CASE STUDY REPORT

The Neajlov Catchment (Romania)

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1. General characteristics

1.1. Location in the Danube River Catchment

This study area established for the implementation of the AQUAMONEY project (WP$_6$) belong to the Lower Danube Catchment (LDC) *(Fig. 1)*. The area is located in the south part of Romania with the geographic position of 24˚51'12"-26˚13'52" E longitude and 43˚55'31"-44˚49'32" N latitude.

The Neajlov River and its catchment are a tributary and a sub-catchment of the river Arges, which in turn is one of the main tributary for the lower Danube river stretch. The Neajlov river catchment belongs also to the four administrative units (counties) – Arges, Dimbovita, Giurgiu and Teleorman.

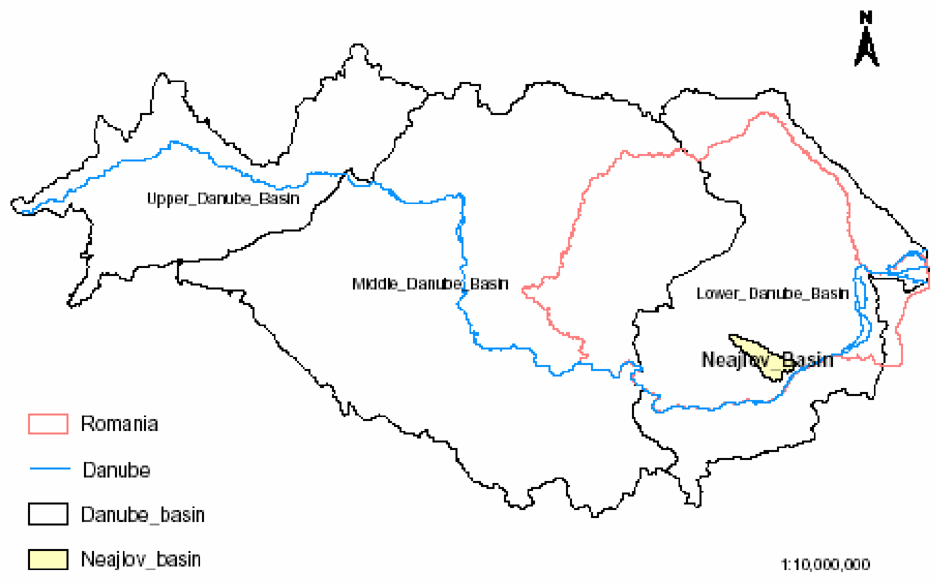

Figure 1. Location of the Neajlov catchment in the Danube Catchment.

1.2.Geomorphology and climate conditions

- The Neajlov catchment is a piedmont plain with a surface of 3718.5 km^2, stretching from 350 m altitude, in the North-West, to 30 m in the South-East *(Fig. 2)* and having an average slope of 2.31 m per km. The river Neajlov is 188 km long and contains in its catchment a stream network with an average density of 0.36 km per km^2.
- The climate is temperate–continental described by: i) average annual precipitation of 496 mm *(Fig.3)*; ii) an average annual temperature of 10˚C in the NW and 11˚C in the SE *(Fig. 4)*; iii) mean annual ET of 409 mm; iv) mean annual surface runoff of 15

mm; v) an annual base flow of 52 mm; vi) an average solar radiation of 326 $kcal \cdot cm^{-2}$; vii) mean wind speed of 5 $m \cdot s^{-1}$ and 30% frequency.

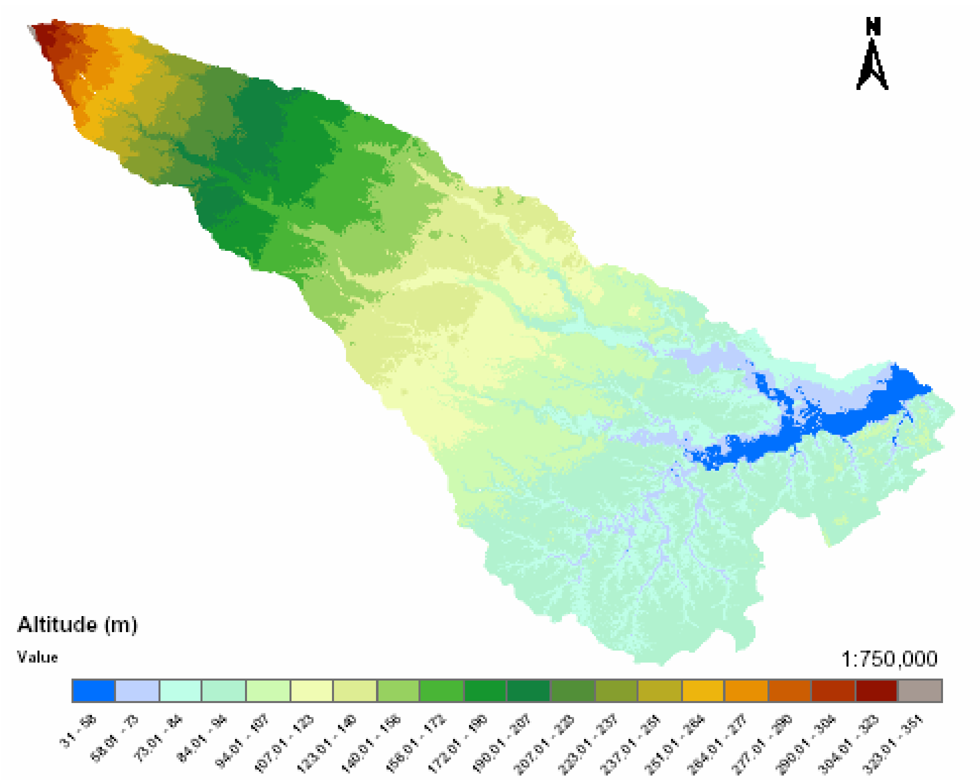

Figure 2. Altitude (m) in Neajlov catchment.

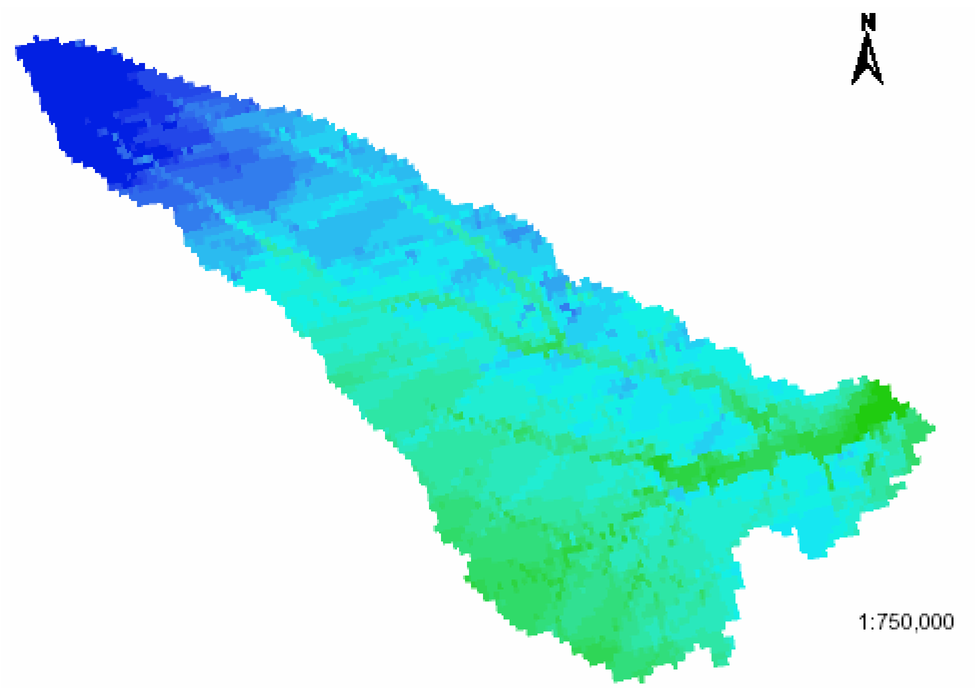

Figure 3. Annual precipitation between 400 - 600 mm (green → blue) in Neajlov catchment.

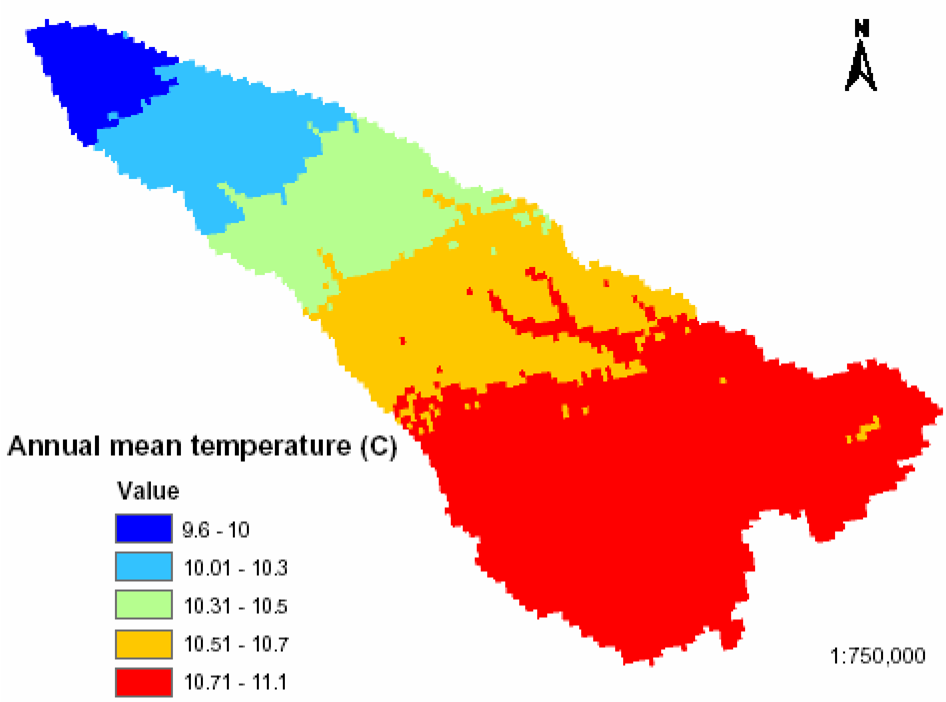

Figure 4. Annual mean temperature (˚C) in Neajlov catchment.

- According with FAO-UNESCO soil classification, within the Neajlov catchment have been described eleven soil classes *(Fig.5)*, from which the dominant are - Luvisols (2250 km^2), Planosols (400 km^2), Chernozems (350 km^2), Vertisols (287 km^2) and Gleysols (254 km^2) (Oprina, P.M., 2006).

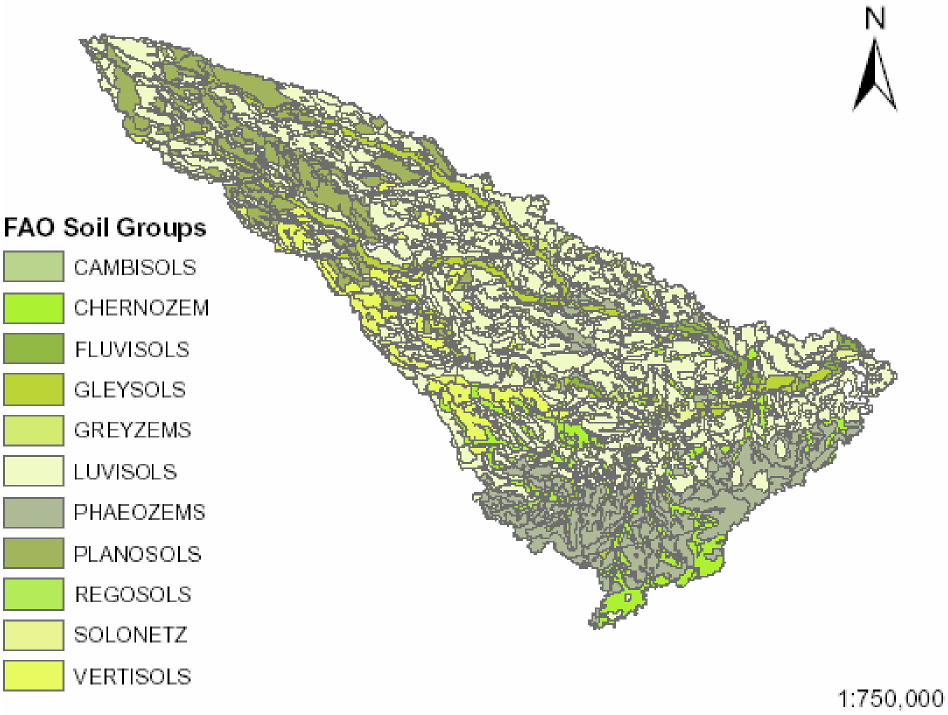

Figure 5. Major soil classes identified in Neajlov catchment, according with FAO-UNESCO classification.

The geological substrate of the area is given by the Moessic platform and four major sediment layers: 1) Permian-Triassic; 2) middle Jurassic–Barremian; 3) Albian–Senonian and 4) Tortonian-Quaternary.

The soil bed consists from quaternary alluvial (2-6 m thick) and loess (5-12 m thick) deposits (Geological Atlas, Romania, 1967).

1.3. Land use and landscape structure

The main categories of land use in the Neajlov catchment are represented by the arable, forest, rural and urban built-up areas *(Table 1, Fig. 6).*

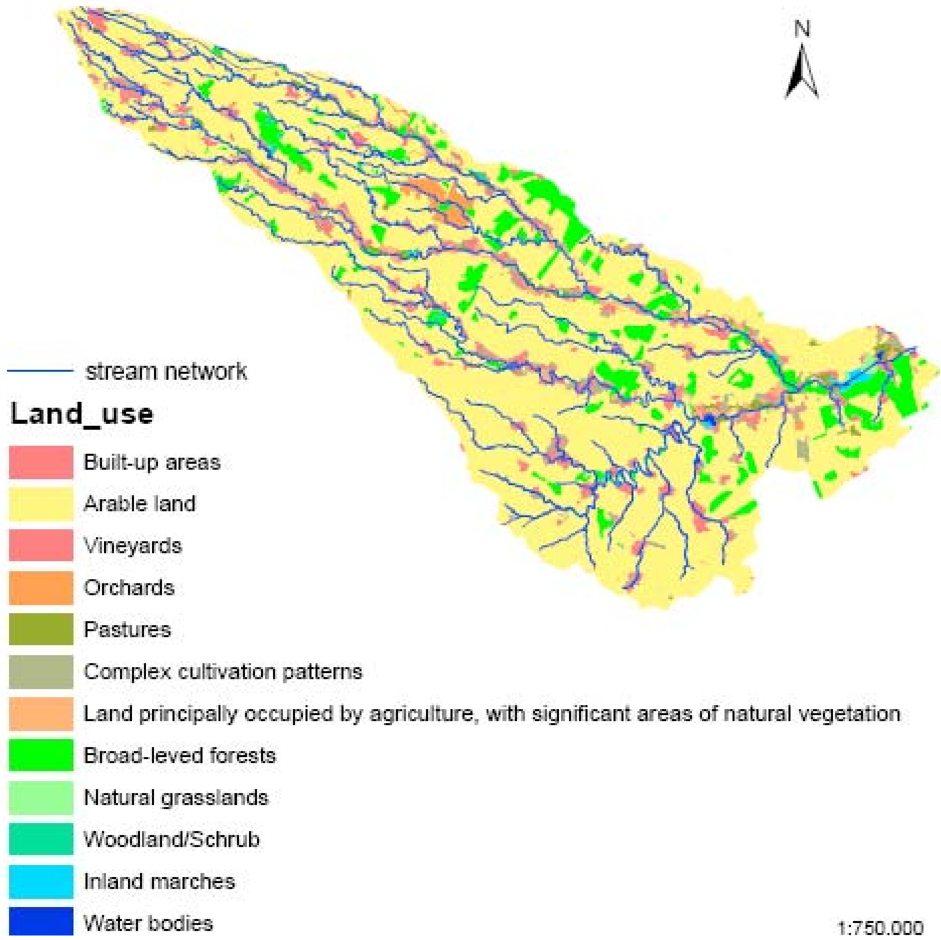

Figure 6. Land use classes according with CORINE Land Cover 2000 in the Neajlov catchment area.

Table 1. Percentage of the main land use classes in the Neajlov basin catchment.

Land use	%
Built-up areas	5.99
Arable land	69.49
Vineyards	1.1
Orchards	1.04
Pastures	3.49
Complex cultivation patterns	3.89
Land principally occupied by agriculture, with significant areas of natural vegetation	2.4
Broad-leaved forest	10.85
Natural grasslands	0.17
Woodland and shrub	0.17
Inland marshes	0.68
Water courses	0.73

The landscapes structure from Neajlov catchment *(Fig.7, 8)* is dominated by man-controlled and subsidized ecosystems or agricultural ecosystems. However significant changes in the structure and management of the agricultural ecosystems occurred after 1990, when state owned and large (thousands of hectares) crop farms and animal husbandry (tenth of thousands of pigs or thousands of cows) have been replaced by small (10-15 hectares) or very small (1-3 hectares) subsistence farms. The process of restructuring the land ownership and farming systems has been accompanied by a significant land abandonment, which accounted almost 25% from agricultural land after 2000 (Postolache, C., 2004).

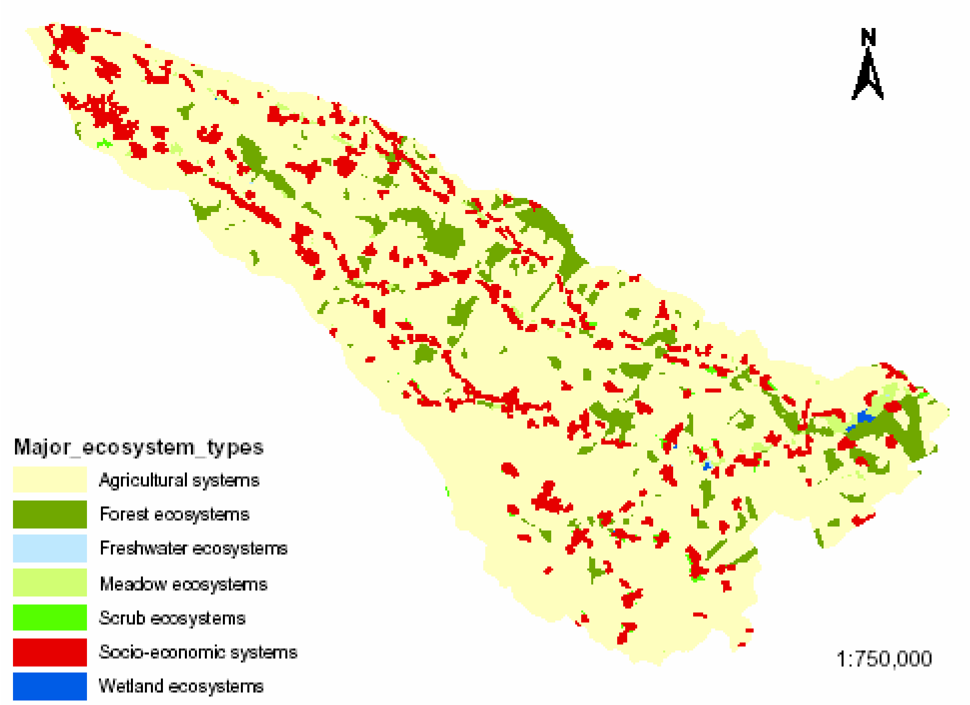

Figure 7. Major ecosystem types in Neajlov catchment.

In addition the irrigation system and the intensive agricultural practices have been almost abandoned, which in turn diminished up to very low level the water demand and the nutrient emission into ground and surface water bodies.

The major crops in the former intensive state and collective farming systems were – corn, wheat, barley, sunflower, beet and fadder. The structure of crops has been preserved at the smaller scale and based on nonintensive agricultural practices.

The increase of arable land and the weight of agricultural ecosystems were done in the last century (in particular after 1950) by replacing the natural and seminatural forests, wetlands and grasslands.

The total human population inhabiting the Neajlov catchment is 260400 individuals with a negative growth rate(r), after 1990, which reached the lowest level of -0.57 percent in 1999.

The rural (76) and urban (3) ecosystems and their built physical capital extend over 5.9 percent from the total area of Neajlov catchment.

From the total human population, 90 percent is living in the rural settlements and 10 percent in the urban settlements. Almost 75 percent of the rural population are currently dependent, from economic point of view, on small / subsistence farms with very low level of intensification. From 10 percent of employed population, 44 percent works in the industrial sector and from that 73 percentage in the oil extraction industry and 21 percent in the processing industry.

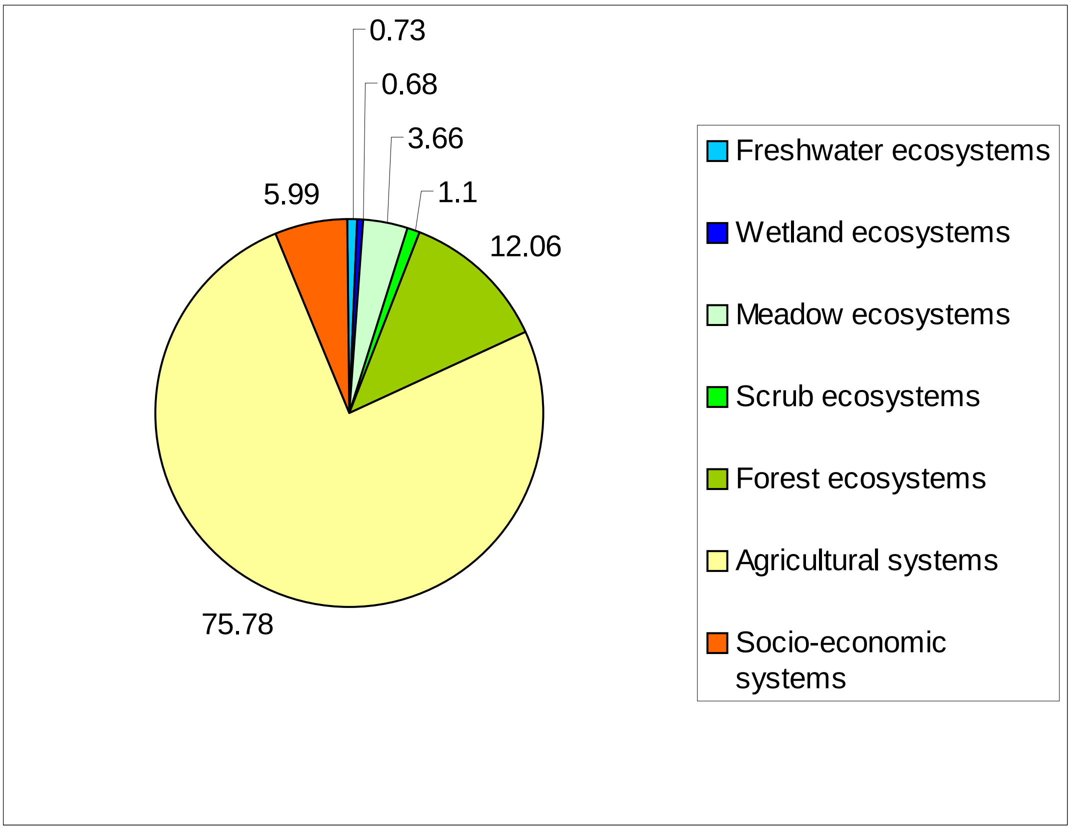

Figure 8. Main ecosystem types in Neajlov catchment.

1.4. The Water Systems Network characteristics from Neajlov catchment

1.4.1. Water course management

The core components of the water network include the river Neajlov and its three major tributaries – Dambovnic, Glavacioc and Calnistea *(Fig. 9, Table 2)*.

The overall catchment comprises 48 sub-catchments with surfaces between 10 and 664 km^2, which have been further clustered into 9 sub-catchments *(Table 5).*

Table 2. Hydromorphometric characteristics of the most important rivers in the Neajlov catchment area.

River	Length (km)	Slope (‰)	Sinuosity
Neajlov	187.84	1.46	1.49
Dambovnic	127.27	1.87	1.56
Calnistea	108.03	0.64	2.05
Glavacioc	112.64	1.88	1.57

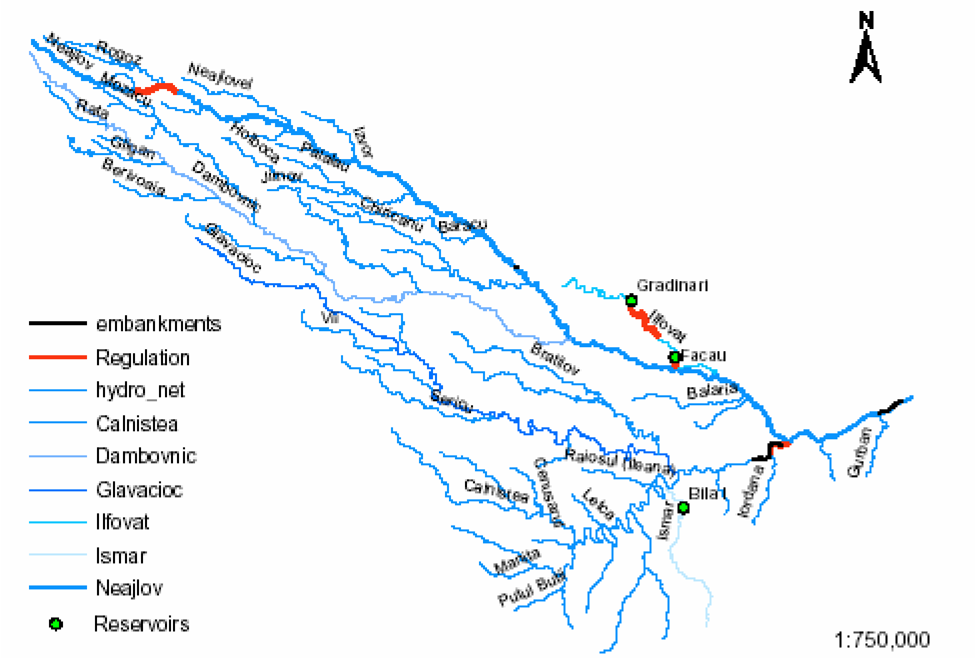

Figure 9. Neajlov catchment river network and main regulation works.

During last five decades in the Neajlov catchment a set of hydrotehnical projects have been implemented, aiming to establish water reservoirs, embankments, new canals for water diversion and river stretch regulation *(Fig. 9).*

Along the main water courses of the hydrological network have been created 95 water reservoirs aiming to serve different uses – irrigation, intensive fishery, industrial and households water supply, from which the most important are Gradinari, Facau and Bila 1 *(Fig. 9, Table 3).*

Table 3. Main reservoirs in the Neajlov catchment.

No	Reservoir	River	Total Volume Mill m^3	NNR Volume Mill m^3	NNR Surface ha	Use
1	Facau	Ilfovat	3.00	2.60	83	Irrigation, fishery
2	Gradinari	Ilfovat	12.40	11.60	179	Multiple
3	Bila I	Ismar	1.00	1.00	67	Fishery

Two channels (22 km and 6 km long) have been built for water transfer (5.3 $m^3 \cdot s^{-1}$ and 2.4 $m^3 \cdot s^{-1}$) from Arges River to the Ilfovat stream in order to supply major built reservoirs.

1.4.2. Ground and Surface water course resources management*[1]

Total groundwater resources in the Arges River catchment are about 696 Mil. M^3/year, from which about 600 Mil. M^3/year can be accessed and use by the socio-economic system. About 60% of these resources are shallow aquifer (below 5 m depth), while 40% are mean and deep aquifer (between 20-100 m depth).
Surface water resources are estimated at about 1960 Mil. M^3/year, and the infrastructure ensure the access of about 1671.6 Mil. M^3/year.
Water abstraction and use in 2002 accounted for 113.4 Mil. M^3/year from groundwater resources and about 628.1 Mil. M^3/year from surface waters. Water uses by socio-economic sectors are:

- Population: 71.2 Mil. M^3/year from GW and 346.3 Mil. M^3/year from SW;
- Industry: 39.8 Mil. M^3/year from GW and 244.9 Mil. M^3/year from SW;
- Agriculture: 2.3 Mil. M^3/year from GW and 36.9 Mil. M^3/year from SW;
    - Irrigation: 12.14 Mil. M^3/year (SW) and 0.12 Mil. M^3/year (GW);
    - Breeding farms: 2.21 Mil. M^3/year (GW);
    - Aquaculture: 24.76 Mil. M^3/year (SW).

Water balance and aquifers characteristics

The detailed water balance for the period 1995-2001, was evaluated with SWAT model (Danielescu, S., and Postolache, C., unpublished data) and MONERIS (MOdelling Nutrient Emissions in RIver Systems) model (Postolache, C., unpublished data). Water balance characteristics are synthetically presented in *Table 4*.

Due to the complexity of spatial distribution of hydrologic balance components a cluster analysis has been performed in order to group the sub-catchments in functional classes.

* Values indicate the volumes of water resources at the Arges River catchment, to which Neajlov catchment belongs

Table 4. Water balance components of the Neajlov catchment, calculated for the period 1995-2001 (without storage changes and transmission losses from river)

Component	[mm/a]	[%]	Remarcs
Average annual precipitation	496		
River discharge	66	13.3	[%] related to precipitation
Evapotranspiration	409	82.45	[%] related to precipitation
Surface runoff	15	20.70	[%] related to river discharge
Baseflow	52	71.76	[%] related to river discharge
Lateral flow	1	1.38	[%] related to river discharge
Point source contribution	3.6	4.97	[%] related to river discharge
Tile drainage runoff	0.43	0.59	[%] related to river discharge

It was observed that regions located in the northern and western part of the catchment are characterized by high values of surface runoff (18-20 mm/a annual average) and as a consequence by high values of total water yield (75-91 mm/a annual average). The infiltration (366 - 377 mm/a) and evapotranspiration (379 / 397 mm/a annual average) are lower than the catchment average (394 / 409 mm). These factors together with the soil properties suggest a very rapid circulation of water from upslope to the river, mainly through surface runoff. The soil water content has the lowest values for the entire catchment (between 41 mm/a and 50 mm/a).

Regions located in the central and southern-western, southern-eastern parts of the catchment are characterized by lower values of surface runoff (11-13 mm/a). The infiltration level is greater for these areas, but is balanced by a higher level of evapotranspiration (420-432). Groundwater discharge varies from 7 mm/a to 89 mm/a, and soil water content lies between 72 mm/a and 122 mm/a.

Aquifers characteristics, detailed on 9 sub-catchments of the Neajlov catchment, are presented in *Table 5*. Data have been obtained by mathematical modeling (MONERIS model). It can be observed that groundwater specific discharge is higher in the upper part of the catchment, while the longer residence time was obtained for the lower part of the catchment (Calugareni).

Table 5. Aquifers characteristics for 9 sub-catchments of the Neajlov catchment evaluated through MONERIS model.

Sub-catchment	Q-GW (discharge)	Areas contribting to GW recharge	Groundwater discharge (long term corrected)	GW residence time
	[m³/s]	[km²]	[mm/a]	[years]
Suseni	0.34	93.76	96.45	31
Slobozia	0.54	162.08	88.43	34
Roata Mica	1.25	378.84	87.71	34
Oarja	0.22	64.01	92.10	33
Furduiesti	0.24	73.90	87.67	34
Morteni	0.20	64.81	83.03	36
Moara din Groapa	0.37	116.56	84.54	35
Vadu Lat	1.18	355.37	88.05	34
Calugareni	4.23	2253.28	49.99	60

Main hydraulic infrastructure

The water supply and waste water management systems have not reached the actual modern requirements in this sector. Only a very small percentage of population, of ~6% is provided with water supply and is connected to waste water treatment plants. In fact, only 2.9% of population living in the catchment is provided with these utilities. The rest live in Gaesti, a town located outside the borders of Neajlov catchment, which discharges the waste water from municipality near Moara din Groapa. There are three waste water treatment plants in the region discharging the waste water in the surface waters: Gaesti, Videle and Drganesti Vlasca *(Fig. 10).* The treatment plants ensure only the removal of organic carbon (biological level of treatment). Average data concerning more information about WWTP discharges are presented in *Table 6.*

Table 6. Information about the level of waste water treatment and discharges for Neajlov basin.

WWTP	Population connected	Level of treatment	Q (mil. m3/a) discharged	TN (t/a)	TP (t/a)	Data period
Gaesti	7124	C	1.12	10.8	2.24	1998-2001
Videle	6418	C	0.48	4.9	0.14	1998-2001
Drganesti Vlasca		C	0.18	2.5	0.11	1998-2001
Pitesti	-	C	11.08	63.2	3.63	1998-2001
Oarja	-	C	0.11	41.6	0.83	1998-2001

C = carbon removal

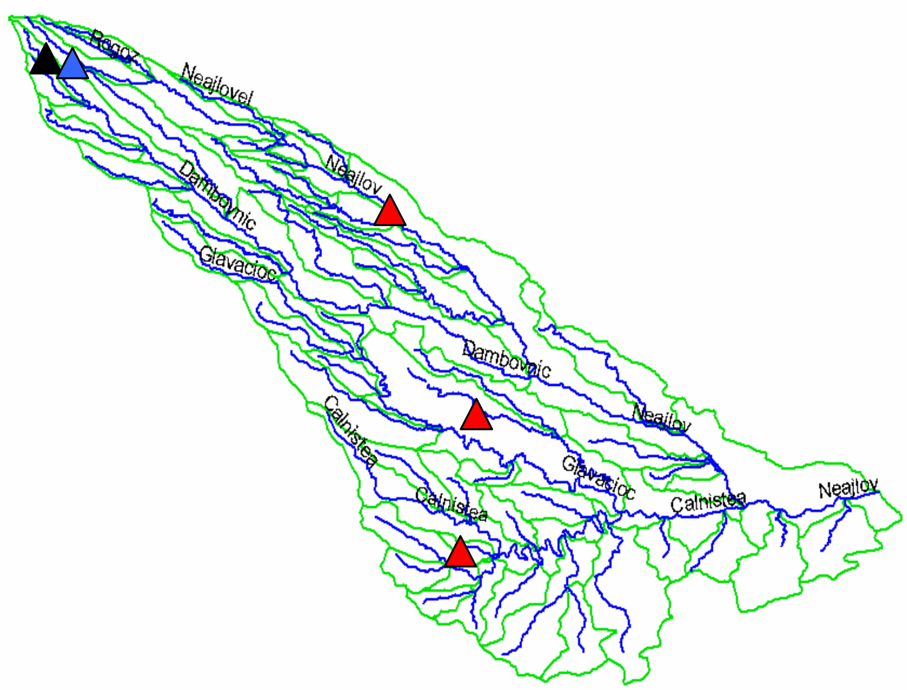

Figure 10. Location of waste water treatment plants in Neajlov catchment (red=population; blue=agriculture; black=industry)

The most important discharges originate in the industrial sector. Even the industrial sector is not well developed in the region, the contribution of the chemical enterprise in Pitesti – ARPECHIM - *(Fig. 10)*, which is discharging in Dambovnic River (near Suseni), is by far the biggest.

Large amounts of nutrients are also emitted from the agriculture, as it can be observed from *Table 6* (Oarja). The breeding farm in Oarja is on the second place in the catchment in respect to N and on the third place in respect to P emissions. Dambovnic River is the recipient of waste waters from both ARPECHIM and SUINTEST treatment plants, which is an explanation for the lower quality of its waters.

1.5. Protected areas

According with article 6 and article 6.3. of the Water Framework Directive (WFD) the concept of protected areas has been extended to cover:

- areas designated for the protection of habitats and species;
- areas designated for water abstraction intended for human consumption;
- nutrient sensitive areas, including areas designated as vulnerable.

In that regard at the Neajlov catchment scale up to now have been established for following protected areas:

- Comana wetland (1260 ha), designated as a Natura 2000 site for bird species protection under the EU-Bird and Habitat directives;
- Teleorman – Glavacioc (185 ha) and Glavacioc – Neajlov (231 ha) as vulnerable areas due to high nitrate load;
- Poieni (51 $l \cdot s^{-1}$), Videle (50 $l \cdot s^{-1}$) and Gradinari (10 $l \cdot s^{-1}$) as protected areas designated for ground water abstraction for human consumption.

1.6. Economic analysis of water use

The water management is based on the solidarity principle and common interest through the cooperation of public administration, water users and representatives of local communities. The qualitative and quantitative water resource management is made by the Romanian Waters National Authority, the instution in charge with all the strategies regarding the management and exploitation of the water resources. The National Authority administrates the national network of hydrological, hydro-geological and quality measurements of the public waters through its Water Directorates organized at basin and group of basin level.

The payment, penalties and rewards system constitutes the economic mechanism established for the qualitative and quantitative management of water use in a monopolistic regime. According with the implementation of the Government Ordinance 1001/1990, the water pricing system consists of unique charges for raw water supplied from different sources to groups of users and unique tariffs provided by the water supplyers for specific water services.

The water charges and taxes that are being set by the Romanian Waters Authority on a national level acording with the Water Law (107/1996) under the supervision of the Competition Council based on the economic analysis of the financial status of the water services providers consider the following cost categories:

- raw materials costs: energy, fuels, and significant other costs (concession fees, raw water, typical chemical substances);
- labor force costs;
- depreciation costs;
- monitoring and hydrological research costs;
- other costs of services provided by third parties;
- maintenance and repairs costs (provided by own activity or other parties).

The resource cost or the private cost of water use is reflected by the payment system according with the beneficiary pays principle, comprising the amount of money paid by the water users (households, public institutions and any other economic agent) to the specialized management units for the following services:

- abstraction, treatment and pumping;
- water distribution for industrial platforms, irrigation, public and other networks;
- water transport through pipes and channels;
- conservation of tourism and recreational opportunities for rivers, natural lakes and reservoirs;
- flood protection activities;
- water pumping for therapeutical waters protection and embankment areas;
- insuring fish resource utility;
- water flow supplement;
- other services related to water use and treatment.

The environmental costs or the external cost of water is reflected by the environmental related taxes *(Table 7)* and the penalties system.

The water users are allowed to discharge effluents, which are loaded with specific pollutants, according with the type of water use, up to certain thresholds, established by water law. However for the permission any economic agent / user has to pay a tax for each chemical compound released with the effluent.

According with the polluter pays principle, the discharge of waste water containing pollutants above the allowed thresholds established by law are punished by penalties set taking into account the difference between the allowed chemical concentration and the discharge concentration level and the volume of the discharges.

The aggregated taxes applied to the discharge pollutants, according with the permission, into the surface and ground waters, together with the tax applied to water abstraction from the available water sources and with the applied penalties, currently describes the environmental / external cost charged by the legal authorities at the expense of water users.

Table 7. Environmental taxes for Romanian water resources.

No.	Tax or Tariff	General framework of taxation	Specific framework of taxation	Level of taxation Euro/m^3
1.	Water treatment and sewage	Water resource management	Water delivered	0,012 euro/m^3 (average rate)
2.	Water abstraction	Water resource management	Household water use from national waters	0,0076 euro/m^3
3.	Water abstraction	Water resource management	Household water use from Danube	0,009 euro/m^3
4.	Water abstraction	Water resource management	Household water use from aquivifer	0,0083 euro/m^3
5.	Water abstraction	Water resource management	Industrial water use from national waters	0,0076 euro/m^3
6.	Water abstraction	Water resource management	Industrial water use from Danube	0,009 euro/m^3
7.	Water abstraction	Water resource management	Industrial water use from aquivifer	0,0084 euro/m^3
8.	Water abstraction	Water resource management	Agricultural water use from national waters	0,0076 euro/m^3
9.	Water abstraction	Water resource management	Agricultural water use from Danube	0,0009 euro/m^3
10.	Water abstraction	Water resource management	Animal husbandry water use from aquivifer	0,0084 euro/m^3
11.	Water abstraction	Water resource management	Irrigation and fishery water use from all sources	0,0006 euro/m^3
12.	Water abstraction	Water resource management	Agricultural water use from aquivifer	0,0048 euro/m^3
13.	Water use	Water resource management	Household water use	0,084 euro/m^3
14.	Water use	Water resource management	Industrial water use	0,022 euro/m^3
15.	Effluents discharges	Measured and estimated effluents of oxidizable material (BOD, COD)	BOD	8,68 euro/t
16.	Effluents discharges	Other measured and estimated effluents	Phosphorus	34,8 euro/t
17.	Effluents discharges	Other measured and estimated effluents	Solid suspensions	2,12 euro/t
18.	Effluents discharges	Other measured and estimated effluents	Nitrogen	34,8 euro/t

Data source: *Environmentally-related taxes data base, OECD/EEA, for 1.10.2003*

The current practice for water pricing is based on a unique price applied at national scale, regardless the fact that the water management is organized at eleven river catchments around the country. In these circumstances significant differences among the river catchments and administrative units in terms of: i) quantity and quality of water resources; ii) the specific seasonal and annual variability in the hydrology at the catchment level; iii) and marginal cost, are not taken into account.

Taking into account resource distribution and scarcity, the pollution problems, the increasing demand for water, the shift from a centralized national economy system to one based on autonomy it is obvious that the unique price can not be an instrument for rational use and sustainable management.

The reason why this system was developed and maintained until this point lies in a series of administrative advantages like:

- allows access to water resources for all users, regardless of their economical viability;
- allows sharing of management risks between different administrative bodies;
- is considered equitable for all users regardless the resource availability.

Nevertheless in spite of these advantages the unique price does not stimulate competition and liability, as the authorities' responsibilities and incomes or deficits are transferred from the local to the national level.

The expected improved practice for economic analysis according with the provision of WFD should be developed by taking into consideration the shortages of the current practice and to extend the analysis to the major functions and broader range of resources and services provided by the inland water ecosystems, under the pressure of different drivers acting across time and space scales. This is in fact the unique goal of the AQUAMONEY project.

1.7. Major water quality and environmental problems

Groundwater quality

Groundwater monitoring system in the Neajlov catchment recorded high concentrations of pollutants in 22 deep wells. The main pollutants are organic compounds, ammonium, and nitrates. High concentrations of organic compounds have been recorded in the northern part of the catchment, in the proximity of the industrial platform ARPECHIM - Pitesti. Ammonium, and accidentally nitrates, is present in larger amounts in those regions characterized by shallow aquifers and more intense agricultural practices (central and southern part of the catchment). Measurements of groundwater nutrient content performed by Arges-Vedea Water Directorate (WDAV – Pitesti) reported mean catchment concentrations of 2.96 mg N/l and 0.07 mg P/l.

Surface water

Eutrophication, pollution with organic compound (phenols,), heavy metals (Mn, Cr, Fe) and oil are the most important impact problems for Neajlov and especially Dambovnic rivers. The Department of Systems Ecology carried out an intense monitoring program over the period of time 2001-2003 (DANUBS project), which was intended to provide good data for the evaluation of nutrient loads in surface waters of Neajlov catchment. A number of 10 sites have been established on the most important rivers of the catchment: four were located on Dambovnic and six sites on

Neajlov River *(Figure 11)*. Data obtained through the implementation of this program (Postolache, C., unpublished data) showed a different distribution of nutrient concentrations, induced by the local conditions: presence of point emission sources, structural and functional particularities of the adjacent ecological systems.

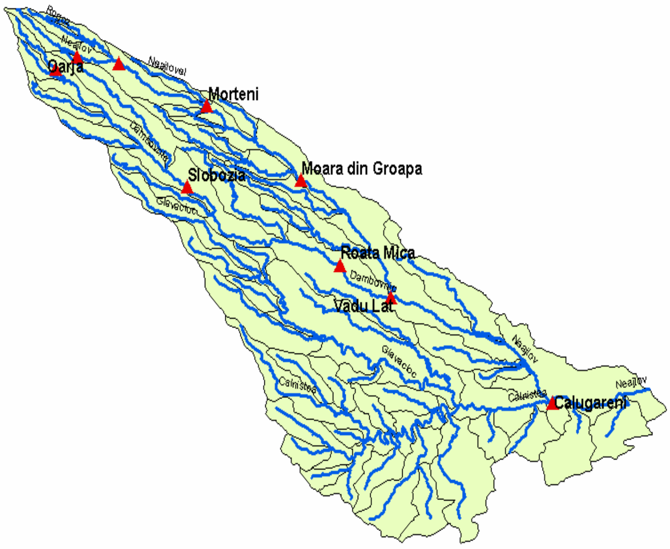

Figure 11. Selected measuring points for the additional sampling program in the Neajlov catchment (2001-2003).

The variation of total nitrogen concentrations is similar for both rivers, being no higher than 15 mg TN/l, with the exception of one site - Suseni. In this point concentrations up to 30 mg TN/l have been determined. The values decrease while moving downstream as a consequence of bigger dilution. The dynamics of total reactive phosphorous is similar with that of total nitrogen. The range of variation is greater for Dambovnic River (up to 4.5 mg TP/l) but no more than 0.7 mg TP/l has been recorded for Neajlov River.

Very irregular variation of both nutrients have been recorded in several points: Suseni and Furduiesti. Both the amplitudes and heterogeneities in nutrient dynamics can be explained by the great influence of point discharges from the local industries: ARPECHIM, SUINTEST (discharging in Dambovnic-Suseni) and, to some extend, Cateasca (even if the amplitude is not too high).

In conclusion, the distribution and variation of nutrients in the surface waters of the Neajlov catchment are highly dependent on the emissions but also on the transport and transformation processes they undergo with different rates in time and space. There are several "hot spots" in the region, characterized by the highest nutrient concentrations: Suseni and Moara din Groapa. They are tightly related to the intensity of point emissions.

2. Pressure, impact, and risk analysis whit regards to the WFD environmental objectives

2.1 Significant pressures impacting on water status

The most important point and diffuse pollution sources present in the Neajlov catchment are:

- the emission points of the chemical industry ARPECHIM - Pitesti - ***Suseni*** (organic compounds, heavy metals oil spills);
- the breeding farm SUINTEST – ***Oarja*** (nutrients, organic matter);
- the waste waters from the beverage industry Cateasca are discharged near ***Furduiesti*** (organic compounds, nutrients);
- ***Roata*** is an oil extraction region (oil pollution);
- ***Moara din Groapa*** is the receiving point of the effluents from the Waste Water Treatment Plant (WWTP) Gaesti (nutrients, organic matter);
- Downstream both Neajlov and Dambovnic rivers the emissions originate mostly from agricultural areas and rural settlements (nutrients).

Nutrient emissions in the surface and ground waters is one of the most severe problem in the cathment and, therefore the mathematical model MONERIS was applied (DANUBS project) in order to quantify the emission nutrient fluxes of different origin - point or diffuse sources (Postolace, C., unpublished data).

The distribution of nitrogen and phosphorous surpluses on agricultural soils in the study region are very similar and show high variability on the administrative levels. The ranges of variation are between 4.5 – 69 kg N/ha/year and 0.8 – 15 kg P/ha/year. With few exceptions, nitrogen surplus is below 40 kg N/ha/year and phosphorous less than 10 kg P/ha/year. The average surpluses for the whole catchment are of 27.6 kg N/ha/year and 6.3 kg P/ha/year. The highest values are reached in the areas where the animal densities are higher: Oarja, Crevedia, Iepuresti, settlements where breeding farms exists. A part of these surpluses is percolating in groundwater, depending on the depth of aquifer and type of soil.

The results obtained by the MONERIS application for the entire catchment of the Neajlov River showed that the total calculated emissions in surface waters are of 1004 t N/year and 175 t P/year *(Table 8)*. The main pathway for nitrogen emissions is groundwater (~ 38%), while for phosphorous is erosion (57%). Urban systems have also an important role in the nutrient emission at the catchment scale, with a contribution of 24% for nitrogen and 19% for phosphorous.

The contribution of WWTP to the total nitrogen emissions is higher in the sub-catchments located on the Dambovnic River. These emissions have two origins: the industrial wastewaters from the oil processing industry located in Piteşti and those from the pig farm in Oarja.

Phosphorus stems mainly from erosion, which contributes with about 0.2 – 0.38 kg P/ha·a to the total area specific emission of the catchments. Point source contribution is dominant only in Suseni, and is gradually decreasing from upstream to downstream. The urban systems account for 10 –20% of total emissions. Area specific phosphorous emission lie between 0.4 – 0.6 kg P/ha·a.

Table 8. Nutrient emissions calculated with MONERIS approach in Neajlov catchment for the period 1998-2002.

Total emissions and proportion of the different pathways	**nitrogen** [t/a]	[%]	**phosphorus** [t/a]	[%]
atmospheric deposition	70.3	7.0	2.3	1.3
tile drainage	19.2	1.9	0.2	0.1
groundwater	385.7	38.4	34.2	19.6
overland flow	0.0	0.0	0.0	0.0
erosion	141.5	14.1	99.6	56.9
WWTP	126.5	12.6	8.9	5.1
urban systems (total)	260.9	26.0	29.8	17.0
Total emissions	**1004.0**	**100.0**	**175.0**	**100.0**

Data included in *Table 9* and *Figure 12* illustrates the share of nutrient emission by activities for all the sub-catchments of the Neajlov catchment. As expected, the highest phosphorus emission stems from agriculture, which accounts for more than 60% of the total with one exception – Suseni, characterized by equal contribution of agriculture and point sources (industry and population). The results of the other activities are hardly detectable.

Table 9. Nutrient emissions by activities in the different sub-catchments of the Neajlov catchment (1998-2002).

1998-2002	Phosphorous				
Catchment area name	Background	Agriculture	Population and Industry	Other diffuse sources	Total
	[kg/ha·a]	[kg/ha·a]	[kg/ha·a]	[kg/ha·a]	[kg/ha·a]
Suseni	0.007	0.521	0.550	0.001	1.078
Slobozia	0.005	0.429	0.258	0.001	0.693
Roata Mica	0.004	0.364	0.157	0.001	0.526
Oarja	0.003	0.366	0.088	0.001	0.458
Furduiesti	0.004	0.394	0.086	0.001	0.484
Morteni	0.003	0.397	0.085	0.001	0.485
Moara din Groapa	0.005	0.412	0.158	0.001	0.576
Vadu Lat	0.004	0.356	0.138	0.001	0.499
Calugareni	0.006	0.364	0.105	0.000	0.476
Suseni	0.26	2.39	11.60	0.06	14.32
Slobozia	0.20	2.06	4.79	0.05	7.10
Roata Mica	0.17	1.88	2.41	0.05	4.51
Oarja	0.17	2.07	0.84	0.08	3.16
Furduiesti	0.17	2.06	0.81	0.07	3.11
Morteni	0.16	2.00	0.80	0.07	3.03
Moara din Groapa	0.25	1.94	1.15	0.06	3.40
Vadu Lat	0.18	1.89	1.65	0.05	3.78
Calugareni	0.19	1.43	1.05	0.05	2.73

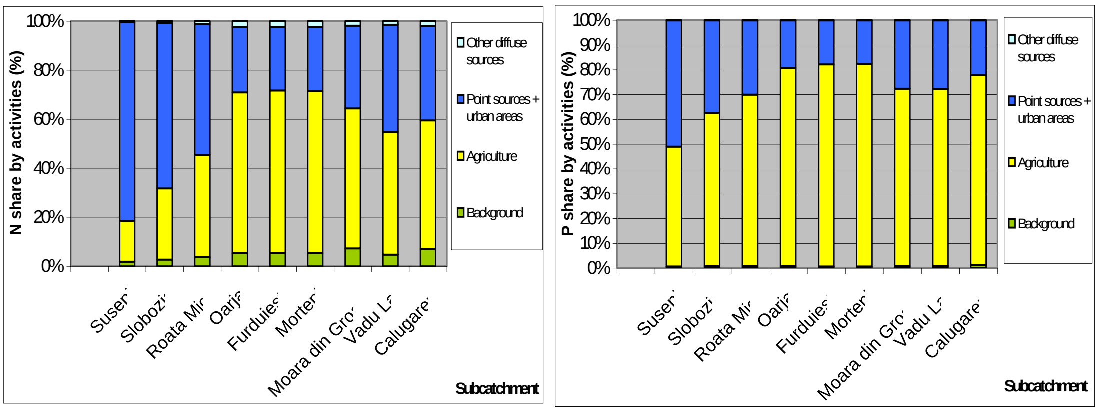

Figure 12. Relative share of nutrient emissions by activities for the sub-catchments included in the Neajlov catchment

For nitrogen the situation is a little bit different: the sub-catchments along Dambovnic River are dominated by point sources and urban systems, while in the others agriculture plays the most important role (through groundwater and erosion). These results have been expected for a region dominated by agricultural practices, even if the pressure from industrial activities in the northern part of the catchment cannot be neglected and was the main driving force for the water quality deterioration in the last decades (Dambovnic River was degraded in the upstream part between 1980 – 1990).

2.2. Impacts on surface and groundwater bodies

The diversity of point and diffuse sources located in the Neajlov catchment or in its proximity, as well as the increase of transfer rates of the chemical compounds towards the components of the natural capital have been the main consequences of the anthropic activities in the region during the last decades. These led to deterioration of surface and groundwater quality consisting in:

- accumulation of some macro elements (nutrients) and changes of their biogeochemical cycles. Eutrophication is one of the most important problems reported for the region, and previous studies showed that important nutrient fluxes originate from agriculture, especially as diffuse sources;
- increase of surface water loads and sediment concentrations in chemical compounds as: phenols, aromatic hydrocarbons (PAH) in the upper part of the catchment, near Pitesti;
- accumulation of heavy metals: Cr, Fe, Mn in sediments and surface waters, along the Dambovnic River;
- decrease of groundwater quality due to accumulation of organic compounds (chemical oxygen demand – COD) in the aquifers near Pitesti, COD, ammonium and nitrates in aquifers located in the southern part of the catchment;
- decrease of water surface area for Comana Lake from about 1300 ha in 1960 to 600-650 ha in the present period, due to decrease of groundwater level.

2.3. Water bodies at risk of not achieving a good status

The risk of not achieving a good status is enhanced for those water bodies which are receptors of residual water fluxes from chemical industry, food industry and oil extraction platforms. Continuous discharges of waste waters and accidental pollution have been recorded every year in the catchment and the "hot spots" mentioned most frequently are:

- Suseni, located on **Dambovnic River**, due to pollution with phenols, PAH, heavy metals from ARPECHIM - Pitesti;
- Suseni **(Dambovnic River)** receptor of waste waters from breeding farm SUINTEST - Oarja;
- Roata, Poeni **(Dambovnic River)** due to accidental pollution with oil (extraction platform);
- Cateasca (Neajlov River) receiving the waste waters from beverage industry (accidental pollution) with organic matter;
- Rogoz chanel - Neajlovel – pollution with oil from Oarja platform.

At the catchment level, **Dambovnic River** is under a continuous and more heavily impact of residual fluxes from the socio-economic system, while Neajlov River is only accidentally not achieving a good status, over limited periods of time and with less severe consequences.

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

Data obtained by the monitoring network for surface water quality showed in 2002 large differences between the main rivers in the catchment in what concern water quality, as indicated in *Table 10*.

Table 10. Length of river sectors in Neajlov catchment in respect to the water quality for 2002 (WDAV).

River	Length (km)*				
	Total	Good to High	Moderate	Poor	Bad
Neajlov	188	171	17	-	-
Dambovnic	127	-	98	29	-
Calnistea	108	108	-	-	-
Glavacioc	113	113	-	-	-
Neajlovel	19	-	-	-	19

*river length calculated in GIS

The detailed analysis of monitoring data over the period 1994-2001 revealed the main control sections where quality problems have been recorded *(Table 11)*.

Table 11. Characterization of surface water quality over the period 1994-2001 for the main control sections located on Neajlov and Dambovnic rivers.

River	Control section	The range of variability of the annual averages of water quality indicators				
		Ammonium (mg/l)	Nitrates (mg/l)	Phosphorous (mg/l)	Phenols (mg/l)	Oil (mg/l)
Neajlov	Oarja	0.23-1.56	0.07-5.4	0.09-0.21	0- 0.07	u.d.l.
	Category	Good-Poor	Good-High	Good-Bad	Good-Moderate	Good
	Moara din Groapa	0.13-0.55	2.2-5.9	0.06-0.1	-	0-0.21
	Category	Good-High	Good-High	Good-High	-	Good-Bad
	Vadu-Lat	0.83-2.2	3.2-11.7	0.06-0.17	0-0.003	0-0.05
	Category	Moderate	Good-High	Good-Bad	Good-Moderate	Good-High
	Calugareni	1.12-1.8	1.5-11.2	0.09-0.198	0-0.003	-
	Category	Good-Moderate	Good-Moderate	Bad	Good-Moderate	-
Dambovnic	Suseni	1.6-6.89	1-6.7	0.07-0.55	0-0.081	0-0.01
	Category	Moderate-Poor	Good-High	Good-Bad	Moderate-Bad	Good-High
	Roata	1.22-2.37	2-7.8	0.08-0.52	< 0.001	-
	Category	Moderate	Good-High	Good-Bad	Good-Moderate	-

u.d.l. = under detection limit

These river sections where it was not achieve a good status are located in the proximity of point emission sources (Suseni, Moara din Groapa, Roata) or downstream Neajlov River and reflect the contribution of both point and diffuse sources (Vadu Lat, Calugareni).

3. Water management framework and major issues

3.1. Institutional framework (including information and stakeholders' involvement)

- Ministry of Environment and Water Management (MEWM) - responsible for the development and implementation of the national water strategy and policy in accordance with the national, European and other international regulations;
- National Agency "Romanian Waters" (RW) – is the institution in charge for quantitative and qualitative water management and for the effective implementation of the national water strategy and policy (M.O. 73/2005);
- National territory is divided in 11 hydrographic basins, for each the national agency RW has a Water Directorate which is further organized into – water management systems (WMS) and hydrotechnical systems (HS) (M.O. 73/2005);

- According with the Law no.107/1996 and Law no. 310/2004 the stakeholders from each hydrographic basin are represented into the so-called "Basin Committee", which in fact allows that the rights and interests of all of them to be promoted into the water management plan;
- Surface and ground water resources are public goods (Law no. 107/1996 and Law no. 310/2004);
- National Agency RW is in charge to develop, maintain and up-date the Water Management Data Base which currently integrates - hydro-meteorological, hydro-geological data, the inventory of non-mobile assets (location, logistic, economic, ownership and environmental aspects) required for water resources management;
- Significant knowledge and data required for water management according with EU-WFD, are delivered by Universities and Research Institutes;
- The water management in the Neajlov River Catchment is carried out by the "Arges-Vedea Water Directorate" and its subunits – Arges WMS, Giurgiu WMS and Teleorman WMS (G.D. 1212/2000 and M.O. 678/2001).

3.2. Major issues

- Increased frequency of droughts alternating with heavy rains and floods;
- For the time being few aggressive point sources pollution, which are responsible for low water quality of Dambovnic and Neajlovel streams (see 2.3. and 2.4.);
- Abandonment and deterioration of the irrigation system;
- Siltation of the man made water accumulation;
- Very poor development of water supply system.

3.3. Major water policy issues

- The need to adapt the water strategy and management to the trend of increasing frequency and intensity of droughts and floods;
- Agricultural landscape planning for multifunctional farming system which may allow for effective diffuse pollution control, habitat connectivity and biodiversity conservation / adaptation;
- Rehabilitation of water quality and the ecosystem health of degraded water bodies (including siltation of water reservoirs);
- Rehabilitation and development of the irrigation system as an effective tool for adaptation;
- Water supply infrastructure development (60 percent of the population living in the Neajlov catcment to benefit by 2013);
- Efficient and effective waste water treatment infrastructure development.

4. ERC Analysis and methodological issues

4.1. Table 12. Ecosystem functions, goods and services and type of values associated (Neajlov Catchment).

Ecosystem functions	Goods and services	Type of value	Cost/Benefit	
Hydrological: Water discharge Water recharge Flood detention	Potable water for households use Water for livestock consumption Aquaculture Crop irrigation Food processing Manufacturing processes Flood protection / control Ground water recharge	Direct use Direct use Direct use Direct use Direct use Direct use Indirect use Indirect use	Full cost	
Biochemical: Nutrient retention Nutrient export Trace elements retention Trace elements export	Water purification Chemical speciation and toxicant removal Micro-climate regulation	Indirect use Indirect use Indirect use	Improve water quality and local climate Human health	**Benefits**
Ecological: Food web support Habitat support Biodiversity	Biological diversity provision Recreation Fishing and hunting Research, education	Non-use Direct use Direct use Indirect use	Biodiversity conservation Eco-Tourism Knowledge Awareness attitudes participation Water resources conservation	

4.2. Proposed methods and tools for ERC & Benefit valuation

Having in mind the overall goal of the project, the major structural and functional characteristics of the ground and surface water ecosystems and landscapes from the Neajlov Catchment, the ecosystem functioning and associated flows of resources / goods and services, the type of values, costs and benefits *(Table 12)* as well as the major water policy and management issues, identified for the catchment, and the availability of the needed data and information or the request for additional data, we believe that there are good premises for Total Economic Valuation of the "Water Services" from this particular case study.

Taking also, into consideration the existing wide range of methods and tools which may allow for total economic valuation of the costs and benefits involved in the water management, their sectoral application and the advantages or disadvantages associated with their use, we have tried to pack a set of them, which if applied together can help for achieving the goal of full economic valuation of water services. These are: i) Market Based transactions; ii) Derived demand functions; iii) Damage costs avoided; iv) Contingent Valuation; v) Hedonic price; vi) Travel cost; vii) Benefit transfer.

That will be accompanied by field survey, data quality assessment, statistical analysis and modeling.

- The analysis is based on holistic and hierarchical approach, applied at ecosystem, landscape and subregional socio-ecological scale (e.g.1-10 km^2; 10-500 km^2; 3000-5000 km^2 / "single water body; stream / small scale catchment")
- The data used extends over more than 10 years, and they allow for structural and functional analysis, identification of major socio-economic drivers and pressures responsible for structural and functional changes; estimation of renewable water and biological resources, water balance, renewable rates or "resource stocks and flows"; identification and estimation of significant flows for major services; data about composition, structure and dynamics of social and built capital; data regarding the structure and metabolism of the subregional socio-economic system. This time interval fits with the time constants specific to the dynamics of structural component of the case study area.
- Additional information required for economic valuation through methods based on the revealed or stated preferences, is instead to be produced with a high degree of confidence. In that regard, the study should rely on appropriate sample structure (to be representative for social capital structure) and size.

4.3. Available sources of data / information

- The Neajlov Catchment has been identified as a subregional socio-ecological complex, part of the national network of sites for Long Term Socio – Ecological Research (LTSER), and of the global ILTER – network. Since more than one decade complementary research and monitoring activities were carried out in this area, and many others are implemented or designed.

  The integrated research and monitoring activities have been or are carried out in close cooperation with the National Agency "Romanian Waters" and Arges –

Vedea Water Directorate and the Basin Committee, as institutions responsible for WFD implementation.

- The available sourced of data information are mostly represented by the data and knowledge base concerning Neajlov Catchment LTSER site, administred by DSES-UNIBUC and Arges – Vedeas Water Management Data Base.

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