STUDY ON THE USE OF MATHEMATICAL MODELS MONERIS FOR ESTIMATING EMISSIONS POLLUTANTS IN THE HYDROGRAPHICAL BASIN OF JIU

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Abstract
*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.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 (**MO**delling **N**utrient **E**missions in **Ri**ver **S**ystems) that was elaborated and applied for the valuation of nutrient emissions (nitrogen and phosphor).*

Keywords: system, management, environmental, basin, Jiu

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 (Ciobotaru V., 2006). In fig. 1 there are the main features of the Hydrographical Basin of Jiu.

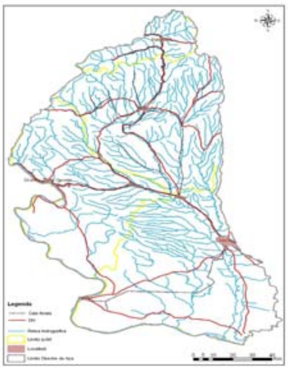

Fig. 1 Representation of General Features of the Hydrographical Basin of Jiu

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 (Ciomoş V., 2005). The environmental management system of the hydrographical basin (PMBH) must be correlated to the arrangement plans of the hydrographical basins (PMBH) and to the development and staging programs (Cogălniceanu D., 1999).

MATERIAL AND METHODS

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 (Ionescu Tudor D. and Şerban Constantinescu, 1968)

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 (Fetter C.W., 1993).

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. 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.

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 (Jula G. and Şerban P., 2000)

RESULTS AND DISCUSSION

In the Hydrographical Basin of Jiu there have been identified 275 rivers with surfaces bigger than 10 km², 14 natural lakes and 12 accumulation lakes with surfaces bigger than 50 ha (fig. 2).

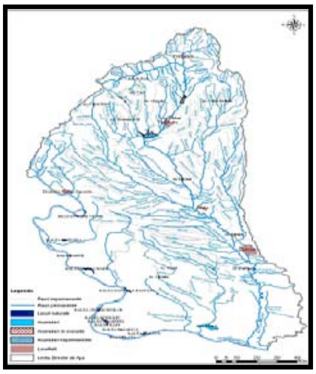

Fig. 2. Map of Surface Waters in the Hydrographical Basin of Jiu

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). 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.

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

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 , NH4 = 68,32 mg/L, extractible substances = 26,68 mg/L; Uricani evacuation: CBO5 = 0,025 mg/L, CCO-Cr = 0,268 mg/L, NH4 =1,294 mg/L, detergents= 0,017 mg/L**;** *Craiova-* there were overflows at the following indexes: CBO5 = 3,793 mg/L, NO2 = 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, NH4 = 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, NH4 = 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. Industry and agriculture – significant punctiform pollution sources– industrial and agricultural identified in the area of the Hydrographical Basin of Jiu are presented in table 3.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.

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

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

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; *Coroiești 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 Bucovaț* – 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.

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 (fig .3 and fig.4).

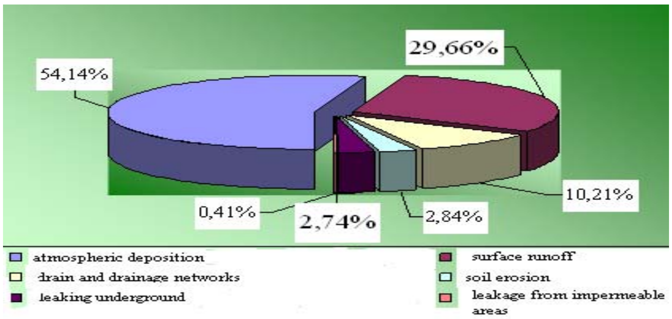

Fig. 3. Possibilities of Producing Diffuse Pollution with Nitrogen in the Hydrographical Basin of Jiu in 2010

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.

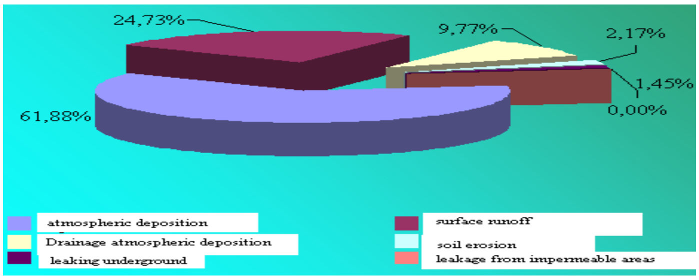

Fig. 4. Possibilities to Produce Phosphor Diffuse Pollution in the Hydrographical Basin of Jiu in the Year 2010

Nitrogen and phosphor emission from diffuse pollution sources, considering the contribution of each category of pollution sources, for 2010, are presented in fig. 5 and fig.6.

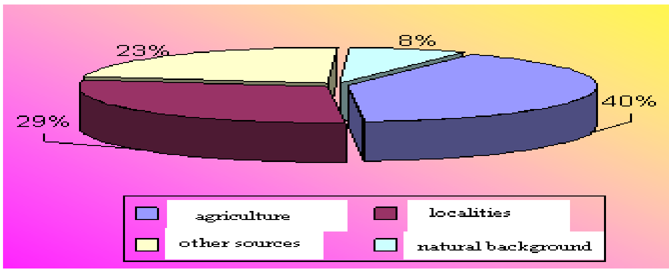

Fig. 5. Nitrogen Emissions from Diffuse Sources in the Hydrographical Basin of Jiu in 2010

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.

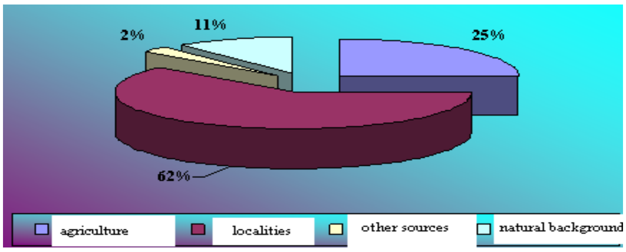

Fig. 6. Phosphor Emissions from Diffuse Sources in the Hydrographical Basin of Jiu in 2010

3. Hydro-technical Constructions

a) Accumulation lakes – the accumulation lakes whose surface is bigger than 0,5 km^2 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.

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

1. 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.
2. In order to estimate the emissions resulted from the industrial and agricultural, punctiform and diffuse pollution sources, we use MONERIS Model that was elaborated and applied for the valuation of nutrient emissions (nitrogen and phosphor).
3. Pollution sources of the rivers from the Hydrographical Basin of Jiu are: human crowds, industry, agriculture and hydro-technical constructions (accumulation lakes, regularizations and embankments derivations).
4. In 2010 are determined 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.
5. 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

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