PINIOS RIVER BASIN - GREECE (Deliverable D34)

Subtitle Report STATUS REPORT

Author Author(s) A. Mahleras, A. Kontogianni, M. Skourtos
Date Date 15.04.2007

Contact information AquaMoney Partners

Institute for Environmental Studies (IVM),
Vrije Universiteit Amsterdam
De Boelelaan 1087, 1081 HV Amsterdam
THE NETHERLANDS

Institute for International and European
Environmental Policy (Ecologic)
Pfalzburger Strasse 43/44, D - 10717 Berlin
GERMANY

Department of Systems Ecology and Sustainability
University of Bucharest (UNIBUC)
Spl. Independentei 91-95,
Postal Code: 050095 Sector 5, Bucharest
ROMANIA

Norwegian University of Life Sciences (UMB)
Department of Economics and Resource Management
P.O. Box 5003, N-1432 Aas
NORWAY

Institute for Water and Environmental Engineering,
Universidad Politecnica de Valencia (UPVLC)
Camino de Vera s/n, 46022 - Valencia
SPAIN

Bureau de Recherches Géologiques et Minières (BRGM)
Direction de la Recherche
3, Av. Claude-Guillemin
BP 36009 45060 Orléans, cedex 2
FRANCE

University of the Aegean (AEGEAN)
Faculty of Environment
University Hill 81 100 Mytilini
GREECE

Research Institute for Soil Science and Agricultural
Chemistry (RISSAC),
Hungarian Academy of Sciences
Herman O. street 15. 1022 Budapest
HUNGARY

School of Environmental Sciences
University of East Anglia (UEA)
Norwich NR4 7TJ
UNITED KINGDOM

Center for Environmental Policy (AAPC)
A. Juozapaviciaus 6/2, Vilnius LT-09310
LITHUANIA

Flemish Institute for Technological Research (VITO)
Boeretang 200, B-2400 Mol
BELGIUM

Department of Agricultural Economics and Engineering
(DEIAGRA)
Faculty of Agriculture
University of Bologna,
Viale Fanin, 50, 40127 Bologna
ITALY

Norwegian Institute for Water Research (NIVA)
Brekkeveien 19, 0411 Oslo
NORWAY

Royal Veterinary and Agricultural University (RVAU)
Food and Resource Economics Institute
Rolighedsvej 25, 1958 Frederiksberg C
DENMARK

Institute for Advanced Studies Carinthia (IHSK)
Domgasse 3, 9020 Klagenfurt
AUSTRIA

Corvinus University of Budapest (CUB)
Fovám tér 8., 1093 Budapest
HUNGARY

European Commission
DG Research
Unit I.2 - 'Environmental Technologies and
Pollution Prevention'

Colophone

This report is part of the EU funded project AquaMoney, Development and Testing of Practical Guidelines for the Assessment of Environmental and Resource Costs and Benefits in the WFD, Contract n° SSPI-022723.

General				
Deliverable	D34			
Deadline				
Complete reference				
Status	Author(s)	Date	Comments	Date
Approved / Released				
Reviewed by				
Pending for Review				
Second draft				
First draft for Comments				
Under Preparation				
Confidentiality				
Public				
Restricted to other programme participants (including the Commission Service)				
Restricted to a group specified by the consortium (including the Advisory Board)				
Confidential, only for members of the consortium				
Accessibility				
Workspace				
Internet				
Paper				

Content

Summary

This report provides an overview of the Pinios Water District and its relevance to the AquaMoney application of water valuation in Greece. The general case study characteristics can be found in chapter 1. Pressure, impact, and risk analysis with regards to the Water Framework Directive environmental objectives is the subject of chapter 2. Policy issues are dealt with in chapter 3 while ERC analysis and methodological issues are described in chapter 4.

The information and the data presented here are taken mainly from the following sources:

1. Ministry of Environment, Physical Planning and Public Works - Central Water Agency (2006), *Report On the Pressures and Qualitative Characteristics of Water Bodies in the Water Districts of Greece and a Methodological Approach for Further Analysis.*
2. Ministry of Development - Department of Water, (2003), *Program plan of water resources management of Greece* (in Greek).
3. Ministry of Environment, Physical Planning and Public Works - Central Water Agency (2007), *Management Plan of Pinios and Acheloos Rivers Basin of Thessaly* (in Greek).

With Law 1739/87 Greece has been divided in 14 Water Districts. The area covered by Pinios RBD is indentical with the Thessaly Water District which in turn coincides almost with the administrative area of Thessaly Region. For this reason where data do not exist for Pinios RBD, the corresponding data from Thessaly Region will be used which imitate real data to a large extent.

1. GENERAL CASE STUDY CHARACTERISTICS

1.1 Location of Pinios River Basin

Pinios River Basin is located in central Greece and coincides with the Thessaly Water District. Thessaly Water District (13.377 km^2) includes the Prefectures of Larissa, Magnesia, Trikala, Karditsa, Pieria, Grevenon and Fthiotidas.The total surface area of Pinios River Basin is 9.500 km^2 (the drainage basin of the Former Lake Karla, appr. 1.050 km^2, not included). Table 1.1 illustrates the land cover (km^2) and the population of the Prefectures of Thessaly Water District.

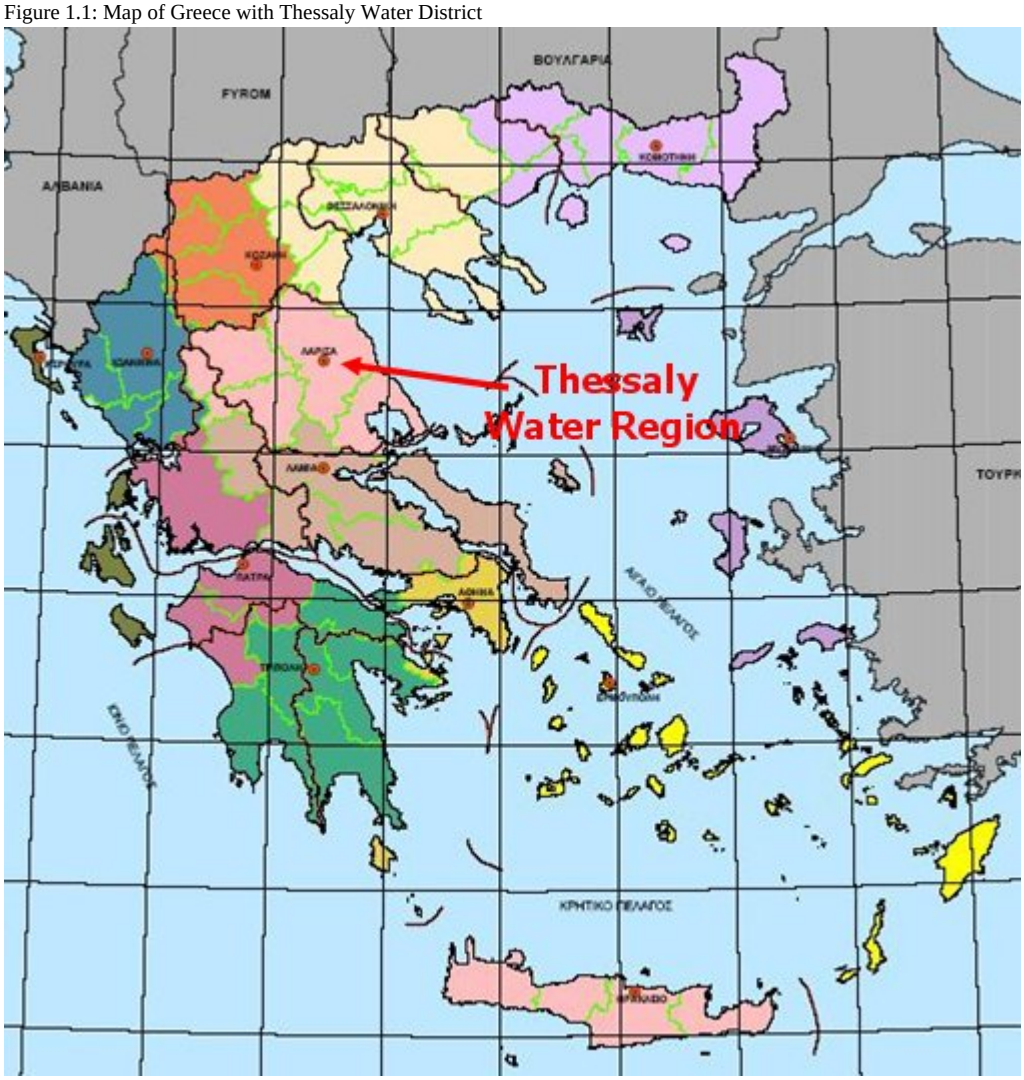
Table 1.1: Area and Population of Thessaly Water District per Prefecture

Prefectures	Land area belonging to Thessaly Water District (km^2)	Percentage of land area belonging to Thessaly Water District	Population belonging to Thessaly Water District (1991)	Population belonging to Thessaly Water District (2001)
Larisa	5.283	98%	270.612	279.305
Magnesia	2.242	85%	182.830	190.642
Trikala	2.667	79%	134.015	133.215
Karditsa	2.163	82%	118.874	121.380
Pieria	113	7%	4.488	4.934
Grevenon	167	7%	5.091	5.237
Fthiotidas	742	17%	15.035	15.732
Sum	13.377		730.945	750.445

Source: Ministry of Development (2003)

Thessaly borders Macedonia to the north, Sterea Ellada to the south, Epirus to the west, and its eastern shoreline is on the Aegean. Figure 1.1 shows Thessaly Water District at the map of Greece.

Figure 1.1: Map of Greece with Thessaly Water District



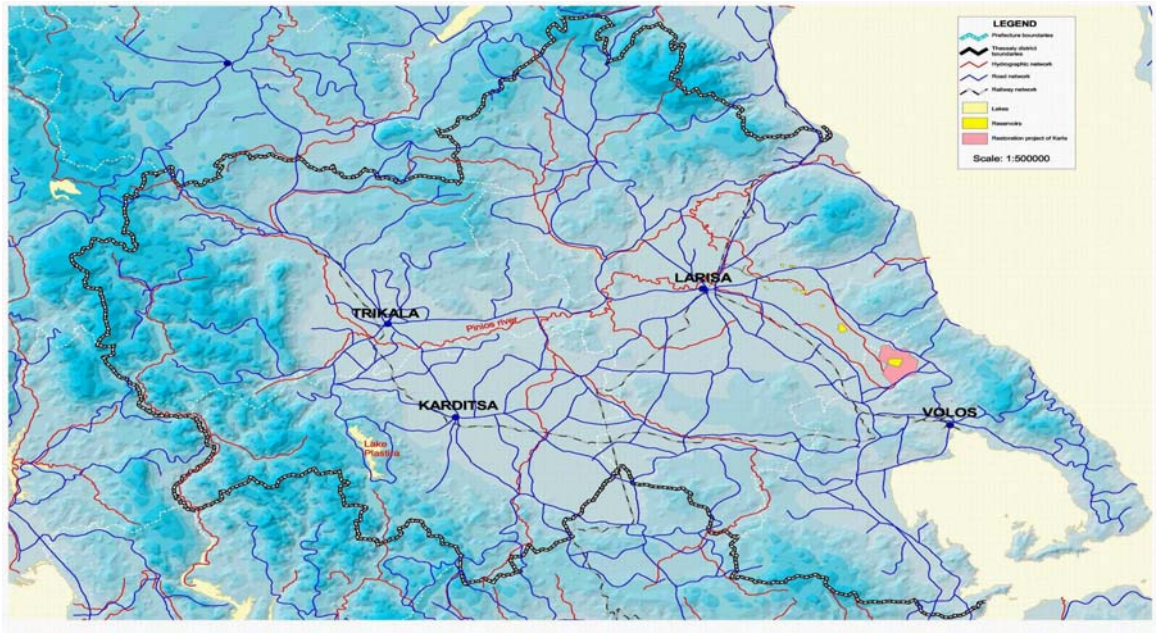
Source: Ministry of Development (2003)

The major urban conurbations within the district are

- Larissa (population 124.394)
- Bolos (population 82.439)
- Trikala (population 48.686)
- Karditsa (population 32.031)

Figure 1.2 details the Thessaly Water District boundary and indicates the principal urban settlements.

Figure 1.2: Thessaly Water District and Pinios River Basin



Source: Ministry of the Environment Urban Planning and Public Works

1.2 Geographical characteristics

1.2.1 Climate

The Water District of Thessaly is divided in three sub-regions:

- The Eastern coastal and mountainous, with Mediterranean climate
- The central flat, with continental climate
- The western mountainous, with mountainous climate.

The average annual temperature varies from 16°C to 17°C. Indicative prices of annual rainfall are 468 mm at the station Larissa, 550 mm at the station Tyrnabou and 1 142 mm at the most mountainous station of Moyzakioy (Koytsogiannis, 1988). In the Water District we observe a dry period of 4 to 5 months in Eastern, which decreases gradually at 2 to 4 months in centrally-western flat and at 1 to 2 months in the western mountainous.

1.2.2 Lithology

The water district presents a simple geomorphology, with mountainous departments parametrically and flat areas in the central regions. The flat department is separated in eastern and western region by the low-altitude mountain of Chalkidonia. These two regions are independent from a hydro-geological point. The medium altitude of the water district is 285 m.

1.2.3 River length, basin area, altitude, etc.

Pinios River originates in the Pindos Mountains and outflows, after 216 km, in the Aegean Sea. The region is surrounded to the north by mountains Olympus and Chasia, to the west by the Pindos Range, to the south by mountain Othrys and to the east by mountain Ossa. The basin of Pinios is divided in the subbasins of Enippeas, Farsaliotis, Sofaditis, Kalentzi, Pamisos, Portaikos, Mourgkani, Lithaiou, Neochoriti and Titarisiou. Thessaly District consists also of two more hydrologic basins: the drainage basin of Lake Karla (1,050 km^2), rising at the eastern side of the District and Lake Plastira at the western side (Table 1.2).

Table 1.2: Surface of the water basins in Thessaly

Drainage Basin	Surface (km^2)
Pinios River	9,500

Lake Karla	1,050
Other Basins	2,812
Total	13,362

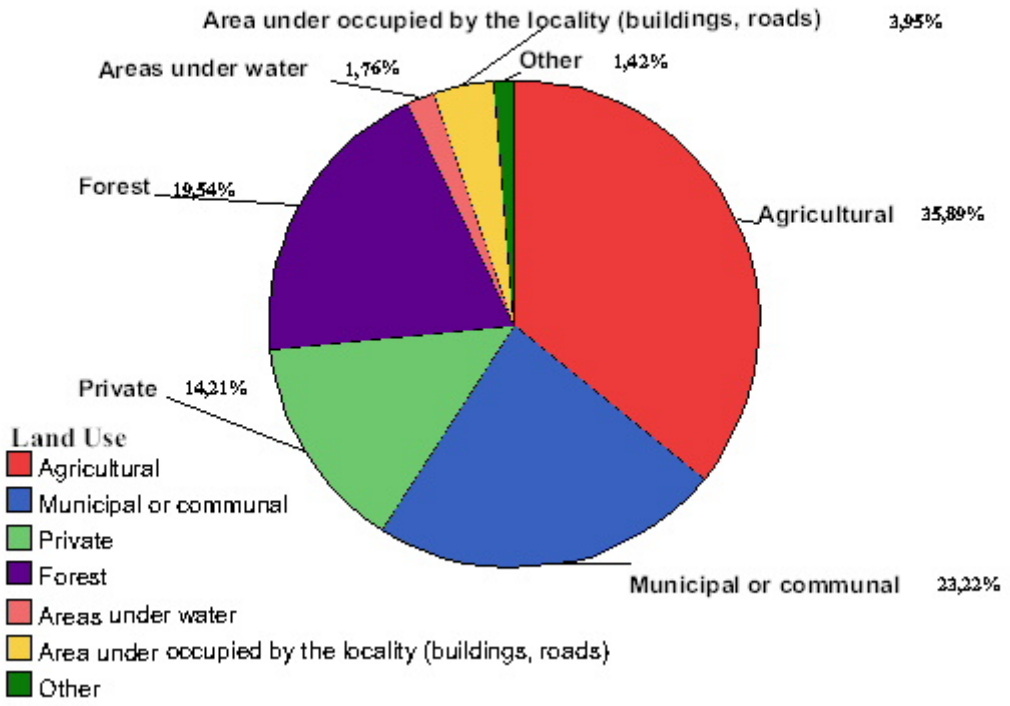
Source: WaterStrategyMan EVK1-CT-2001-00098 (2001)

The main part of the basin includes a mountainous terrain with altitudes more than 2000 m (Pindos and Olympus), agricultural plains (the Thessalic plain) and urban areas. The mean elevation of the catchment is 285 m. Pinios River flows from the western slopes of Pindos Mountains and after the mountainous terrain crosses the alluvial basin of the Thessalic plain and cuts it into two parts. The River flows then eastwards through the Valley of Tempi and discharges into the Aegean. The alluvial basin of the Pinios River estuary is a sensitive and complex hydrogeological environment. Surface and groundwater resources are jointly used to cover rural, urban and industrial needs, whilst on the same time they are essential to the preservation of the wetland developed in the area.

1.2.4 Land uses

More than 1/3 of Thessaly is covered by agricultural land, the other main uses are Municipal or communal (23.22%), private land (14.21%) and forest (19.54%). Fig. 1.3 illustrates the land uses in the Thessaly plain.

Fig. 1.3: Land uses of the Thessaly Plain



…

Agriculture is the major economic sector of Thessaly and the biggest consumer of water (see chapter 1.4 below). An interesting characteristic of the current land use status in Thessaly is that the agricultural land covers more than 1/3 of the total land.

1.2.5 Biotic framework

According to the official data of *Natura 2000* Network in Greece (http://natura.minenv.gr/natura) there are twelve main ecosystems in Thessaly Water District. These include: five mountains [Mount Titaros (GR1250003), Kato Olympos (GR1420001), Mount Pilion (GR1430001), Mount Kerketion (Koziakas) (GR1440002), Antichasia mountains (Meteora) (GR1440003)], two forests [Aestetic Forest of Ossa (GR1420003) and Aestetic Forest of Tempi Valley

(GR1440002)], one gorge [Stena Kalamakiou (GR1440004)], two wetlands [Pinios Delta – Tempi (GR1420002) and Elos Sourpis-Kouri Almiros (GR1430002)] and two forests and rivers complexes [Karla-Mavrovouni-Kefalovryso in Velestino (GR1420004) and Aspropotamos River (GR1440001)].

1.3 Water system characteristics

1.3.1 Annual renewable water resources, non-renewable water resources, use of non-conventional resources (desalination, wastewater reuse)

The available quantity of surface water of Thessaly Water District is estimated at 1,220 million m^3 although practically only 623 millions m^3 are available for use. The annual available quantity of ground water is estimated at 586 millions m^3. The estimation of the annual water balance in Thessaly District is based on the estimation of water resource consumption in relation to the available renewable water resources.

A wide range of estimations have been undertaken to calculate the future trends and the gap in water resource availability. Considering the current levels of water consumption and the available renewable water resources, the deficit in water balance is estimated at 1134 millions m^3. Even if all planned hydrologic public works were constructed and operational, the situation will not change. According to YPEXODE (2007) scenarios, full implemenation of all planed public works will still result in a deficit between 200 and 869 millions m^3 of water.

1.3.2 Streams & rivers characteristics, groundwater (aquifers characteristics, mean recharge and abstraction values, stream-aquifer interactions, etc.), wetlands, estuaries, coastal waters

The main hydro geological basins at Thessaly Water District have been developed alluvial groundwater systems and fields of carstic areas. The main groundwater bodies are:

- **Cone of Pinios-Portaikos-Pamisos** is a high potential shaft of water-bearing stratum, which is supplied by the three rivers but also by the percolation of rain, while part of filtering comes back in the surface via alluvial springs.
- **Cone of Sofaditis** with high potential shaft of water-bearing stratum, the provision with water is done from the river Sofaditis.
- **Rest of west plain** has many groundwater systems which are supplied by the cones of Pinios tributaries with slow rate.
- **Tirnavos biasin** is supplied by Titarisios River but also by the percolation of rain.
- **Rest of east Thessaly (Larisa-Karla)** is supplied (slow rate of recharge) from cone of Titarisios. At Taousani area the groundwater are supplied by the percolation of rain.
- **Carstic system of Koziaka** is developed by limestones and covers an area of 200 km^2. The system supply surface water by springs of Gkouras, Gorgorigios and Xinoparoikou (Discharge capacity 1 m^3/s). The system also supplies the rivers Portaikos and Pimisos.
- **Carstic system of crystalic limestones of central Thessaly**. The area covers 400 km^2 and supply many springs. The average water flow is estimated to 3.2 m^3/s.
- **Carstic system of Mavrovouni-Pilion (Karla).** The area covers 350 km^2 and supply Aegean Sea. The south west district has serious problems of brackishness.
- **Carstic system of Ossa** covers 170 km^2, and supply Pinios River from springs Afroditi, Agias Paraskeuis, Numfon at the location of Tempi (Discharge capacity 1 m^3/s).
- **Carstic system of south calcareous of Thessaly plan** covers an area of 280 km^2, and supply small springs.
- **Carstic system of Othrios** covers an area of 260.300 km^2 and supply small spring, some of them are salty.
- **Carstic system of Kefalovriso Ellasonas** is developed by cristalic limestone, covers an area of 100 km^2 and supply the spring of Kefalovriso(Discharge capacity 1.2 m^3/s).

1.3.3 Main hydraulic infrastructure (reservoirs, diversions, main channels, treatment facilities, artificial recharge facilities, etc.),

A total of 28 dams and reservoirs are currently in use in Thessaly water District. Furthermore, 3 more are under construction and ten planned. The majority of small capacity hydraulic works are operating in the Prefecture of Larisa.

Summarizing the hydraulic infrastructure of Thessaly District for irrigation purpose:

- 76 water pump station,
- 85 small and big dams, 13 tanks,
- 1.712 drillings (government owned - local authority and TOEB) and
- 31.000 private drillings.

The water is transported mainly with irrigation canal networks (length of 4.668 kilometres) and with water pipes (length of 3.241 kilometres). Most networks were manufactured in the 60's and the 70's with problematic operation that impede efficiency of water management. Important losses of water are recorded in the transportation process. In Pinios RBD eleven waste water treatment plants are operational. Three more waste water treatment plants (the plants of Agiofilou (municipality of Hasion), Melivias (municipality of Melivias) and Gaurianis (municipality of Ptelou) are planned. The waste water treatment plants of Livadiou, Agias and Farsalon are in the stage of funding as are also the sewage systems of Gianoulis, Stenfanovounou and Galanovrisis. However there are 42 Municipalities and 8 Municipal districts that have not yet initiated feasibility studies for the construction of sewarage networks and waste water treatment plants.

1.3.4 Water bodies, types and reference conditions. Artificial and HMWB.

There are hundreds of water bodies at Pinios RBD. Greek authorities use "system A" (ANNEX II of WDF) to define surface water categories. The surface water bodies within the Pinios river basin district have been defined only as Rivers.

There are not heavy modified water bodies at Thessaly water District, as it is mentioned in the Greek article 5 report.

Rivers Pinios presents general water quality characteristics (Cl, SAR, conductivity) that satisfy the basic agronomic criteria for irrigation purposes. Despite the occasionally high nitrates concentrations in some sampling stations, the values for nitrates, ammonia and total phosphorus concentrations of the river satisfy the conditions for its classification at A2 category according to the requirements of Directive 75/440/EEC regarding the quality of surface waters intended for the abstraction of drinking water. Concentrations of microorganics, priority substances (Decision No. 2455/2001/EC) and dangerous substances (Directive 76/464/EEC) at Pinios River are lower than the threshold values set for the water quality objectives by the National Legislation (Decision 2/1-2-2001). However high concentrations for some heavy metals (Cr, Cu, Ni, Mg and Al) have been reported.
With respect to Lithaios River, its general water quality characteristics (Cl, SAR, conductivity) satisfy the basic agronomic criteria for irrigation purposes. Monitoring data with respect to the water quality characteristics for Lithaios River are very scarce and thus no conclusion regarding its suitability for various uses can be drawn.
Surface water quality characteristics for rivers Enipeas, Titarisios and Skamnias satisfy the conditions for their classification at A1 category according to the requirements of Directive 75/440/EEC regarding the quality of surface waters intended for the abstraction of drinking water.
Nitrates, ammonia and total phosphorus concentrations in lake Plastira are lower than the threshold values set for various uses (irrigation, abstraction of water for drinking purposes after treatment, support fish life) and the lake can be classified at A1 category according to the requirements of Directive 75/440/EEC regarding the quality of surface waters intended for the abstraction of drinking water. The trophic state of the lake is satisfactory and no sensitivity to eutrophication is anticipated.
For Pagasitikos gulf and in accordance with the demands of the Directive 76/464/EEC for dangerous substances, a special program for the reduction of polution problems of the lakes has been initiated (JMD 15784/1864/21.06.2001)

Ground water
In the Prefecture of Larisa high nitrates concentrations have been reported systematically in the area of Argyropoulio whereas rather occasionally in the areas of Achilio, Agia and Platikampo. Major source of pollution is primarily the intensive agricultural activities and secondarily the livestock wastes and the industrial activities (packaging of agricultural products). It should be noted that the area of West and East Thessaly has been officially designated by the Joint Ministerial Decree (19652/1906/5-08-98) as vulnerable zone. In the Prefecture of Trikala the quality of groundwater is rather satisfactory with low nitrogen concentrations.

In the Prefecture of Karditsa high ammonia concentrations at the area of Mataragka must be associated with the intensive livestock activities taking place in the area. The low nitrogen concentrations at the rest areas of the Water District (08) despite the intensive agricultural activities must be attributed to the high water capacity of the groundwater and the absorption of the pollutants at the Al based alluvial of the rivers.

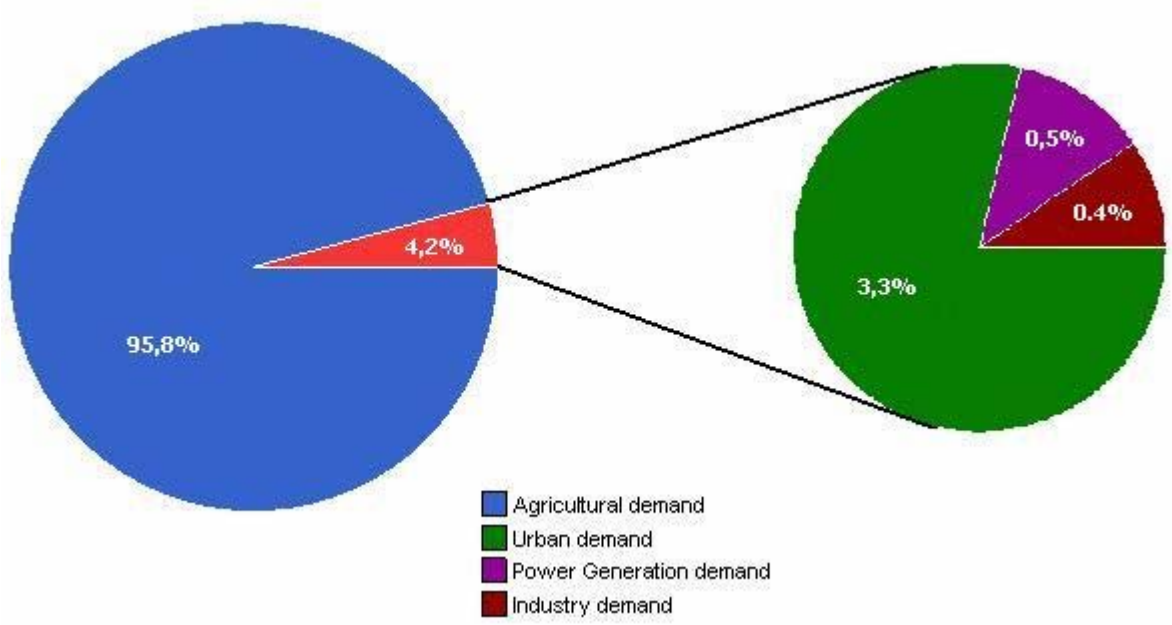
1.4 Characterisation of water use

1.4.1 Water uses and services by socio-economic sectors (agricultural, industry, households, energy, recreation)

General

Abstractions from water bodies are undertaken in order to satisfy the following uses: drinking water, irrigation water, water for industrial process and water for power generation. Fig 1.4 details the percentage of water demand per sector at Pinios RBD. Agricultural sector presents the biggest demand among all sectors with percentage bigger than 95%.

Chart 1.4: Water demand per sector at Pinios RBD



Source: National Data Bank of Hydrological & Meteorological Information

Drinking water

In Pinios RBD and especially in the cities with more than 10.000 inhabitants, municipal water utilities have been established by law. These companies are abbreviated as DEYA and have undertaken the drinking water supply and the collection and treatment of urban waste water. In small cities the water and sewage service is part of the municipal service. There are also intercommunity associations which manage the water service for their communities. According to estimations[1] the quantity of drinking water of Pinios RBD[2] the water demand was around 53.73 hm^3 per year (1994). Other estimations[3] determine the demand of water for water supply in 80 hm^3 for year 1995 and forecast a demand of 136 hm^3 for year 2035. The available data form major DEYA of Pinios RBD (covered population of 489.005 inhabitants according to Cencus 2001) for the year 2005 shows that the total abstractions were more than 64,75 hm^3 and the total consumption was more than 48,1 hm^3.

[1] *The estimate of annual quantity of water for drinking water needs developed on the base of elements of GREEK NATIONAL STATISTICAL ORGANISATION (1994) for the permanent population and the corresponding overnight stays of tourists for the water District.*

[2] *Drawing of program of management of water resources of country*

[3] *Goumas apo axeloou*

Agriculture

The estimations of water use in agriculture sector are based on estimations of irrigated land of Pinios RBD. According to this methodology the demand for water is estimated from 1.285,4 (table 1.3) to 1.568,7 hm^3 per year. Recently, new studies estimate the water demand at 1.618 hm^3.

Table 1.3: Estimations of irrigation land and water demand of Pinios RBD

Prefectures	Irrigated land (000s m^2)	Percentage of irrigated land belongs to Pinios RBD	Irrigated land of Pinios RBD (000s m^2)	Total water demand (hm^3/year)	Water Demand of Pinios RBD (hm^3/year)
Larisa	759.983	100%	759.983	494.2	494.2
Magnesia	167.948	95%	159.551	101.4	96.3
Trikala	330.341	100%	330.341	233.1	233.1
Karditsa	649.297	100%	649.267	437.5	437.5
Pieria	173.151	1%	1.732	107.1	1.1
Grevenon	20.221	5%	1.011	13.0	0.7
Fthiotidas	415.954	8%	33.276	281.0	22.5
Sum	1.935.291				1.285.4

Source: Ministry of Development (2003)

In the Thessaly Plain roughly 500.000 ha are cultivated; of these, 252.500 ha (18,7% of total irrigated land in Greece) are irrigated. The 74.900 ha are irrigated by surface waters and the 177.600 ha are irrigated by underground water of Thessaly Plain. The crops include 160.000 ha cotton (percentage of 63% of irrigated extents), maize, sugar beets and vegetables. Table 1.4 illustrates the irrigated land and the origin of water used (Mean: 2000-2004)

Table 1.4: Estimations of irrigation land and source of water of Pinios RBD

Prefectures	Land irrigatef from surface water	Land irrigated from underground water
Karditsa	32.000	44.800
Larisa	22.400	95.600
Magnesia	12.600	12.100
Trikala	7.900	25.100
Sum	74.900 (29,7 %)	177.600 (70,3 %)

Source: Ministry of Development (2003)

Other Sectors

Livestock-farming

Estimates based on data of National Statistical Service of Greece for the year 1995 estimate the current quantities of water demand at 11.8 hm3 per year.

Industry

The major centers of industrial activity at Pinios RBD are the industrials zones of Larisa and Bolos. The water demand of Larisa's industrial zone is estimated at 0.057 hm^3 per year.

Energy production

At the outskirts of Pinios RBD the dam and the artificial lake of Plastira are situated where the hydroelectric hydroelectric station produces a total wattage of 129.9 MW (3×43.3MW). The system of Plastiras has an additional role for the area because the water of the lake usually covers the irrigation water demand.

Discharges

Discharges into water bodies and water courses also have important impacts on water status. The major point sources of discharges for the Pinios RBD are related to the treatment of sewage. There are eleven waste water treatment plants at Thessaly region; four of them are expanding to cover future pressures while two plants are working on a trial mode. Additional six waste water treatment plants and two sewerage systems are constructed. The future scheme of Thessaly region forecasts the development of twenty six new waste water treatment plants.

Summarizing it could be said that the agricultural sector is by far the biggest water consumer in the region with a percentage of consumption grater than 95%.

1.4.2 Origin of water use

The available information on the origin of water use is focused on irrigation water and water supply. The estimations about irrigation water are based on the size of irrigation land from each source. At the Prefecture of Trikala groundwater is used for irrigation. At the Prefecture of Larisa irrigation water comes at 50% from groundwater and at 50% from surface water. It is expected that after the construction of planed new dams in the area the percentage of surface water used to irrigation will be increased. At the Prefecture of Karditsa the percentage of surface water used for irrigation varies from 40% to 45%. At the Prefecture of Magnesia the plain areas cover their water requirements through groundwater. On the other hand at the mountainous area of Pilion surface water is used for irrigation.

Regarding the water supply of Thessaly region, the percentage of groundwater is 15.7%, the percentage of surface water is 68.3% and the percentage of imported water is 16.0%.

1.4.3 List of protected areas

In the Pinios RBD there are twelve protected areas according to the definitions of Article 6 and Appendix IV of the Water Framework Directive 2000/60/EC. These are: two SPA (Special Protected Areas) and ten SCI (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)

1.4.4 Environmental flow requirements

According to the Greek submission of WFD Article 5 Report to the EU, the estimation of the rivers minimum ecological flow can be made using different methods found in the literature, practices followed in other countries as well as suggestions made in older research projects in Greece (for example the land planning program of Greece by Doxiadis).

In the Greek submission of WFD Article 5 Report to the EU there are not available estimations of environmental flow requirements. In another study (Ministry of Environment 2007) the annually minimum environmental flow requirements of the Pinios River Basin is estimated at 100.000.000 m^3 of water.

1.4.5 Economic analysis of water use

GDP growth in the Region of Thessaly is about 62% below the EU average. The Region of Thessaly's structural problems are due mainly to its distance from the centre of Europe, its large and still uncompetitive agricultural sector, and disparities within the Region and environmental problems. The production of the Region is mainly agricultural, and there are problems with the water provision. The urban population of Thessaly amounts in the 44% of total population (1991) and presents augmentative tendencies in combination in 1981. The rural population amounts in the 40% of total and presents fall, while the semi-urban population progressively increases itself and amounts in the 16% of total. The demographic density of Region is 52,9 residents per km^2, who is enough lower than the national mean 79,7 residents per t. km^2.

The region produces the 6,6% of total GDP of Greece. In the primary sector are produced the 35,5%, in the secondary 22,4% and in the tertiary sector of the 43,1% of regional Crude Domestic Product.

The Construction sector contributes the highest proportion to the gross fixed capital of Thessaly. The Wholesale and Retail Trade, Public Administration and Defense; Compulsory social security, Agriculture, Hunting and Forestry and Manufacturing sectors are also significant contributors. Agriculture, Hunting and Forestry sector contributes much more (twice) in comparison to national average.

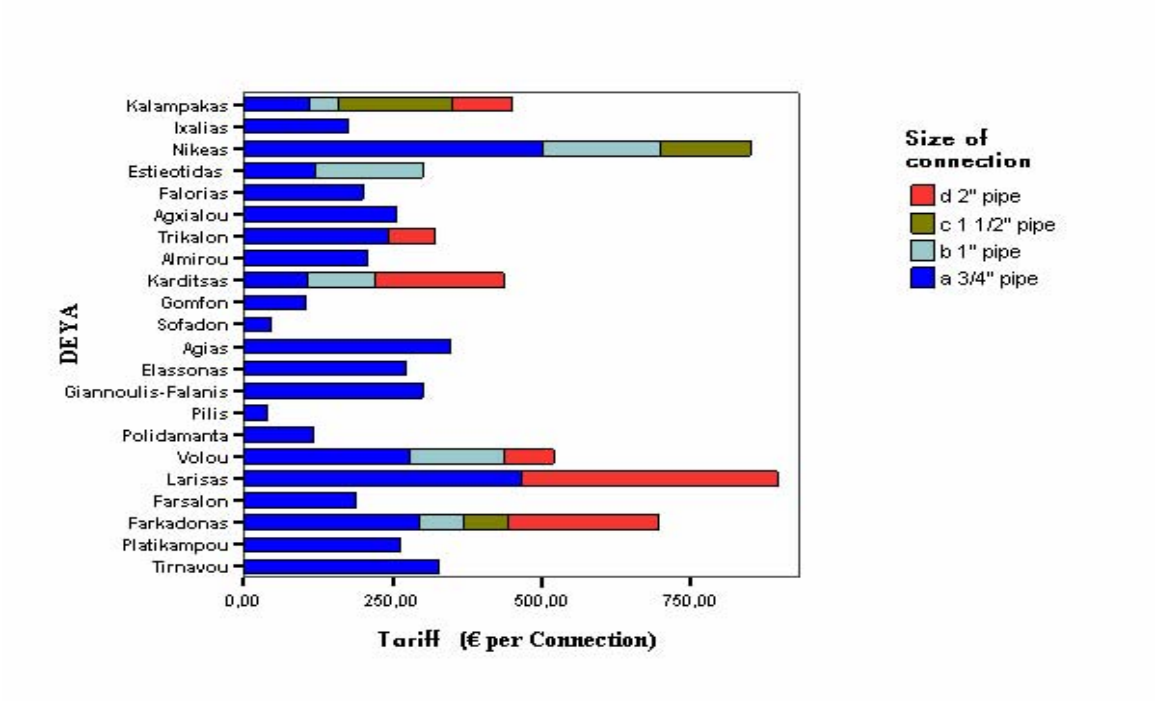
Agriculture, Hunting and Forestry, Wholesale and Retail Trade and Manufacturing sectors are all significant employment sectors in Thessaly. Agriculture, Hunting and Forestry is the sector that appears significantly above national average level.

The largest sector at Thessaly is the Agricultural sector with more than 1/4 of total employments. Additionally it should be mention that agricultural sector employs almost double employments as regard to the Greek average.

In terms of numbers of employees, the largest growth sector between 1991 and 2001 has been in the Real estate, Renting and Business activities sector which has increased by 6.090. The largest reduction in employment numbers has been in the Manufacturing sector which suffered from a decline in employment numbers of 3.083.

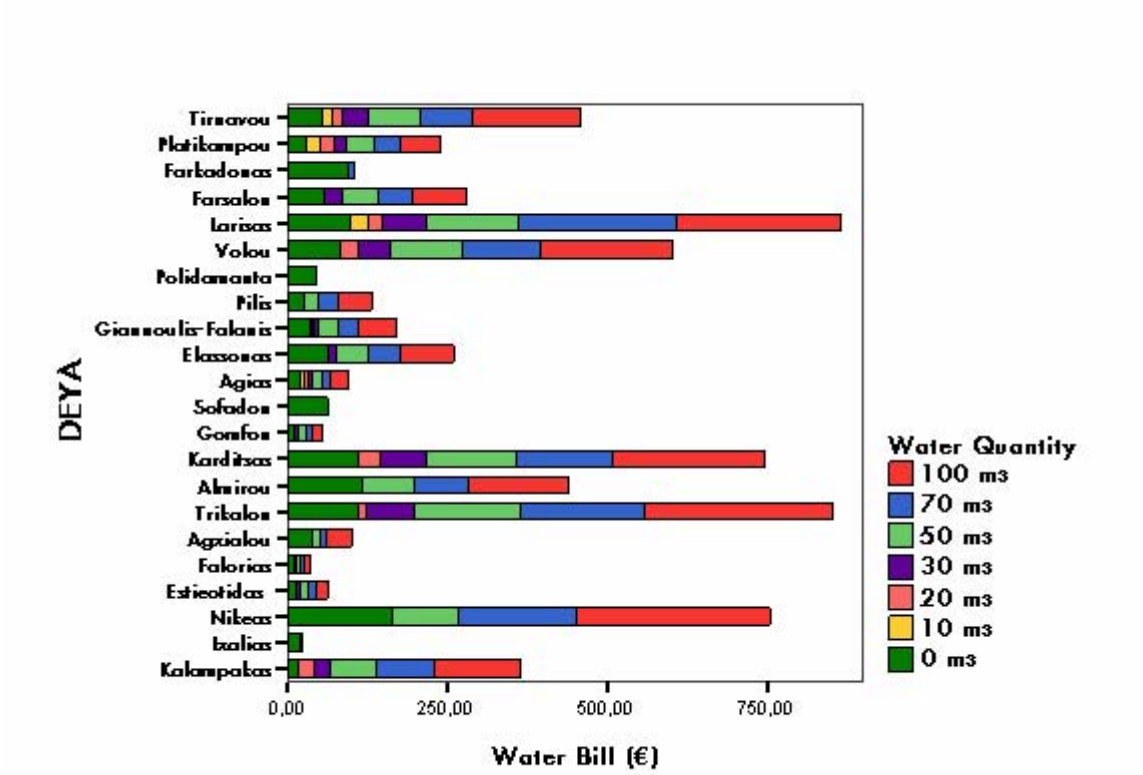
From thirty four DEYA which operate in Thessaly region the available pricing data covers twenty two of them. The pumped water for 2005 was 64.6 millions m^3, while only 42.6 millions m^3 were charged to consumers. The difference in water quantities is substantial, although it is possible that part of pumped water quantity were stored to cover future supply needs. The consumed water for 2005 was 48 millions m^3, while only 42.6 millions m^3 were charged to consumers. DEYA Karditsas shows the bigger difference with percent 328%, for the rest of DEYA except Pilis the quantities range lower than 20%. Fig 1.5 represents the dues for connection with the network of sewerage for DEYA with available data. The data over tariffs is from years 2004 to 2006. Eight DEYA uses scale charges depending on size of connection to the water distribution system. DEYA of Pilis charge 40 euros per connection of 3/4", while DEYA Larisas charge 894.73 euros for 2"pipe connection.

Fig 1.5: Dues for connection with the network of sewerage



The bill of water services can be invoiced one to four times annually according to DEYA policy. Fig 1.6 presents an estimation of annual water bill. There is an alteration on the amount of the total charges. Generally the DEYA of bigger towns charge notable higher amounts of money to the water bills.

Chart 1.6: Annual water bill per consumption



The funding of the waste water treatment plants and sewagerage networks has been raised from European, National and local level funds. At European level the funding comes from the Community Support Frameworks and the Cohesion Fund. At national level the majority of funding comes from funding programmes of Ministry Internal, Public Administration and Decentralisation. At local level the funding came from Prefecture or Self-funding by the DEYA or the Municipality. Charges of use of sewers usually are a fixed charge or a charge of percentage based on water consumption. For consumers with connection to the waste water treatment plants the charge is a percentage based on water consumption ranges 50% to 130% of the value of water, although some DEYA charge a fixed charge, for example DEYA of Ptelou charges 100 € per connection per year. On the other hand consumers with connection to waste water treatment plant of Farkadonas are free of charge. For consumers without connection to sewerage system the payment is based on m3 of waste water disposal. An interesting case is the DEYA of Karditsa which charge 0,787 € per m3 of waste water for Karditsa citizens and 0.179 € per m3 of waste water for consumers who does not live at Karditsa.
The operating cost of waste water treatment plants from available data described below.
Table 1.5 presents the yearly operating cost of waste water treatment plants.

Table 1.5: Operational cost of waste water treatment

	Waste water treatment plant (€ per year)					
	Larisa	Tirnavou	Giannoulis	Volou	Kalampakas	Karditsa
Payroll (€) / employee	531.000 (14)	50.000 (2)	18.000 (1)	1.000.000 (28)	170.000 (10)	115.000 (4)
Energy (€)	212.000	28.000	35.000	-	70.000	40.800
Consumables	-	-	-	-	-	12.500
Chemicals (€)	11.000	400	5.000	-	6.000	-

Maintenance (€)	52.000	10.000	15.000	-	10.000	5.000
Pump rooms (€)	-	1.000	27.000	-	-	83.600
Sum(€)	806.000	89.400	100.000	-	256.000	260.900

Source: Argirouli (2005)

Irrigation water

This section includes the cost of major irrigation works of Pinios RBD and the cost of irrigation water. As it mentions above (chapter 4.2.2.) the institutions which manage the irrigation water are the Local Organizations of Land Reclamation (T.O.E.B.), while the construction of big irrigation works is realized by the General Organizations of Land Improvements (G.O.E.B.) Table 1.6 presents the cost of major irrigation works of Thessaly RBD and the yearly water abstraction capability of them. In the determination of cost it was considered as annual expense interest-rate 6% and annual expenses of maintenance 0.8% on the total cost of work.

Table 1.6: Data on irrigation works of Thessaly RBD

Work	Cost*	Cost (transformed to €)	Yearly water abstraction capability (hm^3)
Smokovo	28	82.171.680,12	114
Girtoni and small reservoir of Karla	7	20.542.920,03	55
Karla	40	117.388.114,5	125
Pili Mouzaki	38	111.518.708,7	122
Kalouda	9	26.412.325,75	30
Palioderli	22	64.563.462,95	43
Neochori	10	29.347.028,61	19
Paleomonastiro	10	29.347.028,61	15
Small dams of Pinios	21	61.628.760,09	24
Kria Vrisi	45	132.061.628,8	210
Theopetra	10	29.347.028,61	15
Note	*	In Billion Drachmas, prices 1994	

Source: Lazaridis (1995)

Table 1.7 presents the ad hoc cost of irrigation water. The average cost of the irrigation water can be estimated at 0.07 € per m^3. According to indicative elements of 9 TOEB of Larissa, the irrigatory fees from surface waters vary from 8 - 10 € per 1000 m^2 of agricultural land.

Table 1.7: Water cost per irrigation work

Work	Cost per m^3 *	Cost (transform to €)
Smokovo	17,55	0,05
Girtoni and small reservoir of Karla	9,09	0,03
Karla	22,86	0,07
Pili Mouzaki	22,25	0,07
Kalouda	21,43	0,06
Palioderli	36,55	0,11
Neochori	37,60	0,11
Paleomonastiro	47,63	0,14
Small dams of Pinios	62,51	0,18
Kria Vrisi	15,30	0,04
Theopetra	47,63	0,14
Note	*	In Drachmas, prices 1994

Source: Lazaridis (1996)

The members of TOEB usually pay dues which cover roughly the 60% of the functional and administrative expenses of the organization. The remaining annual expenses are covered by the State which respectively finances also the investment of new facilities. In most of the cases the consumed quantity of water is not measured while the dues are calculated according to the irrigated land and independently from the type of crop, the season or the method of irrigation.

1.4.6 Trends and future projections

From the available studies of Thessaly University not important changes in the climate of region are forecasted for the next ten years. The next decade is possible to present phenomena of bigger drought as well as more intense floods. According to the current and future rural policy of Greek authorities no big changes in the structure of crops are foreseen. On the other hand, there are sings on urbanization of rural population. This element leads to the need of bigger quantities for water supply (better quality). There is not enough data to forecast the future of Thessaly economic growth. It is forecasted that in the next ten years small tanks and barrages of local importance are going to be developed. It is though difficult to forecast if greater scale public works are going to be implemented that can influence the water balance of the region. Also, it is difficult to forecast the completion of the work of storage and transport of water from Acheloos River. The current situation is rather negative for the growth of this work. The replacement and extension of networks of water supply are forecasted to be continued with the current rhythms (probable inadequate).
The Ministry of the Environment Urban Planning and Public Works (2007) has developed 58 scenarios with the combinations of many parameters like:

- Acheloos river diversion[4]
- Diversion of Dum Palaioderli
- The consumption of agricultural land equal to 1000m^2 of Thessaly.
- The development of new hydraulic works.
- The availability of ground water
- The modernization of irrigation facilities.

It seems that only under the circumstances described by best case scenario, Pinios River will have enough quantities of water and could achieve minimum environmental flow requirements.

1.5 Major water quality and environmental problems

Rivers Pinios present general water quality characteristics (Cl, SAR, conductivity) that satisfy the basic agronomic criteria for irrigation purposes. Despite the occasionally high nitrates concentrations in some sampling stations, the values for nitrates, ammonia and total phosphorus concentrations of the river satisfy the conditions for its classification at A2 category according to the requirements of Directive 75/440/EEC regarding the quality of surface waters intended for the abstraction of drinking water. Concentrations of microorganics, priority substances (Decision No. 2455/2001/EC) and dangerous substances (Directive 76/464/EEC) at Pinios River are lower than the threshold values set for the water quality objectives by the National Legislation (Decision 2/1-2-2001). However high concentrations for some heavy metals (Cr, Cu, Ni, Mg and Al) have been reported.
With respect to Lithaios River, its general water quality characteristics (Cl, SAR, conductivity) satisfy the basic agronomic criteria for irrigation purposes. Monitoring data with respect to the water quality characteristics for Lithaios river are very scarce and thus no conclusion regarding its suitability for various uses can be drawn.
Surface water quality characteristics for rivers Enipeas, Titarisios and Skamnias satisfy the conditions for their classification at A1 category according to the requirements of Directive 75/440/EEC regarding the quality of surface waters intended for the abstraction of drinking water.
Nitrates, ammonia and total phosphorus concentrations in lake Plastira are lower than the threshold values set for various uses (irrigation, abstraction of water for drinking purposes after treatment, support fish life) and the lake can be classified at A1 category according to the requirements of Directive 75/440/EEC regarding the quality of surface waters

4 Acheloos river diversion is a big hydraulic plan that has been studied in depth last decades, by Hellenic authorities. The diversion is going to supply with fresh water the Thessaly Water District. The scheme had already been widely criticised and subjected to legal proceedings in the Greek courts.

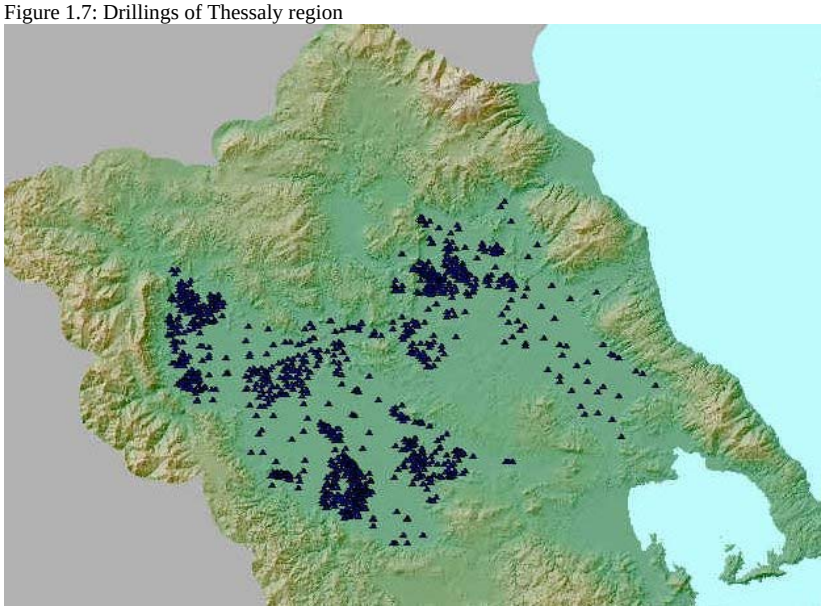
intended for the abstraction of drinking water. The trophic state of the lake is satisfactory and no sensitivity to eutrophication is anticipated.
For Pagasitikos gulf and in accordance with the demands of the Directive 76/464/EEC for dangerous substances, a special program for the reduction of polution problems of the lakes has been initiated (JMD 15784/1864/21.06.2001).

Quality of groundwater

In the Prefecture of Larisa high nitrates concentrations have been reported systematically in the area of Argyropoulio, whereas rather occasionally in the areas of Achilio, Agia and Platikampo. Major source of pollution is primarily the intensive agricultural activities and secondarily the livestock wastes and the industrial activities (packaging of agricultural products). It should be noted that the area of West and East Thessaly has been officially designated by the Joint Ministerial Decree (19652/1906/5-08-98) as vulnerable zone. In the Prefecture of Trikala the quality of groundwater is rather satisfactory with low nitrogen concentrations. In the Prefecture of Karditsa high ammonia concentrations at the area of Mataragka must be associated with the intensive livestock activities taking place in the area. The low nitrogen concentrations at the rest areas of the Water District (08) despite the intensive agricultural activities must be attributed to the high water capacity of the groundwater and the absorption of the pollutants at the Al based alluvial of the rivers.

Focusing on water quantity we could mention that in Thessaly region more than 32.700 drillings for irrigation purpose are in operation (figure 1.7). From the total of drillings in the Thessaly region, continuous fall of hydrostatic level and important reduction of exploitable supplies of water has been observed.

Figure 1.7: Drillings of Thessaly region



Source: National Data Bank of Hydrological & Meteorological Information

The underground water of Thessaly (apart from minimal regions) is overexploited. The fall of the level of underground water differ locally. Table 1.8 illustrates the locations with negative water balance in relation to baseline years 1972-1974 when hydrologic system status was characterized as satiated.

Table 1.8: locations with negative water balance

Location	Water balance	Shortage water level (m)
Thessaliotidos (Sofades, Anabra)	Less negative	15-20
Palama	Less negative	15-20
Brysion- Farsalon	Less negative	15-40
Chalkis - Kileler	Negative	30-50
Taoysanis-Nikeas -Zapeioy	Negative	40-50

Ypereias - Orphanon	Negative	50-60
Myron- Kalou Nerou	More negative	50-100

Source: Goumas (2006)

The fall of the level of underground water leads to the replacement of useless drillings. It has been calculated that the last 20 years roughly 3.000 private drillings were replaced. From the 491 public drillings that function from 1980 the 155 were made useless or replaced.

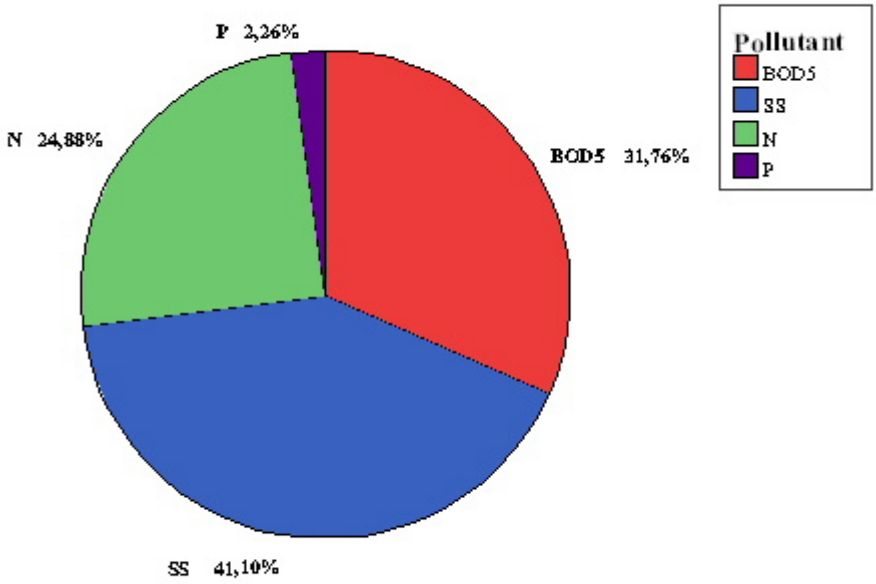
Summarizing it is helpful to underline that according to the official data published the major problem of Pinios River is not a problem of quality but a problem of quantity.

2. PRESSURE, IMPACT, AND RISK ANALYSIS WITH REGARDS TO THE WFD ENVIRONMENTAL OBJECTIVES

2.1 Significant pressures impacting on water status

Thessaly is a mainly agricultural region containing two of the larger Greek cities (Larisa and Volos). The region also has significant industrial activity while the regional authorities are promoting the tourist development of the coastal areas. Despite the fact that the region is rich in water resources there is a seasonal deficit during the irrigation period that leads to intense conflict between the two main water uses, irrigation and the urban water supply. This has caused considerable unrest and public dissatisfaction.

Figure 1.8: annual pollution loads



The organic load and the load of suspended solids are primarily associated with the livestock activities (60% and 56% respectively) and secondarily with urban wastewater (21%) and industrial activities (19%). The last two activities are

related to point source pollution whereas the 1/3 of the pollution load from livestock activities is mainly diffuse pollution and it is mainly located (64%) at the Prefectures of Larisa and Trikala. Main nitrogen pressures are associated with agriculture run offs and frees livestock activities (64%), whereas significant point sources are confined livestock activities (29%) and urban wastewater (6%). The major pressures for phosphorus are livestock wastes (61%) and secondarily urban wastewater (19%). Discharges into water bodies and water courses also have important impacts on water status. The major point sources of discharges for the Pinios RBD are related to the treatment of sewage. There are eleven waste water treatment plants at Thessaly region; four of them are expanding to cover future pressures while two plants are working on trial mode. Additional six waste water treatment plants and two sewerage systems are constructed. The future scheme of Thessaly region forecasts the development of twenty six new waste water treatment plants.

2.2 Impacts on surface and groundwater bodies

The current state is that seasonal water deficit happened during the irrigation period, nitrates concentration for both surface and ground waters exceeds (in a few sampling points) the limit values for drinking water while results for pesticides also show elevated values. Impacts from the seasonal deficit are a significant economic pressure for agricultural sector which result also to social discomfort with significant protests from the farmers during the irrigation period. Environmental impacts can be very important. Pollution, eutrophication of the waters, and the severe decrease in flow during the times of maximum abstraction compromises the aquatic ecosystem integrity and the ecology of the surrounding areas. The underground water of Thessaly (apart from minimal regions) is overexploited. The falls of level of underground water differ locally. Table 1.9 illustrates the locations with negative water balance in relation with 1972-1974 when hydrologic system status was characterized as satiated.

Table 1.9: Locations with negative water balance

Location	Water balance	Shortage water level (m)
Thessaliotidos (Sofades, Anabra)	Less negative	15-20
Palama	Less negative	15-20
Brysion- Farsalon	Less negative	15-40
Chalkis - Kileler	Negative	30-50
Taoysanis-Nikeas -Zapeioy	Negative	40-50
Ypereias - Orphanon	Negative	50-60
Myron- Kalou Nerou	More negative	50-100

Source: Goumas (2006)

2.3 Water bodies at risk of not achieving a good status

Major problems of quality and quantity deterioration have been observed in groundwater and are due primarily to over exploitation of the aquifer. A significant decrease of the level of the aquifer is observed, resulting to a major increase in abstraction cost and in many cases ground settling. At the same time, over exploitation of coastal aquifers has lead to intrusion of sea water.

2.4 Diagnosis of water quality and ecological issues (aquatic and related terrestrial ecosystems)

As has already mentioned twice (at chapters 1.3 and 1.6), the water quality is general acceptable for the present uses of water, although there are water related threats for the major ecosystems of the area.

Table 1.10: Threats of the major ecosystems

Ecosystem	Code	Threat description	Intensity
Lake of Tavropos	GR1410001	Management of water levels	B
Kato Olympos	GR1420001	Irrigation	B
Delta Pineiou –Tempi	GR1410002	Irrigation	A
Lake Karla- Mavrovouni-Kefalovryso	GR1410004	Irrigation	B
		Irrigation	C
		Water pollution	B
		Drainage	B,A
		Canalisation	B, A
Mount Pilion GR1430001		Water pollution	B
Elos Sourpis Kouri Almiros	GR1430002	Port areas	B
		Water pollution	B
		Canalisation	A
Aspropotamos	GR1440001	Irrigation	
Stena Kalamakiou	GR1440004	Irrigation	A
		Water pollution	B

Source: Goumas 2006

From table 2.4 it seems that the water related threats of the ecosystems are associated with irrigation water issue and water scarcity.

2.5 General trends and future pressures

The future pressures are related with the future water use issues. The trends of future use of water are based on empirical estimations, so it is very difficult the future pressures to be forecasted. It could be inference that if the present use and consumption continues then the same pressures will impact on water.

3. POLICY ISSUES

3.1 Water management framework and major issues

Scarcity of irrigation water is the major water related issue in the Thessaly Plain and the Pinios River Basin. According to the official announcements and data publication no severe quality issues are currently detected at the region. Water availability for irrigation purposes is a topic that has been for decades postponed and its solution seen only in a intensification of water supply throught the notorius mega-progect of Achelloos River deviation. It is hard nowdays to talk to the farmers about water demand management and any hint on raising water prices is met with severe reaction.
The Greek water institutions are scattered in central Ministries (mainly Ministry of Agriculture, Ministry of Environment and Ministry of Development) although the new framework introduced by the WFD reallocate the water management responsibilities to the Regional Authorities (Perifereies).

3.2 Relevant water policy questions in the basin

An interesting point is the institutional framework and the water policy. One basic problem is that the administrative structure of Greece (regions and prefectures) is unconnected with the management of water resources. That has effect to the weakness of reduction of various sizes (developmental, finances, demographic etc) in river basins. Another problem is the multiple split of competences (relative with the water resources), in a lot of institutions, which are practiced in all levels of administrative divisions. The weakness of co-ordination of action of this institutions, many times are presented with competitive activities in the use of water, in national, regional, even in local level.

3.3 Information sources and stakeholder involvement

The institutions that share information are:

- The Ministry of the Environment Urban Planning and Public Works, with information about water quality, water use, geographical data and land use
- The Hellenic National Meteorological Service, with meteorological data
- The Public Power Corporation S.A. with data for major hydroelectric Plans
- The Ministry of Agriculture with information about water quality, water use, and agricultural Census
- The Ministry of Interior with data of municipal water consumption
- The Ministry of Development with information about land use, populations and groundwater
- The National Observatory of Athens with meteorological data
- The Water Supply Companies (EYDAP, EYATH, DEYA and EDEYA) with information about water quality and water consumption
- The National Statistical Service Statistics and other research institutes(universities et cetera)

4. ERC ANALYSIS AND METHODOLOGICAL ISSUES

4.1 List of main water-related goods and services provided in the basin

The main water-related goods and services provided in the Pinios basin are:

Use Values			Non-Use Values
Direct Use Value	Indirect Use Value	Option and Quasi-Option Value	Existence Value
Provision of drinking water Provision of water for crop irrigation Provision of water for livestock Provision of water for food product processing Provision of water for other manufacturing processes Provision of water/ as support system for preventing land subsidence Buffer values Sea water intrusion values Improved water quality through support of living organism	Nutrient retention Flood control Storm protection Groundwater recharge External ecosystem support Micro-climatic stabilisation Shoreline stabilisation Transport and treatment of wastes and other by-products of human economic activity	potential future uses (as per direct and indirect uses) future value of information	biodiversity culture, heritage bequest values

4.2 List possible benefits and cost from that water services [see Annex]

- Change in value of crops or production irrigation costs
- Change in welfare from increase or decrease in availability of drinking supply or cost function water
- Change in value of food products or production costs
- Change in personal utility or satisfaction
- Change in value of livestock products or production costs

4.3 Type of ERC analysis to performance (select them) and possible definition of resource and environmental cost (see D12, Practical working definition of ERC)

	Benefit		Cost	
Environmental				
Resource			√	Water scarcity

4.4 Proposed methods and tools for the valuation of ERC:

Stated preferences methods (combined CV and choice experiment)

4.5 Available studies/information on cost/benefits and expected problems of information

Cost-benefit analysis for water related projects is not mandated neither it is practiced in Greece. Therefore, the reluctance to understand and agree on the basic theoretical and practical principles of monetary assessment of cost and benefits is more that apparent. The present case study will therefore rely on the design of primary survey and data collection for the first time on such a scale and theoretical accurancy. Data collection is a rather tendious isues since they are scattered and in many cases unwillingly made public.

References

1. Assimakopoulos D. (2005), *The Greek experience.* In: Conference: Management, of the Greek Water Resources, Athens, The Citizens Movement, 2005. (Available at http://www.kinisipoliton.gr/themata-perivallon/nero/praktika/5%20Assimakopoulos.doc)
2. European Environmental Agency (EEA) (2001), *Sustainable water use in Europe, Part 2: Demand management*, (report No 19), Copenhagen.
3. Argirouli F. (2005), *Study of Feasibility and Arrangement of Biological Health in Tourist and Coastal Regions.* Thessaly (in Greek).
4. Tsakiris G., G. Cavadias, D. Pangalou, A. Nanou (2005), *Drought Preparedness and Mitigation in Greece. Analysis of the Organizations and Institutions.* Published in Options Méditerranéennnes, Série B, No. 51
5. Hellenic Union of Municipal Enterprises for Water Supply and Sewerage (http://www.edeya.gr/index_en.htm)
6. Lazaridis, L., G. Kalaouzis, D. Koutsoyiannis, and P. Marinos, (1996), *Basic engineering and economic characteristics regarding water resources management of Thessaly*. Proceedings of the International Conference on Water Resources Management, Larissa, Technical Chamber of Greece. (Available at http://www.itia.ntua.gr/e/docinfo/31/)
7. Loukas A, Vasiliades L (2004), *Probabilistic analysis of drought spatiotemporal characteristics in Thessaly region, Greec*e. Nat Hazard Earth Syst Sci 4:719–731
8. Mamassis, N., R. Mavrodimou, A. Efstratiadis, M. Heidarlis, A. Tegos, A. Koukouvinos, P. Lazaridou, M. Magaliou, and D. Koutsoyiannis, (2006), *Investigation of alternative organisations and operations of a Water Management Body for the Smokovo projects. Investigation of management scenarios for the Smokovo reservoir*. Report 2, 73 pages, Department of Water Resources, Hydraulic and Maritime Engineering - National Technical University of Athens, Athens.
9. Ministry of Development, (2003), *Plan of program of management of water resource of the country* (in Greek).
10. Ministry of Environment Physical Planning and Public Works, Central Water Agency (2006), *Report On the Pressures and Qualitative Characteristics of Water Bodies in the Water Districts of Greece and a Methodological Approach for Further Analysis.* Athens
11. Ministry of Environment Physical Planning and Public Works, Central Water Agency, (2007), *Management Plan of Pinios and Acheloos Rivers Basin of Thessaly* (in Greek).
12. Ministry of Environment, Physical Planning and Public Works of Greece Water Section. *Pinios Pilot River Basin Greece, WG 4.1: Integrated Testing of Guidance Documents in Pilot River Basins* (Available at http://www.minenv.gr/pinios/page5.html)
13. Ministry of Environment, Physical Planning and Public Works of Greece Water Section. *Water Framework Directive, Integrated Testing of Guidance Documents in Pilot River Basin Pinios Pilot River Basin - Greece* http://www.minenv.gr/pinios/page5.html)
14. Nikos Skoulikidis (2005), *General characteristics of Pinios R basin.* Institute of Inland Waters, Hellenic Centre for Marine Research.
15. Perfecture of Magnesia (2005), Strategic plan of Magnesia Development Volos (in Greek),
16. Regulatory Authority for Energy (RAE) (http://www.rae.gr/en/)
17. WaterStrategyMan (WSM) DELIVERABLE D1. Available at: environ.chemeng.ntua.gr/WSM/Uploads/Deliverables/FirstYear/Deliverable%2001.pdf)