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Activity 2 "Identification of human pressures and impacts on the surface waters of Aoos/Vjosa watershed"

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THE GOULANDRIS NATURAL HISTORY MUSEUM
GREEK BIOTOPE / WETLAND CENTRE

ECAT Environmental Center for Administration & Technology
TIRANA

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Contents

I. Introduction

In the frame of the project titled "Transboundary cooperation for the surface water resources management in the Aoos/Vjosa catchment", financed by the Hellenic International Development Cooperation Department, Ministry of Foreign Affairs, the Greek Biotope Wetland Centre (EKBY) collaborated with the Albanian partner Environmental Centre for Administration and Technology (ECAT) in order:

a. To strengthen the Greek – Albanian cooperation in the field of sustainable water resources management.
b. To promote sustainable management of surface water resources in the Aoos/Vjosa catchment and
c. To contribute to the implementation of the Water Framework Directive 60/2000/EC, in the Aoos/Vjosa catchment.

The project started on November 2005 and lasted until to October 2007. This is the final joint report of Activity 2 "Identification of Pressures and Impacts of Human Activities in the water resources of the Aoos/Vjosa catchment".

The main objective of this activity is to identify the pressures exerted by human activities on the surface waters of the Aoos/Vjosa river catchment.

The above study has been completed based on:

a. The review of the literature, published and unpublished data.
b. In Albania, the collaboration with central and local agencies (Ministry of Environment, Forest and Water Administration, Ministry of Agriculture and Consumer Protection, Ministry of Interim, as well as with the Local Government Unit of Vjosa watershed).
c. The collaboration with related university departments, research institutes of the Albanian Academy of Sciences (Institute of HydroMeteorology, Institute of Biological Research, Institute of Forest and Pasture Research, Hydraulics Research Center, etc.) and other organizations.

II. Description of the study area

1. Location

The transboundary river Aoos/Vjosë is situated in southwestern Albania and northwestern Greece (Map 1). The total length of the river is about 272 km, of which 80 km is in Greece. Aoos/Vjosa[1] River catchment has approximately total area of 6706 km^2 (~4365 km^2 in Albania and ~2341 km^2 in Greece). In Greece the catchment is mainly extended in the Region of Epirus and to a lesser degree in Dytiki Macedonia. The lowest altitude is around 400 m and the highest 2636 m. The river springs in the Pindus mountain range, in northern Epirus, Greece and flows through the Vikos-Aoos National Park, where it forms a unique canyon.

In Albania the catchment is shared among seven districts: Permet, Gjirokaster, Tepelene, Kolonja, Fieri, Mallakastra and Vlora with a mean elevation of 855 m (Saraci R., Tirane 1984). Aoos/Vjosë River enters Albanian territory close to Molivoskepastos village (on the Greek side) and Perat village (on the Albanian side). The river flows into the Adriatic Sea, north of Vlorë, Albania forming the Narta lagoon (Map 1).

2. Climate

Influenced by warm winds from the sea, Vjosë River catchment is characterized by mild climatic conditions. Differences in elements of climatic parameters are irrelevant. Hence, the mean annual temperature is 15.1 °C in Tepelene town and 14.8°C in Permet town. Mean temperature of January is 6.9 and 5.8 respectively and of July is 24.1 °C for both towns, (Gjeografia e Shqiperise, Vol. 2).

The amount of rainfall does not have big differences along the valley. In Tepelene the amount of rain is 1327 mm/year, in Kelcyre 1245 mm/year, in Permet 1272 mm/year and in Dorez 1162 mm/year.

Due to geographical position and the bold relief, climatic conditions in the Aoos catchment are diverse. In lowlands climate is ranging between Mediterranean and Mid-European and towards higher altitude it resembles alpine conditions. The catchment is characterized by high precipitation (in Konitsa snowing lasts for almost 5 days/year) and 70 to 120 days of rainfall, mean highest temperature is 29.7 °C and mean lowest -9 °C (Table 1).

[1] The name *Vjosë* will refer to the Albanian section and the name Aoos to the Greek section

Table 1. Mean annual precipitation in Aoos catchment.

Subcatchement	Area (km^2)	Mean annual precipitation (mm) 1951-1988	Water volume x 10^6 m^3
River Aoos	812	1782	1447
River Sarantaporos	914	1486	1358
River Voidomatis	418	1815	758
Total catchment	2144	1695	3563

3. Geomorphology

Aoos/Vjosa River is on of the longest rivers on the east coast of the Adriatic Sea. The river catchment is eastwards close to Aliakmon River catchment, south and westwards close to Arahthos, Thiamis, Povlla, Bistrica and Kalasa river catchments. Towards the north, the catchment is close to Seman, Osum and Ahaknon river catchments and it flows into the Adriatic. Mean catchment slope is Im = 28 %, mean slope of riverbed is Is = 4 %.

Aoos River catchment lies within the Ionian geotectonic zone (Ministry of Development 1996). The Ionian zone extends from the Ionian Islands towards the west side of the Pindos mountain range and south to the gulf of Messologi. The Ionian zone is very plastic and active due to the high portion of limestone (Map 2).

On the northeast part of the catchment there is also a portion of ophiolithic complex (serpentinites and ophicalcites) and in the Saradaporos subcatchment formations of mesohellenic groove (sandstones, conglomerates, marls). The Ionian zone is typical of a sequence of large anticlines and synclines of general direction NW-SE which is also the typical Pindous mountain range direction. The stromatographic sequence of the Ionian zone is:

Evaporitic series and Triassic breccias (Permian-Triassic). Evaporitic zone contains limestones and anhydride deposits.

Calcareous series (Upper Triassic – Upper Eocene). Dolomites and dolomite limestone (Upper Triassic – Middle Liasio) mainly lie in the outer Ionian zone and Timfi Mountain.

Flsych (Upper Eocene - Aquitanian). Succession of silty marls and medium to coarse sandstones.

The lithological column of Ionian zone is filled in with blue marls of the Burdigalian and lacustrine Pliocene sediments (sandy clays).

The middle part of Vjosa River is situated in the Southern Mountain Region, and its length is 166 km and the width ranges from 600 to 1500 m. In this part, the river has created one of the most important valleys of Albania, which is the main valley of the Southern Mountain Region.

Lithological diversity, morphological and morphogenetic evolution, geotectonic movements have created a great contrast between different sectors of this valley.

The relief of the valley is very shredded (1 – 5 km/km^2). Smaller values exist in the territories with calcareous structure, while upper values at the flyschy deposits. Relief energy has values between 300-500 m/km^2. High values have small diffusion and can be encountered at the left slope of the valley (Dhembel-Nemecke), at the Kelcyra gorge.

Morphological features of Vjosa valley are very different along its course, depending on the lithological construction and the structures, which the valley crosses. Based on the morphological and lithological features, Vjosa valley can be divided in three main sectors:

from Mesareja to Kelcyra,

from Kelcyra to Dragoti and

from Dragoti to Pocem.

After the Pocem, the valley unifies with Myzeqe plain.

In the first sector, the valley is developed in the Permeti synclinal structure in the direction SE-NW, in compliance with the direction of the main structures. The river has elaborated the valley into flyschy rocks of lower Oligocene. Here the valley is wide and has the shape of the riverbed. In the same places, at the terrace of first level, the valley width reaches 1500 m as in the case at the Kelcyra town, Kosine, Permet town, etc. There are also sectors where the valley is 200-400 m narrow like in Badelonje, Petran and Iliar. The most important morphological elements in this sector of Vjosa valley are the river terraces. They occur at both sides of the river at different hypsometric levels, but most developed are those at the right slop of the valley.

In the second sector of valley (Kelcyre-Dragot), Vjosa River swifts from east to west. In this part, the river has created a great gorge of Kelcyra, 13 km long and more than 1000 m deep. In this part the river has elaborate in depth the valley through erosion, separating mountain Trebeshina from mountain Dhembel and mountain Shendelli from mountain Lunxheria. From Dragot to Pocem stretches the third sector. In this sector, the valley is extended attaining in some parts 1-2 km (Qesarat, Kute, Pocem). Only in this sector and at Dorez and Pocem in particular the river is narrow, taking again the shape of the gorge. This sector is different form others. Gravely earth is very well developed, particularly in the right side of the valley (from Dragot to Pocem). Most of the valley, including this sector has an erosive origin and only partially have erosive-tectonic origin (Dorez, Pocem). Its slopes are asymmetric and in some places very much shredded.

4. Hydrology

Aoos River catchement includes the extended cartsic hydrogeologic unit of Timfi and the units of Amarantos and Arenon Grammou. These units drain in Voidomatis springs (mean discharge 4.6 m^3/s), in Isvoro/Amarantos springs (mean discharge 0.56 m^3/s) and in the spring of Pefkofito (mean discharge 0.2 m^3/s) of total mean discharge 5.36 m^3/s. This volume corresponds to mean annual discharge through those springs $169x10^6$ m^3. The Timfi system (2665 km^2) receives $477x10^6$ m^3 annually and $230x10^6$ m^3 percolate giving a percolation factor of 0.48. In Table 2 indicative discharges from several springs in the catchment during summer are presented.

Table 2: Karstic springs in the Aoos river catchement

Spring name	Discharge m^3/sec (Summer '80)
Arrenon	0.25
Isvoros	0.52
Kavasila	0.08
Pyzaria	0.10
Arvinitsa	0.03
Magoula	0.09
Alakos	0.04
Anouka	0.11
Agia Triada	0.12
Gastromeni	1.80
Neles	0.33
Fteri	0.21
Vovousa	0.22
Klidonia	0.34

The main tributaries in the Aoos catchement are Saradaporos River and Voidomatis River (Map 1). The former springs from Grammos Mountain and the north of Smolikas Mountain and the latter from the south of Timfi Mountain. Mean annual discharge of Aoos at the boarders is 52 m^3/sec and this does not include water of Saradaporos (including Saradaporos is 70 m^3/sec).

River Vjosa is the biggest river in the South Albania and one of the biggest rivers of this country. There are several urban areas in the Albanian catchment yet it is stated to be the least affected among the six watersheds of Albania (Fig. 1, 2) and the river the cleanest (National Water Strategy for Albania, 1996).

Figure 1: View of upper part of Vjosa catchment

The main tributaries of Vjosa are Drino, Shushica, Langarica, Dishnica, Benca and Luftinja. River Drino is the biggest tributary of Vjosa. It springs from Elates Mountain (1257 m) in Greece. It has a catchment area of 1320 km^2 from which 256 km^2 are situated in Greece. Only Drino River enters in Albanian territory and up to discharge in river Vjosa, it passes through a wide gravel riverbed, in Dropulli plain. Also, Kseria, Suha, Nunica, and Kardhiqi torrents discharge in Drino River (Table 3). These torrents bring considerable amount of solid materials, mainly gravel.

Table 3: Physical characterists of Vjosë, Drino and Shushica rivers.

River	Length (km)	Area (km^2)	Catchment mean elevation (m)	Catchment slope (%)	Bed slope (‰)
Vjosë	272	6706	855	28	4.1
Drino	84.6	1324	746	28	5
Shushica	81.6	715	540	28	9

A characteristic feature of the Vjosa catchment is the presence of deep karst aquifers, which assure an abundant underground supply during dry season.

Figure 2: View of upper Vjosa watershed

Precipitation in Vjosa catchment is generally higher than mean value for Albania. Particularly Drino and Shushica Rivers are characterized by heavy precipitation. In the upper part of the catchment in Albania territory, high values of *runoff coefficient* have been observed. The highest values of specific discharge are observed in Shushica (0,032 $m^3/s/km^2$) and Drino (0,030 $m^3/s/km^2$) rivers. Some basic features for Vjosa catchments (Figure 3) are presented in Table 3 and 4 (National Water Strategy for Albania, 1996).

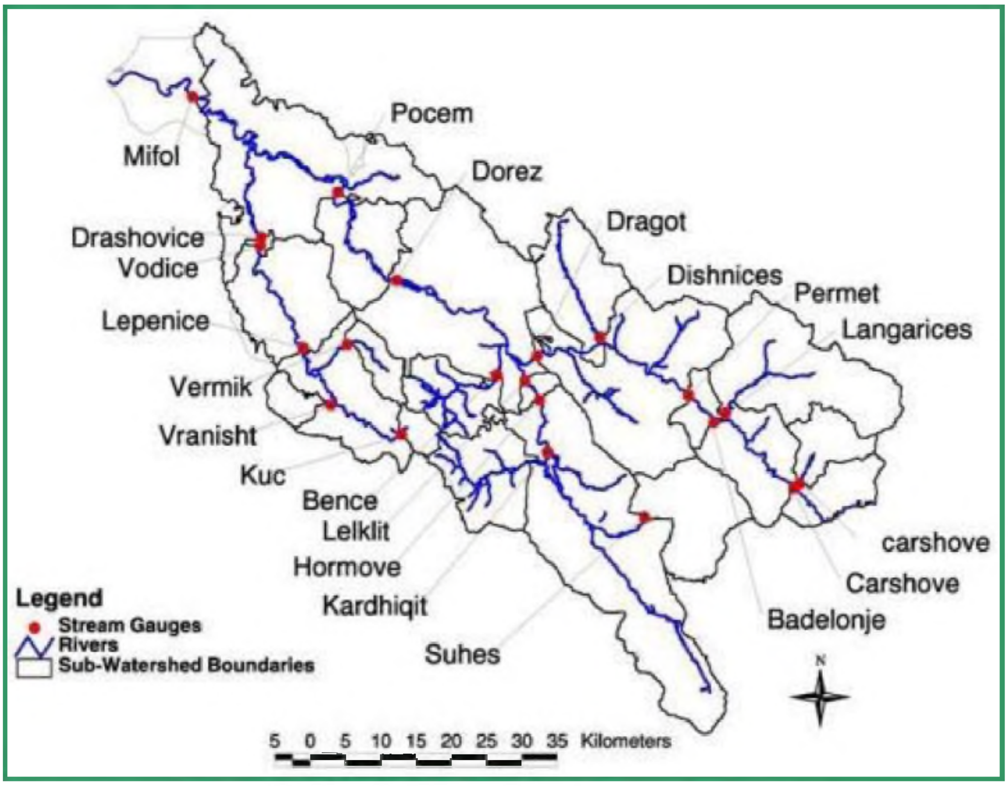

Figure 3: Location of hydrometric stations at Vjosa catchment

Table 4: Hydrographic and hydrological features of the Vjosa catchment

River	Station	Area (km^2)	Altitude (m)	Discharge (m^3/s)	Rainfall (mm)	Runoff (mm)	Runoff coefficient
Vjosa	Biovizhde	2170	1220	60.2	1260	874	0,69
Vjosa	Petran	2420	1190	62.2	1210	810	0,67
Vjosa	Permet	2810	1160	67.5	1220	757	0,65
Vjosa	Dragot	3470	1090	91.4	1320	830	0,63
Vjosa	Dorze	5420	963	158	1570	918	0,58
Vjosa	Mifol	6680	858	176	1520	829	0,55
Drino	Hormove	1300	748	39.0	1950	945	0,48
Shushica	Vodice	587	618	18.9	1870	1014	0,54
Bistrica	Krane	108	475	22.9	1800	6679	3,71
Kalasa	Blerimas	228	579	6.29	1556	869	0,56
Pavlla	Bogaz	337	556	5.86	1553	548	0,35

Mean annual flow of Vjosa River, at the outlet into the Adriatic Sea is 195 m^3/sec, and minimum flow 33 m^3/sec. Flowing module is relatively high; 0.029 $m^3/sec/km^2$ and flowing coefficient 0.61. Figures 4 and 5 show a hydrometric station at Vjosa River.

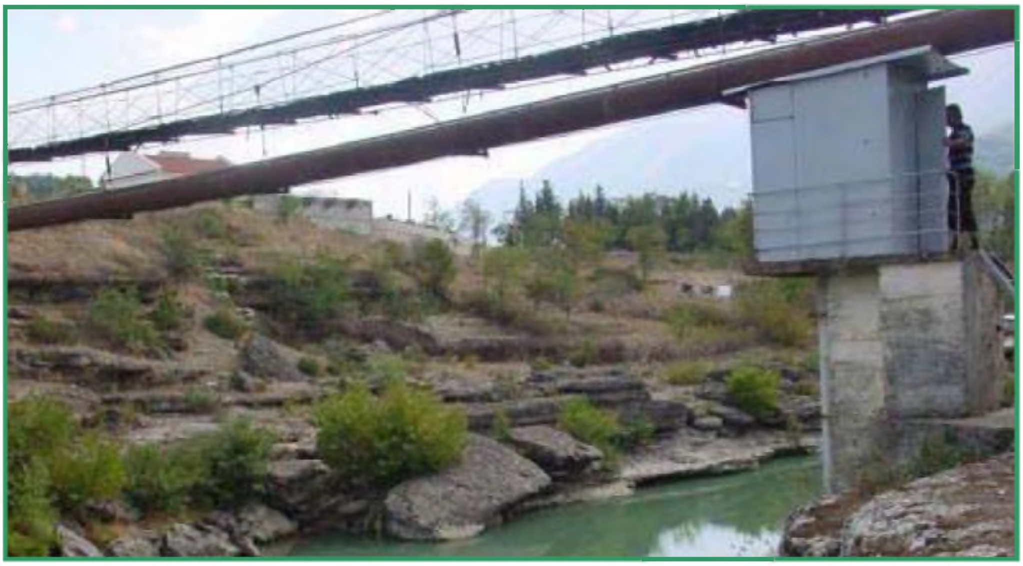

Figure 4: View of one Hydro Metric Station at Vjosa River

Figure 5: The sign shows maximum historic level of Vjosa River

Narta Lagoon is second to Karavasta Lagoon on the Albanian coast. Wetland habitats occupy 52 % of the total surface of Narta. The other main habitat (40 %) is agricultural land. Forests compose the third main habitat covering only 6 % of the territory. The core wetland is Narta lagoon, a shallow marshland of 2900 hectares surrounded by hills in the southern and western part, salinas (salt flats, 20% of the lagoon area is used for salt production) and agricultural land in the north, and two shallow wetlands in the northwest.

The lagoon is a complex system from hydrogeomorphological point of view. Hydrogeomorphological processes in the lagoon are extension of hydrographical net; solid alluvium of different small rivers mainly during winter period; refraction of Adriatic sea waves. The main geomorphologic process is accumulation and deposition of sand mostly from inland and from the sea. Narta is a typical coastal lagoon and as described above it is connected with the sea via two access channels, which until 1966 covered an area of 4180 ha. Since then, 1290 ha have been converted into commercially operated saline. The catcment area of the lagoon covers about 7300 ha. Water exchange between the lagoon and the sea take place due to of the periodic changes of water levels. The water level in the lagoon is conditioned also from other atmospheric factors such as rain, evaporation etc. As the Albanian coast, the Narta lagoon is essentially micro tidal; the tidal range does not exceed 0.5 m. Tidal current velocities are 0.1-0.4 m/s. Storm waves, accompanying wind velocities over 15 m/s, occur 0.5 % of the year, with 2 m wave height and 20-30 m wave length. Waves over 2 m high, with lengths of 60-80 m, occur 3 % of the year. Coastal current velocities are usually 0.3-0.5 m/s.but may reach a maximum of 1.5-2.0 m/s. Calm prevails during 1-2 % of the year. The main hydrological constraints in the lagoon are:

- little freshwater draining into the lagoon (during winter season)
- little exchange of water with the sea
- pollution from sea and land.

During summer water temperature raises up to 30 ^{o}C causing intense bacterial metabolism and oxygen depletion. Narta lagoon is suffering rapid degradation due to slow water renewal rate.

During summer, salinity reaches high values (up to 78 ‰) due to the high evaporation, little rainfall and low water exchange with the sea. Winter high precipitation and low evaporation causes the salinity level to drop to 36 ‰.

The regime of atmospheric precipitation and evaporation affects the regime of water level in the lagoon. Regarding the water exchange process, this is low due to the small dimensions of the communication canals. Tidal effect is almost zero. However, during the driest period of the year, the water supplied from the sea into the lagoon, although in small quantities, secures its existence. It is important to mention that the wind regime also influences the water level regime in the lagoon. The strong southern winds cause a decrease of the level by 20-25 cm, while the northern winds cause an increase by 15-20 cm. Wind influence on the water level is particularly considerable due to the shallow depth of the lagoon.

In the plain area of Vjosa River, three hydro pumping stations operate and a poor network of draining ditches exists. The drainage system is not functioning properly because of siltation of the ditches, pump malfunctioning, power shortages, etc. Following heavy rainfalls, the main portion of agricultural land is flooded for several weeks.

The area is generally poor in groundwater resources. Groundwater accumulates in the shallow sandy deposits and it is typically of poor quality and low volume. The depth of the groundwater level varies from 1 - 10 m and people occasionally draw water from hand-dug wells. The primary groundwater flow is west towards the Adriatic Sea.

5. Land Cover/Use

Aoos/Vjosa river catchment is mainly covered by forestland ~23 % (CORINE type *Broad-leaved forest*, 311) (Table 5, 6, 7, Map 3). The total area covered by CORINE land cover *natural* types (CORINE codes 311, 312, 313, 321, 322, 323, 324, 331, 332, 333, 334) is approximately 82 % of the total catchment. The area covered by agricultural land (CORINE types 211, 212, 221, 222, 242, 243) is only 4.6 % of the total catchment. This shows that human impact on the catchment is very limited.

The Albanian part of the catchment is covered ~23 % by forestland (CORINE type *Broad-leaved forest*, 311) and the total area covered by CORINE land cover *natural* types (CORINE codes 311, 312, 313, 321, 322, 323, 324, 331, 332, 333, 334) is approximately ~82 % whereas total agricultural land (CORINE types 211, 212, 213, 221, 222, 223, 242, 243) is ~15.5 %. The Greek part of the catchment is covered 23.5 % by forest land (CORINE type *Broad-leaved forest*, 311) and the total area covered by CORINE land cover *natural* types (CORINE codes 311, 312, 313, 321, 322, 323, 324, 331, 333) is approximately 94 % whereas total agricultural land (CORINE types 211, 212, 213, 221, 222, 223, 242, 243) is ~5 %.

Table 5: Land cover/use of Aoos/Vjosa catchment according to CORINE 2000 data.

CORINE code	CORINE Description	%
111	Continuous urban fabric	0.009
112	Discontinuous urban fabric	0.9
121	Industrial or commercial units	0.02
122	Road and rail networks and associated land	0.012
124	Airports	0.04
131	Mineral extraction sites	0.011
133	Construction sites	0.01
142	Sport and leisure facilities	0.008
211	Non-irrigated arable land	2.215
212	Permanently irrigated land	0.259
213	Rice fields	0.004
221	Vineyards	0.15
222	Fruit trees and berry plantations	0.362
223	Olive groves	0.753
231	Pastures	0.514
242	Complex cultivation patterns	4.4
243	Land principally occupied by agriculture, with significant areas of natural vegetation	7.6
311	Broad-leaved forest	23.05
312	Coniferous forest	7.95
313	Mixed forest	4.054
321	Natural grasslands	12.79
322	Moors and heath land	2.85
323	Sclerophyllous vegetation	12.85
324	Transitional woodland-shrub	11.67
331	Sparsely vegetated areas	0.98
332	Bare rocks	0.6
333	Sparsely vegetated areas	5.23
334	Burnt areas	0.033
411	Inland marshes	0.22
421	Salt marshes	0.019
422	Salines	0.081
511	Water courses	0.299
512	Water bodies	0.182

Table 6: Land cover classes according to CORINE project in the Aoos river catchment for the first and second year of implementation (1991 and 2000).

CODE	Description	Area (m^2) 1991	% 1991	Area (m^2) 2000	% 2000
112	Discontinuous urban fabric	2465488,3	0,0832	2926127,5	0,0988
133	Construction sites	not recorded*		264652,35	0,0089
211	Non-irrigated arable land	2751384,2	0,0929	4407452,6	0,1488
212	Permanently irrigated land	14578415	0,4922	17693985	0,5973
221	Vineyards	4043666	0,1365	not recorded	
222	Fruit trees and berry plantations	465026,7	0,0157	not recorded	
242	Complex cultivation patterns	18763814,7	0,6335	15743990,6	0,5315
243	Land principally occupied by agriculture, with significant areas of natural vegetation	46163426,4	1,5584	40082320,4	1,3532
244	Agro-forestry areas	258159,3	0,0087	not recorded	
311	Broad-leaved forest	535526982	18,0790	455957440,4	15,3928
312	Coniferous forest	585685082,5	19,7723	455690947,2	15,3838
313	Mixed forest	274134443	9,2546	258872603,5	8,7394
321	Natural grasslands	358304424	12,0961	239461192,1	8,0840
322	Moors and heath land	37360888,1	1,2613	9181225	0,3100
323	Sclerophyllous vegetation	199623614,45	6,7392	84691367,6	2,8591
324	Transitional woodland-shrub	730171271,1	24,6501	425050225,3	14,3494
331	Sparsely vegetated areas	21784393	0,7354	24768492,6	0,8362
333	Sparsely vegetated areas	127800324	4,3145	79275299,5	2,6763
511	Water courses	2265071	0,0765	707625,6	0,0239
512	Water bodies	not recorded		7998572,3	0,2700

not recorded: these classes have not been recorded on the respective year.*

Table 7: Land cover classes according to CORINE in the Vjosa catchment (2000).

CODE	Description	Area (m^2)	%
111	Continuous urban fabric	693996	0
112	Discontinuous urban fabric	65783348	1
121	Industrial or commercial units	1396971	0
122	Road and rail networks and associated land	903324	0
124	Airports	3043145	0
131	Mineral extraction sites	822637	0
133	Construction sites	769293	0
142	Sport and leisure facilities	633031	0
211	Non-irrigated arable land	160424255	2
212	Permanently irrigated land	18770034	0
213	Rice fields	316973	0
221	Vineyards	10904518	0
222	Fruit trees and berry plantations	26238175	0
223	Olive groves	54573577	1
231	Pastures	37236529	1
242	Complex cultivation patterns	318842147	4

Table 7: continued

CODE	Description	Area (m^2)	%
243	Land principally occupied by agriculture, with significant areas of natural vegetation	550838728	8
311	Broad-leaved forest	1668841128	23
312	Coniferous forest	576113790	8
313	Mixed forest	293888758	4
321	Natural grasslands	926046664	13
322	Moors and heathland	206927427	3
323	Sclerophyllous vegetation	930423325	13
324	Transitional woodland-shrub	845169149	12
331	Beaches, dunes, sands	71188705	1
332	Bare rocks	43744937	1
333	Sparsely vegetated areas	378793431	5
334	Burnt areas	2397767	0
411	Inland marshes	1611889	0
421	Salt marshes	1407844	0
422	Salines	5916566	0
511	Water courses	21698641	0
512	Water bodies	13222108	0

6. Biodiversity

There are more than 1000 species of plants in the Vjosa river catchment and a reach fauna. Vegetation coverage in this valley mainly presented from Mediterranean shrubs as for example; various berry trees, heather, arbutus, etc, extended up to the upper part of valley, but more developed are in the right slope of Vjosa (Prifti 1984). They are stretched up to 700-800 m above sea level. At the same altitude, in the right slope of the river between Kaludhit and Petrani grows the Macedonian fir (*Abies borisi-regis*), a Mediterranean relic. Along the riverbed plane-trees and willows, maples (Acer sp.), linden-tree (*Tilia* sp.), hornbeam (*Carpinius* spp.) are common.
Fauna in the Vjosa river watershed is multifarious including birds, mammals and amphibian**.** In this respect should be mentioned**,** wolf (*Lupus canis*)**,** fox **(***Vulpes vulpes*), wild rabbit (*Lepus europeaus*), wild goat (*Rupicapra rupicapra*), brown bear (*Ursus ursus*), *Sus scrofa*, Vjosa trout, *Pelicanus crispus,* etc. (Gjeografia e Shqiperise, Vol. 1). The wetland complex of Vjose-Narta has been highly appreciated for its natural and biodiversity resources by numerous national and international documents such as BIO SAP National Report (2002), NBSAP (1999), CAMP (1996), CZMAP (1996), and the report on Activity 7.2.4 "Specially Protected Areas and implementation of the SPA Protocol" for Albania (SPA/RAC, UNEP/MAP, 1996).

Aoos catchment is of high ecological and aesthetic value due to rare flora and fauna and the picturesque landscapes i.e. 12 habitat types of Dir. 92/43/EEC Annex I. The geographical isolation of the area, the relatively small human influence and the great variation of habitats and microclimatic conditions favour the abundance of numerous important species. The National Park of Vikos-Aoos lays in the catchment and the Vikos Gorge is listed as the deepest gorge in the world by the Guinness Book of records among others. With walls of up to 1 km in height, the 12 km gorge on the Voidomatis River is spectacular. A large number of Greek endemic species are abundant in the catchment several of which are Balkan endemics (e.g. *Aesculus hippocastanum, Erysimum cephalonicum, Abies borisii-regis, Bupleurum karglii, Campanula hawkinsiana* etc). SA regards wild fauna, 13 species have been recorded in the catchment which are registered in Dir. 92/43/EEC, Annex II: *Myotis blythii, Ursus arctos, Lutra lutra, Lynx lynx, Rupicapra rupicapra balcanica, Triturus carnifex, Bombina variegata, Testudo hermanni, Testudo marginata, Elaphe quatuorlineata, Elaphe situla, Vipera ursini and Salmo macrostigma.*

III. Method

The main target of this deliverable was the identification of pressures exerted by human activities and their impact on the surface waters of river Aoos/Vjosa catchment. To this direction it was intentional to adopt the conceptual framework methodology of the Guidance Document no 3: Analysis of Pressures and Impacts' for the Common Implementation Strategy for the WFD (2000/60/EC), tailored to fit in the conditions and data availability of Albania and Greece. In addition, Greek and international literature on the implementation of the DPSIR method and related Albanian publications were reviewed (Pasha 2000, Troendle 2002, Karageorgis et al 2005, Pirrone et al 2005, Borja et al 2006).

The implementation of the DPSIR method comprises four steps (Fig. 6):

i) Description of factors (*drivers*) that drive, influence and direct pressures exerted especially land use, urban development, industry, agriculture and other activities.

ii) Identification of pressures with possible impacts on the quality and quantity of the water body and on water uses, by considering the magnitude of the pressures and the susceptibility of the water body.

iii) Assessment of the impacts resulting from the pressures and

vi) Evaluating the possibility of failing to meet the objective.

A short description of the basic terms of their interrelation is provided (Guidance Doc. no 3) (Box 1):

Box 1. *The DPSIR framework as used in the pressures and impacts analysis*	
Driver:	an anthropogenic activity that may have an environmental effect (e.g. agriculture, industry etc)
Pressure:	the direct effect of a driver (e.g. an effect that causes a change in flow or a change in the water chemistry etc)
State:	the condition of the water body resulting from both natural and anthropogenic factors (i.e. physical, chemical and biological characteristics)
Impact:	the environmental effect of the pressure (e.g. fish deaths, ecosystem modified etc)
Response:	the measures taken to improve the state of the water body (e.g. restricting abstraction, limiting point source discharges, developing best practice guidance for agriculture)

However, as the objective of the study was not to fully implement the provisions of the WFD but to contribute to this direction only Drivers, Pressures, State and Impact of the DPSIR model were applied.

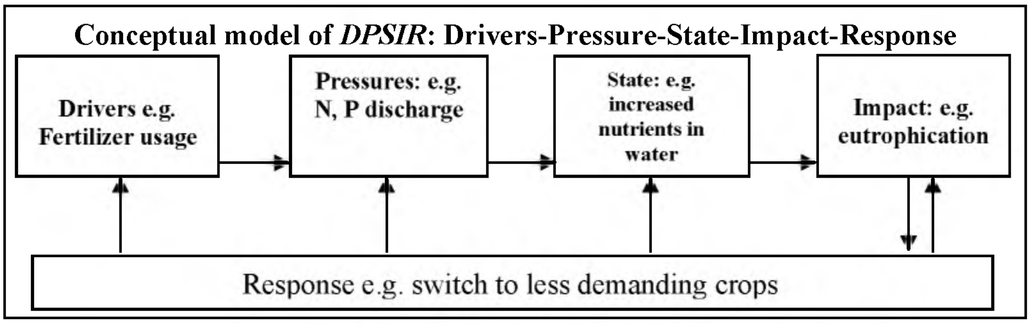

Figure 6: Conceptual model of the DPSIR method. The "impact" module connotes the environmental adverse effect of the anthropogenic activity represented by the "driver".

At this point it should be stressed that the distinction made between *state* and *impacts* separates effects that are sometimes combined or confused. One reason for this is that because some impacts are not easily measurable and state is often used as an indicator of or substitute for impact e.g. physical/chemical parameters are used for the description of ecological status.

Due to the above assumption, *state* is examined based on data availability and presented in combination with impacts.

It is also necessary to mention that in the Guidance Document no 3 for the implementation of the WFD it is pointed out that only significant pressures should be identified. The term "*significant*" represents any pressure that contributes to an impact that may result to the failing of specific environmental objectives. However in this case due to limited information all potential pressures were identified.

Data used for the analysis of pressures and impacts were assessed for accuracy and completeness and it concerns type and magnitude of significant pressures in the Aoos/Vjosa river catchment.

1. Identification of drivers

Drivers or driving forces are generally social and economic in nature - for example, an expanding economy, commercial and industrial development, increasing populations and standards of living. As such they encompass activities that produce or potentially produce a series of pressures, as point or non-point sources.

A broad classification of driving forces exists in the Guidance Document No 3 however, the analysis and addition of more types depends on each case of river basin (Appendix I). This list may be extended depending on the prevailing conditions in a specific river basin.

In the case of Aoos/Vjosa catchment, taking into account the available information regarding socio-economic activities (e.g. General Secretariat of National Statistical Service of Greece census 1991-2001, Beka 2001), the following drivers have been identified: land use changes, urbanisation, agriculture, stock farming, mining, power supply, industry.

Furthermore, based on data availability they have been quantified by summing up data such as hectares of arable land, population, number of cattle/sheep etc.

2. Identification and assessment of pressures

According to the DPSIR framework, *pressure* is the *direct effect of a driver (e.g. an effect that causes a change in flow or a change in the water chemistry etc).* Taking into account the list in Appendix I the following pressures have been identified in the river catchment (Table 8).

Table 8: Existing drivers and pressures by them in the Aoos/Vjosë catchement

Driver	Pressure
Land use changes	Water yield
	Sediment yield
Urbanisation	Drainage-municipal wastewater
	Abstraction for water supply
Agriculture	Drainage
	Abstraction for irrigation
Stock farming	Drainage
	Abstraction for animal watering
Mining	Hydromorpholy alteration
Power supply	Flow regulation
Industry	Chemical pollution

For the assessment of pressures in the catchment different approaches have been adopted based on the availability of quantifiable data related to the drivers.

Hence, pressures from industry and power supply were assessed qualitatively for both countries.

Pressures exerted form urbanization, agriculture and stock farming were also assessed in the same way for the Albanian part of the catchment while more analytical methods were used for the Greek part and they described in the next paragraphs.

2.1. Urbanisation

Urbanisation mainly exerts pressures on water resources by wastewater and abstraction of water for human households.

For the Greek part of the catchment, assessment of pollution pressure from urban wastewater was based on Health Provision E1β/221/22.1.65 (Official Journal 138/B/24.2.65) as it was amended with the Health Provision C1/17831/71 (Official Journal 986/B/10.12.71) and the Ministerial Decision 5673/400 which defines minimum loads for the calculation of wastewater specific contribution from various installations (Table 9).

Table 9: Mean daily wastewater discharge (L/day) per capita from various sources (Health Provision E1β/221/22.1.65).

Installation type	Load (L/day/per capita)
Dwellings	100
Hotels	150
Hospitals	200
Schools	50
Boarding schools	100
Camps	75

Pressure from organic load (BOD_5) and nutrients (N, P) (Directive 2000/60/EE) were estimated using various sources such as the Natural Environment Research Council of UK, Directive 91/271/EEC, Directive 98/15/EEC and scientific publications (e.g. Schouw et al 2003) (Table 10).

Table 10: Estimated BOD, N and P human daily release.

Average human excrement per day	
Feces	120 g
Urine	1.1 L
BOD_5	60 g
Total nitrogen	10 g
Total phosphorus	3 g

Source: Natural Environment Research Council of UK

Pressure from water abstraction for household use in the catchment was estimated based on the assumption that water consumption is 200 L/day/ per capita during cold season (275 days) and 330 L/day/per capita during warm season (90 days) (FEK 174 B/22-03-1991).

For the Greek part of the catchment, data related to population size derived from the census of 1981, 1991 and 2001. This was used in the assessment of the above pressures.

The number of future consumers was estimated as population projections for the areas of interest. To this direction the *interest method* was adopted, using data such as census 1981, 1991 and 2001:

$$En = Eo\,(1+\varepsilon)n \qquad (1)$$

where Eo equals present population (permanent or real),
En equals the population after n years,
ε is the annual average increase percentage of population

$$\varepsilon = (E_2/E_1)^{(1/\Delta t)} - 1 \qquad (2)$$

where E_1, E_2 is census for years t_1 and t_2 and $\Delta t = t_2 - t_1$

Equation (2) calculates the increase percentage of population for 1981 – 1991 and 1991 – 2001 and the average is used in equation (1).

2.2. Agriculture

Agricultural mainly exerts pressure on water resources by nutrient loads and water abstraction for irrigation.

Phosphorus and nitrogen concentrations in surface runoff vary extensively depending on land uses, soil and climatic conditions. In this study for the assessment of pressure by the above nutrients values derived from Ministry of Development (2003) have been used (Table 11), in combination with land uses information from CORINE Land Cover database.

In order to estimate water consumed for irrigation in the catchment a yearly average water demand for each type of crop equal to 500×10^3 m^3/km^2 and CORINE Land Cover database was used. Losses from irrigation networks and applied methods are included (Ministry of Development, 2003).

Table 11: Estimates of N and P depending on land use.

Land use	Total N (kg/ha/year)	Total P (kg/ha/year)
Non cultivated arable land	2	0,1
Cultivated land	16	0,6
Urban area	5	1

2.3. Stock farming

Livestock produce considerable loads of N, P and BOD_5 and in order to assess pressure from this anthropogenic activity estimates were adopted from FAO (FAO Taiganides, 1978) and Gray (1989) (Table 12).

Table 12: Estimates of volume, strength and nutrient content of animal wastes

Animal	Daily volume of effluents / animal (m^3/day)	COD (mg L^{-1})	BOD_5	N	P (kg tn^{-1})	K	Humidity %
Cattle	50	150000	16100	11.1	4,5	13,4	87
Swine	4.5	70000	30000	8.9	4,5	4,5	85
Poultry	0.1	170000	24000	38	31,3	15,6	32-75$^{\alpha}$
Sheep-goat$^{\beta}$	36		0,9	0,43	0,15	0,31	

α: depending on the farming method
β: Taiganides 1978 in kg/day/1000kg LW, where LW means animal live weight

The total daily water need of an animal depends on several factors such as the species and variety, animal's size, age and usage, farming conditions, mean daily temperature etc. Hence a lactating animal will generally require more water than a non-lactating animal, a heavier animal will require more water than a light animal, and almost all animals require more water during high temperature days. Typical average total daily water need figures for a number of different animals were derived from Ward & McKague 2007 and FAO (Taiganides 1978) and presented in Table 13.

Table 13: Estimates of daily water needs from livestock

Animal	Daily volume of water / animal (m^3/day)
Cattle	70
Swine	15
Poultry	0.5
Sheep-goat	15

Also for the assessment of pressure from manure produced, estimates from FAO (Taiganides 1978) were used and given in Table 14. Data related to livestock in the Greek part of the catchment (type of animal and population) derived from the General Secretariat of National Statistical Service of Greece. Also for the estimation of both water consumption and loads from stock farming, livestock assumed spatially distributed at municipality level and hence this pressure was considered as non-point.

Table 14: Typical input-output data in modern animal feedlots (Taiganides 1978).

Animal	*Feedlot type*	*Animal size range (kg/head)*	*Time in feedlot (days)*	*Materials input*		*Materials output*	
				Feed (kg/head/day)	Water (Litre/head/day)	Product (kg/head)	Waste (manure) (kg/head/day)
CATTLE							
Beef	Open	250-500	100-180	8-16	40-120	500	2-20
	Housed (slotted floor)	250-500	100-180	8-16	40-120	500	10-30
	Housed (solid floor)	250-500	100-180	8-16	40-120	500	10-30
Dairy	Stalls	500-650		15-25	60-320	10-40[α]	40-60
	Free stalls	500-650		15-25	100-130	10-40[α]	40-60
	Cow yard	500-650		15-25	120-320	10-40[α]	40-60
SWINE							
Pork pigs	Open (dirt)	20-100	150-180	1-3	4-20	100	1-3
	Housed (slotted floor)	20-100	150-180	1-3	4-20	100	1-5
	Open (solid floor)	20-100	150-180	1-3	4-20	100	1-5
POULTRY							
Broilers	Housed (litter)	0-2	40-60	0,05-0,1	0,1-0,2	1,5-2	0,05-0,06
Layers							
	Housed (cages)	1,5-2	400	0,1-0,12	0,15-0,2	0,6-0,9[b]	0,1-0,2
	Housed (litter)	1-5-2	400	0,1-0,12	0,15-0,2	0,6-0,9[b]	0,1-0,2
Turkeys	Open	2-14	120-170	0,2-0,3	0,3-0,5	8-14	0,3-0,6
Ducks	Open, wet	0·5-4	40-60	0,2-0,3	40-130	3-4	
SHEEP							
Lambs	Housed	30-60	40-150	2-3	4-7	40-60	1,5-3
Sheep	Housed	50-100	40-150	2-4	7-13	Wool, mutton	2-4
	Open	50-100	40-150	2-4	7-13	Wool, mutton	2-4
HORSES	Stable	300-600		9-14	30-40	Recreation, work	20-60

α Milk in kg/cow/day
b Eggs/hen/day

3. State and impact assessment

In the above-mentioned Guidance Document No 3, there is a clear distinction between "state" and "impact". The main reason for this is that many of the impacts are not easily measurable and state is often used as an indicator of, or surrogate for, impact.

In this study the "state" of Aoos/Vjosa River was assessed and quantified in terms of discharge and nutrient concentration.

A clear assessment and quantification of the "impacts" that certain pressures exert on an ecosystem requires time series of coinstantaneous data of both environmental factors (e.g. fauna and flora species population, habitat extent etc.) and pressures (e.g. abstracted discharge, pollutant loads). Since the elaboration of such a research was not among the objectives of this study certain "state" physical and chemical parameters e.g. water discharge, water temperature, pH, NO_2-N, NO_3-N, NH_4-N, PO4-P, metals, BOD_5 have proposed by the national and European legislation were used to demonstrate the impacts of human activities on water resources in the catchment and their state. Information for those parameters were derived from Greek competent authorities e.g. Ministry of Agriculture, the General Secretariat of National Statistical Service of Greece, the Ministry of Economy of Albania etc and scientific publications.

IV. IMPRESS implementation in the Aoos/Vjosë catchment

1. Identification of drivers in Aoos/Vjosë catchment

1.1 Land Cover/Use changes in Aoos/Vjosë Watershed

Land Cover/Use study and their dynamic of changes have been objects of the "Albanian Watershed Assessment Project" (AWAP) (Troendle 2002). Based on the studies carried out by Habili et al. 2000, Pasha 2000, Xhemalaj et al. 2000, land cover/use maps of Vjosa watershed have been prepared for a series of years (1960, 1970, 1980, 2000) to assist the assessment of land cover/use change for the related time period (Figures 7 and 8, Table 15).

Table 15: Land use/cover type category (%) for the Vjosa River catchment (Troendle 2002).

Land use type	% in the catchment				
	1960	1970	1980	1986	2000
Bare/Sand/Rock	3,94	4,17	4,01	10,76	12,51
Broadleaf Forest	10,10	12,39	13,12	9,90	9,28
Conifer Forest	0,58	1,57	2,60	2,06	1,85
Cultivated Land	18,57	21,93	23,32	22,64	21,13
Orchards	0,53	2,01	2,98	1,02	0,93
Pastures	47,89	39,08	36,84	32,97	34,57
Shrubs	16,06	16,2	14,35	17,87	16,95
Urban/Suburban Land	2,33	2,64	2,77	2,77	2,77

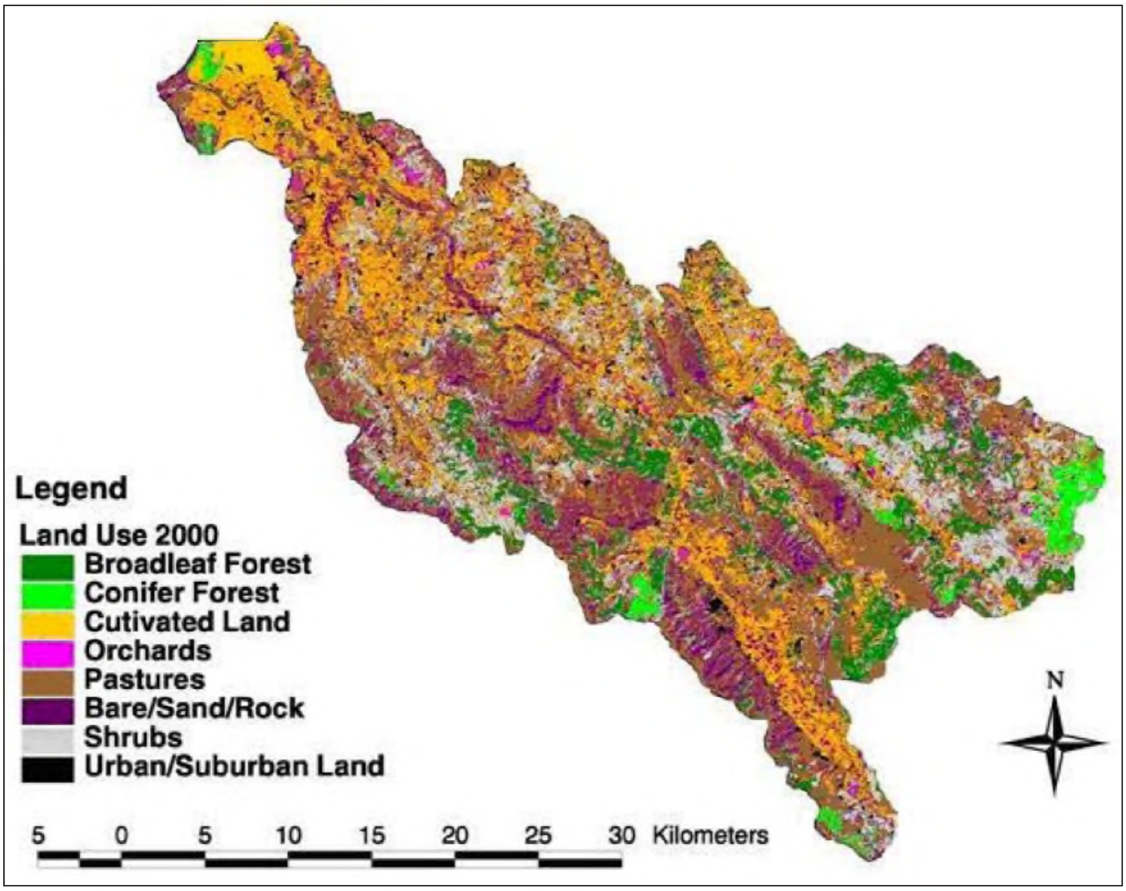

Figure 7: Land Use Map of Vjosa watershed in 2000.

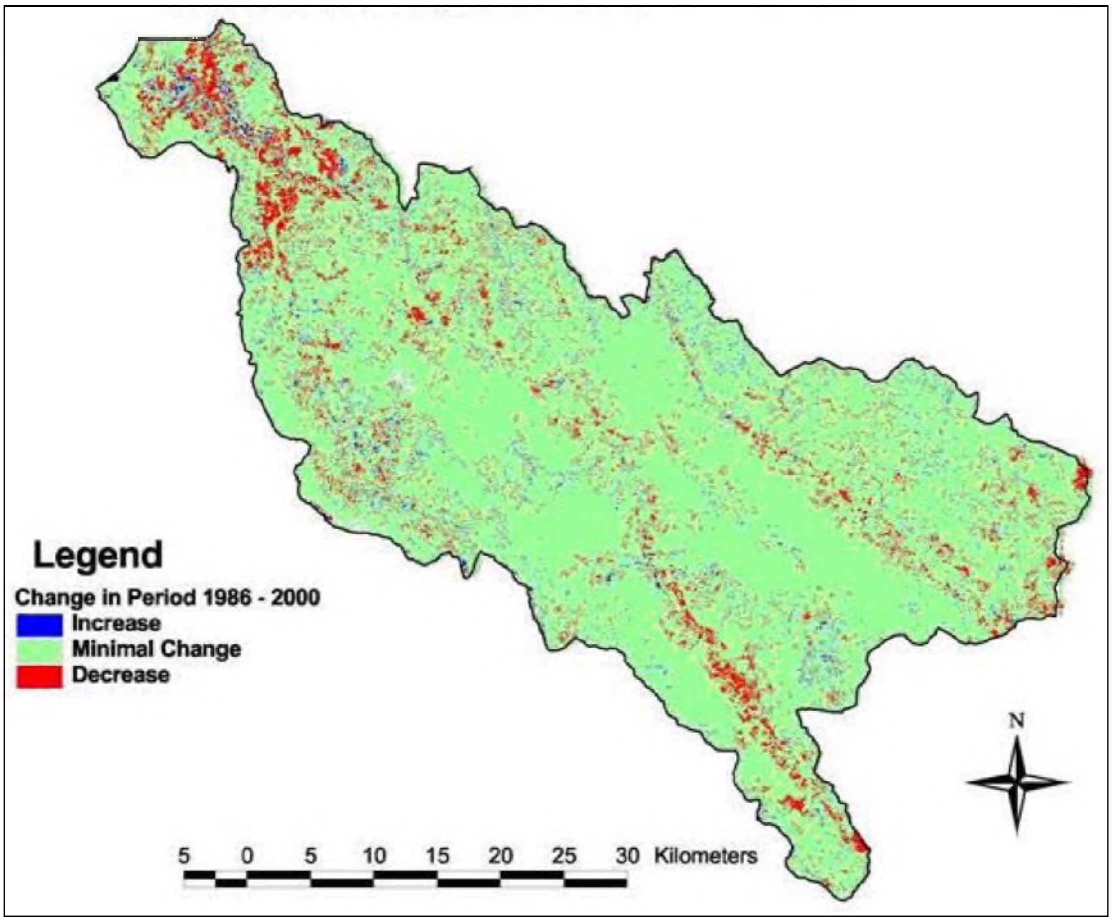

Figure 8: Map of Land Cover Change for the time period 1986-2000

1.2 Urbanisation in Aoos/Vjosa Watershed

The Prefectures of Ioannina, Kastoria and Grevena share the Greek section of the catchment where estimated population is 35000 inhabitants (Census 2001) (Table 16).

Table 16: Permanent and real population of municipalities and communities in Aoos catchment, census 2001.

Prefecture		Permanent	Real
Ioanninon	Koinotita[1] Vovousas	150	179
	Koinotita Fourkas	117	206
	Koinotita Aetomilitsas	39	304
	Koinotita Papigko	161	357
	Koinotita Distratou	420	487
	Municipality Timfis	1006	1493
	Municipality Kentriko Zagori	1217	1601
	Municipality Ano Pogoniou	1398	1663
	Municipality Mastorochorion	1382	2072
	Municipality Kalpakiou	1986	2324
	Municipality Anatoliko Zagori	1814	2402
	Municipality Egnatias	2469	2800
	Municipality Metsovou	4079	4417
	Municipality Konitsas	5690	6225
Kastorias	Koinotita Arrenon	581	623
	Municipality Nestorio	1533	1782
Grevenon	Koinotita Avdellas	12	448
	Koinotita Samarinas	64	701
	Koinotita Perivoliou	32	454
Total population in Aoos catchment		24118	30084

[1]Koinotita: Community

Population density is about 14.4 inhabitants/km^2 distributed in 103 residential areas including scattered settlements, villages and one town (population > 2000 inhabitants) (Map 4, 5). Population has principally gathered at the lowlands of Aoos catchment and along the valleys of Aoos River and one of its main tributaries, Sarantaporos River (Map 4, 5).

The projection of permanent population in Aoos catchment is given in Fig. 9 as it has been estimated for the years 2010, 2020 and 2030 following the method described in Section III.

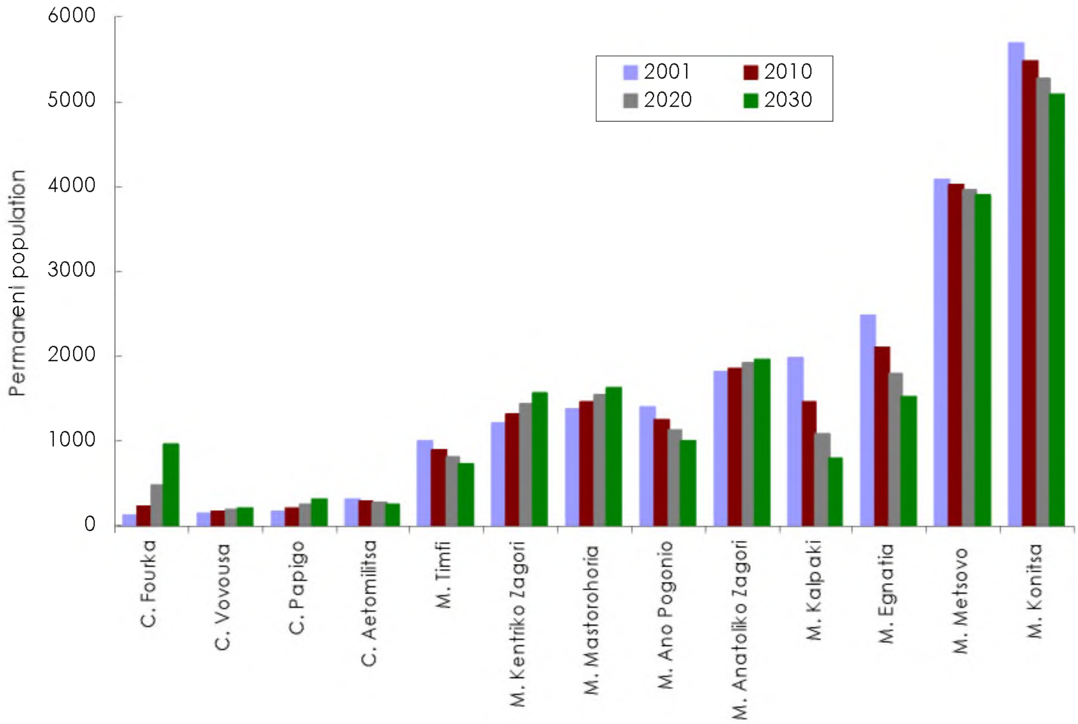

Figure 9: Projection of permanent population in communities (C) and municipalities (M) of Aoos catchment for 2010, 2020 and 2030. Permanent population of Aetomilitsa community increased from 2 (Census 1991) to 39 inhabitants (Census 2001) instead real population was used (real population 277 Census 1991, 304 Census 2001).

Aoos catchment has become a popular tourist destination during the past few years with increasing demand for hosting facilities and additional pressure to water recourses is exerted (Table 17 and 18).

Table 17: Number of hosting establishments Ioannina Prefecture.

Hotels, hostels, camping sites etc			Beds		
Hotels etc	Camping sites	Total	Hotels etc	Camping sites	Total
108	1	109	3.906	210	4.116

Source National Statistical Service of Greece, 2003

Table 18: Permanent population, surface and population density in urban, rural areas, plains and mountainous in Aoos catchment (National Statistical Service of Greece, 2001).

	Number of agglomeration	Population	Surface (km^2) With inland water	Surface (km^2) Without inland water	Population density	Mean altitude
Totals	106	21294	2411.89	2409.22	9.78	850
Urbans	1	2869	54.06	53.9	52.6	
Rurals	105	15462	2255.48	2253.406	3.43	
Plainsmen	1	328	7.28	7.28	22.52	
Semimountainous	7	1866	88.056	88.056	10.6	
Mountainous	98	19100	2316.558	2313.884	4.12	

Albania has Europe's highest total fertility rate (2.8), double the European average (1.4). Its birth rate (17.2/1000 in 1999) is also one of the highest in Europe (Western Europe 11.3/1000 in 1998). During the years 1945-1990 the population tripled from little over 1 million to the current total of 3,411,000. Although the country's total fertility and birth rates are high, the rate of population increase is declining due to massive emigration since 1990. There are also many ethnic Albanians living in adjoining areas of Yugoslavia (Kosovo) and FYROM. The average population density is 111 inhabitants/km^2 (EU average: 114 inhabitants/km^2). More than 60% of the population is concentrated on the Western Lowland, especially in areas in and around the main cities. The urban population is growing fast. In 1989 it was 36% of the total population; by 1999 it had risen to 41%. This urbanization with substantial population movements started after 1990, when the law banning free movement was abolished. Population density varies considerably within the country. In the most populated regions, the lowland between Tirana (445976 inh.) and Durrës (157339 inh.), it is over 300 inhabitants/km^2. In the mountainous northern region it is much lower (40 inhabitants/km^2). The infant mortality rate is a good indicator of the general well being of the population. Albania's infant mortality rate was 12.2 per 1000 live births in 1999 (West European average is 3 to 7 per 1000), significantly lower than the 60 per 1000 recorded from 1970 to 1975. In 1998 life expectancy at birth for men was 71.5 and for women 78.7 years (UN 2002).

Administratively Vjosa catchment consists of seven districts: Permet, Gjirokaster, Tepelene, Kolonja, Fieri, Mallakastra and Vlora. The population in this area is about 290000 inhabitants, living in seven towns and more than 300 villages (Map 5). It is estimated that more than 80% of the inhabitants live in the rural areas (Fig. 10) where the main activity is agriculture.

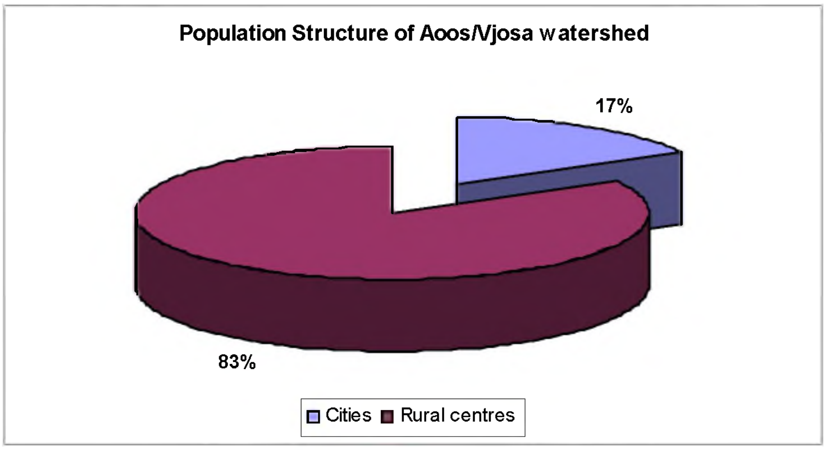

Figure 10: Population structure of Vjosa catchment

Family structure of the rural areas (number and age of family members) is defined based on the survey carried out by Beka, I. (2001). Based on the survey it results that rural families have in average 4.97 persons. About 63 % of the families have 3-5 persons (Fig. 11).

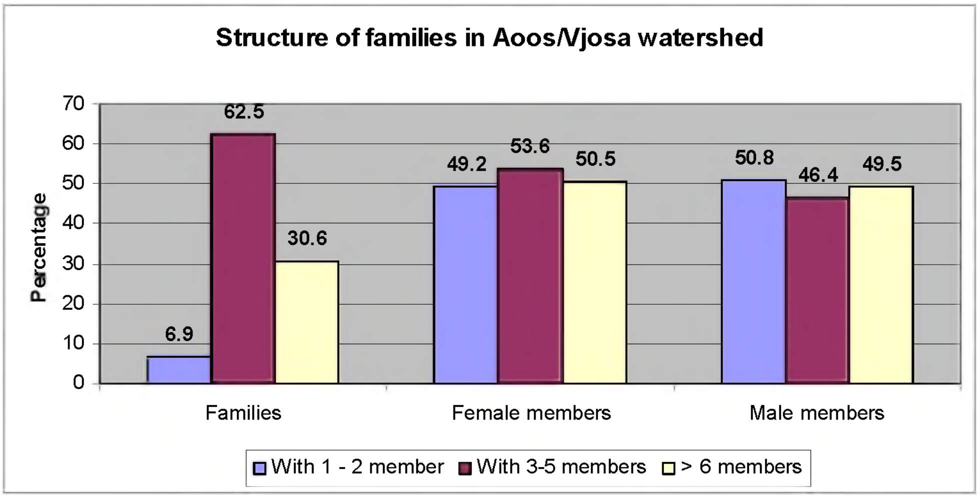

Figure11: Families structure in Vjosa catchment

Another important indicator is the educational level in Vjosa catchment. Most of the population of these areas has finished the elementary school and only 16.5% of the people have not completed any schooling (Fig. 12).

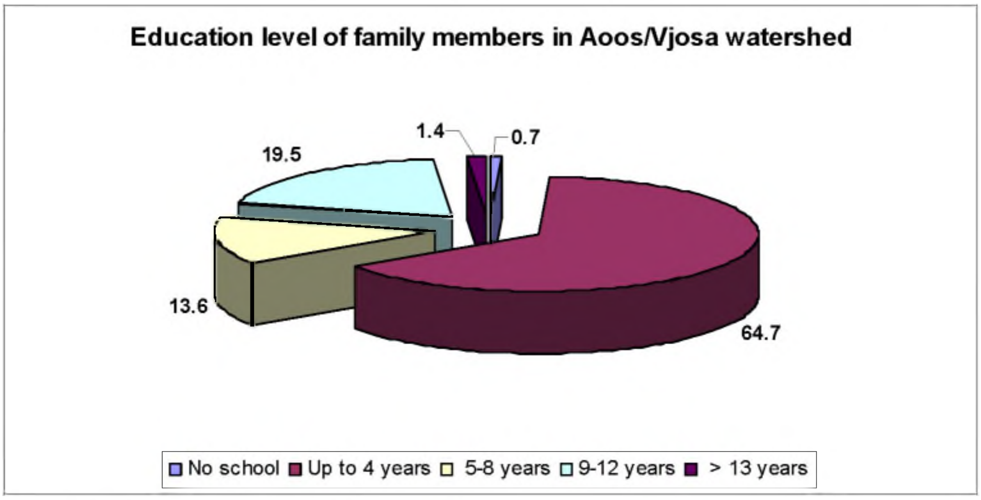

Figure12: Education level in Vjosa catchment

1.3 Agriculture in Aoos/Vjosa Watershed

Aoos River runs mainly through hilly land and human activities are limited. Agriculture is mainly confined in Konitsa floodplain. Following to CORINE 1991 database, in the Greek part of the catchment the total agricultural land was about 3% (86.7 km^2). This portion includes all types of agricultural land of any intensity level and irrigation practices.

The permanently irrigated portion of the agricultural land was about 0.5 % (2.7 km^2) (Map 3). The update of CORINE land cover classes ten years later (2000) showed some changes to agriculture in Aoos catchment. Three land-cover classes (vineyards, fruit trees and berry plantations and agro-forestry area) had not been recorded, total agricultural land decreased to 2.6 % (78 km^2) and permanently irrigated land increased to 0.6 % (Table 5, 6, 7, Map 3).

In Vjosa catchment agriculture is the prevailing economic activity. Agriculture is still oriented to the production for family needs because of the small size of the average farm. Only 20-30 % of the crop production is sold in the market and 70 % of the revenue is provided from the livestock production. The main development features of agricultural sector in Vjosa catchment as well as in entire Albania are as follows:

- Rural economy is still the dominant sector with 54% of GDP provided from agriculture (entirely privatized), 21% from the services, 13% from construction and 12% from industry.

- Over 50% of the population lives in rural areas and employment source comes mainly from agricultural activity (self-employment in farm).
- Official employment figures account over 60% of employment rate for the people engaged in the private agricultural sector
- Local food production covers about 70 % of the total demand for food of Albania but the rate of processed imported food is still very high.

Natural vegetation of Vjosa valley has been transformed from human intervention. There are deforested relevant areas and substituted with arable plants and fruit trees as olive and citrus trees, almond, vineyard and pomegranate. Between Permet and Tepelene prevails cultivated fruit trees, pastures and smaller livestock, while in the area between Mallakaster and Vlore arable plants and cattle are prevailed.

Agricultural sector, after the great decline in 1991-92, started to improve after 1993 as result of agricultural land privatization. Since the beginning of the transition period the annual growth of agricultural production has ranged with 3-10 %. In addition to the privatization of agricultural land and all other capitals in formed agricultural cooperatives and former state enterprises are also carried out the privatization reform in the processing industry. For the agro-processing enterprises classified as small and medium, the privatization process is almost entirely completed. Over 95% of the production of food and fishing industry is also provided from the private sector. (Beka, I. 2001, Final Study Report).

The region of Vjosa is mainly expanded in hilly and mountainous areas. The traditional agricultural sector in the region is mainly composed of farmers who produce for their own family needs, where livestock production is dominant compared to agricultural crops.

A comparison between the cropping structure of the selected crops between 1990 (the exact year before liberalization) and the later information on the cultivated areas with alternative crops shows that the traditional farmers are moving towards livestock production (Table 19).

Table 19: Crop production and use in 1999 (Vjosa catchment).

Crops	House holdings	Cultivated area (ha)	Irrigated area ha	Irrigated area % of area cultivated	Total production (tn)	Quantity sold (kg) raw	Quantity sold (kg) processed	Total sales (lek) raw	Total sales (lek) processed
Wheat	35	50.55	18.4	36.4	164150	2750	48000	30500	0
Maiz for grain	0	10	4.2	42.2	36750	400	0	13000	0
Other cereals	0	0	0	0.0	0	0	0	0	0
Lucerne	56	20.92	17.52	83.7	621500	10000	0	66000	0
Other forages	86	16.52	15.1	91.4	296500	0	0	0	0
Tomatoes	87	3.15	2.619	83.1	62880	37000	1	3816201	1
Other green vegetables	29	23	1.017	44.2	34460	9801	1	300001	1
Second season vegetab	7	0.712	0.532	74.7	10570	5000	0	42400	0
Second season forages	51	1.5	1	66.4	29800	0	0	0	0
Onions and garlic	50	1	0.846	85.0	9020	1	1	1	1
Potatoes	61	1.63	1	60.7	49001	7600	0	243200	0
Pulses	35	3.42	2.75	80.4	4795	5430	0	340000	0
Melons / water melons	32	2.5	1.88	75.2	78000	39100	0	1107000	0
Grapes	1	7	0.3	4.2	75097.3	41735	5738	2198000	1213000
Citrus	18	0.005	0	0.0	200	0	0	0	0
Other fruits	59	1.285	1.07	83.3	9360	600	0	48000	0
Olives	0	41.21	31	75.2	99150	0	20770	0	4312000
Sugar beats	0	0	0	0.0	0	0	0	0	0
Tobacco	0	0.12	0.09	75.0	120	0	0	0	0
Sunflower	0	0	0	0.0	0	0	0	0	0
Soya beans	0	0	0	0.0	0	0	0	0	0

Referring to the above data, it may be concluded that with the privatization of agricultural sector there has been a deviation from cultivation of wheat as traditional product. At the same time, the production of potatoes and beans was supported.

The level of inputs and mechanization use in agriculture it is very low. In general, the availability of inputs and especially their distribution systems have been progressively improved and agricultural input supplies are increased through import. A critical issue remains the quality of seeds. As a result of high prices for agricultural inputs and the lack of credit in agriculture, the level of use for agricultural inputs remains very low. Only about 23% of the families buy seeds and only 30% use chemical fertilizers (Fig. 13).

The farmers come across many difficulties in terms of agriculture mechanization. In Albania, there is a considerable number of tractors and combines (imported during 1992-96), but there is a serious lack of agricultural machinery to be able to apply modern agricultural technologies. The owners of agricultural machinery offer mechanization services (plow, sowing, weeding, and transport) to the other farmers with very high fees, therefore the use of mechanization is very low and most of the farmers use the domestic animals or their hand work to complete their agricultural work processes.

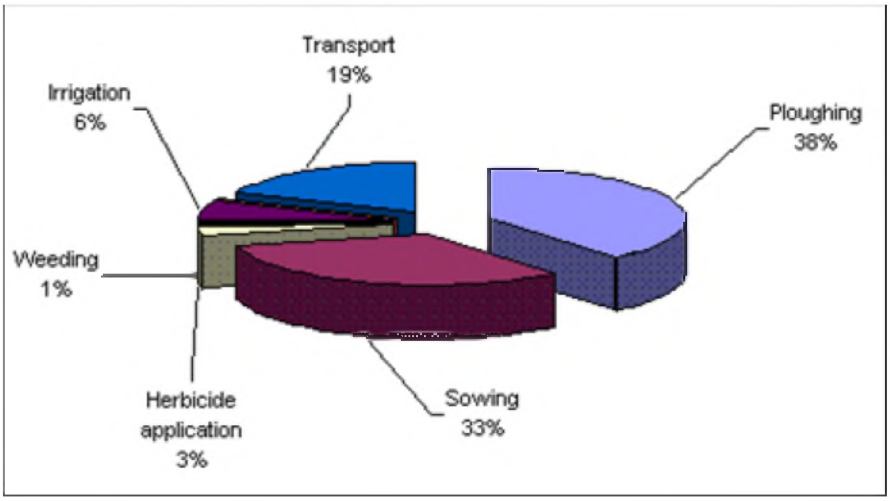

Figure 13: Level of mechanization in the Vjosa region

A phenomenon noticed in the Albanian agriculture is leaving the land as bare land (not cultivated). The reasons given by the families for this phenomenon are shown in the graphic below (Fig. 14). The most important are lack of productivity and the low quality of agricultural land. In addition, lack of capitals and lack of irrigation are estimated to be restrictive factors that lead to leaving bare the agricultural land.

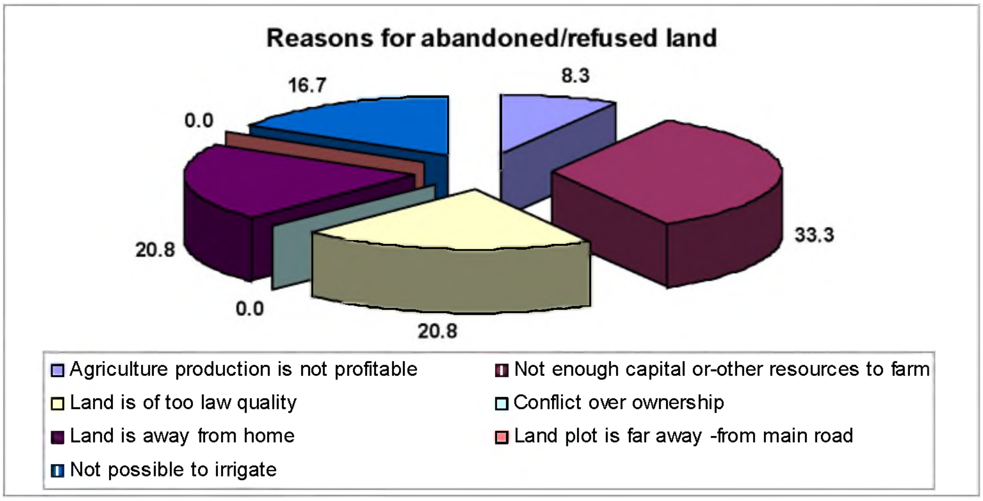

Figure 14: Reasons for abandoned/refused land.

1.4 Stock farming in Aoos/Vjosa Watershed

Composition and population of farm animals, which represent livestock production in Aoos catchment, are shown for each administration area in Table 20.

Fishermen are only amateurs and there are only 300 – 400 fishing in Voidomatis River and use both legal (rod and line, nets) and illegal (electricity) methods. However there are no any other official data since there is only the Amateurs Fishermen Club of Ioannina with 250 registered members. In Voidomatis River there is a trout fishery close to the junction with Aoos River.

In Vjosa region livestock husbandry has been a traditional economic activity. Nowadays, it continues to be very important; it accounts for over 40% of the total agricultural production. Despite this importance, however, it is highly underdeveloped for two main reasons: inadequate feeding of the animals and improper breeding. The yields of milk and meat are the lowest in Europe; milk yield is even lower than it was in the state farms before privatization of animals.

Table 20: Distribution of agricultural animals and holdings in admnistrative agglomerations of Aoos catchment (National Statistical Service of Greece, censu 2001).

Administration	Cattle				Ships		Goats		Swine		Horses		Rabbits		Poultry		Bee hives	
	Total		Females															
	H.[4]	Animals	H.	Animals	H.	Animals	H.	Heads	H.	Animals	H.	Animals	H.	Animals	H.	Animals	H.	Hives
Perf[1]. Ioannina																		
M[2]. East Zagori	7	145	7	99	128	4977	148	2514	3	1886	64	78	9	180	250	66100	19	409
M. Ano Pogoniou	3	341	3	203	78	9933	46	2438	3	1560	9	10	7	117	42	17550	11	400
M. Egnatia	9	182	9	107	366	23431	361	4737	31	8846	131	178	18	170	430	305388	15	406
M. Kalpaki	7	200	7	168	146	15298	89	2366	6	8150	25	36	14	241	150	442547	8	175
M. Kentriko Zagori	30	898	30	717	89	6934	70	4732	5	604	24	46	8	158	93	47089	12	514
M. Konitsa	14	790	13	369	131	7336	209	7614	2	113	59	78	52	1245	169	119737	17	377
M. Mastrorohoria	15	722	15	541	67	2798	72	2695	1	8	56	82	8	155	151	2387	17	383
M. Metsovo	34	1442	33	1182	223	16280	159	4522	1	50	68	131	1	10	156	1163626	11	802
D. Timfi	9	569	9	305	68	2036	65	1419	0	0	3	4	1	20	101	1492	20	668
C[3]. Vovousa	0	0	0	0	14	647	4	30	0	0	0	0	1	70	10	234	1	5
C. Distrato	0	0	0	0	11	682	40	267	8	46	21	44	17	140	50	742	5	19
C. Papigko	1	26	1	20	3	71	8	455	0	0	4	8	0	0	9	156	0	0
C. Fourka	6	98	6	75	3	41	0	0	0	0	2	2	0	0	6	79	0	0
Perf. Kastoria																		
C. Samarina	0	0	0	0	2	364	0	0	0	0	0	0	0	0	0	0	0	0
Perf. Grevena																		
M. Nestrio	3	61	3	56	18	2458	22	872	38	96	2	4	5	56	65	2206	3	62
C. Arrenes	6	108	6	78	31	1862	44	2290	2	2	20	37	1	10	27	403	2	52
TOTAL	144	5582	142	3920	1378	95148	1337	36951	100	21361	488	738	142	2572	1709	2169736	141	4272

[1]Perf: Prefecture, [2]M: Municipality, [3]C: Community
[4]H: Holdings

The main grazing animals are sheep and goats. Sheep have been traditionally very important animals to Albanian peasants. Sheep depend entirely for feeding on grazing lands, especially pastures, both the winter and summer ones. During the summer period, they are utilizing also the arable lands, after crop harvesting, as well as vineyards. During all seasons, particularly spring and autumn, they are also grazing in the olive groves. The size of the flocks is small (about 20-30 animals), but in some areas larger flocks can be found belonging to one or more farmers (mixing). Goats depend entirely for feeding on the grazing lands, especially shrub lands and the coppice forests. The fodder collected from shredding of the oak trees is primarily used during winter. Goats are normally mixed with sheep in the same flock, but in some areas pure goat flocks can be also found. In Fig. 15 livestock production and use, family consumption and selling for 1999 are illustrated. Families sell more livestock products mainly milk, yogurt, sub-productions and meat than crop products

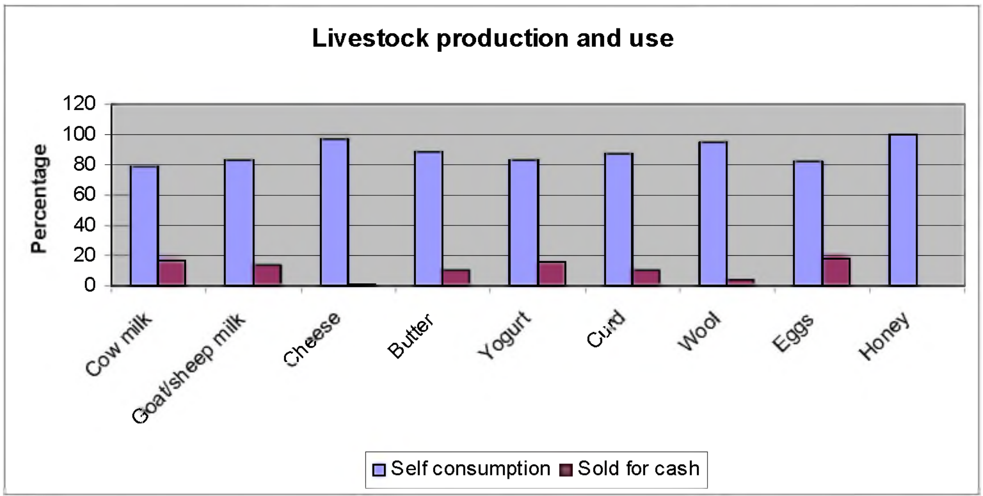

Figure 15: Livestock production and use.

2. Identification of pressures on surface water of Aoos/Vjosa catchment

2.1 Potential effect of land use changes on water yield

The hydrologic change, which occurred between periods, was indexed as the difference in the hydrologic condition score for the two successive time periods that occurred as a result land-use/cover type changes during the interval. To do this we assumed that a numeric relationship existed between hydrologic efficiency (numerical rating) and the land use/cover type classes. As noted earlier, fully forested sites generally use the greatest amount of precipitation on-site and return the least amount of precipitation back as stream flow. Generally, the presence of forest insures adequate infiltration of precipitation into the soil, maximizing detention of water on-site. This water may drain slowly toward the stream channel or to groundwater; aquifers or else the vegetation may take it up and transpire it back into the atmosphere. In addition, a dense forest canopy intercepts a greater percentage of the precipitation, which in turn is evaporated back into the atmosphere, further reducing the amount of precipitation that is ultimately returned as stream flow. Reducing forest cover usually causes an increase in stream flow that could be associated with increased flooding. Barren areas or rock outcrops usually retain and therefore utilize the least amount of the precipitation on-site while yielding the greatest percentage of precipitation to stream flow. Therefore, it was assumed that forested areas had the greatest hydrologic value (10) while barren areas, rock outcrops, and urban areas had the least favourable hydrologic value (1). All other land use or cover types were rated some where between 1 and 10 depending on our perception of their hydrologic influence (Table 21).

A relatively high composite score indicates a “good” hydrologic condition with water being retained well on-site resulting in reduced storm flow. A lower average score would indicate the composite land use condition is less optimal or poor, hydrologically, retains less water on-site, and probably results in greater total annual stream flow and higher peak flows. If the numeric score for any sub-watershed increased between two periods, it indicates the hydrologic condition improved as a result of the land use changes that occurred between the two time periods. If the numeric score decreased between two periods, watershed condition worsened with respect to water retention on-site. In general, hydrologic condition of Aoos/Vjosa watershed declined from 1960 to 2000 (Table 22). The Vjosa watershed is less heavily populated and less heavily impacted and, for the most part, watershed degradation was minimal with only a slight reduction in score over time.

Table 21: Hydrologic Ratings by Land Use Class (Troendle 2002).

Land Use	Rate	Land Use	Rate
Unproductive Land	1	Shrubs	6
Urban/Suburban Land	1	Cleared Broadleaf Forest	6
Empty	1	Cleared Coniferous Forest	6
Cultivated Soils	2	Sand	8
Grapes, Olives, Orchards	4	Coniferous Forest	10
Pasture	4	Broadleaf Forest	10

Table 22: Average Hydrologic rating for the Aoos/Vjosa Watershed for each of the time (Troendle 2002).

Hydro Station Name	Average Hydrologic rating				
	1960	1970	1980	1986	2000
Badelonje	5.20	5.71	5.69	5.41	5.29
Bençe	4.78	5.12	5.07	4.47	4.45
Carshove	5.19	6.07	6.00	6.05	5.72
Carshove	4.53	5.44	5.27	5.53	5.43
Dishnice	4.24	3.86	3.88	3.53	3.51
Dorez	4.37	4.34	4.30	3.87	3.83
Dragot	4.82	5.23	5.29	4.81	4.75
Drashovice	3.65	4.10	4.11	3.55	3.50
Hormove	4.03	3.91	4.09	3.56	3.46
Kardhiq	5.14	5.20	5.53	4.68	4.64
Kuç	5.99	6.26	6.37	5.28	5.24
Langarices	5.48	5.73	5.88	5.56	5.44
Leklit	4.82	5.60	5.65	5.23	5.19
Lepenice	5.22	5.32	5.25	4.83	4.73
Mifol	3.84	3.76	3.69	3.39	3.21
Permet	4.56	4.71	5.14	4.58	4.47
Poçem	4.37	4.14	4.15	3.60	3.52
Suhes	5.13	5.44	5.60	5.04	4.99
Vernik	4.66	4.87	4.86	4.16	4.14
Vodice	3.86	4.07	3.92	3.48	3.42
Vranisht	4.97	5.07	5.10	4.33	4.18

2.2 Potential effect of land uses changes on sediment yield

A similar analysis was done to evaluate the effect of land use changes on sediment production. An erosion index, similar to the hydrologic rating, was developed for each of the land use categories. To a large degree, the numerical score for the erosion ratings were simply the reverse of the hydrologic ratings. Forest, considered the best hydrologic condition is also the best condition for minimizing erosion. However, instead of the score of 10 given for hydrology, forest was given a score of 1, being the lowest, for erosion hazard. The erosion ratings for all land use/cover type conditions are presented in Table 23.

Table 23: Erosion Ratings, by Land Use Class (Troendle 2002).

Land Use	Rate	Land Use	Rate
Unproductive Land	10	Shrubs	4
Urban/Suburban Land	10	Cleared Broadleaf Forest	4
Empty	10	Cleared Coniferous Forest	4
Cultivated Soils	8	Sand	8
Grapes, Olives, Orchards	6	Coniferous Forest	2
Pasture	6	Broadleaf Forest	2

The numerical score for the average erosion condition for each of the sub-watersheds, for each period is presented in Table 24 for the Vjosa watershed. As was the case for the hydrologic characterization, there has been some degradation in watershed condition (increased scores) from 1960 to 2000, implying greater erosion on-site and presumably greater sediment delivery to the stream channel.

Table 24: Erosion rating for land uses in the contributing area above each stream gauge on the Vjosa River for each time period (Troendle 2002)

Hydro Station Name	Average Erosion Rating				
	1960	1970	1980	1986	2000
Badelonje	5.20	4.87	4.92	5.13	5.22
Bençe	5.54	5.35	5.38	5.98	6.00
Carshove	5.30	4.65	4.77	4.62	4.86
Carshove	5.70	5.06	5.25	4.96	5.04
Dishnice	6.03	6.38	6.37	6.70	6.72
Dorez	5.97	6.04	6.06	6.41	6.46
Dragot	5.49	5.29	5.26	5.71	5.76
Drashovice	6.43	5.97	5.95	6.59	6.64
Hormove	6.21	6.37	6.24	6.75	6.88
Kardhiq	5.32	5.29	5.09	5.91	5.95
Kuç	4.56	4.42	4.37	5.44	5.47
Langarices	5.00	4.89	4.90	5.07	5.15
Leklit	5.53	5.03	5.01	5.36	5.39
Lepenice	5.17	5.10	5.15	5.60	5.69
Mifol	6.49	6.61	6.67	6.80	6.99
Permet	5.57	5.50	5.29	5.79	5.91
Poçem	6.22	6.33	6.34	6.59	6.71
Suhes	5.28	5.10	5.03	5.50	5.53
Vernik	5.69	5.54	5.55	6.34	6.36
Vodice	6.24	6.08	6.22	6.68	6.75
Vranisht	5.46	5.39	5.34	6.08	6.21

However, as with the hydrology, the magnitude of change is not particularly great. In the case of the Vjosa Watershed (Table 24) the decline has been minimal with the greatest changes actually occurring from 1960 to the 1980's with little net change since 1986. In most cases the net rating is close to the middle (5) with ratings ranging from 4.5 to 6.

2.3 Urban areas

The pressure exerted in Aoos catchment as abstraction for household use was estimated on the base of the method described in Section II (Table 25).

Table 25: Future water needs (m^3/day/capita) in relation to population projections for 2010, 2020 and 2030 within local administration divisions (municipalities>1000 inhabitants and communities<1000 inhabitants). Water is estimated for the cold and warm period according to Greek legislation (FEK 174B/22-3-1991).

	Future water needs (m^3/day/capita)					
	2010		2020		2030	
	cold max	warm max	cold max	warm max	cold max	warm max
Community						
Vovousa	33.08	54.59	36,49	60,21	40,25	66,41
Fourka	47.20	77.88	95,22	157,11	192,08	316,93
Aetomilitsa	57.44	94.78	54,27	89,55	51,28	84,618
Papigo	40.50	66.82	50,94	84,05	64,07	105,72
Total	178.22	294.07	236.92	390.92	347.68	573.678
Municipality						
Timfi	180.72	298.18	162.32	267.83	145.8	240.57
K. Zagori	264	435.61	286.36	472.49	310.6	512.50
Ano Pogonio	250.72	413.69	224.83	370.97	201.61	332.66
Mastorohoria	291.14	480.39	306.68	506.02	323.04	533.02
Kalpaki	293.57	484.40	216.98	358.02	160.37	264.62
An. Zagori	372.23	614.19	381.92	630.17	391.86	646.57
Egnatia	419.54	692.24	356.45	588.14	302.84	499.70
Metsovo	802.81	1324.68	790.02	1303.54	777.44	1282.78
Konitsa	1095.45	1807.49	105.44	1739.91	1015.07	1674.86
Total	3970.18	6550.87	2831	6237.09	3628.63	5987.28

Also, following the proposed method the daily loads of human wastewater (BOD, total nitrogen and phosphorus) have been estimated in Aoos catchment (Table 26).

Table 26: Estimated human loads in Aoos catchment for 2010, 2020, 2030.

Year 2010	Feces (g/day)	Urine (L/day)	BOD (g/day)	N (g/day)	P (g/day)	Wastewater (L/day)
Community						
Vovousa	20295	186	10147	1691	507	15098
Fourka	23356	214	11678	1946	583	17375
Aetomilitsa	34468	316	17234	2872	861	25642
Papigo	42840	392	21420	3570	1071	35700
Municipality						
Timfis	169278	1551	84640	14106	4231	125933
K Zagori	181523	1664	90761	15126	4538	135042
Ano Pogoniou	188553	1728	94276	15712	4713	140272
Mastorochoria	234926	2153	117463	19577	5873	174771
Kalpaki	263498	2415	131749	21958	6587	196027
An. Zagori	272348	2496	136171	22695	6808	202606
Egnatia	317467	2910	158734	26455	7936	236177
Metsovo	500805	4591	250402	41733	12520	372569
Konitsa	705798	6470	352899	58816	17644	525072

Year 2020	Feces (g/day)	Urine (L/day)	BOD (g/day)	N (g/day)	P (g/day)	Wastewater (L/day)
Community						
Vovousa	19175	175	9587	1597	479	16912
Fourka	22068	202	11034	1839	551	19463
Aetomilitsa	32566	298	16283,389	2713	814	28723
Papigko	30480	279	15240	2540	762	20200
Municipality						
Timfis	159941	1466	79970	13328	3998	141065
K. Zagori	171511	1572	85755	14292	4287	151269
Ano Pogoniou	178153	1633	89076	14846	4453	157127
Mastorochoria	221968	2034	110984	18497	5549	195771
Kalpaki	248964	2282	124482	20747	6224	219581
An. Zagori	257320	2358	128660	21443	6433	226951
Egnatia	299957	2749	149978	24996	7498	264556
Metsovo	473182	4337	236591	39431	11829	417337
Konitsa	666869	6112	333434	55572	16671	588165

Year 2030	Feces (g/day)	Urine (L/day)	BOD (g/day)	N (g/day)	P (g/day)	Wastewater (L/day)
Community						
Vovousa	18118	166	9059	1509	452	15098
Fourka	20851	191	10425	1737	521	17375
Aetomilitsa	30770	282	15385	2564	769	25642
Papigko	38400	352	19200	3200	960	32000
Municipality						
Timfis	151119	1385	75559	12593	3777	125933
K. Zagori	162051	1485	81025	13504	4051	135042
Ano Pogoniou	168326	1542	84163	14027	4208	140272
Mastorochoria	209725	1922	104862	17477	5243	174771
Kalpakiou	235232	2156	117616	19602	5880	196027
An. Zagori	243127	2228	121563	20260	6078	202606
Egnatia	283412	2597	141706	23617	7085	236177
Metsovo	447083	4098	223541	37256	11177	372569
Konitsa	630087	5775	315043	52507	15752	525072

Estimated water need for total human consumption as the percentage of the mean yearly precipitation in Aoos catchment is estimated 0.0003 % and 0.015 % for the year 2030. As the percentage of the mean yearly discharge of the river (70 m^3/sec) before it leaves the Greek territory is estimated 0.0005 % for the year 2010 and 0.02 for the year 2030. These estimates do not include evapotranspiration.

The annual water consumption (2003, m^3), in popular destinations of Aoos catchment is given in Table 27.

Table 27: Annual water consumption (2003, m^3) in popular destinations of Aoos catchment.

Municipality	Hotel water consumption (m^3/year)
Konitsas (agglomeration Konitsa, agglomeration Amarantos)	5132
Metsovo	12175.30
Timfi (agglomeration Tsepelovo, agglomeration Skamneli)	427,40
Papingo	436.20

Source National Statistical Service of Greece, 2003

In Aoos catchment there is not any wastewater treatment plan and sewerage in all municipalities comprises of septic tanks. Sewage is collected by sewage trucks and wastewater is disposed in small streams in the catchment that finally end up in Aoos River. Concerning solid wastes, there is not any properly organised pit and waste is disposed in remote uncontrolled areas.

According to available data and Greek legislation in power (Ministerial Degree 46399/1352/1986, Ministerial Degree 5673/400/1997 etc) Aoos catchment is not sensitive surface water body and following the provisions of Directive 91/271/EEC on the size of agglomerations where collecting systems should be provided there is not immediate need for such measures.

In Vjosa catchment due to lack of detailed information regarding the distribution of the population, only a rough estimation of wastewater discharge and water abstracted for household use was possible and that was for the whole population of the Vjosa catchment (Table 28).

Table 28: Rough estimation of human wastewater and strength of the total population in Vjosa catchment.

Total population in Vjosa catchment	Wastewater (L/day)	Feces (g/day)	Urine (L/day)	BOD (g/day)	N (g/day)	P (g/day)
290000	29000000	34800000	319000	17400000	2900000	870000

However the results from this approach should be considered only as indicative since standards of leaving in this part of the catchment are not comparable to those the method has adopted. However an overview of the spatial distribution of these kinds of pressure in the catchment can be obtained in Map 4.

Regarding sewage waters and solid waste, all towns within Vjosa catchment shear the same problem. Sewerage network in towns cover only 60-70 % of the houses and does not exist in villages and rural agglomerations. Sewage is discharged without any treatment in Vjosa River.

Solid waste is approximately 0.5-0.6 kg/inhabitant/day. These include wastes from households and other activities e.g. as restaurants, shops, hospitals, etc. There are not metallic or plastic containers for the collecting solid wastes in towns, but in same places there are fixed concrete points only.

From the sanitation point of view, disposal places are not controlled and placed in appropriate locations, and there is not any disposal technology. In the case of Kelcyra town the urban solid waste are disposed directly on the banks of Vjosa River.

In villages there are not landfill sites or any other type of organized pit. Only in some cases, farmers are using composting processes for the production of organic fertilizer.

Furthermore during the last fifteen years a new problem emerged, which has a negative impact on urban environment and this is uncontrolled and illegal building, mainly in green areas of towns.

2.4 Agricultural areas

The pressure exerted in Aoos catchment from non-cultivated rural areas (~222198 ha) as well as from agricultural land (~12586 ha) in terms of nutrient loads (N & P) and water abstraction for irrigation has been estimated on the base of the method described in Section II and is given in Table 29 and Figure 16. Data related to agricultural area was derived from the CORINE land cover database (Table 5, 6, 7). Respectively, in Table 30 the pressure that exerted from non-cultivated rural areas (~594353 ha) as well as from agricultural land (~117814 ha) in Vjosa catchment has been estimated. In this case, nutrient loads were estimated by assuming that only 30% of the agricultural land is cultivated intensively (following to the information given in Paragraph 1.3) while for the rest it was considered as non-cultivated rural area.

Table 29: Annual nutrient loads in Aoos and Vjosa catchment from non-cultivated rural areas and agricultural land.

CORINE Land cover type	N (kg/ha/year)		P (kg/ha/year)	
	Aoos	Vjosa	Aoos	Vjosa
Non-cultivated rural land	444397	1188707	9.4	59435.35
Agricultural land	201381	1885032	7551.8	70688.7

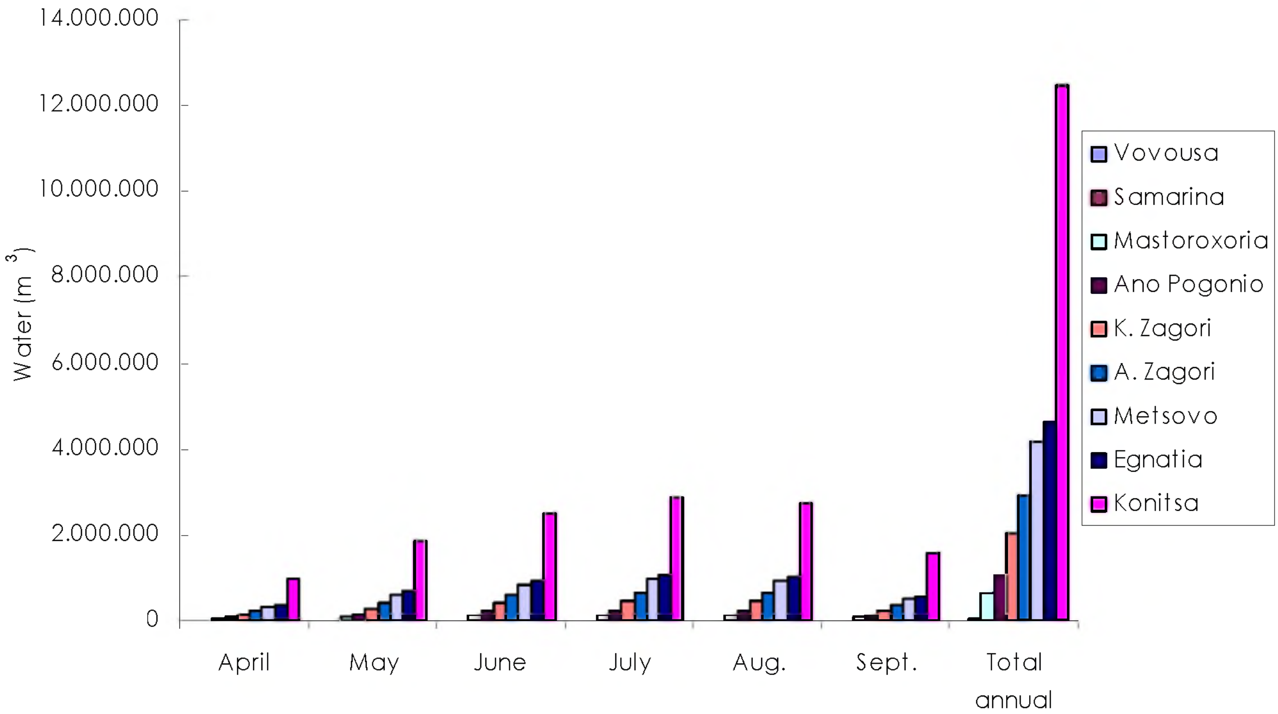

Figure 16: Estimated water abstraction for irrigation In Aoos catchment.

In the past, 50-60 m^3/sec of water was abstracted from Vjosa River for the irrigation of agricultural land. After political and economic changes in Albania in 1990, the irrigation system was not anymore maintained, and the amount of water supplied from Vjosa for irrigation was drastically diminished. In Aoos River catchment the water abstracted for irrigation is estimated to be about 20 $\chi 10^6$ m^3 annually. Pressure from irrigation is exerted during the dry season, which extends from April to September. This amount of water represents 0.5 % of the mean yearly precipitation in Aoos catchment and 0.9 % of the mean yearly discharge of the river before it leaves the borders.

2.5 Stock farming

Animal farming is a human activity that exerts pressure both on water quality and quantity in the river catchment. Nutrients (N, P) and other chemicals (e.g. antibiotics), organic and microbial loads cause serious degradation of water quality. At the same time, animal farming consumes considerable amounts of water for watering and sanitation (e.g. washing feed lots etc). Pressure from animal farming in Aoos catchment is illustrated in Fig. 14-16.

The pressure that exerted in Aoos catchment from stock farming in terms of nutrient loads (N & P), manure and water abstraction for watering and sanitation has been estimated on the base of the method described in Section II and is given in Figures 17 to 19. Data related to type and population of the animals were derived from the General Secretariat of National Statistical Service of Greece (Table 20).

For the Albanian section of the river catchment, data to be quantified and related to type and number of animals were not available.

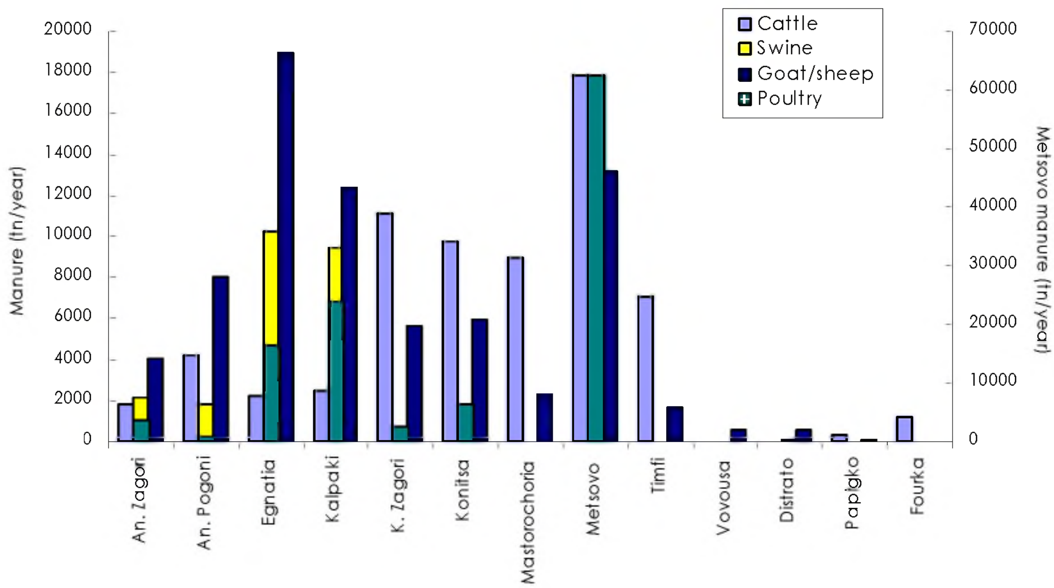

Figure 17: Manure production (tn/year) by agricultural animals in municipalities of Aoos cathment. Number of animals was derived from data provided by the National Statistical Service of Greece (census 2001). Animal categories comprise most types i.e. cattle include beef and dairy cows, bulls, calves, steers and heifers, swine include boars, grower and finishing pigs, nursing and weaner pigs, sow and gifts, poultry include broilers, roaster and hens, pullets and turkeys.

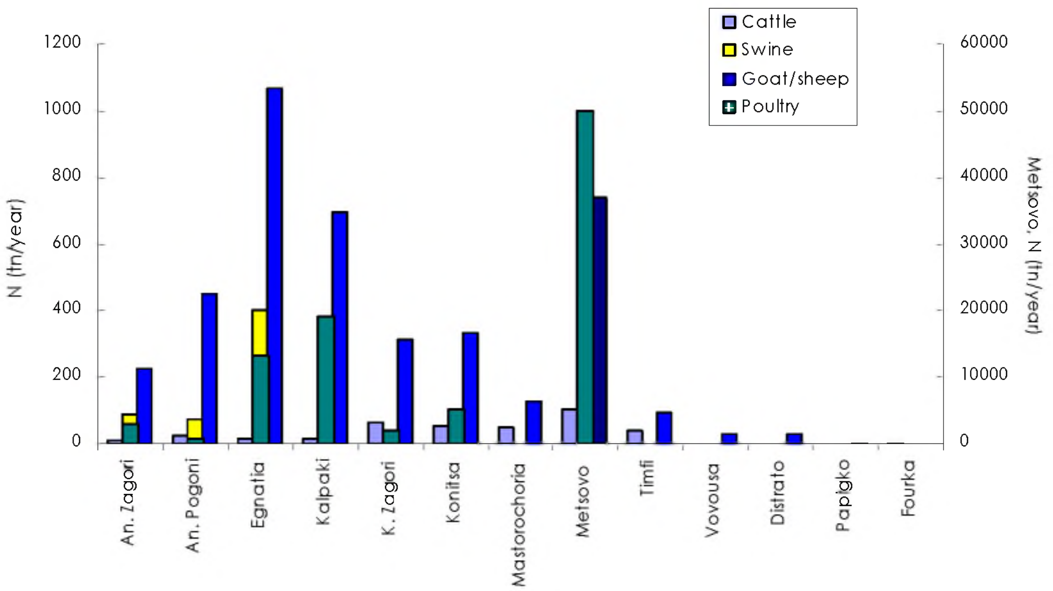

Figure 18: Nitrogen loads (tn/year) from cattle, swine, goats/sheeps and poultry in the Aoos catchment. Metsovo loads are on the left-hand y-axis due to much higher values. Number of animals was derived from data provided by the National Statistical Service of Greece (census 2001). Animal categories comprise most types i.e. cattle include beef and dairy cows, bulls, calves, steers and heifers, swine include boars, grower and finishing pigs, nursing and weaner pigs, sow and gifts, poultry include broilers, roaster and hens, pullets and turkeys.

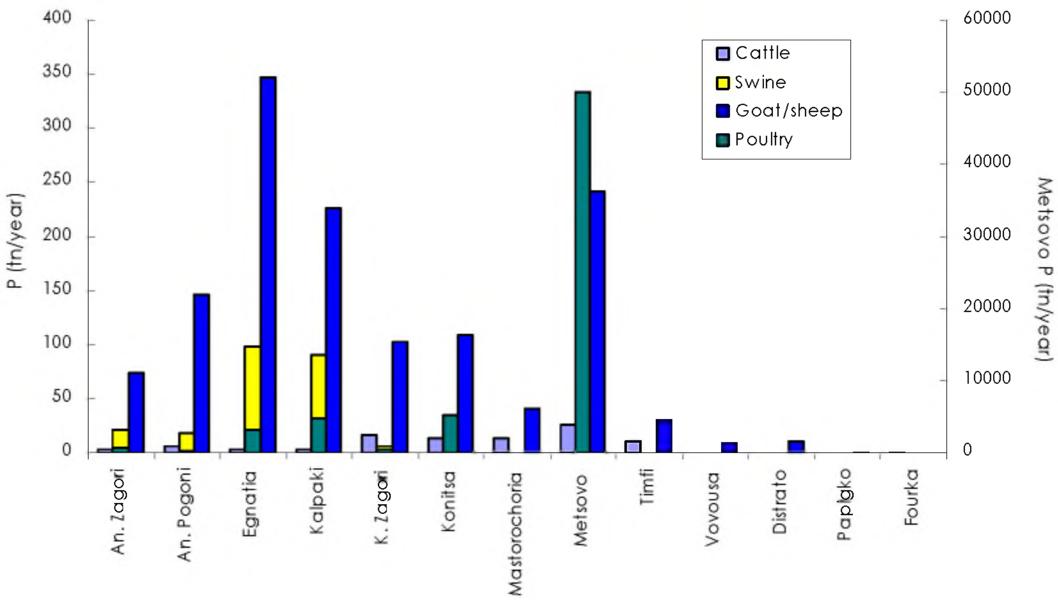

Figure 19: Phosphorus loads (tn/year) from cattle, swine, goats/sheeps and poultry in the Aoos catchment. Metsovo loads are on the left-hand y-axis due to much higher values. Number of animals was derived from data provided by the National Statistical Service of Greece (census 2001). Animal categories comprise most types i.e. cattle include beef and dairy cows, bulls, calves, steers and heifers, swine include boars, grower and finishing pigs, nursing and weaner pigs, sow and gifts, poultry include broilers, roaster and hens, pullets and turkeys.

2.6 Pressure from power supply

In Aoos catchment a hydroelectric power plan operates since 1991. It comprises an extensive complex of 7 dams and 10 km of pipe network diverting about 1.5 m^3/sec water into Araxthos River. The reservoir, which is on Politses plateau, NE of Metsovo town, collects Aoos spring water and precipitation of the plateau (90x10^6 m^3/year). Water level of the reservoir fluctuates between 1315 – 1343 m of absolute altitude and at highest water level the volume is 260 x 10^6 m^3, surface is 11,5 km^2 and depth reaches 73 m. The hydroelectric station is one of the most powerful in Greece (210 MW, mean annual power 310GWh, useful reservoir capacity 170 hm^3, tailwater elevation 655 m). Water is also diverted to Araxthos River available to be used to another hydroelectric power plan (Pournari) and for irrigation in Arta plain.

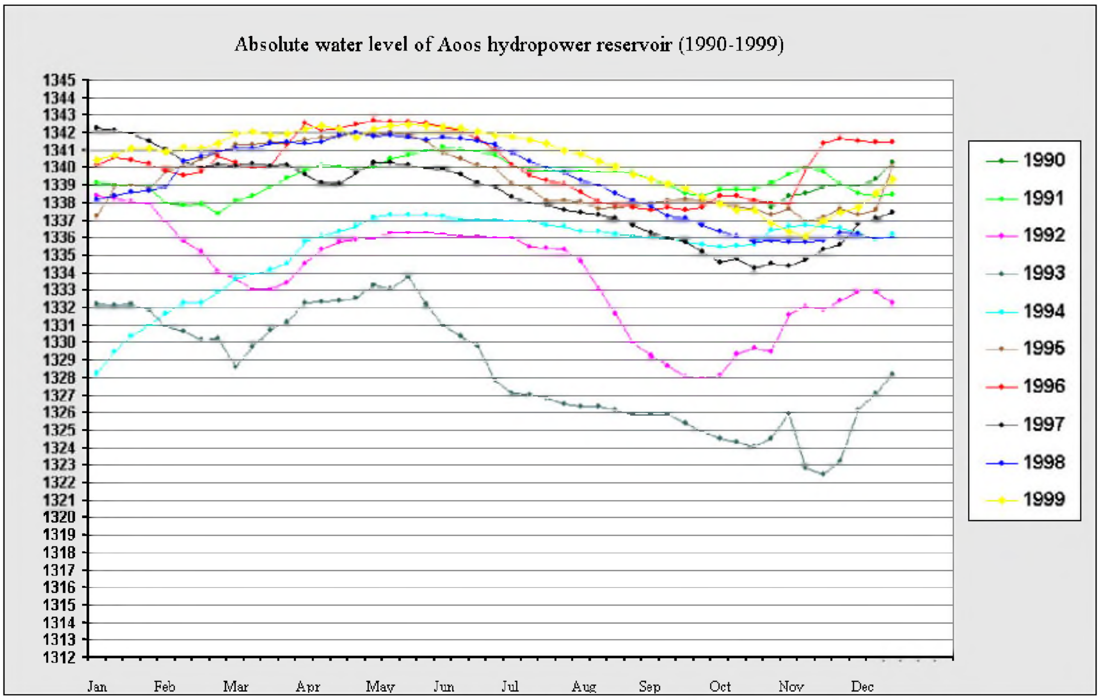

Figure 20: Absolute water level of Aoos hydropower reservoir (National Power Company of Greece).

Further to the above, there are plans for several hydroelectric dams in Aoos cathment at Armata, Vovousa, Elefthero, Agia Varvara, Pirsogianni, Eptahori (Theodorakis et al 2000, Stefanakos 2002).

In Vjosa catchment a hydropower scheme is going to be constructed on Vjosa River downstream of Kalivaci (Dorze), approximately 28 km from the town of Tepelena. The Kalivaci scheme comprises a fill-type dam using excavation materials and gravel, a diversion tunnel and a power station. The hydropower plant will be constructed on limestone formations. The river is exploited from a head of 110 m to 65 m. An Italian company BEGETI has this concession and is in the process of carry out a detail geological survey for this site.

Further to the above the Albanian government is building a new 97 MW, $112 million oil-fueled power plant at a six-hectare site about 6 km north of Vlorë. The selected site was used for many years as an oil terminal and is in a zone earmarked for industrial development. The project is supported by a $25 million credit from the World Bank's International Development Association, $37.5 million from the European Bank for Reconstruction and Development, $37.5 million from the European Investment Bank, and $12.6 million from KESH (Albanian Energy Corporation). The World Bank's credit is called the Albania: Power Sector Generation and Restructuring Project. The annual energy that Albania can produce today is 4000 GWh while the demand is 6800 GWh. That gap must be met somehow, either by importing it or producing it in country.

Albania's electricity crisis is largely the result of the fact that the country gets 95 percent of its electricity from hydropower (dams), which drops in dry years when shrinking reservoirs cannot keep the turbines going enough to supply the energy needed. Before 1997, Albania produced enough electricity to meet domestic demand and also to export to neighboring countries. But, the demand for electricity has increased four times compared to the early 1990s, while poor maintenance of energy facilities and low rainfall have cut electricity output in half.

While it has many benefits, hydropower is vulnerable to changes in weather and to drought cycles. Albania has made the decision to diversify its sources of electricity. Thermal power plants would help in that effort and provide a stable supply of electricity that would start to address rising demand in Albania. Still, even if the Vlorë power plant operates tomorrow, it would only meet 30 % of the gap in the current demand for electricity in Albania.

Also, the project is in line with the recommendations of the "Albania Energy Sector Study" done for Albania in 2003 and is part of the country's Energy Sector Strategy, which was based on a very comprehensive study of the sector, approved by the government, and endorsed by the World Bank and other donors.

On August 1, 2007, the Council of Territorial Adjustment of Vlorë region unanimously approved the construction permit for the power plant in an open meeting with public participation, including representatives from the Civic Alliance. Construction started on August 27, 2007. The plant should be operational by 2009.

2.7 Pressure from industry

Industrial wastewater exerts serious pressure on water resources of a river catchment. However in this study due to lack of quantifiable information only a qualitative assessment of the pressure is conducted. In Table 30 are given the possible discharged important pollutants according to industry type in an area.

Table 30: Industry type and possible discharged pollutants of Annex VIII and X of the WFD.

Industry	Annex VIII	Annex X
Refinery	BOD_5, Cu, Co, Cr, Zn, CN, V, hydrocarbons, aldehyde, mercaptanes	Ni, Pb, phenols
Plastic	Zn, CN, toluene, xylin, glycols, formaldehyde, FREON, vinyl	Pb, Hg, Cd, phenol
Steel	Cr, Zn, Fe, Ba, CN	Pb, phenol
Tannery	BOD_5, Cr, N	Phenol
Textile industry	BOD_5, Cr, Cu, Ba, toluene, organochloro compounds, 3-Cl-ethylene	Hg, Cd, Pb, phenol
Colours	Cr, As, CN, ketones, glycols, polychlorinated hydrocarbons	Cd, Pb, hydrocarbones
Agrochemicals	polychlorinated hydrocarbons	Phenol
Fertilizers	BOD_5, NH_3, P_2O_5, V, As, Cr, PCBs	Pb, Hg
Wood processing		Phenol
Food processing	BOD_5, N, P, fats, oils	

Aoos catchment is free from any industry that consumes $\geq 20m^3$/day (Ministry of Development, 2006) or discharges any hazardous substances. In fact there are only 40 mainly food processing enterprises employing over 20 workers in the whole region (National Statistical Service of Greece census 1991). The above is expected to release nutrient loads (N, P) and fats into the streams of Aoos catchment.

Food processing is also the main industrial activity in Vjosa catchment. However it remains low and mainly is conducted in small factories and workshops.

The development of agro-processing industry is mainly held up by the lack of sufficient supply of the agricultural products and the competition from low price goods and with disputable quality coming from import. The main agriculture products in the Vjosa catchment grains, livestock products, fruits, different jams (fig, cherry, walnuts etc.), cannery production, pickles, vines and other alcoholic drinks are included.

In general pressure from industry in Aoos/Vjosa catchment is expected to be marginal.

2.8 Pressure from mining and quarries

There are 6 large quarries in Aoos catchment, which operate after owners have submitted an Environmental Impact Assessment (EIA) study to obtain a license (Table 31). These pose a threat to the hydro-morphology of the catchment.

Table 31: Quarries in Aoos catchment.

Material exracted – Owner	Municipality	Area (m^2)	Common Ministerial Degree of EIA study
Schists querry - "Tsoureka Bros.	Metsovo	25308	108530
Marble – "I LIASKOS & Co"	Metsovo	96425	68508
Schists querry - "G. K. Gravanis"	An. Zagori	15499	95965
Marble – "Gikas Bros & X. Gelis"	An. Zagori	37161	112869
Marble – "X. Pappas"	An. Zagori	21625	6225
Schists querry – "A. Grouidi & E. Zafiridi"	Kipoi	14465	106284

Quarries alter the hydrologic behavior of the area where they are established. However due to their small size, the pressure that exert on the water balance of their catchment in most of the cases is considered low (Map 6).

The main extraction activity in Vjosa catchment regards gravel extraction from riverbed. This kind of activity is intensive, having a negative impact on the riverbed of Vjosa and its tributaries. There are about 56 gravel extraction points (Cukalla, M. 2000). Twenty-six of these are on the main river bed of Vjosa River, 16 gravel quarries are in Shushica river bed (tributary of Vjosa) and about 14 are located on the

Drino river bed. The map in Fig. 20 shows the location of gravel quarries in the Vjosa catchment and Fig. 22 a view of gravel quarry.

The most active gravel extraction points are situated at the low part of Vjosa River, from the estuary until the joining point with the Shushica River. In this part of Vjosa bed there are 11 gravel extraction points.

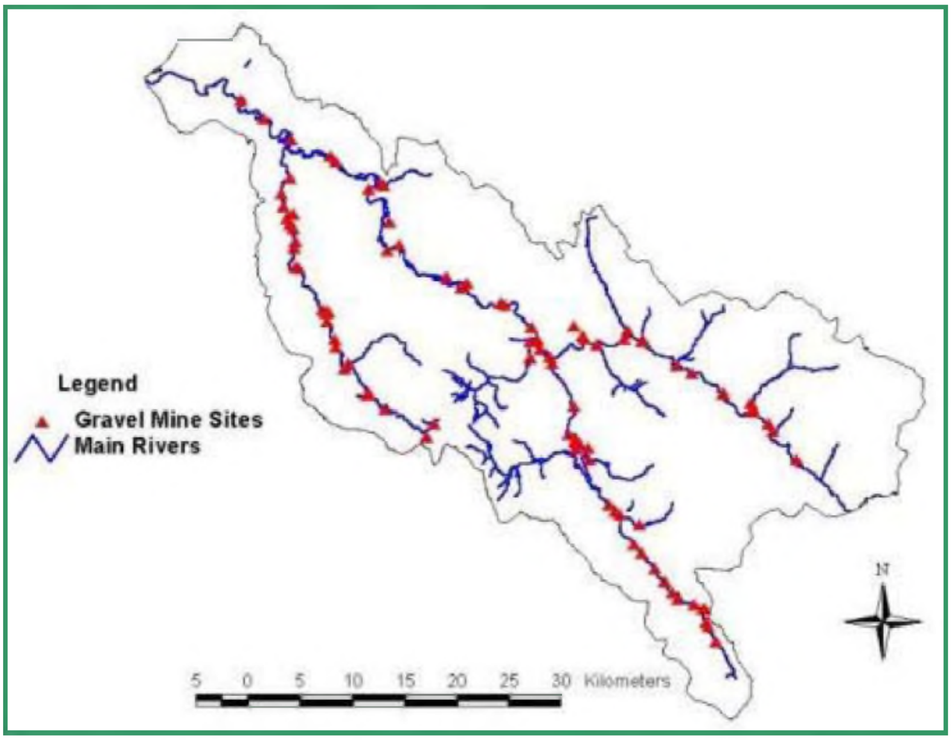

Figure 21: Map of gravel extraction points in Vjosa River catchment.

Figure 22: View of a gravel extraction point in Vjosa river catchment

2.6. Other pressures

Several other human activities (drivers) take place in the catchment of Aoos/Vjosa and potentially exert pressure on the water resources. Uncontrolled pits, various infrastructure types such as roads and railway generate various types of pollution in the catchment. Also changes on the river hydrology by land reclamation works, protection of dwelling areas and agricultural land from flood risk exist in the catchment.

Pits and landfills are used by small villages and operate under relevant hygiene legislation. In most cases, small municipalities operate pits where litter is incinerated and then buried once or twice every year. In areas of low-density population or areas far out from the central network of waste disposal, waste ends in streams or forests.

Road run-off is another major source of pollution. Road construction changes the land use and produces a man made landscape. The constant use of roads therefore directs that structures such as drainage systems must be maintained in order for safe commuting. These artificial networks can have an effect on the environment also.
One of the main interactions between roads and rivers occurs via drainage that facilitates the movement of water from the impermeable surface of the road directly into lotic systems. This road run-off is most of the time untreated. Within the run-off, there are substances that have the potential to affect river water quality and the sediment that occurs within the river. Examples of such substances include metals, de-icing salts, oil derivatives and hydrocarbons such as Polynuclear Aromatic Hydrocarbons (PAHs), nutrients such as nitrites, sediment and biological material. The traffic, fixed structures within the road corridor and the activities that border it, supply the pollutants. Sources include road furniture (signs and barricades), fuels, the various paving materials, litter, agrochemicals, road kill and even the transported goods. Therefore, run-off can contain a mixture of highly variable compounds with varying toxicity that is usually diverted untreated into receiving waters. However, the understanding of the effects and specifically quantifying these effects is not as well researched as the pollution type. Chemical analysis methods provide accurate measurements of the run-off components but the impact that these have on the stream systems they discharge into is less understood.

3. State and impacts on surface water of Aoos/Vjosë catchment

Chemical quality of surface water in the Aoos catchment is monitored by Ioannina Chemistry Service, the Greek Ministry of Rural Development and Food and the Greek Ministry of Environment, Spatial Planning and Public Works.

Table 32: European legislation for water quality.

Directive	Water use
Dir. 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water	Potable water
Dir. 76/160/EEC for bathing waters	Bathing
Dir. 78/659/EEC on the quality of fresh waters needing protection or improvement in order to support fish life	Freshwater fish support
Dir. 79/923/EEC on the quality required of shellfish waters	Shellfish aquaculture
79/409/EEC (Birds Dir.)	Conservation of wild birds
Dir. 91/271/EEC on urban wastewater treatment	Areas with nutrient excess
Dir. 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources	Nitrogen pollution
Dir. 92/43/EEC	Protection of natural habitats, flora, fauna
Dir. 98/83/EE on the quality of water intended for human consumption	Potable water
Dir. 2000/60/EE	WFD, Potable water

Ioannina Chemistry Service conducts water chemical analysis since June 2000. Samples are being collected from several rivers of Epirus and results show that river water in this area is among the cleanest in Greece as microbial loading is concerned. Information about the location of sampling points and raw data were not available.

The Greek Ministry of Ministry of Rural Development and Food is monitoring water chemistry of the Aoos catchment at two points (Klidonia - Aoos River and Mellisopetra - Sarantaporos River) since 1983 (Map 7). However, data only until 1998 were available and there are no complete time series for most of the parameters.

The variation of physical and chemical parameters for year 1984 are presented in Fig. 23 comparison with their limits as set by relevant EU Directives (Dir. 76/659/EEC, 79/923/EEC and Dir. 98/83/EEC.

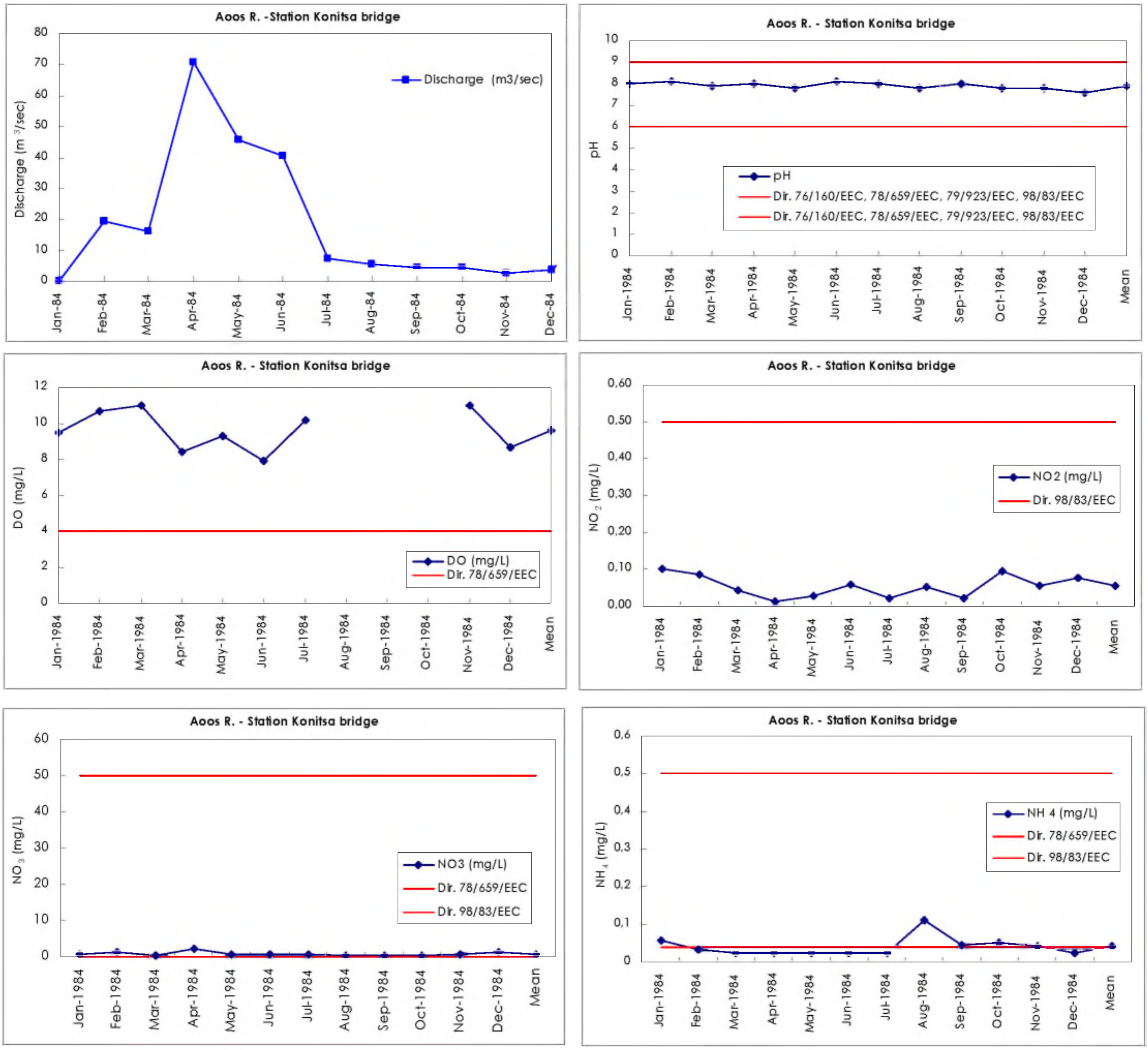

Figure 23: Variation of physical and chemical parameters in Aoos River. (Greek Ministry of Rural Development and Food, Qualitative and quantitative characteristics of rivers and lakes in Greece, 2001). Red lines show upper and lower limits according to relevant EU Directive.

The Greek Ministry of Environment, Spatial Planning and Public Works started monitoring water chemistry in Aoos catchment at 3 stations (Konitsa Bridge, Bourazani and Voidomatis River, Map 7) in 1995 and stopped in 1998 (Table 32). Sampling was conducted three times per year and parameters measured varied with the year. However, these values (Table 33) were also within the limits of European legislation indicating the good quality of river water.

Table 33: Water chemistry of Aoos R.

Date	Station	NO_3 (mg/L)	NO_2 (μg/L)	NH_4 (mg/L)	DO (mg/L)	BOD_5 (mg/L)	pH	PO_4 (mg/L)
1995	Aoos-Konitsa bridge	3.917	0.026	0.058	11.767	0.75	8.03	0.08
	Voidomatis R.	3.96	0.029	0.188		0.75	7.83	0.9
	Aoos-Bourasani	3.4	0.026	0.063		0.9	7.96	0.065
1996	Aoos-Konitsa bridge	3.289	0.012	0.1			8.35	0.142
	Voidomatis R.	3.663	0.023	0.194	9.188	5.027	8.2	0.364
1997	Aoos-Konitsa bridge	2.342						
	Aoos-Bourasani	3.665						
	Voidomatis R.	3.141						
1998	Aoos-Konitsa bridge	1.633						
	Aoos-Bourasani	2.7						
	Voidomatis R.	0.767						

(source Ministry of Environment and Public Works)

Following the results of a large-scale project for the assessment of water resources in Greece funded by the Ministry of Development, average nitrate concentration for years 1983-2005 is much lower (1.41 mg/L) than the annual average for several European rivers (2.63 mg/L) (YPAN 2006). According to Chatzinikolaou et al 2008, Aoos/Vjosa River is predominantly undisturbed, with high habitat quality and a rich macrobenthos community. The same authors have demonstrated that the existence of macrobenthos communities sensitive to pollution prove the good quality of river waters (Fig. 24, Table 34).

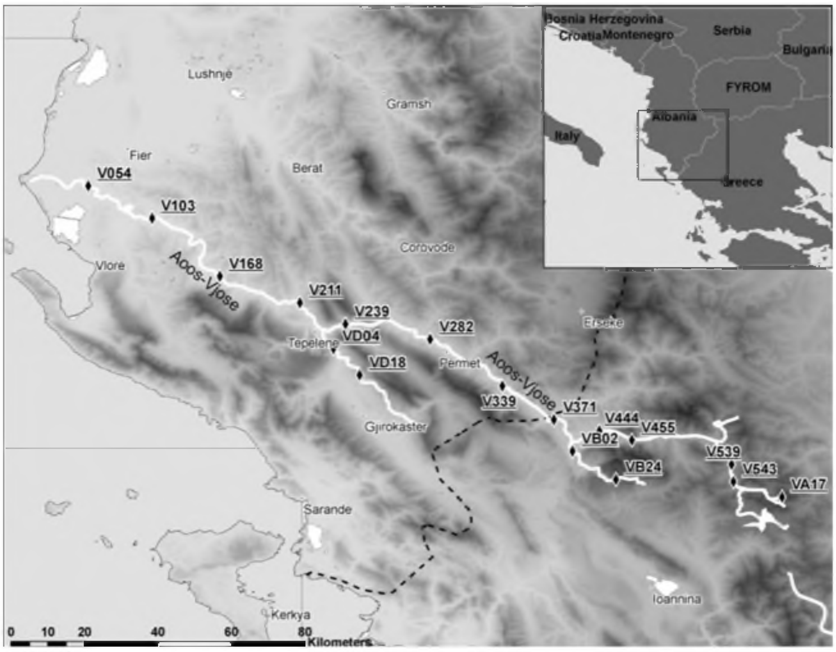

Figure 24: Extensive sampling (Spring - Autumn 2001, 17 stations) along Aoos/Vjosa River (Chatzinikolaou et al, 2008) showed the good quality of surface water.

Table 34: Results of physicochemical variables and discharge at 17 sites along Aoos-Vjose in Spring and Autumn 2001 (Chatzinikoloau et al 2008).

Site	DO (%)	DO (mg/l)	BOD_5 (mg/l)	pH	Temp. (°C)	Cond. (µS/cm)	Alkal.	TDS (mg/l)	TSS (mg/l)	Total hardness	PO_4-P (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	NH_4-N (mg/l)	Discharge m^3/s
Spring															
V054	97.8	10.04	1.62	8.1	16.0	502	166.0	255	95.0	215.0	0.0270	0.0075	1.20	0.040	182.0
V103	97.6	10.80	2.49	8.2	15.1	436	160.0	226	65.0	212.5	0.0120	0.0060	1.25	0.035	159.0
V168	97.2	10.35	0.16	8.1	13.2	410	116.0	212	45.0	135.0	0.0240	0.0040	1.20	0.000	152.0
V211	99.8	10.54	3.34	8.1	13.0	451	159.0	231	0.0	192.5	0.0100	0.0035	1.85	0.000	144.0
VD04	97.7	10.90	1.43	8.1	14.1	475	168.0	249	0.0	212.5	0.0280	0.0078	1.40	0.036	42.5
VD18	95.9	9.97	2.32	7.9	13.9	501	171.0	258	0.0	217.5	0.0070	0.0030	1.15	0.000	0.0
V239	97.3	10.48	2.56	8.2	12.6	463	240.0	240	15.0	195.0	0.0120	0.0050	1.50	1.250	94.3
V282	102.4	11.20	2.48	8.3	11.6	469	170.0	242	20.0	210.0	0.0280	0.0078	1.40	0.036	85.0
V339	96.9	10.86	2.22	8.4	10.3	416	161.0	211	45.0	210.0	0.0350	0.0120	1.20	0.075	61.0
V371	97.2	11.01	2.99	8.1	9.6	339	125.9	171	9.0	285.7	0.0143	0.0041	0.32	0.008	49.0
VB02	89.8	10.20	1.93	7.8	9.4	276	59.8	138	273.0	125.0	0.0276	0.0023	0.06	0.078	106.1
VB24	96.2	11.14	2.04	7.9	8.9	230	104.6	117	50.0	214.3	0.0152	0.0020	0.09	0.015	47.4
V444	97.1	11.50	2.90	8.3	8.1	265	122.7	131	84.0	232.1	0.0124	0.0006	0.08	0.000	8.0
V455	94.3	11.26	2.81	8.3	7.9	264	121.6	133	83.0	214.3	0.0143	0.0006	0.08	0.000	35.0
V539	92.3	11.25	1.27	8.1	7.1	190	61.4	98	95.0	125.0	0.0086	0.0000	0.06	0.000	6.1
V543	93.6	11.49	2.44	8.1	6.8	180	54.4	86	171.0	89.3	0.0190	0.0012	0.06	0.005	29.0
VA17	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Autumn															
V054	94.1	9.39	1.20	7.8	15.4	608	160.0	304	0.0	265.0	0.0000	0.0045	1.12	0.000	35.0
V103	112.5	10.77	2.00	8.1	17.3	630	150.0	322	15.0	290.0	0.0040	0.0080	0.05	0.000	28.0
V168	104.5	10.50	1.80	7.8	15.1	602	150.0	281	0.0	205.0	0.0035	0.0050	1.25	0.000	25.0
V211	113.8	11.62	2.20	8	14.4	641	150.0	359	6.0	275.0	0.0040	0.0090	1.20	0.000	19.0
VD04	103.5	10.56	0.95	7.9	14.6	613	180.0	352	0.0	290.0	0.0080	0.0040	1.44	0.035	4.0
VD18	109.0	11.05	1.55	7.9	14.7	660	170.0	326	0.0	275.0	0.0048	0.0020	1.00	0.035	2.7
V239	87.3	9.13	1.30	7.8	13.2	848	170.0	441	0.0	295.0	0.0040	0.0060	0.85	0.000	13.4
V282	130.1	12.75	1.70	8.5	16.3	502	150.0	298	0.0	245.0	0.0035	0.0120	1.03	0.000	13.2
V339	167.5	14.80	0.85	8.7	15.4	521	145.0	264	5.0	260.0	0.0110	0.0150	1.40	0.050	10.0
V371	120.0	12.60	3.74	8.4	14.3	483	72.6	271	77.7	285.7	0.0375	0.0034	1.16	0.182	6.3
VB02	75.3	7.98	5.17	7.1	12.5	425	69.4	217	38.9	250.0	0.1258	0.0055	0.56	0.702	2.0
VB24	80.1	9.16	2.95	7.9	9.2	272	53.4	148	52.4	142.9	0.0158	0.0010	0.55	0.012	12.0
V444	93.3	10.33	2.64	8	10.9	349	96.0	173	56.6	267.9	0.0192	0.0010	0.12	0.032	1.5
V455	93.9	10.06	4.35	8	12.3	337	104.6	183	51.7	178.6	0.0208	0.0011	0.15	0.052	4.6
V539	107.7	10.79	3.23	8.9	15.2	299	101.4	150	24.3	142.9	0.0192	0.0011	0.09	0.061	0.0
V543	93.4	9.76	3.35	8.8	13.3	247	93.9	129	22.1	321.4	0.0192	0.0010	0.06	0.032	3.4
VA17	82.9	9.69	3.20	8.1	8.7	183	74.7	92	7.1	214.3	0.0208	0.0014	0.20	0.052	0.1

Karamanis et al. in their recent study (2008) showed low concentrations of metals and radioactivity thus supporting further the good quality of river water (Table 35).

Table 35: Metal concentration and radioactivity in Aoos river water (Karamanis et al 2008)

Aoos-Station	V	Cr	Mn	Fe	Ni	Cu	Zn	Mo	Pb	Radio Activity (Bq/L)		
	(μg/L)									Gross A	Gross B	Ra
Konitsa-Mpourazani	1.2-bdl	3.2-bdl	9.4-0.2	106-6.5	8.5-1.6	6.7-0.6	13.7-0.3	20.9-bdl	1.7-0.1	0.031-bdl	0.041-0.005	0.0028-0.0008

According to the composition, the water of Vjosa belongs to the class of bicarbonates and in the group of calcium: $HCO_3 < CA^{++} + Mg$ (mg-eq/L). The correlation between the amount of ions and ions of bicarbonates and sulphate is linear (National Water Strategy for Albania, 1996). Average mineralisation of the waters of Vjosa River is 350 mg/L. Only Langarica torrent is an exception, it has a perennial average mineralisation of 700 mg/L (Table 36).

Table 36: Ion content of waters of Vjosa River (mg/L)

River	Station	Ca	Mg	Na	K	HCO_3	Cl	SO_4	Total ions
Drino	Ura Leklit	80.92	9.48	7.30	0.94	195.47	14.82	72.68	381.61
Pr. Carshoves	Carshove	50.82	20.22	5.57	0.72	235.85	10.33	16.32	339.89
P. Langarices	Ura Kadiut	88.33	22.71	85.92	7.03	239.29	198.86	41.92	684.06
Vjosa	Biovizhde	63.05	20.43	4.63	0.60	234.78	14.61	36.33	374.44
Vjosa	Petran	57.55	16.03	8.17	1.05	183.14	14.59	54.64	335.17
Vjosa	Permet	55.96	16.44	11.02	1.15	183.63	21.61	48.29	338.16
Vjosa	Doraz	67.86	14.01	12.28	1.15	193.95	29.07	53.01	371.37
Vjosa	Mifol	58.76	13.70	13.70	1.16	179.79	23.07	51.61	341.79

In the Vjosa River, the mineralisation appears to decrease in the first months of the year and reaches the lowest value in May. Then the mineralisation gradually increases and reaches the highest value in August and September. In Drino River, the mineralisation appears to be higher then in the Vjosa River. The water of this river contains greater quantities of calcium, bicarbonate and sulphate ions.

The chemical regime of Vjosa is in close connection with the water regime. This connection creates the possibility to determine the quantitative correlation between mineralisation and discharge (Table 37).

Table 37: Relation between mineralisation and discharge in the Vjosa catchment. Total ions = aQ^b (National Water Strategy for Albania, 1996).

Station	**a**	**b**
Biovizhde	577	-0.178
Permet	573	-0.139
Dorez	534	-0.091

The main nutrients (N, P) are not usually present in the waters of the hydrographic network of Vjosa River (Table 38). They have been mainly observed during the winter months in small quantities probably due to increased surface runoff. The phosphates are in quantities from 0.1 mg P_2O_5/L to 0.5 mg P_2O_5/L. The quantity of silicates comes up to 12 mg SiO_2/L. The content of iron in the waters of this river reaches 6 mg/L (Table 38) (National Water Strategy for Albania, 1996).

Table 38: Water chemistry of river water in Albania territory (maximum and minimum value mg/L).

Vjosa-Station	O_2	BOD	COD	NO_2	NO_3	NH_4	S.S.	P_2O_5	SiO_2	Zn	Cu	Mn	Fe
Lunxheri	11.05	2.31	0.84	0.200	0.04	0.50	75.0	0.310	7.00	0.080	0.035	0.593	6.012
	8.15	0.90	0.25	0.100	0.04	0.07	12.0	0.310	0.80	0.006	0.006	0.029	0.049
Gjirokaster	10.90	18.20	24.00	0.400	2.20	2.00	180.5	0.500	8.00	0.150	0.120	2.000	2.179
	0.00	1.00	0.35	0.010	0.01	0.15	2.2	0.140	1.44	0.011	0.020	0.029	0.012
Permet	10.95	2.20	6.76	0.050	0.00	0.15	5500.0	0.150	12.00	0.090	0.040	1.750	5.400
	2.60	0.50	0.24	0.006	0.00	0.10	35.0	0.150	4.50	0.006	0.030	0.020	0.430

The content of organic matter expressed by BOD_5 in the waters of the hydrographic network of Vjosa River ranges from 0.24 mg/L to 24 mg/L. The content of oxygen ranges from 0 to 11 O_2 mg/L. The waters of Vjosa have a slightly alkaline reaction and the values of pH vary from 7.8 to 8.3.

The different polluting discharges from the city of Gjirokaster caused in some cases the diminution of the dissolved oxygen (Table 37).

Compared with other rivers, the water of Vjosa can be considered as the cleanest river of Albania (National Water Strategy for Albania, 1996).

In Narta lagoon different ecological units show signs of ecological deterioration. Narta lagoon suffers from putrefaction, pollution from industrial and urban activities, over fishing, over hunting, water imbalance, absence of fresh water entrances etc. Kallenga and Limopua suffer from uncontrolled interferences in relation to the seawater entrance. Dune systems are facing degradation and destruction from sand extractors. Agricultural land is in need of an appropriate irrigation and drainage system while the salt marshes suffer from the absence of key investments related to sea water entrances, water balance and dyke erosion.

Distribution of mean annual discharges in Vjosë basin is presented in Table 39.

Table 39: Mean monthly and annual discharges for the Vjosë catchment (National Water Strategy for Albania, 1996).

River	Station	Area (km^2)	Monthly and annual discharges (m^3/s)												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	mean
Vjosa	Biovizhde	2170	85,4	92,6	82,0	110,1	85,3	43,5	22,5	15,0	15,2	23,1	53,3	86,4	60,2
Vjosa	Petran	2420	99,3	99,2	94,1	94,3	75,1	40,5	20,5	16,8	16,6	30,4	60,2	100,0	62,2
Vjosa	Permet	2810	102,0	105,6	104,0	117,4	83,5	42,5	22,5	17,2	17,3	31,8	63,4	103,1	67,5
Vjosa	Dragot	3470	117,0	158,0	123,0	117,0	138	59,2	32,9	23,3	22,6	47,7	130,0	128,0	91,4
Vjosa	Dorze	5420	280,0	259,1	223,3	223,9	167,1	92,1	53,8	38,3	37,0	65,2	170,0	258,6	158,0
Vjosa	Mifol	6680	327,7	314,1	250,0	230,2	163,6	83,9	50,9	45,6	46,4	80,3	206,0	312,5	176,0
Drino	Hormove	1300	84,6	82,5	61,2	44,2	26,1	13,8	8,75	6,22	6,10	13,1	44,9	76,3	39,0
Shushice	Vodice	587	38,6	34,2	25,3	22,5	16,1	8,24	4,99	4,20	4,81	11,7	25,9	32,5	18,9
Bistrice	Krane	108	28,5	28,1	27,1	25,0	21,6	19,7	17,7	15,6	16,1	17,7	22,0	25,4	22,0
Kalasa	Blerimas	228	13,3	16,0	10,4	7,24	3,77	1,47	0,583	0,392	0,925	2,44	6,48	12,5	6,29
Pavlla	Bogaz	337	13,0	11,9	8,36	5,88	3,44	2,21	1,30	0,842	1,07	2,46	6,99	12,9	5,86

Human activities in the catchment that are associated with the river's water regime are power supply and agriculture. However both of them seem to have a minor impact on Aoos/Vjosa River.

The main reservoir of the hydroelectric power plan in the Greek part of the catchment receives about 90 x 10^6 m^3 per year. This volume corresponds to a mean yearly discharge of 2.9 m^3/s from which 1.5 m^3/s is diverted outside of the catchment (to Arahthos River) for irrigation purposes. The rest is stored into the reservoir and released following to the power supply demands from station. Taking into account the mean yearly discharge of Aoos River at the Greek-Albanian borders (52 m^3/s), it is obvious that the discharge detained from the dam is negligible. However a detailed monitoring of the river's discharge downstream of the dam before and after its operation that would allowed for a more accurate assessment of the impacts on the river's water regime was not available.

Also, a potentially threat for the river's integrity constitutes the hydropower scheme on Vjosa River downstream of Kalivaci (Dorze) in the Albanian part of the catchment, which is under construction. However its impact on Vjosa River remains unknown since no any data related to its capacity and operation are available.

Regarding agriculture in Aoos catchment, water from its tributary Voidomatis is diverted for the irrigation of 450 ha through the networks of Aristeri Ohthi and Klidonia. A mean discharge of 0.3 m^3/s during the irrigation period is estimated to be abstracted from Voidomatis River.

In the Albanian part of the catchment no large scale abstractions have been recorded in the recent decades for irrigation purposes. An amount of 50 – 60 m^3/s was abstracted for irrigation before the political changes in the country. However since then the irrigation networks were not any more maintained and the amount of water supplied from Vjosa for irrigation was drastically diminished.

A large number of quarries operate along Aoos/Vjosa River, mainly in the Albanian part of the catchment, exerts pressure on the river's bed morphology and its riverine ecosystems. However the impact from this activity on the water quality of the river seems to be minor as Chatzinikolaou et. al 2008 have found in their study. Following to the results of the later, only in one case quarry activities, located in the Greek part of Aoos/Vjosa, have caused significant modifications on the river's bed and banks morphology, classifying this part of the river as "severely modified", according to the River Habitat Survey. Following the results from a total of 17 sampling sites along the river (Fig. 24) it has been characterized as Semi-natural, Predominantly unmodified or even pristine.

Conclusions

The DPSIR model, adopted by the European Environmental Agency links socio-economic and environmental information using indicators of different categories (*Driving forces, Pressure, State, Impacts and Responses*) (UNEP/RIVM, 1994; RIVM, 1995). *Driving forces* represent the needs that require the existence of a certain economic activity. The "intensity" of the *Pressure* depends on the nature and extent of the *Driving forces* and also on other factors which influence human interaction with natural environment. The *Impacts* are related to ecosystems and human well-being due to *State* modifications. The policy *responses* lead to changes in the DPSIR chain.

The main problem during the implementation of the DPSIR model in the Aoos/Vjosa catchment was lack of organized and systematic recording of information related to the current socio-economic activities, hydrological, biological and physicochemical parameters of the river catchment.

The General Secretariat of National Statistical Service of Greece and CORINE Landcover were the main sources of information and cover extensively the large gap of data. These sources combined with information from other projects and research studies increased the potential of assessing several driving forces and pressures while others were only qualitatively appraised.

Design and establishment of monitoring network of physical and chemical parameters and the water balance in the catchment should be a priority for the competent agencies in order to conserve and protect the river catchment. In addition special studies such a hydrological model should be considered.

The abrupt relief of the Greek section of the catchment and the socio-economic conditions in the Albanian limited the development of activities.

Agriculture in the Greek part is practiced intensively however only in a confined area (86.7 km^2). In the Albanian side, regardless agriculture expands to the biggest part of the catchment and occupies 50 % of the population, it covers only household needs. Mechanization, fertilizers and agrochemicals are only used in less than 30 % of agricultural land. The above lead to limited pressure by agriculture in the river catchment.

As regards urbanization, Konitsa town (Greece) is the biggest in Greek territory. The rest of the population is scattered in small villages. There water needs and wastewater loads are not significant pressure. In Albania the expanding economy has caused significant movement of the rural population to large towns of the catchment. The lack of or inadequate sewerage and solid wastes systems in those tows exert significant pressure on water resources at the disposal areas. Sewerage network in the towns cover 60-70% of the house and does not exist in the villages. Wastewater is discharged without and previous treatment in the Vjosa River.

Industry in the catchment is limited and concerns mainly agricultural products in the Albanian side.

The existing hydropower station on the springs of Aoos River in Greece have a minor effect on the water balance due to hold and diversion of river water. The impact of the under construction power plan in Albania was not assessed adequately due to lack of information.

Finally, gravel mining in the river catchment is the most significant pressure yet without having caused any irreversible effect.

Narta lagoon area shows signs of deterioration as it suffers from putrefaction, pollution from industrial and urban activities, over fishing, over hunting, water imbalance, absence of fresh water entrances etc. However there is a completed management plan for the lagoon waiting to be implemented.

This study has demonstrated that the quality and quantity of Aoos/Vjosa River are at good conditions. Significant pressures are

- Gravel mining
- Inadequate sewerage and wastewater treatment
- Uncontrolled solid waste disposal
- The construction of new hydropower plans and industrial agriculture pose threats for the near future.

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Appendix I

The pressure checklist is presented in two stages. First, in Table 1 the pressures have been grouped into four main classes of driving forces that may impact the different water body categories and prevent them from meeting the objectives. A tentative indication of these likely-to-be relationships is reported in the Table 1. This table is an entry to the following uncompleted list of pressures in Table 2, as the numbers in the first column of Table 1 refer to the corresponding lines in Table 2.

Table1*. Pressures to be considered. See Table 2 for more details.*

n°	DRIVING FORCES	Water Body Category				OBJECTIVES				
		Rivers	Lakes	Coastal/Transitional	Groundwater	WFD (biota)	Tap water, NO3	Bathing, recreation	Habitats, Birds	Shell/fish farming
10	**Pollution**									
11	Household	x	x	x	x	x	x	x		
12	Industry (operating, historical)	x	x	x	x	x	x			
13	Agriculture	x	x	x	x	x	x	x	x	
14	Aquiculture /fish farming	x		x		x				
15	Forestry	x	x	x	x					
16	Impervious areas	x	x	x		x		x		
17	Mines, quarries	x			x	x				
18	Dump, storage sites	x		x	x	x				
19	Transports	x		x					x	
20	**Alteration of hydrologic regime**									
21	Abstraction (agri, industry, household)	x	x		x	x	x			x
22	Flow regulation works	x		x		x			x	
23	Hydropower works	x		x		x			x	
24	Fish farming	x				x				
25	Cooling	x								x
26	Flow enhancement (transfers)	x			x	x			x	
30	**Morphology (changes in)**									
31	Agricultural activities	x	x	x		x			x	x
32	Urban settlements	x	x	x		x	x		x	
33	Industrial areas	x	x	x		x			x	
34	Flood protection	x	x	x		x				
35	Operation, maintenance	x	x	x		x				
36	Navigation	x	x	x					x	
40	**Biology**									
41	Fishing/angling	x	x	x		x				
42	Fish/shellfish farming	x	x	x		x				x
43	Emptying ponds	x	x						x	x

Table 2. Uncompleted list of Pressures to be considered

n°	SOURCE	Source within the source type
10	DIFFUSE SOURCE	
12	urban drainage (including runoff)	ndustrial/commercial estates
11		urban areas (including sewer networks)
16		airports
19		trunk roads
19		railway tracks and facilities
19		harbours
13	agriculture diffuse	arable, improved grassland, mixed farming
13		crops with intensive nutrient or pesticide usage or long bare soil periods (e.g. corn, potato, sugar beets, vine, hops, fruits, vegetables)
13		over grazing – leading to erosion
13		horticulture, including greenhouses
13		application of agricultural waste to land
15	forestry	peat mining
15		planting/ground preparation
15		felling
15		pesticide applications
15		fertilizer applications
22		drainage
19		oil pollution
11	other diffuse	sewage sludge recycling to land
		atmospheric deposition
19		dredge spoil disposal into surface waters
19		shipping/navigation
	POINT SOURCE	
11	waste water	municipal waste water primarily domestic
11		municipal waste water with a major industrial component
11		storm water and emergency overflows
11		private waste water primarily domestic
11		private waste water with a major industrial component
19		harbours
12	industry	gas/petrol
12		chemicals (organic and inorganic)
12		pulp, paper & boards
12		woollens/textiles
12		iron and steel
12		food processing
12		brewing/distilling
12		electronics and other chlorinated solvent users
12		wood yards/timber treatment
12		construction
25		power generation
12		leather tanning
19		Shipyards
12		other manufacturing processes
17	mining	active deep mine
17		active open cast coal site/quarry
17		gas and oil exploration and production
15		peat extraction
17		abandoned coal (and other) mines
17		abandoned coal (and other) mine spoil heaps (bings)
17		tailings dams
18	contaminated land	old landfill sites
18		urban industrial site (organic and inorganic)
18		rural sites
18		military sites
13	agriculture point	slurry
13		silage and other feeds
13		sheep dip use and disposal
13		manure depots
12		farm chemicals
19		agricultural fuel oils
19		agricultural industries
18	waste management	operating landfill site
18		operating waste transfer stations, scrap yards etc.
18		application of non agricultural waste to land
14	aquaculture	land based fish farming / watercress / aquaculture
14		marine cage fish farming
12	manufacture, use and emissions from all industrial/agricultural sectors	priority substances

n°	SOURCE	Source within the source type
12		priority hazardous substances
12		other relevant substances
	ABSTRACTION	
21	reduction in flow	abstractions for agriculture
21		abstractions for potable supply
21		abstractions by industry
24		abstractions by fish farms
23		abstractions by hydro-energy
21		abstractions by quarries/open cast coal sites
22		abstractions for navigation (e.g. supplying canals)
20	ARTIFICIAL RECHARGE	
26		groundwater recharge
30	MORPHOLOGICAL	
22	flow regulation	hydroelectric dams
21		water supply reservoirs
22		flood defence dams
22		diversions
22		weirs
36	river management	physical alteration of channel
35		engineering activities
31		agricultural enhancement
31		fisheries enhancement
32		land infrastructure (road/bridge construction)
36		dredging
36	transitional and coastal management	estuarine/coastal dredging
36		marine constructions, shipyards and harbours
31		land reclamation and polders
30		coastal sand suppletion (safety)
30	other morphological	barriers
	OTHER ANTHROPOGENIC	
12		litter/fly tipping
11		sludge disposal to sea (historic)
33		mine adits/tunnels affecting groundwater flows
40		exploitation/removal of other animals/plants
10		recreation
41		fishing/angling
40		introduced species
40		introduced diseases
10		climate change
31		land drainage