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STUDY REGARDING THE IMPLEMENTATION OF THE ENVIRONMENTAL MANAGEMENT SYSTEM FOR THE HYDROGRAPHICAL BASIN OF JIU

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ABSTRACT. Water management should offer solutions for providing in present and in future the water needed by the population and the economy, starting from the renewable, but limitative feature of the fresh water resources and from the unitary management principles on hydrographical basins of the surface and underground resources, from the quantitative and qualitative viewpoint. The environmental management system of the hydrographical basin must be correlated to the arrangement plans of the hydrographical basins and to the development and staging programs. In order to implement the environmental management system in the framework of the Hydrographical Basin of Jiu, in 2010, a study has been developed regarding the identification of the water resources in the basin area (rivers, natural and accumulation lakes), of their features and of the pollution sources of specific polluters.

ВНЕДРЯВАНЕ НА СИСТЕМА ЗА УПРАВЛЕНИЕ НА ОКОЛНАТА СРЕДА В ХИДРО- БАСЕЙНА НА Р. ЖИУ

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РЕЗЮМЕ. Управлението на водите включва вземането на решения за осигуряване на вода необходима за населението и икономиката на настоящия и бъдещ етап като се използват възобновяеми източници. Ограничените ресурси от прясна вода изискват уеднакваване принципите за управление на хидрографските басейни включващи повърхностни и подземни водни ресурси. Системата за управление на околната среда в тези басейни е свързана с тяхното специфично разположение и съответните програми за тяхното развитие. С цел внедряване на управленска система на околната среда в рамките на Хидриграфския басейн на р. Жиу през 2010 г. е извършено проучване за определяне водните ресурси в зоната на басейна (реки, езера, язовири) и техните характеристики, както и източниците за замърсяването им.

Introduction

The hydrographical space afferent to Water Direction of Jiu exceeds the Hydrographical Basin of Jiu and the Danube's tributaries in the South-West of Oltenia: Bahna, Topolniţa, Blahniţa, Drincea, Balasan, Desnătui, Jilţ. The Hydrographical Basin of Jiu is placed in the South-West of Romania, between 43º45'- 45º30' latitude North and 22º34' - 24º10' longitude East. The outline of the basin is limited as shown below:

- North from big heights of the Surian, Parâng, Retezat, Cerna Mountains that separate it from the basins of the tributaries of Mureş, Sebeş, Strei and Cerna Mureş;
- West from the high tops of the hills and of the platforms, to the neighbourhood of the Sărbătoarea locality and further in the field to the line of the Sărbătoarea–Segarcea– Măceşu localities, separating it from the ones of Cerna–Dunăre, Bahna, Topolniţa, Blahniţa şi Desnătui;
- East from the limit of the basin of Jiu, then it is a narrow top that separates it from the one of the Olt, to Craiova. Towards South, Jiu enters in Câmpia Română, and the basin limit follows a line that would unite the Leu–Ghizdăveşti–Bechet villages;
- South from the limit is formed by the flow of the Danube.

Between these limits, the Hydrographical Basin of Jiu occupies a surface of 10.080 km², has a length of 260 km and an average width on the upper side of 60 km and in the lower side of 20 km.

From the administrative point of view, the hydrographical space of Water Direction of Jiu occupies almost integrally the counties of Mehedinţi, Gorj, Dolj and the sub-Carpathian side of Hunedoara county (table 1).The hydrographical basin of the Jiu river has a surface of 10.080 km² (4,2% of the country surface). A feature of the Hydrographical Basin of Jiu is the elongated shape. The hydrographical network has a length of 3876 km and a density of 0,34 km/km². The average altitude of the Hydrographical Basin of Jiu varies between 1649 m in the North area and 24,1 m in the junction area. The average slope of the basin is 5 %. The water resources of the Hydrographical Basin of Jiu are made of surface resources (rivers and natural lakes) and of underground resources.The total surface water resources in the hydrographical space of Jiu-Danube are of 4059 mil. m³ /year, and the usable ones are 2109,5 mil. m³ /year. These represent 74% of the total water resources (surface and underground) and they consist mainly of the Jiu river and its tributaries, respectively the Danube's direct tributaries in the South-West of the country, Bahna, Topolniţa, Blahniţa, Drincea, Balasan, Desnătui. The water resources of the natural lakes are very reduced. On the rivers inside the Jiu-Danube hydrographical space there are 67 accumulations having complex use and a useful volume of 147,61 mil. m³. Unlike other water flows, the Jiu does not have important tributaries and its supply is accomplished almost uniformly over its entire flow, a fact that is more strikingly expressed by the variation of the average multi-yearly debit along its flow (Sadu 21,6 m³/s, Filiaşi 63,9 m³/s, Rovinari 45,6 m³/s and 87,7 m³/s at the junction with the Danube), but also some areas poor in resources (Amaradia basin 2,6 m³/s). The unsuited waste management at the level of localities represents a local diffuse pollution source. The way of collecting and removing the mud resulted from the purification stations may lead to the pollution of water resources. The development of urban areas needs more attention from the viewpoint of waste collecting, by building some ecological waste dumps and by removing the uncontrolled depositing of waste, often met on the shores of the rivers and lakes (fig. 1).

Fig.1

Table 1. Administrative and demographic characteristics of the territory of the Jiu River Basin.

County	Area [km²]	% of area hydrographic total basin	Population (people)	% of total population per hydrographic basin
Hunedoara	1051.5	6,31	132090	9,04
Gorj	5131.3	30,77	275741	18,87
Dolj	6146.8	36,86	672187	45,98
Mehedinţi	4347.3	26,06	381643	26,11
TOTAL	16712.9	100	1461661	100

The accumulation lakes are placed especially in the hydrographical basins of the Jiu, Bistriţa, Motru, Baboia, Valea de Peşti and Desnătui rivers and they were built for multiple goals: supplying drinkable and industrial water, energetic goal and protection against floods. The Valea de Peşti and Işalniţa accumulations are the most important accumulations in the Hydrographical Basin of Jiu and they were mainly built in order to provide the water supply for the localities in Valea Jiului (Petroşani, Uricani, Lupeni, Vulcan, Petrila, Aninosa) and for Craiova. In the Hydrographical Basin of Jiu there are three important accumulations: Vădeni, Tg-Jiu and Turceni that were built for a hydro-energetic purpose. In the hydrographical basins of the Motru (Valea Mare Accumulation), Bistriţa (Vâja and Clocotiş Accumulation) and Tismana (Tismana-downstream Accumulation) rivers, there are accumulations that are a part of the Cerna-Motru-Tismana hydro-energetic system that have as a main destination the capitalization of the hydro-energetic potential. In perspective, by the Tismana-downstream accumulation we will provide the covering of the water demands for the rural localities in Gorj country and the adding of the water demand for Craiova [9].

The evaluation process of the anthrop pressures and their impact at the water bodies level leads to the identification of those water bodies that risk not to reach the wanted goals, considering the crossing of the following important stages (fig. 2):

- identifying activities and pressures;
- identifying the significant pressures;
- assessing the impact;
- assesing the risk of not accomplishing the environmental goals.

The goal of assessing the impact of different types of significant pressures is to supply information that will be used in the risk analysis and in featuring the waters status. The methodological elements regarding the identification of the significant pressures and the evaluation of their impact on the

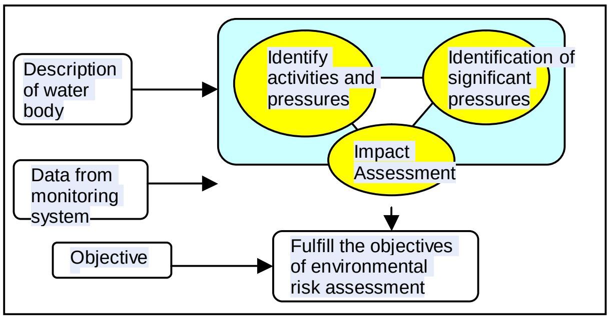

Fig. 2. Stages needed by the Analysis of Pressures and of the Impact on Waters

surface waters status contain the identification of the water bodies that have the risk of not reaching its goals which were applied at the basins and hydrographical spaces level. The mathematical model may be used in order to estimate the effects of the basic measures suggested by applying the available models: MONERIS (nutrients), WAQ (nutrients) and QUAL 2K (organic substances). In order to assess the risk, we have considered the following risk categories:pollution with organic substances; pollution with nutrients; pollution with dangerous substances; hydro-morphological alterations.*The ecological risk* is defined by 3 risk categories: pollution with organic substances, pollution with nutrients and hydro-morphological alterations.

The chemical risk is defined by only one category namely pollution with priority substances and with other polluters, considering the limit values suggested in the new directive regarding the quality environmental standards in the water policy field, a directive that fines the Water Framework Directive.

The total risk consists of the ecological risk and the chemical one and the evaluation is given by the worst situation found at the two risk categories [7].

Material and Method

Environmental Management System of the Hydrographical Basin of Jiu represents the tool for implementing the Water Framework Directive regulated by Article 13 and annex VII and has the purpose of balanced management of water resources and protection of aquatic ecosystems, having the main goal of reaching a "good status" of the surface and underground waters [1]. During this process, 4 main categories of problems were found: pollution with organic substances, pollution with nutrients, pollution with mainly dangerous substances and hydro-morphological alterations.

In order to implement the environmental management system in the framework of the Hydrographical Basin of Jiu, in 2010, a study has been developed regarding the identification of the water resources in the basin area (rivers, natural and accumulation lakes), of their features and of the pollution sources of specific polluters [5].

In 2010, there were observed the quantities of organic substances (expressed as CCO–Cr and CBO5) and of nutrients (total nitrogen and total phosphor) evacuated in the surface waters, on categories of human representative crowds, on industrial and agricultural pollution sources.

For human crowds (>10.000 equivalent inhabitants) *Petroşani- Aninoasa - Lupeni- Vulcan- Petrila-Uricani, Craiova, Târgu- Jiu, Drobeta Turnu – Severin, Simian, Motru, Filiaşi, Strehaia, Rovinari ,Bumbeşti – Jiu, Băileşti, Tg-Cărbuneşti and Turceni,* water samples were collected, quality indexes were determined and, after the chemical laboratory analysis, indexes of the overflows were determined. The most important punctiform pollution sources– either industrial, or agricultural considered in the study were: *E.M.Uricani, E.M. Lonea, Coroieşti Preparation Factory S.C. Termoelectrica S.A. – S.E. Paroseni , E.M. Vulcan ,E.M. Lupeni , E.M. Paroseni, Turceni Energetic Complex, E.M.C. Motru –Lupoaia quarry , SADU II Mechanical Factory, S.C . Rovinari Energetic Complex, S.C Macofil S.A., S.C. Craiova Energetic Complex, Craiova Energetic Complex– Sucursala Electrocentrale Craiova II Electro-centrals Filial, S.C. Sugar S.A. Podari, Petrom S.A.– DOLJCHIM Combine of Craiova, Pneumatology Hospital of Leamna ROMAG- PROD Subsidiary, S.C. FELVIO S.R.L Bucovaţ, A.N.P.- Penitentiary with Half-Open System Pelendava Craiova, S.C. GIMCO S.R.L S.C. SIMCO-VAR. S.A TG- JIU.* In order to estimate the emissions resulted from the industrial and agricultural, punctiform and diffuse pollution sources, we use MONERIS Model (Modelling Nutrient Emissions in River Systems) that was elaborated and applied for the valuation of nutrient emissions (nitrogen and phosphor). The MONERIS Model quantifies the contribution of different categories of pollution sources to the total nutrient emission and considers all the pollution sources, not only the ones identified as significant.

In order to analyze the pressures and the impact, we used the DPSIR concept (*Driver-Pressure-State-Impact-Response*), being necessary to use information and data regarding the anthrop activities and the changes at the water body status level and the response (the basic measures that are to be taken in order to improve the water body status). The analytic scheme of DPSIR is illustrated in fig. 3.

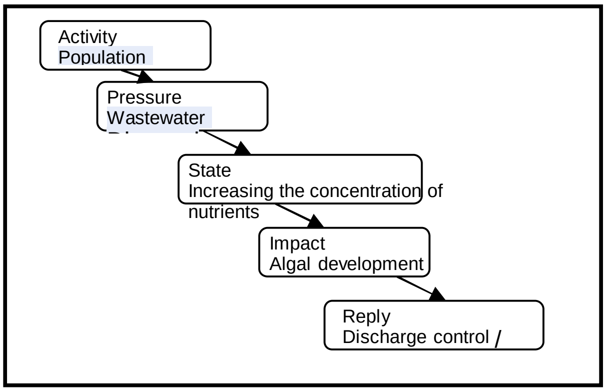

Fig. 3 Illustrating the DPSIR Concept

Results and Discussions

In the Hydrographical Basin of Jiu there have been identified 275 rivers with surfaces bigger than 10 km^2, 14 natural lakes and 12 accumulation lakes with surfaces bigger than 50 ha [8].
Pollution sources of the rivers from the Hydrographical Basin of Jiu are:

1. Human crowds – crowds that have more than 2000 equivalent inhabitants, that have waste waters collection systems with or without purification plants and that discharge water resources. After the analysis of punctiform pollution sources, there has been a number of 71 significant punctiform sources (32 of them urban, 36 of them industrial and 3 of them agricultural). Urban waste waters contain materials in suspension, organic substances, nutrients, heavy metals, detergents, oil hydrocarbons, organic micro-polluters, depending on the existing types of industry and pre-purification level of the collected industrial waters. The quantities of organic substances (expressed as CCO – Cr and CBO5) and of nutrients (total nitrogen and total phosphor) discharge in surface waters, according to crowd categories, determined in 2010, are shown in table 2.

The values of the quality chemical indexes determined in the water samples specific to the human crowds are: *Petroşani- Aninoasa - Lupeni- Vulcan- Petrila-Uricani* – the waters are unsatisfactorily purified, registering overflows compared to the authorized values, thus: Dănutoni evacuation: CBO5 = 3,45 mg/L, CCO-Cr = 7,298 mg/L, detergents = 1,74 mg/L, extractible substances =1,94 mg/L; Lonea evacuation: CBO5 = 9,539 mg/L, CCO-Cr = 98,11 mg/L , NH_4 = 68,32 mg/L, extractible substances = 26,68 mg/L; Uricani evacuation: CBO5 = 0,025 mg/L, CCO-Cr = 0,268 mg/L, NH_4 =1,294 mg/L, detergents= 0,017 mg/L; *Craiova-* there were overflows at the following indexes: CBO5 = 3,793 mg/L, NO_2 = 0,362 mg/L, total phosphor = 3,960 mg/L, extractible substances = 3,308 mg/L; *Târgu- Jiu* – there were overflows at the following parameters: suspensions = 9,1 mg/L, CBO5 = 32,845 mg/L , CCO-Cr = 20,022 mg/L, NH_4 = 14,092 mg/L, total phosphor = 10,134 mg/L, synthetic detergents = 1,328 mg/L; *Drobeta Turnu – Severin, Simian* - suspensions = 45,833 mg/L, NH_4 = 4,893 mg/L, total phosphate = 0,695 mg/L , sulphates = 36,483 mg/L, synthetic detergents = 0,717 mg/L; in Simian commune, the parameters which were exceeded were: total nitrogen = 2,986 mg/L and total phosphor = 1,150 mg/L; *Motru , Filiaşi , Strehaia, Rovinari* - there were overflows at the ion NH4 = 1,931mg/*L; Bumbeşti – Jiu* – there were overflows at the ion Cl¯= 24,258 mg/L ; *Băileşti* – there were overflows at the suspension index = 18,083 mg/L, CBO5 = 12,825 mg/L, NH4 = 44,564 mg/L *; Calafat* – there were overflows at NH4 = 4,177 mg/; *Tg-Cărbuneşti, Turceni* – there were overflows at the following parameters: suspensions =25,900 mg/L,CBO5 = 14,420mg/L, NH4 = 0,292 mg/L, detergents = 1,316 mg/L [2];

2. Industry and agriculture – significant punctiform pollution sources– industrial and agricultural identified in the area of the Hydrographical Basin of Jiu are presented in fig.4. The observed quantities of organic substances (expressed as CCO – Cr and CBO5) and of nutrients (total nitrogen and total phosphor) at the level of 2010, on categories of industrial and agricultural pollution sources, from the viewpoint of discharges on polluting substances in the surface water resources are shown in table 3.The values of quality indexes determined on collected water samples, on pollution sources – either industrial or agricultural are: *E.M.Uricani* – there were overflows at the suspensions parameter = 35,917 mg/L; *E.M. Lonea* – there were overflows of the mine waters, the ion of chlorine Cl¯=155,1 mg/L; *Coroieşti Preparation Factory S.C. Termoelectrica S.A. – S.E. Paroseni , E.M. Vulcan* - there was an overflow at the suspensions index = 21,667 mg/L *; E.M. Lupeni , E.M. Paroseni* – there were overflows at the extractible substances = 3,050 mg/L; *Turceni Energetic Complex* – there were overflows at: residual waters - suspensions = 25,542 mg/L, industrial waters-suspensions = 26,833 mg/L and technological waters – suspensions= 28,292 mg/; *E.M.C. Motru –Lupoaia quarry* –residual waters at NH4 = 0,420 mg/L , technological waters at suspensions = 32 mg/L and calcium = 98,400 mg/L *; SADU II Mechanical Factory*- there were overflows: at the residual waters in suspensions = 2 mg/L, at the filtered residue = 18,800 mg/L , at the technological waters suspensions = 6 mg/L ; *S.C . Rovinari Energetic Complex , S.C Macofil S.A. , S.C. Craiova Energetic Complex* – there were overflows at: suspensions = 28,545 mg/L, CBO5 = 5090 mg/L, CCO-Cr = 7,817 mg/L and NO3 = 1,158 mg/L; *S.C. Craiova Energetic Complex –Craiova II Electro-centrals Filial* –there were overflows at suspensions = 34 mg/L*; S.C. Sugar S.A. Podari* – there were overflows at: NH4 = 10,554 mg/L, total phosphor = 28,760 mg/L and extractible substances = 3,556 mg/L*; Petrom S.A.– DOLJCHIM Combine of Craiova* – there were overflows: at the meteoric channel at NH4 = 7,858 mg/L, at Sybetra at suspensions = 214,750 mg/L, NH4 = 55,283 mg/L, NO3 = 184,863 mg/L, at Kellog at NH4 = 2,694 mg/L , NO3 = 19,762 mg/L and at general evacuation at NO3 = 53,933mg/L; *Pneumatology Hospital of Leamna* – there were overflows at: suspensions = 111mg/L , CBO5 =19,475 mg/L , NH4 = 76,868 mg/L, total nitrogen = 64,850 mg/L , synthetic detergents= 0,065 mg/L and extractible substances= 28,500 mg/L; *RAAN Filial ROMAG-PROD* – the activity profile is to produce heavy water by means of the isotopic exchange proceedings, at 2 temperatures in the sulphuretted hydrogen – water system, there were overflows at total phosphor = 0,145 mg/L; *S.C. FELVIO S.R.L Bucovaţ* – there were overflows at extractible substances = 106,275 mg/L; *A.N.P.- Penitenciary with Half-Open System Pelendava Craiova*-the activity profile is agro-zoo-techny, meat and milk processing, there were overflows at: NH4 = 23,692 mg/L , NO2 = 0,2 mg/L , total nitrogen = 52,699 mg/L , total phosphor= 17,249 mg/L, extractible substances = 8,100 mg/L; *S.C. GIMCO S.R.L* – the activity profile is intensively raising the chickens; *S.C. SIMCO-VAR. S.A TG-JIU* – there were overflows at suspensions =18 mg/L [6].

Table 2. Quantities of organic substances and nutrients discharged by the human crowds in the water sources in the Hydrographical Basin of Jiu.

Categories of pollutants discharged	Organic substances (CCO-Cr) t/an	Organic substances (CBO5)t/an	Total nitrogen (Nt) t/an	Total phosphorus (Pt) t/an
>100.000 l.e.	8061,424	3428,233	1836,405	868,688
10.000-100.000 l.e.	1166,029	569,761	217,8	18,318
2000-10.000 l.e.	63,298	38,247	14,801	1,494
<2000 l.e.	-	-	-	-
Total	9290,751	4036,241	2069,006	888,5

Table 3. Discharges of organic substances and nutrients in the water resources in the industrial and agricultural punctiform sources in the hydrographical basin of Jiu hydrographical basin of Jiu.

Type of Industry / pollutants discharged	Organic substances (CCO-Cr) t/an	Organic substances (CBO5)t/an	Total nitrogen (Nt) t/an	Total phosphorus (Pt) t/an
Industry IPPC	12933,143	2904,359	31,389	12,831
Industry NON IPPC	1313,617	321,987	16,295	26,009
Industry TOTAL	14246,76	3226,346	47,684	38,84
Other point sources	170,997	8,606	8,509	0,056

By applying the Moneris Model, they calculated the contribution of the means of producing the diffuse pollution with nitrogen and phosphor in the year 2010 [4] (fig.4 and fig.5).

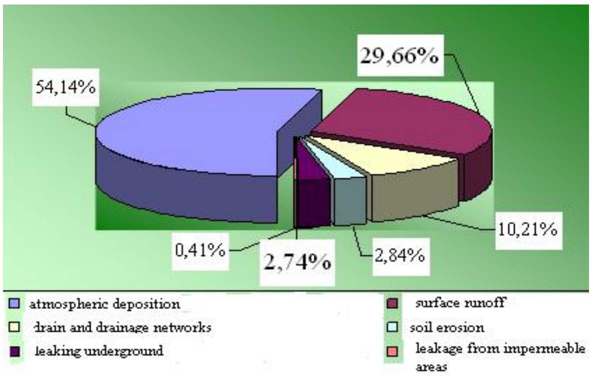

Fig.4. Possibilities of Producing Diffuse Pollution with Nitrogen in the Hydrographical Basin of Jiu in 2010

The underground leakage represents the main way of diffuse emission for the nitrogen and the leakage in the urban water proof areas presents the biggest contribution to the phosphor diffuse emission.

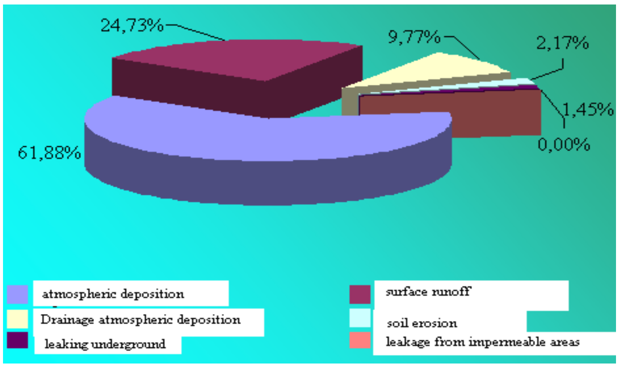

Fig. 5. Possibilities to Produce Phosphor Diffuse Pollution in the Hydrographical Basin of Jiu in the Year 2010

Nitrogen and phosphor emission from diffuse pollution sources, considering the contribution of each category of pollution sources, for 2010, are presented in fig. 6 and fig.7.

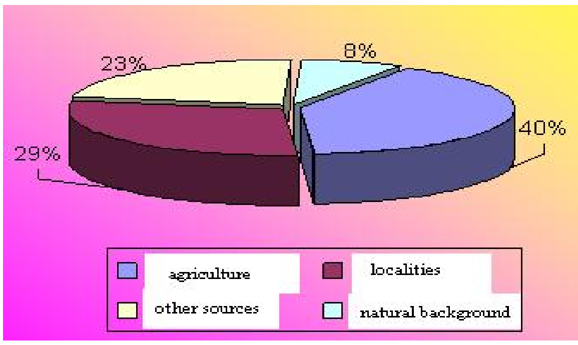

Fig.6 Nitrogen Emissions from Diffuse Sources in the Hydrographical Basin of Jiu in 2010

The specific average diffuse emission on the total surface for nitrogen is 5,2 kg N/ha, and for phosphor is 0,49 kg P/ha. Half of the nitrogen quantity emitted by the diffuse sources is due to the agricultural activities, resulting a specific emission of 3,9 kg N/ha agricultural surface.

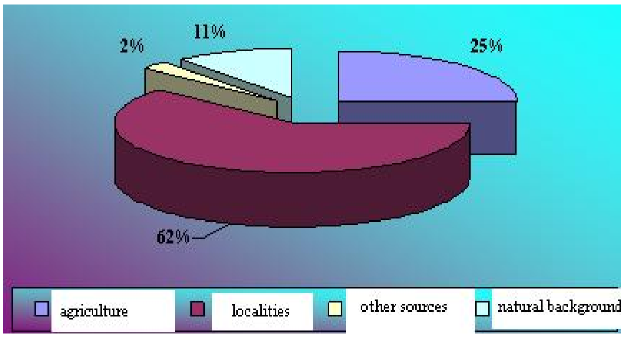

Fig.7. Phosphor Emissions from Diffuse Sources in the Hydrographical Basin of Jiu in 2010

3. Hydro-technical Constructions

a) Accumulation lakes – the accumulation lakes whose surface is bigger than 0,5 km² are 12 in the Hydrographical Basin of Jiu and produce mainly as a hydro-morphological pressure the stop of the leakage continuity and the regularization of their flows.

b) Regularizations and embankments – on the territory of the hydrographical Basin of Jiu there are 170 sectors of river regularized on a total length of 712,1 km. By analysing their hydro-morphological parameters, we find that 43 regularization works totalling 342,3 km can be considered as significant hydro-morphological pressures. From the 190 embankments of the Hydrographical Basin of Jiu totalling a length of 511,3 km, 94 of them may be considered significant hydro-morphological pressures having a total length of 450,58 km. Regularizations and embankments produce mainly as hydro-morphological pressure changes of the water flows morphology, alterations of the hydraulic features and stops of the lateral continuity [3].

c) Derivations – the 8 hydro-technical objectives in this category have the task to supplement the affluent flow in the Valea de Peşti, Valea Mare, Tismana-downstream accumulation and to provide the industrial water demand for the localities in Valea Jiului (Petroşani, Uricani, Lupeni, Vulcan, Petrila, Aninosa), producing significant changes of the debits of the water flows on which they work.

Conclusions

The industrial and agricultural pollution sources contribute to the pollution of water resources, by evacuating the polluters that are specific to the activity type which is developed. We may evacuate organic substances, nutrients (alimentary industry, chemical industry, fertilizers industry, cellulose and paper, zootechnical farms), and also dangerous organic micro-polluters (organic chemical industry, oil industry). Beside the punctiform pressures that were exerted, the agricultural activities may lead to the diffuse pollution of water resources. The means by which polluters (the nutrients and the pesticides) get to the water bodies (surface leakage, percolation). The diffuse agricultural pressures affect the surface and underground waters quality.

The Hydrographical Basin of Jiu contains several categories of works: accumulations, derivations, regularizations, embankments and protections of shores executed on water bodies having different goals (energetic ones, providing the water supply, regularizing the natural debits, protecting against the waters destructive effects, fighting against the humidity excess), having functional effects for human communities. The goal of assessing the impact of different types of significant pressures is to supply information that will be used in the risk analysis and in featuring the waters status.

In 2010, there were observed the quantities of organic substances (expressed as CCO–Cr and CBO5) and of nutrients (total nitrogen and total phosphor) evacuated in the surface waters, on categories of human representative crowds, on industrial and agricultural pollution sources. In order to estimate the emissions resulted from the industrial and agricultural, punctiform and diffuse pollution sources, we use MONERIS Model (Modelling Nutrient Emissions in River Systems) that was elaborated and applied for the valuation of nutrient emissions (nitrogen and phosphor).

In order to analyze the pressures and the impact, we used the DPSIR concept (Driver-Pressure-State-Impact-Response), being necessary to use information and data regarding the anthrop activities and the changes at the water body status level and the response (the basic measures that are to be taken in order to improve the water body status).

Recommended for publication by Editorial board

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