m^3.
(2) Dams with height less than 15 m measured from the lowest part of the general surface of foundation to the crown, whose reservoirs have storage capacity exceeding 100 000 m^3.
(3) Dams with height less than 15 m measured from the lowest part of the general surface of foundation to the crown, whose reservoirs have storage capacity exceeding 100 000 m^3.

The Rio Zêzere sub-basin has the highest useful storage capacity and a total storage capacity exceeding $1{,}000\times10^6$ m^3. The largest dams encountered in the Tagus RBD - Castelo de Bode and Cabril – are located in this sub-basin and their useful capacity is 900.5×10^6 m^3 and 615×10^6 m^3, respectively.

The sediments extraction activities are carried out in the Tagus River (a section of approximately 106 km, between Abrantes and Vila Franca de Xira) and Sorraia and Zêzere rivers. As shown in Table 26, the Tagus RBD has 140 sites used for sediment extraction.

Table 26 – Sediment extraction in the Tagus RBD.

River	Sub-basin	Extraction Sites (no.)	Volume extracted (%)
Tejo	Tejo Superior e Tejo Inferior	22	91
Zêzere	Rio Zêzere	10	1
Sorraia	Rio Sorraia	108	8

In the Tagus River, 22 sites are registered which correspond to 91 per cent of the total volume of sediment extracted. This value corresponds to the maximum volume that is allowed in the extraction permits presently issued. The permits issued for rivers Zêzere and Sorraia allows a maximum of volume extracted of 500 m^3/per year.

In the Tagus RBD there are 265 surface water abstraction in which 86 per cent are for consumptive use (industry, agriculture and urban) and 14 per cent for non consumptive use (Figure 28). However, the volume abstracted for non consumptive uses, namely the production of energy, is much higher than the volume abstracted for consumptive uses, representing 79 per cent of the total volume abstracted.

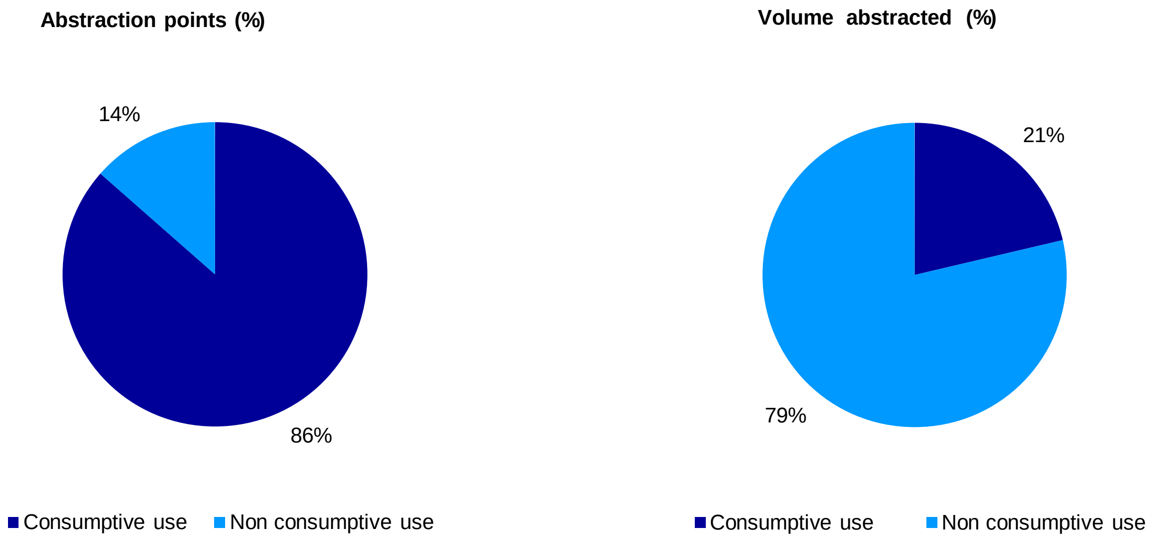


Figure 28 – Surface water abstractions and the volume abstracted per consumptive and non consumptive uses.

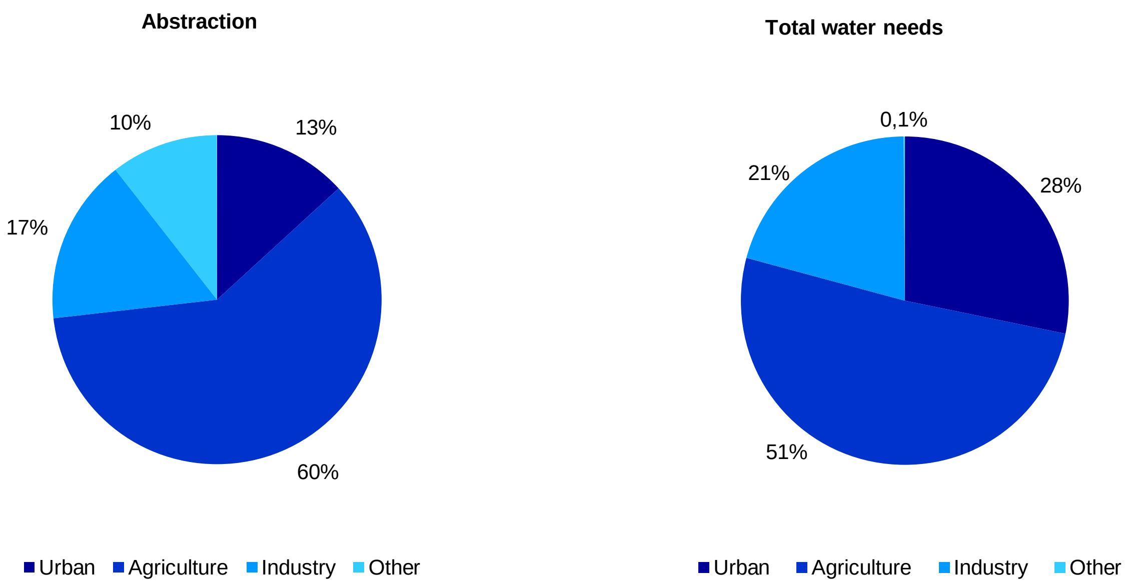


Figure 29 – Percentage of surface abstraction and the volume abstracted per type of consumptive uses

The surface water abstractions for agriculture are highly concentrated in the sub-basin Rio Sorraia, where there is a quite intensive agricultural activity developed along extensive areas of irrigated land. As regards water abstraction for urban water supply, it is mainly concentraded in the sub-basin Rio Zêzere, being the Castelo de Bode reservoir responsible for water supply to the Lisbon Metropolitan Area.

As regards the extractive activities the Tagus RBD has 35 active and 231 inactive mines and 79 active quarries. The mining and quarrying areas are 125.8 km^2 and 4.52 km^2, respectively. The sub-basin Rio Zêzere has 80 per cent of the active mines and 30 per cent of the total number of quarries.

4.2. Groundwater

The pollutant inputs to the groundwater bodies were estimated for both point and diffuse sources and pollutant chosen was the Nitrogen (N_{Total}) (Table 27). The information is presented in aggregate format, considering as pollution loads from point sources the septic tanks (urban) and from diffuse sources the contributions from agriculture, livestock farming (pig farms, poultry and cattle farming) and industry.

Table 27 – Estimates of pollutant load from point and diffuse sources in the Tagus RBD.

Source	N_{Total} (%)
Point - Urban	0.04
Diffuse - Livestock farming	47.2
Diffuse - Industry	1.8
Diffuse - Agriculture	51

The greatest contribution of N_{Total} loads to the groundwaters is from Agriculture, being more representative in the water bodies Ota-Alenquer and Pisões-Atrozela, 100 per cent and 100 per cent, respectively.

The livestock is the second highest with 47.2 per cent of the total N_{Total} loads. The activity sectors more representative are the pig and cattle farming. The Monforte-Alter do Chão is the groudwater body which is most affected by these sectors with 71 per cent of the total N_{Total} input and the groudwater bodie Bacia do Tejo-Sado / Margem Esquerda with 59.9 per cent.

In the Tagus RBD there are approximately 40,000[7] groundwater abstractions intended for different uses. In 2009, the application of the Economic and Financial Regime for water uses covered around 4000 groundwater abstractions intended for public supply, agriculture and other uses as shown in Figure 30.

[7] The value does not take into account the groundwater abstractions registered under the exceptional period of regularization of existing water uses established under the legislation. The data is currently under analysis.

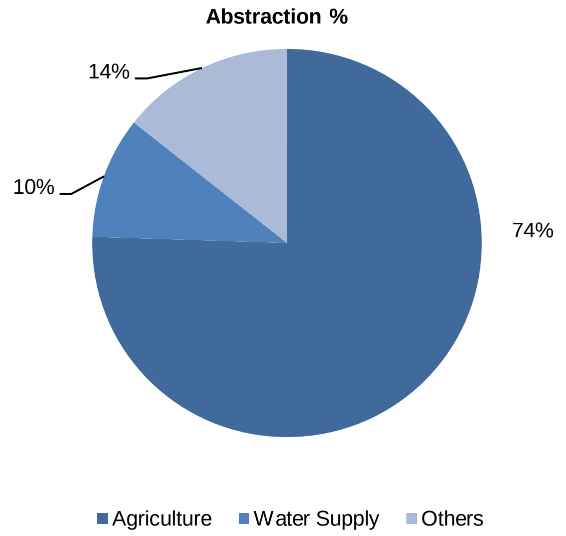


Figure 30 – Groundwater abstractions per type of consumptive uses.

Figure 31 – Agricultural areas – Leziria, Vila Franca de Xira.

5. Data and Information on Water Resources

The monitoring programmes include a number of networks which have specific objectives, both in terms of qualitative and quantitative aspects. Taking into account the provisions set under the WFD, the quality is assessed as water status. The sampling stations were defined based on a set of criteria, in order to ensure coherence and representativeness of the collected data.

The monitoring networks are grouped as follows:

- Water Status
  - Surface Water: Surveillance, Operational, Investigative
  - Groundwater: Chemical Status - Surveillance & Operational; Quantitative Status
- Hydrometric
- Meteorological
- Sediments

5.1. Water Status Monitoring

5.1.1. Surface Water

The Table below summarizes the number of stations in each monitoring network by water body category. It also shows the stations that are part of the protected areas network. The density is calculated by linear extension (km) or area (km2). The monitoring programmes include a number of networks which have specific objectives, both in terms of qualitative and quantitative aspects. Taking into account the provisions set under the WFD, the quality is assessed as water status. The sampling stations were defined based on a set of criteria, in order to ensure coherence and representativeness of the collected data.

Table 28 – Monitoring networks and number of monitoring stations per water body category.

	Water body category							
Network	River		River (reservoirs)		Transitional		Coastal	
	Stations (no.)	Extension (km)	Stations (no.)	Area (km^2)	Stations (no.)	Area (km^2)	Stations (no.)	Area (km^2)
WFD - Surveillance	83	1,666.72	10	70.09	3	175.85	1	380.08
WFD - Operational	85	2,492.36	13	58.40	5	191.73	2	1.60
Density (per 1,000 km^2 drainage area)	7.3		9.27		9.96		23.36	
Stations density	26.70		155.59		21.77		7.86	

Network	Water body category							
	River		River (reservoirs)		Transitional		Coastal	
	Stations (no.)	Extension (km)	Stations (no.)	Area (km^2)	Stations (no.)	Area (km^2)	Stations (no.)	Area (km^2)
Protected Areas								
Water intended for human consumption	83.9 % of all abstrations							
Protection of aquatic species with economic value	27.69 Stations per 1,000 km of designated segments							
Sensitive zones (eutrophication)	100 % (all identified zones)							
Habitats Stations density	24.14		147.43		21.77		7.86	
Birds Stations density	25.78		61.42		21.77		2.63	
Bathing waters	100% (all designated waters)							

The overall monitoring programme includes 202 stations distributed by the different water body categories (Table 29).

Table 29 – Number of stations per water body categories.

Categories	Monitoring	Surveillance Programme	Operacional Programme	Investigative Programme
	(No. of stations)			
Rivers	168	83	85	-
Lakes*	23	10	13	-
Transitional waters	8	3	5	-
Coastal waters	3	1	2	-

*Lakes mean reservoirs

As for additional monitoring of Protected Areas, the overall number of monitoring stations existing is presented in Table 30.

Table 30 – Number of monitoring stations in protected areas under relevant EU legislation.

Habitats and Birds Directive	Drinking Water Directive	Bathing Waters Directive	Fish Waters Directive	Shellfish Waters Directive*	Nitrates Directive	UWWT Directive**
80	26	57	35	-	-	2

* There is no shellfish waters designated in Portugal mainland.

*UWWT – Urban Waste Water Treatment Directive

5.1.2. Groundwater

The quantitative status monitoring network aims at assessing and following the temporal and spatial variation of the available groundwater resources. The measurements of the water level and spring flows are carried out in 103 stations. As regards the chemical status, the surveillance and operational networks include 217 monitoring stations.

Table 31 – Number of monitoring stations on groundwater.

Nr. Monitoring stations	Chemical		Quantitative
	Surveillance	Operacional	
Total	252	52	163

5.2. Hydrometric

Within the Tagus RBD area there are 129 monitoring stations to measure rainfall and 159 hydrometric stations.

5.3. Meteorological

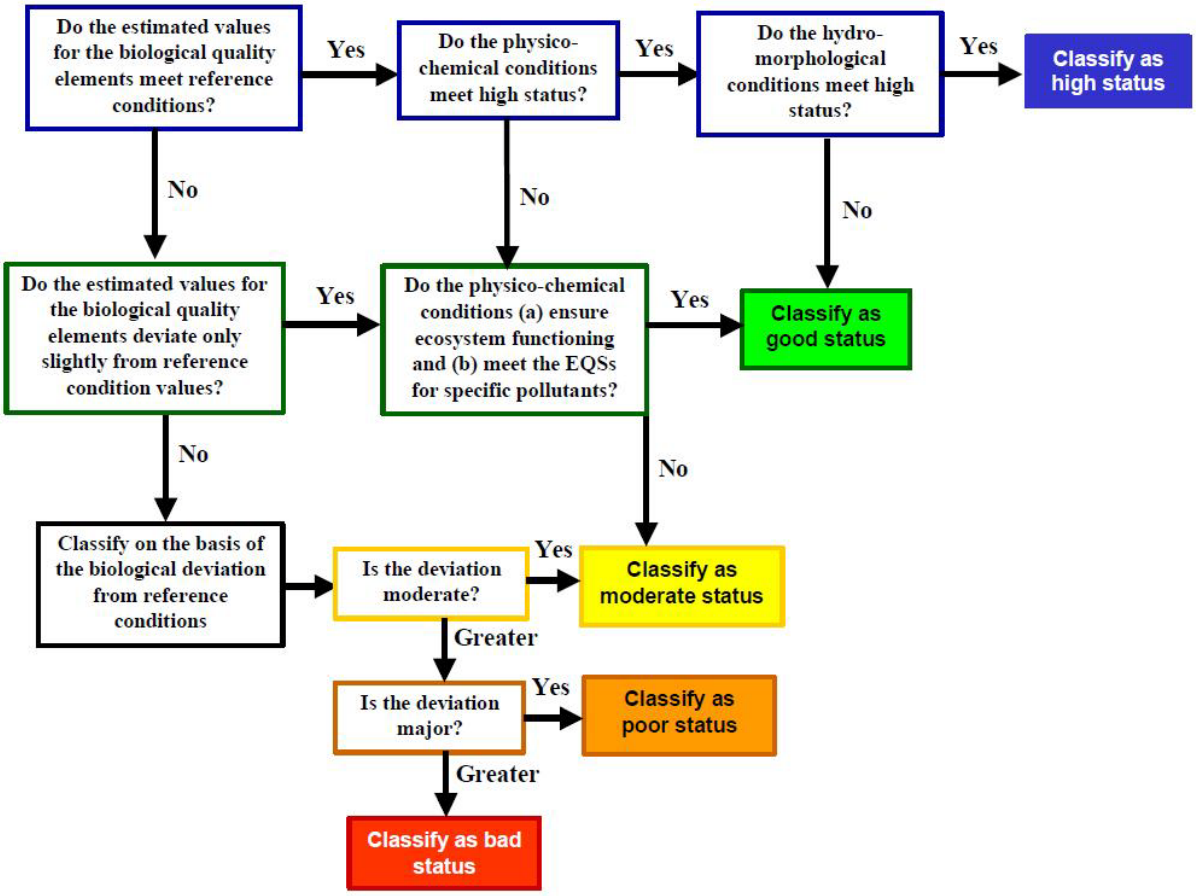
The climate characterization and classification in the RBD is based on the data provided from 21 meteorological stations.

5.4. Sediments

The sediments monitoring network includes 32 stations. This network has the objective to develop bathymetric assessments and to evaluate reservoir sedimentation.

STATE OF THE RESOURCE

The surface water status classification system includes biological, hydromorphological and physico-chemical quality elements (Figure 32). Each EU Member State should establish a water status classification system taking into account the results from the intercalibration exercise[8]. The overall set of data available was considered insufficient to provide a robust classification of the water status hence the need to develop further studies to fill the gap. Besides the significant level of uncertainty a first exercise was carried out taking into account the monitoring programmes in place, the pressures analysis and expert judgement.



Source: CIS Guidance no.13 on Overall Approach to the Classification of Ecological Status and Ecological Potential

Figure 32 – Indication of the relative roles of Biological, hydromorphological and physic-chemical quality elements in ecological status classification according the normative defitinitions in WFD.

The preliminary water status assessment developed under the Tagus RBMP shows that 54 per cent of the surface water bodies and 66.7 per cent of the groundwater bodies are classified as good and higher.

[8] The intercalibration exercise is referred in the European Water Framework Directive (Annex V section 1.4.1) and aims at harmonizing the application of 'good ecological status' in all Member States, and ensuring that the common application is consistent with the definitions of the Directive.

In general terms, Figures 33 and 34 show that the sub-basins located on the right bank in the northern part of the RBD have the highest results of water status/potential and the greater percentage of water bodies classified in good status. The Rio Zêzere, Rio Pônsul, Rio Erges, Rio Ocreza, Ribeira de Aravil and Tejo Superior sub-basins should be highlighted. The worst results are verified in the sub-basins near the estuary area such as Ribeira de Magos, Estuário, Ribeiras Costeiras do Sul e Água Costeira do Tejo.

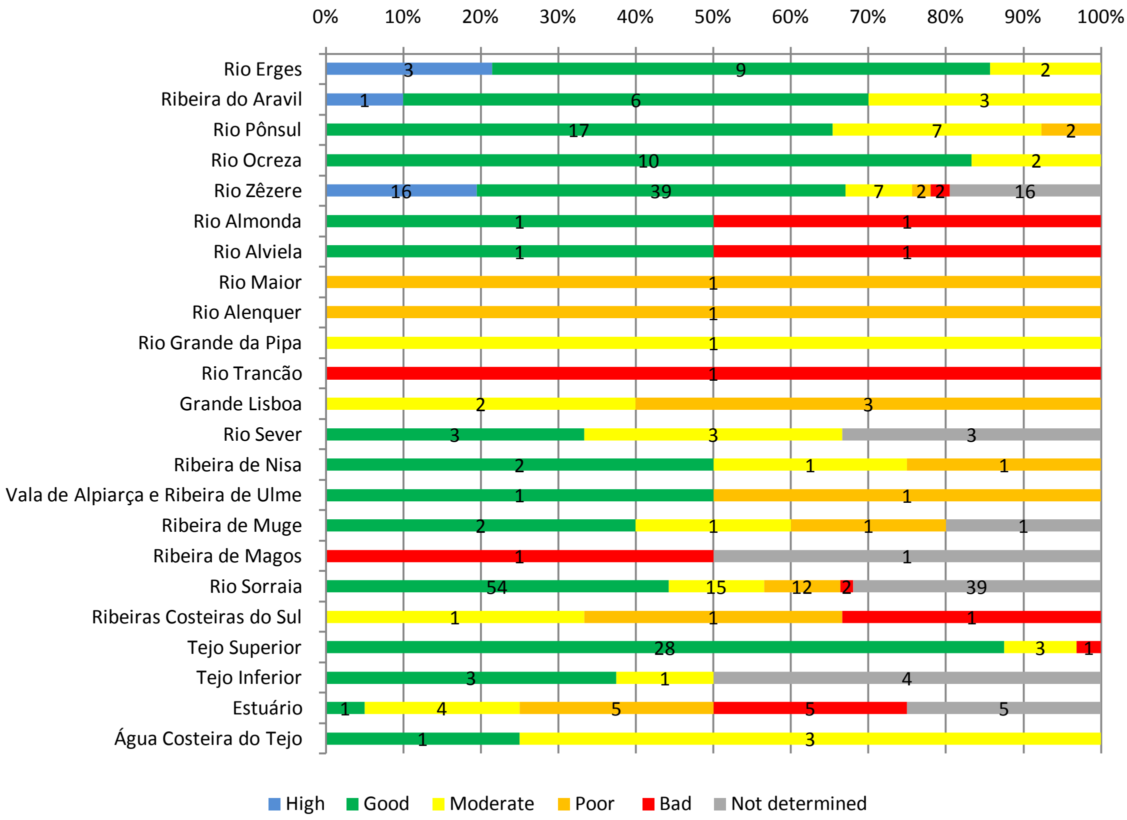


Figure 33 – Water status classification by sub-basin.

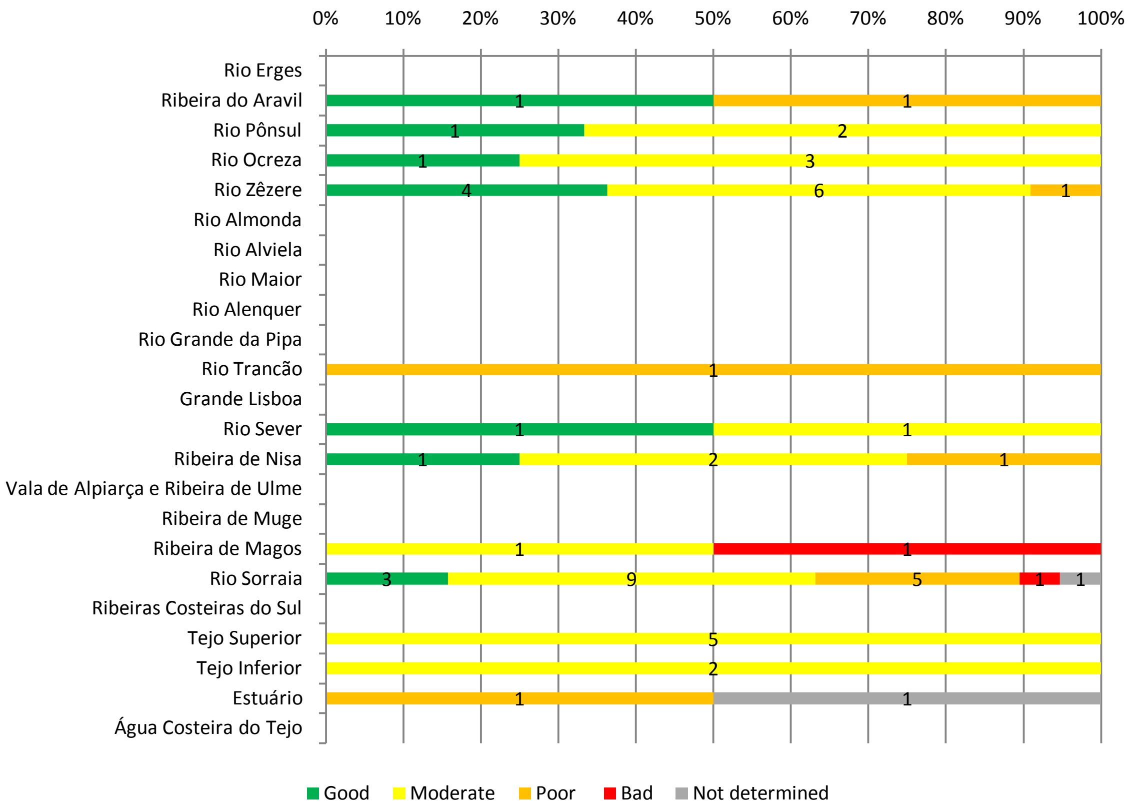


Figure 34 – Classification of heavily modified and artificial water bodies (ecological potential and chemical status) by sub-basin.

In synthesis, Figure 35 shows the global results of the water status in the Tagus RBD. The results presented should be considered as provisional and as a first attempt to implement the water status classification system envisaged in the WFD. The level of uncertainty associated with this exercise is still quite significant.

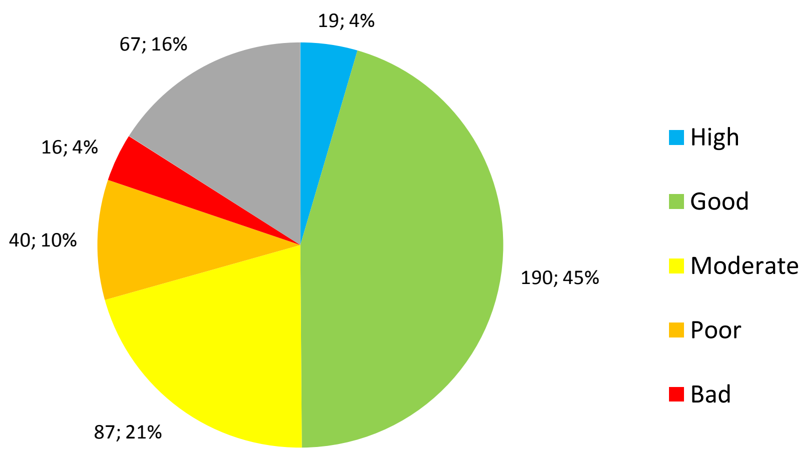
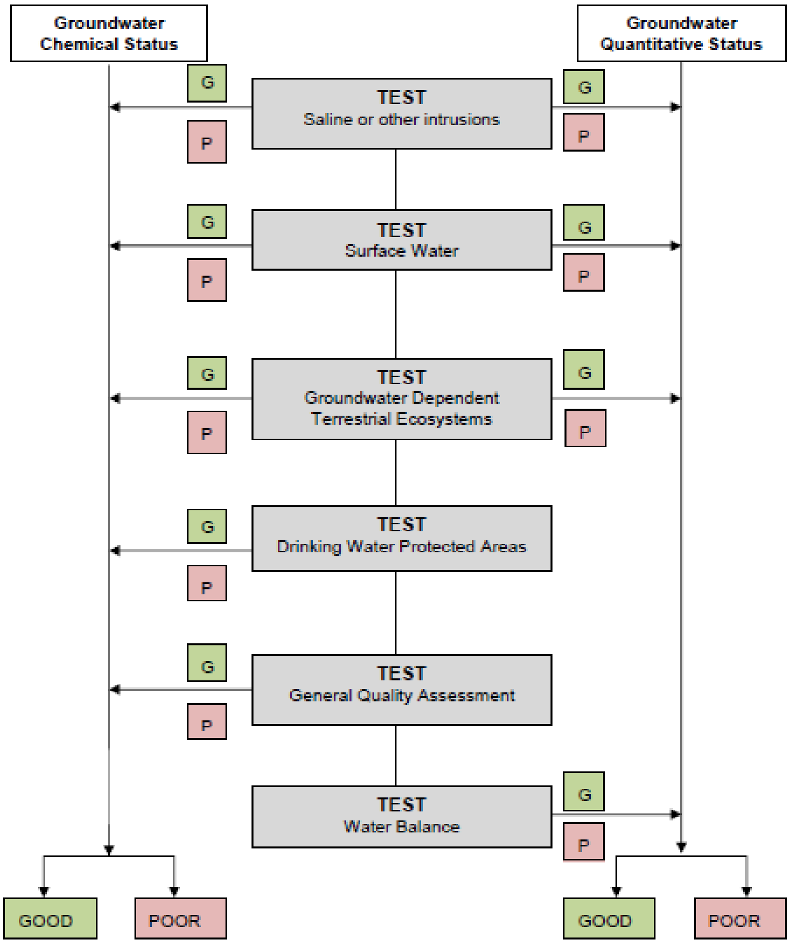


Figure 35 – Overall surface water status classification.

The groundwater status classification system includes a series of parameters and the compliance with a set of classification tests for both quantitative and chemical status (Figure 36).



Source: CIS Guidance no.18 on Groundwater Status and Trend Assessment.

Figure 36 – Overall procedure of classification tests for assessing groundwater status.

As regards the quatitaive status assessment, all the groundwater bodies are classified as "good" status. In Table 32, the results of the chemical stuatus assessment are shown.

Table 32 – Groundwater Status

Groundwater body	Quantitative Status	Chemical Status	Groundwater Status
Maciço Antigo Indiferenciado da Bacia do Tejo	● Good	● Good	● Good
Escusa	● Good	● Good	● Good
Monforte – Alter do Chão	● Good	● Poor	● Poor
Estremoz – Cano	● Good	● Poor	● Poor
Orla Ocidental Indiferenciado da Bacia do Tejo	● Good	● Good	● Good
Ourém	● Good	● Good	● Good
Ota – Alenquer	● Good	● Good	● Good

Groundwater body	Quantitative Status	Chemical Status	Groundwater Status
Pisões – Atrozela	● Good	● Poor	● Poor
Bacia do Tejo-Sado Indiferenciado da Bacia do Tejo	● Good	● Good	● Good
Bacia do Tejo-Sado / Margem Direita	● Good	● Good	● Good
Bacia do Tejo-Sado / Margem Esquerda	● Good	● Good	● Good
Aluviões do Tejo	● Good	● Poor	● Poor

The three groundwater bodies partially included in the Tagus RBMP (Penela-Tomar, Sicó-Alvaiázere and Maciço Calcário Estremenho) achieved the classification of good status.

In synthesis, the overall classification of the groundwater bodies is presented in Figure 37.

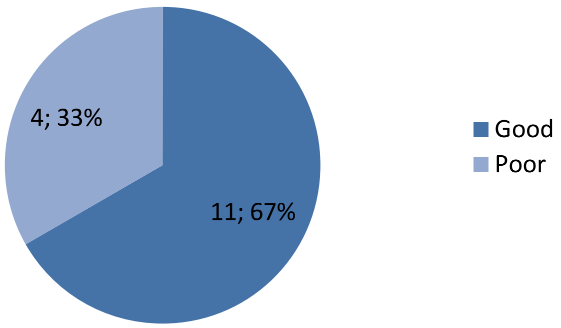


Figure 37 – Overall groundwater status classification.

Significant Water Management Issues (SWMI)

Under the Tagus RBD planning process, the Significant Water Management Issues (SWMI) were identified and the draft report was published in 2009. During the six month consultation period, 5 public sessions took place, being 2 of them co-organized with the Spanish competent authorities (Figure 38). The final report was then adopted and the SWMI will be addressed under the RBMP.

Figure 38 – SWMI public sessions.

The Significant Water Management Issues was aggregated in two major groups:

- pressures and impacts
- regulation, institutional and economic

The National Water Authority (INAG, I.P.) developed a general methodology to identify the SWMI and the RBD Authorities applied it to each RBD (Figure 39).

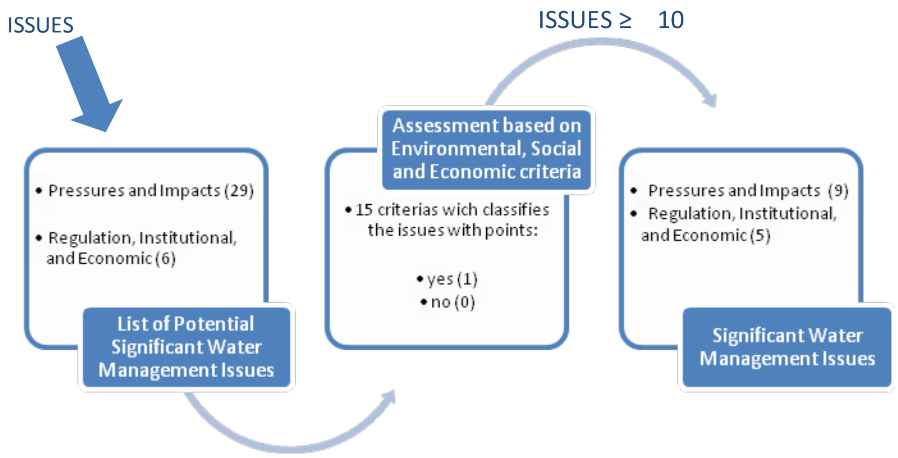


Figure 39 – General methodology for identifying the SWMI.

In the case of the Tagus RBD, from the application of the general methodology and a specific threshold (10), fourteen SWMI were identified, nine of them related to pressures and impacts and five related to regulation, institutional and economic aspects. In Tables 33 and 34 the lists of the SWMI identified are shown.

Table 33 – SWMI related to pressures and impacts.

SWMI	General description
Inflow from Spain	Inflow from Spain is important in international rivers - Minho, Lima, Douro, Tagus and Guadiana. The quantitative and qualitative aspects should be considered.
Nutrients enrichment	Nitrates present in surface waters may be from natural or anthropogenic sources. Anthropogenic sources include urban wastewater discharges, agroindustrial waste and wastewater discharges and fertilizers that are leached from soils. Phosphorus is an essential element for living organisms and the limiting factor for algae growth. It is present in natural waters in dissolved forms (orthophosphates, polyphosphates and organic compounds) and particulate matter. The presence of phosphorus in excessive quantities in water may cause episodes of eutrophication. The excessive quantities are usually associated with urban wastewater discharges, industrial products, especially those containing detergents and fertilizers, and agricultural land.
Groundwater contamination	The presence of certain substances in the groundwater may be due to the occurrence of natural processes such as decomposition of organic matter in soil or leaching of mineral deposits and/or human activities.
Eutrophication	Excessive quantities of nitrogen and phosphorus compounds in waters in association with other factors, *e.g.* light and temperature, can lead to: - Blooms of algae, macrophytes and periphyton, with negative effects on the ecosystems and the

SWMI	General description
	quality and uses of water - High concentrations of chlorophyll pigments - Proliferation of potentially toxic algae (e.g. cyanobacteria) and consequent degradation of water quality due to the presence of toxins, with risk to animal and human health - Increasement of turbidity and reduction of dissolved oxygen concentration.
Floods	Floods may be due to natural causes as a result of exceptional weather conditions and their effects can be minimized to some extent, through proper management of land use and water resources and the construction of defence works. Floods may have implications on the water status.
Metal pollution	The metals are naturally dissolved in water and their presence may result from erosion of rocks and soils. The presence of heavy metals in water due to human activities (urban and industry wastewater discharges and mining activities) can lead to serious ecological problems, with the aggravating circumstance that there is a natural metal background level.
Priority and dangerous substances pollution	These substances are usually persistent, bioaccumulative and toxic. They are widespread in the environment and therefore its control should be primarily made at source.
Microbiological pollution	Natural waters contain microorganisms and indigenous microorganisms from human or animal feces. These can contain a wide variety of pathogenic microorganisms. Microorganisms are present in natural waters due to urban wastewater discharges and urban runoff and urban and agricultural contaminated soils.
Organic Pollution	The existing ammonia nitrogen in water may have a natural origin and result from the decomposition of organic matter and inorganic nitrogen, biological activity, the reduction of gaseous nitrogen by microorganisms in the water and gas exchange between air and water. The presence of ammoniacal nitrogen in water can also be due to urban wastewater discharges and industrial products (e.g.production of paper and pulp). The non-ionized form of ammoniacal nitrogen (NH_3) when present in high concentrations in water, in combination with certain conditions of temperature and pH is toxic to aquatic life. The BOD_5 and COD presence in water are due to a wide variety of sources.

Table 34 – SWMI related to regulation, organisation and economic aspects.

Lack of updated and specialised knowledge
Insufficient or inefficient surveillance and or conformity checking procedures
Insufficient or inefficient licensing
Insufficient monitoring of water bodies
Insufficient or inefficient metering and communication from users of the water abstractions and wastewater discharges

The Tagus River Basin Management Plan includes a programme of measures established in order to address each one of the SWMI indentified above. The selection of the measures is made taking into account social, economic and environmental aspects.

DRIVERS OF CHANGE

As regards the drivers influencing the pressures on water resources, the population concentration in certain areas of the RBD and some economic sectors were identified as relevant in the context of the water resources management. A summary of the main economic sectors identified and the respective general trends of evolution for 2015 and 2021 are presented in Table 35. These milestones correspond to the timetable established under the WFD to the achievement of the environmental objectives.

Table 35 – General trends of the main economic sectors in the Tagus RBD.

Sub-basins	Population		Agriculture		Livestock Farming		Industry		Golf		Energy		Navigation	
	2015	2021	2015	2021	2015	2021	2015	2021	2015	2021	2015	2021	2015	2021
Rio Erges	→	↘	↘	↘	↘	↘	↗	↑	→	→	→	→	-	-
Ribeira do Aravil	→	→	↘	↘	↘	↘	↘	↗	→	→	→	→	-	-
Rio Pânsul	→	→	↘	↘	↘	↘	↘	→	→	→	→	→	-	-
Rio Ocreza	→	→	↘	↘	↘	↘	↘	→	→	→	→	↑	-	-
Rio Zêzere	→	→	↗	↗	→	↘	↘	→	→	→	→	↗	-	-
Rio Almonda	→	→	↘	↘	→	↘	↘	↗	→	→	→	→	-	-
Rio Alviela	→	→	↘	↘	→	→	↘	→	→	→	→	→	-	-
Rio Maior	→	→	↘	↘	→	→	↘	↗	→	↑	→	→	-	-
Rio Alenquer	→	→	↘	↘	→	→	↘	→	→	→	→	→	-	-
Rio Grande de Pipa	→	→	↘	↘	→	→	↘	↗	→	→	→	→	-	-
Rio Trancão	→	→	↘	↘	→	→	↘	→	→	→	→	→	-	-
Grande Lisboa	→	→	↘	↘	→	↘	↘	↘	↗	→	→	→	-	-
Rio Sever	→	→	↘	↘	↘	↘	↓	↘	→	→	→	→	-	-
Ribeira de Nisa	→	→	↘	↘	↘	↘	↘	→	→	→	→	→	-	-
Vale de Alpiarça e Ribeira de Ulme	→	→	↘	↘	→	→	↗	↗	→	→	→	→	-	-
Ribeira de Muge	→	→	↘	↘	→	→	↘	↗	→	→	→	→	-	-
Ribeira de Magos	→	→	↘	↘	→	→	↘	↘	→	→	→	→	-	-
Rio Sorraia	→	→	↘	↘	→	↘	↘	↗	↑	↗	→	→	-	-
Tejo Superior	→	→	↘	↘	↘	↘	→	↗	→	→	→	→	-	-
Tejo Inferior	→	→	↘	↘	→	→	↘	↗	→	→	→	→	-	-
Estuário	→	→	↘	↘	→	→	↘	→	↑	→	→	→	→	↑
Ribeiras Costeiras do Sul	→	→	↘	↘	↘	↘	→	↗	→	↑	→	→	-	-
Água Costeira do Tejo	→	→	↘	↘	→	↘	↘	→	↗	↑	→	→	-	-
Tagus RBD	→	→	↘	↘	→	↘	↘	→	↑	↗	→	→	→	↑

Legenda: ↓ below -25.0% ↘ between -25.0% e -5.0% → between -5.0% e +5.0% ↗ between +5.0% e +25.0% ↑ above +25.0%

Source: Tagus River Basin Management Plan (draft version for public consultation).

From the information provided above it should be highlighted the decreasing trend of the agriculture sector and the increasing trend of tourism.

The climate change should also be considered as a driver despite the uncertainty associated to the various scenarios developed. It is expected that the economic sectors more dependent on weather conditions will be more seriously affected such is the case of agriculture and tourism. The reduction of water availability will have an impact on the ecosystems and various activities, in particular the energy production. The water quality will also be an issue of extreme importance as regards water uses, ecosystem services and human health.

As regards the impact of climate change on Portuguese water resources, the information on Table 36 focus on the interlinkages between the type of impact and the driving force, scenarios and causes associated.

Table 36 – Impacts of climate change on Portuguese water resources.

Impact	Impacts of Climate Change		
	Driving	Scenarios	Causes
Water Availability	↓	• Reduction of water availability: Surface water (flow); groundwater (recharge) • Increased risk of drought	• Decrease in annual precipitation values • Increase rainfall variability • Increasing asymmetry of regional precipitation • Increasing asymmetry of the seasonal rainfall
Water needs	↑	• Possible increase in water needs for irrigation • Increased demand of water for energy production	• Increased evapotranspiration • Strengthening of hydroelectric capacity • Betting on biofuels
Flood risk	↑	• Increased risk, intensity and frequency of floods	• Increased variability in rainfall regime • Increase of the maximum values of precipitation (North country)
Quality of surface water	↓	• Decreased water quality • Deteriorating river ecosytems	• Decreased flow • Increase in water temperature • Increase in diffuse pollution loads
Quality of Groundwater	↓	• Salinization of aquifers	• The rising sea level • Increased evapotranspiration • Decrease in recharge

Source: Adapted from Oliveira & Ribeiro, 2008

The average results indicates an increase in average air temperature of about 4°C and a reduction in rainfall (18 per cent), runoff (30 per cent) and average annual evaporation (11 per cent), relative air humidity (6 per cent) and hourly precipitation (17 per cent). As regards the variation of the seasonal precipitation is expected to increase in winter precipitation average of about 2.5 per cent. The remaining seasons will suffer a decrease in precipitation, and have half the summer rainfall over the analysed period (1951-1980). As regards the variation of mean temperature, all the seasons record increases above 2.5°C, highlighting the next summer with an increase of 5.5ºC.

RESPONSE OPTIONS

The strategic objectives set at river basin level and the environmental objectives established at water body level shall be achieved, in accordance with the timetable and provisions established under the European and National legal framework.

The Tagus River Basin Management Plan includes a general characterisation of the river basin, focusing in the natural factors and human activities that may have an impact on water resources, the current state of the water bodies and the relevant socioeconomic aspects. Through the identification of the most significant water management issues, the objectives should then be established taking into account both environmental and socioeconomic criteria.

The definition of both the objectives and the associated corrective measures should be an iterative process, since it is important to take in due account the uncertainty and the lack of data to establish clear cause-effect relations. This is even more relevant when one have to cope with the technical challenge to set environmental objectives, which includes biological, physico-chemical and hydromorphological quality elements, a stringent timetable to achieve specific targets and the diversity of socioeconomic conditions at river basin level.

Under the Tagus RBMP, the establishment of the environmental objectives took into account the following criteria:

- Ecological status/potential of water bodies;
- Confidence level of the ecological status/potential classification results;
- Compliance of specific quality objectives established for the protected areas;
- Pressures types;
- Confidence level of the pressures assessment;
- Measures established.

The Table 37 summarizes the approach used in the definition of the environmental objectives, including the application of the derogations and prorogations set under the WFD.

Table 37 – Overall approach used for the definition of environmental objectives.

Ecological Status/Ecological Potencial	Biological quality elements	Phsyco-chemical quality elements	Objective Deadline	Exemption (justification)	Objective – Protected Area
Good or High	Good or High	Good	2015	-	2015
Moderate	Good or High	Moderate	2015	Diffuse Pressure - 2021	
	Moderate	Moderate	2015	Diffuse Pressure - 2021	
	Moderate	Good	2015	-	
Poor	Poor	Good	2021	-	
	Poor	Moderate	2021	Diffuse Pressure - 2027	
Bad	Bad	Moderate	2021	Diffuse Pressure - 2027	
	Bad	Bad	2021	Diffuse Pressure - 2027	
Not determined			Environmental objectives not defined		

By the application of the approach presented above, the following overall results were achieved:

- Good status in 2015 – 279 water bodies
- Good status in 2021 – 331 water bodies
- Good status in 2027 – 354 water bodies
- Objectives not yet defined – 71 water bodies

The results are also aggregated by sub-basin (Figure 40) and it should be highlighted that all water bodies included in the Rio Erges, Rio Ocreza, Rio Grande da Pipa, Ribeira de Nisa e Água Costeira do Tejo sub-basins are expected to achieve the good status in 2015.

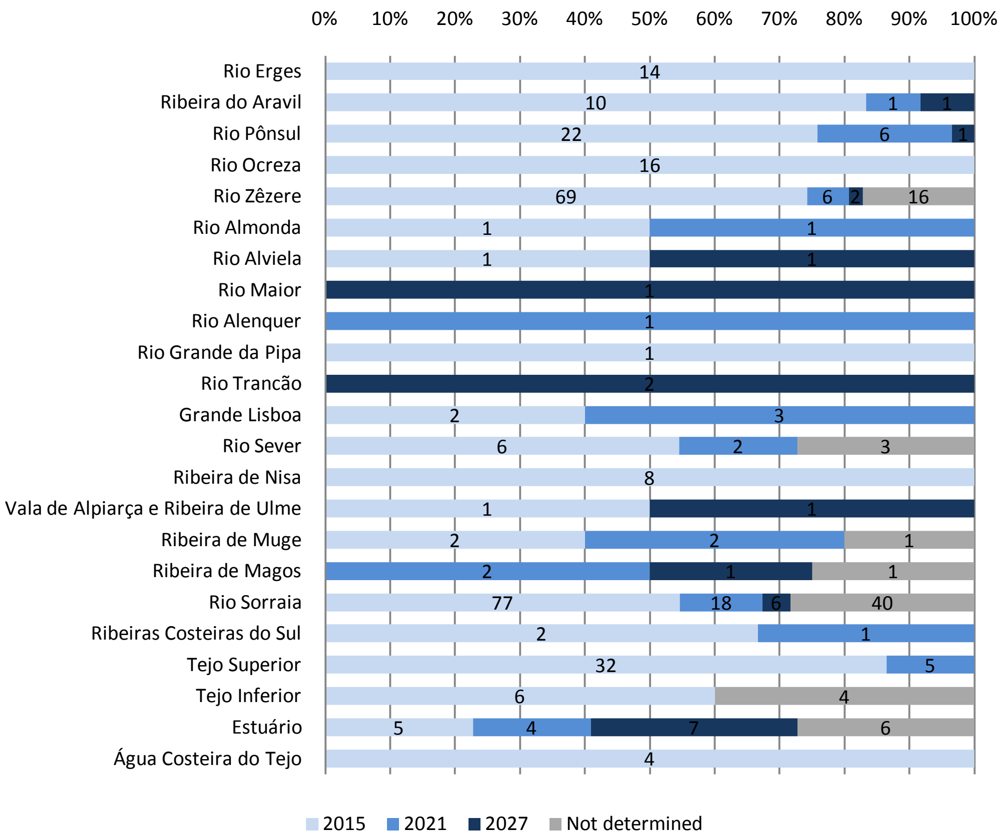


Figure 40 – Environmental objectives aggregated by sub-basins.

The environmental objectives established for groundwater bodies are shown in Table 38. The prorogation of the deadline to 2021 is mainly due to technical feasibility reasons related to the implementation of the corrective measures.

Table 38 – Environmental objectives for the groundwater bodie

Groundwater bodies	Status	Environmental objectives			Exemption justification
		2015	2021	2027	
Maciço Antigo Indiferenciado da Bacia do Tejo	Good	X			
Escusa	Good	X			
Monforte-Alter do Chão	Poor	X			
Estremoz-Cano	Poor		X		Technical feasibility
Orla Ocidental Indiferenciada da Bacia do Tejo	Good	X			
Ourém	Good	X			
Ota-Alenquer	Good	X			
Pisões-Atrozela	Poor		X		Technical feasibility
Bacia do Tejo-Sado Indiferenciado da Bacia do Tejo	Good	X			
Bacia do Tejo-Sado/Margem Direita	Good	X			
Bacia do Tejo-Sado/Margem Esquerda	Good	X			
Aluviões do Tejo	Poor			X	Technical feasibility

The classification of poor status achieved in four groundwater bodies is mainly due to high concentrations of nitrates (NO_3^-). In the Pisões-Atrozela groundwater body high leves of pollutants such as Pb and pesticides were also detected.

Based on the environmental objectives established both to surface and groundwater bodies, including the uncertainty issues associated with it, an **adaptive approach to water management** is the adequate response to the challenges faced by the competent authorities to implement an integrated water resources management. The need to both integrate other sectoral policies (*e.g.* agriculture, energy) and the climate change scenarios, and to ensure a higher level of water protection requires a full involvement of all actors and the development and implementation of tools to support the decision making process.

The **funding sources** available for the establishment of the programme of measures includes mainly the amounts charged under the application of the Water Resources Tax and also the National Strategic Reference Framework (NSRF[9]). As stated in the NSRF webpage, it has as strategic aim *"...the qualification of the Portuguese people through an emphasis on knowledge, science, technology and innovation, as well as the promotion of high and sustained levels of economic and socio-cultural development and territorial qualification within a framework of expanding equal opportunities and increasing the efficiency and quality of public institutions."*

The achievement of this main strategic aim is ensured by the concretisation of three intervention areas by all the Operational Programmes during the 2007-2013 period and with the support of the Structural Funds and the Cohesion Fund. The areas focus on human potential, competitiveness factors and territorial enhancement.

The National Strategic Reference Framework includes the following Operational Programmes:

- Thematic Operational Programmes for Human Potential, Competitiveness Factors and Territorial Enhancement, co-funded respectively by the European Social Fund, European Regional Development Fund and by the ERDF and Cohesion Fund.
- Continental Regional Operational Programmes - North, Centre, Lisbon, Alentejo and Algarve - co-funded by the European Regional Development Fund.
- Operational Programmes for the Autonomous Regions of the Azores and Madeira, co-funded by the European Regional Development Fund and the European Social Fund.
- Operational Programmes for Territorial Cooperation - Cross-border (Portugal – Spain and the Mediterranean Basin), Transnational (Atlantic Area, South West Europe, Mediterranean

[9] The National Strategic Reference Framework constitutes the framing for the application of the Community's policy for economic and social cohesion in Portugal for the 2007-2013 period.

and Madeira – Azores – Canaries), Inter-regional and Inter-regional Cooperation Networks, co-funded by the European Regional Development Fund.

- Technical Assistance Operational Programmes, co-funded by the European Regional Development Fund and the European Social Fund.

From the programmes above mentioned, the most relevant in terms of water resources management and geographical scope are the Continental Regional Operational Programmes of Centre, Lisbon and Alentejo, the *Operational Programmes for Territorial Cooperation* and the Opperational Programme for Territorial Cooperation.

To address the various issues identified in the Tagus RBD, a programme of measures is being designed under the planning process. In general, the measures currently under implementation or to be implemented can be grouped as follows:

- Measures related to pressures and impacts
- Measures related to regulation, institutional and economic aspects

1. Measures related to pressures and impacts

In relation to **water supply and wastewater treatment**, it was approved in 2007 the Strategic Plan for Water Supply and Waste Water Treatment (PEASAAR II – 2007-2013) to proceed with the water sector strategy set out by the previous PEAASAR (2000-2006). The plan sets objectives and indicates measures to optimize the management and environmental performance of the water sector. It also aims at minimizing the inefficiencies of the systems to rationalize the costs and establishing funding models and the guidelines for the tariff policy.

The main operational objectives are:

- Provide to 95 per cent of total population of Portugal water supply by public systems, considering in each system a coverage level of at least 80 per cent of the population
- Provide to 90per cent of total population of Portugal wastewater collection and treatment by public systems, considering in each system a coverage level of at least 70 per cent of the population

For the specific economic sectors of **agriculture and agro-industry**, a National Strategy for Agricultural and Agro-Industrial Waste Water Treatment (ENEAPAI) was approved in 2007, based on new approaches to define sustainable solutions from an environmental perspective and to ensure the reduction/elimination of the pollution caused by discharges from the agro-industrial activities to water and soil.

The main operational objectives consists on elaborating Regional Plans for Integrated Management, taking into account the characterisation of the installations, the pollution loads and the local environmental conditions, defining Funding Support Models, implementing a management model and preparing manuals of good practices.

As regards the improvement of the **efficient use of water**, the National Plan for Efficient Use of Water was approved in 2005 aiming at reducing water losses, increasing water metering and promoting general public awareness to sustainable water use issues.

The **extreme events** issues, such as floods and droughts, are mainly dealt through the elaboration of specific plans and the establishment of alert systems. It should be highlighted the measures established under the European Floods Directive and the European Union Action on Water Scarcity and Drought and the existing coordination procedures set by the Portuguese and Spanish Authorities. For example, specific measures such as the classification of flood zones, preliminary assessment of floods risk, preparation of floods hazard maps and elaboration of flood risk management plans have to be implemented.

Accordingly to the EU Action on Water Scarcity and Drought the approach to tackle these issues should focus on the following areas:

- Putting the right price tag on water;
- Allocating water and water-related funding more efficiently;
- Improving drought risk management;
- Considering additional water supply infrastructures;
- Developing water-efficient technologies and practices;
- Encouraging a water-saving culture in Europe; and
- Improving knowledge and data collection.

As regards the Floods Directive, the approach proposed to address these issues consists in the development of flood risk management programmes covering the following elements:

- **Prevention of damage** by avoiding construction of houses and industries in flood-prone areas; by adapting future developments to the risk of flooding; and by promoting appropriate land use, agricultural and forestry practices;
- **Protection** through the implementation of measures to reduce the likelihood of floods and/or the impact of floods;

- **Preparedness** of the population about flood risks and what to do in those circumstances;
- Development of **emergency response** plans;
- **Recovery and lessons learned in order to** return to normal conditions as soon as possible and mitigate both the social and economic impacts on the affected population.

In order to address **climate change**, besides the reduction of the greenhouse gas emissions, it is necessary to identify and implement adaptation measures. Therefore, taking into account the pressures on water resources, both at quantity and quality level, and the effects on the magnitude and frequency of extreme events episodes, the vulnerability should be studied at river basin level, including the identification of the impact in the ecosystems and economic activities. The set of mitigation measures identified should then be implemented by the relevant actors.

The implementation of integrated river basin management includes the jointly consideration of qualitative, quantitative and ecological aspects but also the integration of land use practices and extreme events issues, including the long term developments such as climate change.

In what concerns the areas for **abstraction of water for public supply** and **groundwater recharge**, the delimitation of protection zones for these areas and the establishment of safeguard rules for their use are well underway. Figure 41 illustrates the distribution of groundwater abstraction protection areas already approved by regulation and the situations currently under study.

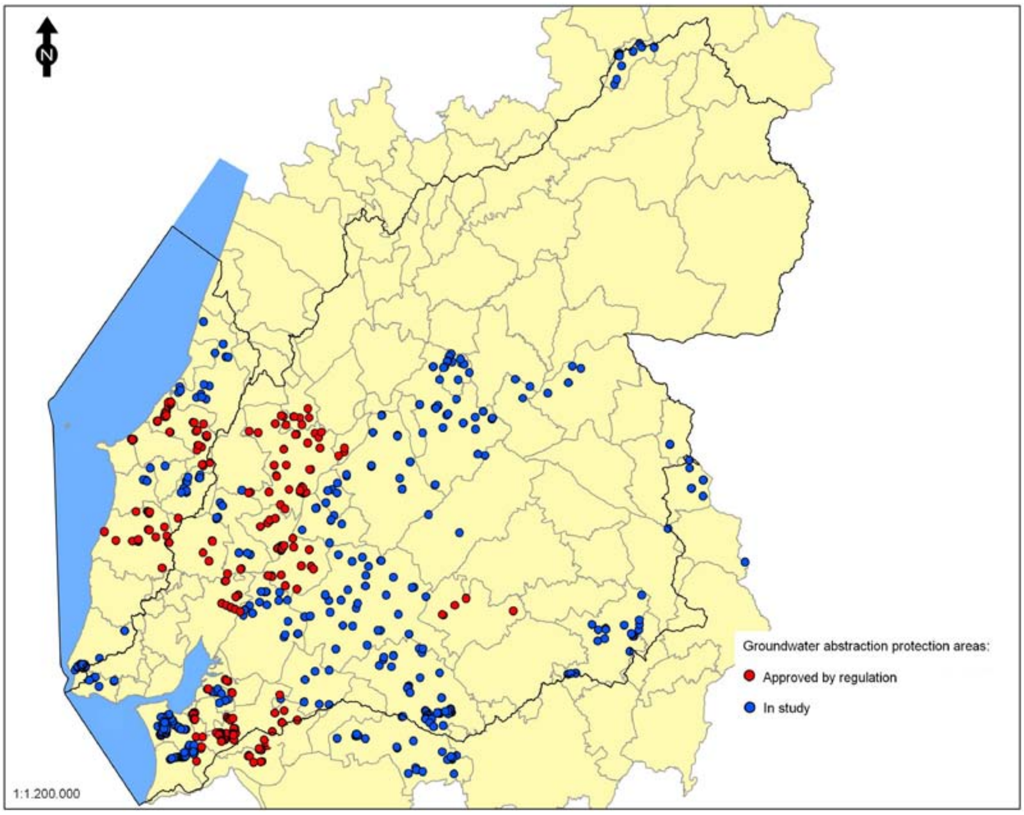


Figure 41 – Groundwater abstraction protection areas.

For the **zones subject to pollution by nitrates from agriculture**, these areas are designated and a specific Action Programme is elaborated and implemented aiming at reducing the inputs of nitrates from agricultural sources. The approach to address this issue is set under the relevant EU Directive and includes the following phases:

- Identification of polluted or threatened waters
- Designation of "vulnerable zones"
- Establishment of Action Programmes including compulsory measures
- Establishment of Code(s) of Good Agricultural Practice including voluntary measures
- Monitoring programmes

For other waters identified as threatened by nitrates pollution and not yet designated as vulnerable zones a quite similar approach is adopted but taking also into account the different sources of pollution. Thus, it is possible to established taylor-made measures.

The **conservation and rehabilitation of water bodies and riparian zones** is related to the achievement of the environmental objectives established at water body level but may also constitute a way to recover the ecosystems and to promote local and regional development (Figure 42).

Figure 42 – Margins rehabilitation.

Under the **protection against pollution accidents** it is important to identify and assess the pollution risks from all potential sources and define specific measures to be implemented by the operators. The establishment of a warning system is also adequate. It should also be highlighted the measures to be implemented under the European Directive on environmental liability with regard to the prevention and remedying of environmental damage.

The **coastal risk assessment** is based on the continuous monitoring and development of tools to support risk-based management for these areas. Besides that a strategy for an integrated protection of the coastal areas were jointly prepared by ARH do Tejo and the relevant municipalities. This strategy is well underway, the risk areas are all identified with safety signals and the communication and emergency response procedures are established. In Figure 43 an example of intervention is shown and the set of signals used to identify the risks on coastal areas.

Figure 43 – Example of risk management intervention on coastal areas and the set of risk signals.

Besides the risk management activities, the coastal areas are currently subject to an extensive monitoring program in order to collect relevant data to support the analysis of the evolution of the shoreline.

2. Measures related to regulation, institutional and economic aspects

As regards the **legal framework and institutional model,** by the adoption of the Portuguese Water Law, in December 2005, and further regulation, the issues related to both themes are considered duly addressed.

The new institutional framework aims at reducing the inefficiencies of administrative and institutional nature and therefore improving the quality of the services provided to water users. The establishment of partnerships with the stakeholders constitutes a priority for ARH do Tejo. With this approach it is possible to address a higher number of issues and in a more adequate way. By doing that, the competent authority has the opportunity to share its approaches and solutions with the users and other authorities and to get them on board with their expectations, proposals and commitment. The main aim is to create participative water governance by developing a participative process and increase water users participation and involvement in the water planning and management (co-responsibility).

To achieve that it is important to create mechanisms of communication and participation, in order to increase knowledge on the heritage and environmental, cultural, social and economic characteristics and values of the Tagus RBD. Through the consultation of the ARH do Tejo site (www.arhtejo.pt) it is possible to check all relevant information regarding its own activity and the Tagus RBD.

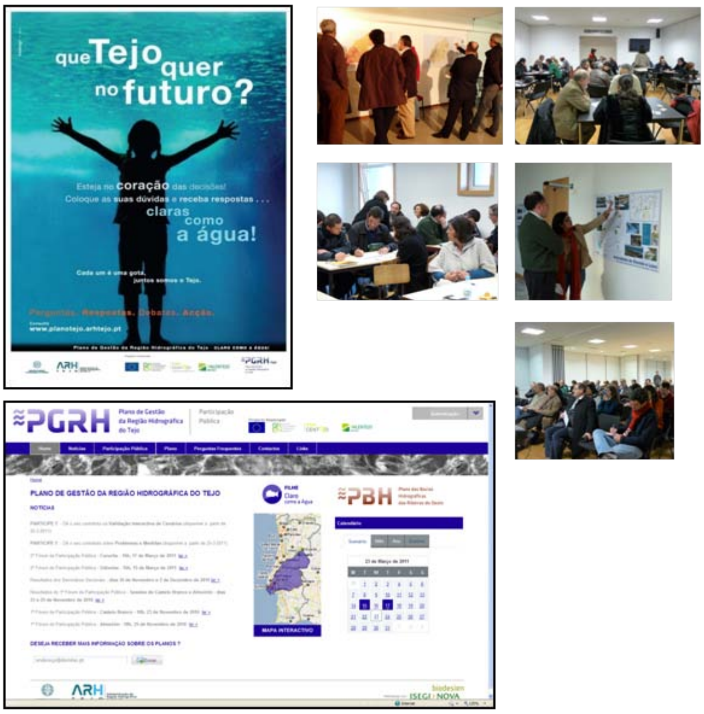


Figure 44 – Public Participation initiatives developed under the Tagus RBMP process.

Figure 45 – The ARH do Tejo Initiatives - publications, workshops and newsletter.

In this context, we may also highlight **capacity building** as an important issue, considering the new approaches and concepts that must be implemented. The competent authority must be prepared and **promote knowledge** on water resources in general and, in particular, on water regulations. This is particularly relevant for agents involved in water resources inspections and regulatory conformity checking (Figure 46).

Figure 46 – Capacity building on water resources regulations in the Tagus RBD.

The review of the **Water Use Licensing System** approved in 2007 aims at preventing unequal treatment of water users from the public administration and streamlining the existing legislation. The ARH do Tejo has developed an informatic application that enables the users to request a license online. The tool provides a support to the submission process and for the emission and management of permits issued for water uses.

The tool already provides the following services:

- Application forms
- Submission of requests for use of water resources
- Adminitrative processing steps and analysis of the requests
- Issue of licenses
- Electronic communication with users

This tool will be further developed in order to include the management issues associated with the licensing process, in particular the communications from and to the users. The version currently in use already covers 11 types of water resources uses from a total of 27.

The licensing online page (Figure 47) presents a commom interface for both internal and external users.

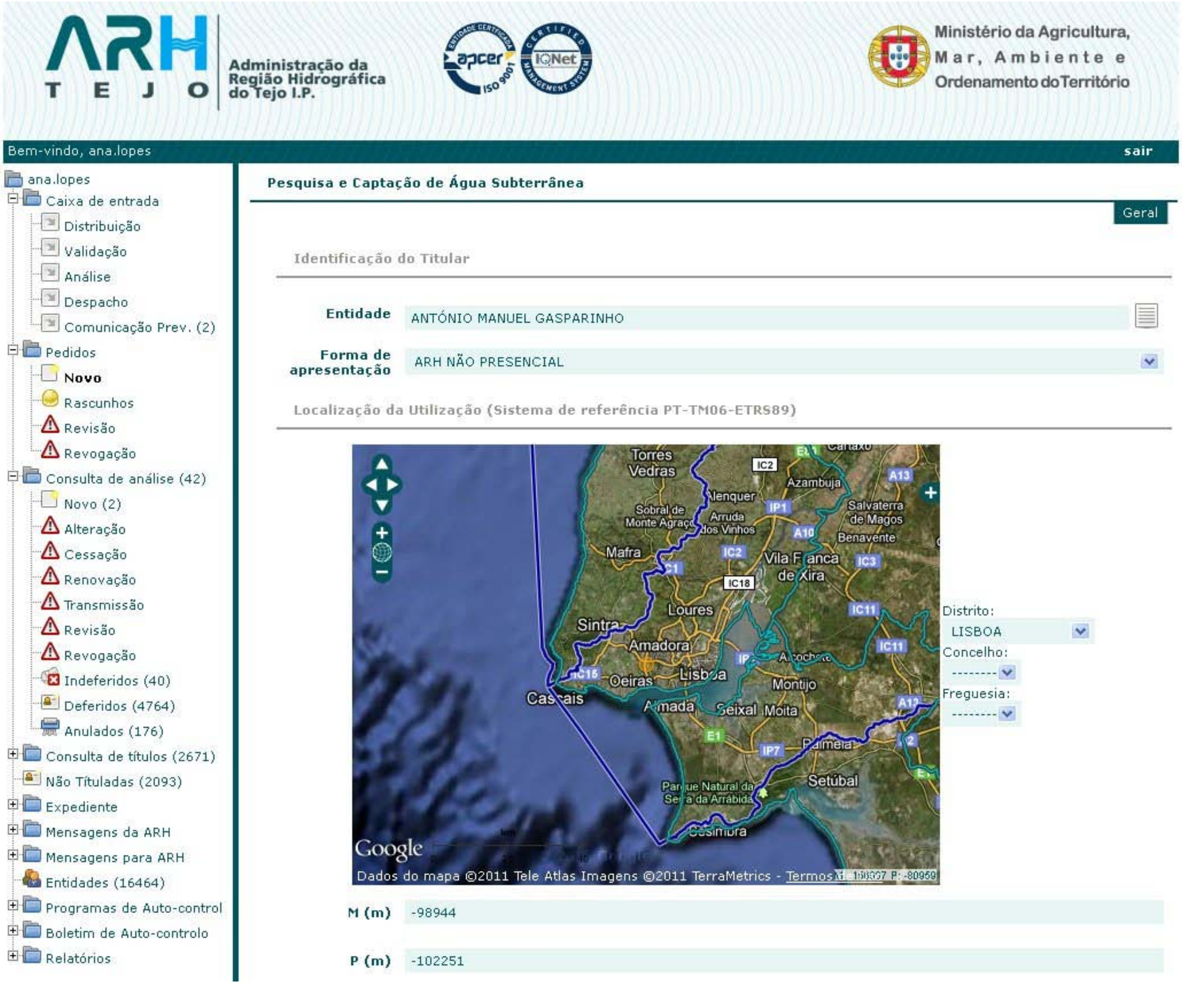
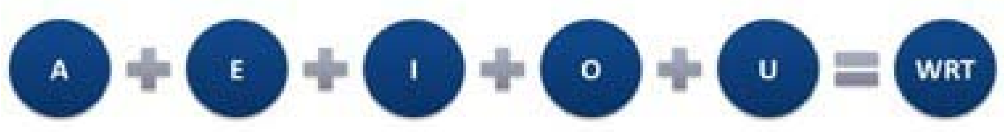


Figure 47 – ARH do Tejo licensing online tool.

The review of the **Economic and Financial Regime** approved in 2008 aims at:

- Establishing an economic and financial regime in order to improve the efficiency and sustainability of water use.
- Establishing a Water Pricing Policy based on the integration of both social and economic value of water and environmental aspects of water resources management.
- Implementing the polluter-pays and user-pays principles.
- Internalizing the costs associated with damage to the water status, including environmental and resource costs.
- Promoting adequate contribution from the different water uses.

The economic and financial regime encompasses three instruments: Water Resources Tax, Water Services Tariffs and Protocols. The Water Resources Tax is applicable to water abstraction, wastewater discharges, occupation of water public domain and sediments extraction (Figure 48).



A - Water abstraction on Public Water Domain (m^3).
E - Wastewater discharges on Public Water Domain (m^3).
I - Dredging on Public Water Domain (m^3).
O - Area occupation on Public Water Domain (m^2 or m).
U - Use of waters subject to public management and planning (m^3).

Figure 48 – Components of the Water Resources Tax (WRT).

The measures selected to tackle the existing problems are adequately characterized, including the specific objectives, cost-effective analysis, timetable and parties responsible for the implementation. The consolidated programme of measures, that is an integral part of the Tagus RBMP, includes various types of measures, in particular:

- Legislative instruments
- Economic or fiscal instruments
- Point source controls
- Diffuse source controls
- Abstraction controls
- Educational projects
- Research and demonstration projects
- Emission controls
- Rehabilitation projects
- Administrative instruments

The implementetaion of the programme of measures aims at achieving the objectives set at water body and river basin district levels. Therefore, it is of crucial importance to ensure the adequate technical and financial means to carry out the task and to promote the close involvement of all stakeholders in the process. The establishment of partnerships is of utmost relevance to succed in the concretization of a real integrated management of water resources.

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