Main pressures data of HGUs within the Júcar RBD — Table 24 (Cont.)

Code	Name	Mean annual recharge (hm³/year)	Total Abstraction (hm³/year)	Diffuse pollution	Artificial recharge
8.36	VILLENA-BENEJAMA	27.12	67.84	Very low	No
8.37	ALMIRANTE-MUSTALLA	55.65	21.00	Very low	No
8.38	PLANA GANDIA-DENIA	137.75	74.25	High	No
8.39	ALMUDAINA-ALFARO-SEGARIA	35.19	7.97	Low	No
8.40	SIERRA MARIOLA	27.72	25.40	Very low	No
8.41	PEÑARRUBIA	0.94	11.70	Very low	No
8.42	CARCHE-SALINAS	1.89	17.61	Very low	No
8.43	ARGUEÑA-MAIGMO	2.44	9.98	Very low	No
8.44	BARRANCONES-CARRASQUETA	17.71	8.47	Very low	No
8.45	SIERRA AITANA	17.82	3.14	Very low	No
8.46	SERRELLA-AIXORTA-ALGAR	18.95	16.11	n.d.	No
8.47	PEÑON-MONTGO-BERNIA	58.05	24.84	Very low	No
8.48	ORCHETA	33.70	3.67	n.d.	No
8.49	AGOST-MONEGRE	2.21	4.39	n.d.	No
8.50	SIERRA DEL CID	1.92	7.02	n.d.	No
8.51	QUIBAS	1.77	13.22	n.d.	No
8.52	CREVILLENTE	1.14	17.26	n.d.	No

Table 25 shows a summary of data corresponding to the initial characterisation of HGUs, from which a great variability of surfaces, recharge and abstraction levels is observed.

To adapt the definition of GW bodies to the WFD objectives, the General Directorate of Water (GDW) is redefining the HGUs for the whole Spanish territory with the collaboration of the IGME and the RBDs. The criteria followed for the new delimitation of GW bodies are:

- The previous HGUs will be used as the basis for the delimitation, validating the criteria used for their definition, and refining the limits using more physical criteria following the geological maps.
- In the case of a shared aquifer, the limits of the RBD will be used to assign to each Basin Authority the GW bodies placed exclusively in its own territory.
- Not all limits of the GW body need to be impervious.

Summary of data of HGUs within the Júcar RBD — Table 25

	Minimum	Maximum	Mean
Total surface (km²)	34	7 660	776
Permeable surface (km²)	16	3 625	459
Recharge (hm³/year)	0.9	511	72
Abstraction (hm³/year)	0.1	407	35

- Rivers can be used as a criterion for the GW body partition if the status in both sides of the river is different.
- Limits of the human activity influence should be used to establish limits in the interior of permeable surfaces of great extension.
- If there is an area within a GW body that is clearly at risk of failing to achieve the environmental objectives and the rest of the GW body is not, the GW body should be divided.
- Where there are confined aquifers below other aquifer, the definition of more that one

Figure 78 **Preliminary delineation of aquifers within each HGU**

Hidrogeological units

GW body in a vertical line should be an exceptional solution only justified by the importance of the aquifer in the level below and if there are substantial differences between the two aquifers.

- In the case of partially confined aquifers, the delimitation of the GW body should include all wells that extract water from the confined aquifer to reflect the pressures on that water body.
- For several reasons, it is desirable not to define very small water bodies (the minimum size should be between 50 and 100 km^2) unless the established criteria recommend it.

This work of adapting GW bodies is being completed through a study that is being carried out by the Júcar RBD. The main goal of this study is to delineate main aquifers (or even aquifer sectors) that comprise each GW body and to determine the water balance at the aquifer scale. This more detailed scale will allow establishing relationships that are more accurate with aquatic ecosystems in rivers, springs, etc. A preliminary delineation of aquifers is shown in figure 78.

Additional work is being carried out regarding the identification of springs. Required data to develop this work have been drawn from different sources: the map of scale 1:25 000 elaborated by the National Geographic Institute of Spain, the register of springs edited by the Local Administration of the Province of Alicante and the database on springs of the Spanish Geological and Mining Institute. Furthermore, a fieldwork to confirm the existence of springs is being done, since there is a chance that some of them may carry water just during wet years, or they might have dried years ago. Figure 79 gives an idea on the profusion of springs throughout the Júcar RBD. Information on springs is highly related to aquifer characterisation, and especially, to the dependence between aquatic and terrestrial ecosystems.

Springs — Figure 79

2.2.2. *Further characterisation*

According to the Water Framework Directive, following the initial characterisation, MS must carry out further characterisation of those GW bodies or groups of bodies identified as being at risk.

This further characterisation must include relevant information on the impact of human activity and, when relevant, information on geological characteristics of the GW body and its hydrodynamic properties (hydraulic conductivity, porosity and confinement). Information should include also characteristics of the superficial deposits and soils from which the GW body receives its recharge, in addition to stratification characteristics, an inventory of associated surface systems, estimates of the directions and rates of exchange of water between the groundwater body and associated surface systems. Finally, sufficient data should be included to calculate the long-term annual average rate of overall recharge to characterise the chemical composition of the GW.

Although the deadline for this activity is not year 2004, this more detailed characterisation is already being conducted for some of the aquifers identified as being at risk. This is described in the following paragraphs and in the pressure impact analysis. An illustrative example of further characterisation is the Mancha Oriental aquifer in which a very detailed mathematical modelling has been carried out.

The Mancha Oriental aquifer, with a surface of 7 660 km^2, is located under an extensive irrigated area. A significant increase of the irrigated surface area, and the subsequent rise of water abstractions from 1983 to 2000 (figure 81) have produced a fall on the aquifer water levels and a reduction of aquifer discharges to the Júcar River. However, the progress in the *aquifer exploitation plan* defined in the JHP (CHJ, 1998) has made possible to stabilise water abstractions in past years. Some of the guidelines of this plan have forbidden new abstractions from 1997, and have promoted the integration of water users into a unique water community.

As a part of the *aquifer exploitation plan*, remote sensing techniques together with digital cadastre data have been used to estimate the evolution of the irrigated area over the aquifer and the type of agricultural crops (see figure 80).

Figure 80 Remote sensing image of the Mancha Oriental aquifer and identification of classified crops

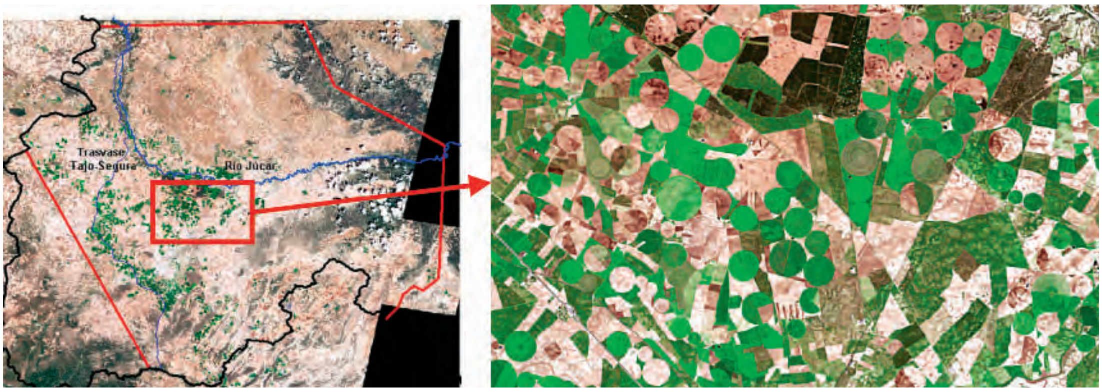
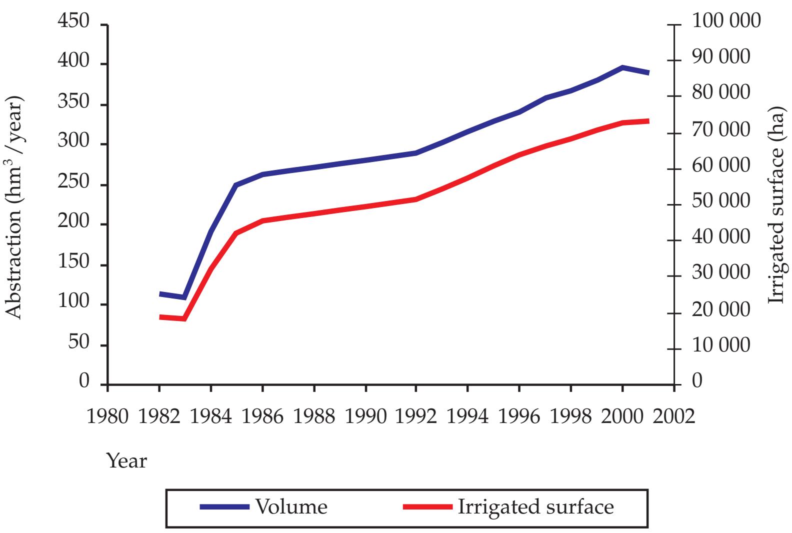


Figure 81 Annual irrigated surface and agricultural abstractions at Mancha Oriental aquifer



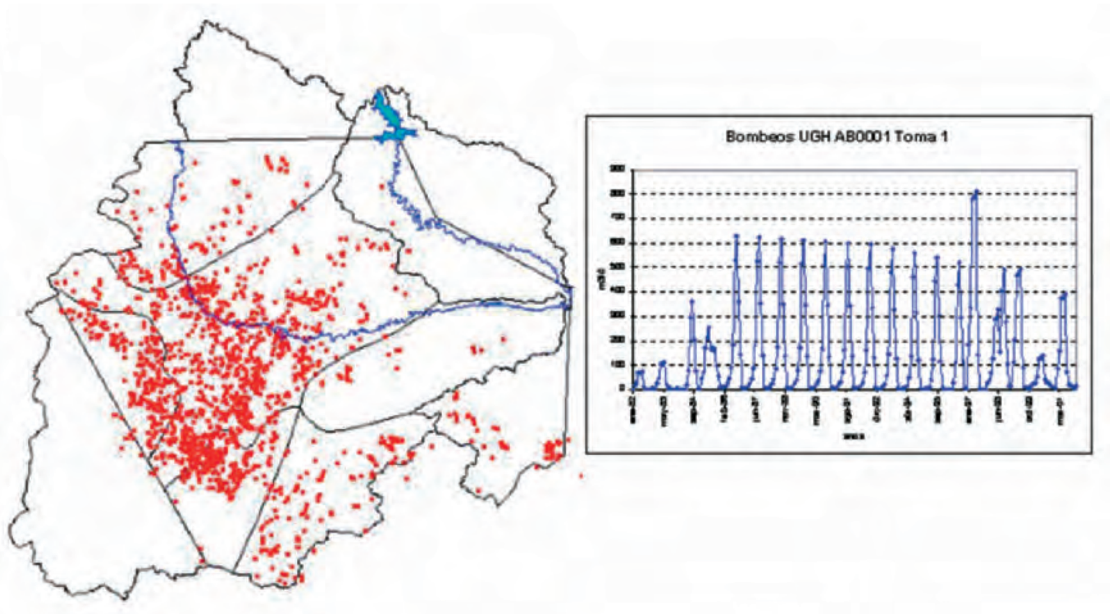
To evaluate the volumes abstracted from the aquifer an estimation of the irrigated surface has been carried out. The irrigated surfaces have been derived from images obtained by remote sensing. For those years in which there were no remote sensing images available, or these did not cover the whole area of study other data were used. For instance, *1-T forms* have been used together with statistical methods to estimate the irrigated surface. The *1-T forms* are official documents, edited on an annual basis, that include information on agricultural surface at the municipal level. To obtain the abstracted volumes (figure 81), the irrigated areas are multiplied by the average irrigation dose of the considered period, and the volumes extracted for urban supply are added to the resulting volumes.

Temporal series of monthly abstractions have been estimated using all this information for each well present in the aquifer (approximately 2 000), as it is shown in figure 82.

Furthermore, data on GW level evolution has been collected and analysed throughout the aquifer, being more significant the water level drops detected in the southern area, as it can be seen in figure 83.

A three-dimensional groundwater model has been constructed (figure 84) to improve the existing knowledge on the GW flow evolution of the Mancha Oriental aquifer and to study relationships among abstractions, aquifer water level and GW discharges to the Júcar River. This model uses the information on abstractions and aquifer water levels previously described. Well-detailed information on the aquifer geological characteristics, coming from geophysics studies conducted at the Complutense University of Madrid (UC, 2003), has been incorporated to the model.

Monthly abstractions per well at the Mancha Oriental aquifer | Figure 82



Aquifer water levels in the Mancha Oriental aquifer | Figure 83

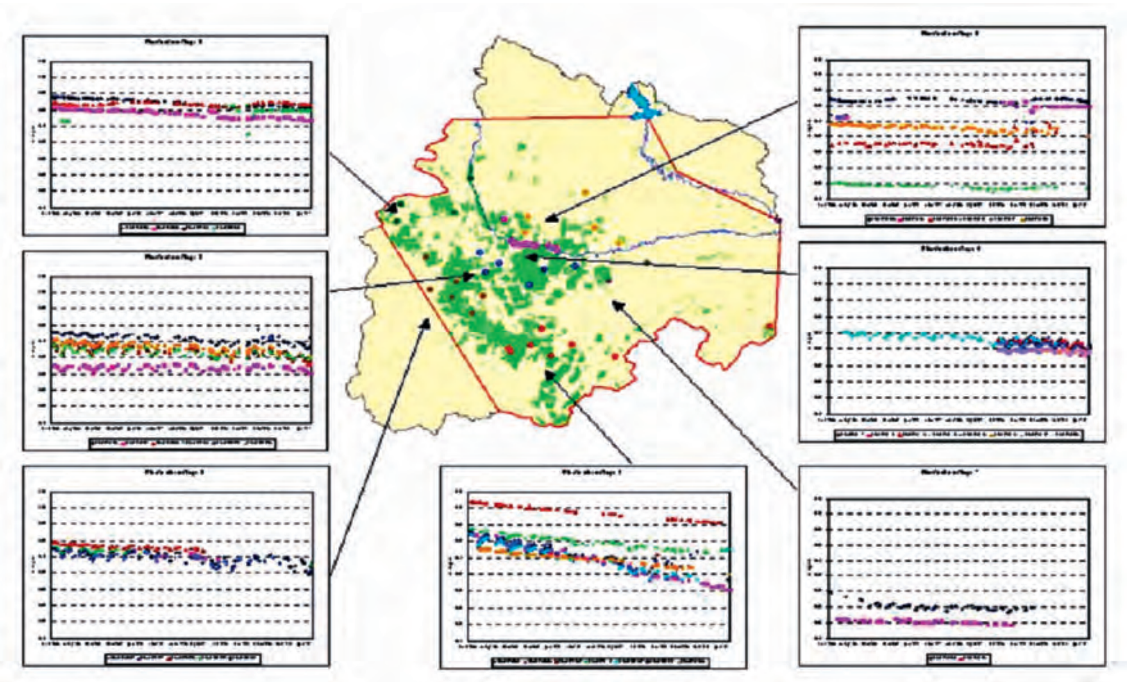
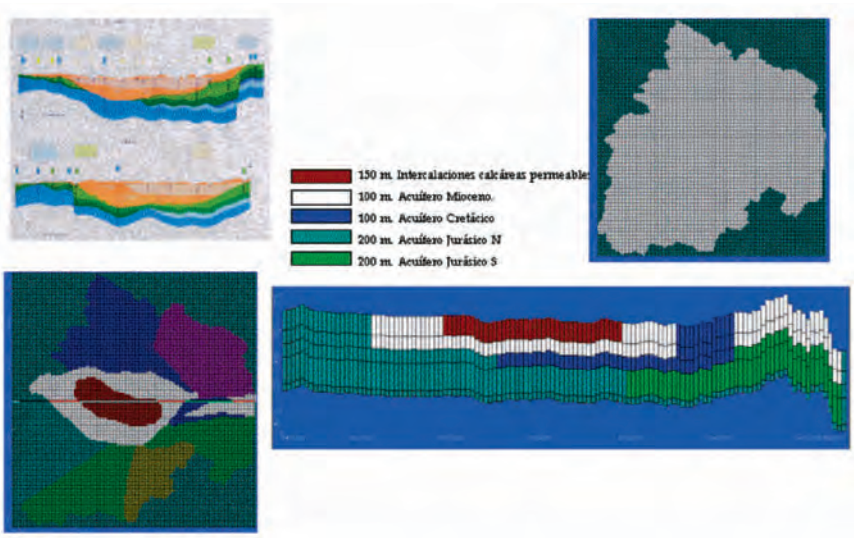
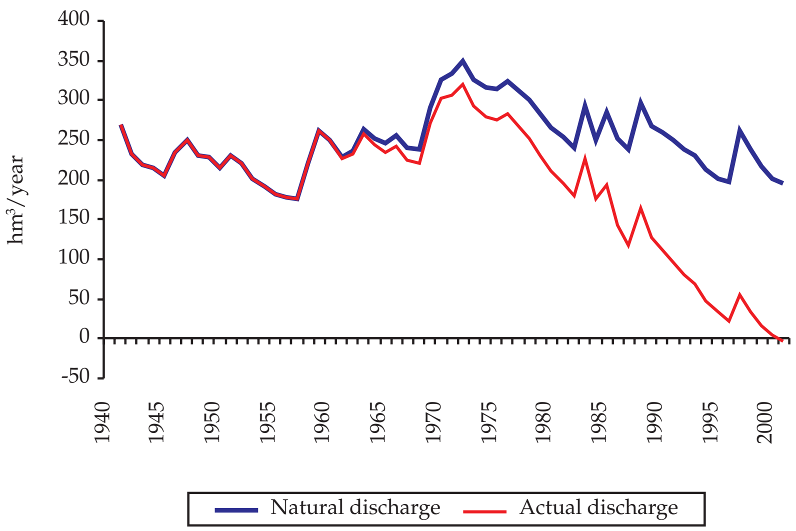


Figure 84	Implementation of a three-dimensional groundwater model of the Mancha Oriental aquifer



This model is being used to simulate the reduction of the aquifer drainage to the Júcar River, and to estimate the future progress of the aquifer depending on the management practices applied. Figure 85 illustrates the effect of pumping on the Júcar River flow discharges.

Figure 85	Effect of pumping on the Júcar River flow discharges



Another study case carried out recently at the Júcar RBD analyses the aquifers draining into the Almenara's wetland. Almenara is on the List of Wetlands adopted by the Valencian Autonomous Community. This List is under the umbrella of Act 11/1994 for Natural Protected Spaces, and it establishes the regime of private land enclosed within the delineation of these wetlands.

Almenara is a typical coastal Mediterranean wetland, which is characterised by being affected by human action (figure 86). During the past decades, irrigation needs have lead to an increase in abstractions on the surroundings and the hydraulically connected aquifers to this wetland. These actions, have in turn, diminished inputs and water levels, which has had a significant negative effect on the Almenara wetland. However, the situation is stabilising, since no longer is permitted to build wells for new crops within or in the wetland area of influence.

Almenara Wetland. Aerial Image on the left, land cover on the right — Figure 86

The Almenara's wetland is located on the limit between the provinces of Valencia and Castellón, it has a surface area of approximately 1 500 ha. It is featured by having a marine origin, although its present functioning is quite independent from the Mediterranean Sea. Similarly to the L'Albufera Lake, this ecosystem is considered very valuable for holding a great diversity of species (flora and fauna). The wetland is affected by human pressures since agricultural exploitation takes place on a high degree within and off the wetland limits. In this context, some types of crops are suitable and even desirable to coexist with the natural condition of the ecosystem provided that pollution does not occur from excess of fertilisers. For instance, rice fields, which are flooded for most part of the year may benefit the ecosystem. To a lesser degree, summer vegetable crops that do not need dry conditions throughout the year may be flooded most of the winter season feeding the wetland. Conversely, orange tree crops are not suitable for the wetland's functioning because of their intolerance to saturated soil. The two first examples of crops are the ones that are mostly cultivated within the wetland, whereas the third takes place in the outer space on the coastal plain and over the aquifers that feed the wetland. Nevertheless, in the past decade, there has been an increasing transformation from summer vegetable into orange tree crops within the wetland limits, which is expected to damage the ecosystem. This crop shift is associated to a drainage effect by lowering the water table or by an earth filling action, in addition to increase water needs. Fortunately, this tendency seems to be changing again.

For studying all these coupled effects, the Júcar RBD has developed a GW flow model of the coastal plain and part of the aquifers connected with the wetland (namely for the wetlands Algar-Quart and Salto del Caballo). The model has represented the effort of one year of extensive data collection and analysis. This information has been incorporated into the VISUAL MODFLOW code, which is a commonly used GW modelling program for hydrogeology. This model was constructed to better understand the three-dimensional hydrogeological system of that part of the coastal plain. The model can simulate past, current and future GW occurrence and movement, to determine the GW balance, and to provide an easily update tool to evaluate numerous management scenarios related to water surface levels, seawater intrusion, and the effect of drainage due to agricultural activity.

3. REGISTER OF PROTECTED AREAS

Though it is not article 5 but article 6 and Annex IV of the WFD, which describe the establishment of a register of protected areas, the deadline for having completely defined those areas is also December 2004. This is why this report also includes the description of the works developed to create the register.

The register of Protected Areas required under Article 6 shall include the following types of Protected Areas:

- Areas designated for the abstraction of water intended for human consumption under Article 7;
- Areas designated for the protection of economically significant aquatic species;
- Bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC;
- Nutrient-sensitive areas, including areas designated as Vulnerable Zones under Directive 91/676/EEC and areas designated as Sensitive Areas under Directive 91/271/EEC; and
- Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites designated under Directive 92/43/EEC and Directive 79/409/EEC.

3.1. Areas designated for the abstraction of water intended for human consumption

Water needs for human consumption within the Júcar RBD are estimated to be 650 hm^3/year for a population of 4.3 millions inhabitant plus an equivalent population of 1.3 millions due to the tourist sector. Surface water resources provide half of water needs, giving service to large cities as Valencia (1.2 millions of inhabitants in the metropolitan area), Albacete (150 000 inhabitants), and part of the supply of Alicante (366 000 inhabitants) and Elche (202 000 inhabitants). GW is used to supply most towns and villages of the District, with a total volume of 370 hm^3/year. Major towns supplied with GW are Castellón de la Plana (180 000 inhabitants), Cullera (132 000 inhabitants), the rest of the supply of Alicante (366 000 inhabitants) and Elche (202 000 inhabitants). Finally the Marina Baja system (155 000 inhabitants) is a clear example of combined use of superficial and groundwater.

This situation gives a picture with numerous abstraction points (wells) intended for human consumption disseminated all over the territorial area of the Júcar RBD. The WFD, by fixing rigorous limits (10 m^3/day or serving more than 50 people), obliges to consider under protection the vast majority of water bodies where abstraction points are located.

Council Directive 75/440/EEC, modified by Directive 80/778/EEC, which in turn was modified by Directive 98/83/EEC, on the quality of water intended for human consumption protects waters for this purpose and establishes the quality objectives required. To locate every water source that complies with all WFD requirements, it has been necessary to conduct a survey within the *Alberca* program. This is an ongoing nationwide information program developed by the Ministry of Environment, which gathers information concerning water abstraction licenses within the Register of Water of the RBDs.

Figure 87 shows a preliminary map with the location of this type of protected areas, but only for abstractions greater than 1 000 m^3/day, which add up to 150 points. However, the number of procedures to give licenses for abstractions for urban supply of more than 10 m^3/day are about 2 000. Analyses to consider all sorts of abstractions are being carried out.

Figure 87	Preliminary map with location of points for abstractions (greater than 1 000 m³/day) intended for human water consumption

- 1 000 - 2 000
- 2 000 - 4 000
- 4 000 - 10 000
- > 10 000
- Hydrogeological Units

3.2. Areas for the protection of economically significant aquatic species

Up to now, shellfish has been the only organism considered economically significant within the District. The Directive 79/923/EEC on quality required for shellfish waters modified by Directive 91/692/EEC, aims to safeguard shellfish populations by setting water quality standards in areas where these molluscs grow and reproduce. Since this Directive applies to those coastal and brackish waters which designation belong to Regional Governments, coordination relationships with Environmental Departments of the Autonomous Community are being established in order to make the updated domain of these protected areas available.

Table 26	Bathing water areas selected in the District regulated by Directive 76/160/EEC

System	River or lake	Reach
Júcar	Cabriel	Lagunas de Cañada del Hoyo
Júcar	Júcar	Embalse de La Toba
Júcar	Júcar	Playa de Cuenca
Júcar	Júcar	El Chantre
Júcar	Lake Anna	Gorgo de la Escalera
Júcar	Lake Playamonte	Playa - Monte
Júcar	Júcar	Playeta de Alcalá del Júcar

3.3. Areas for recreational waters

This category encompasses water areas designated for bathing, and it is associated to Directive 76/160/EEC. This Directive applies to bathing areas in inland and seawater. The water quality police for the bathing areas under the umbrella of the Directive is a complex subject that is outside the competency of the River Basin Authority (RBA). Their control belongs to the Ministry of Health and the health departments of the Regional Governments carry out the data collection. Therefore, coordination between the Environmental and Health Ministries is necessary. Actually, the Regional Governments have the list of bathing ar-

Surface inland water bodies under quality standards for bathing (EU legislation) — Figure 88

eas submitted to the Directive 76/160/EEC, which is showed in the figure 88 and table 26.

In the other hand, the Júcar Hydrological Plan (JHP), approved by Royal Decree 1664 of 1998, indicates the locations for protection of inland bathing waters as shown in the table 27.

Bathing water according JHP (CHJ, 1998) — Table 27

River	Reach
Mijares	Núcleos de Montanejos, Vallat, Espadilla y Fanzara
Palancia	Embalse del Regajo y en paraje de Fuente Baños
Turia-Guadalaviar	Embalse de Arquillo de San Blas
Turia-Sot	Núcleo de Sot de Chera
Serpis-Encantada	Barranco de La Encantada
Guadalest-Algar	Paraje de Las Fuentes del Algar
Júcar-Magro	Núcleo de Casas del Río
Júcar-Cabriel	Enguídanos y Boniche
Júcar	Antella, Alcalá, El Picazo, Valverde, Cuenca y Villalba de La Sierra

3.4. Nutrient sensitive areas

This category includes those nutrient-sensitive areas, including vulnerable zones regulated by Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources. The category also contains areas designated as sensitive under Directive 91/271/EEC concerning urban wastewater treatment. Royal Decree 261/1996 transposed the nitrate Directive into the Spanish legislative system.

Vulnerable zones were designated in Spain following the provisions of Directive 91/676/EEC, through Regional Government proposals, which are in charge of their designation. This category

Figure 89	Vulnerable areas subject to nitrate pollution

Table 28	Values of kg N/ha by crop type and irrigation system recommended by the Valencian Autonomous Government

Crop type	Gravity irrigation system	Drip irrigation system
Artichoke	250-300 kg N/ha	200-240 kg N/ha
Onion, melon, tomatoes	200-250 kg N/ha	160-200 kg N/ha
Citrics	200-240 kg N/ha	240-300 kg N/ha

encompasses surface water bodies intended for human consumption with nitrate concentration in breach of Directive 75/440/EEC, and GW bodies having nitrate concentration higher than 50 mg/l.

The Valencian Autonomous Community Government implemented the Directive by Decree 13/2000 designating vulnerable zones within its territory in terms of municipal districts. As a result, the vast majority of coastal plains within the Valencian Region are qualified as vulnerable zone as shown in figure 89. The Castilla-La Mancha Government had implemented the same action in 1998.

Diffuse pollution due to the use of fertilisers in agriculture is the main cause of high nitrate concentrations. It is later described in section 4.1.6.3, how some aquifers present values higher than 50 mg/l. As a result, codes of good agricultural practices are being implemented to reduce pollution induced by intensive agriculture. The Valencian Autonomous Community Government adopted the recommended values assigned to each crop type and irrigation system shown in table 28.

Sensitive areas as referred to in the provisions of Directive 1991/271/EEC — Figure 90

Sensitive areas as referred to in the provisions of Directive 1991/271/EEC include mainly natural freshwater lakes, other freshwater bodies, estuaries and coastal waters, that present eutrophication, or will present it in the near future if protective actions are not taken. As a primary and rough criteria adopted for the identification of these affected surface water bodies, those receiving discharges from wastewater treatment plants with a capacity higher than 10 000 equivalent inhabitants have been considered. Sensitive areas were established in Spain by the Water and Coast Secretariat Resolution of May 25th, 1998. The areas defined in the Júcar RBD are shown in figure 90.

Figure 91 — **Proposed areas for the Natura Network 2000**

Site of Community Importance (SCI)
Special Protection Area (SPA)

Source: Regional Governments

3.5. Areas for protection of habitat or species

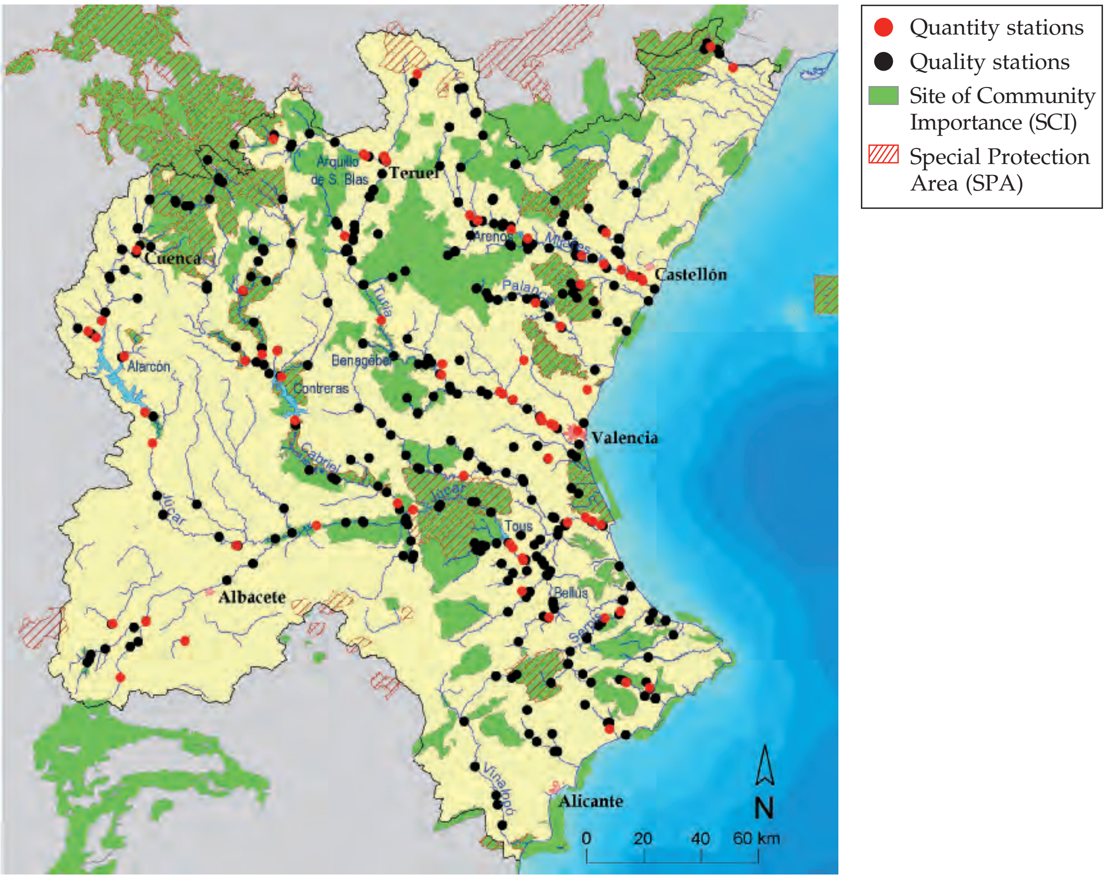
This category includes those areas pertaining to the Natura Network 2000 and those surface water bodies supporting fish life. This Network is regulated by two essential Directives: Directive 92/43/EEC, which promotes the protection of the European Community natural heritage and Directive 79/409/EEC, which supports the conservation of birds since 1979. Directive 78/659/EEC focuses on the quality of fresh waters needing protection or improvement in order to support fish life and regulates surface water for that purpose.

The Natura Network 2000

The competencies for designating protected areas lie on the State based on the proposal carried out by the Regional Governments (Valencia, Castilla-La Mancha, Aragón and Cataluña). At present, the final proposals are to be sent to the EC for their approval.

Figure 91 shows the Spanish proposed areas to be included in the Natura Network 2000 within the Júcar RBD. These areas belong to the Sites of Community Importance (SCI) and the Special Protection Areas (SPA), which are areas with special protection for the birds.

Surface water monitoring networks and Natura 2000 sites | Figure 92



The area covered by Natura 2000 sites is approximately 9 500 km^2, which represents 22% of the total surface of the Júcar RBD. A large proportion of protected areas are located in the mountainous areas and in main watercourses. Major wetlands, mostly located on the coastal strip, are also included in this proposal.

In figure 92, surface water networks for quality and quantity operating in the Júcar RBD have been represented. Quality network includes biological and ICA (Integral Water Quality) stations, while the quantity network includes all gauging stations operating nowadays that belong to the official gauging station network or to the SAIH (Automatic Hydrologic Information System). As can be seen in the figure, most rivers flowing through Natura 2000 sites are monitored. This type of analysis will be taken into consideration in the programme of measures to be defined to improve the monitoring networks.

Figure 93 | Cyprinid reaches reported to EC

Support Fish Life Waters

Directive 78/659/EEC was transposed to the Spanish legislation by a Royal Decree, which extends the Water National Act, and establishes quality objectives. To apply these quality objectives, waters are divided into salmon waters (more strict water quality standards) and cyprinid waters. The designation of river reaches belonging to one of these classes is done by the River Basin Hydrological Plans.

Article 31 of the JHP establishes that minimum quality objectives for rivers in the RBD must be those defined for cyprinid waters, unless a river reach cannot meet those objectives due to natural reasons. Information on some of the cyprinid reaches (figure 93) has been sent to the EC indicating if they meet the defined quality objectives.

4. IMPACT OF HUMAN ACTIVITY ON THE STATUS OF WATERS

The analysis of pressures and impacts is regulated by article 5 and annex II of the WFD. As every other aspect enclosed in article 5, this analysis must be accomplished by the end of 2004, having its first revision in 2013 and every six years thereafter as a regular basis.

4.1. Identification of significant pressures

4.1.1. *Introduction*

The main goal of the pressures and impacts analysis is to evaluate the risk of failing to achieve the environmental objectives established by the WFD for each water body. It must be specified that the following analyses have only been applied to the categories of rivers and groundwater.

A key task for the development of the pressures and impacts studies is to have an adequate and precise spatial and temporal characterisation of water uses for each agricultural, urban or industrial water demand existing in the Júcar RBD. Consequently, data on water origins and water destinations are being compiled, geo-referenced and are also being related one to each other.

Particularly important for the development of the human pressure analysis have been the tools developed by the CEDEX and other GIS applications developed by the Júcar River Basin Authority (RBA) that provide powerful means for the analysis and visualization of spatially distributed data. By using these tools, a digital model of the Júcar RBD has been created, which allows accumulating along the drainage network in a continuous way either variable such as irrigation surface, runoff, wastewater discharge, etc.

4.1.2. *Driving forces and main significant type of pressures*

Driving forces related to land use as urban development, industry and agriculture expansion have been considered key elements that exert or may exert pressure on surface water bodies and which lead to cause significant impacts. Main pressures produced by driving forces are: significant water abstraction, regulation works and other hydromorphological alterations, diffuse and point source pollution (highly related to land cover use and other anthropogenic effects).

A significant part of water abstraction is due to urban demand. It is worth mentioning, that the Júcar RBD is characterised by presenting a population pattern highly influenced by tourism, which means that there are some areas subject to important seasonal water demands. Tourism resorts are mainly located in the coastal strip, though in recent years it has also been detected an increase of inland tourism.

There are 749 municipalities within the Júcar RBD, with a total population of 4 359 741 inhabitants according to the census of 2001. This number is considered the permanent population of the area, but in addition, due to the tourism sector, it is necessary to add an equivalent population of 1 438 389. This increment of population was obtained taking into account the effect produced by 4 770 271 visitors and 21 501 507 hotel-nights, 95% of which occurs on the Valencian Autonomous Community. This magnitude gives an idea of the significance of this economic sector, particularly for this specific area, and in general, for the whole Júcar RBD.

In addition, it is noticeable that the projections made for total population by the JHP in 1998, using data until 1992, were underestimated, as figure 94 shows. This was due mainly to the evolution of immigration and tourism, and as a result, an increasing level of abstraction for urban supply has occurred in recent years.

Total population (permanent plus equivalent from tourism) in the Júcar RBD — Figure 94

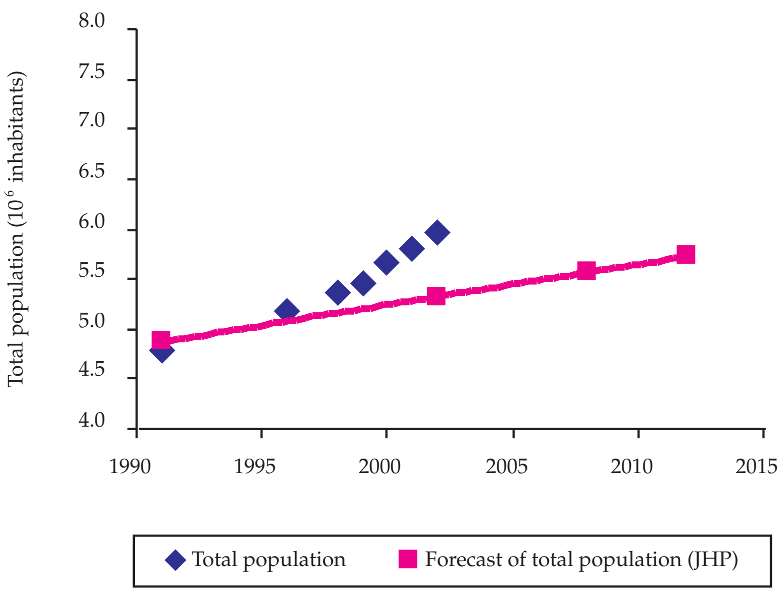


Figure 95	Unit water demand by municipality (litres/inhabitant/day)

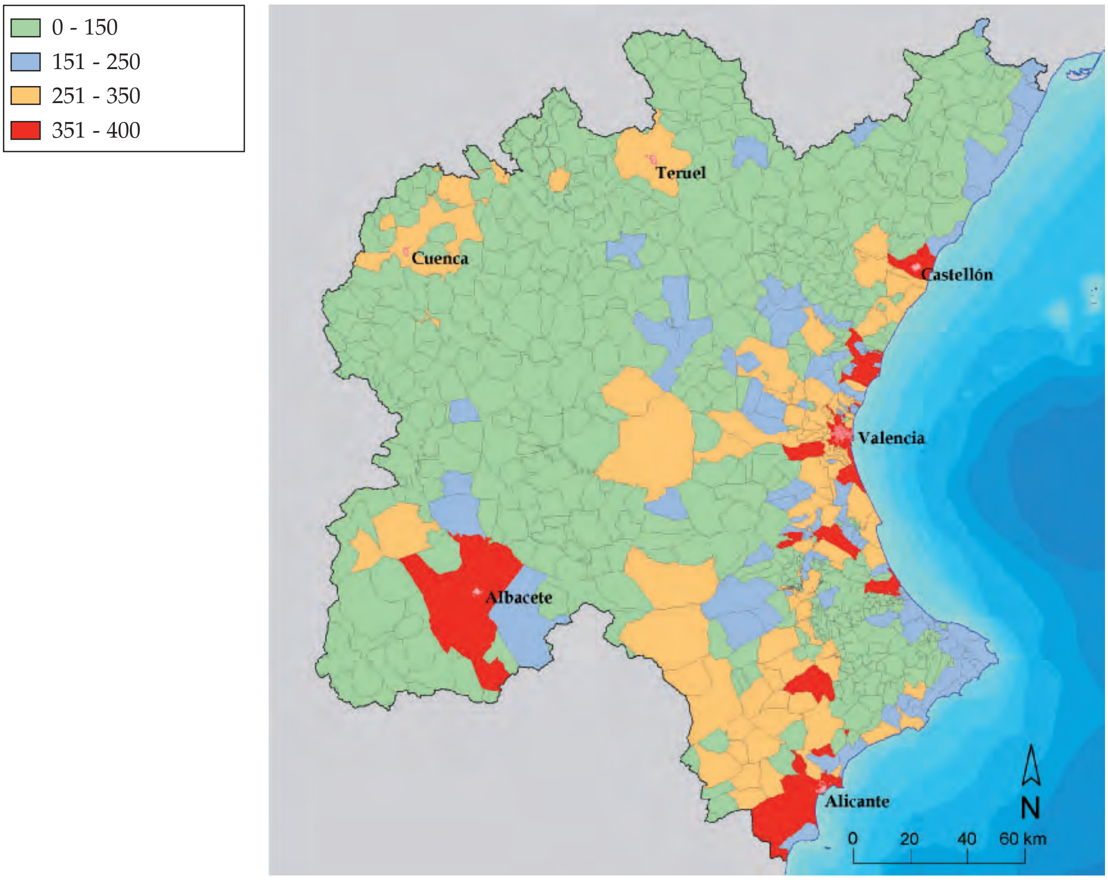


Figure 96	Sprinkler irrigation

Water demand per capita for urban purposes depends mainly on the size of the population and on the industrial activity, and it varies throughout the different municipalities. Demand ranges from 150 litres/inhabitant/day in small villages of the interior of the District, to about 350 litres/inhabitant/day in largest towns, located mainly in the coastal area (figure 95).

The main fraction of water abstraction in the Júcar RBD is due to agriculture demand, which accounts for nearly 80% of total abstractions to irrigate a surface of about 357 500 ha. Mean water consumption is about 4 700 m^3/ha/year and the mean efficiency is close to 60%. The total abstraction for agriculture has been estimated in 2 800 hm^3/year in the latest years.

There are several approaches intended to assess water demand: direct methods using data on water consumption and indirect methods based on agricultural land census, unit demands by crop type and efficiency of irrigation systems (figures 96 and 97). Nevertheless, whichever method is used, water abstraction assessment for irrigation purposes is not an easy or immediate task.

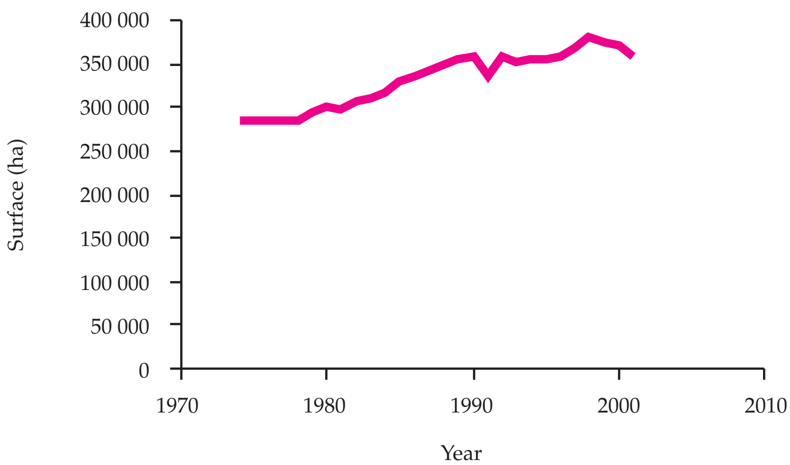
The key stage for the assessment of agricultural water demand is collecting and gathering information from the *1-T forms* (mentioned in Section 2.2.2). These documents, which are edited on an annual basis, enclose information on agricultural surface at the municipal level. Figure 98 shows the evolution of the total irrigated surface since 1974 for the Júcar RBD.

The reliability of this information usually depends on the type of crop. For instance, figures on herbaceous crops, as cereal, legumes, forage, oleaginous, etc., are quite precise since this kind of crop is subject to EU subsidies policy, and their declaration is mandatory according to the Common Agricultural Policy (CAP). Vegetables and fruit crop figures have a lower accuracy than herbaceous ones; nevertheless, the *1-T forms* can be considered a quite trustful source. The main types of irrigated land in the Júcar RBD are: mandarin tree (27%), orange tree (19%), barley (6%), maize (6%), rice (4%), wheat (4%), alfalfa (3%), vineyard to eat (3%), olive for oil (2%), almond tree (2%), vineyard for wine (2%), peach tree (2%), onion (1%), garlic (1%) and others (17%). Figure 99 gives an idea of the crop distribution within the Júcar RBD for year 2002.

All this information is collected and analysed for each of the Agricultural Demand Unit (ADU) defined in the Júcar RBD (figure 100).

Drip irrigation — Figure 97

Irrigated surface in the Júcar RBD — Figure 98



Source: 1-T Forms

Distribution of irrigated crops within the Júcar RBD (year 2002) — Figure 99

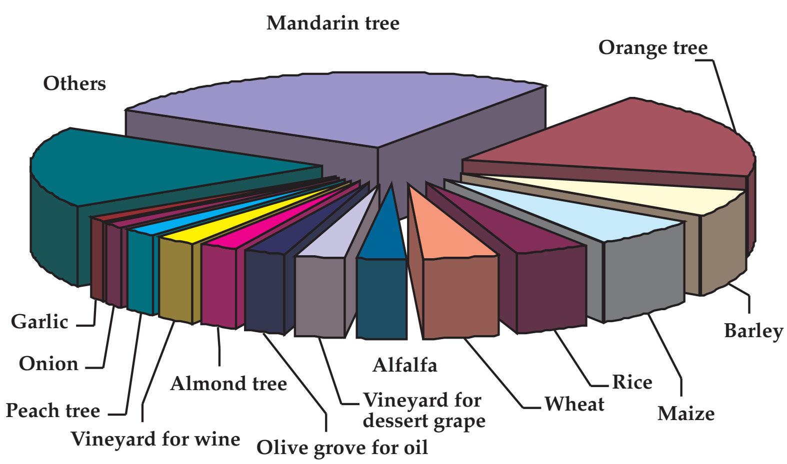
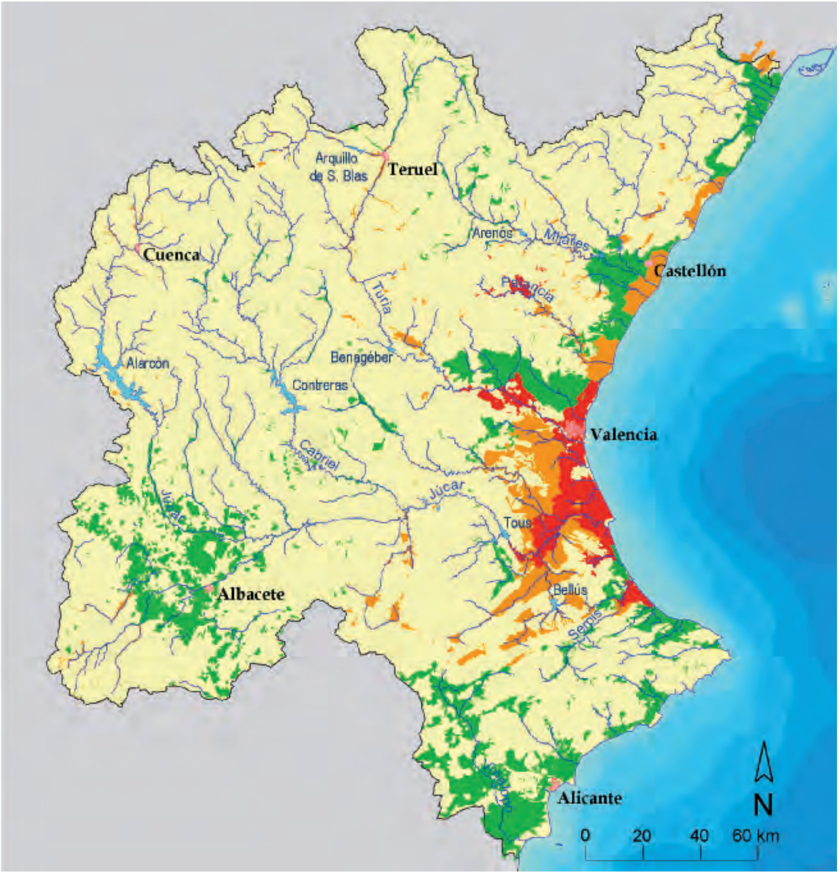


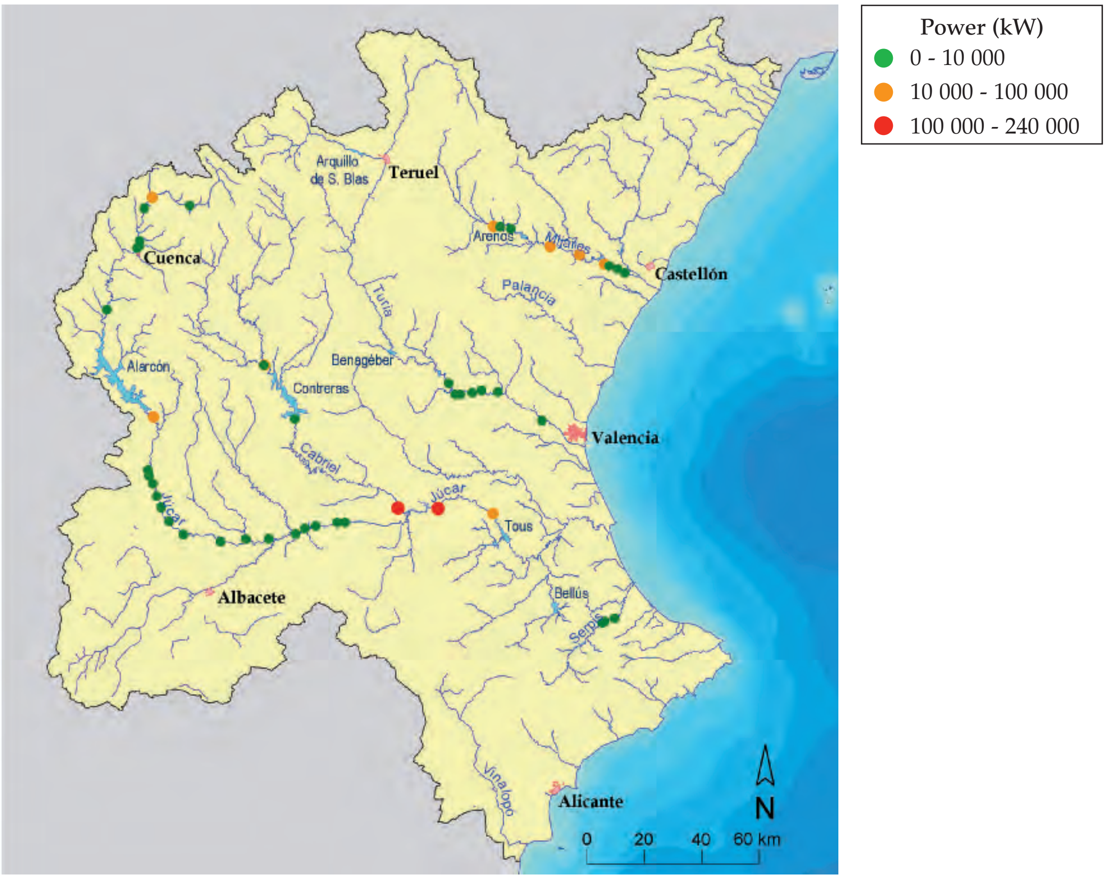
Figure 100	Water demands at ADUs (m³/ha/year)

- 4 000 - 6 500
- 6 500 - 12 000
- 12 000 - 20 000



Another significant water use in the Júcar RBD is the hydroelectricity production. At present, there are 54 hydroelectric power stations located in the main rivers of the District: Júcar, Turia and Mijares.

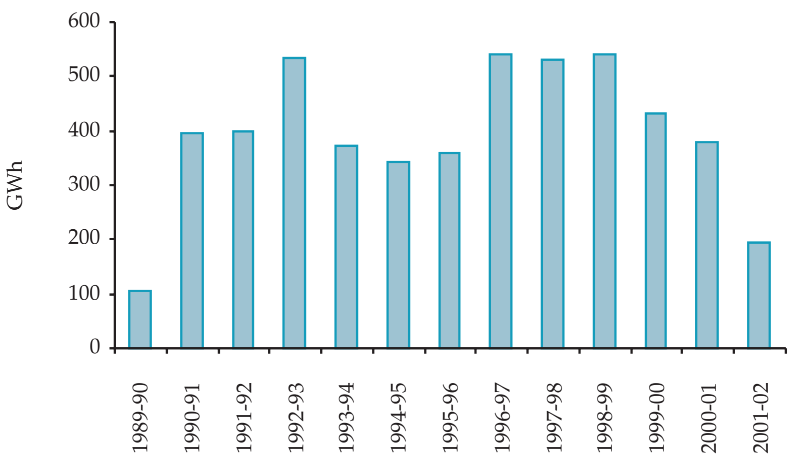
Hydropower stations | Figure 101



The hydropower production varies from 350 GWh in the driest years to 540 GWh in wet years (see figure 102). Millares hydropower station was temporarily out of service from year 1998, because of the construction of the new Tous dam, until its recent inauguration in year 2003 in a new location. This explains the reduction in the hydroelectric production in the last years.

There is a highly important hydraulic reversible complex that is used to regulate the hydroelectric production, called the Cortes-La Muela hydropower station. It has an upper reservoir of 22 hm^3 with a net jump of around 500 meters, turbine power of 630 MW installed and it elevates around 3 000 hm^3 per year with a consumption of 700 GWh per year. This data have not been added to the total of figure 102 due to the special characteristics of a reversible central.

Hydropower production in the Júcar RBD | Figure 102



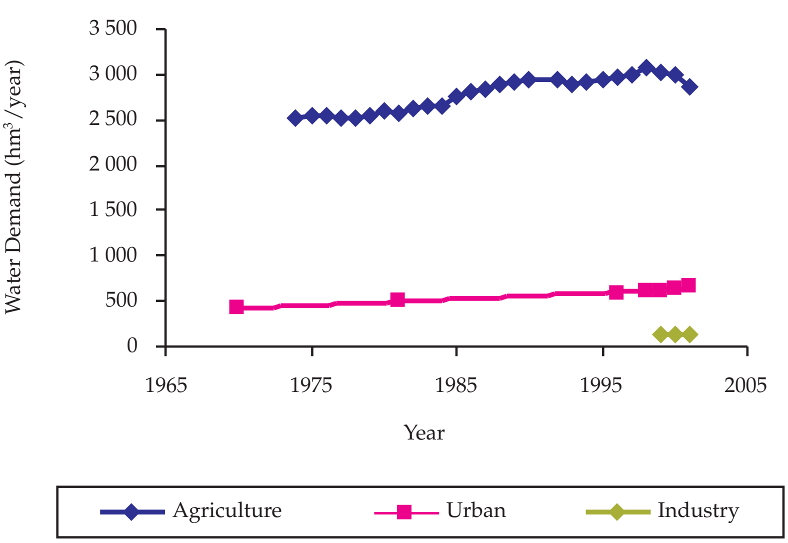
4.1.3. *Effects of water abstractions on flow regimes*

Modifying the flow regime through abstraction affects both surface and GW bodies. Mean annual water resources within the Júcar RBD are estimated to be 3 260 hm^3/year, whereas the total abstraction of surface flows is approximately 2 030 hm^3/year. About 80% of the flow is provided by the three most significant sub-basins of the District, which are the Júcar, the Turia and the Mijares, whereas the rest of sub-basins contribute with the other 20%.

An important part of the overall available water resources, around 2 360 hm^3/year, comes from GW bodies discharges, which accounts for 70% of total water resources. This percentage gives an idea of the importance of this type of water resource in the Júcar RBD. An approximate average volume of 1 660 hm^3/year is abstracted directly from aquifers.

The temporal evolution of water demands for the different sectors (urban, agricultural and industrial) is shown in figure 103. As shown, agricultural and industrial water demand are stabilising and even decreasing, while water demand for urban use has significantly increased in past years.

Figure 103 Water demands in the Júcar RBD



Two GIS models were created for the whole area of the District to assess the impact of abstractions due to human activities.

The overall urban/industrial demand is about 773 hm^3/year, being 653 and 120 hm^3/year for urban and industrial use respectively (including refrigeration purposes). An approximate 50% of this demand is supplied by surface water resource, 380 hm^3/year. The rest, is taken directly from aquifers.

This section deals with abstractions from surface and GW bodies jointly, since both of them result on direct pressures on surface water bodies. Additionally, a specific study just on pressures over GW bodies is described in section 4.3.

Figure 104 shows a representation of the first GIS model that was used to evaluate urban/industrial demand pressures. This model encompasses a grid of cities, towns, villages and industries coming from 1:25 000 Spanish digital maps. This grid is overlapped with surface water bodies derived from the model developed by CEDEX. Each cell of the model, having a 500 m x 500 m resolution, belonging to the urban/industrial grid, has an assigned urban/industrial demand. A previous GIS analysis was developed by the Júcar RBD to make the assignment of each cell from the water demand data obtained from Municipalities.

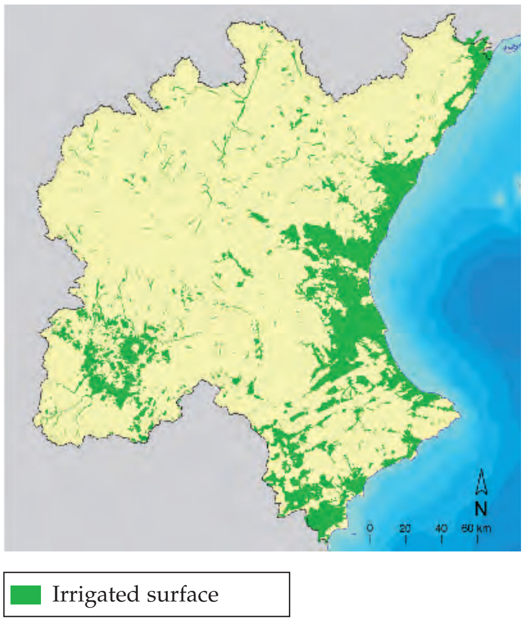
After conducting the spatial analysis, the map showing the accumulated water demand throughout surface water bodies was obtained. Colouring reaches by the level of abstraction that they represent, was the final step and the result is shown in figure 104. Light blue colours represent the lowest pressures, while the highest pressure is shown with intense red colours.

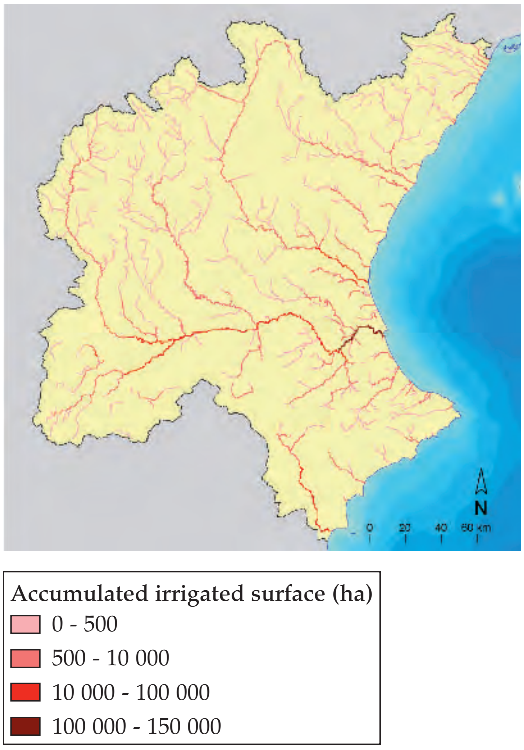
As it is noticeable, the central and southern parts of the coastal strip of the basin are more water demanding for urban supply than the northern part. Middle and final reaches of the main rivers, as the Júcar and the Turia, are suffering high levels of pressure compared to other water bodies within the RBD. This is also happening for some of the southern rivers, as the Serpis and the Vinalopó, which present high demands, not only during their last reaches, but also all along their courses.

The second GIS model accumulates the irrigated surface in each 500 m x 500 m cell of the river network (figure 105). The accumulated irrigated surface for the Júcar River stands out from the

GIS model of water abstraction for urban/industrial supply — Figure 104

GIS model of irrigated areas — Figure 105





rest, although, the Turia and the Vinalopó Rivers are also suffering high levels of pressure.

The last step of the analysis consisted on determining the spatial distribution of the unit water demand for irrigation and accumulated values on surface water bodies. For doing this, water demand data based on the type of crop and its location, established by the current JHP, were applied in each of the polygons that delimitate agricultural demand units (ADU). Then, this map was superimposed on the grid map used for the pressures accumulation analysis (500 m x 500 m resolution), and a value of agricultural unit water demand was assigned to each cell. The figure 106 shows the spatial distribution of water demand for irrigation in each ADU, and the accumulated water demand on rivers.

Figure 106 GIS model of surface water abstraction for agricultural use

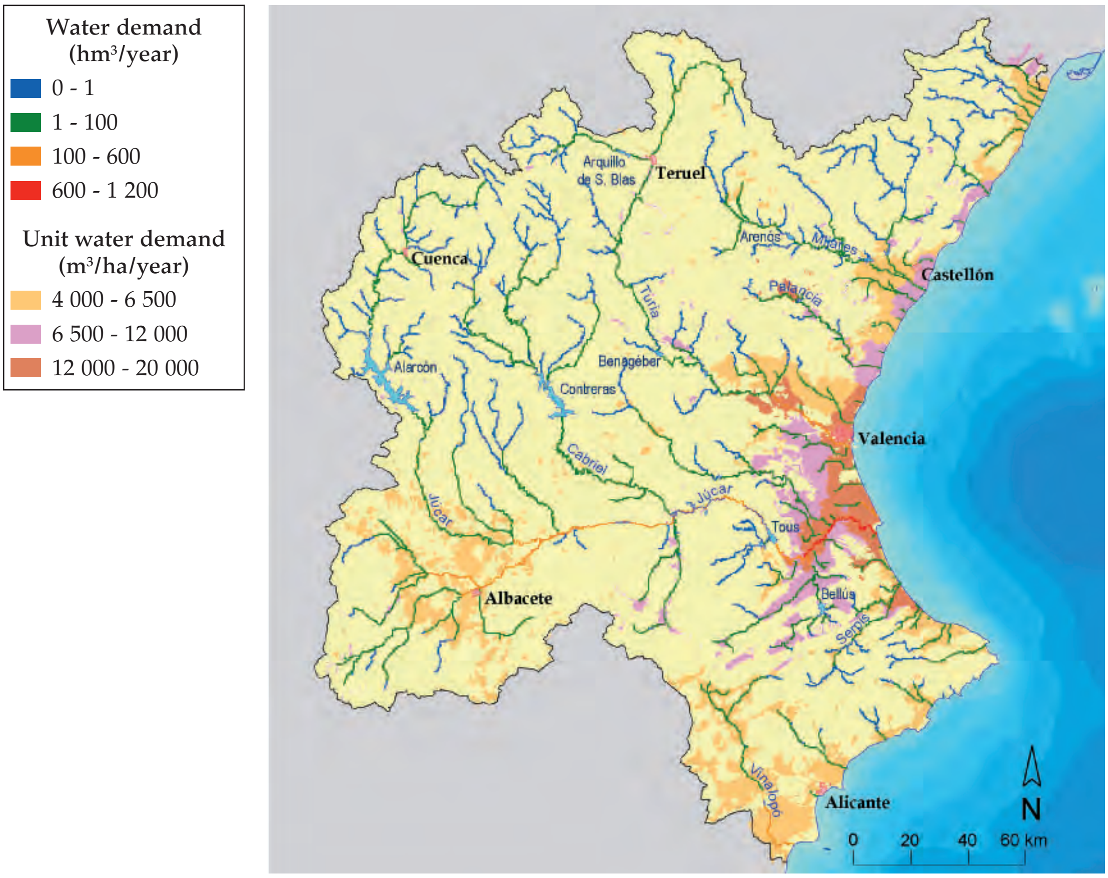
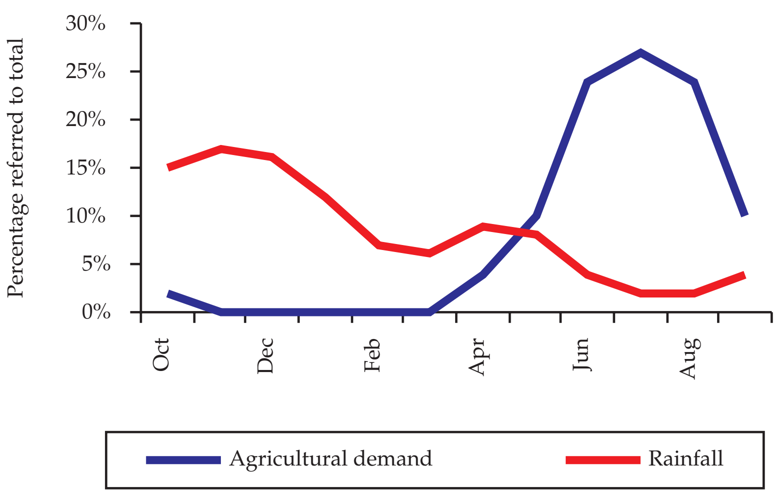


Figure 107 Precipitation versus agricultural demand patterns

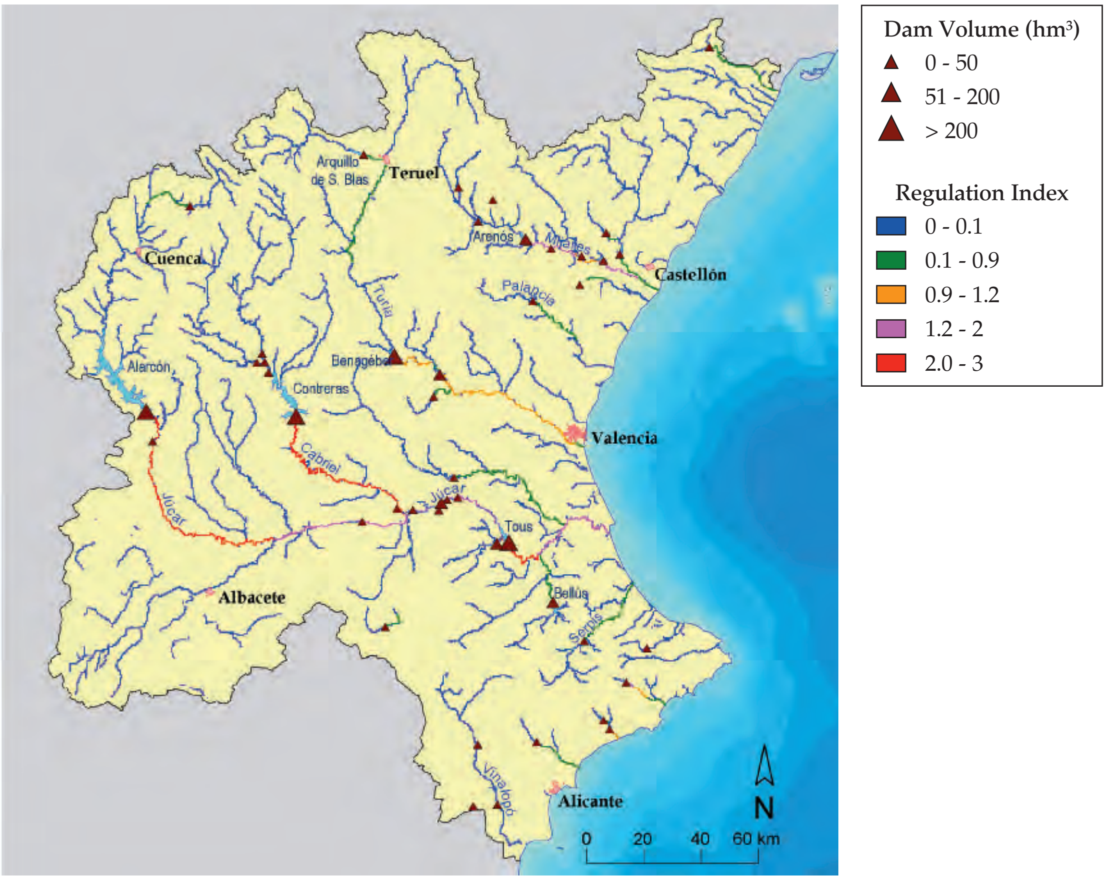


4.1.4. *Flow regulation*

A typical precipitation pattern for a regular year in the Júcar RBD is shown in figure 107. As shown in the figure, the absolute maximum corresponds to the November-December period and there is a relative maximum on April. This pattern largely contrasts with agricultural water needs also shown in the same figure, which in the case of the Júcar RBD represent nearly 80% of the overall water demand. As illustrated, agricultural water demand is higher during the summer and lower during the winter. To tackle this unbalanced situation, surface water flow at rivers is regulated by means of reservoirs. This regulation produces impacts that affect in more or less degree the aquatic system and the dependant environments.

Through this section the quantification of the effects of modifying the flow regime through regulation will be described. The first parameter that gives an idea of the magnitude of water regulation, is the total surface storage capacity in the District. This parameter in the Júcar RBD is close to 3 300 hm^3, distributed among 28 main reser-

Ratio between water storage capacity and mean annual runoff | Figure 108



voirs. This capacity is apportioned into inter-annual and intra-annual regulation dams. Inter-annual regulation dams have much greater capacities than annual regulation dams, and allow storing water resources in wet years to be latter supplied during dry years. Annual regulation dams only allow distributing runoff seasonally, usually from winter to summer.

GIS tools, developed for the spatial analysis, make possible calculating a continuous variable that expresses the potential regulation pressure. This potential is shown as the ratio between the accumulated water storage capacity and the mean annual natural runoff at each point of the river network. Figure 108 shows this ratio.

From this analysis, it follows that major rivers as the Júcar, and also its main tributaries, the Cabriel, the Turia and the Mijares, are subject to a strong regulation capacity from the upper/middle stretches to their mouth. Upper parts of the rivers and short watercourses are less affected by regulation structures.

Nevertheless, operation rules adopted for dams would give a more accurate idea of the occurring pressure due to flow regime regulation. This part of the study is still ongoing, but this report presents partial results from the work developed for some of the reservoirs in the Júcar River system.

Inflows to and outflows from the Alarcón reservoir are shown in figure 109, representing how the hydrological regime of the Júcar River in Alarcón is highly modified by this regulation. Figure 110 shows the Cenia River flow discharges, which are much less modified by the Ulldecona dam. Studies are being carried out to quantify the effects on ecosystems and habitat resulting from changes applied to hydrological regimes.

Figure 109	Monthly inflows and outflows to/from Alarcón Dam in the Júcar River

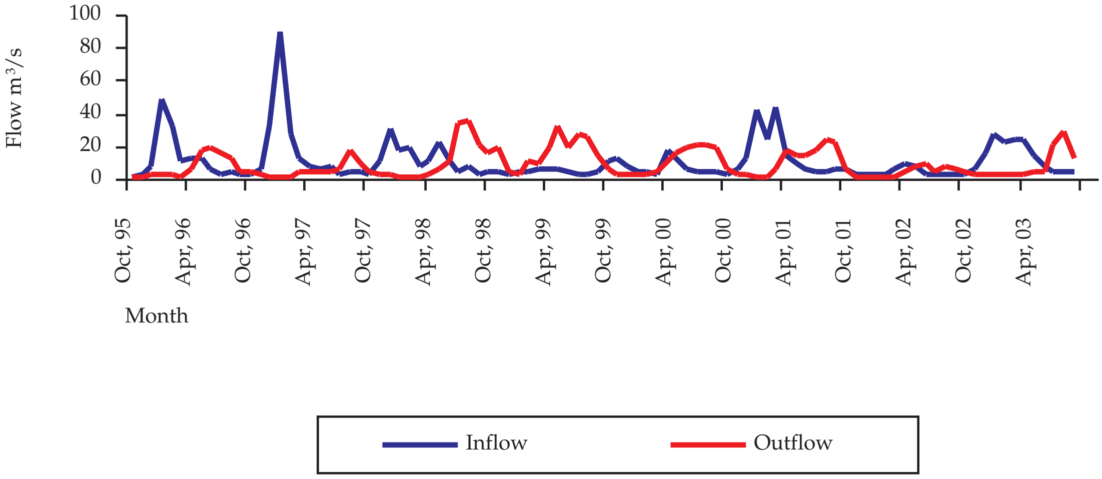
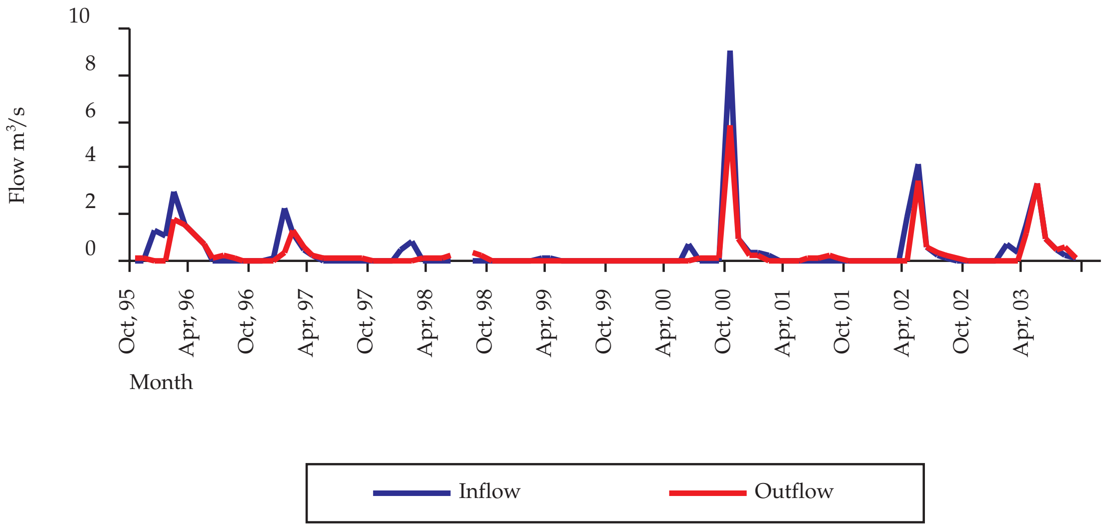


Figure 110	Monthly inflows and outflows to/from Ulldecona Dam in the Cenia River



Definition of the different levels of hydromorphological alteration caused by regulation works (Montana's method) — Table 29

Hydromorphological status	Ecosystem Quality	Percentage referred to natural flow Oct-Mar	Percentage referred to natural flow Apr-Sep
Very good state	Optimal	60-100	80-100
Good state	Exceptional	60-40	60-80
Good state	Excellent	30-40	50-60
Medium state	Good	20-30	40-50
Poor state	Degraded	10-20	30-40
Poor state	Poor	5-10	10-30
Very poor state	Very Degraded	< 5	< 10

Definition of the different degrees of hydromorphological alteration of dams (Montana's method) — Table 30

Dam	Maximum Storage (hm^3)	Natural inflow Oct- Mar (m^3/s)	Outflow Oct-Mar (m^3/s)	Winter ecosystem quality	Natural inflow Apr-Sep (m^3/s)	Outflow Apr-Sep (m^3/s)	Summer ecosystem quality
Ulldecona	11	0.39	0.18	Exceptional	0.33	0.41	Optimal
Arenós	137	3.56	2.51	Optimal	3.69	4.92	Optimal
Regajo	6	0.43	0.14	Excellent	0.32	0.58	Optimal
Arquillo San Blas	21	3.63	1.49	Exceptional	2.52	2.70	Optimal
Benageber	221	5.39	2.77	Exceptional	3.96	6.72	Optimal
Alarcón	1 112	11.71	4.61	Excellent	13.66	21.23	Optimal
Contreras	852	4.38	0.27	Poor	3.89	8.78	Optimal
Beniarres	27	0.57	0.15	Good	0.21	0.88	Optimal
Guadalest	13	0.54	0.50	Optimal	0.50	0.69	Optimal
Amadorio	16	0.09	0.05	Exceptional	0.04	0.15	Optimal

At present, different criteria to quantify the level of hydromorphological alteration produced by great regulation works (dams) are being analysed. One of the criteria proposed by the CEDEX is based on the Montana's method (Tennat). This method defines the different levels of hydromorphological alteration comparing six months of natural inflows with the reservoir outflows according to the table 29.

When applying these values to the most probable (50 percentile) inflows to, and outflows from main reservoirs the indicators shown in table 30 are obtiained.

The analysis above refers to the hydromorphological conditions right below the reservoir. Downstream, the river recovers from the alteration produced by the dam and the effect caused by it diminishes.

In spite of the results obtained by the application of this method, the important effect of regulation works on the hydrological regime is evident, as well as the need to deepen in these studies and not to apply only methods developed for other areas. It is also necessary to analyse if the generation of flows greater that the natural flows during the summer is optimal for the fluvial ecosystems.

Figure 111	Small weir for irrigation

Figure 112	Traditional weir (azud de Sueca) in the Júcar River

4.1.5. *Morphological alterations of water bodies*

This type of pressure includes two kinds of main anthropogenic alterations on the surface water bodies: retention structures or weirs, and channelling of natural rivers.

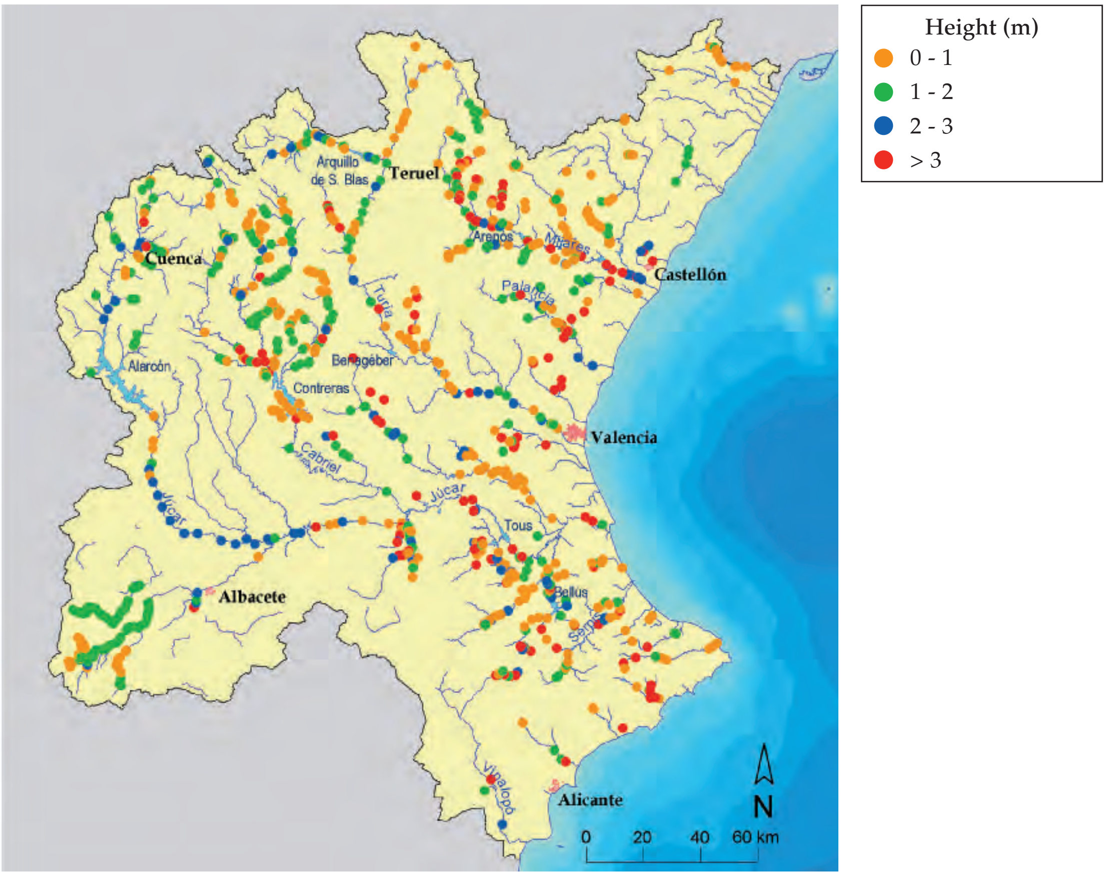
Retention structures or weirs have the main purpose of raising or diverting water, mainly for irrigation purposes (figure 111). These structures sometimes result in difficult obstacles for the regular circulation of aquatic species.

A thoroughly study has been done within the Júcar RBD for obtaining the precise location and characteristics of this type of structures. This study has been based on digital cartography with scale 1:25 000, and supported by field-work done by the River Guard Service (RGS) of the RBD. This Service has conducted a survey along the watercourses, either by checking cartography data or by adding missing structures on the maps. Then, a database enclosing all this information was created and added to the subsequent associated GIS coverage. The information collected until now, includes the name of the watercourse, weir's owner, weir's height, use of water, zone of river guard and Universe Transverse Mercator (UTM) coordinates obtained through a GPS system. Figure 113 indicates the location of weirs on surface water bodies.

The number of weirs identified is about 1 100, being 80% below 2 m height and 40% below 1 meter. Figure 114 depicts the complete distribution of weirs according to their height.

The process to quantify the level of pressure and impact that these retention structures produce has not been established yet. The GDW has commissioned CEDEX to work on this area, and this Centre is now conducting a nationwide study to determine the impact level, based on the height of the weir. It is clear that given the abundance of weirs it would be important to establish at least three measures of impact, light, medium or severe impact, corresponding to the different weirs height. Adopting low thresholds for medium or severe impact could mean that most of the surface water network will be labelled as *heavily modified* if measures are not adopted. Last information on this issue suggests that a weir that is higher than 2-3 meters may be considered as a barrier that may cause significant impacts on the natural conveyance of aquatic ecosystems.

Small weirs Figure 113



The second type of morphological alteration, river channelling, may produce regime modifications by artificially straightening the river channel, changing thus the morphology of riverbanks or producing changes in flow velocity, among other effects.

Similarly to the survey on small weirs, a thoroughly study for obtaining the precise location and characteristics of canalised river reaches has been carried out. This study has also been based on digital cartography with a scale 1:25 000 and supported by fieldwork done by the RGS of the District. As a consequence of this work, a database including all the information was created and incorporated to a GIS system. The main information collected includes the length of channelling, the UTM coordinates for the origin and the end of the reach obtained through GPS tools, characteristics of the channelling, and the corresponding zone of river guard. Figure 115 indicates the location of channelled river reaches. Figure 116 illustrates an example of validation of the information taken in the fieldwork by river guards with a GIS operator, by testing the received data by means of ortophotos. Similarly, a parallel study is being conducted to establish indicators that may define significant pressures and impacts.

Number of weirs classified by height Figure 114

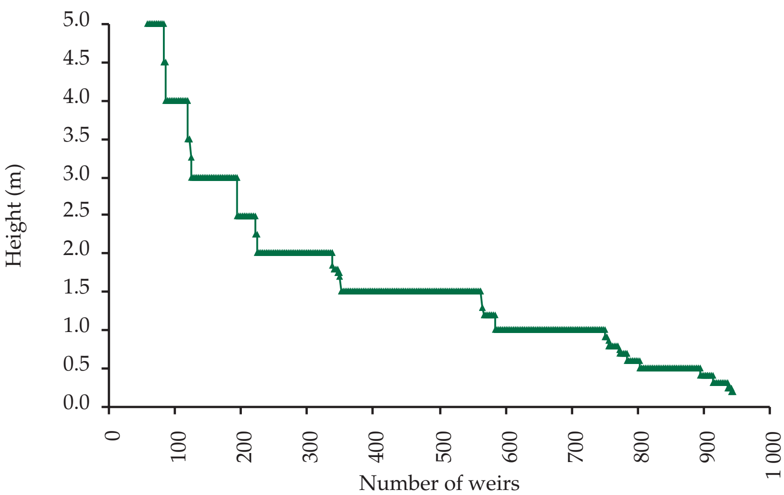


Figure 115 | Channelled river reaches

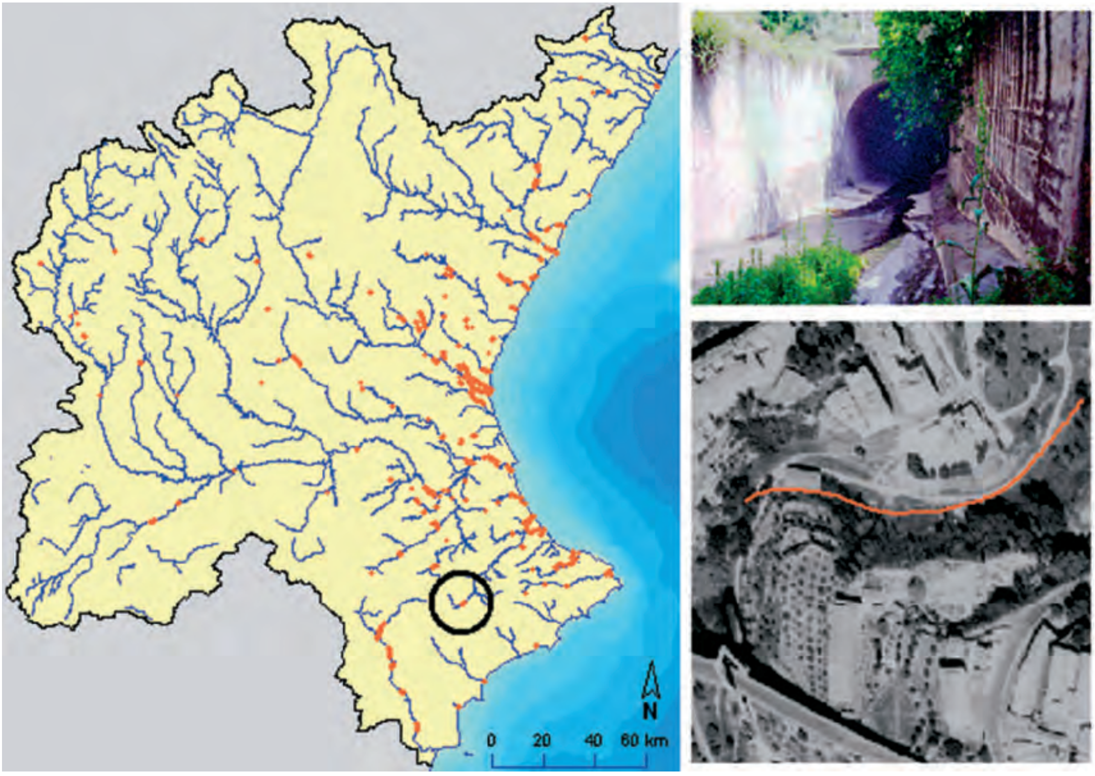
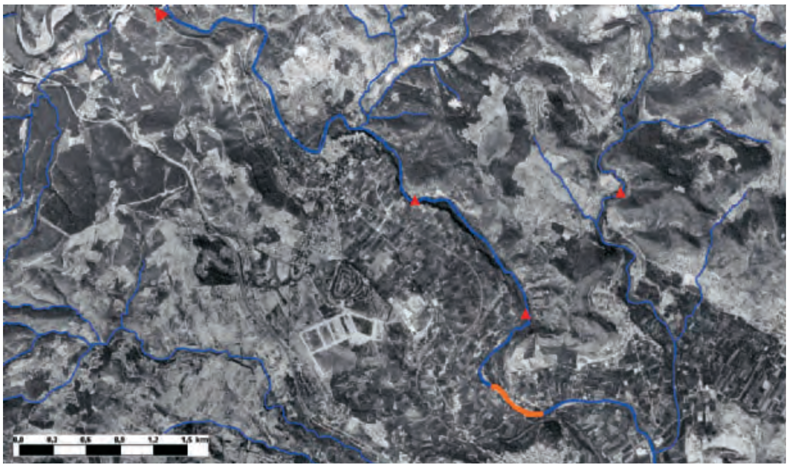
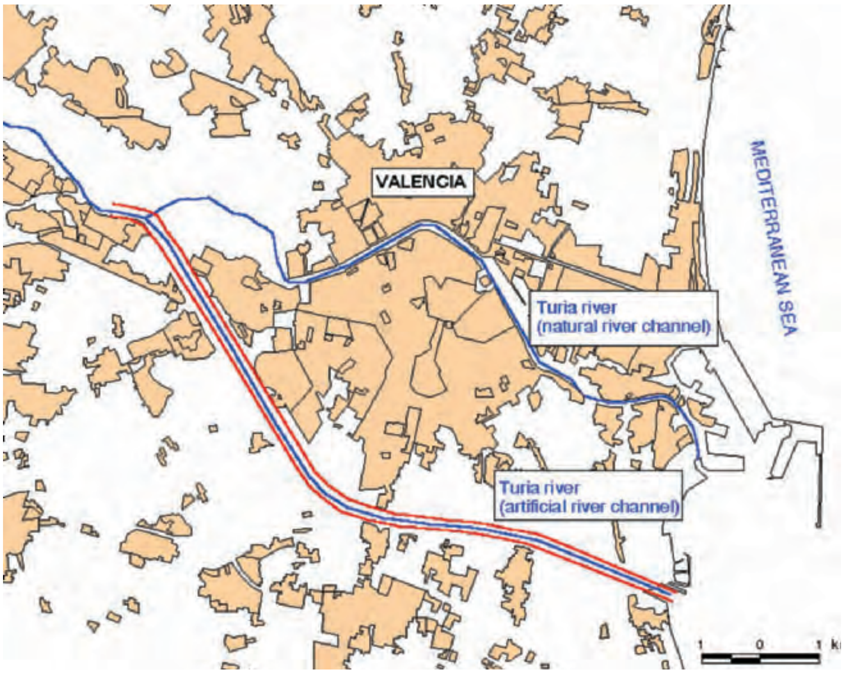


Figure 116 | Validation of channelling data taken in the fieldwork



The most studied channelling of a river in the Júcar RBD corresponds to the last reach of the Turia River, which was canalised when passing through the city of Valencia. Because of the 1957 flood, a new artificial floodway outside the city, at the South, was designed and constructed to evacuate floods (figures 117 and 118). The natural river course has been used as a recreational area where parks, museums, and green corridors have been constructed, standing out the area called *Ciudad de las Artes y las Ciencias* that has an Art building, a Science museum, the Hemispheric and the Oceanographic Park.

Turia River canalisation in the city of Valencia | Figure 117



Note: taken from EEA, 2001

Canalisation at the Turia river mouth | Figure 118

4.1.6. *Pollution pressures from diffuse and point sources*

4.1.6.1. Introduction

Pressure analysis of point source and diffuse pollution on surface water bodies is being carried out following the provisions of the draft document *Technical Guide for the impact and pressure concerning surface water pollution*, elaborated by the Department of Control and Wastewater Treatment of the GDW. This document develops the WFD Guidance Document *Analysis of Pressures and Impacts in accordance with the Water Framework Directive,* in turn generated by the working group named IMPRESS, described in section 1 of this report, composed of European experts from governmental and non-governmental organisations.

Analysis on pressures due to point source pollutants is focused on identifying and characterising this kind of pollution, mainly due to urban and industrial water use.

The urban wastewater study includes large metropolitan areas and small villages. The metropolitan areas are associated to large wastewater treatment facilities that may include some kind of industrial discharge. Small villages usually have small or medium size facilities.

Industrial disposals are analysed according to the type of activity or more specifically, by those activities enclosed in Directive 96/61/EEC on Integrated Pollution Prevention and Control (IPPC) by means of checking the European Pollutant Emission Register (EPER) if possible. Moreover, the remaining types of disposals are also being analysed and classified (such as sources of hazardous substances, fish farmer, mine disposal or landfills).

The pressure analysis on diffused pollutant sources is being developed by means of the information enclosed in the CORINE Land Cover digital map developed by the European Environment Agency (EEA), which is based on satellite imagery dating of 1990. The final goal of this analysis is to determine the level of pressure coming from agrarian exploitation, industrial activities, etc.

The previously mentioned Technical Guide proposes two non-excluding ways for developing the IMPRESS process depending on the type of data needed for its implementation: a qualitative and a quantitative analysis. The qualitative analysis is mainly based on the information enclosed in point source pollution inventories and in the surface water quality monitoring network database. The final result is a classification of surface water bodies of high, medium and low risk of failing to achieve the WFD environmental objectives. On the other hand, the quantitative analysis is implemented by means of mathematical models, with which water bodies are categorised accordingly to the risk. A value for this risk is assigned to each water body, so each of them can be sorted out by its status. Ideally, both types of analyses should be conducted in parallel, and once finished, the results should be compared.

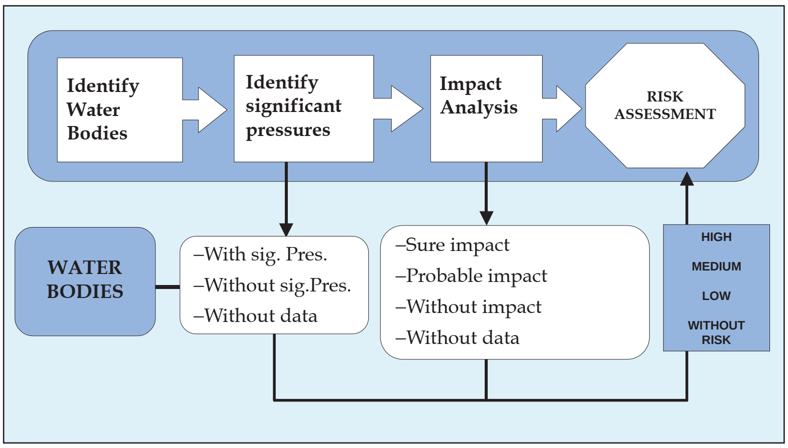
Up to now the analyses carried out are mainly based on the qualitative approach proposed in the Spanish Technical Guide. However, some aspects coming from quantitative approach have also been considered, as for instance, the use of models to represent the decay of the pollutant through the surface water body network.

Figure 119 illustrates the proposed steps for the implementation of the qualitative analysis. The *Identification of surface water bodies* has been previously done as it has been described before in this report.

The identification of significant pressures is crucial, and a thoroughly study is needed for the classification of water bodies according to the level of pressure they are suffering. The following three groups have been defined: water bodies under significant pressure, water bodies under no significant pressure and water bodies lacking data on significant pressures.

The results of the pressure analysis for different types of pollution are presented, summarised and classified by point and diffuse pollution

Figure 119 **Proposed steps for carrying out the IMPRESS qualitative analysis**



sources. The information that has made possible the survey comes from the records of discharges to watercourses and from the databases on wastewater treatment plants.

4.1.6.2. Pollution from point sources

The main pollution pressures from point sources referred in the *Technical Guide for the impact and pressure concerning surface water pollution* are shown in table 31.

First, a database and a GIS system that included all point sources pollution available at the Júcar RBD were developed. Points of source pollution were classified by their different origins: urban, industrial, fish farming, etc. This classifying process was very arduous and it was done carefully, since the rest of the analysis strongly depends on it.

Most of the significant urban pollution discharges have large wastewater treatment plants associated, which correspond with principal villages (see figure 120 in blue colour). The rest of urban conglomerations may have small systems of treatment (red colour in figure 120).

One of the analyses carried out, consisted on studying the relationships between the information available at the urban discharge database (about 1 800 discharge points), and the data coming from the water treatment facilities, which

Main point sources pollution Table 31

Activity or Driving force	Pressure	Possible change in state or impact
Industrial (IPPC and non-IPPC)	Effluent disposal to surface and groundwater.	Dangerous substances have direct effect, increased suspended solids, organic matter alters oxygen regime, nutrients modify ecosystem.
Urban activity	Effluent disposal to surface and groundwater	As above.
Thermal power generation	Return of cooling waters cause alteration to thermal regime.	Elevated temperatures, reduced dissolved oxygen, changes in biogeochemical process rates.
	Biocides in cooling water	Direct toxic effect on aquatic fauna.
Fish farming	Feeding, medication, escaping	Nutrients, diseases, veterinary products, artificial fish population, modified food web.

Source: GD *Analysis of Pressures and Impacts,* EC 2003c

Urban discharges locations with (blue colour) and without (red colour) large wastewater treatment plants Figure 120

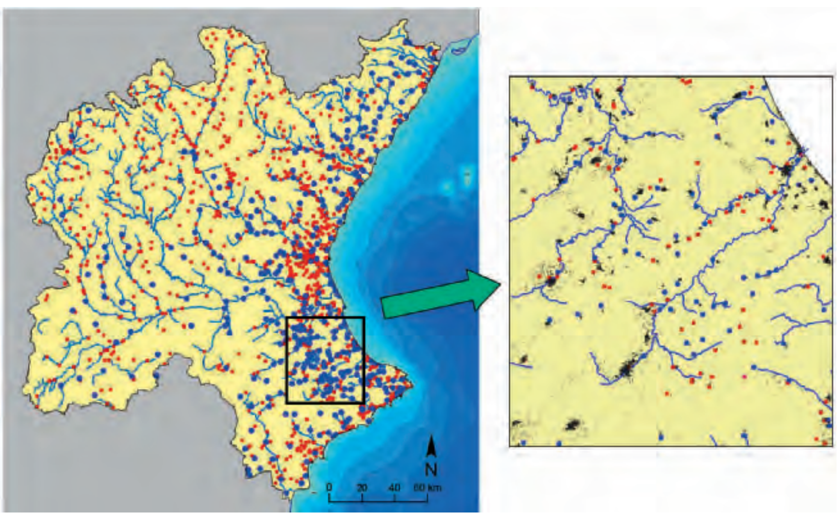
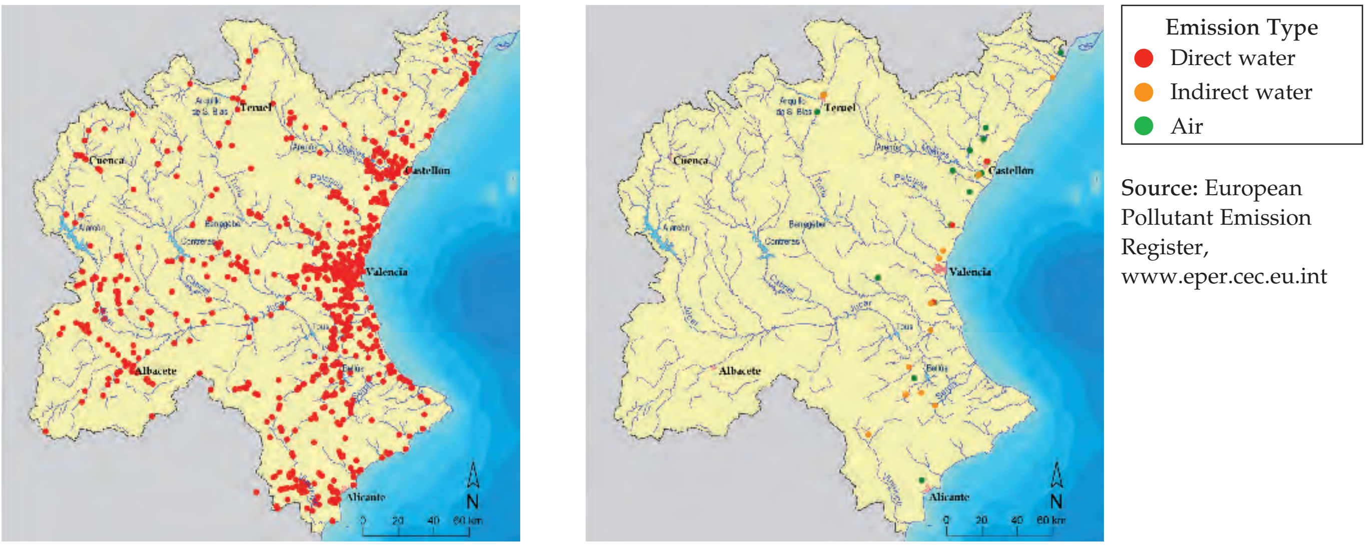
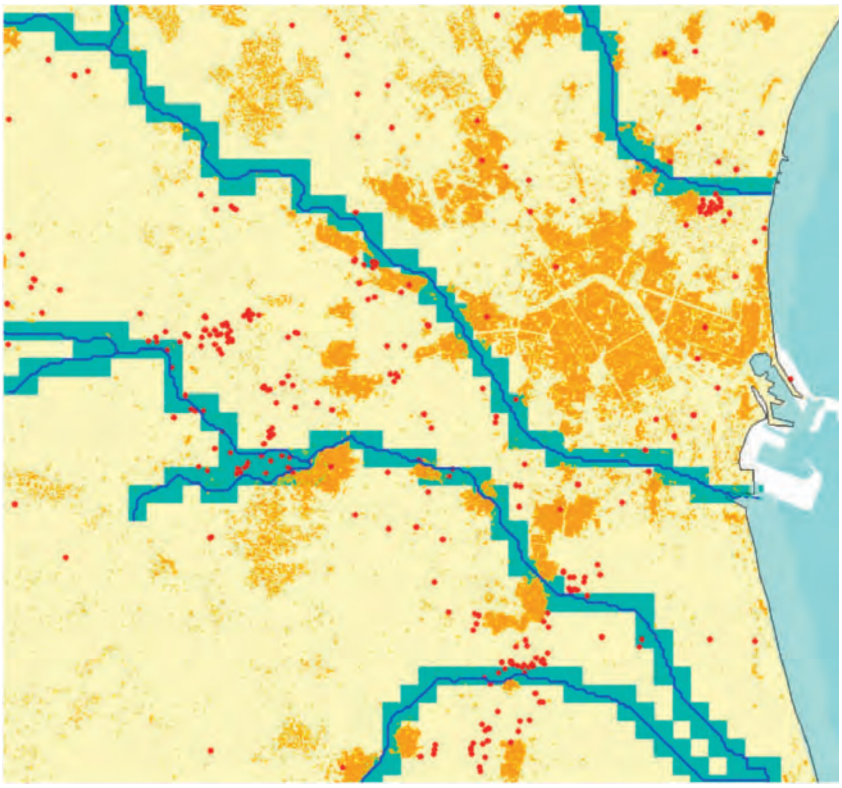


Figure 121	Industrial discharges (left side) and IPPC discharges (right side)



Source: European Pollutant Emission Register, www.eper.cec.eu.int

Figure 122	Industrial discharges locations in the metropolitan area of Valencia



were available in a different database (about 300 points). A high percentage of the urban wastewater volume (74%) passes through large water treatment facilities.

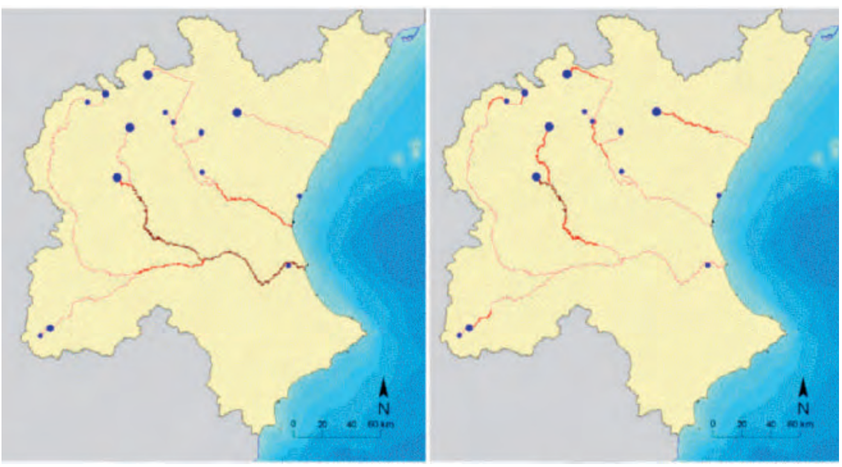
Industrial discharges are quantitatively smaller than urban discharges, but they are very important from the qualitative point of view, especially those discharges coming from IPPC activities (see figure 121). Similarly to the urban discharges analysis, the first step here was to develop an analysis of databases and the identification and location of the discharge points within the basin.

Once all the available information was analysed, it was found that in certain areas there was a great concentration of discharge points with a very small volume, being the sum of all of them quite significant (see figure 122). This fact meant that it was necessary to use all available data without previous filters, being very relevant to consider the type of industrial activity producing the discharge.

After determining the location and the characteristics of the most important pollution point sources, the next step is to obtain their effect on water bodies. Figure 123 shows, as an illustrative example, the location of fish farms jointly with the effect of their pollutant discharge, characterised by presenting high concentration of nutrients (phosphorous and nitrogen) and organic matter. By the use of the developed GIS tools, this effect has been accumulated on rivers. In addition, for reliability of the model, a decay law inherent to the biodegradation principle in the aquatic system should be considered. For its application and, as a first approach, the inverse exponential function ($C=C_0\, e^{-kx}$) has been chosen and applied to the variable that represents the distance from the discharge to the sea, affected by a constant factor *k*. Values of *k,* which mainly depend on biological processes and on the amount of flow, have been adjusted considering data from the monitoring network on surface water quality. Figure 123 shows the accumulated discharges in the left side and the pollution effect of the fish farm discharges in the right side, the reduction of the pollution effect with distance from the point of discharge can be observed.

Urban discharges were also accumulated with an exponential decay function, based in the biodegradation of organic compounds, as shown in figure 124.

Fish farm facilities and accumulated pollution on surface water bodies — Figure 123



Note: accumulated volume of fish farm (hm^3/year) in the left side, and pollution effect of fish farm discharges in the right side including the autodepuration process

Figure 124	Accumulated urban discharge on water surface bodies

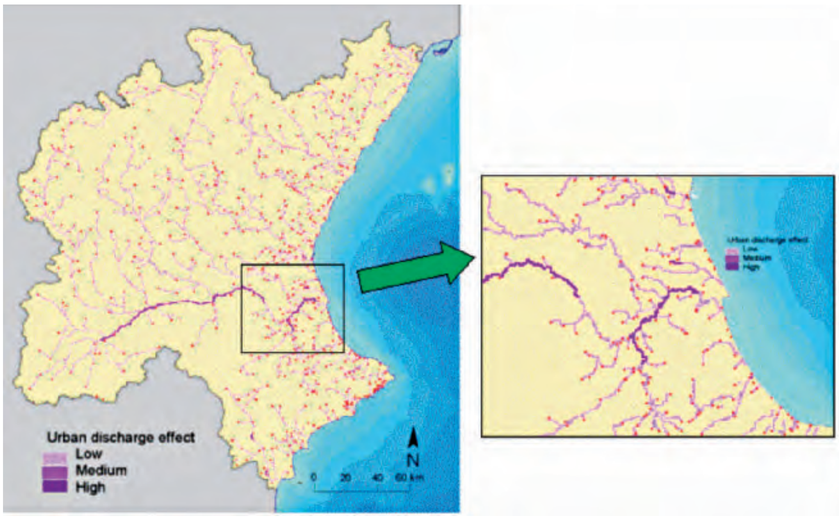
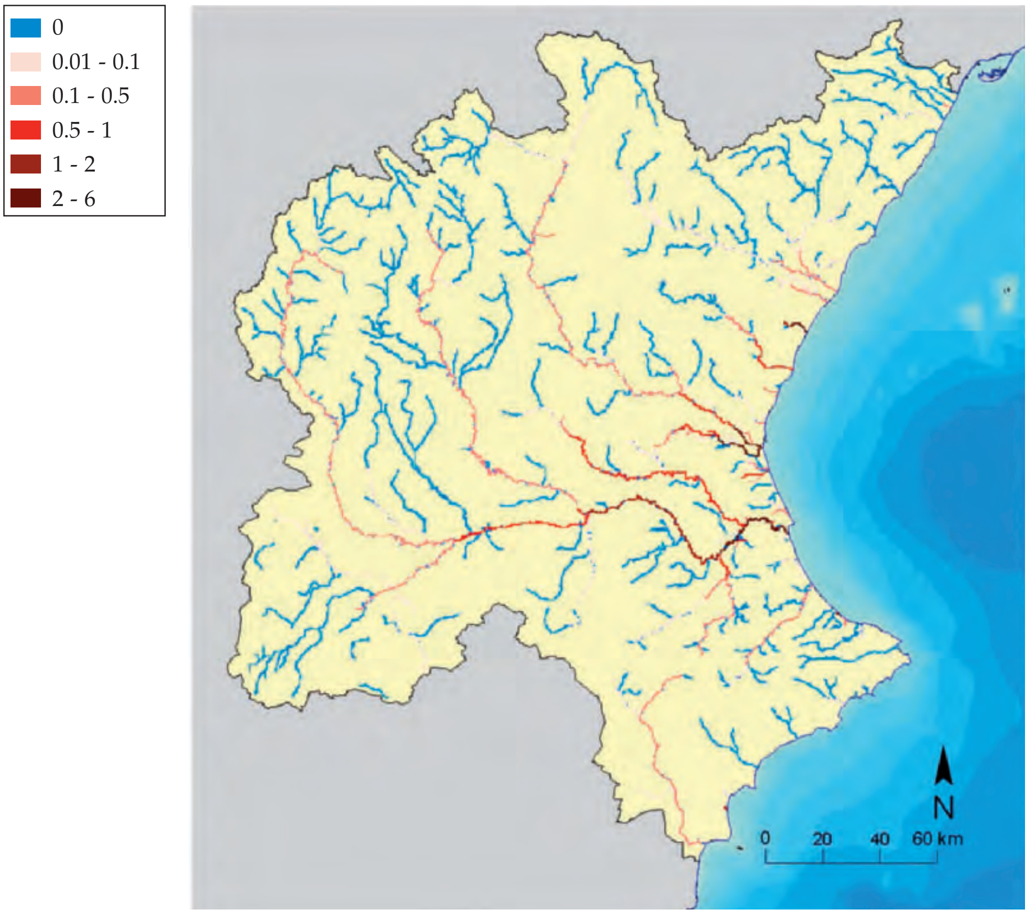


Figure 125	Accumulated industrial discharge pollution volume on water surface bodies (hm³/year)



The industrial discharges were accumulated on surface water bodies under the hypothesis that self-depuration is more difficult to occur, and therefore, in this preliminary analysis no decay function was used (figure 125).

4.1.6.3. Diffuse pollution

The most important source of diffuse pollution comes from agricultural practices in irrigated and non-irrigated areas (figure 126).

The diffuse nitrogen pollution caused by agricultural practices has been analysed within the Júcar RBD. This analysis was carried out by using a simplification of the methodology applied by the Ministry of Environment in a study that analysed nitrate contamination in all Spanish territory (MIMAM, 2001). Major agrarian nitrogen inputs and outputs have been quantified to obtain the nitrogen excess as the difference between both. The balance of nitrogen has been calculated for all the municipalities within the Júcar RBD using data from 2002.

Nitrogen inputs that have been considered are due to inorganic fertilisers, organic fertilisers from cattle rising (manure), grazing livestock excrements, irrigation water, spare organic fertilisers from cattle rising that are not used to fertilise the crops, seeds, biological fixation and atmospheric deposition. The processes that remove nitrogen from the soil are the uptake from crops, volatilisation and denitrification. Figure 127 illustrates the nitrogen cycle between soil, atmosphere and water environment focusing in agricultural practices.

Irrigated and non irrigated agricultural land | Figure 126

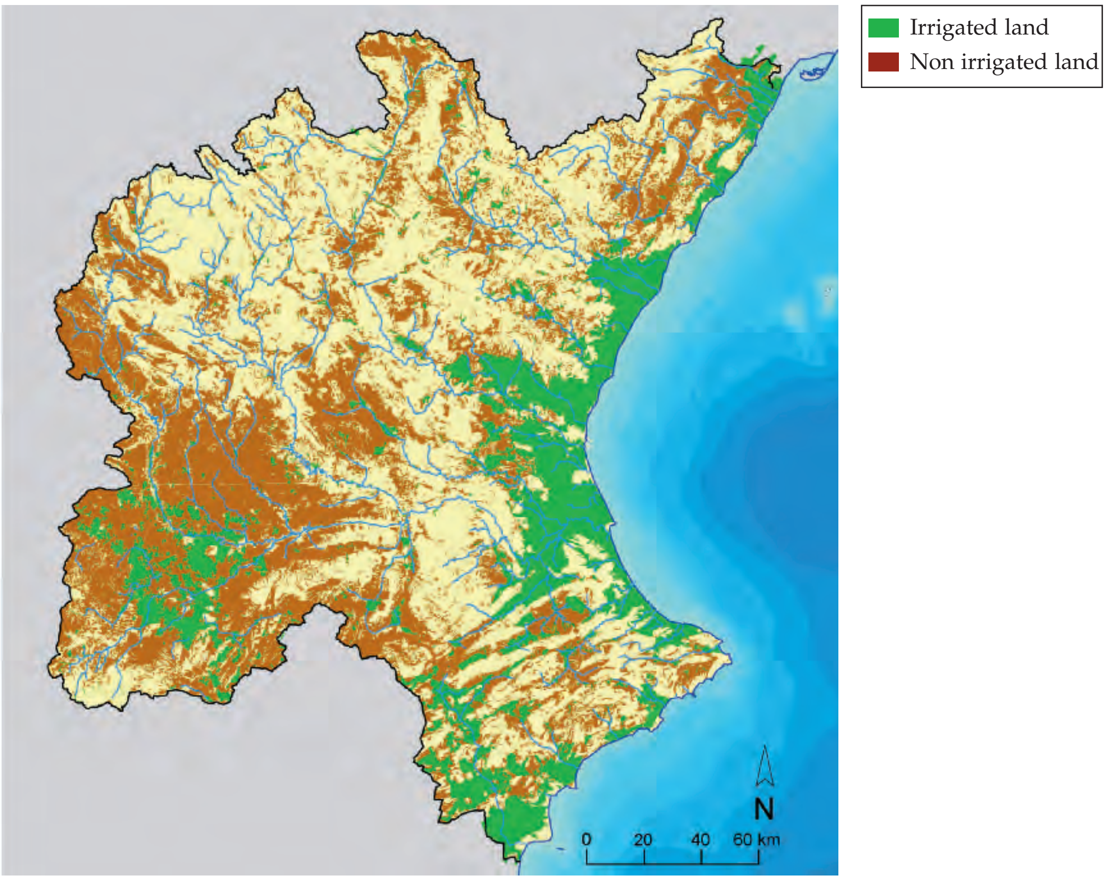


Figure 127 Simplified nitrogen cycle in agricultural soils

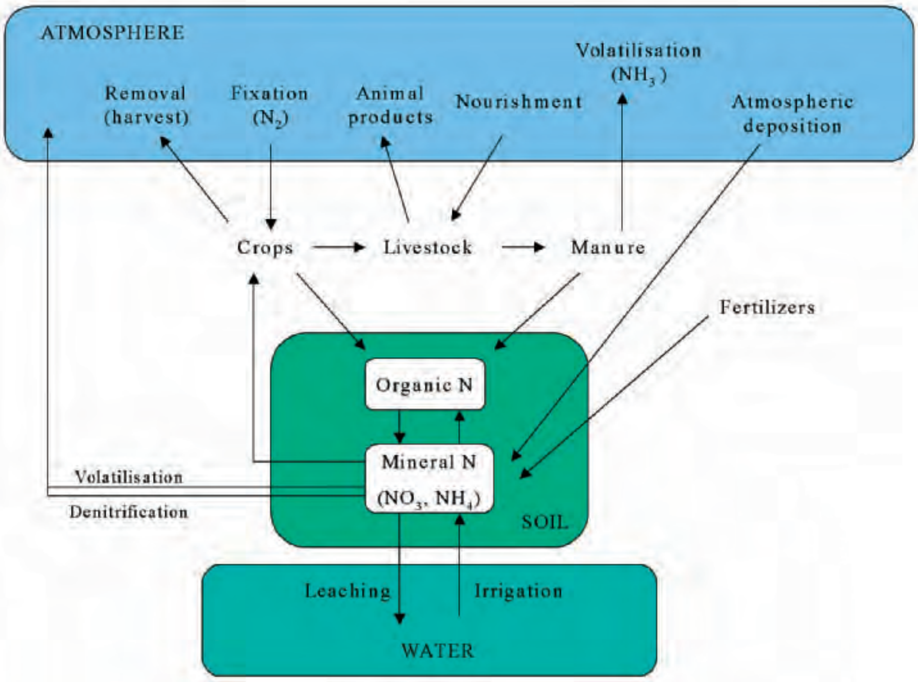


Table 32 Nitrogen inputs and outputs for year 2002 within the Júcar PRB

	N Kg	%
Inorganic fertilisers	97 180 238	58%
Organic fertilisers (manure)	11 655 094	7%
Spare organic fertilisers	3 409 833	2%
Grazing livestock excrements	15 285 855	9%
Irrigation water	16 535 012	10%
Seeds	1 704 916	1%
Biological fixation	6 819 666	4%
Atmospheric deposition	15 344 248	9%
TOTAL INPUTS	167 934 864	100%
Crop extraction	80 929 147	84%
Volatilisation	13 989 236	14%
Denitrification	1 715 019	2%
TOTAL OUTPUTS	96 633 482	100%
EXCESS	71 301 382	

Table 32 summarises the results of the balance for year 2002 within the Júcar RBD. The application of inorganic fertilisers is the most important input and, together with organic fertilisation, accounts for 65% of the total inputs.

Each element of the balance and the data used for its estimation are described in the following paragraphs.

To assess the amount of nitrogen provided by inorganic and organic fertilisers, the surface cultivated with each kind of crop is multiplied by the corresponding fertiliser dose. Those surfaces are found in the *1-T forms* provided by Municipalities. The amount of nitrogen applied to each crop has been extracted from the mentioned study of the Ministry of Environment.

The evaluation of the amount of nitrogen provided by irrigation waters has been carried out for each Agricultural Demand Unit (ADU) defined in the Júcar RBD, and the results have been extrapolated to the municipalities. The following data has been collected for every ADU: nitrate concentration in GW and superficial irrigation water from the superficial and GW monitoring networks, water consumption (gross demand), irrigated area and percentage of GW used within the ADU. The following formula has been used to calculate the amount of nitrogen provided by irrigation waters:

$$I = D*C*S*R/1\ 000$$

Where:

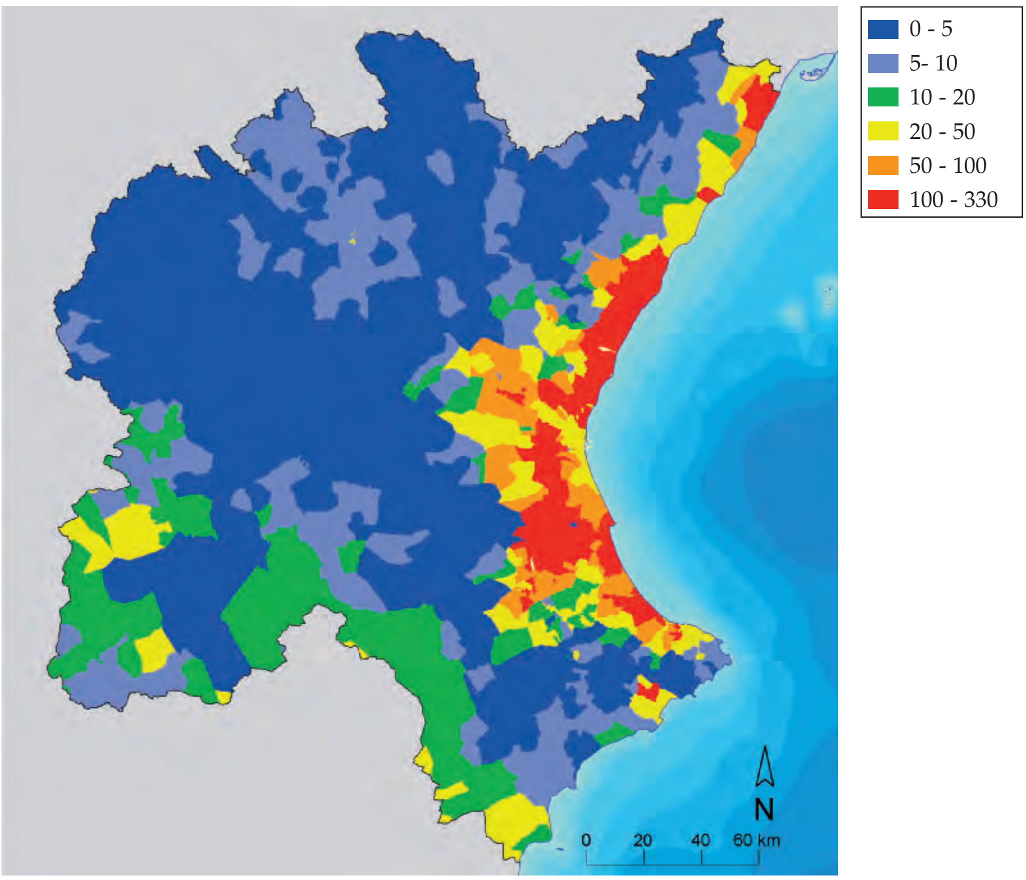
- I: Nitrogen input (kg)
- D: Water consumption (m^3/ha/year)
- C: Nitrate concentration in waters used for irrigation (mg/l)
- S: Irrigated area (ha)
- R: Percentage of N contained in Nitrate (22.6%)

As there is no livestock data easily available at municipal scale, the amount of nitrogen provided by grazing livestock excrements has been first evaluated at the province scale. The cattle census has been obtained from the Ministry of Environment, and the value of production of nitrogen by each type of animal has been extracted from a study of the Ministry of Environment for year 1996 (MIMAM, 2001). To calculate how much nitrogen is produced by grazing livestock, the number of animals is multiplied by the amount of nitrogen that each kind of animal produces in a year. To get the input at the municipal scale, the results obtained for every province are distributed to the municipalities according to the pasture surface within each municipality.

The other four inputs: spare organic fertilizers, seeds, biological fixation and atmospheric deposition, have not been directly quantified, but they have been estimated through the proportion between them, and the input by inorganic fertilisers estimated in MIMAM (2001).

Extraction by crops is of high importance, reaching up to 84% of the total extractions. To evaluate the amount of nitrogen extracted by the crops, the following data has been used: the cultivated surfaces from *1-T forms*, the crop yield, the extraction coefficient for each crop and the percentage of nitrogen extracted by the crop that will remain as waste after harvest. Cultivated surfaces are then multiplied by crop yields to obtain the production of each crop; productions are multiplied by the extraction coefficient to calculate the nitrogen that is extracted by crops. Finally, the amount of nitrogen that is left in the fields

Nitrogen excess in the Júcar RBD municipalities (kg of N per ha) Figure 128



after the harvest is calculated, and it is subtracted from the earlier estimated extraction, thus getting the amount of nitrogen that is actually removed through harvest.

Quantitatively the second most important process of extraction is volatilisation; this is the emission of gaseous ammonia from the soil to the atmosphere. It is calculated as a percentage of the inorganic fertilisation plus a percentage of the total amount of organic fertilisation, which is the sum of organic fertilisers from cattle rising, the grazing livestock excrements and the organic fertilisers from cattle rising that are not used to fertilise crops.

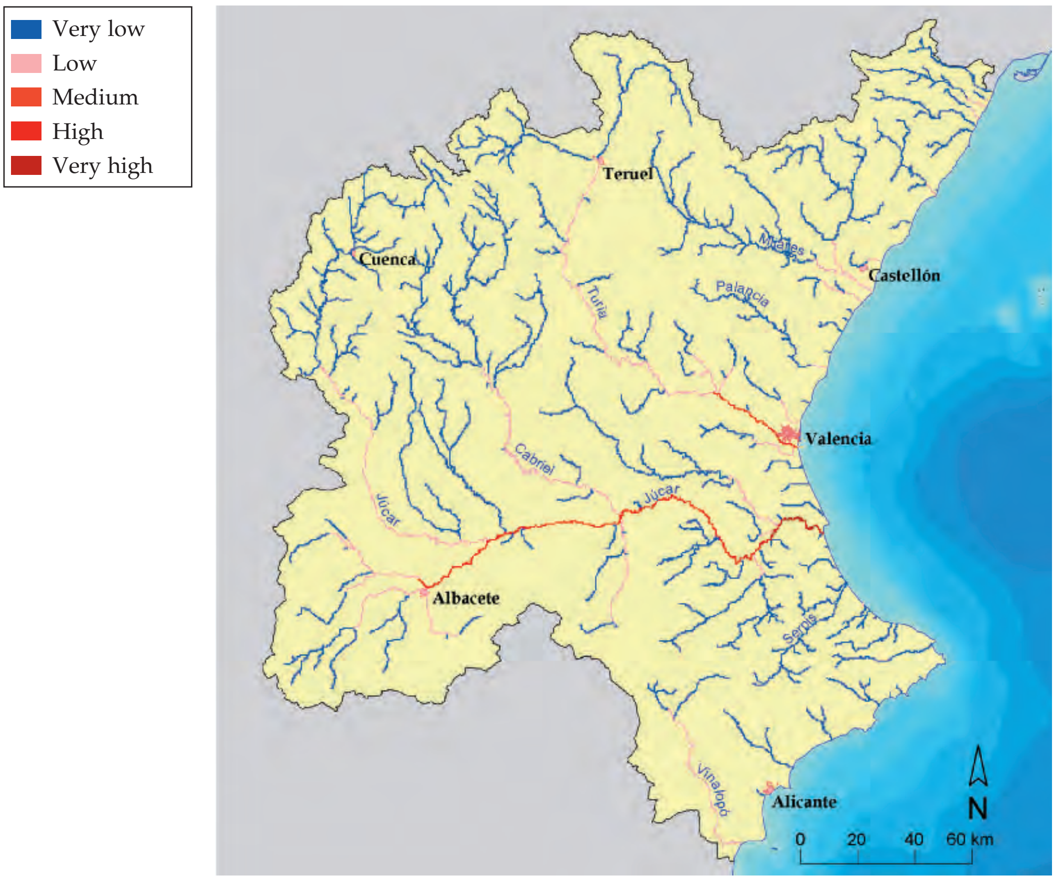
Denitrification is produced by soil microorganisms that convert nitrate to gaseous nitrogen (N_2). It is considered 1.25% of the total amount of nitrogen incorporated into the soil; this is the sum of a percentage of inorganic and organic fertilisation inputs, the biological fixation, and the nitrogen contained in the waste from crops that remains after harvest.

The excess of nitrogen has been calculated as the difference between total inputs and total outputs within each municipality, this has been divided by the municipality surface to obtain the kg of N per ha, as shown in figure 128.

In the inland areas the excess of this element is generally low, except for the province of Albacete and part of Alicante, while in the coastal areas, the excess values are very high, reaching in some cases more than 300 kg of N per ha. These areas with high nitrogen excess coincide with the vulnerable areas designated by Spain (figure 89) following the provisions of Directive 91/676/EEC.

The highest inputs of nitrogen are due to the application of inorganic fertilisers in irrigated areas, and this is precisely the agrarian activity that can most easily produce water contamination, mostly in aquifers. The second most important input is due to irrigation waters, which produce high impacts to the same areas as the fertilisation of crops. Due to these two inputs, the coastal area and the irrigated areas of the province of Albacete suffer great pressure; in fact, they present several points in which registered nitrate concentration in groundwater is higher than 50 ppm, and in some cases above 200 ppm.

Figure 129 **Pressure in rivers from nitrogen diffuse pollution from agrarian sources**



A preliminary map of the pressure on surface water bodies due to the excess of nitrogen is shown in figure 129.

The map of the excess of nitrogen is a good approximation to know how diffuse pollution affects water bodies. Nevertheless, not the total excess of nitrogen reaches surface water bodies quickly. Some important amounts of nitrates are deposited in the non-saturated soil and in the aquifers. Therefore, it is necessary to model the transport of nitrogen in the water cycle, including the lixiviate of the cultivated land to the aquifer, and the returns of the excess of irrigation with high concentrations of nitrates to water bodies. For this reason, in the pressure and impact analysis the indicator used to assess the diffuse pollution caused by agricultural activities has been only the irrigation returns to water bodies, obtained from the water surplus at any irrigation area, because these returns are a sure pressure, as it is shown in the figure 130.

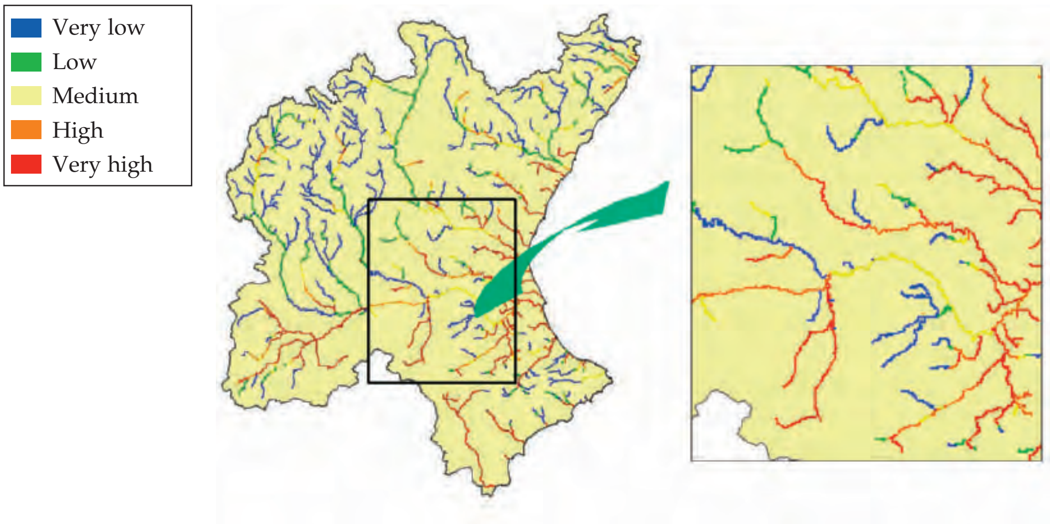
4.1.6.4. Pressure indicator from point source and diffuse pollution

A pressure indicator has been obtained from the different sources of point and diffuse pollution, using adequate weights to each type. This indicator reflects the quantity of pollution load over the actual surface water body flow. This flow is obtained from the natural flow, by removing abstractions due to urban, industrial and agricultural demands. This general pressure indicator is shown in figure 131, classified in five categories, from very low pressure to very high.

Irrigation return flows from agricultural activity — Figure 130

Note: a zoom of the last reach of the Júcar River is shown on the right

Figure 131 **Global pressure indicator on surface water bodies**



4.2. Impact on surface water bodies

4.2.1. *Assessment of impact*

A preliminary water pollution impact assessment has been carried out following the provisions of the *Manual for the impact and pressure concerning surface water pollution*, similarly to how the pressure analysis was developed. The impacts related to hydromorphological and quantitative pressures are currently being under study.

An impact analysis should compare the water body status with the environmental objectives determined by the WFD. At this point, the use of records from the monitoring surface water networks database is essential, and it can be supplemented with studies documenting a particular impact on the water status, as for example the disappearance of specific species from a water body or algae bloom phenomena. As a result of this assessment every water body must be grouped as it follows:

- Water bodies subject to *sure impact*.
- Water bodies subject to *probable impact*.
- Water bodies subject to *no impact*.
- Water bodies lacking data on status.

The proposed approach in the technical manual classifies the impact as "sure" or "probable", and develops a methodology for its implementation which makes full use of surface water monitoring networks currently available within the basin (quality and biological).

As a general criterion, it is established that a *sure impact* takes place when an effect, as a result of a pressure, is in breach of the legislation in force. A *probable impact* occurs when quality standards and environmental objectives defined by the WFD or future environment legislation are not being met. To determine whether an effect is a *sure impact* is much more straightforward than to determine if it is a *probable* one. Direct application of the current legislation and subsequent regulations is all that is needed to determine a *sure impact*. Since the WFD is now being legislative developed and implemented, it is necessary to make interpretations of its text, and to adopt some assumptions at this level of its implementation. To detect a *probable impact* some parts of the WFD must be carefully studied, such as terms of reference, or environmental objectives for water bodies.

As it has already been described, water bodies subject to *sure impact* are those surface water bodies that are in breach of the national current legislation on water quality, and thus there is a risk of failing to achieve the environmental objectives by 2015. Since water status is determined by the poorest of its ecological and chemical status, for reaching a good water status both its ecological and chemical status must be at least *good*. Given the fact that the existing legislation in force only covers physico-chemical parameters, this type of impact assessment will only be based on the chemical status, or in other words, the ecological status is not taken into account at this stage. For the development of this criterion, it must be checked if substances are in higher concentration than the ones fixed by the water quality standards in the national or European legislation:

- Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in Member States
- Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community
- Council directive 76/160/EEC of 8 December 1975 concerning the Quality of Bathing Water
- Council Directive 78/659/EEC of 18 July 1978 on the quality of fresh waters needing protection or improvement in order to support fish life
- Council directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment
- Council directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources

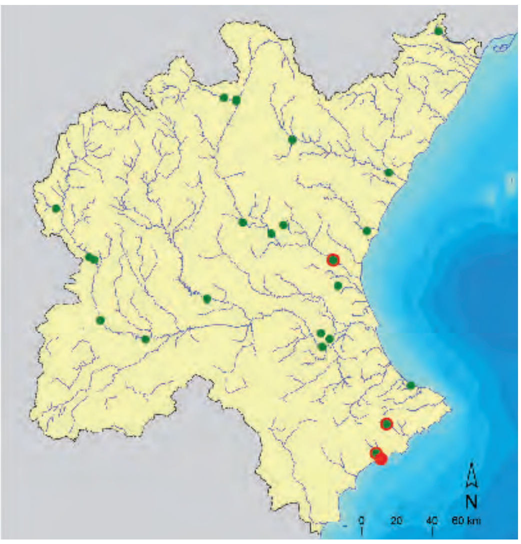
Water bodies subject to *probable impact* are those that most likely will not achieve the environmental objectives set by the WFD, or its status will be poorer than *good* by 2015. In this case, although current environmental and water legislations are met for the water body, some of the following circumstances occur: biological indices showing quality status poorer than *good*, irregularities in the functioning of aquatic ecosystem, deficiency for dissolved oxygen, salinisation, eutrophication or occurrence of substances included in annex VIII of the WFD.

Finally, water bodies subject to *no impact* are those without significant damage, that is, they present high quality standards.

Some of the results of the analysis carried out to determine if a *sure impact* is produced are shown in figures 132 and 133. Left map of figure 132 shows stations determining water bodies in breach of legislations regarding water intended for the abstraction of drinking water. Map on the right of the figure shows those waters in breach of rules regarding fish life standards. Very few *sure impacts* are actually produced, and they are mainly located in the southern part of the Júcar RBD.

The results of the analysis represented in figure 133 correspond with the study of substances from List I and List II of the Spanish Royal Decree 995/2000. Control points where a positive detection of substances enclosed in List I occurred are shown on the left part of the figure, while the right figure represents those included in list II. Similarly to the previous impact analysis, it is observed that very few sure impacts occur.

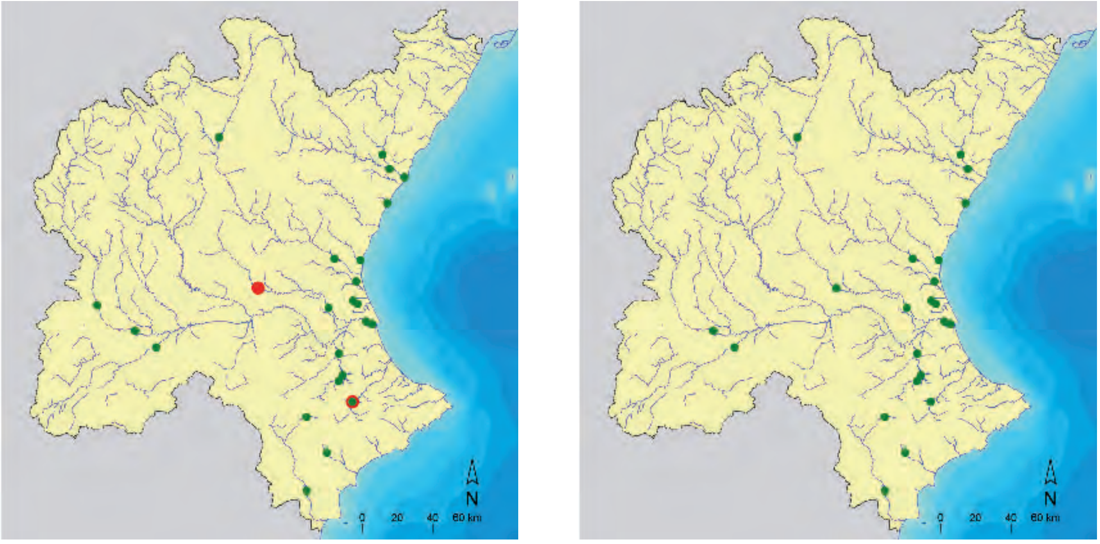
Monitoring stations showing sure impact. Water intended for human consumption (left) and support fish life standards (right) — Figure 132



- Not in breach
- In breach

Figure 133 **Monitoring stations showing sure impact locations. Substances enclosed in list I (left) and list II (right)**

- Not in breach
- In breach

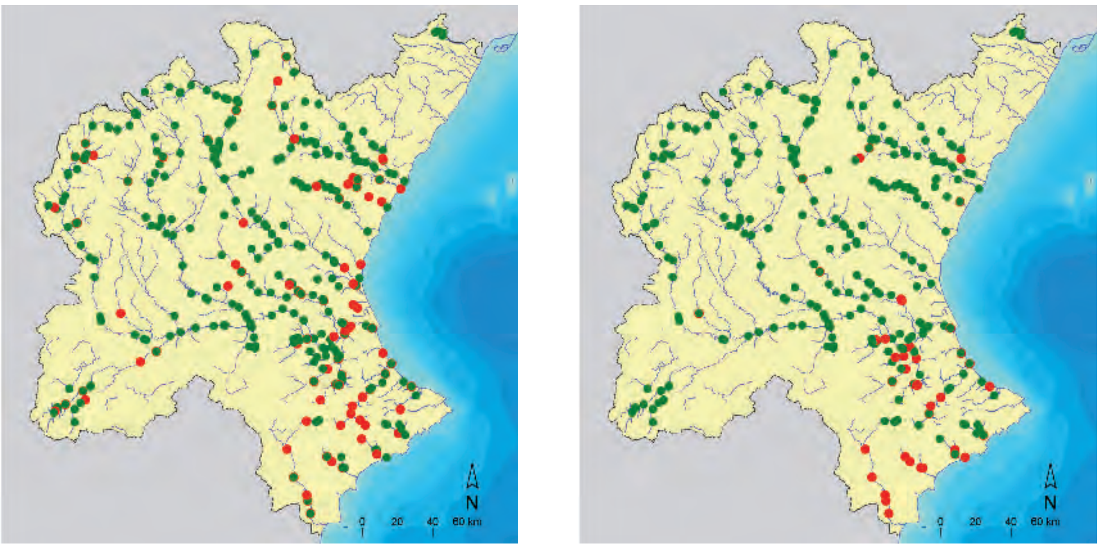


The *probable impact* of water bodies has been determined with data corresponding to chemical and biological status, and the criterion used is based in the specifications set by the WFD. Annex V of the WFD indicates the quality elements for the classification of ecological status for water bodies, indicating that it is necessary to consider the chemical, the biological, and the hydromorphological status to define the ecological status. The chemical and biological status are analysed in this report, keeping the hydromorphological analysis for future works.

In order to analyse the chemical status of water bodies, data from different quality networks have been used. Most important parameters related to the suitability of the water for fish life and for others uses have been specifically analysed to determine a preliminary status. Two chemical indices are shown in figure 134, the dissolved oxygen index for supporting cyprinid fish life on the left map, and the chlorine index on the right one. The limits used to define the *good status* (green colour in figure) are those defined in the cyprinid criterion (100% of data greater than 4 mgO_2/l and 50% of data greater than 7 mgO_2/l) and in the USA Environmental Protection Agency for chlorine criterion (mean value lower than 230 mg/l, and maximum value lower than 860 mg/l).

Figure 134 **Chemical indices. Dissolved oxygen index for supporting cyprinid fish life (left) and the chlorine index (right)**

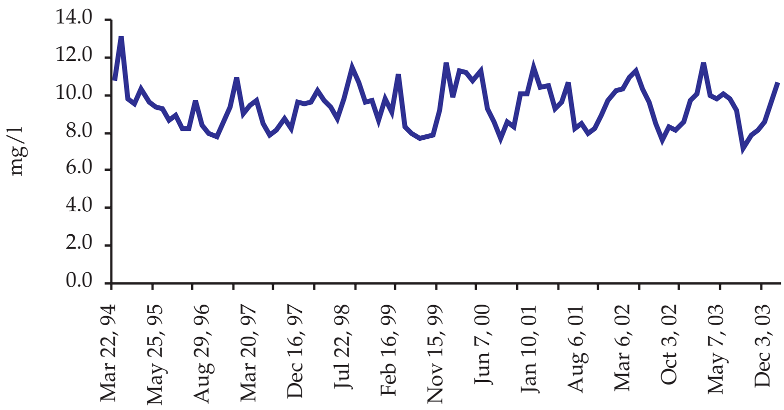
- Not in breach
- In breach



The evolution of dissolved oxygen in one of the monitoring stations ("Los Frailes" in the Júcar River) is shown in figure 135.

In addition, the behaviour of other chemical indices has been studied. On the left map of figure 136 the phosphorous index is shown, which is highly related to the pressure produced by urban discharges. High levels of this index correspond to values greater than 0.15 mg/l, and are represented with red colour in the figure. The eutrophisation index at reservoirs is shown on the right side of the same figure. Eutrophisation index of dams was valuated with the Classification of the level of Eutrophia of lakes and dams (OCDE, 1982). High levels of this index are supposed when the mean value is greater than 8 mg/m^3 or the maximum value greater than 25 mg/m^3 and are represented in red colour in the figure 136 on the right.

Oxygen dissolved in "Los Frailes" control station in the Júcar River — Figure 135



Different types of indices are used in the Júcar RBD to determine the biological status of surface water bodies: macroinvertebrate index with the Iberian Biological Monitoring Working Party (IBMWP) that has been adapted in Spain from the BMWP, the diatom index, the ecotrophic index and finally, the macrophyte index. In figure 137, the results of applying these indices are shown, demonstrating that all indices applied produce, in general terms, similar results though some specific differences, currently under study, are found.

Chemical indices. Phosphorous index (on the left) and eutrophication index (on the right) — Figure 136

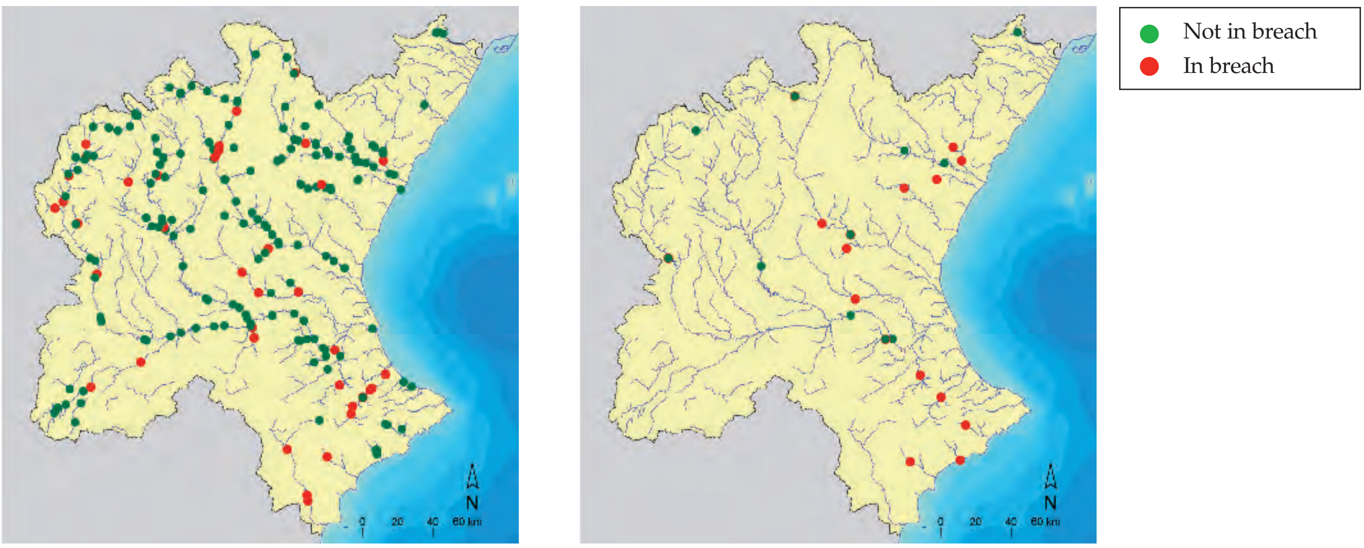
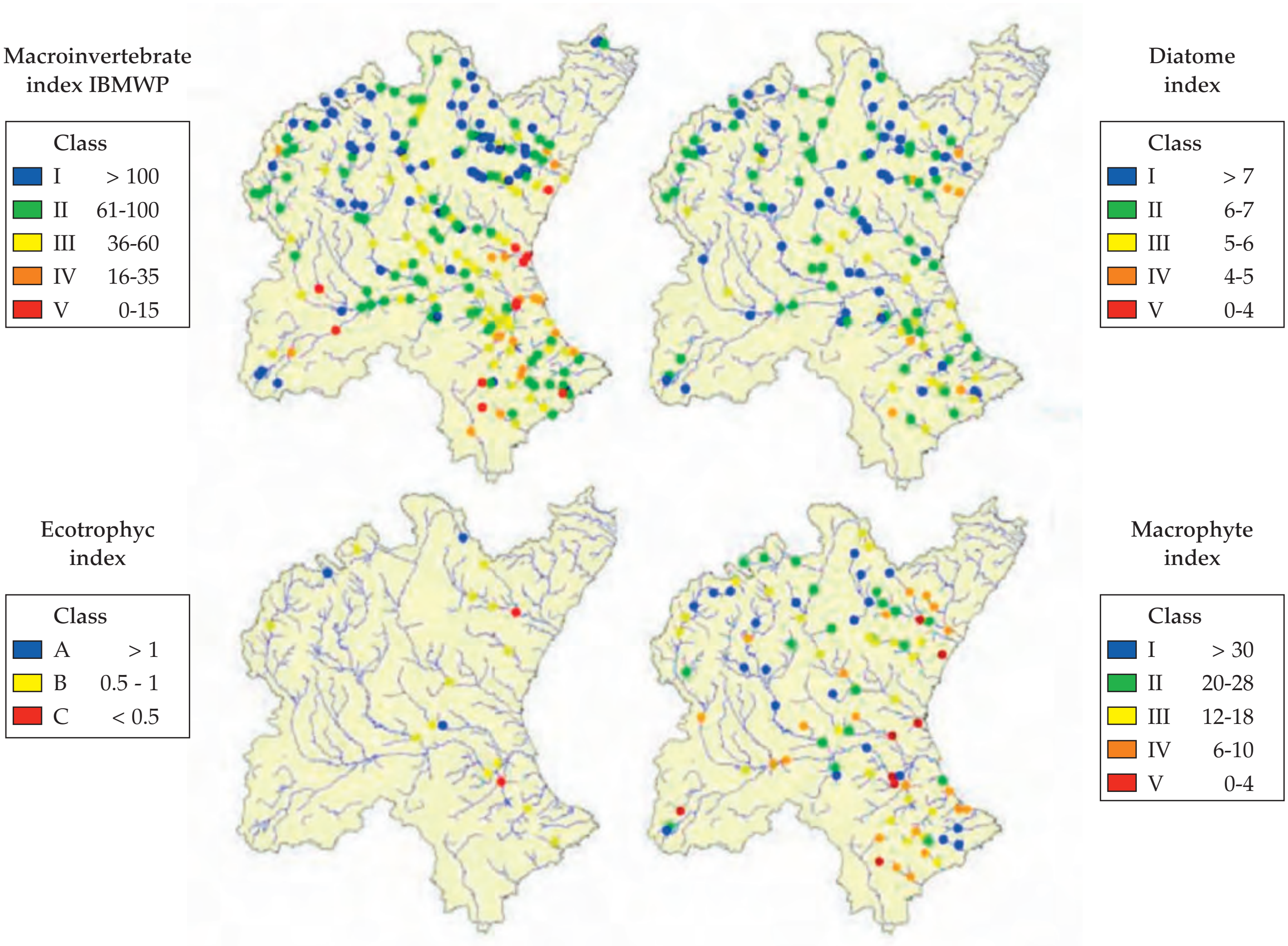
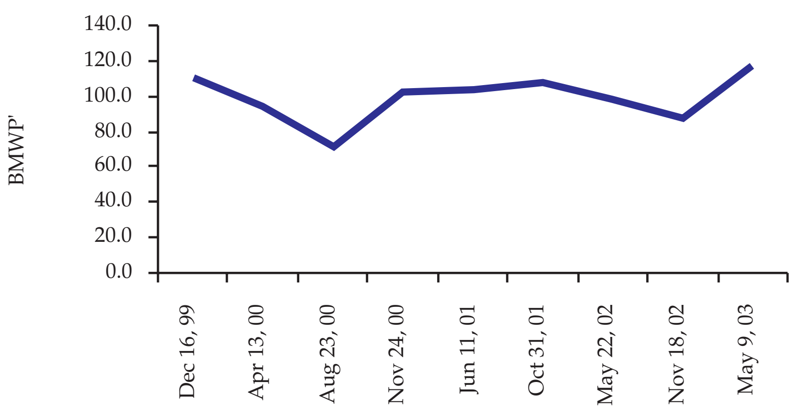


Figure 137	Biological indices



The evolution of the Biological IBMWP index in the “Los Frailes” monitoring station is shown in figure 138.

Figure 138	Biological IBMWP index in “Los Frailes” control station at the Júcar River



The previously described indices could be combined in order to determine the biological status of surface water bodies. The comparison between the values of the IBMWP index and the values of the combination of the poorest status for the 4 defined biological indices is shown in figure 139. From the analysis of this figure, it is derived that the combination procedure using the poorest status of each biological index gives place to a lower biological status. This occurs especially in the mountainous reaches of the north-western area where “good status” is obtained instead of a “very good” one, and in the southern part of the Júcar RBD area, where one lowest class of the biological status is obtained.

IBMWP index (left) and combination of 4 biological indices (right) — Figure 139

- 0 - 15
- 15 - 35
- 35 - 60
- 60 - 100
- > 100

- Very high
- High
- Medium
- Low
- Very low

New analyses are being carried out to improve the estimation combining quality elements and indicators in different ways such as it is shown in the figure 140.

The next step consisted on combining the chemical status with the biological status, which has been done for each defined stretch of the Júcar RBD surface water bodies. Because of this combination, the impact due to pollution in surface water bodies is shown in figure 141.

Combination of indicators defined in the WFD — Figure 140

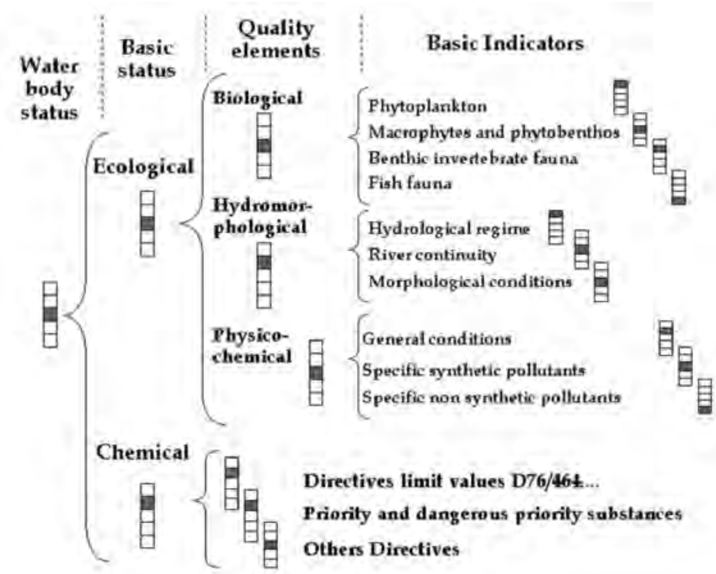
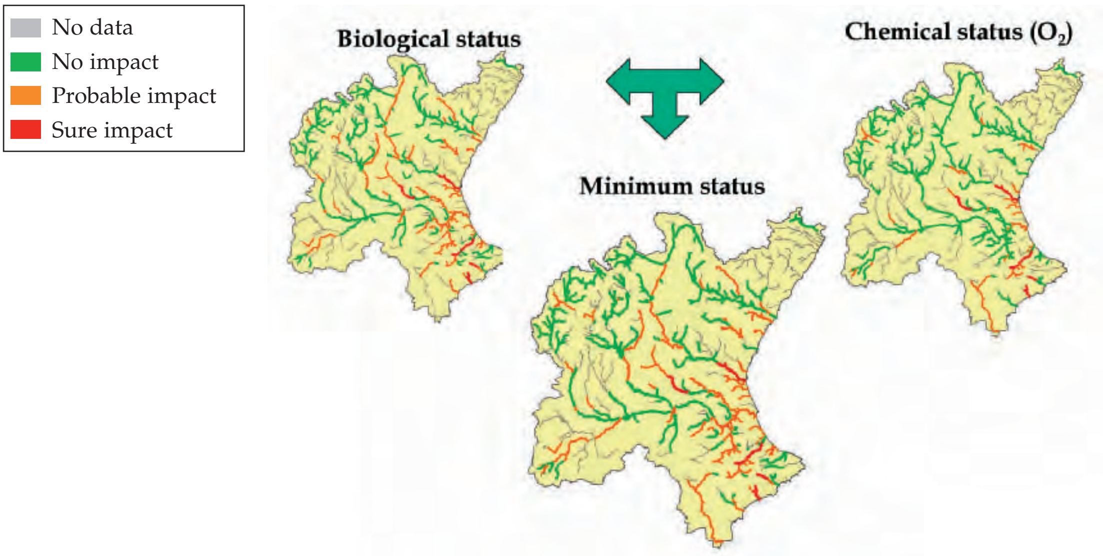


Figure 141	Biological (left) and chemical (right) impacts



The recent GD of the REFCON Working Group "*River and lakes – Typology, reference conditions and classification systems*" (EC, 2003f) establishes in section "*2.6 Classification of ecological status*", that the biological conditions as well as the supporting hydromorphological and the physico-chemical quality elements are to be mainly used by MS in the assessment of ecological status.

To classify ecological status, the Directive stipulates that the lowest values for the biological and physico-chemical monitoring results for relevant quality elements should be used.

Specific hydromorphological quality elements are required for determining high status. For other status classes, the hydromorphological elements are required to have "conditions consistent with the achievement of the values specified for the biological quality elements."

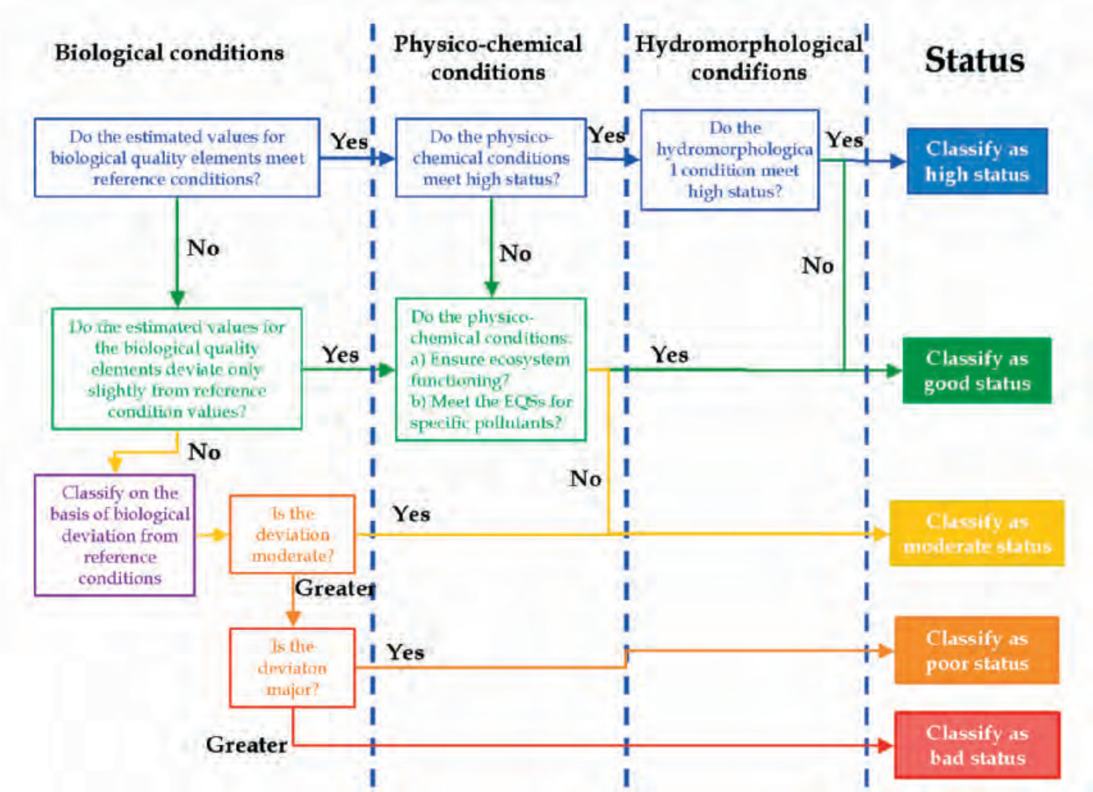
Similarly, specific physico-chemical quality elements are required for the determination of high and good status. For other status classes, the physico-chemical elements are required to have "conditions consistent with the achievement of the values specified for the biological quality elements". These relative roles of biological, hydromorphological and physico-chemical quality elements in status classification are presented in Figure 142.

There is a clear distinction between the role of general physico-chemical quality elements and specific pollutants in classification of ecological status. In good ecological status, general physico-chemical quality elements should not reach levels outside the range established. This should be done to ensure ecosystem functioning and the achievement of values specified for biological quality elements ((a) in the middle box of figure 142) and specific pollutants should meet the Environmental Quality Standards (EQS) set in accordance ((b) in the middle box of figure 142)).

In this analysis, to determinate the ecological status of water bodies, it has been considered, as a preliminary approach, the minimum status between the biological and chemical status.

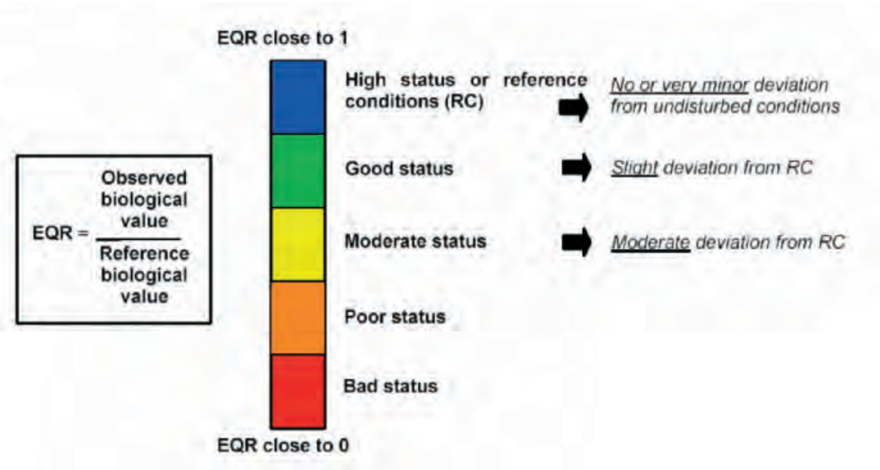
Once the EQS are defined for all the ecotypes, the classification of ecological status will be based on ecological quality ratios, which are derived from the ratio between EQS defined for each ecotype and biological quality values obtained for each river reach that belongs to any ecotype, as illustrated in figure 143.

Methodology to establish the ecological status | Figure 142



Note: Adapted from REFCON, EC, 2003f

Basic principles for classification of ecological status based on Ecological Quality Ratios | Figure 143



Note: Taken from REFCON, EC, 2003f

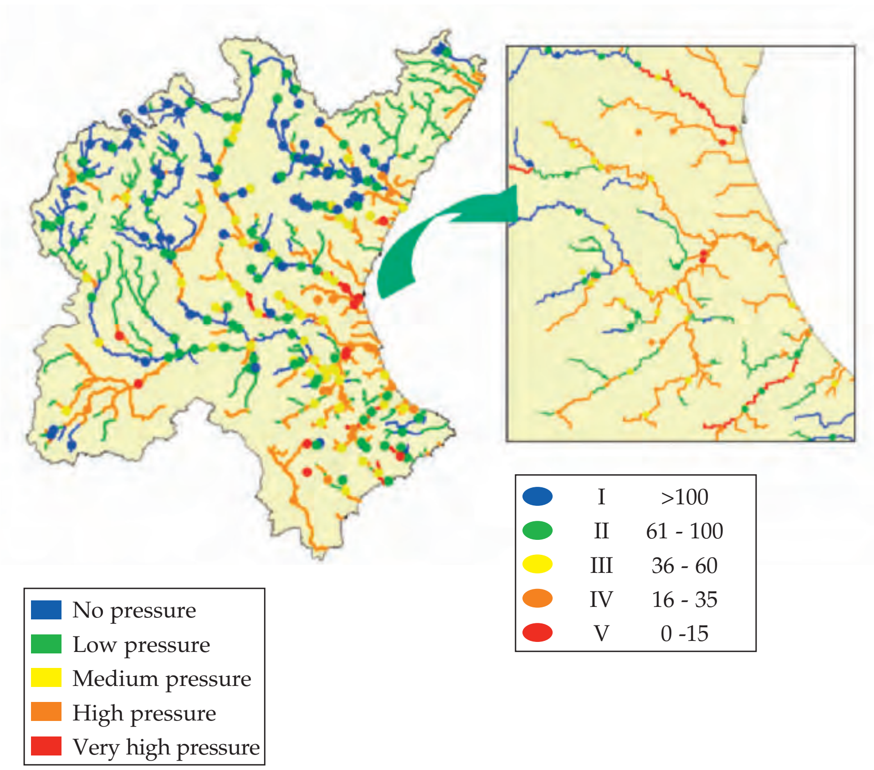
4.2.2. *Water bodies at risk of not achieving a good status*

There is a very high correlation between the results obtained for the significant pressures and impacts and the IBMWP index (see figure 144).

Combining the results obtained for significant pressures and impacts in every water body it is possible to come up with the risk assessment of failing to reach the environmental objectives. A classification has been done with the following classes: water bodies with high risk, medium risk and low risk. The criteria defined in MIMAM (2003) have been applied to obtain the risk of water bodies and these are indicated in table 33.

After applying classes of table 33, the preliminary results of water bodies at risk of not reaching a *good status* are shown in figure 145.

Figure 144 — Pressures (reaches) and impacts (points) using IBMWP



Criterion for risk assessment on surface water bodies	Table 33

RISK ASSESSMENT	WATER BODY
HIGH	Significant Pressure + Sure Impact
	NO Significant Pressure + Sure Impact
MEDIUM	Significant Pressure + Probable Impact
	NO Significant Pressure + Probable Impact
	Significant Pressure + NO DATA on status
LOW	NO Significant Pressure + NO DATA on status
	NO Significant Pressure + NO impact
	Significant Pressure + NO impact

Combination of pressures and impact to obtain a preliminary risk of not achieving good status — Figure 145

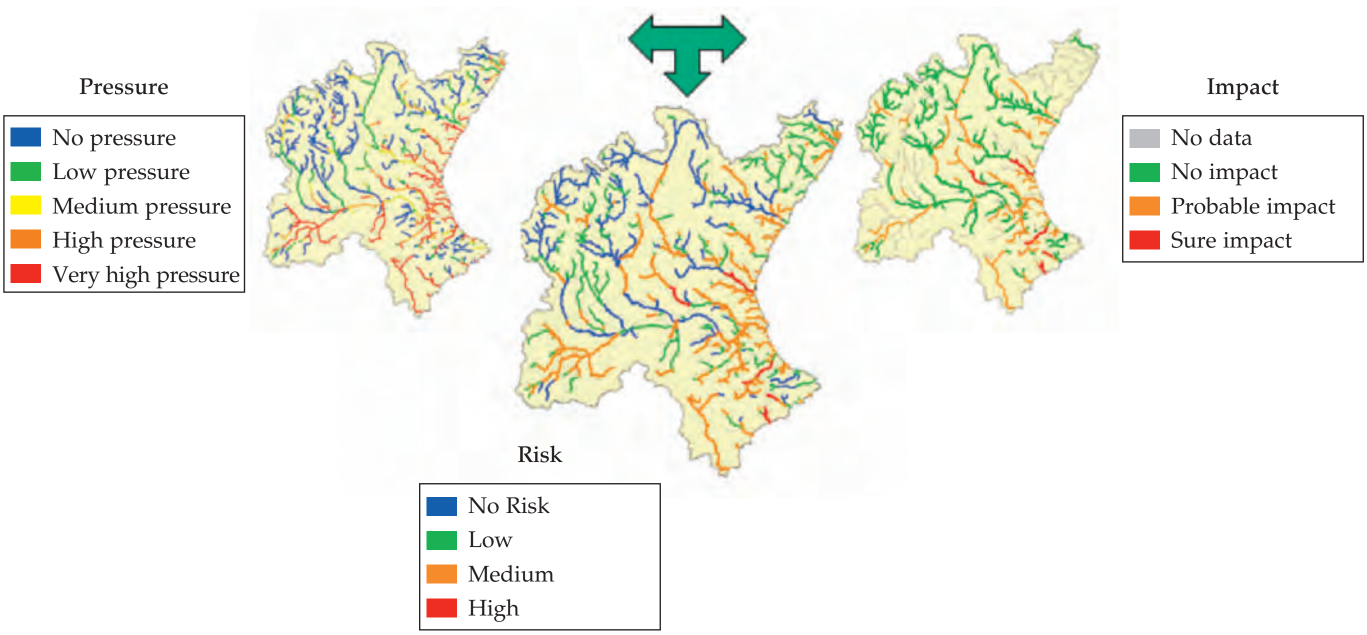
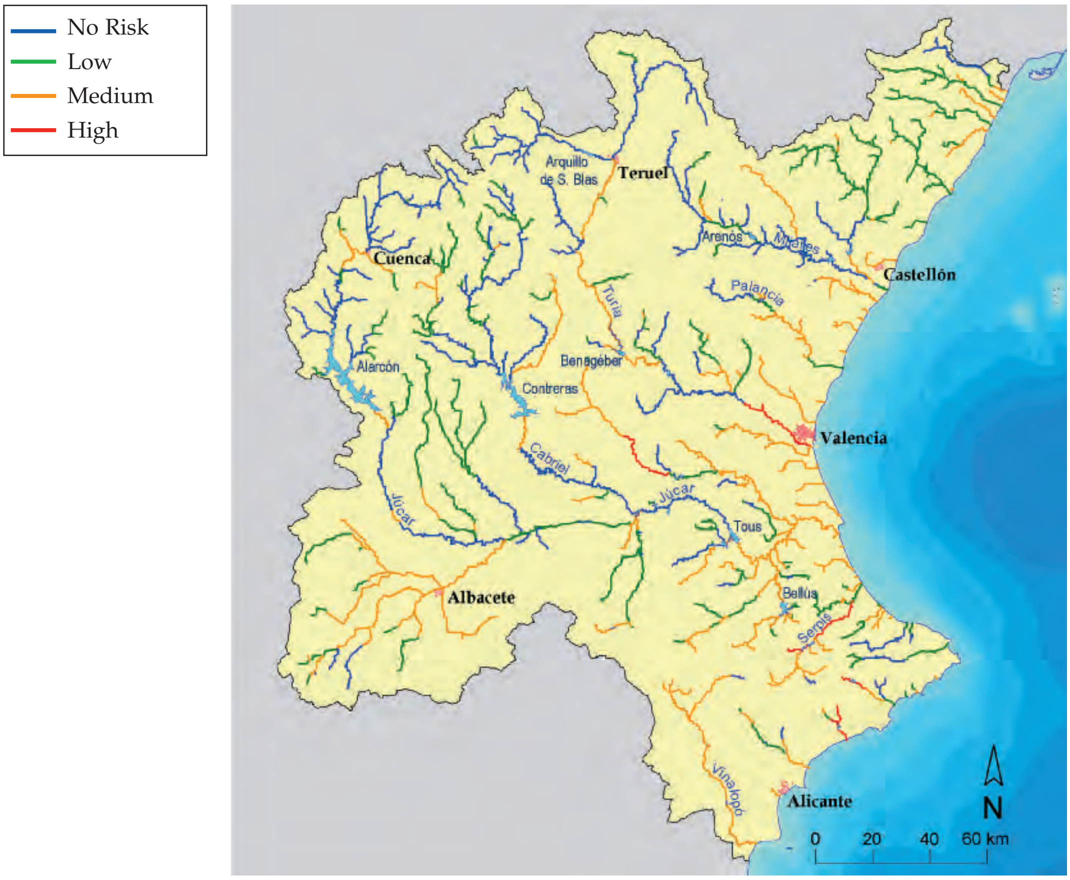


Figure 146	Preliminary surface water bodies at risk of not reaching good status



As it is derived from figure 146, a few reaches are in high risk of not reaching a *good status*, being located on the Turia, the Magro and the Serpis Rivers. The reaches with no risk or low risk correspond to the upper reaches of surface water bodies, where there are lower pressures. These preliminary results are being studied.

Figure 146 shows superficial water bodies at risk of not reaching good status. Next, the most significant river reaches at risk within the District are described.

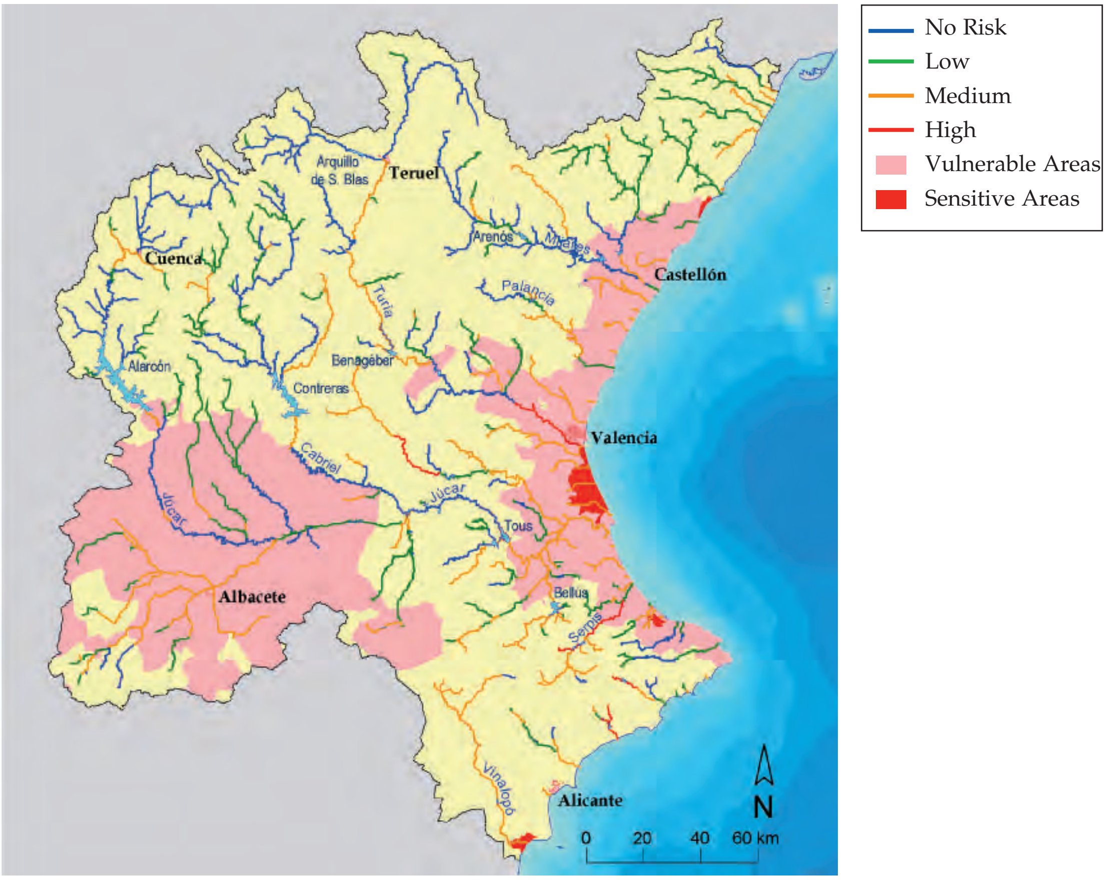
The last reach of the Turia River in the metropolitan area of Valencia is characterised by the existence of important industrial and urban areas and traditional irrigated land, which, in one hand, produces a reduction of river flows and, in the other hand, increases emission of pollutants, as organic matter, fertilisers and other compounds.

The flows of middle reaches of the Magro River are low, so discharges from Requena and Buñol urban and industrial areas produce a significant degradation of the biological and physico-chemical conditions of these river reaches. The II Treatment Plan of the Valencian Region has projected to improve wastewater treatment systems as well as reduce nutrients of these areas, which will probable lead to a better status of waters.

The Serpis River reach at risk of failing to achieve the environmental objectives is characterised by the existence of important industrial areas all along the river. There are many towns, Alcoy, Muro de Alcoy and other urban areas in the upper reaches of the river, and Lorcha, Ayelo and Vilallonga in the middle reaches, all of which are important sources of industrial contamination. The Beniarrés reservoir improves the biological and physico-chemical quality; downstream, status deteriorates again because of the previous mentioned industrial areas of the middle reaches.

Preliminary surface water bodies at risk considering vulnerable and sensitive areas as zones with sure impact

Figure 147

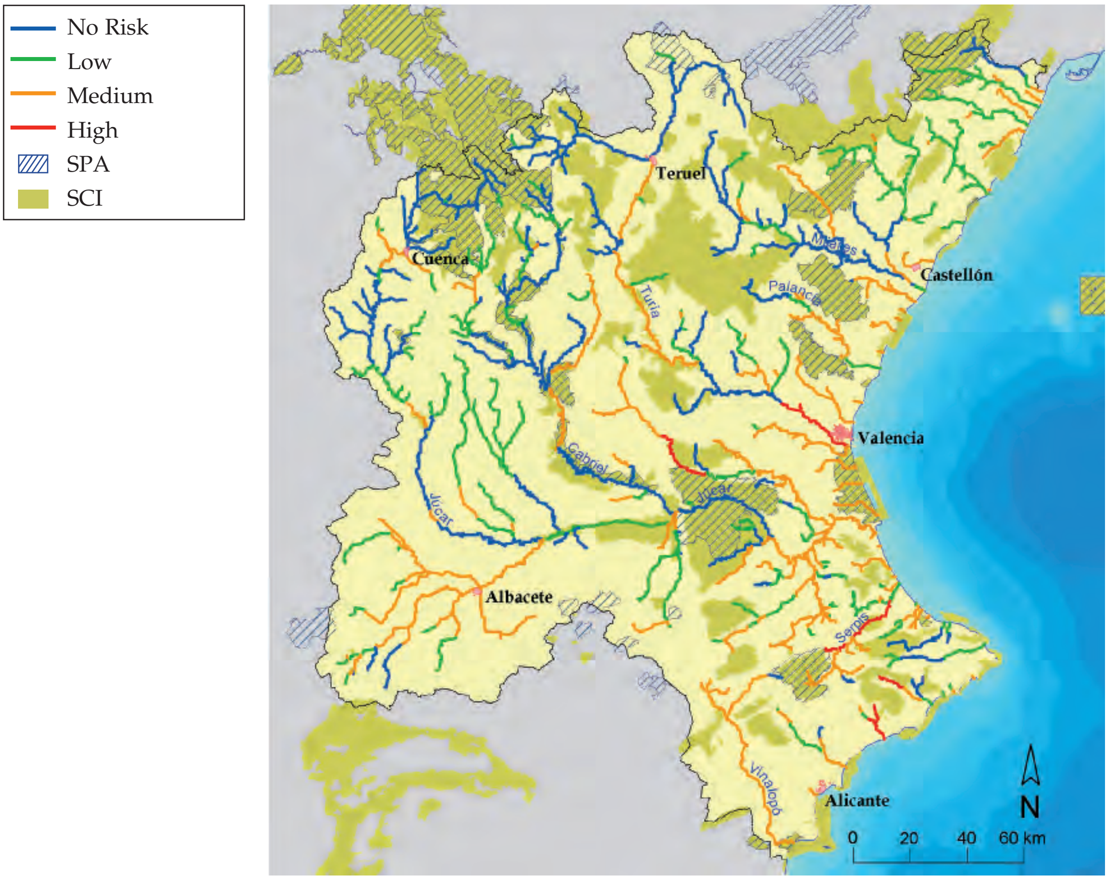


According to the already mentioned *Manual for the impact and pressure concerning surface water pollution* a "sure impact" is considered to occur in those Vulnerable zones which were designated by Spain following the provisions of Directive 91/676/EEC, and in the sensitive areas, as referred to the provisions of Directive 1991/271/EEC. This consideration would produce a significant change in the designation of the reaches at the risk of failing to reach the environmental objectives. Some lakes and dams and many reaches near the coast change their category to water bodies at risk of failing to reach the environmental objectives (see figure 147).

This situation reflects the problems due to nitrate in coastal aquifers, but it is excessively pessimistic because an important part of the river flows come from the surface flow of mountainous areas, and not from the aquifer discharges. This criterion could be reconsidered in the Manual.

As it is shown in figure 148, as a general rule rivers going through Natura 2000 sites have none or low risk of failing to achieve the environmental objectives. However, in the middle and specially in the low areas, some reaches of rivers with mean and high risk are part of Natura 2000 sites.

Figure 148 — **Preliminary surface water bodies at risk and Natura 2000 sites**



4.2.3. *Detailed analysis for water bodies at risk of not achieving a good status*

Following the general analysis previously described, more detailed analysis are being carried out using water quality simulation models in certain reaches of the Júcar RBA. The Júcar RBA, in collaboration with the Hydraulic Engineering and Environment Department of the Polytechnic University of Valencia, is using detailed simulation models of organic matter decay, nitrogen cycle, conservative pollutants transport, etc. These models are included within the traditional management simulation models presently used in the Júcar RBD, which in turn, rely on the source point and diffuse pollution results obtained in the section on pressures.

One study case, in which chemical conditions have been analysed in detail, is the final reach of the Júcar River. This reach is characterised by having important agricultural surfaces of traditional irrigation, which go from the Tous reservoir to the river mouth. From the water management point of view it is a very complex area, due to the importance of agriculture, the presence of weirs, and the existing connection between the river and the aquifer, in addition to the high environmental value of the reach, belonging to the proposed Natura 2000 Network (see figure 149).

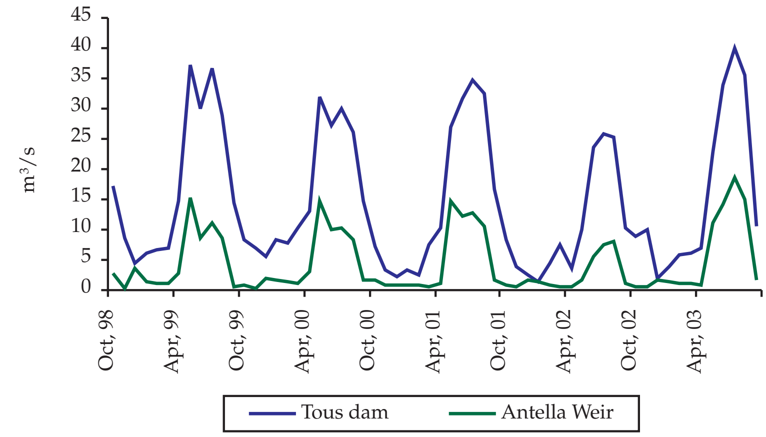
Scheme of the final reach of the Júcar River | Figure 149

This river reach suffers local problems due to low flows and deficient physico-chemical conditions. Concerning flows, in most part of this reach they are high, and only in two small river reaches they are very low: first in the reach downstream the Antella weir in winter months (figure 150), and second in the reach between the Sueca weir and the Marquesa weir in summer months (figure 151).

Flows fluctuation shown in figures 150 and 151 greatly influences physico-chemical water conditions, especially if the effect of human activities, existing agricultural surfaces, and urban areas close to the river are considered. In this sense, diffuse nitrogen pollution from fertilisers and wastewater discharges stand out. Most of the towns within the area have wastewater treatment plants. However, two important ones, Alcira and Carcagente, will be treating their wastewater discharges once the treatment plant being constructed is finished.

Diffuse pollution makes nitrate concentration in the final reach of the Júcar River to rise, when returns from irrigation are incorporated, reaching values of almost 30 mg/l of NO_3^- in the area of the river mouth, as shown in figure 152. These concentrations are lower than the established values for water intended for human consumption (50 mg/l of NO_3^-), but they contribute to the eutrophication processes present in the Marquesa weir (the last weir at the Júcar river).

Circulation flows in the final reach of the Júcar River (Tous-Antella Weir) | Figure 150



Circulation flows in the final reach of the Júcar River (Huerto Mulet-Cullera Weir) | Figure 151

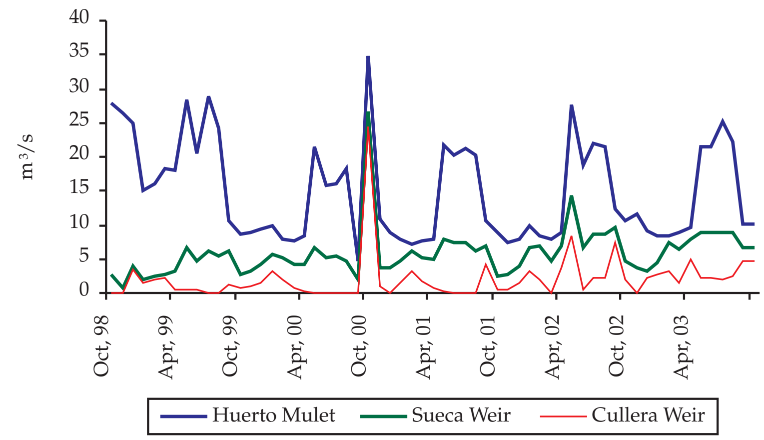
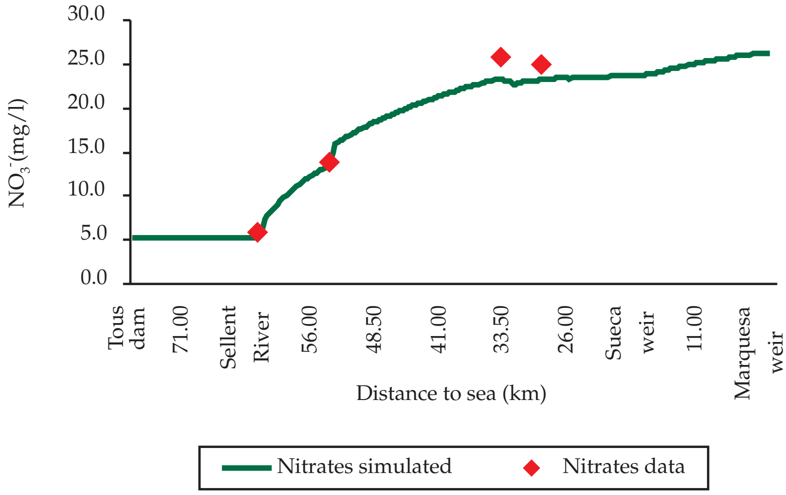
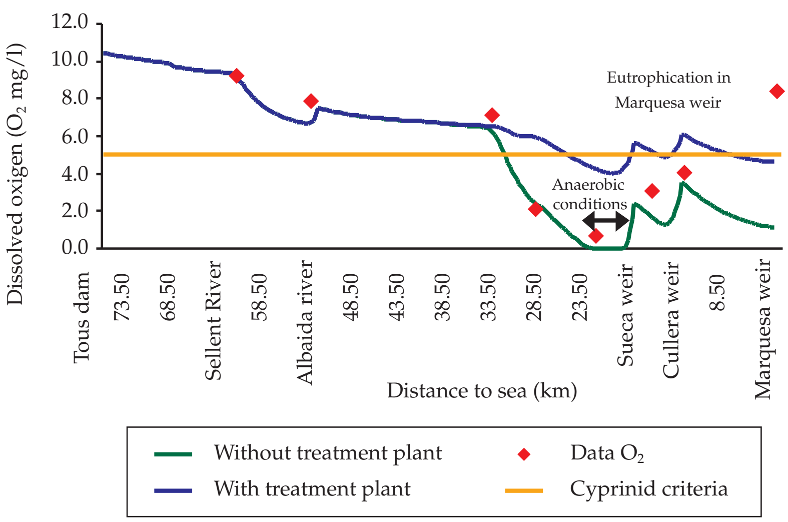


Figure 152	Nitrate concentration (mg/l) in the final reach of the Júcar River



Source point urban pollution, and mainly that produced by Alzira and Carcaixent, is characterised by its high levels of organic matter and the subsequent water depletion of oxygen. This loss of oxygen induces anaerobic conditions downstream the discharge points (figure 153). Accordingly to the simulation model, once the treatment plant is operational, water oxygen content will rise in the worst reaches to 4 mg/l of O_2, which is very close to the recommended values for cyprinids (5 mg/l of O_2) and will reduce the risk of not achieving the environmental objectives by 2015.

Figure 153	Concentration of oxigen dissolved (mg/l) in the final reach of the Júcar River



In figure 153, the simulated appearance of eutrophisation processes with high oxygen production in the Marquesa weir, where content in nutrients is high, stands out, as confirmed by the data gathered at this point. These negative processes would be avoided if the water treatment plant under construction incorporates a tertiary treatment process to remove phosphorous.

The methodology described in this chapter includes a general analysis of the biological and physico-chemical status of water bodies, to get a general vision of water bodies status in the Júcar RBD, and to identify the areas where it is necessary to develop a more detailed analysis of the risk of failing to achieve the good ecological status. The described case of the final reach of the Júcar River is one example where detailed water quality mathematical models are necessary to study the actual situation and future trends.

4.3. Impact on groundwater

4.3.1. *Assessment of impact*

The Water Framework Directive (WFD) in article 5 and Annex II requires that MS undertake the following activities for groundwater (GW) bodies before the end of 2004: characterisation, impact of changes in GW levels, impact of pollution on GW quality and impact of human activity on GW.

Sections below describe how the Júcar RBD is developing these activities by means of carrying out an initial characterisation and a quantitative and qualitative analysis.

4.3.1.1. Quantitative analysis

One of the tasks completed for the quantitative status assessment of GW bodies, as an expression of the degree of affection of a GW body by direct and indirect abstractions, has been the preliminary estimate of available resource for each hydrogeological unit (HGU) in accordance with the new concept introduced by the WFD (art. 2.27).

This concept defines *available resource as the long term annual average rate of overall recharge of the body of GW less the long term annual rate of flow required to achieve the ecological quality objectives for associated surface waters, to avoid any significant diminution in the ecological status of those waters, and any significant damage to associated land ecosystems.*

Available groundwater resource (hm³/year) in the HGUs of the Júcar RBD — Table 34

Code HGU	Name	Rain infiltration	Losses from rivers	Returns from irrigation	80% Lateral recharge	Environ. volumes	Available resource
8.01	CELLA-MOLINA DE ARAGON	9.80	0	0.2	0.00	7.42	2.58
8.02	MONTES UNIVERSALES	193.31	0	2.37	0.00	7.39	188.29
8.03	ARQUILLO-TRAMACASTIEL-VILLEL	6.95	0	0.68	0.00	5.15	2.48
8.04	VALLANCA	33.95	0	0.85	0.00	0.00	34.80
8.05	JAVALAMBRE	47.10	0	2.83	24.00	29.43	44.50
8.06	MOSQUERUELA	143.35	0	5.45	0.00	79.46	69.34
8.07	MAESTRAZGO	161.83	0	13.75	32.00	49.90	157.69
8.08	PUERTOS DE BECEITE	19.76	0	0.39	0.00	10.33	9.82
8.09	PLANA DE CENIA-TORTOSA	6.93	0.3	6.14	4.00	7.40	9.97
8.10	PLANA DE VINAROZ-PEÑISCOLA	7.89	0	18.66	37.60	40.00	24.15
8.11	PLANA DE OROPESA-TORREBLANCA	4.50	0	11.69	12.14	8.00	20.33
8.12	PLANA DE CASTELLON	30.04	20	59.73	25.60	74.00	61.37
8.13	ONDA	18.20	0	2.79	0.00	1.60	19.39
8.14	ALTO PALANCIA	46.41	0	9.54	0.00	32.85	23.10
8.15	ALPUENTE	44.83	0	2.52	0.00	24.07	23.28
8.16	OLMEDA	2.38	0	0.48	0.00	0.98	1.88
8.17	SERRANIA DE CUENCA	499.12	0	11.98	0.00	166.61	344.49
8.18	LAS SERRANIAS	65.71	0	3.33	0.00	34.20	34.84
8.19	ALCUBLAS	15.01	4.56	1.35	17.67	31.98	6.61
8.20	MEDIO PALANCIA	32.95	5	20.55	24.00	22.79	59.72
8.21	PLANA DE SAGUNTO	6.62	0	26.46	11.98	29.92	15.14
8.22	LIRIA-CASINOS	19.42	0	41.19	31.98	4.00	88.59
8.23	BUÑOL-CHESTE	30.14	0	59.64	23.99	27.76	86.01
8.24	UTIEL-REQUENA	32.88	0	2.75	8.00	2.77	40.86
8.25	PLANA DE VALENCIA NORTE	18.66	0	74.92	34.16	39.80	87.94
8.26	PLANA DE VALENCIA SUR	48.16	0	181.66	18.25	132.38	115.69
8.27	CAROCH NORTE	90.06	0	32.4	0.00	22.18	100.28
8.28	CAROCH SUR	77.63	0	33.29	1.60	2.70	109.82
8.29	MANCHA ORIENTAL	147.72	60	78.91	72.00	35.54	323.09
8.30	JARDIN-LEZUZA	50.93	0	20.25	0.00	19.28	51.90
8.31	SIERRA DE LAS AGUJAS	28.08	0	15.07	0.00	3.85	39.30
8.32	SIERRA GROSA	71.28	0	26.91	0.00	21.63	76.56
8.33	ALMANSA	2.77	0	2.74	0.00	0.00	5.51
8.34	SIERRA OLIVA	3.10	0	0.31	0.40	0.00	3.81
8.35	JUMILLA-VILLENA	0.74	0	0.57	0.00	0.00	1.31

Table 34 (Cont.) Available groundwater resource (hm^3/year) in the HGUs of the Júcar RBD

Code HGU	Name	Rain infiltration	Losses from rivers	Returns from irrigation	80% Lateral recharge	Environ. volumes	Available resource
8.36	VILLENA-BENEJAMA	23.56	0	3.56	0.00	3.00	24.12
8.37	ALMIRANTE-MUSTALLA	42.13	0	13.52	0.00	20.83	34.82
8.38	PLANA GANDIA-DENIA	34.22	10	46.53	37.60	57.77	70.58
8.39	ALMUDAINA-ALFARO-SEGARIA	33.28	0	1.91	0.00	13.63	21.56
8.40	SIERRA MARIOLA	27.22	0	0.5	0.00	3.63	24.08
8.41	PEÑARRUBIA	0.79	0	0.15	0.00	0.00	0.94
8.42	CARCHE-SALINAS	1.18	0	0.71	0.00	0.00	1.89
8.43	ARGUEÑA-MAIGMO	2.18	0	0.26	0.00	0.00	2.44
8.44	BARRANCONES-CARRASQUETA	14.94	0	0.63	1.71	0.00	17.28
8.45	SIERRA AITANA	16.60	0	1.22	0.00	11.98	5.84
8.46	SERRELLA-AIXORTA-ALGAR	16.66	0	2.29	0.00	5.65	13.30
8.47	PEÑON-MONTGO-BERNIA	55.08	0	2.97	0.00	5.54	52.51
8.48	ORCHETA	15.13	0	3.6	11.98	0.64	30.07
8.49	AGOST-MONEGRE	2.10	0	0.11	0.00	0.00	2.21
8.50	SIERRA DEL CID	1.24	0	0.68	0.00	0.00	1.92
8.51	QUIBAS	1.21	0	0.56	0.00	0.00	1.77
8.52	CREVILLENTE	0.39	0	0.75	0.00	0.00	1.14

The estimation of available water resource requires determining not only water volume of those aquifers, but also the discharges from GW bodies to rivers, springs or to the sea for environmental purposes. A preliminary study has been done to define these environmental needs following the criteria of minimum flows established by the JHP (CHJ, 1998). From these environmental needs, the average annual volume that needs to be kept in different HGUs to satisfy environmental needs has been determined. In addition, 80% of the lateral transferences between different HGUs has been considered as an environmental restriction to maintain minimum lateral transferences, and to avoid reducing renewable resources of the HGUs located downstream.

The difference between renewable resources of each HGU (recharge by rain infiltration, river flow losses, recharge by irrigation returns, and 80% lateral inflow from other aquifers) and required environmental volumes (discharges to rivers, lateral outflows to other aquifers, flows to wetlands and discharges to the sea) gives the available resource shown in table 34 and figure 154.

Available groundwater resource (hm³/year) in the HGUs | Figure 154

- 175 - 400
- 100 - 175
- 50 - 100
- 25 - 50
- 0 - 25

Note: Impervious surface or local aquifers in light yellow areas

Total abstraction in each HGU is obtained by adding urban, agricultural and industrial abstractions (table 35). These values are represented by different colours in figure 155, showing that the greatest abstractions are mainly located in coastal aquifers, except for the Mancha Oriental aquifer in the Castilla-La Mancha Autonomous Community.

Table 35 Abstractions (hm^3/year) in the HGUs of the Júcar RBD

HGU Code	Name	Urban Abstraction	Agriculture Abstraction	Industrial Abstraction	Total Abstraction
8.01	CELLA-MOLINA DE ARAGON	0.15	0.00	0.00	0.15
8.02	MONTES UNIVERSALES	0.43	0.00	0.00	0.43
8.03	ARQUILLO-TRAMACASTIEL-VILLEL	0.14	0.00	0.00	0.14
8.04	VALLANCA	0.27	0.00	0.00	0.27
8.05	JAVALAMBRE	0.41	0.00	0.00	0.41
8.06	MOSQUERUELA	3.04	1.19	1.74	5.97
8.07	MAESTRAZGO	11.50	23.73	0.42	35.65
8.08	PUERTOS DE BECEITE	0.62	0.17	0.00	0.79
8.09	PLANA DE CENIA-TORTOSA	0.04	11.77	0.00	11.81
8.10	PLANA DE VINAROZ-PEÑISCOLA	8.15	37.32	3.67	49.14
8.11	PLANA DE OROPESA-TORREBLANCA	2.65	23.38	0.00	26.03
8.12	PLANA DE CASTELLON	51.41	62.93	19.89	134.23
8.13	ONDA	1.40	2.18	0.47	4.05
8.14	ALTO PALANCIA	5.09	4.37	0.42	9.88
8.15	ALPUENTE	1.22	0.00	0.00	1.22
8.16	OLMEDA	0.20	0.00	0.00	0.20
8.17	SERRANIA DE CUENCA	9.16	0.00	0.00	9.16
8.18	LAS SERRANIAS	1.43	3.37	0.42	5.22
8.19	ALCUBLAS	0.10	3.06	0.00	3.16
8.20	MEDIO PALANCIA	6.19	56.57	0.49	63.25
8.21	PLANA DE SAGUNTO	1.57	34.96	9.01	45.54
8.22	LIRIA-CASINOS	17.34	52.48	5.65	75.47
8.23	BUÑOL-CHESTE	11.33	69.51	0.70	81.54
8.24	UTIEL-REQUENA	3.46	10.47	2.38	16.31
8.25	PLANA DE VALENCIA NORTE	3.13	16.00	39.58	58.71
8.26	PLANA DE VALENCIA SUR	23.09	38.22	4.55	65.86
8.27	CAROCH NORTE	13.96	45.39	1.73	61.08
8.28	CAROCH SUR	8.97	30.56	0.99	40.52
8.29	MANCHA ORIENTAL	8.87	397.73	0.00	406.60
8.30	JARDIN-LEZUZA	0.70	4.77	0.00	5.47
8.31	SIERRA DE LAS AGUJAS	2.87	31.56	2.40	36.83
8.32	SIERRA GROSA	5.37	35.48	1.36	42.21
8.33	ALMANSA	2.65	2.08	0.00	4.73
8.34	SIERRA OLIVA	2.38	4.01	0.00	6.39
8.35	JUMILLA-VILLENA	14.89	20.57	0.66	36.12
8.36	VILLENA-BENEJAMA	33.07	28.34	6.43	67.84
8.37	ALMIRANTE-MUSTALLA	1.40	19.60	0.00	21.00
8.38	PLANA GANDIA-DENIA	19.33	51.73	3.19	74.25
8.39	ALMUDAINA-ALFARO-SEGARIA	1.24	6.69	0.04	7.97
8.40	SIERRA MARIOLA	17.72	5.94	1.74	25.40
8.41	PEÑARRUBIA	10.19	1.51	0.00	11.70

Abstractions (hm³/year) in the HGUs of the Júcar RBD — Table 35 (Cont.)

HGU Code	Name	Urban Abstraction	Agriculture Abstraction	Industrial Abstraction	Total Abstraction
8.42	CARCHE-SALINAS	8.72	8.68	0.21	17.61
8.43	ARGUEÑA-MAIGMO	5.74	4.08	0.16	9.98
8.44	BARRANCONES-CARRASQUETA	5.76	1.60	1.11	8.47
8.45	SIERRA AITANA	0.13	3.01	0.00	3.14
8.46	SERRELLA-AIXORTA-ALGAR	11.41	4.57	0.13	16.11
8.47	PEÑON-MONTGO-BERNIA	15.84	8.89	0.11	24.84
8.48	ORCHETA	1.23	2.03	0.41	3.67
8.49	AGOST-MONEGRE	0.36	3.95	0.08	4.39
8.50	SIERRA DEL CID	3.20	1.80	2.02	7.02
8.51	QUIBAS	2.12	6.37	4.73	13.22
8.52	CREVILLENTE	1.66	12.49	3.11	17.26

Abstractions (hm³/year) in the HGUs — Figure 155

0 - 25
25 - 75
75 - 125
125 - 250
250 - 500

Note: Impervious surface or local aquifers in light yellow areas

Water balance estimations have been carried out from available resource and abstractions data (table 36). The degree of exploitation for each HGU has been expressed by means of the exploitation index, K, which is defined as:

$K_{HGU} = (\text{Abstraction}_{HGU} / \text{Available resource}_{HGU})$

Table 36 **Exploitation index in the HGUs of the Júcar RBD**

HGU Code	Name	Available resource (hm³/year)	Total Abstractions (hm³/year)	K
8.01	CELLA-MOLINA DE ARAGON	2.58	0.15	0.06
8.02	MONTES UNIVERSALES	188.29	0.43	0.00
8.03	ARQUILLO-TRAMACASTIEL-VILLEL	2.48	0.14	0.06
8.04	VALLANCA	34.80	0.27	0.01
8.05	JAVALAMBRE	44.50	0.41	0.01
8.06	MOSQUERUELA	69.34	5.97	0.09
8.07	MAESTRAZGO	157.69	35.65	0.23
8.08	PUERTOS DE BECEITE	9.82	0.79	0.08
8.09	PLANA DE CENIA-TORTOSA	9.97	11.81	1.18
8.10	PLANA DE VINAROZ-PEÑISCOLA	24.15	49.14	2.03
8.11	PLANA DE OROPESA-TORREBLANCA	20.33	26.03	1.28
8.12	PLANA DE CASTELLON	61.37	134.23	2.19
8.13	ONDA	19.39	4.05	0.21
8.14	ALTO PALANCIA	23.10	9.88	0.43
8.15	ALPUENTE	23.28	1.22	0.05
8.16	OLMEDA	1.88	0.20	0.11
8.17	SERRANIA DE CUENCA	344.49	9.16	0.03
8.18	LAS SERRANIAS	34.84	5.22	0.15
8.19	ALCUBLAS	6.61	3.16	0.48
8.20	MEDIO PALANCIA	59.72	63.25	1.06
8.21	PLANA DE SAGUNTO	15.14	45.54	3.01
8.22	LIRIA-CASINOS	88.59	75.47	0.85
8.23	BUÑOL-CHESTE	86.01	81.54	0.95
8.24	UTIEL-REQUENA	40.86	16.31	0.40
8.25	PLANA DE VALENCIA NORTE	87.94	58.71	0.67
8.26	PLANA DE VALENCIA SUR	115.69	65.86	0.57
8.27	CAROCH NORTE	100.28	61.08	0.61
8.28	CAROCH SUR	109.82	40.52	0.37
8.29	MANCHA ORIENTAL	323.09	406.60	1.26
8.30	JARDIN-LEZUZA	51.90	5.47	0.11
8.31	SIERRA DE LAS AGUJAS	39.30	36.83	0.94
8.32	SIERRA GROSA	76.56	42.21	0.55
8.33	ALMANSA	5.51	4.73	0.86
8.34	SIERRA OLIVA	3.81	6.39	1.67

Exploitation index in the HGUs of the Júcar RBD — Table 36 (Cont.)

HGU Code	Name	Available resource (hm³/year)	Total Abstractions (hm³/year)	K
8.35	JUMILLA-VILLENA	1.31	36.12	27.60
8.36	VILLENA-BENEJAMA	24.12	67.84	2.81
8.37	ALMIRANTE-MUSTALLA	34.82	21.00	0.60
8.38	PLANA GANDIA-DENIA	70.58	74.25	1.05
8.39	ALMUDAINA-ALFARO-SEGARIA	21.56	7.97	0.37
8.40	SIERRA MARIOLA	24.08	25.40	1.05
8.41	PEÑARRUBIA	0.94	11.70	12.51
8.42	CARCHE-SALINAS	1.89	17.61	9.32
8.43	ARGUEÑA-MAIGMO	2.44	9.98	4.09
8.44	BARRANCONES-CARRASQUETA	17.28	8.47	0.49
8.45	SIERRA AITANA	5.84	3.14	0.54
8.46	SERRELLA-AIXORTA-ALGAR	13.30	16.11	1.21
8.47	PEÑON-MONTGO-BERNIA	52.51	24.84	0.47
8.48	ORCHETA	30.07	3.67	0.12
8.49	AGOST-MONEGRE	2.21	4.39	1.99
8.50	SIERRA DEL CID	1.92	7.02	3.66
8.51	QUIBAS	1.77	13.22	7.48
8.52	CREVILLENTE	1.14	17.26	15.19

A summary of the outcome of this preliminary quantitative analysis is shown in figure 156, where also some graphs for aquifer water level historical evolution have been included. The red colour shows how current use of GW resources does not meet the environmental restrictions for supplying enough surface water to the associated aquatic ecosystems. Therefore, it is clear that environmental objectives are not completely satisfied at this moment and there is a risk of not reaching the environmental objectives. Consequently, a further characterisation will be needed. The orange colour represents those abstractions that are close to the available resources and could present problems in the future. Finally, the rest of the units (represented in yellow, green and blue) are representative of a good quantitative status.

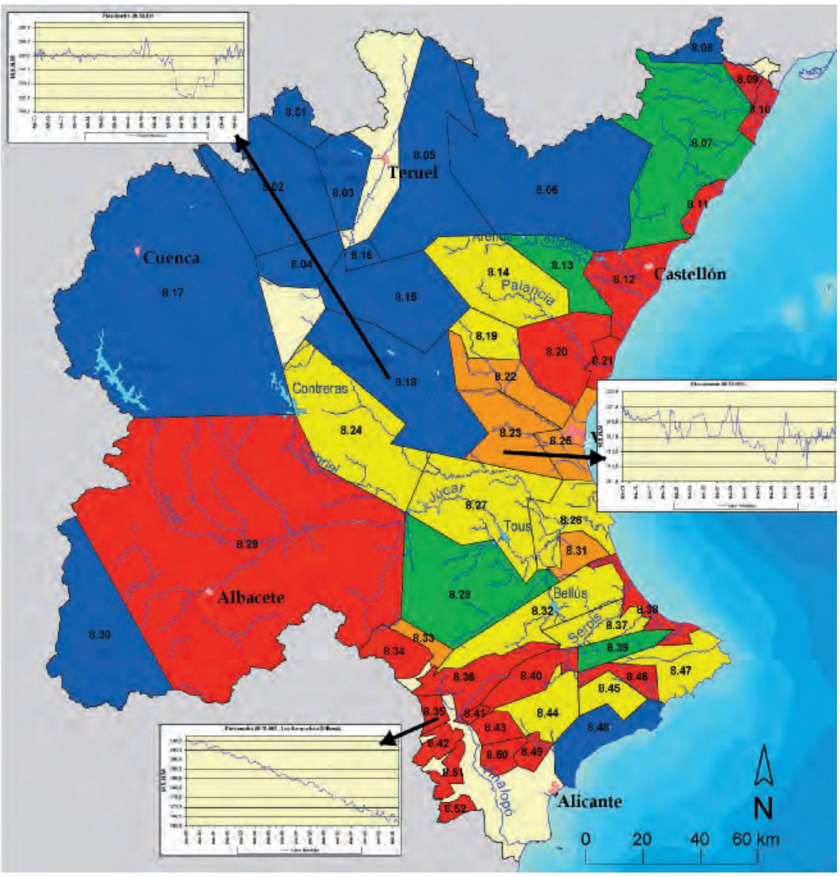
Definition of exploitation levels — Table 37

	Exploitation level	Value of K	Number of HGU
Very low exploitation	1	0 - 0.19	13
Low exploitation	2	0.2 - 0.39	4
Medium exploitation	3	0.4 - 0.64	10
High exploitation	4	0.65 - 1	5
Very high	5	>1	20
Total			52

Figure 156 | Exploitation index for the HGUs

- 0 - 25
- 25 - 75
- 75 - 125
- 125 - 250
- 250 - 500

Note: Impervious surface or local aquifers in light yellow areas

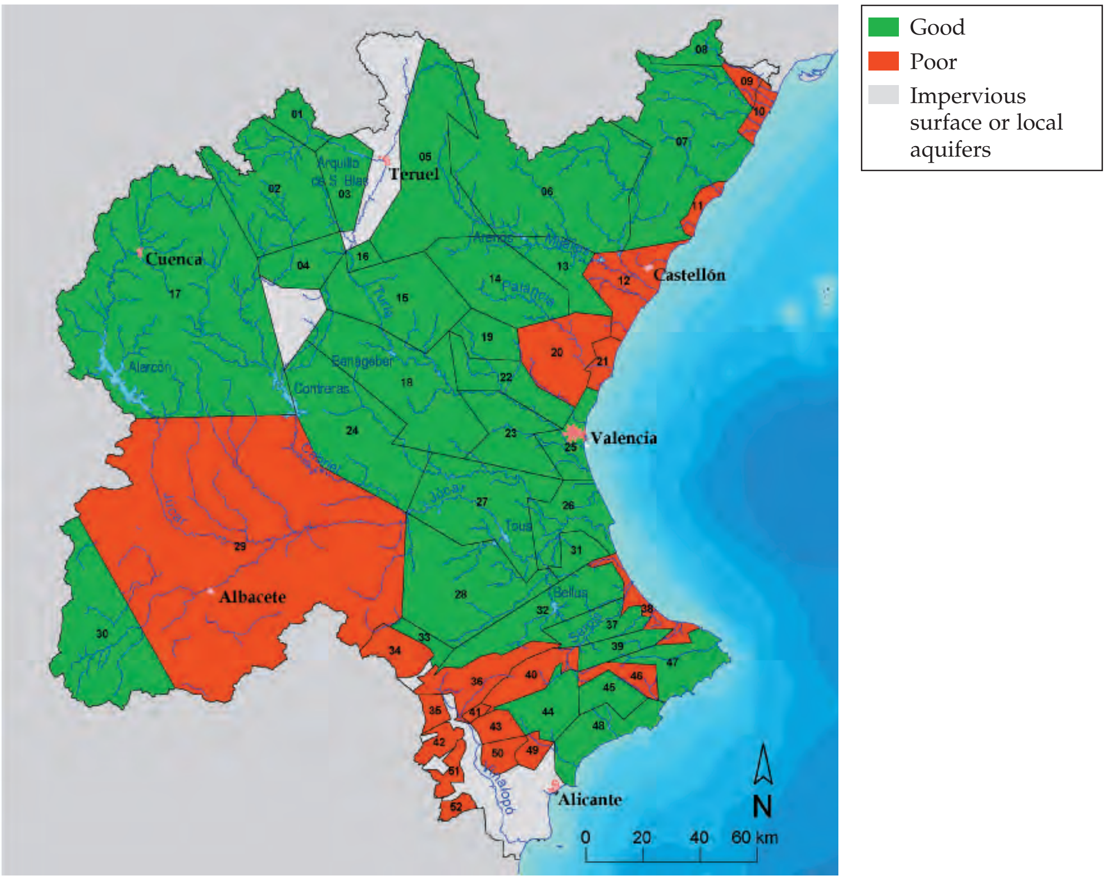


In order to check these preliminary results, it will be necessary to compare, in a systematic way, these results with the evolution of control points that are representative of the piezometric level for each HGU. This task is currently being carried out, and first results indicate a good fit between piezometric level behaviour and the former characterisation (figure 156).

As a result of previous studies, a preliminary quantitative status of GW bodies is shown in figure 157. As seen in the figure, aquifers with no *good status* are located in the Vinalopó area in the southern part of the District, in the Mancha Oriental aquifer on the western area, and in coastal aquifers located in the province of Castellón close to the Mediterranean coastal wetland chain.

These results show the global status of each HGU. However, it is known that in some HGUs there are problems in some specific aquifers that make up the HGU. This is the case of HGU 8.24 "Utiel-Requena", 8.32 "Sierra Grosa" or 8.39 "Almudaina-Alfaro-Segaria". Other HGU, as 8.48 "Orcheta", are mainly made up of aquifers of local interest. Detailed analyses are being carried out (studying the water balance of the aquifers, their connexion with rivers and springs, etc.) as it is mentioned in section 2. These analyses will allow obtaining a better disaggregation of the exploitation index in the HGUs of Júcar RBD.

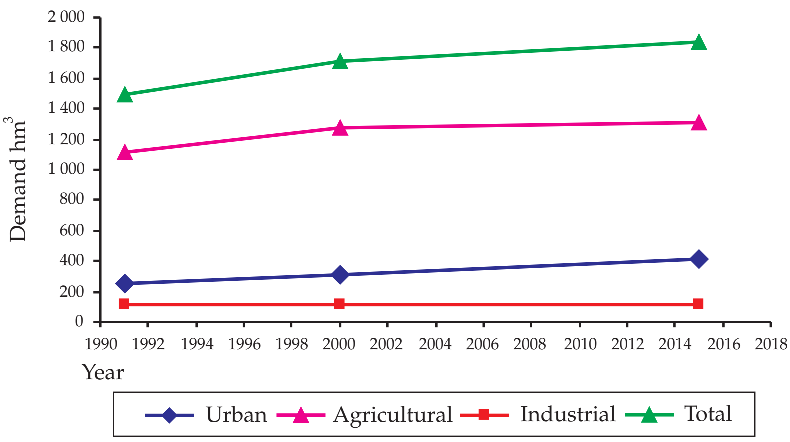
Preliminary assessment on quantitative status for GW bodies — Figure 157



Likewise, a similar study is being conducted making use of the same methodology to assess the quantitative status for the year 2015. Because of the increasing urban demand, the level of abstraction has been predicted to rise (from 1 660 to 1 850 hm^3).

Projections of GW demands for year 2015 are shown in figure 158, the most important increase is produced by urban demand due to the increase of the permanent and seasonal population occurred in recent past years. Regarding agricultural demand, future previsions show that there will be no increase of irrigated areas as has been occurring. Finally, there is more uncertainty for the industrial projection because it strongly depends on new technologies and on the economical progress, though in practical terms, this volume is relative small.

Groundwater demands projection up to year 2015 — Figure 158



4.3.1.2. Chemical impact

The chemical monitoring network operative within the Júcar RBD has been used to assess the chemical impact of GW bodies. This network accounts for 140 sampling wells and the monitoring frequency is twice a year. Laboratory analyses include different substances or parameters, such as nutrients, basic chemistry, and metals.

For the chemical assessment of GW bodies Section 2.3.2 of Annex V of the WFD has been studied as a reference. It establishes that a GW body is in a good chemical status according to two groups of indicators:

- General Indicators: pollutants concentrations do not exceed the community quality norms, and therefore, do not hamper the water body from achieving the associated environmental objectives specified for the surface water bodies and do not provoke damages to the land associated ecosystems.
- Conductivity: variations do not indicate salinity or other intrusions.

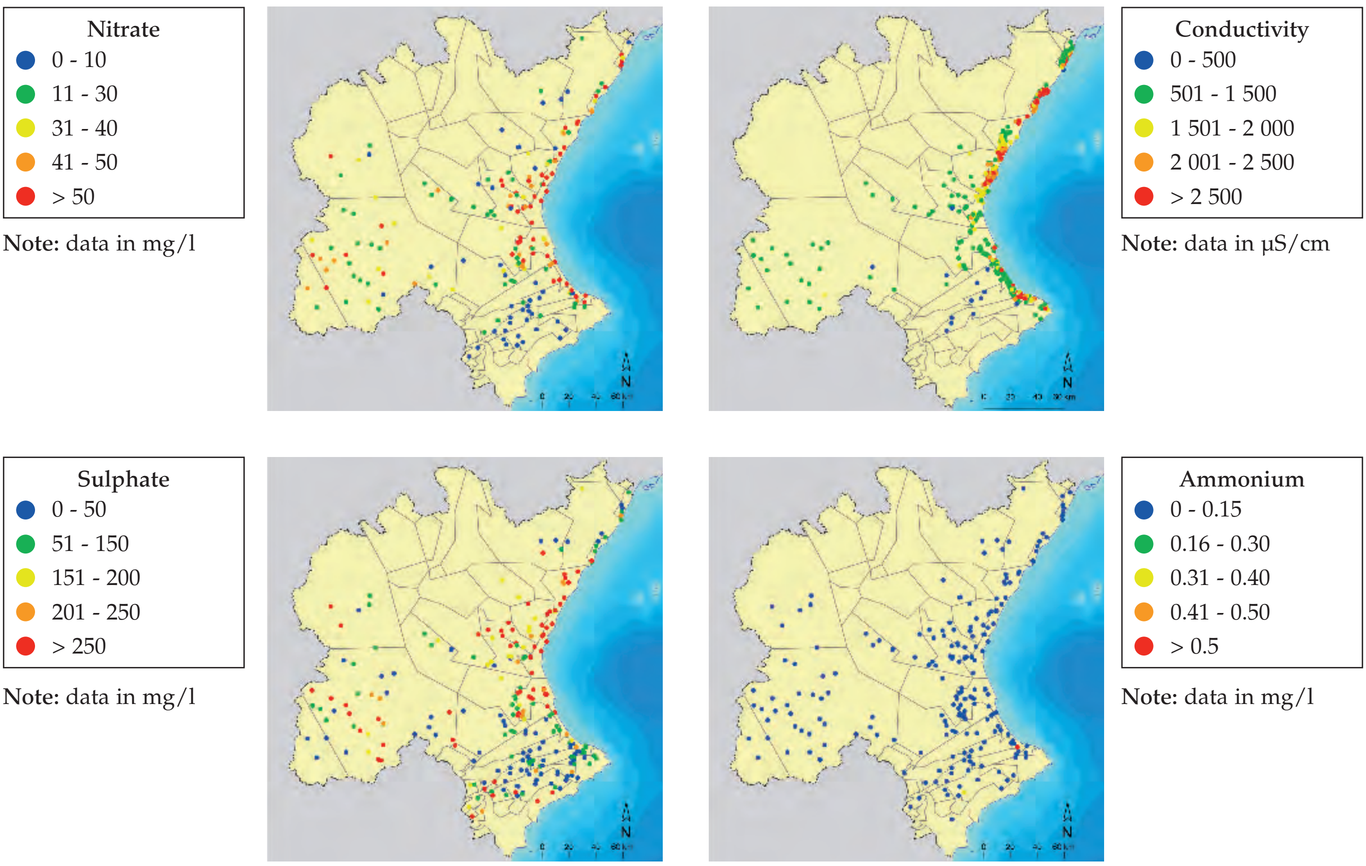
In addition, the proposed Groundwater Framework Directive (GWFD) establishes that GW or a group of GW bodies is in a good chemical status when:

a) Measured concentration of nitrates and active components of pesticides, including the corresponding metabolites, degradation and reactive products do not exceed the associated quality norms (50 mg/l for nitrates and 0.1 mg/l for active components of pesticides)

b) Regarding any other polluting substance, it is demonstrated, that the concentration agrees with what is stated in the definition included in section 2.3.2. of Annex V of the WFD previously mentioned.

Similarly, the proposed GWFD determines that Member States will establish, by the end of 2005, threshold values for each of the pollutants that, according to the analysis of characteristics for GW or groups of GW bodies developed in each MS territory, may have contributed to cause a risk in these bodies. As a minimum requirement, MS will establish threshold values for pollutants listed in Annex III.

Figure 159 **Water quality parameters in HGUs**



Following, there is a description of the methodology used for the evaluation of the chemical status of GW bodies in the Júcar RBD. The threshold considered for each analysed parameter, with the objective of defining a good or a bad GW body status, is determined by the corresponding quality norm if it exits, and if there is not any, values have been proposed.

From the data provided by the GW quality network of the Júcar RBD, an exercise has been developed for the following parameters: nitrates, sulphates, conductivity and ammonium. Analysis has been carried out for the 2000 - 2003 period. With the intention of getting representative results for all the water bodies, the control points selected to make the analysis had to fulfil two conditions. First, all control points must have at least two measures, and second, there must be at least two control points in each HGU to be able to determine later on the status of the GW body. Once established the representative control points for this period of time, the median for each one of these points has been calculated. The result obtained is shown in figure 159.

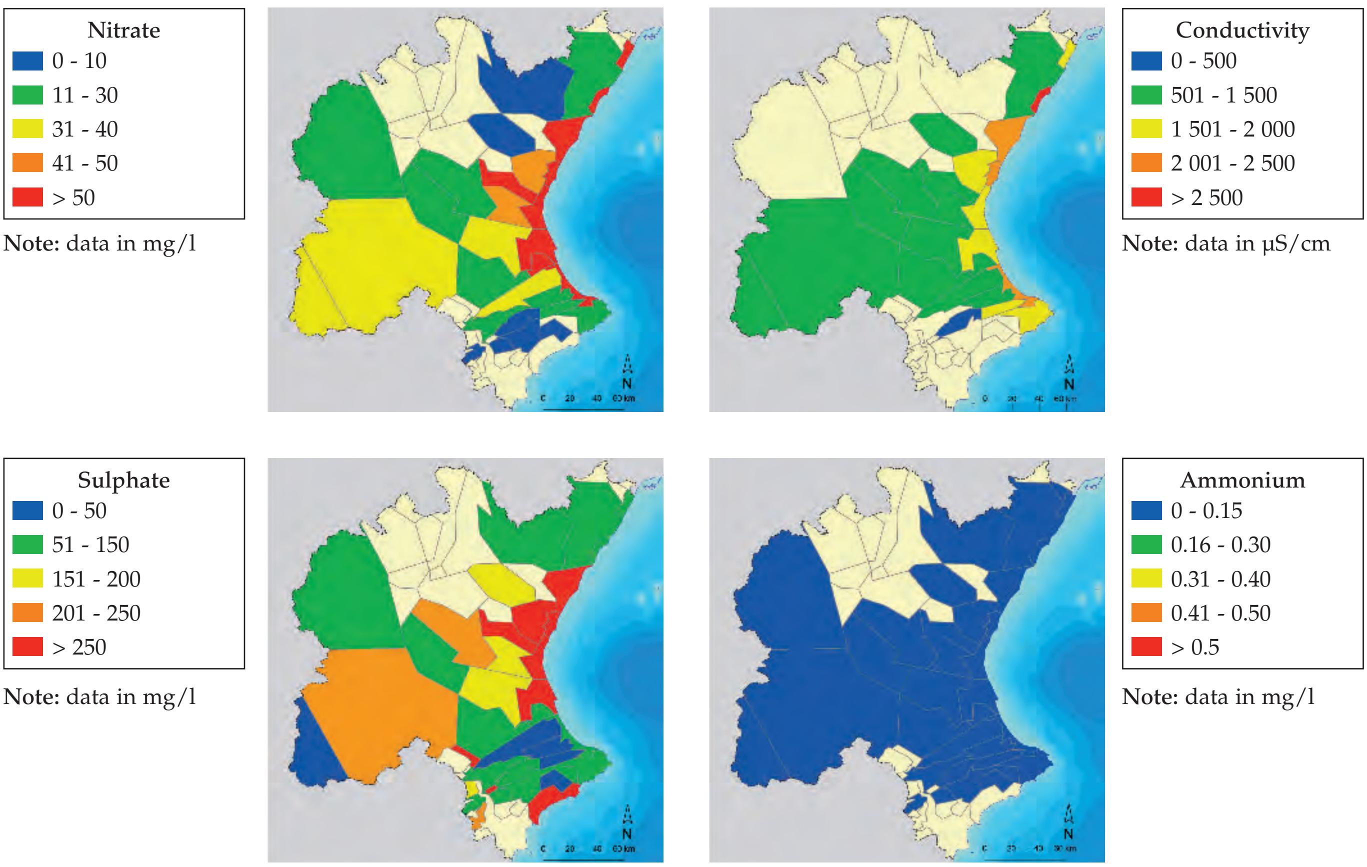
Point values for each HGU have been averaged and the resulting value has been assigned to the corresponding HGU. In figure 160, the status of each HGU is shown for each of the parameters.

Then, for each parameter and each HGU it has been estimated if that unit is in good or bad status. In order to do this, different threshold values for each parameter have been used, nitrates: 50 mg/l (established by the quality directive 91/676/EEC), conductivity: 2 500 µS/cm, sulphates: 250 mg/l and ammonium: 0.5 mg/l.

The established values are based on the values discussed during the preparation of the proposal COM 2003/550 of the Directive on Groundwater Protection against Pollution. Some of these values have produced large discussions, as the ones corresponding to sulphates.

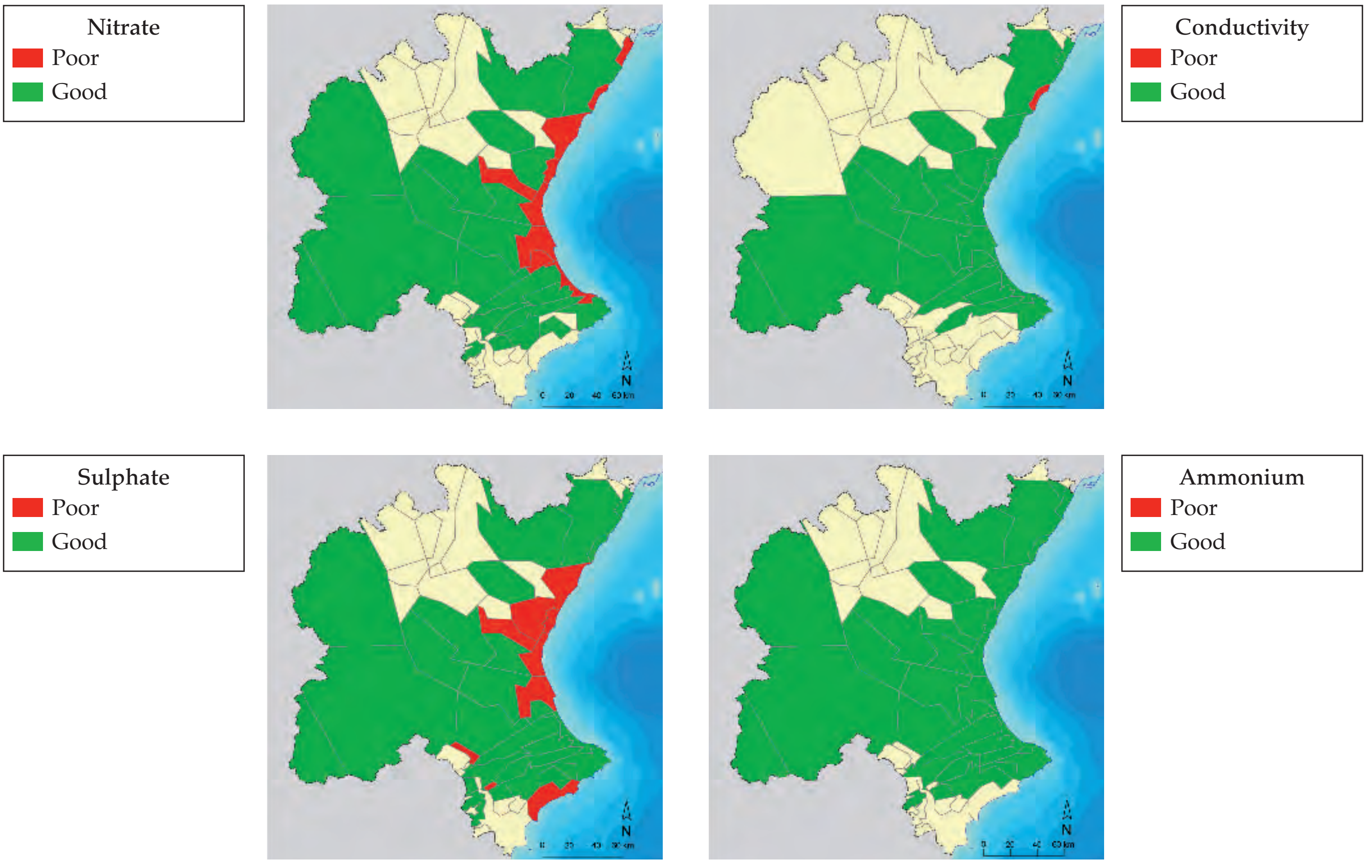
Figure 161 shows the status of the four parameters in the Júcar RBD GW bodies.

Values of the mean water quality parameters in HGUs — Figure 160



Note: no data available in light yellow areas

Figure 161 **Preliminary assessment of the status of water quality parameters**



Note: no data available in light yellow areas

Areas with higher contents in nitrates are mainly located in the Mediterranean coastal strip. High levels of nitrates in this region are due to the existence of a great surface of irrigated land, and therefore, a high use of fertilisers, which produces diffuse pollution in coastal plains. It is important to consider that there are several wetlands along the coast that receive groundwater from these aquifers, which can lead to a modification of the chemical conditions of these water bodies, and consequently of the associated habitats.

Highest conductivity values occur also in the coastal strip. Abstractions from coastal aquifers, as well as from those adjacent aquifers that feed them, produce a reduction of groundwater flows to the sea, which leads in some areas to a non-desirable progress of the marine intrusion.

High contents in sulphates focus in areas with highest surface of irrigated land and in natural areas with evaporitic materials.

In the Júcar RBD high levels of ammonia have not been detected in any location. Measured concentrations are far below the established threshold, which means that there are no significant organic contamination problems.

The analysed parameters have been combined following the recommendations of the GD ECOSTAT to obtain the chemical status in each of the HGU. Once the status of each of the previously listed parameters has been established, the chemical status is calculated, taking as the chemical status the worst of all status for that HGU, using the one-out all-out principle described in the GD. If there is no data on any of the parameters, no specific status is defined.

Preliminary assessment on chemical status | Figure 162

Poor
Good

Note: no data available in light yellow areas

The evolution of different parameters in some of the control points is shown in figure 163. It can be observed that in the Valencian Plain the level of nitrates since the end of the 80's is higher than the established threshold, due to the existing traditional irrigated land and the use of fertilisers. In the Oropesa-Torreblanca Plain the content in salts is very high, which indicates processes of marine intrusion probably induced by the great volumes abstracted from that HGU. The content of sulphates in the southern area of the District is stable as shown in the figure for Caroch Sur. Finally, the content in ammonia within the basin is below the limits established.

Figure 163	Temporal evolution of chemical parameters at different HGUs

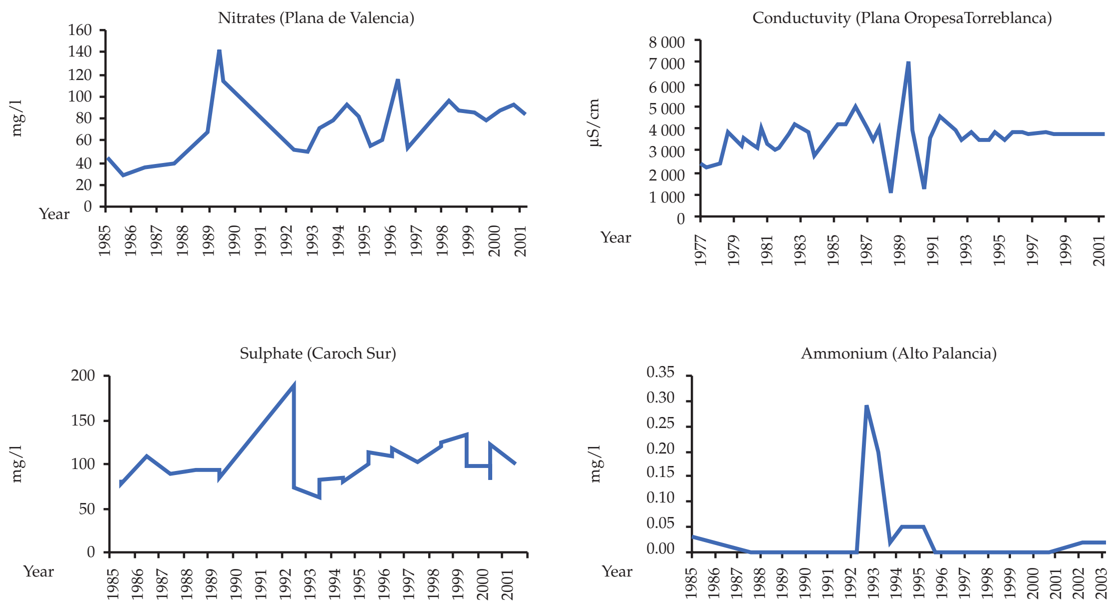
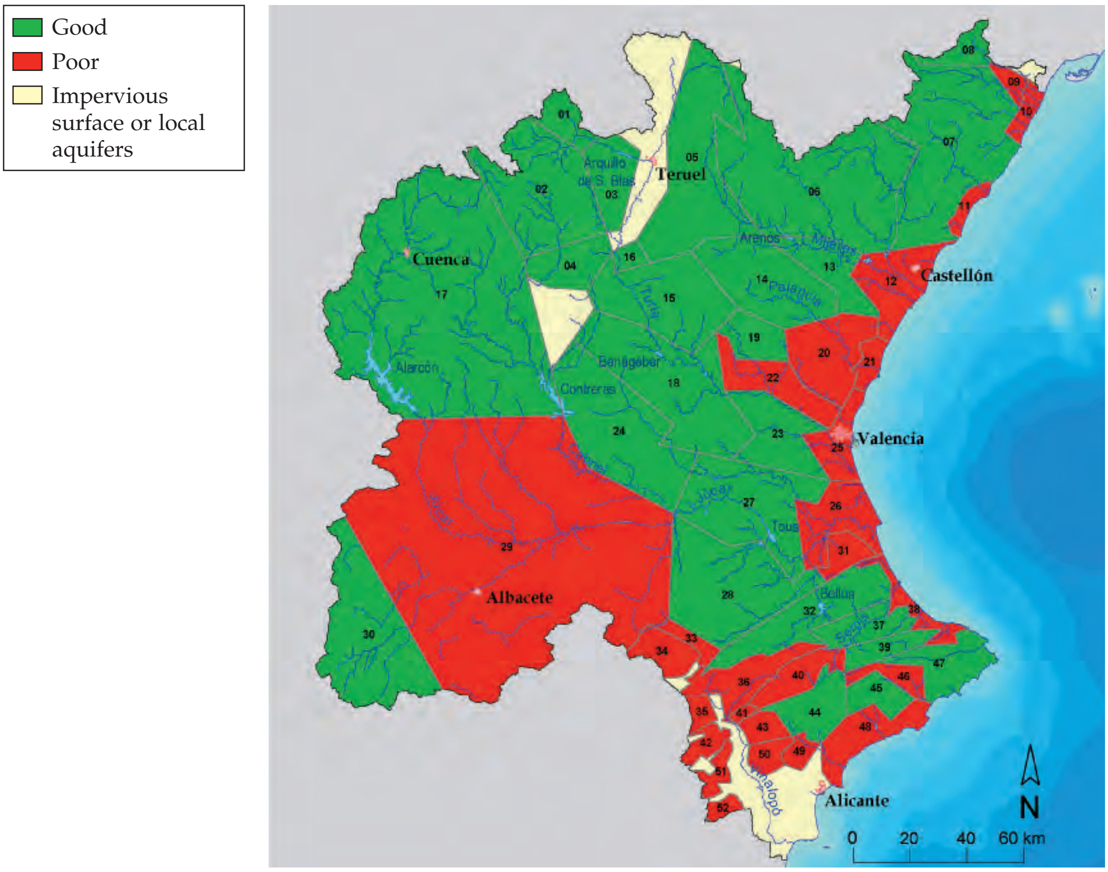


Figure 164	Preliminary assessment on GW bodies at risk of not reaching good status



4.3.2. *Water bodies at risk of not achieving good status*

Water bodies at risk of not reaching a *good status* are obtained as the worst status derived from the preliminary assessments on quantitative (figure 157) and chemical status (figure 162). For those HGUs in which the chemical status has not been defined, the risk of not reaching a good status is based on quantitative status. The results of this combination are shown in figure 164. This figure represents GW bodies at risk of not reaching *good status* located on the following areas:

a) The coastal area in which abstractions and fertilisers for irrigation are quite important and there are significant environmental restrictions due to the requirements for wetlands and for preventing marine intrusion,
b) The Vinalopó area where there are aquifers with high degree of overexploitation and
c) The Mancha Oriental Aquifer where abstractions have become greater than the renewable water resource in the past twenty years.

4.4. Pressures and impacts for coastal and transitional waters

The terms established by the WFD to accomplish the objectives are too short to develop an adequate analysis for pressures and impacts for coastal waters. According to the mentioned Guidance Document on Transitional and Coastal Waters (EC, 2003e), the first analysis must be based on the existing information on pressures and on those available methods for evaluating impacts. However, this same Guidance also mentions the unavailability of tools to quantify pressures and evaluate the impact on coastal and transitional waters.

The General Directorate of Coasts and the CEDEX are developing a study for the Júcar RBD. The first basic task of this study, of great value to develop following ones, is the identification of significant pressures in coastal waters. To identify the type of pressures, the mentioned Guidance is being used to select pressures considered to be relevant for the Júcar RBD, and to indicate those that directly impact the coastal environment.

The pressures to be considered within the Júcar RBD are summarised in table 38:

Type of pressures being considered for coastal waters — Table 38

Diffuse	Point source	Morphological	Other
Diffuse pollution by pesticides and fertilisers	River Discharges	Dredging: to improve or maintain navigation channels	Historical marine depositions of mud
Diffuse pollution from port drainage	Discharge of urban waste waters (municipal)	Ports: commercial, fishing, and yachting harbour	Recreational: anchoring
Atmospheric deposition	Discharge of mixed waste waters (municipal)	Land gained from the sea	Fishing
Spills/discharges of dredging material in surface waters	Private domestic discharges	Provision of sand for security reasons	Invasive species
Navigation	Private and mainly industrial discharges Port discharge	Barriers Offshore dikes, channelling, spikes, breakwaters	Climatic change
	Industrial discharge Agricultural		

Figure 165	Location of pressures on the Júcar RBD littoral

Dike
Armour rock
Harbor
Breakwater
Port
Regenerated coast

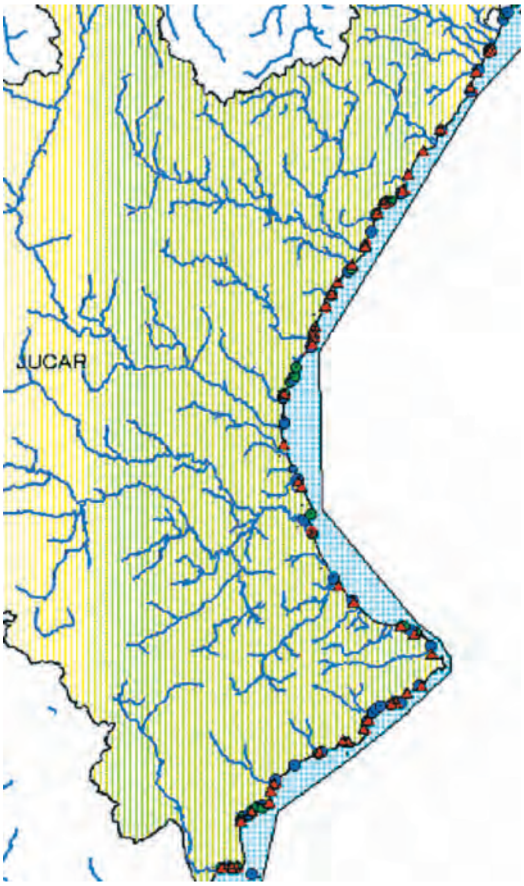


Figure 165 shows the geographical representation of the above listed pressures.

Complementary data provided by the CEDEX on eroded reaches within the Júcar's coastal line have been used to classify reaches into three types according to different levels of coastal line retrocession as shown in table 39.

This data corresponds to the coastal line restitution from year 1947 to 1995, and the number of identified reaches is shown in table 40.

The maximum length of these reaches is 6 500 m, and the medium length is about 2 km. This reaches are shown in figure 166.

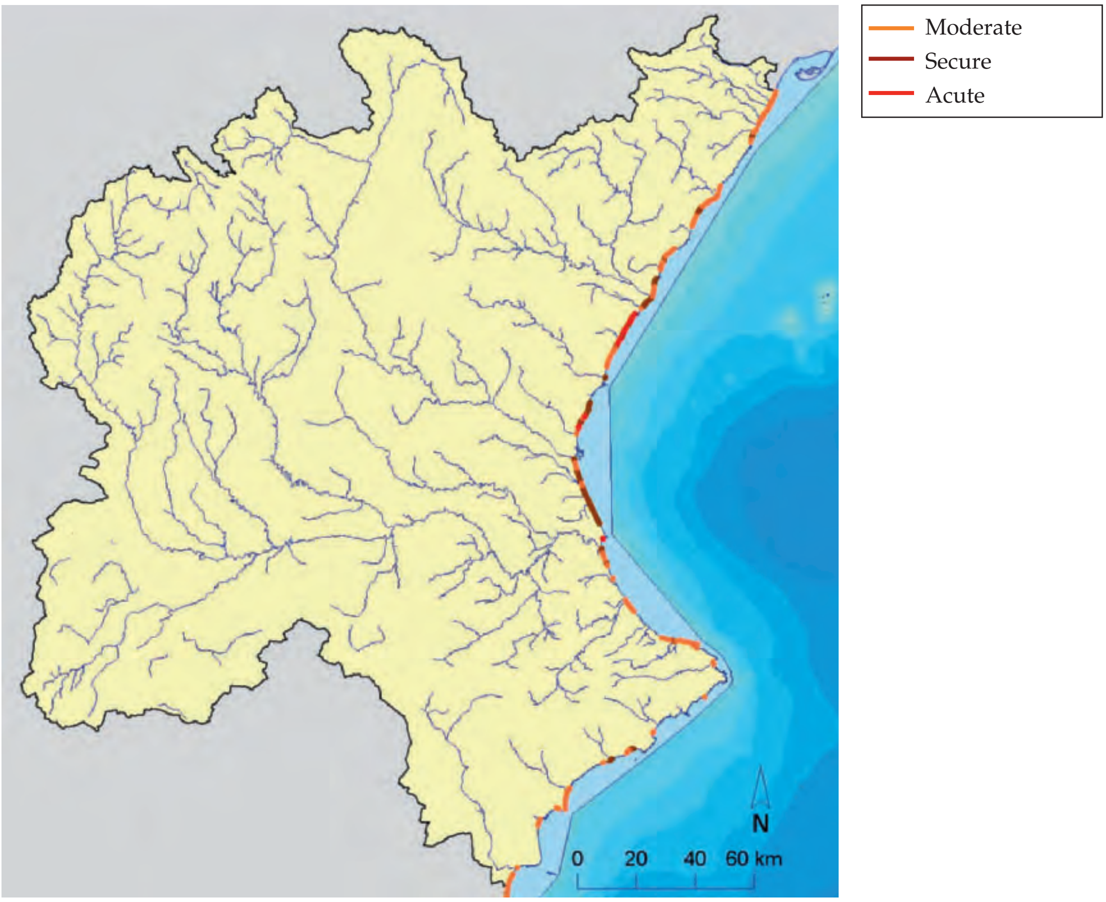
Table 39	Relationship between coastline regression and erosion

Degree of erosion	Regression Length
Acute	>100 meters
Severe	50-100 meters
Moderate	>25 meters

Number of eroded reaches and degree of erosion on the Júcar RBD littoral — Table 40

Coastal District	Number of reaches	Degree of erosion
Alicante	4	Moderate
	2	Severe
Valencia	6	Severe
	8	Moderate
Castellón	1	Acute
	6	Severe
	4	Moderate

Location of eroded reaches on the Júcar RBD littoral — Figure 166



5. ECONOMIC ANALYSIS OF WATER USE

5.1. Introduction

The provision of Article 5 concerning the economic area requires assessing the following aspects:

- The degree of accomplishment of the principle of cost recovery for water services as a tool for appraising economic efficiency and equity. The economic analysis must include the long term forecast of supply and demand, and, where data is not available, estimates of volume, price and cost associated to water services are acceptable.

- The most cost-effective combination of measures in respect of water uses should be included in the program of measures under Article 11 based on estimates of the potential costs of such measures.

Moreover, article 9.1 of the WFD establishes that environmental and resource costs must be taken into account for water services, accordingly to provisions of Annex III and particularly to the polluter pay-principle.

The economic analysis described in this report consists of two main parts: (1) the cost recovery of water services, and (2) the economic characterisation of water uses, the future trends and the measures. The cost recovery of water services is analysed for different users (farmers, households, industries), by considering storage and main transportation, distribution, sewage collection, wastewater treatment, and the environmental and resource cost. While, the economic characterisation of water uses, future trends and measures are analysed for the different types of users.

5.2. Spanish institutional map of water services

The masterpiece of the Spanish legislative framework on water is the 1985 National Water Act and its succeeding modifications, as the one recently occurred in January 2004 in order to complete the transposition of the WFD. This law dictates norms for the economic and financial regime on the use of the public hydraulic domain, and it is developed by subsequent regulations.

Two main levels in the hydraulic system have been differentiated for the development of the economic analysis. The first one, called *high supply level,* comprises the storage, regulation and conveyance of water by means of large dams, channels and pipelines. This level relates to public works that need large investments and long periods of amortisation. In most cases, this level is only associated to surface water, since groundwater usually does not need such large infrastructures. Final users of this level are either Municipalities or urban water suppliers and Irrigation Associations.

The second level, called *low supply level*, is comprised of distribution networks, such as urban pipes, used by Municipalities or Irrigation Associations which supply the resource directly to water users: farmers, households, industries, and energy plants. This level also includes those infrastructures needed to return wastewater to watercourses, including drains, sewerage systems and wastewater treatments plants, that work under the conditions set out by water legislations. Final users of this level are mainly households and farmers. It is important to mention that, in most cases, industrial users are connected to the urban network and only a small number of large industrial units has their own water supply system.

There are interrelated responsibilities between those two levels (*high and low supply*) and the Spanish Administrations (central, regional, and municipal). As a rule, River Basin Authorities (RBAs), which are autonomous public organisations within the Ministry of Environment, are in charge of the management of water hydraulic systems that make possible the *high supply level*. Each system usually includes one or more dams and a number of distribution pipelines or channels that form a unique exploitation system suitable to be managed as a single administrative unit.

The *low supply level* is focused on water delivery to urban and irrigation areas. Generally, the Municipalities are in charge of drinking treatment plants and the urban network distribution, while Irrigation Associations are in charge of the irrigation network and assign water shares to the final user, the farmer. These Irrigation Associations are public entities with delegated management from the RBAs.

Table 41 summarises the institutional map of water services depending on the type of service, responsibility and levies applied.

Table 41 **Institutional map of water services, responsibilities and applied tariffs**

SERVICE	RESPONSIBILITY	LEVIES
Dams and main channels (surface water)	River Basin Authority	*Canon de regulación* (regulation fee) *Tarifa de utilización* (distribution fee)
Wells (groundwater)	Service provided by Municipalities, Irrigation Associations or individual users	Either by Municipalities or by Irrigation Associations (see below)
Water distribution in urban areas	Municipalities (with Regional Governments in some cases)	*Tarifa de abastecimiento* (urban water supply fee)
Water distribution to irrigation	Irrigation Associations ("public entities" with delegated management)	*Derrama* (apportionment of taxes): Apportionment of expenditures (according to cultivated ha, water use or combination)
Wastewater collection and treatment in urban areas	Municipalities and Regional Government	*Canon de saneamiento* (sewage fee, only for urban and industrial uses)
Control of discharges	River Basin Authority	*Canon de control de vertidos* (surveillance discharge and spill fee, only for urban and industrial uses)

5.3. Cost recovery analysis for surface waters

5.3.1. Services of abstractions and conveyance of surface waters

The Júcar RBA is the main provider of surface water resources to cities and Irrigation Associations as well as industrial users and hydroelectricity companies within the District. The RBA is also in charge of the management of each "*exploitation system*" suitable to be managed as a single administrative unit. Figure 167 shows hydraulic infrastructure facilities for water supply within the Júcar RBD.

Costs (and the cost recovery) of services provided by the RBA need to be assessed in the context of its contribution to the total cost of water services in the basin. The RBA has been efficient at providing services of surface water at relatively low costs (including subsidies), but it only provides 25% of the total abstraction services (75% are "self- services" of farmers from GW and urban water distributors). The highest costs come from distribution (including cost of GW abstraction), wastewater collection and treatment services of both urban areas and Irrigation Associations.

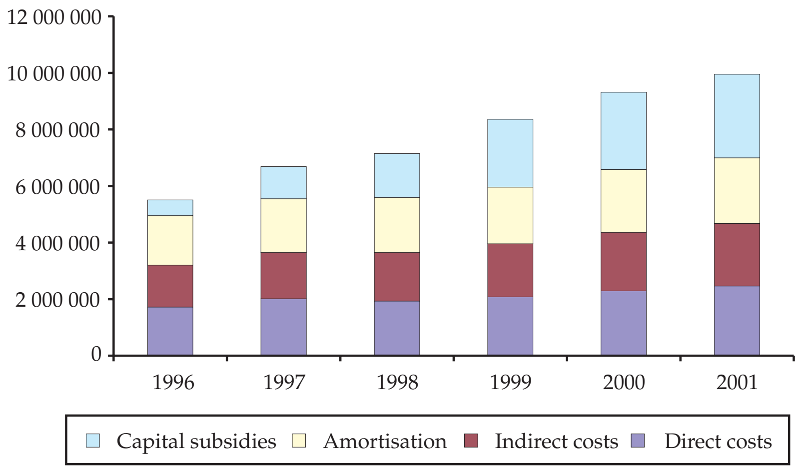
Total costs for water services of abstraction, storage, regulation and conveyance of surface water by means of large dams, channels and pipelines, provided by the Júcar RBA were 8.4 million euros in 2001 (at current prices), excluding the cost of flood prevention services of multifunctional infrastructures of 1.5 million euros. This contrasts with the 92.9 million euros of total estimated costs of services for GW abstraction. 54% of costs of services provided by the RBA were capital costs, and 46% current costs (direct and indirect).

Hydraulic infrastructure facilities for water supply — Figure 167

The importance of cumulative subsidised capital costs as a percentage of the total has been increasing steadily since 1996 (figure 172). Whereas in 1996 they represented 10% of the total, in 2001 it amounted to 29% of total costs.

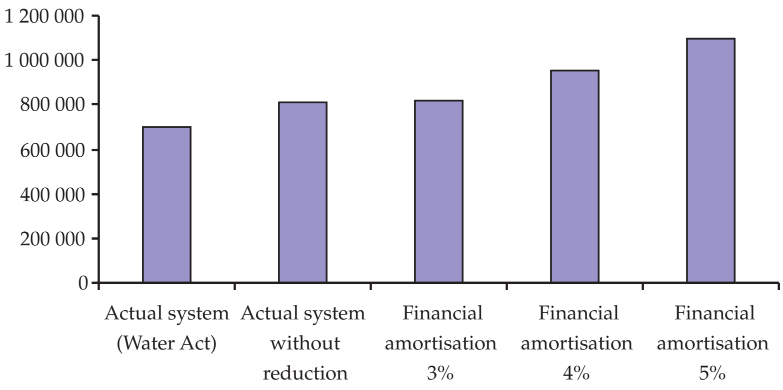
The subsidised investments are amortised over the working time of the infrastructures in the same way as non subsidised ones are. Therefore, the capital subsidies calculated for one year include previous annuities in addition to the current ones. As a result, these amounts increase each year, specially since European subsidies are received.

Evolution of the structure of total costs of water services provided by the Júcar RBA, in euros — Figure 168



Note: data include cost of flood prevention services
Source: GDW

Figure 169	Comparative analysis of several amortisation models in the Júcar RBD (€)



Source: GDW

A comparative analysis of several rules for determining the annual amortised cost value has been carried out by the Spanish Ministry of Environment for the infrastructures built after 1986. This analysis reveals that similar results for the actual rule or Water Act, are obtained if analogous amortisation periods are used, even when the comparison is made with amortisation rules used by financial entities (figure 169).

In the cost allocation for the different users/beneficiaries, the flood prevention is considered as one beneficiary more, together with present and future users. Dams are multifunctional infrastructures that provide important flood prevention/protection services in the Júcar RBD. These are considered public goods that are not recovered by users, since it is considered that they must be financed by the society as a whole. Costs of flood prevention are shown in table 42.

In the case of the Júcar RBD, about 69.5% of the total cost (without including subsidies) is related to the different types of present users and it is charged to them by means of levies and fees. There is a cost of about 15% that accounts for the reserved infrastructures capacity for future users that is not being charged, in addition to a 15.5% associated to the concept of floods that is neither charged to users for water services (figure 170).

After deducting the cost associated to flood prevention and stock for future users, the remaining cost is distributed through the different users. This procedure is regulated by article 301 of the *Reglamento del Dominio Público Hidráulico* (Hydraulic Public Domain Regulation), where the criterion applied is based on the magnitude of the water supply, the rationalisation of water use, the equity in the allocation to different users and the self-financing for services.

In Spain, the process set to establish these allotments is based on a system of equivalence coefficients for water consumption that takes into consideration the strategic valuation of the resource and those benefits obtained by users due to its use.

Allotments for each user come from a function of theoretical benefits coming from the use of water. These equivalences are fixed in the *Juntas de Explotación* (Exploitation Boards) meetings for each exploitation system.

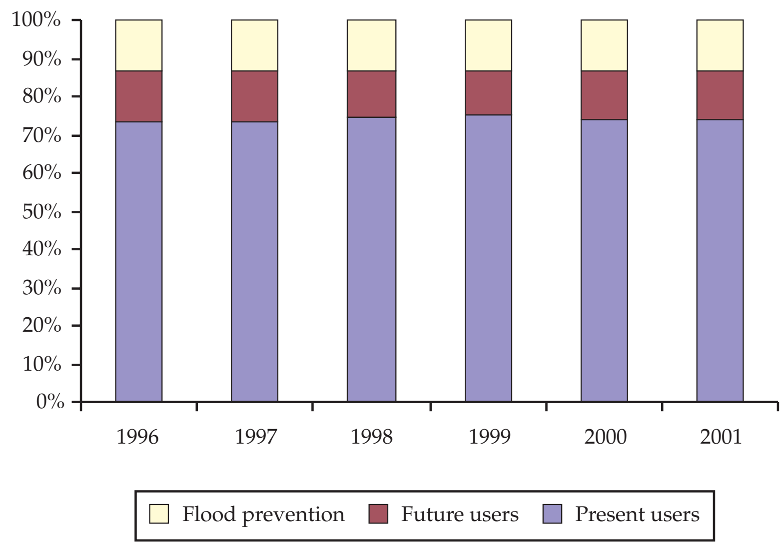
During past years, the equivalence between agricultural and urban uses has been established with a ratio of 1 m^3 of water for urban use to 4 m^3 for agricultural use (1 to 4). This means that for each m^3 of water supplied, agriculture pays 25% compared to urban supply (table 43).

Cost of flood prevention — Table 42

SYSTEM	% of total costs of dams associated to flood prevention	Costs € associated to flood prevention in 2001
Arenós - Sichar	20%	258 249.28
Benagéber - Loriguilla	15% 50%	239 219.33
Alcora	30%	10 492.76
Amadorio	15%	23 571.94
Arquillo	80%	93 124.64
Beniarrés	20%	27 714.97
Contreras	15%	168 915.26
Forata	15%	15 055.95
Guadalest	15%	28 588.00
María Cristina	70%	40 783.17
Regajo	25%	24 481.21
Ulldecona	20%	23 523.24
Alarcón	15%	133 777.88
Total cost for lamination		1 087 497.63

Note: capital costs subsidies of 0.458 million euros in 2001 have not been included
Source: Júcar RBA

Evolution of the different proportions of costs attributed to each service in the Júcar RBD — Figure 170



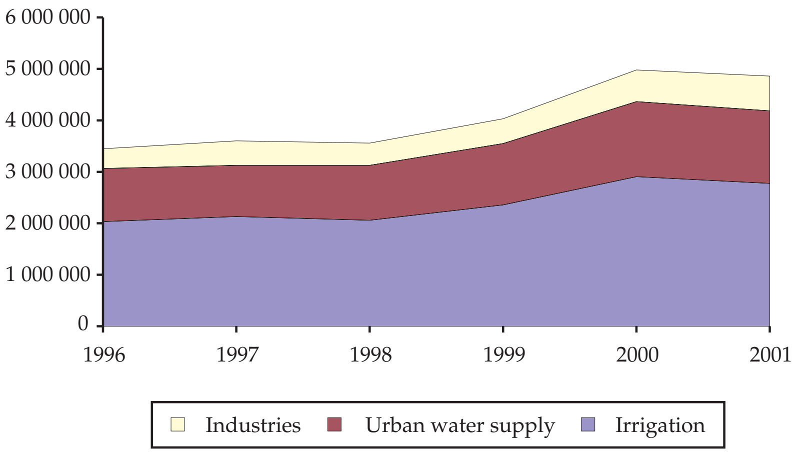
Source: GDW

Table 43	Equivalent coefficients to obtain a theoretical volume in charges calculation in the Júcar RBD

Source: GDW

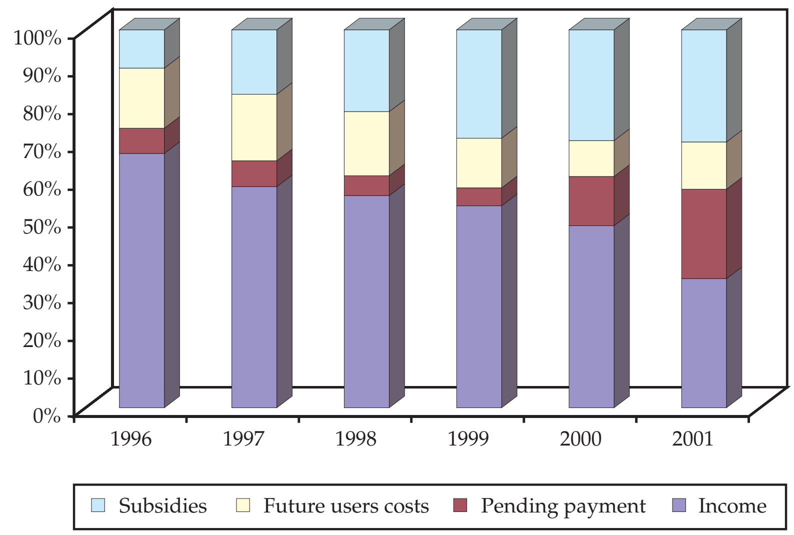
Reservoirs	Irrigation	Urban supply	Hydropower	Industrial
Arenós - Sichar	1*V (m³)	4*V (m³)		
Benagéber - Loriguilla	1*V (m³)	4*V (m³)	0.96*P (kWh)	
Amadorio	1*V (m³)	4*V (m³)		
Arquillo	1*V (m³)	2.5*V (m³)	0.96*P (kWh)	1*V (m³)
Beniarrés	1*V (m³)		0.96*P (kWh)	
Contreras	1*V (m³)	4*V (m³)	0.96*P (kWh)	
Guadalest	1*V (m³)	4*V (m³)		

Figure 171 Invoices by type of users in the Júcar RBD (€)



Source: Júcar RBA

Figure 172 Evolution of water services cost allocation in the Júcar RBD



Note: flood prevention services, their costs and subsidies, are not included in this structure
Source: GDW

The total amount invoiced for user charges was 4.9 million euros in 2001, and these have been increasing steadily (in current prices). 50% of the total invoiced amounts are due to irrigation users.

In 2001, from the total cost of water services of abstraction, regulation and conveyance of water by means of large dams, channels and pipelines provided by the Júcar RBA (excluding flood prevention costs, but including subsidies), the 57.8% was invoiced to present users, but only the 34.2% has been actually collected, due to the delay in the pending payments. The rest of these costs, not charge to users, are attributable to future users warranty (12.5%) and to capital subsidies (29.7%).

5.3.2. *Water distribution, wastewater collection and treatment services to urban users*

The cost recovery analysis of the District has been carried out for urban services of water purification, distribution, wastewater collection and treatment services that are provided for a population of 4.3 million in addition to other urban consumers (industries, commercial and institutional users). This population within the District is distributed as follows: 3.9 million in the Valencian Autonomous Community, 48 000 in Teruel, 370 000 in Cuenca and Albacete and 18 000 in Tarragona. Municipalities are responsible for these services, and these are delivered directly to each municipality, to a group of them (mancommunities), and/or through specialised organisations via concessions with private companies, or through public or Public Private Partnership (PPP) companies[1] (around 37 privates companies operate in the Júcar RBD). This delivery of

[1] Two main sources of information on costs have been drawn for urban use: the annual exploitation report of water supplying companies and the distribution tariffs approved by the *Regional Water Pricing Commissions* to be charged to municipalities.

Cost of water purification and distribution services - 2002 (80% of the population) — Table 44

Region	Population	Volume delivered (m^3)	Total costs (€)	% of population sampled	Cost per m^3 (€/m^3)	Annual cost per person (€/person)	Average income per m^3 (€/m^3)
Valencian Region	3 353 995	282 292 246	204 908 917	86.11%	0.73	61.09	0.71
Cuenca and Albacete	82 965	6 084 092	4 343 819	22.30%	0.71	52.39	0.85
Teruel	31 158	2 915 000	1 095 396	64.70%	0.38	35.16	0.37
JÚCAR	3 468 118	291 291 338	210 264 417	80.37%	0.72	60.63	0.71

Source: GDW

water services occurs similarly for wastewater treatment services, although in this case Regional Governments have created specialised organisations to provide them.

Information on costs and incomes from user charges for these services provided by responsible authorities[2] shows that total costs for services in the Júcar RBD in 2002 was 377 million euros and total income was 360 million euros. Total water provided to urban consumers has been estimated in 360 hm^3/year, with an average efficiency of 80% of the networks. The unit cost was 1.05 euros and average income per m^3 consumed was about 1 euro.

Cost recovery of water purification and distribution services (corresponding to about 80% of the population), shows that the average cost in the RBD of these types of services is 0.72 euros per m^3. This includes the payment of the charges to the Júcar RBA for services provided and the costs of groundwater abstraction. The costs of these services represent 69% of total costs of water services in the RBD, and they are about 60 euros per person per year.

Estimates of total costs, factoring up for the total population and according to the m^3 consumed in the different areas of the basin, allow calculating total costs for providing the services in the Júcar RBD, which are close to 259 million euros per year (total income of 257 million euros). 90.4% of this total corresponds to services in coastal municipalities of the Valencian region, 9% of those in Albacete and Cuenca, and 0.6% of those in Teruel.

Differences in average unit costs aggregated by region are not significant, except in the case of Teruel, which presents lower unit costs. Differences observed in unit costs are often due to different causes that include: different costs of water abstraction according to whether they use surface (1/3) or groundwater (2/3) or mix sources (including desalination); and whether services are provided by a public, private company or as municipal services considering also that accounting practices are different according to the law. An important factor to consider in the analysis of unit costs is the importance of non-resident population (tourism) in the coastal municipalities. Infrastructures, therefore, have to be designed in these areas for a greater population and maintained all year around.

The income of this service comes from tariffs paid by users, but models of tariffs are not homogeneous in all the regions. The most common models consist of two part tariffs. The first part is intended to cover the fixed cost of services, while the second part is volumetric and has several blocks of consumption (from 1 to 3, but in some cases there are up to 7). Invoices are usually bimonthly, but may also be monthly and quarterly. In the Júcar RBD the average tariff for a consumption of 88 m^3 is about 0.5 euros per m^3 (data from AEAS Spanish association for water supply and wastewater collection, 2001).

[2] Direct information have been obtained for services provided in around 200 municipalities of a total of 750 (around 80% of the population in distribution services and 90% of population in wastewater treatment services). Information on cost recovery in small municipalities of less than 2 000 people (not incorporated in bigger delivery areas) and estimation of cost recovery of wastewater collection has been difficult to obtain in most cases.

The average income for water distribution and purification services was 0.71 euros per m^3 delivered. This price reflects a level of cost recovery of more than 98% of the costs of purification and distribution services. This data corresponds to those services provided for the 80% of the population of the District.

Information collected and analysed shows a level of subsidies of 2% for total costs. These subsidies are mainly used for capital costs, and they come from a variety of sources including European funding, Central government and regional Government Departments. Subsidies to capital costs may come in the form of direct investments from Governmental agencies (mainly the regional Department of Public Works or Environment) or capital transfers (mainly from the Ministry of Public Administration through the provincial governments and the Regional Government Departments of Local Administration). These are often, in turn, financed by the European Regional Development Funds (ERDF) or by the Cohesion Fund. Since 1995, Municipal Governments have also received directly Cohesion Funding. Small municipalities in rural areas and those in areas with aged population are favoured by the Ministry of Public Administration subsidies, and in these cases, subsidies per person can be seven times higher than in other regions.

Regarding the cost recovery of wastewater collection and treatment services: the Institute of Water of Aragón (for Teruel), EPSAR (public regional company in the Valencian region) and the municipalities of Albacete and Cuenca[3] show that the average cost in the Júcar RBD of wastewater treatment services was 0.25 euros in 2002 per treated m^3, an average of 17.53 euros per equivalent inhabitant.

Estimates of total costs factored up to the total equivalent population (6.7 million) with wastewater treatment services allow calculating the total costs of providing services in the RBD, and results show that 0.25 euros/treated m^3 is the unit cost. 90% of these costs are incurred in services provided in the coastal provinces of the Valencian Autonomous Community.

Average income per m^3 in 2002 was 0.22 euros per m^3, which reflects a level of cost recovery of more than 90% for wastewater treatment services. This information corresponds to services provided to 88% of the population.

Sewage collection services are mainly provided by Municipalities and information on these services has been obtained only for a sample of Municipalities through an ad-hoc survey. This information has been complemented with the investment budget analysis in major cities of the basin. Data is still insufficient and difficult to obtain. Preliminary data provided for the main provincial capitals allowed calculating the average costs per m^3, which results showed an approximate cost of 0.42 euros/m^3 (including capital costs). Income from sewage collection charges has been estimated in average to be 0.16 euros/m^3.

The important level of subsidies in this service is related to the fact that Municipalities directly carry out investments partly with financing from the Ministry of Public Administration (through the Regional Governments), which is only in part reflected in user charges. The investments in the

Table 45 **Wastewater treatment costs in the Júcar RBD 2002 (% of the total treated wastewater)**

Source: GDW

Province/Region	Volume (m^3)	Equivalent inhabitant (e i)	Covered services	Total costs (€)	Cost (€/m^3)	Cost (€/e I)	Average income (€/m^3)
Valencian Region	418 157 644	5 994 075	100.00%	106 033 721	0.25	17.69	0.2275
Teruel	3 717 525	63 799	100.00%	1 025 050	0.28	16.07	0.2263
Cuenca and Albacete	5 840 000	136 000	14.33%	1 497 847	0.26	11.01	0.1963
TOTAL JÚCAR	**427 715 169**	**6 193 874**	**88.40%**	**108 556 618**	**0.25**	**17.53**	**0.2271**

[3] Data has been provided for 100% of the services in the regions of Valencia and Aragón. This is not the case for the provinces of Cuenca and Albacete that represent 10% of total wastewater treated in the Júcar RBD.

Júcar RBD in wastewater collection infrastructures are also carried out to provide services of collection of urban runoff, often considered a "public good". This is especially important in the coastal provinces of the Júcar RBD, characterised by presenting torrential rain. To guarantee the safety of the population, in addition to the services of sewage collection provided to individual beneficiaries, is considered a main public responsibility.

Cost recovery of water services in the Júcar RBD is shown in figure 173. Overall, cost recovery of services provided in 2002 to urban water consumers was 95.74% (when costs of sewage collection services are included in the analysis this value decreases).

Investments in urban water services (distribution, sewage collection and wastewater treatment) during the period 1992-2002 in the Júcar RBD, were 1 464 million euros (at constant prices of 2002). Temporal evolution of these investments is shown in figure 174. The main use of investments in urban water services is for the service of wastewater treatment (57.2% of the investment), followed by the water supply service (32.7%) and the sewage collection services (10.1%). There is some missing information for small and medium size municipalities and for some Regional Governmental Departments.

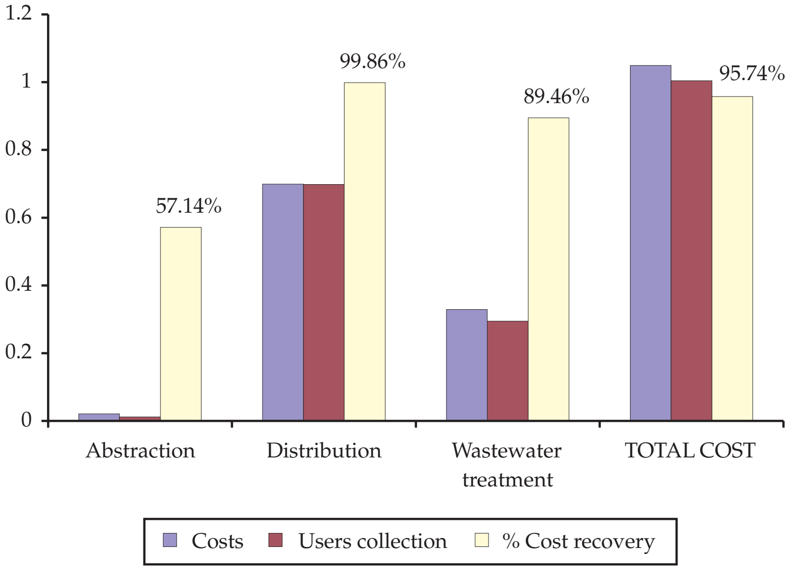
Analysing the sources of subsidies of the urban water services of distribution, sewage collection and wastewater treatment, it is found that main agents during the last decade were the Autonomous Governments (60%) in turn often funded with ERDF funds, followed by the Ministry of Environment (in part with European financing) and the Provincial Governments (with ERDF co-financing). The investments financed with Cohesion funds for projects of the regional governments or the Municipalities have been increasing steadily since 1997.

5.3.3. Water distribution services for irrigation farmers

Cost recovery of water distribution services for irrigation farmers is obtained from services provided by Irrigation Associations. The distribution services of irrigation water are often either "self-services" (individual farmers abstraction and transportation from wells) or are provided by Irrigation Associations.

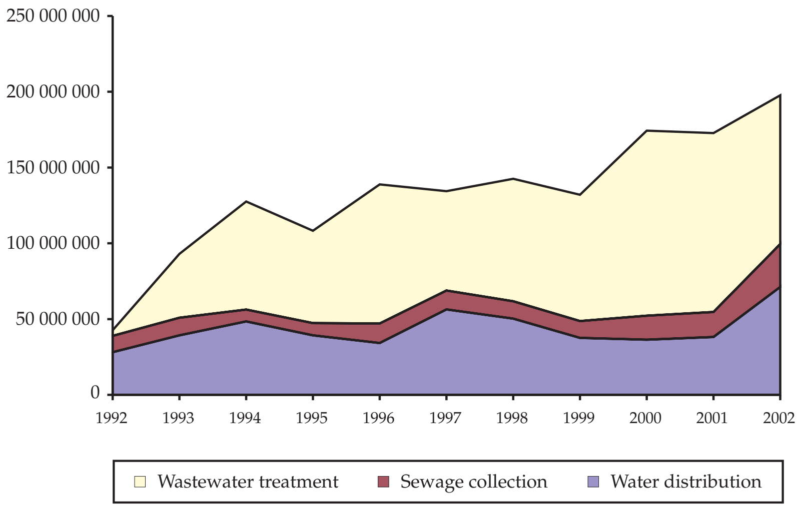
Irrigation Associations mainly provide water distribution services but also, in some cases, advisory services to farmers, regarding for example fertilisers and pesticides, crops and markets. Associations may also provide important water management services when it is necessary to organise common management issues and mediate in conflicts between different associates. They have a public statute and their decisions are binding although the Júcar RBA exerts tutelage and members can appeal decisions to the Júcar RBA.

Cost recovery (€/m³) of water services in the Júcar RBD — Figure 173



Source: GDW

Investment in urban water services in the Júcar RBD. 1992-2002 — Figure 174

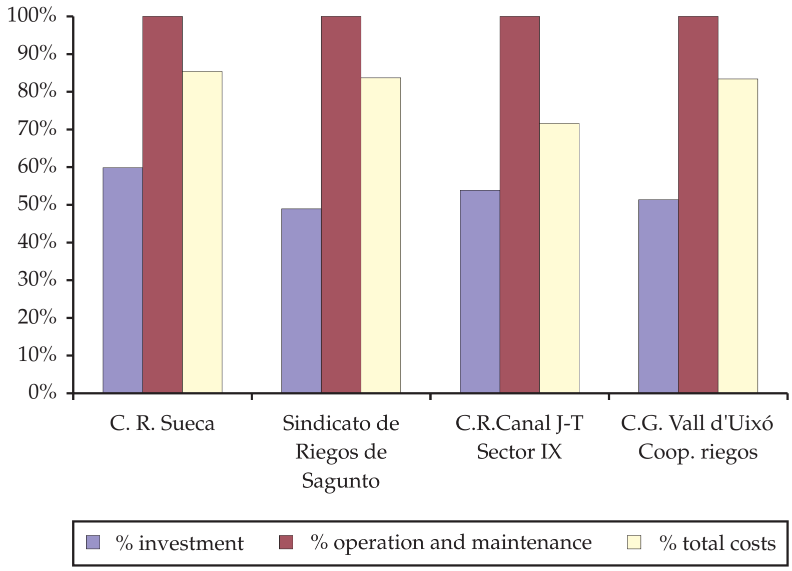


Note: data in euros, at constant prices of 2002
Source: GDW

The analysis of cost recovery of distribution services provided by Irrigation Associations must be seen as provisional. A review of information sources and a cross checking of information from them, including the survey of the National Institute of Statistics, have shown inconsistencies of information and different results from detailed field studies. The National Association of Irrigation Associations (FENACORE) and regional departments of agriculture have collaborated in carrying out an ad-hoc survey of the associated members and in providing information on investments and co-financing of Irrigation Associations. This analysis based on provisional information[4] has shown that the total costs of services provided by Irrigation Associations can vary as much as from 430 to 1 360 euros per ha per year (including estimated capital costs of subsidised investments). Variations are related, in part, to the source of water (surface or groundwater or mixed) and to the extension covered by the services, but the most important costs are associated to personnel (varying between 39% and 56% of the total cost). Costs include payments made to the Júcar RBA by Irrigation Associations using surface water and the costs of amortisation, operation and maintenance of common wells.

Irrigation associations have received subsidies to carry out investments for the improvement of the collective distribution infrastructure; to adapt networks to make it possible for farmers to install drip irrigation; and in some cases for the construction of desalination plants. Regional Governments also carry out some infrastructures (declared of general interest) incorporated in the Public Works plans, as for example main channels, or those associated to small regulation reservoirs and for wastewater reuse. These subsidies and direct investments are co-financed by the ERDF or the European Agricultural Guarantee Fund (EAGF) and the Regional Government and Central government.

Figure 175 Cost recovery in a sample of Irrigation Associations



Source: GDW

The information provided by the Regional Government of Valencia showed that from 1986 to 2002 there has been a total investment of 819 million euros (975 million euros at 2002 constant prices) varying between 7 million in 1986 to 109 million in 2002. 323 million euros of investment costs have been provided by the irrigation farmers for the same period, which accounts for 39%.

According to provisional figures, the rate of cost recovery varies on average between 72% and 85% (figure 175).

5.3.4. *Detailed cost recovery studies*

Following, specific and more detailed cost recovery studies carried out in the Júcar RBD are described. Up to now, most of the work developed for the economic analysis has been focused in a preliminary study case aiming to assess the cost recovery degree of water services in one of the 19 hydraulic systems existing in the Júcar RBD. This system is called Benageber-Loriguilla (figure 176).

Table 46 Total income (€) of the Júcar RBA from user charges to irrigation farmers (current costs)

1996	1997	1998	1999	2000	2001
2 033 665	2 132 781	2 059 324	2 357 330	2 906 100	2 775 887

Source: GDW

[4] Detailed information on investments and subsidies has been provided by Irrigation Associations of Cuenca, Albacete and Teruel. Information from Valencia is not available yet at the same level of detail, and has therefore not been incorporated in the analysis.

The Benageber-Loriguilla hydraulic system comprises two dams and one conveyance channel, in addition to networks associated to the *low level supply* as main distribution conduits, wastewater treatment plants, and their users. Figure 176 illustrates the hydraulic system and the location of those main users.

This study case is going to be used as a model for conducting similar studies in each water hydraulic system within the Júcar RBD.

The methodology used for this economic study resides, for the most part, in carrying out an appraisal between cost and fees charged to the different types of users for every service measured by unit of volume. Since most of the information needed to develop the study was not directly available to the Júcar RBD because some services and the associated charges are the responsibility of other Administrations and water users, gathering and collecting of this information was a crucial stage in this study.

A separate analysis has been developed for each of the two levels of supply previously described: the *high level supply* and the *low level supply*. In addition, the wastewater treatment component has also been considered as an independent level.

Flow regulation and water distribution, mainly to Municipalities and Irrigation Associations, is managed by the Júcar RBA by means of large dams and channels. The cost associated to this part of management can be apportioned into the following concepts: direct-indirect expenses and amortisation.

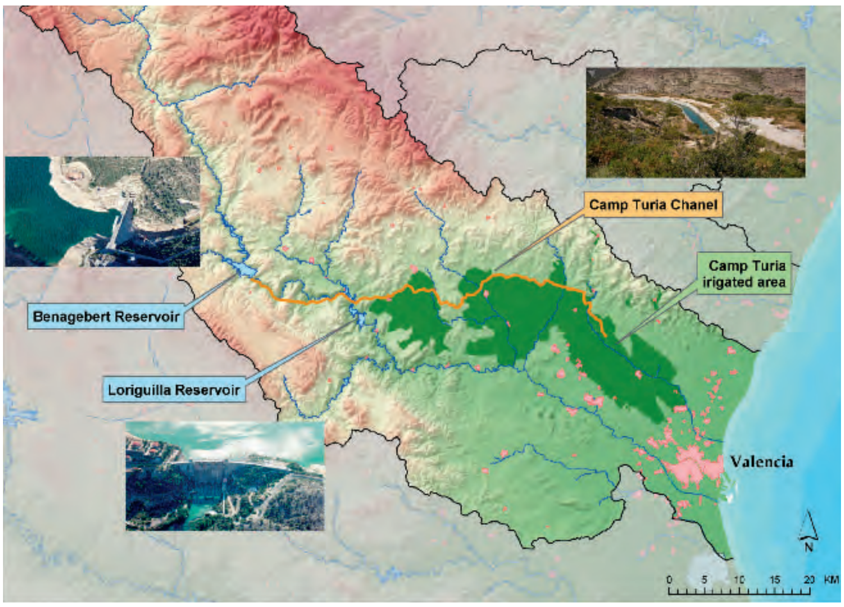
The costs associated to direct and indirect expenses are divided into two groups and made available by the RBA, since this entity is in charge of the operation, maintenance and custody of hydraulic systems. These costs can be divided into operation/maintenance expenses (direct cost) and general functioning expenses (indirect cost).

The repayment cost is calculated in an analogous way as it is established for the regulation fee, that is, annual amortisation of 4% discount rate for a period of 50 and 25 years applied to dams and channels respectively.

From ancient times, the construction of infrastructures to regulate and distribute water resource has been a common activity in the basin. Nowadays, infrastructures dated of 500 years still exist and working properly. This represents infrastructures used nowadays, but from the financial point of view, they can be considered amortised. Therefore, given the fact that some of the hydraulic infrastructures managed by the RBD have been functioning for a time comparable to, or even much greater than, the redeemed period selected, the following two cases had to be considered.

- Case (1): the initial overall investment is well known and was done not long ago (few years or a decade at the most), then the cost is evaluated by means of regular repayment laws used by financial agencies or banks.

Benageber-Loriguilla hydraulic system and associated water users Figure 176



- Case (2): the initial overall investment is unknown, and even if it could be obtained, the infrastructure has been functioning for so long, that the cost updating to the current value provides null results. In this situation, models for assessing the overall construction cost have been used.

A differentiation has been made according to uses and different expenses costs for the level of distribution for the *low level supply* (networks of urban supply and irrigation). Two main sources of information on costs have been drawn for urban use: the annual exploitation report of water supplying companies and the distribution tariffs approved by Regional Water Pricing Commissions to be charged to Municipalities.

From the annual exploitation report of water supply companies, detailed information was obtained for the following: overall expenses corresponding to exploitation and administration, investment carried out, income and revenue corresponding to water treatment and distribution service and volume of water distributed and billed (considering water losses through the network). From the exploitation annual memory of Irrigation Associations similar concepts as for the urban case were obtained, that is, overall expenses, investment, incomes, revenues and distributed volume.

Investments carried out by different administrations in the modernisation and improvement of the distribution network, and maintenance of secondary watercourses to allow farmland drainage, should be considered as a subvention for Irrigation Associations with no return. These investments could be grouped as: investments done by the Júcar River Basin Authority (RBA), considering a period of amortisation of 25 years with a discount rate of 4%, and investments done by the Regional Administrations, considering a period of amortisation of 25 years with a discount rate of 4%.

In relation with sewer and wastewater treatment the following expenses and fees have been gathered from diverse sources:

- Annual exploitation report from Autonomous Community Administrations from where the functioning and maintenance costs associated to main sewer and wastewater treatment systems were drawn.
- Assessment of the amortisation cost of water treatment plants and main sewer systems obtained from the initial investment, considering a period of amortisation of 25 years with a discount rate of 4%.
- Overall Wastewater treatment levy collected and charged by the Regional Administration and the total sewage volume treated.
- Assessment of the overall wastewater treatment tax collection through the overall volume consumed by households.
- City Budget: Investment, functioning and maintenance costs done by Municipalities associated to sewer and wastewater treatment.
- Overall Wastewater treatment levy collected and charged by Municipalities and total sewage volume treated. Tariff per unit of volume approved by the City Council.

Finally, an estimation of surveillance discharge levies to be collected by the RBA was carried out.

The application of the components and methodology described above was applied to the Benageber-Loriguilla system. Basically, this system encompasses three major elements: a large dam called *Benageber* and its conveyance channel called *Campo del Turia*, and a second large dam called *Loriguilla* located downstream. Basic data on the characteristics of this infrastructure and associated hydrological variables are shown in table 47.

Table 47 **Main characteristics of Benageber and Loriguilla reservoirs**

	Benageber	Loriguilla
Date of construction	1955	1965
Height over foundation	110 m	74 m
Storage capacity	221 hm^3	73 hm^3
Catchment basin	4 365 km^2	613 km^2
Average annual regulated flow	245 hm^3	184 hm^3
Environmental flow downstream	0.7 m^3/s	0.5 m^3/s

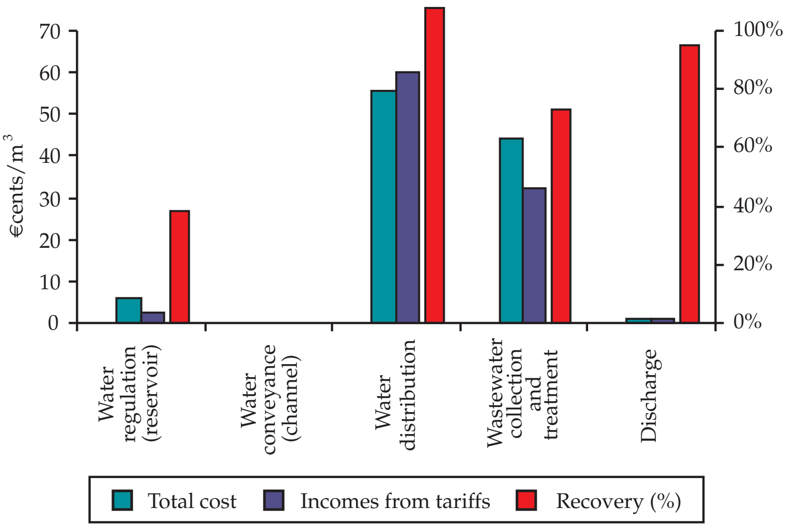
There are users for water services coming from three different sectors: urban, agricultural and hydropower. A geographical analysis was done for identifying, georeferencing and quantifying all users served by either infrastructure. In addition, it was necessary to create a database to gather the previous information required for developing the study.

Urban demand comprises a portion of the Valencian metropolitan area, which includes not only the city of Valencia, but also the nearby towns and residential areas. Agricultural demand includes the area supplied by the Campo del Turia channel including mainly two types of crops, orange trees and vegetables. During an average year, part of the water used for irrigation purposes comes from surface resources of the Turia River, and the rest is taken from aquifers. There is also one hydropower plant at the foot of each dam, which contributes to the electric supply of the area.

The conclusions of the financial analysis after contrasting costs and incomes from tariffs for different users can be summarised as follows:

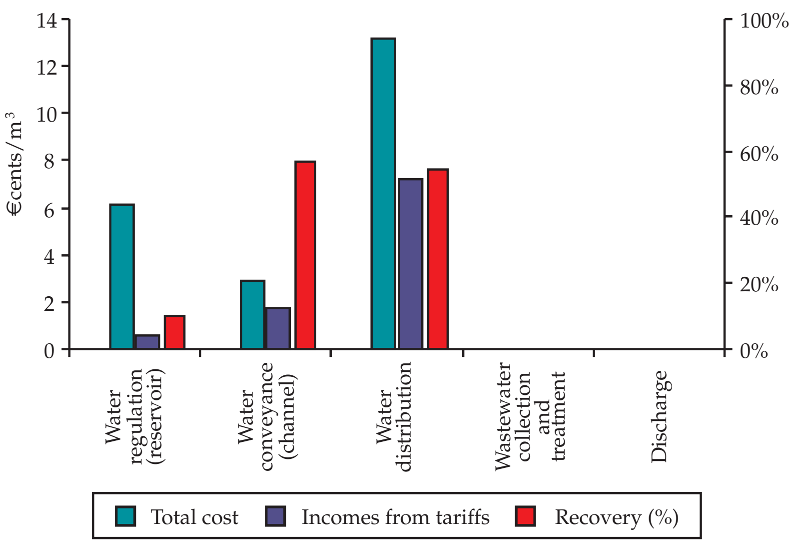
- The greatest portion of the cost for an urban user of Valencia is associated to water distribution, wastewater collection and treatment (figure 177). In the case of an agricultural user of the Campo del Turia, for example, this greatest portion accounts for water distribution, representing 60% of the total cost (figure 178). This information reflects that distribution is what mainly affects the total cost, therefore, the type of amortisation rule used to recover investments in dams and main channels is not highly relevant.
- Operation/maintenance and functioning cost associated to water regulation and conveyance are fully recovered through incomes from tariffs for either type of user.
- Amortisation of investments and operation/maintenance cost associated to water distribution are fully recovered for urban user.
- The total cost associated to wastewater collection and treatment are nearly full recovered, being the degree of cost recovery around 75%.

Cost recovery for the city of Valencia (urban user of the Benageber-Loriguilla system) — Figure 177



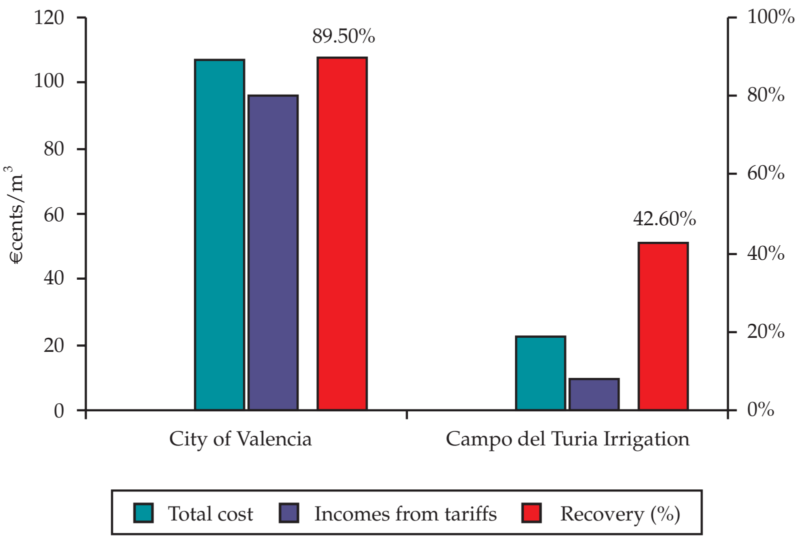
Source: Júcar RBA

Cost recovery for the Campo del Turia channel (agricultural use of the Benageber-Loriguilla system) — Figure 178



Source: Júcar RBA

Figure 179 Cost recovery for users of city of Valencia (urban use) and Campo del Turia (agricultural use) at Benageber-Loriguilla system



Source: Júcar RBA

Finally the relationship between total costs and total incomes from tariffs is showed in figure 179, where the recovery from urban users is nearly 90%, while from agricultural users is close to 45%. This important difference between urban and agricultural recovery is mainly due to the low degree of cost recovery coming from the water distribution to agricultural users.

5.4. Financial cost for groundwater use

This chapter includes the results of a study on financial costs of groundwater (GW) commissioned by the GDW.

Main variables to assess the financial cost for GW use are the cost of well drilling and construction, pumping devices and the associated power supply, but above all, the variable with the most significance is the flow rate of pumping.

The financial cost has been evaluated for each hydrogeological unit (HGU) within the RBD and the following elements have been allocated for each type of user: amortisation cost for well drilling, amortisation cost for pumping device, maintenance and functioning expenses, flow rate, pumping height and total cost.

The cost associated to distribution has not been taken into account in this economical study. Moreover, some externalities have been neglected, as for example the effects on other downstream users.

Furthermore, the following assumptions have been considered for the performance of the financial study:

a) Periods of amortisation:

- 20 years for the cost of the well drilling, construction, sheathing and connection to main and basic electrical civil works.
- 10 years for the cost of electrical transformers and pumping devices, which include pipelines and pumps with the complementary equipment.

b) The amortisation cost is a constant value all over the years since the rate for updating is considered to be zero.

c) Discount rate has adopted a constant value of 4% through all the amortisation period.

d) The price of electricity has been considered as a constant value (0.07 euros/kWh)

e) The initial investment for well drilling and well construction has been evaluated as a lineal function of the drilling length. The cost for a unit of length fluctuates between 144 and 264 euros.

f) The investment for the pumping device mainly depends on the flow rate and the pumping height. For each groundwater unit an average pumping height has been adopted by computing mean values of the last 10 years.

g) The assessment of maintenance and functioning expenses, which include repairs, checking, lubricants and labour expenses associated to the personnel in charge of functioning and custody, have been simplified as 2 percentage of the overall initial investment cost.

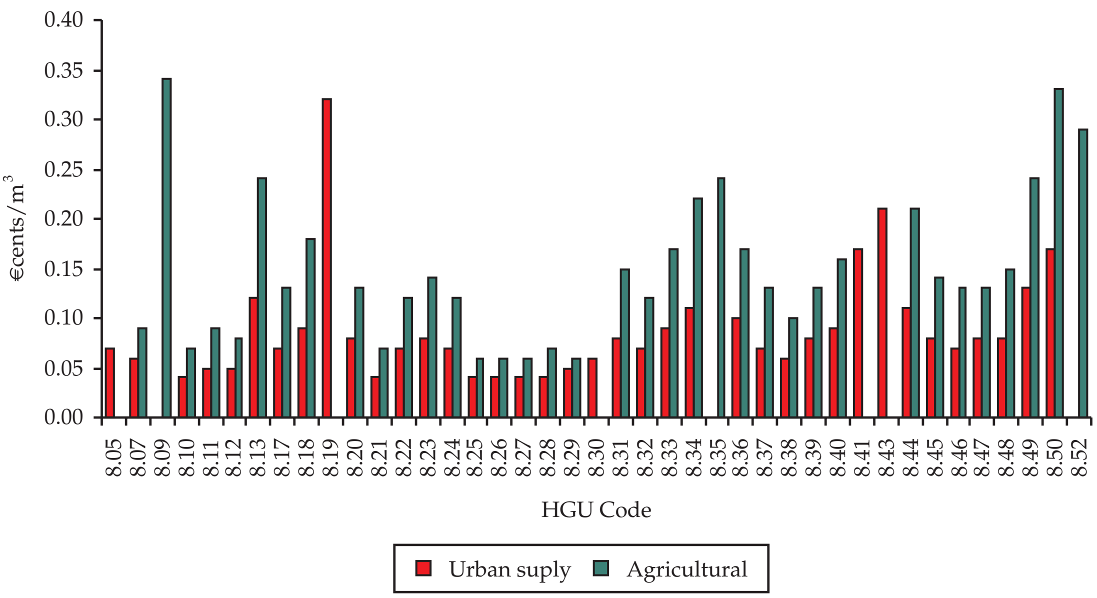
The resultant cost is obtained by applying the following formula:

$$C = \frac{A_{20} + A_{10} + G}{3.6\, Q\, t} + a\, k\, h$$

Where A_{10} and A_{20} refer to amortisation costs associated to periods of 20 and 10 year previously explained, G is the average expense for maintenance and functioning, Q is the yield rate, t is the number of hours functioning in a year, 3.6 is a conversion factor, a is the cost of energy required to raise a volume of 1 m^3 one meter high, k is the price of electricity (0.07 euros/kWh) and h is the mean pumping height assumed wherever is applied.

Results of this methodology are shown in figure 180.

Cost of a cubic meter for water services from groundwater in HGUs — Figure 180



Source: GDW

As a conclusion, the unit cost (with some exceptions) is under 0.25 euros/m^3, being the weighted average cost 0.06 and 0.09 for urban/industrial water supply and irrigation respectively.

Figure 181 shows that GW cost is higher in the south-eastern region of the Júcar RBD (Vinalopó area) where GW levels are much deeper; being this high cost a limiting factor for groundwater use. On the other hand, in the coastal aquifers of the Valencian Plain, costs are much lower, since aquifer levels are very close to the ground.

5.5. Tools for estimating environmental and resource costs

The provision of Article 5 and Article 9 of WFD, require carrying out an economic analysis (Annex III of WFD) which allow assessing the accomplishment of the principle of cost recovery for water services, including environmental and resource costs, taking account of the long term forecast of supply and demand for water.

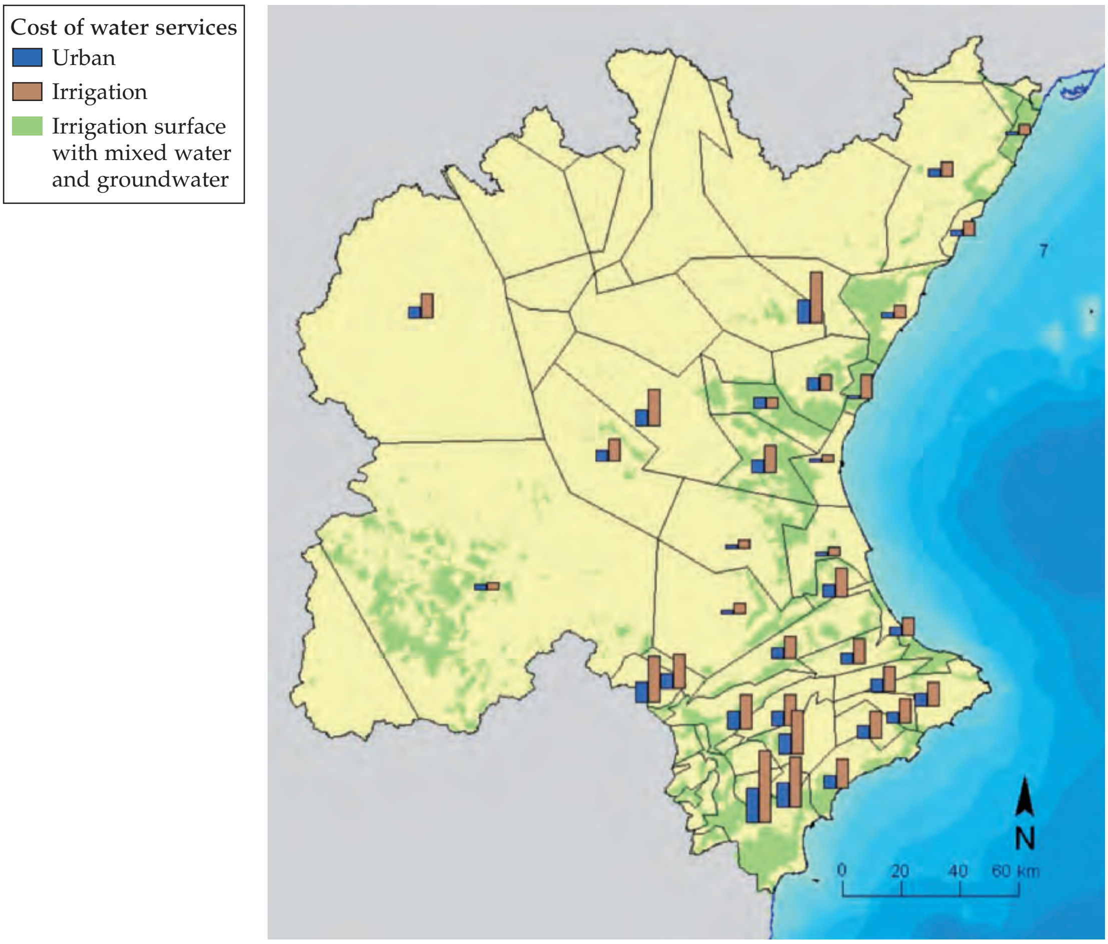
The Júcar PRB apportions the total cost into three separated components: financial, environmental and resource.

The financial cost is being evaluated by the use of the methods previously described. Next, environmental and resource costs are detailed.

5.5.1. *Environmental costs*

Regarding environmental costs, the Spanish legislation establishes a general taxation pursuant to the polluter-pays principle for urban and industrial wastewater discharges into the public domain. There is a levy aiming to protect aquatic ecosystems suffering discharges. This levy is called *canon de control de vertidos* (surveillance discharge/spill fee) and establishes an annual payment for users that discharge wastewater into water bodies, and it is invested in studying, monitoring, protecting and

Figure 181 — **Cost of a cubic meter for water services (agricultural and urban) from groundwater in HGUs**



improving the environment. This levy is not equivalent to those taxes established by Autonomous Community Administrations and Municipalities for financing sewerage and wastewater treatment plant systems. Since these Administrations are also in charge of water supply, the general principle applied for allocating household disposal fees, is that the amount of wastewater is equivalent to the amount of consumed water.

For the purpose of cost recovery analysis, information must be collected on the forecasted costs of measures aimed at reducing, eliminating or mitigating environmental pressures, according to the existing legislation and the actual costs incurred.

The economic value of avoided damages (with future measures) can be estimated with the help of *direct* and *indirect* economic valuation methods. There are, however, many difficulties for implementing this approach in Spain in view of the fact that there are very few partial and context dependent valuation studies.

5.5.2. *Resource costs*

The marginal opportunity cost of the resource (MOCR) in a certain location and time can be defined as the cost for the system of having available one unit less of resource.

The assessment of the MOCR is being carried out by means of hydro-economic models (figure 182) at the basin river scale. These models allow representing dynamically the marginal economic value in different locations in the basin, taking into account resource availability, storage capacity, losses, return flows, surface and GW interactions, and willingness-to-pay (or marginal economic value) of the various demand units. The Hydraulic Engineering and Environmental Department of the Polytechnic University of Valencia, by means of a collaboration agreement with the Júcar RBD, is developing these models.

Economic value functions that express the relation between supplied water and marginal value

Scheme of hydro-economic models for the Júcar River — Figure 182

Source: Júcar RBA

Annual disaggregated demand economic functions — Figure 183

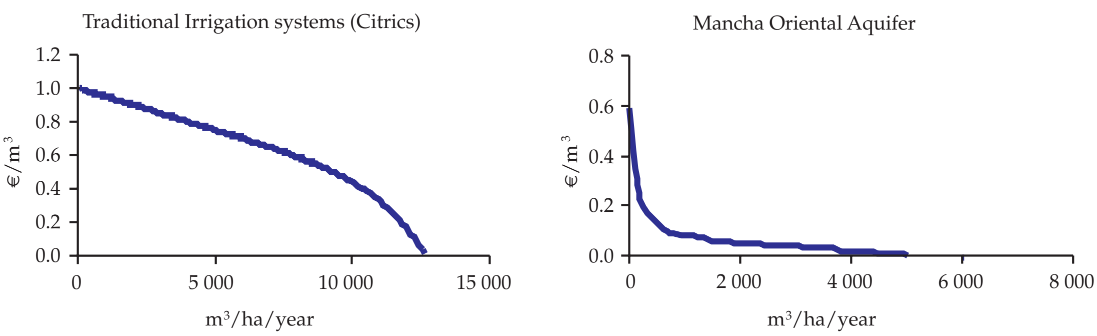
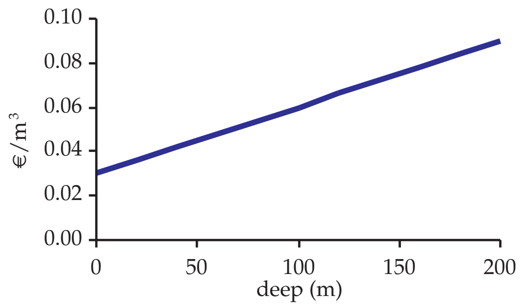


Figure 184	**Approximation to the pumping cost variable of groundwater in the Mancha Oriental aquifer**

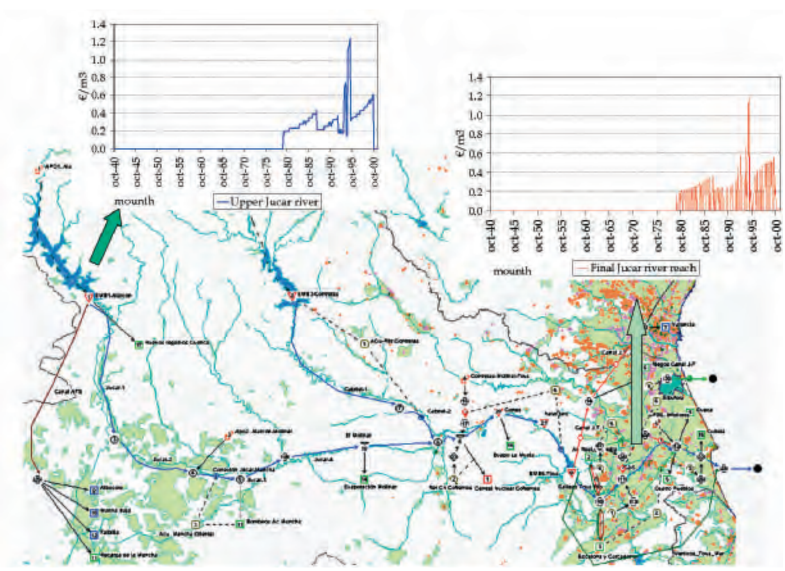


per year are being defined for different water uses (figure 183). The integration of the economic demand function up to a certain level of supply (area under the demand curve) provides the economic benefit imputed to this supply level. It is noticeable that economic functions of elements from the system are essential to obtain useful results.

Operating cost to be considered in the economic analysis includes variables such as cost of intake, distribution and treatment of the resource for both surface and GW supply. In figure 184 the variable pumping cost for GW users of the Mancha Oriental aquifer is shown.

Two complementary approaches that may be used in the economic analysis follow. The optimisation approach, on one side, assumes that perfect market conditions exist that allow for economically optimal water use. In addition, this approach states that the analysis of shadow prices or dual values yields an upper bound of the MOCR at different locations and times. On the other side, the simulation approach assumes that the system is operated with allocation rules established *a priori*. These rules may correspond to priorities and historical rights, hence reproducing the current *modus operandis* of the system. The MOCR is obtained by comparing the aggregated benefits of the system with the benefits that would occur if one less unit of water were available at a given location and at a given time. The gap between results corresponding to the economically optimal water use and to the current water allocation system allows assessing the "distance" between the optimum and any analysed management.

Figure 185	**Time evolution of MOCR upstream (blue) and downstream (red) the main reservoirs**



These proposed approaches can be applied to the Júcar RBD since hydrological models for water management, which reproduce surface and GW interactions at the basin level, had been previously developed and successfully applied in the Júcar Hydrological Plan (JHP). In systems in which the GW component is important, the model must be able to simulate both the surface and the GW systems, as well as their interaction. The isolated analysis of an aquifer would not allow assessing pumping stresses influences on the ecological status on downstream locations. The computation modules for incorporating the economic analysis to these hydrological models have been recently developed and tested.

The use of these models captures and highlights the spatial and temporal variability of MOCR. To obtain the resource cost at a certain location and time (for instance a given month), the perturbation entails to add (or remove) a differential water volume (ΔVolume) at the location of interest. Thereafter, the model carries out a new resource allocation, using the allocating rules, and after that, the total economic benefit of this modified case is evaluated. The difference in total benefit from the base to the modified case is computed. The ratio ΔBenefit/ΔVolume is an approximation of the marginal resource cost. This reflects the economic cost of water scarcity, according to the allocation criteria declared. Figure 185 shows the time evolution of MOCR upstream and downstream the main reservoirs. The highest MOCR values correspond to the driest periods, when it is not possible to provide all the supply to cover demands.

Finally, it has to be noticed that, once hydro-economic models are in operation, they can provide additional interesting economic outputs. For instance, a similar approach could be applied in order to assess the opportunity costs incurred by the society as a consequence of the use of resources to achieve and implement environmental regulations and the resulting reduction in production. Given the difficulty in assessing environmental cost as costs of damages done to the ecosystem, an indirect partial assessment of environmental costs could be the marginal opportunity cost of the environmental measures that allow maintaining the good ecological status. For example, the maintenance of ecological flows in a reach of the river represents a cost for the system, which corresponds to economic losses for supply reduction in the affected demands.

Impact assessment of measures applied to reach environmental objectives, requires the use of models that incorporate a good understanding of the hydrological cycle and the relationships between pressures, impacts and measures.

Impacts of different measures to improve the quality of water bodies may be either measures for reducing the quantitative pressure on the resource or measures with greater emphasis on the improvement of the physico-chemical quality of water. Quantitative measures include demand management, improvement of supply efficiencies, system's yield increase and supply increase among others. Contrary, qualitative measures include sewage treatment and control of disposals. These two types of measures are not independent, but are in fact closely interrelated. This analysis has to be undertaken by water bodies, but also in a comprehensive way by water systems. The pilot case analysed for the Cidacos River basin for application of the WFD (MIMAM and Gobierno de Navarra, 2002) is a clear example of the importance of taking into account the interrelation among the different water bodies. This study finds out that considering three river reaches conjunctively reduces considerably the global cost of the program of measures to achieve the quality standards. It also shows that the least expensive alternative is obtained by implementing more measures in the upstream reach than the strictly required for the reach. A comprehensive model that integrates water quality and quantity aspects is required to simulate the effectiveness of measures taken for each water system. Besides, return flows of different uses have to be properly quantified. In conclusion, water quality and water quantity interactions between surface and GW subsystems call for an integrated basin modelling.

A model for water quality assessment in the Júcar River system is also being developed. The model can be used to simulate several indicators simultaneously, computing how different measures at different points of a system affect the interconnected water bodies, and the conjunctive effect of the measures to achieve the quality objectives in water bodies.

Therefore, development of cost-effectiveness analysis, determination of impacts and effectiveness of the set of measures on water bodies, and assessment of resource and environmental costs and economic impacts on demands necessarily require developing comprehensive simulation and optimisation models able to reproduce the performance and operation of the system. The models have to include quality and quantity aspects of water resources, infrastructure and economic functions that represent water value for demands and costs incurred in the supply. The models above mentioned (simulation, optimisation and quality assessment models), if included in the same decision support system can be used in an integral, iterative and interactive way. These models can be also used to analyse impacts of different strategies of cost-recovery. The assignment of the cost of measures to different users constitutes not only a financial mechanism for cost-recovery, but also an economic instrument for demand management, which impact can be analysed by the demand economic functions previously estimated.

5.6. Economic characterisation of water use and trend analysis

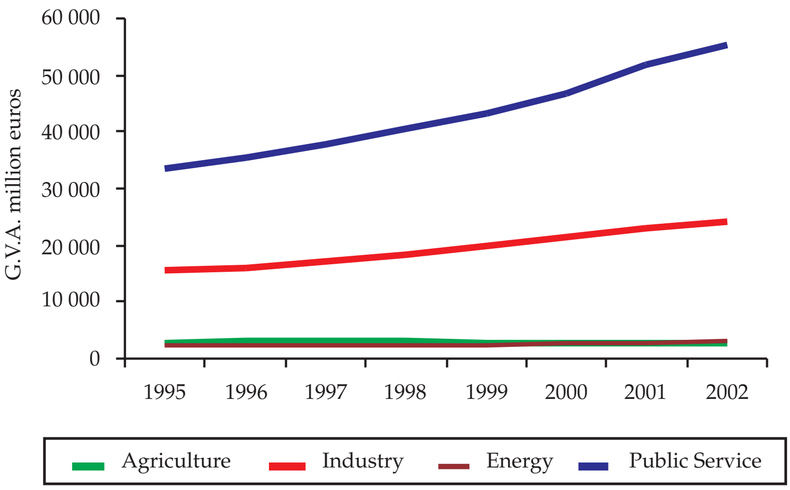
As the GD *"Economics and the Environment"* (EC, 2003b) establishes as the first step for year 2004 the characterisation of river basins, this section develops an assessment of the economic significance of water uses and trend analysis up to 2015.

The analysis developed in this section begins with a general view of the different sectors of the economic activity, valuing the evolution of the Gross Value Added (GVA) and the employment generated by each sector and its general tendencies. As a measurement of general productivity for each of the analysed sectors, the variable updated GVA/employment and its evolution in the last years have been calculated. In order to deepen on these data, a particular overview of each sector is offered, giving a more detailed description (by activity, by regions...) on economic variables, measures related to the use of water and trends for each sector.

5.6.1. *General analysis*

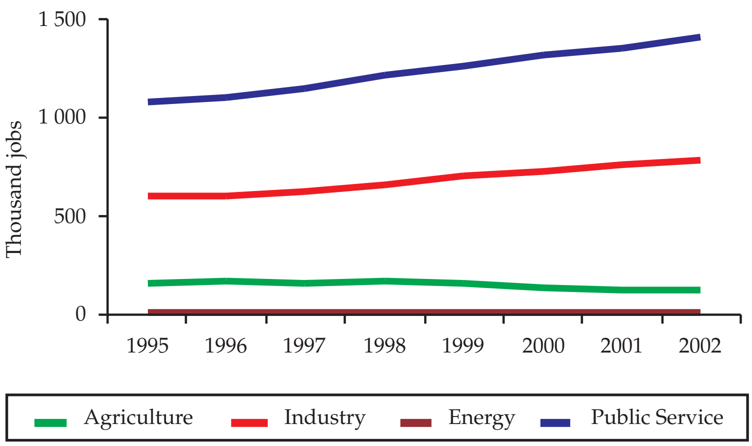
The economic characterisation of water uses begins with a global overview of productive activities in all seven provinces that lie within the Júcar RBD (Albacete, Alicante, Castellón, Cuenca, Tarragona, Teruel and Valencia). This includes the analysis of the GVA evolution, employment and productivity between 1995 and 2002. In order to develop this analysis, the Spanish Regional Accounts by the National Institute of Statistics (INE) have been consulted.

Figure 186	**Updated GVA according to the productive activities in the seven provinces related to the Júcar RBD**



Source: INE

Figure 187	**Employment according to the productive activities in the seven provinces related to the Júcar RBD**



Source: INE

The total GVA of the seven provinces shows an increasing trend and rises to 85 500 million euros in 2002.

The sector that contributes the most to the total GVA (65%) is the public service sector (hostelry, transport, entertainment…) being, in addition, this GVA the one with the greatest annual growth (figure 186). One of the activities to emphasise in this sector is tourism, which contributed in 2002 with more than 1 400 million euros just in the Valencian Autonomous Community. Industry, in value and in growth, is the second greatest sector (28% of the total GVA), leaving the other sectors, agriculture (3%) (agriculture, cattle, forestry, fishing etc.) and energy (4%) (power product extraction, petroleum refining, energy production and distribution etc.) with insignificant growth.

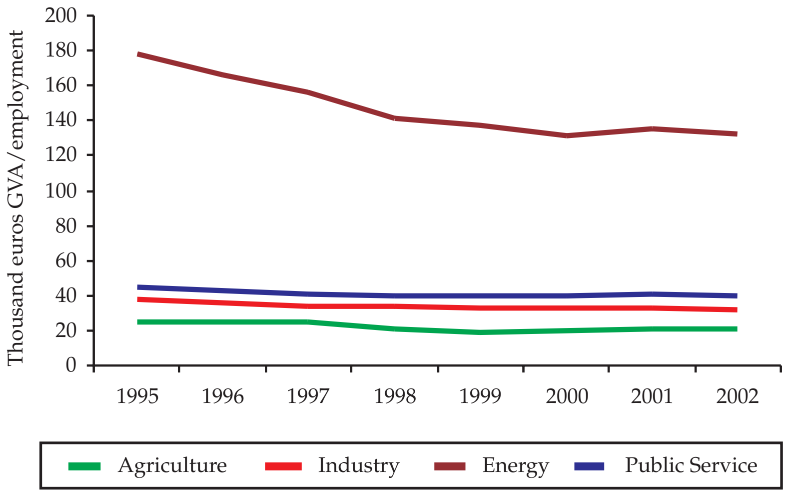
The activity developed in the seven provinces generates, as a whole, more than 2 300 000 jobs, and this number presents an increasing tendency for the last years.

Concerning employment, public service and industry sectors remain as the greatest producers of jobs (60% and 34%, respectively), and they increase annually (figure 187). In the agriculture sector, the number of employments (5%) has descended in the last years, whereas in the energy sector (1%) employment has hardly changed.

As a measurement of the general productivity of each of the analysed sectors, the variable updated GVA/employment has been calculated, obtaining a much greater value in the energy sector, far away of that one obtained for public service, industry and agriculture. Nevertheless, the tendency of the productivity in the energy sector is decreasing, while the others tend to stay quite stable (figure 188).

Productivity (updated GVA/employment) according to the productive activities in the seven provinces that lie within the Júcar RBD

Figure 188



Source: INE

5.6.2 *Sector analysis*

Each of the sectors and activities, which are present in the Júcar RBD (agriculture, urban areas, tourism, industry, energy) are analysed in greater detail in this section. These analyses are focused in the Júcar RBD area and the most representative variables of each of these sectors are recorded as well as their trend and, as accurate as possible, average values of supply, volumes and polluting agents of discharges produced in each sector.

These analyses have been carried out by a team of multidisciplinary experts coordinated by the Water Economy Department of the General Directorate of Water (GDW).

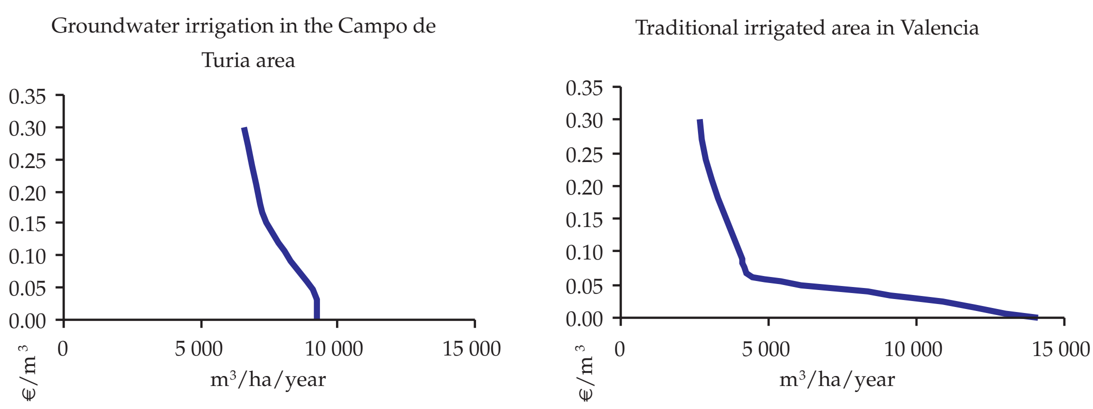
5.6.2.1. Agriculture

In recent years agricultural and cattle activities in the RBD have experienced a continuous loss of importance in economy. In 2002 the Agriculture and Cattle GVA in the Júcar RBD was 2 000 millions euros, 2.9% of the total GVA. Agricultural activities in the District contribute to 9.7% of the total GVA of national agriculture, and total people employed in the agricultural sector in 2002 were 121 300.

The ageing population, the small average size of land holdings (87% are smaller than 5 ha) and the specialisation of agriculture in the region are main aspects to be considered in the decline of the sector.

Economic characterisation (€/m³) of agriculture demand in specific areas as a function of volume (m³/ha/year)

Figure 189



Source: GDW

Production functions and water demand functions have been characterised for the different Agricultural Demand Units (ADU) (figure 189 shows two examples) according to the types of crops existing in each ADU (extensive farming, citric and fruits). The average net margins for different crops in the Júcar RBD are shown in table 48.

Past trends show a shift in crops cultivated and accordingly, water consumption has shifted to cover citrus demand. Localised water systems have increased in new irrigation areas in the past 10 years, while gravity systems are slowly decreasing. GW plays a fundamental role in the development of irrigation systems in the District.

According to the Regional Accounts, in the last eight years the value of the primary activities has grown in the District at an annual average rate of 0.18% as compared with the National of 1.62%.

Table 48 **Irrigated area (ha) and average net margins (euros/m³) for different crops in the Júcar RBD**

Crops	Irrigated (ha)	Net margin (euros/m³)
Cereals	79 603	0.12
Oilseeds	1 503	0.08
Potato	2 971	0.17
Feed crops	17 131	0.11
Vegetables	28 166	1.28
Citrus	179 604	0.75
Fruit nut trees	10 179	0.18
Olive oil	10 071	0.22
Vineyard	30 696	0.65

Source: GDW

In the Júcar RBD case the speed and depth of transformation of agricultural practices is remarked with variations in the different parts of the District. In the Valencian Autonomous Community, these activities only grew to an annual rate of 0.9%, in Aragón the rate of growth was practically zero, and in Castilla La Mancha an annual decrease of 0.8% took place. Employment in the sector decreased in Spain between 1995 and 2002 at an average annual rate of 0.5%. In the Júcar RBD this tendency is more accused, with an annual reduction of agricultural employment of 3.5% in Valencian Autonomous Community and 4.7% in Aragón. This contrasts with the increase in the value of the Final Agrarian Production.

For the case of agriculture, it is not possible to simply establish a trend scenario projecting to the future the dynamics observed in the past stage of the sector. This is a consequence of the relative weight of institutions that have been and are, in last instance, those that determine not only the financial incentives of the sector, but also the possibility of expansion of irrigation areas. Therefore, the evolution of the arable land surface land that could be irrigated will depend in the trend scenario on the forecasts of the National Irrigation Plan and the RBD Hydrological Plan. The evolution of future crop distribution, on the other hand, depends on Common Agriculture Police (CAP) scenarios (for CAP products) and forecasts on relative prices (for non CAP products). Simulation of changes in the income from different crops considering CAP reform (affecting mainly irrigation areas in the interior) and in non CAP products leads to different crops and to future expected changes in water use for 2015. Results of expected pressures for 2015, with a high degree of uncertainty, are summarised in table 50.

Table 49 **Economic Indicators: Relative Growth of Agriculture, Cattle, Forestry and Fishery (1995-2003)**

Source: Estimations from the Spanish Regional Accounts (INE)

	Growth Rates		Regional Contribution		Agric GVA/Reg GVA	
	GVA	Agriculture GVA	GVA	Agriculture GVA	1996	2003
Valencian Community	3.44%	0.89%	9.72%	7.10%	4.10%	3.00%
Castilla La Mancha	3.01%	-0.79%	3.50%	8.24%	14.65%	9.66%
Cataluña	2.65%	0.77%	18.25%	7.09%	2.08%	1.59%
Aragon	2.53%	0.05%	3.12%	4.15%	7.56%	5.46%
Spain	3.09%	1.62%	100%	100%	5.30%	4.11%

As regards cattle, past evolution data show very different growths that depend on the species, as it is shown in table 51.

However, these future trend scenarios would be dramatically determined, by the reform of incentive systems of the CAP. Due to the lack of estimations on the specific impact of the CAP reform in the Spanish territory, in the trend scenario the rates of the reference study of the EU were assumed for the RBD until year 2009. From 2009 to 2015 a growth rate equal to the inter annual average between 2001 and 2009 was assumed.

The 2015 Scenario by types of species as well as the gross polluting loads associated to them appears in table 52, jointly with the situation for year 2001. Calculations on future pressures are based on unit pollution of load by type of cattle.

5.6.2.2. Urban areas

The urban water supply and sanitation sector in the Júcar RBD has been estimated to have a turnover of 351 million euros per year plus additional equivalent capital costs of 36 million euros per year. These figures correspond to a sample of water services providers, covering 86% of the total population of the Júcar RBD, including all (but 6) population centres of more than 2 000 people.

In 2001, the water supply sector provided water services of water supply, sewage collection and treatment to approximately 35 000 industrial es-

Scenarios of Total Gross pressures of Agriculture in 2015 in the Júcar RBD — Table 50

Crops	Total (ha)	Non irrigated (ha)	Irrigated (ha)	Water consumption (m^3)	Dose N (kg)	Dose P_2O_5 (kg)	Dose K_2O (kg)
Cereals	463 805	381 288	82 517	270 491 328	39 805 684	19 865 904	11 553 500
Olive	108 638	97 861	10 776	41 431 551	4 912 469	3 467 064	3 828 735
Vineyard	215 901	183 173	32 728	109 570 717	8 514 472	7 827 351	10 588 844
Vegetables	33 974	880	33 094	170 654 273	5 336 182	3 681 473	4 312 244
Citrus	212 172	0	212 172	1 092 989 382	59 387 911	19 088 971	24 391 463
Non-citrus fruit trees	144 023	108 587	35 436	130 872 704	6 565 729	4 765 988	6 544 275
Other crops	385 508	333 329	52 178	310 425 980	5 326 843	3 263 994	3 808 523

Source: GDW, RBD Agriculture Forecast Model

Animal stock by type in the Júcar RBD and evolution — Table 51

Species	Heads 1989	Heads 1999	Growth rate
Cattle	52 472	83 635	4.66%
Sheep-goats	1 561 486	1 696 624	0.83%
Swine	730 885	1 444 992	6.82%
Horses	9 306	7 871	-1.67%
Poultry	12 428	18 961	4.22%
Rabbits	118 429	246 500	7.33%

Source: Agrarian Census of 1989 and 1999

Table 52 Scenarios of Total Gross pressures of Cattle in the Júcar RBD

Source: GDW based on European Commission (2003) Prospects for agricultural Markets in the EU 2003-2010. General Directorate of Agriculture.

	Pork		Beef-Veal		Sheep-Goat		Horse		Poultry	
	2001	2015	2001	2015	2001	2015	2001	2015	2001	2015
Heads	1 685 057	1 845 465	94 643	96 915	1 730 403	1 771 946	8 063	8 257	21 954 024	22 481 094
Nitrogen (kg/year)	17 502 688	25 190 591	3 745 216	3 835 131	11 939 779	12 226 428	225 925	231 349	10 647 702	10 903 330
Phosphorus (kg/year)	1 701 908	1 863 919	1 519 968	1 556 459	4 879 736	4 996 888	129 492	132 601	4 829 885	4 945 841
OM (kg/year)	92 256 876	101 039 183	62 180 507	63 673 329	133 742 833	136 953 713	5 297 391	5 424 571	48 079 313	49 233 595

tablishments, and to 4 420 878 domestic consumers of permanent population, in addition to visitors (including services for tourism and other commercial activities). Water consumption in urban areas of the RBD is then not only related to domestic consumption but also to tourism, industry using the general urban water supply systems and other commercial and institutional uses (including public gardens). The level of pressure on water resources is related to the intensity of all these uses in a given urban area, but also, to factors such as temperature and other climatic factors that explain levels and differences in consumption between localities and between summer and winter. The average consumption in a sample of municipalities of the Júcar RBD is included in table 53 which shows the differences according to the characteristics of the municipalities in the different provinces of the basin.

The importance of pressures over water supply is reflected by the existence of 2.5 million houses in the Júcar RBD, approximately 62% of them being primary homes and the rest secondary. In the last 20 years the number of houses has increased by 690 000 (234 636 in the province of Alicante and 301 062 in the province of Valencia). Coastal areas have suffered higher increases than interior zones, and the maximum overall growth has been registered in the province of Alicante (third maximum growth in Spain). The differences between regions and among interior and coastal areas are important in this District. Whereas the Castellón province increased annually an average of 2.07%, Teruel average growth was below 1%.

Table 53 Average municipal consumption by province in the Júcar RBD

Zone	l/inhab./day	l/dwelling/day
Alicante inland	249	490
Alicante coast	383	443
Valencia inland	169	354
Valencia coast	237	308
Castellón inland	192	349
Castellón coast	501	392
Albacete	216	430
Cuenca	216	430
Teruel	216	430
Tarragona inland	192	349
Tarragona coast	501	392

Source: GDW on the basis of ad-hoc survey and data provided by the Regional Government of Valencia

The importance of tourist activities and pressures on water resources exerted by non residents, does not preclude growth of resident population in the District. Resident population growth has been increasing from very low rates (0.24% inter annual growth rate in the 80's) and it is important to consider that the Valencian region is the third area of immigration in Spain.

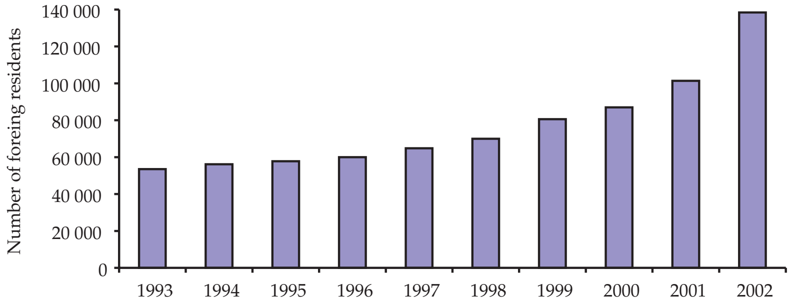
In spite of this, there are important inter territorial differences in the basin: the interior zones are highly depopulated, whereas Alicante and Castellón have experienced the highest increases on permanent residents. The combination of increase in the number of built houses and the low population growth has led to a fall of the average number of inhabitants per household. In twenty years, occupation has fallen from 2.12 persons per house to 1.72, especially where there has been greater construction of tourist apartments and second homes.

Inter annual growth rate of dwellings built in the Júcar RBD (1991-2001) — Table 54

	Principal	Secondary	Total
Alicante	2.44%	0.41%	1.55%
Alicante inland	1.83%	-0.17%	1.14%
Alicante coast	2.87%	0.63%	1.78%
Valencia	1.66%	1.52%	1.61%
Valencia inland	2.05%	0.62%	1.56%
Valencia coast	1.26%	2.42%	1.67%
Castellón	2.24%	1.88%	2.07%
Castellón inland	1.62%	2.46%	1.97%
Castellón coast	2.69%	1.56%	2.13%
Albacete	1.44%	1.84%	1.57%
Cuenca	1.25%	1.78%	1.48%
Teruel	1.01%	0.42%	0.72%
Tarragona	1.73%	0.04%	0.91%
Tarragona inland	1.72%	1.76%	1.74%
Tarragona coast	1.73%	-1.58%	0.21%
Júcar RBD total	1.90%	1.21%	1.63%
Júcar RBD inland total	1.82%	0.90%	1.48%
Júcar RBD coast total	1.98%	1.47%	1.77%

Source: INE and GDW

Foreign residents in the Valencian Autonomous Community — Figure 190



Source: INE

Figure 191	Dwellings built in the Júcar RBD (1993-2002)

Source: Ministerio de Fomento (Ministry of Public Works and Infrastructures)

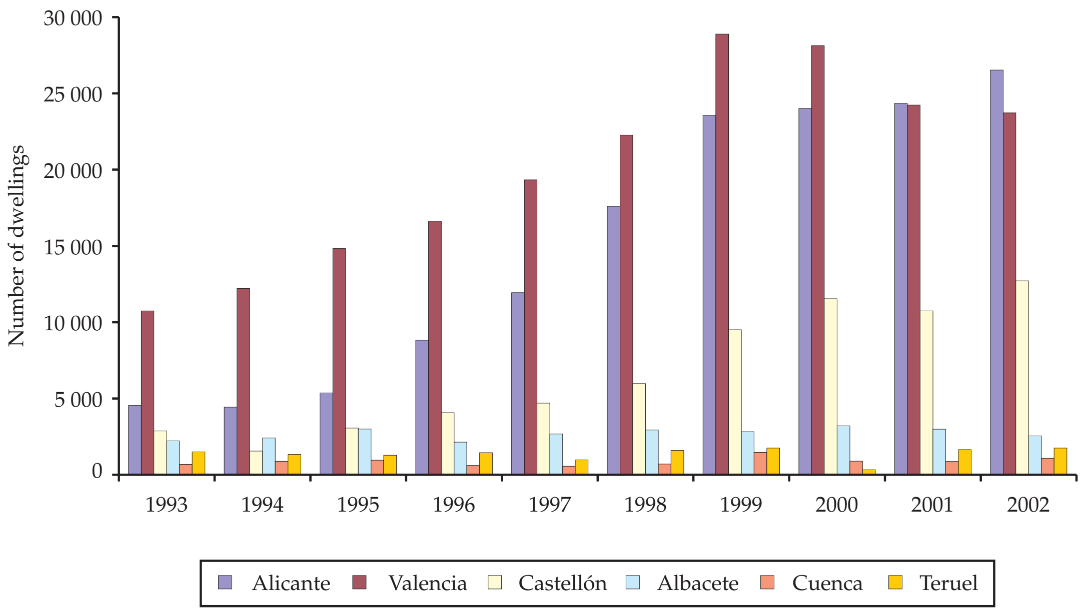
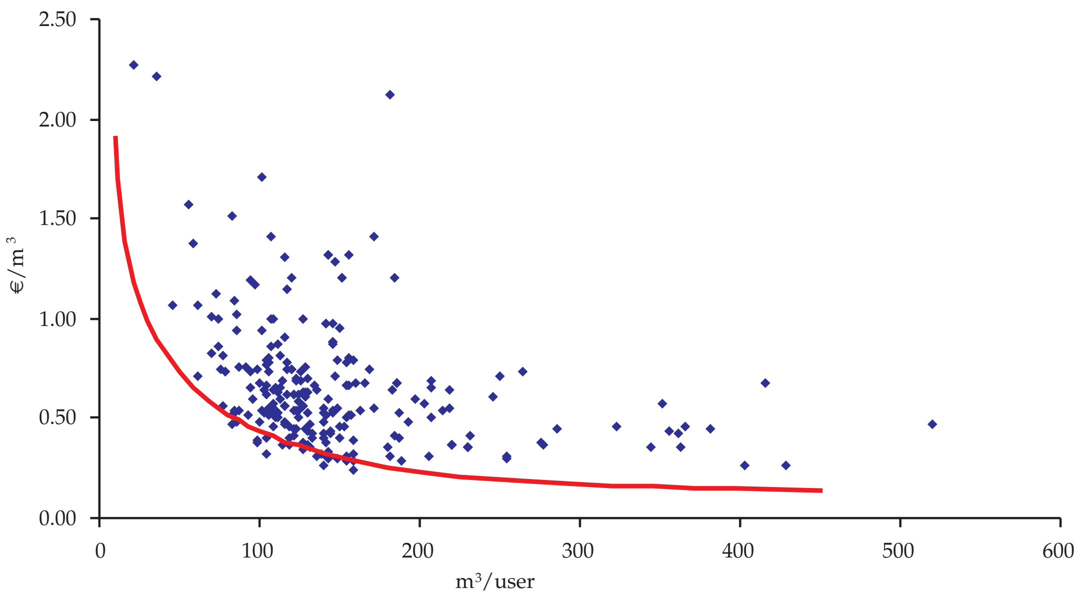


Figure 192	Economical curve for urban users

Source: Price Commission of the Valencian Region



In the Júcar RBD, the analysis of water demand in a sample of municipalities has shown that the differences in water consumption in different municipalities can be explained by per capita income and water price differentials, although demand is quite inelastic. A study made for the economic characterisation of water use in the Júcar RBD revealed that elasticity was –0.65, so a reduction of 1% in water consumption would require a price increase of 1.54%. Rent could influence trends in the long term because it leads to a higher consumption per capita. Gardens, swimming pools and leisure activities are associated to higher income levels and higher water consumption.

Pressures in 2015 are being estimated for each municipality considering different hypothesis in relation to the trend of housing construction. They are being adjusted considering the effect of price and rent in consumption, and considering in the future possible scenarios the existing efficiency of the supply networks (improvements in efficiency could be incorporated as part of the program of measures).

Total water consumption will have differential impacts in water resources depending on the system's efficiency. This efficiency is quite high, but with important differences in the municipalities within the Júcar RBD as can be observed in table 55.

5.6.2.3. Tourism

The tourist sector in the Júcar RBD has experienced an exponential growth in the last 30 years, and the number of hotels, apartments, campings and rural accommodation has increased substantially. The economic analysis of water use in tourism needs to consider the importance of continental, transition and coastal waters as a component of leisure activities (thematic parks, golf courses, sailing) and as an attraction factor (bathing, landscapes and water environments of increasing tourist interest).

92% of the employment generated by this sector in the Júcar RBD concentrates in the Valencian region, in the coastal districts of Tarragona, but mainly in the coastal areas downstream main rivers. There are 26 978 establishments registered in the sector in the Valencian region alone (10% of the national total)

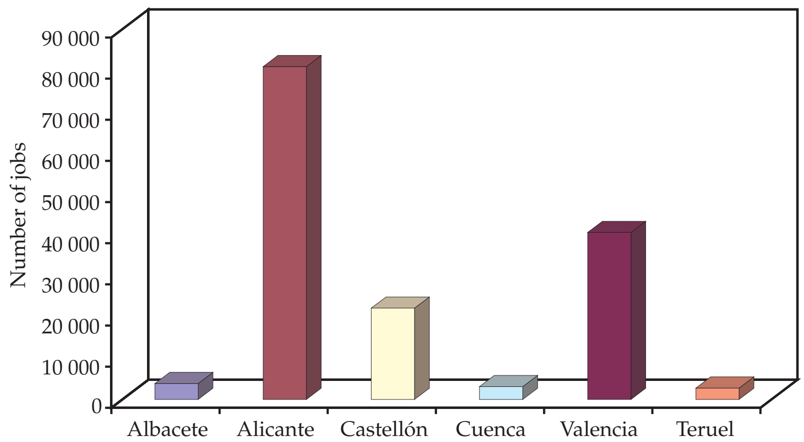
Just in the Valencian region there are 94 400 beds in hotels, with 20 million day stays concentrating in the summer months (14 million in Alicante and 10.5 in Benidorm alone).

Average system efficiencies in the Júcar RBD — Table 55

Zone	Efficiency
Alicante	77.2
Alicante interior	66.0
Alicante coast	81.3
Valencia	64.7
Valencia interior	68.1
Valencia coast	63.8
Castellón	73.3
Castellón interior	66.1
Castellón coast	75.0
Albacete	72.0
Cuenca	70.8
Teruel	72.7
Tarragona	67.4
Tarragona interior	65.0
Tarragona coast	72.0
Total Júcar RBD	68.8
Total Júcar interior	70.6
Total Júcar coast	69.8

Source: GDW

Employment in the tourism sector in the Júcar RBD — Figure 193



Source: GDW

Table 56	Tourist accommodation in the Júcar RBD (year 2002)

Province	Hotel spaces	Camping spaces	Rural Tourism spaces
Valencia	19 377	2 420	977
Castellón	17 829	2 103	1 492
Alicante	49 149	177	791
Albacete	5 841	980	502
Cuenca	4 579	910	241
Teruel	1 656	1 028	838
TOTAL	98 431	7 618	4 841

Source: Agencia Valenciana de Turismo (Valencian Tourist Agency); Guía de Servicios Turísticos de Castilla-La Mancha

Eight municipalities in the Júcar RBD (Benidorm, Alicante, Valencia, Gandía, and Peñíscola, Benicassim, Oropesa and Castellón) concentrate 70% of total hotel accommodation. Hotel accommodation in the interior concentrates in the cities of Cuenca, Albacete and Teruel, although rural tourism establishments have increased slightly in areas of special natural value such as the Hoz del Júcar, the Sierra de Albarracín, Gúdar and Javalambre.

An important fact that has relevant influence in water services in the Júcar RBD is the irregular distribution of tourism along the year. This causes great differences in the volume of supply required and discharges produced in the different seasons. As a measurement of this phenomenon, a seasonality index (maximum /minimum monthly occupancy) has been calculated according to main tourist areas. This index shows larger values in the littoral areas and there are important differences among the areas analysed.

The most important part of the tourist activity is focussed in apartments (there are 977 000 non permanent dwellings in the RBD) mainly in the provinces of Valencia and Alicante. Non-permanent accommodation in the interior (Cuenca, Albacete and Teruel) are often second homes that are owned in property, but used only during holiday periods along the year.

Table 57	Number of visitors, day stays and average stay in Hotels in the Valencian Region (year 2003)

Source: Instituto de Estudios Turísticos (Tourist Studies Institute)

	Number of visitors	Number of days of stay	Average stay
Spain	62 490 261	227 870 818	3.65
Valencian Community	5 579 748	21 636 627	3.88
Alicante	3 025 580	14 285 115	4.72
Castellón	780 512	3 068 791	3.93
Valencia	1 773 656	4 282 720	2.41

Table 58	Seasonality index in the Valencian region

Source: GDW and Agencia Valenciana de Turismo (Valencian Tourist Agency)

Touristic area	Seasonality index
Alicante	2.16
Benidorm	1.81
Litoral Alicante	2.76
Interior Alicante	2.13
Castellón	6.62
Litoral Castellón	7.56
Interior Castellón	3.12
Valencia	7.73
Valencia city	1.50
Litoral Valencia	3.28
Interior Valencia	2.56
VALENCIAN REGION	2.38

The importance of accommodation for tourism is reflected in the proportion of construction process in the coastal strip of Alicante, Valencia, Castellon and Tarragona. Today 61.5% of the coastal strip has been developed (35% in Tarragona) creating a linear conurbation along the main roads N340, AP7 and N332. In Alicante and Valencia building along the coastal strip is allowed up to 20 meters in 75% of the coastal strip. In Castellón this is allowed in 44% due to the existence of protected areas along the coast.

The development of associated tourist activities such as thematic parks, golf courses and boat moorings are significant water uses that have served to increase both expenditure and reduce seasonality of tourism. The Turnover from a golf course has been estimated to vary between 1.5-9 million euros per year, and each one creates an average of 150 employments. The average water use ranges between 6 500 and 10 000 m^3/ha /year (a total estimated of 12 hm^3 / year in the Júcar RBD), and the apparent productivity obtained per m^3 in a golf course in the RBD is estimated to be 10.6 €/m^3, creating between 80 and 378 employments per hm^3. In addition, proximity to a golf course increases the property values between 15 and 20%.

The analysis of the indicators of water use by tourist activities reflects the high seasonally of consumption and the higher consumption per tourist compared to the resident population.

Other tourist accommodation and associated services in the Júcar RBD for 2002 — Table 59

Province	Non permanent residences	Golf Courses	Boat moorings
Valencia	418 707	6	4 090
Castellón	141 727	3	1 628
Alicante	302 018	8	8 346
Tarragona	5 900	n.a	n.a
Albacete	55 231	2	--
Cuenca	34 871	--	--
Teruel	18 551	--	--
TOTAL	977 005	19	14 000

Note: n.a. means not analysed
Source: INE

Water use in hotels in Benidorm (2001-2003) — Table 60

Type of hotel	Average water consumption per day of stay (l/person/day)	Average water consumption per space (l/space/day)
One star	174	105
Two stars	194	167
Three stars	287	253
Four stars	361	289

Source: Aquagest

Table 61	Water use in other accommodation in the Júcar RBD (l/space/day)

Source: Aquagest

Camping	Rural accommodation
84	30

Table 62	Water use in tourist apartments in Benidorm (2001-2003)

Source: Aquagest

Type of dwelling	Characteristic
Apartment housing	Average consumption: 163 l/house/day
Without garden or swimming-pool	Maximun Summer Term: 363 l/house/day
Single family housing	Average consumption: 865 l/house/day
Garden and swimming pool	Maximun Summer Term: 2068 l/house/day

Past trends show that tourist hotel accommodation has increased overall 22.46% from 1996-2002. The total stays have increased from 1994 to 2002 by 34.46% with the most important increases occurring in Valencia and Castellón. Non-permanent residences have been built at an average rate of 1.47% per year in the basin with the highest average rate of increase in Castellón (average of 1.88% p.a.) and Valencia (1.52% per year). A total of 260 000 non-permanent houses have been built in the last 20 years. Rural tourism has increased ten times in the same period.

If future growth of hotel and non hotel accommodation continues at past rates and considering the trends that increase occupancy rates, pressures as water use and pollution loads, will be expected to increase. Growth of pressures will be uneven and are not expected to strictly follow the existing spatial pattern. Although trends show that the coastal areas of Alicante (Marina Alta and Marina Baja) have the greatest share of the total activity, the saturation of these areas, as already reflected in recent trends, may mean that other municipalities will experience the greatest growth. This change of growth could occur in areas further from the coast in the North of Alicante and South of Valencia and the coastal municipalities in Castellón.

The continuance of present trends, both in overall accommodation and in occupancy rates, is supported by market analysts. These analysts base this information on sustained demand of housing by European household given the low prices (average of 1 027 € per m^2) compared to the rest of Spain and to other European countries.

In the trend scenario, it is important to consider that there are current projects to build 55 new golf courses in the Valencian region. This will lead to an increasing trend of requiring the use of adequate treated wastewater in golf courses. Tourism shows an increasing diversification trend towards higher value added tourism, so it would be expected an increase of productivity of the activity (in relation to water use). The trend scenario may be likely affected by the fact that the tour operators still support the present model of tourism. There are also some adjustments that may be considered from the trend scenario because in spite of the tenfold increase in rural tourism, experts indicate that this trend cannot be expected to continue and could be expected only some growth in the Northeast of Castellón and in Las Marinas.

Trend scenario of gross pressures from tourism in 2015 in the Júcar RBD — Table 63

	Total accommodation by types (in 2015)	Total estimated volume of water consumed (hm^3/year in 2015)
Apartments (number of non principal houses)	1 228 370	175
Hotel accommodation spaces	115 762	8
Golf Courses	67	39
Rural Tourism and Camping spaces	13 988	1

Note: data have been obtained before considering efficiency in Water Supply Systems
Source: GDW

The trend scenario may only be viable if there is enough zoned land for new developments. The detailed analysis of planning documents in 161 municipalities in the coast or near to the coast in the RBD, further support the trend scenario. There is enough zoned residential land in the municipalities of the region of Valencia to continue building. According to urban planning expectations, areas that would expected highest growth rates are located in Alicante and above all in the Castellón coastal municipalities as Peñíscola and Oropesa. These municipalities in Castellón have 20.6% of the total residential zoned land in the region of Valencia

5.6.2.4. Industry

The economic significance of the industrial activity in the RBD is reflected on its contribution of 11 400 million euros to the GVA (12% of the Spanish total industrial GVA) and of 414 000 job positions. Industrial activities estimated to contribute the most to pollution in the District are the chemical, the food and the metal industry. These activities are estimated to contribute overall up to 70% of total discharges, and also to each of the measured quality parameters such as BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), Total Nitrogen, Total Phosphorous, Suspended solids and Heavy Metals.

92% of the industrial activity (and the associated pressures) of the Júcar RBD concentrates in the Valencian region and mainly in the specialised clusters of coastal industrial districts downstream main rivers and tributaries. There is some industrial activity also in the provincial capitals of the interior (6,8% of the total GVA) and along the Vinalopó River.

General characteristics of the industry in the Júcar RBD (constant euros of 2002) — Table 64

	GVA (1000 €)	Employment	Productivity (€/employee)
Júcar *	11 371 764	413 982	27 469
Valencian region *	10 505 284	380 850	27 584
Cuenca and Albacete *	683 747	27 747	24 642
Teruel *	94 803	2 854	33 218
Tarragona *	87 931	2 531	34 741
Spain	94 240 000	2 937 400	32 083

* Activity in the region/province lying in the basin
Source: GDW on the basis of the Regional Accounts of the INE

Table 65	Economic significance of industrial activity by production sectors in the Júcar RBD

Source: GDW

	Value Added	%	Employment	%
Food and Drink	1 138 042	10.01%	42 126	10.18%
Textile, leather and shoes	1 798 879	15.82%	100 264	24.22%
Wood and cork	407 664	3.58%	17 366	4.19%
Paper: edition and graphic arts	703 026	6.18%	22 790	5.50%
Chemical Industry	586 175	5.15%	10 031	2.42%
Plastic	613 218	5.39%	16 995	4.11%
Mineral non metallic products (including ceramics)	2 303 367	20.26%	59 385	14.34%
Metallurgy and metal products	880 385	7.74%	36 131	8.73%
Machinery and mechanical equipment	690 242	6.07%	26 153	6.32%
Electric: electronic and optical equipment	242 505	2.13%	7 841	1.89%
Manufacturing of transport material	936 831	8.24%	21 893	5.29%
Other manufacturing	1 143 941	10.06%	53 009	12.80%
TOTAL	11 371 764		413 982	

Table 66	Estimated indicators of economic water use in the Júcar RBD

Source: GDW

Water consumed ($m^3/10^3$ €)	10.17
Total volume of discharges ($m^3/10^3$ €)	4.36
BOD (mg/€)	282.47
COD (mg/€)	964.01
Suspended solids (mg/€)	169.61
Total Nitrogen (mg/€)	26.74
Total phosphorus (mg/€)	8.22
Heavy metals (mg/€)	2.69

The sectors with the greatest economic importance in the Júcar RBD are the textile, the shoe (16% of total GVA in the District) and the non-metallic mineral industries (including ceramics) accounting for 20% of the total GVA. Ceramics industry concentrates in Castellón with 92% of the total production at the national level. Textiles and shoe industries concentrate in Alicante, along the Vinalopó River and in the metropolitan area of Valencia. Some main structural characteristic of the industrial sector in the RBD is that it is export-oriented and is based on small and medium-sized companies. 90% of establishments in the RBD have less than 20 employees and there are only 393 establishments with more than 100 employees.

The linking of economic and pressure information has been carried out using the emission coefficients available at the national level. The significance of the pressures of chemical, the food and the metal industries (70%) contrast with the contribution of these activities to the total GVA in the District (5.15% in the case of the chemical industry; 10% in the case of the food industry and 7.74% in the case of the metal industry). These pressures, however, are quite concentrated because activity is localised in specific industrial districts in the metropolitan areas of Valencia, the Vinalopó region, Alicante and the Plana of Castellón. The food industry is more disseminated and is also present in industrial areas, upstream in provincial capitals of the region.

Industrial production has increased at an average rate of 3.6% per year in the period 1997-2002 within the District with sustained improvement in productivity and a clear trend of convergence to the national total growth (specially in the food industry). Past trends in the 1997-2002 period, show changes in the structural composition of production with decreasing importance of the food, the textile, the leather and the shoe sectors, while non-metallic minerals (mainly ceramics), machinery, and plastic materials continue gaining importance. This pattern of structural change has had impacts in total pollution loads and in water extractions.

If future growth of the industrial sector continues at the past rate of 3.6 % and considering the differential growth of the activities (e.g. 1.13% for food, 4.61% for the ceramics sector) pressures as water use and pollution loads are expected to increase.

Scenarios of total pressures of industry in 2015 in the Júcar RBD Table 67

	Trend	Macroeconomic adjusted
Total Volume of Water consumed (hm^3/year)	156.3	156.8
Total volume of discharges (hm^3/year)	68.6	71
BOD (t/year)	3 948	3 864
COD (t/year)	13 478	13 281
Susp. Solids (t/year)	2 457	2 473
Total Nitrogen (t/year)	387	389
Total Phosporous (t/year)	115	114
Heavy metals (t/year)	39	41

Note: data correspond to water characteristics before treatment in collective urban wastewater treatment plants
Source: GDW

5.6.2.5. Energy sector

Water use in the energy sector is used to refrigerate nuclear and thermal plants and for hydroelectricity production. Impacts produced by this sector relate to hydromorphological indicators and to temperature. In the Júcar RBD, there are 66 sections of rivers, of a total of 1 323 in Spain, with hydroelectricity installations, 17 of them present small installations of less than 10 MW. Hydroelectricity production of the RBD is estimated to be around 540 GWh/year, which is not very relevant at the Spanish context.

There are 7 conventional thermal and 1 nuclear power plants that use water for refrigeration purposes in the Júcar RBD with an installed potential of 1 933 MW, (800 MW in combined cycles with gas), and 1 025 MW respectively. These represent 7.56% of the total national thermal production and 13.1% of the national nuclear production, base of the electric system. According to the Júcar Hydrological plan (JHP) the water use in the thermal and nuclear plants is 35 hm^3. Temperature changes mainly affect nuclear plants with open circuits and major thermal plants.

The value of the hydroelectricity produced in the Júcar RBD at market prices is estimated to be 71.2 million euros. The number of people employed in the energy generation activity in Spain in 2001 in companies of UNESA (Spanish Electrical Industry Association) has been reported to be 9 500. There are additional jobs in auxiliary industries of maintenance, engineering, systems etc.

Electricity generation in Spain is a regulated activity. Prospects are that there is going to be further integration into the European electricity market to ensure meeting demands for energy with sufficient warranty and to contribute to the stabilisation of energy prices. For hydroelectricity, the prospects according to UNESA are that production in Spain will increase about 10%.

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DICTIONARY OF ABBREVIATIONS AND ACRONYMS

ADU	Agricultural Demand Unit
AWB	Artificial Water Bodies
CAP	Common Agricultural Police
CCA	Committee of Competent Authorities
CEDEX	Centre for Studies and Experimentation in Public Works
CIS	Common Implementation Strategy
DEM	Digital Elevation Model
DI	Diatoms Index
EAGF	European Agricultural Guarantee Fund
EEA	European Environment Agency
EI	Ecotrophic Index
EPA	Environmental Protection Agency
EPER	European Pollutant Emission Register
ERDF	European Regional Development Fund
EU	European Union
FENACORE	National Association of Irrigation Associations
GD	Guidance Document
GDW	General Directorate of Water
GES	Good Ecological Status
GIS	Geographic Information System
GVA	Gross Value Added
GW	Groundwater
HGU	Hydrogeological Unit
HMWB	Heavily Modified Water Bodies
IBMWP	Iberian Biological Monitoring Working Party
ICA	Integral Water Quality Network
ICAB	Biological Quality Indicators
IGME	Spanish Geological and Mining Institute
IGN	Spanish National Geographic Institute
IMPRESS	Working group for the Analysis of Pressures and Impacts studies of the WFD
INE	National Institute of Statistics
IPPC	Integrated Pollution Prevention and Control
JHP	Júcar Hydrological Plan
MI	Macrophytes Index
MOCR	Marginal Opportunity Cost of the Resource
MS	Member States
NACE	Spanish National Activity Codification
NGO	Non-Governmental Organisations
PPP	Public Private Partnership
PRB	Pilot River Basin
RBA	River Basin Authority
RBD	River Basin District
REFCON	Guidance on establishing reference conditions and ecological status class boundaries for inland surface waters
RGS	River Guard Service
ROI	Marine Intrusion Monitoring Network
SAIH	Automatic Hydrologic Information System
UK	United Kingdom
UNESA	Spanish Electrical Industry Association
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UTM	Universe Transverse Mercator
WATECO	Working group for the economic studies of the WFD
WFD	Water Framework Directive
ZEPIM	Mediterranean Specially Protected Areas

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