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INTEGRATED ENVIRONMENTAL IMPACT AND RISK ASSESSMENT OF THE AGRICULTURAL AND RELATED INDUSTRIES IN THE PRUT RIVER BASIN

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ABSTRACT. Integrated water resources management is an important challenge in the countries with historic water pollution problems, enhanced by the occurrence of extreme climate phenomena, and by the insufficient stakeholder coordination and co-operation. In Romania, although the main problems that agricultural activities pose to water resources in the Prut river basin are the non-point sources, there are also major water quality issues related to the inefficiency of the municipal/industrial wastewater treatment plants. Environmental Impact Assessment (EIA) and Risk Assessment (RA) procedures identify the possible consequences of a planned/implemented activity, in order to facilitate the process of choosing wisely the best alternative. This study presents the development and implementation of a methodology for the quantitative assessment of the environmental impact and associated risk of the agricultural activities within Prut catchment. The integrated EIA and RA methodology considers environmental impacts determined for one category (*surface water)* by using representative water quality indicators for the case of agricultural pollution: biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), ammonia (NH^{+}_{4}), total nitrogen (TN) and total phosphorus (TP). The study uses data collected during 2005 - 2008 from the monitored agricultural (and animal farms) in the Prut catchment. The improved EIRA methodology proposes the correlations of the impact magnitude with the wastewater discharges flows, and of the impact gravity with the pollutant concentrations. The results revealed high environmental impacts and associated risks within Prut catchment due to agricultural and related industrial activities. Furthermore, this integrated EIA and RA procedure presents the advantages of rapidity, critical environmental analysis and the potential of improving the decision making processes within sustainable water resources management.

Keywords: *Environmental impact assessment, risk assessment, agriculture, water resources*

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INTRODUCTION

Sustainable water resources management represents an important challenge for the newest EU member states due to the need to comply with the principles of the European Water Framework Directive (WFD), while solving the historic water pollution problems and ensuring a sustainable pathway for the development perspectives. In Romania, only 52% of the population is connected both to water and sewage services and more than 71% of the wastewater is untreated or insufficiently treated [1,2]. The water “issues” are crucial for the existence of humans and ecosystems and for the economic and social development and thus interconnected also with food assurance and its security, and human health.

Preserving food security involves essential improvement of the agricultural production systems in the imperative direction of higher productivity, low rates of energy consumption and also, low environmental impacts. In order to stabilize output and income, production systems must become more resilient. A resilient and productive agriculture requires changes in the management of environmental components and an efficient use of resources [3].

The Integrated Water Resources Management (IWRM) has been defined by the Technical Committee of the Global Water Partnership (GWP) as, "*a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*". This process is emerging as an accepted alternative to the sector-by-sector, top-down management style that has dominated in the past and agrees on the fact that all the uses of water resources are interdependent. High irrigation demands and polluted effluents from agriculture means less freshwater for drinking or industrial use, contaminated municipal and industrial wastewater that pollutes rivers and threatens the natural ecosystems. Agriculture is the main consumer of water in the world, up to 70 % of the water withdrawn from rivers and groundwater goes into irrigation [3], and is becoming a rising concern in an era of water scarcity. On the other hand, it contributes approximately with 60% of nitrates, 25% of phosphorus and 70 % of sediments entering the watercourses [4]. With the increase in food requirement, the sustainability of upland agriculture has posed threats to downstream and coastal areas of river basins [5]. The social, environmental and economic impacts are immense.

These water-related challenges are further enhanced in the new European Union member countries by historic water-related problems in connection to outdated or very often inexistent wastewater treatment infrastructure, as well as major drawbacks in the cooperation and coordination between the relevant stakeholders [1,6], Romania being one of the countries that deals with historic water quality related key issues.

Compliance with the Water Framework Directive (WFD) requires substantial reductions in agricultural wastewater discharges and the diffuse pollution of watercourses from agriculture has become a major environmental concern in Romania due to the impact posed upon the groundwater as well as the surface water by numerous diffuse pollution sources that are difficult to be quantified.

The agriculture pollution point sources should comply with the following requirements:

- 96/61/EC - The Integrated Prevention and Pollution Control Directive – (IPPC Directive) [7],
- 2006/11/EC Directive which improves and replaces the 76/464/EEC Directive, regarding waterbodies pollution with dangerous substances [8],
- 91/676/EEC Directive, regarding nitrates pollution of water bodies from agriculture [9],
- 86/278/EEC Directive (SEVESO Directive), regarding major accident pollution [10].
- the national regulations:
    - 352/2005 Governmental Decision (G.D.) which improves and replaces 188/2002 G.D. regarding wastewater discharging conditions [11];
    - 351/2005 G.D. regarding the gradual discharging and loss of priority substances wastewater loaded [12].

The Romanian agriculture sector is characterized by a significant segment of population - economically and socially vulnerable farmers, who face many impediments in complying with the complex European required set of agriculture regulations. The government's funding support for agriculture is modest; hence the EU financial absorption represents a crucial opportunity to sustain economic growth, and implicitly a sustainable agriculture. So far, Romania's absorption rate of European funds was low. The rate of absorption of structural funds for 2007-2010 is of 13.48 percent [13], due to inadequate management of the funds from the European Union and to the conflicts of interest in managing these funds.

Another opportunity for getting a higher rate of investment in Romanian agriculture seems to be the attraction of foreign investors, due to high potential together with rising prices of agricultural products on the international market. The area of cultivated agriculture land in Romania is around 9.4 million hectares and foreign investors own over 500,000 hectares, according to the [13]. The Italian investors own over 300,000 hectares of agriculture land in Romania and Danish, over 130,000 hectares of forests. Dutch and French are also among the most interested foreign buyers of Romanian agriculture land. But often the foreign investments are hindered by the highly fragmented lands, furthermore, the banks or national programmes are much more focused on large costumers then small ones, precisely, to avoid risk of failure.

All these paradigms are leading to the current situations of Romanian agriculture low development, with high rate of family labour force, small unmonitored farms, inadequate agricultural/zootehnical practices and also pollutants high loaded wastewaters discharged into natural water bodies. These are also the reasons why, currently, the lack of relevant data and expertise [2] in the Romanian water system for monitoring the environmental indicators, necessary for realistic environmental flows awareness, hinders the sustainable management of the water resources.

Several studies highlight the need for improved and robust management strategies to assess and mitigate the fertilisers, manures, pesticides [14], nitrogen [15] and phosphorus [16,17] losses to water natural resources from agriculture and zootechnics.

Considering all these aspects of both political and water quality related background for Romania, the necessity of scientific reliable management strategies that would help the decision-making processes within IWRM is compulsory. Given these complex particularities of water resources management in Romania, where, according to Barjoveanu et al. [18] an opportune initial step would be the development of an integrated method for environmental impact and associated risk assessment of the major water polluters within a certain river basin. This method quantifies exactly the environmental impacts and associated risks, especially for prioritizing future actions.

This study applies a method for the environmental impact and risk assessment of the main agricultural/zootehnical agents from Prut river basin onto watercourses. Thirteen agricultural/zootechnical activities that discharge wastewater directly into the Prut River were considered for the assessment of the pollution with seven pollutants (BOD, COD, TSS, NH_4^+, detergents, TN and TP) specifically selected in accordance with the typically wastewater discharges' composition and the existing available data.

RESULTS AND DISCUSSIONS

The integrated method was applied to assess the environmental impact and associated risk for thirteen agricultural/zootechnical units from Prut catchment, using the mean concentration values of the 7 quality indicators (BOD, COD, TSS, NH_4^+, detergents, TN and TP). The probabilities of occurrence of these impacts were calculated for each indicator, with formula given by Eq. (5), as a frequency of discharge events that overcome 70% of MAC, over a data series that covered three years (2005-2007). Thus, it was possible to compare the impacts and associated risks for each location and for every quality indicator, as presented in the next figures.

Figure 1 presents the results of the integrated quantification of impacts and associated risks induced by the wastewater discharges from agricultural/ zootechnical analyzed units, considering the seven quality indicators. These graphs show a comparison of the impacts and associated risks of these effluents discharged in the Prut River for each of the water quality indicators (BOD, COD, TSS, NH_4^+, detergents, TN and TP) and it may be observed that there are 4 most problematic wastewater effluents in terms of BOD and COD discharges in the natural water bodies. These are the vinery 1, the zootechnics/agricultural unit from Iasi County, the vinery 4 from Vaslui County and the vinery 5 from Galati County.

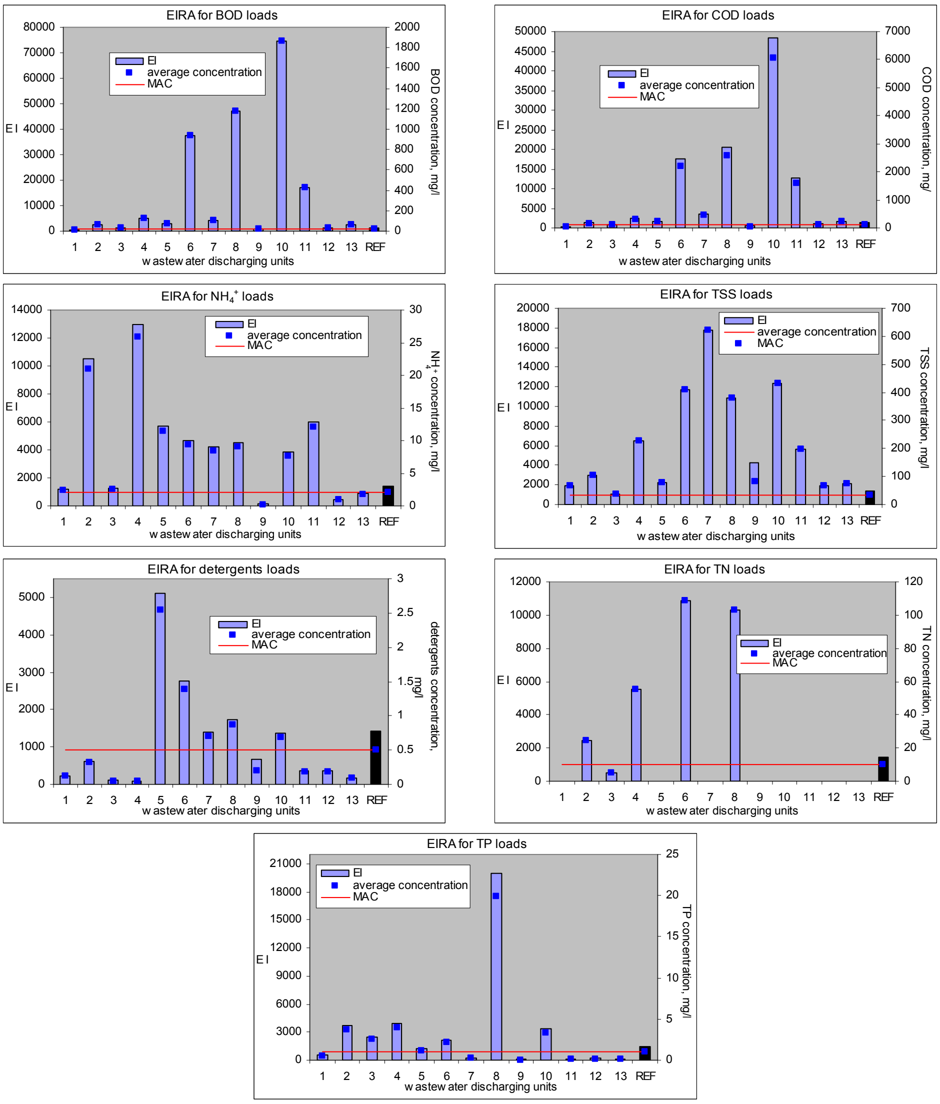

Figure 1. Integrated quantification of environmental impacts and associated risks (EIRA) for each of the water quality indicators

Note: *The numbers on the X-axis represent the wastewater discharging unit in accordance with Table 3* (1- Zootechnics and food processing 1; 2- Zootechnics and food processing 2; 3-Zootechnics and food Vineyard processing 3; 4- Zootechnics and food processing 4; 5- Poultry production; 6-Vineyard and vinery 1; 7- and vinery 2; 8- Zootechnics and agricultural unit; 9- Vineyard and vinery 3; 10- Vineyard and vinery 4; 11- Vineyard and vinery; 12- Grain crops unit; 13- Sugar production)

Regarding the TSS and NH_4^+ quality indicators, it may be observed that the EI magnitude are decreased as compared with the BOD and COD situation, but there are more locations where the MAC value was dramatically exceeded except 5 locations (the zootechnics and food processing 1 and 3 units from Botosani County, the vinery 3 from Vaslui County, the grain crops unit and the sugar production from Galati County). In terms of TN concentration, due to the lack of quality data for this pollutant only five locations were analyzed and four of them present higher values of the EI comparing to the reference. The TP loaded wastewaters discharged from the analyzed agents slightly exceed the reference, except one location (the zootechnics/agricultural unit from Iasi County), where the EI value touch higher magnitude.

The wastewater discharging agents with higher values than reference for EI in terms of detergents concentration are the poultry production, the vinery 1 and 2, the zootechnics and agricultural unit from Iasi County and the vinery 4 from Vaslui County. It may be also observed that in Botosani and Galati counties, the EI of the detergents discharges onto the water bodies are lower then the reference.

The EIRA methodology considers the environmental risk as a function environmental impacts magnitude and their probability of occurrence. The environmental risk was correlated with the probability of occurrence for a pollution event (exceedences of MAC) within the results interpretation (presented in Figure 2). It may be observed how the low probability of occurrence induced low values for the ER, especially in the TP and the detergents concentration cases, where many locations with low values for ER are obtained. The same four locations that were previously highlighted regarding the damages caused on the receiving water bodies by the BOD and COD concentrations, present probabilities of 100% for high magnitude of the MAC exceedences, inducing high values for associated risk.

In Figure 3 for each agricultural/zootechnical pollution source, the global EI and ER were calculated based on the above discussed calculations.

Among all thirteen analyzed discharging points (agricultural/zootechnical units) there are five locations where the global environmental impacts and associated risks values induced on natural water bodies of Prut River (and its tributaries) are in accordance with the reference situation considered by the authors. These locations are the zootechnics and food processing 1 and 3 from Botosani County, the vinery 3 from Vaslui County, the grain crops unit and sugar production agent from Galati county.

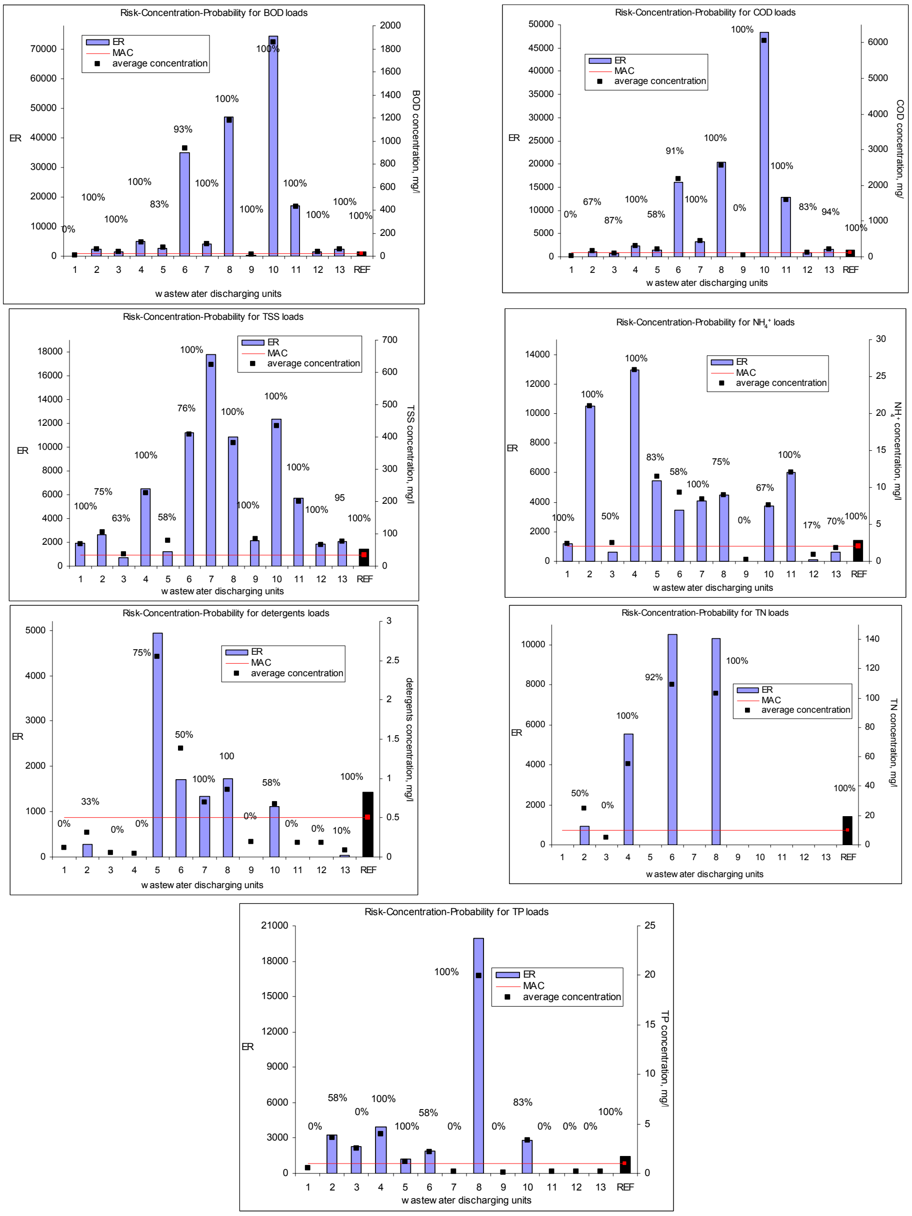

Figure 2. The correlation environmental risk-pollutant concentration-event probability

***Note**: The numbers on the X-axis represent the wastewater discharging unit in accordance with Table 3* (1-Zootechnics and food processing 1; 2-Zootechnics and food processing 2; 3-Zootechnics and food processing 3; 4-Zootechnics and food processing 4; 5-Poultry production; 6-Vineyard and vinery 1; 7-Vineyard and vinery 2; 8-Zootechnics and agricultural unit; 9-Vineyard and vinery 3; 10-Vineyard and vinery 4; 11-Vineyard and vinery; 12-Grain crops unit; 13-Sugar production)

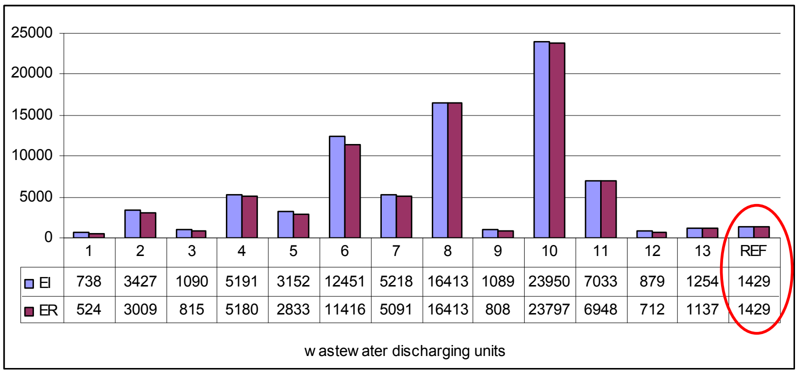

Figure 3. Integrated quantification of environmental impacts and associated risks

Note: *The numbers on the X-axis represent the wastewater discharging unit in accordance with Table 3* (1-Zootechnics and food processing 1; 2-Zootechnics and food processing 2; 3-Zootechnics and food processing 3; 4-Zootechnics and food processing 4; 5-Poultry production; 6-Vineyard and vinery 1; 7-Vineyard and vinery 2; 8-Zootechnics and agricultural unit; 9-Vineyard and vinery 3; 10-Vineyard and vinery 4; 11-Vineyard and vinery; 12-Grain crops unit; 13-Sugar production)

CONCLUSIONS

In this case study, the agricultural/zootechnical activities that discharge wastewater into the Prut River and its tributaries were considered for the integrated environmental impact and associated risk assessment of the pollution with seven related water quality indicators that are related to the agricultural pollution (BOD, COD, TSS, NH_4^+, detergents, TN and TP).

The integrated assessment is based onto a method that allows the determination of impacts and risks of point-sources on a single environmental component (surface waters) based onto multiple impact components (expressed by the water quality indicators).

The results revealed that all of the analyzed wastewater discharging agents present very high risk values for the surface waters, from both the point of view of the magnitude (environmental impacts), as well as from the probability of occurrence that can confirm the weak points of the existing agricultural production systems and the lack of good agricultural practices.

The EIRA method provide also information on the components and probabilities for every impact category, which in our case demonstrated that for the wastewater treatment plants there are serious problems related especially to BOD, COD and ammonia discharges.

Unless the efficiency of both the agricultural production systems and the wastewater infrastructure do not improve, the environmental risks remain high and the magnitude of the polluting events may also cause dramatically damages to the receiving water bodies. Furthermore, this study has shown that the integrated impact and risk assessment methodology can be used as a simple and reliable instrument for identifying and analyzing the hot spots in a river basin, which contributes to the decision making processes in sustainable water management.

EXPERIMENTAL SECTION

Integrated environmental impact and risk assessment methodology development for applications in water resources management

Environmental Impact Assessment (EIA) is an important procedure used to predict the environmental consequences after or before certain decision is taken. Hence, EIA ensures that the potential effects are foreseen and adequately addressed at an early stage in the project planning, improving prioritization process of the planned actions to facilitate wiser choices/decisions among the alternatives.

EIA is now increasingly being employed within the context of sustainable development objectives to reach better decisions [19, 20, 21, 22, 23], role that was highlighted also at the United Nations Conference on Environment and Development (UNCED) in 1992 by Principle 17 of the *Rio Declaration*.

A number of authors [14, 24, 25] link comprehensive assessments on the expansion of integration addressing both risk assessment (RA) and environmental impact assessment (EIA), as a tool to help decision making process within water resources management. Generally, EIA describes the induced impacts on natural components, meanwhile risk assessment (RA), traditionally refers only to human health (originally referred to occupational health, then public health and safety) and recently, its mean was extended to the environmental level [26,27].

Despite potential benefits of these EIA and RA used to complement each other, revealed by these studies, their application in defining and quantifying the impacts and associated risks related to surface water pollution is rarely used. Developing such an integrative and objective methodology of assessment, that considers both impacts and the associated environmental risks on surface water resources may be a reliable tool for decision making in water resources management.

Two previous studies [18,28] provided a full description of the methodology developed for the integrated environmental and risk assessment (EIRA), as well as the arguments for its application as an instrument for water resources management. The EIRA methodology considers the environmental risk as a function of magnitude of environmental impacts and their probability of occurrence (Eq. 1).

$$ER_j = EI_j \cdot P_j \tag{1}$$

where: ER_j – environmental risk for environmental component j; EI_j – environmental impact on environmental component j; P_j – probability of impact occurrence on environmental component j.

The above mentioned method assesses the environmental impacts (EI_j in Eq. 1) by designating certain importance units for different environmental components (air, surface water, groundwater, human health etc.) and subsequently, by quantifying these impacts through the *environmental quality parameters* (*EQ* in Eq. 2). In this study, only the impacts and risks on surface waters were considered, skipping thus the step of prioritizing among the environmental components and importance units (IU) value of 1000 was used.

$$EI = \frac{IU}{EQ} \tag{2}$$

where: *EQ* – environmental quality parameter; *IU* – importance units.

In Eq. 2, the environmental quality parameter, which measures the magnitude of impacts is calculated by comparing the measured concentrations of the considered pollutants, *i.e.* organic biodegradable compounds expressed by the Biochemical Oxygen Demand (BOD), bio- and non-biodegradable organic compounds expressed by the Chemical Oxygen Demand (COD), total suspended solids (TSS), ammonia (NH_4^+), detergents, total phosphorus (TP) and total nitrogen (TN) with their respective maximum allowed concentrations (MAC), leading thus to a non-dimensional measure of the environmental impacts magnitude, as presented in Eq. (3).

$$EQ = \frac{MAC}{MC} \tag{3}$$

where: *MAC* – maximum allowed concentration of quality indicators as regulated by the national legislation, through the Government Decision no. 352/2005 [11] (Table 1); *MC* – measured concentration of quality indicators.

In this study, the EIRA methodology was developed so as to consider the impacts on surface water ($EI_{(sw)i}$) as presented by Eq. (4), for each pollutant separately and furthermore by calculating an average of the global environmental impacts and associated caused by each agriculture/zootechnics activity.

$$EI_{(sw)i} = \frac{IU_{sw}}{EQ_{(sw)i}} \tag{4}$$

where*:* $EQ_{(sw)i}$ – quality of *surface water*, considering the quality indicator i; IU_{sw} – significance units obtained by *surface water*.

The environmental impact assessment of the wastewaters entering the natural system was performed considering seven quality indicators' concentrations of the effluents from thirteen agricultural/zootechnical activities, that discharge wastewaters in the Prut River and that are monitored by the Prut Water Directorate. These indicators were considered based on the fact that they induce significant environmental impact and risks onto the natural water bodies, especially in relation with the agricultural pollution, nutrient inputs, zootechnical and wine associated activities. As soon as the environmental impacts are determined, the quantification of risks is possible by using Eq. 1.

The probability units (P_j) of the impact occurrence were calculated using historic data series that allowed for calculating the frequencies of events during which 70% of the maximum allowed concentrations (MAC) was reached, which represents the attention threshold (AT) for a polluting event (Eq. 5).

$$P = \frac{n}{m} \tag{5}$$

where: n – number of attention thresholds reached over the data series; m – total number of measurements of the data series.

Since only one environmental component (surface water) is considered, the scale proposed considers the adaptation of the assessment methodology [28, 29] for quantifying the impacts and associated environmental risks to a reference in accordance with the analyzed context thus bringing objectivity to the evaluation.

An ideal scenario that considers the situation of **reaching the attention threshold** (AT) for each of the 7 analyzed pollutants, with **a maximum probability (**100**%)**, was analyzed. Further more, for each quality indicator was calculated a reference EI and also ER for every wastewater discharging unit (**EI_{ref} = 1428.5** and **ER_{ref} =1428.5**).

Study area

The Prut River, the second longest tributary of the Danube River, is located in the North-Eastern part of Romania and it forms the border between Romania and Republic of Moldova. With a total area of 27,500 km^2, the length of the drainage system totalizes, on the surface of 3 countries (Ucraina, Romania and Moldova), 11,000 km, out of which 3,000 km have permanent water flow (Baseu, Jijia, Bahlui) and almost 8,000 km with intermittent water flow [30].

The Barlad River is the most important left-side tributary of the Siret River. The study area is Prut-Barlad catchment (Figure 4) that lies, almost entirely, on Botosani, Iasi, Galati and Vaslui counties and partially on Neamt, Bacau and Vrancea counties.

Distribution of the river basin by counties in the study area is different depending on the existing drainage system and the establishment of the watershed between catchments of Siret and Prut Rivers, such as counties Botosani, Iasi, Vaslui, Galati have a rate of 90-100% and Bacau, Neamt and Vrancea in smaller proportions (Table 1). In the analyzed catchment a total of 2,277,678 people live, 1,120,160 of them in urban areas and 1,157,518 in rural areas [31].

Land use in the Prut River Basin (Figure 5) is influenced by physical and geographical conditions, and also by human influence factors. Agriculture includes animal farms and the cultivation of arable lands, with mainly maize, potatoes, sunflower, sugar beet. The total agricultural area is about 68.2% (12,406.2 km^2) of the Prut River Basin (Management Plan, 2008).

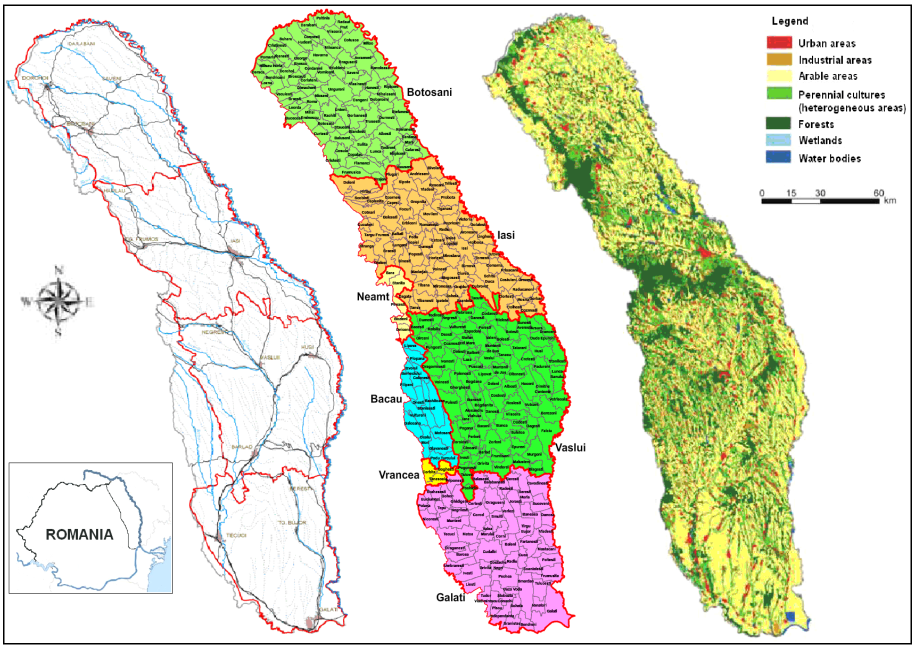

Figure 4. The water system, administration allocation and land uses in Prut river basin

Table 1. Administrative and demographic characteristics of the Prut River Basin

No	County	Area (km^2)	% from total surface of Prut River Basin (%)	Population (no. inhabitants)	% from total population of Prut River Basin (%)
1	Botosani	4,782	23.60	443,558	19.47
2	Iasi	4,564	22.52	680,656	29.89
3	Vaslui	5,318	26.24	452,832	19.89
4	Galati	4,328	21.35	647,455	28.43
5	Neamt	172	0.85	6,533	0.28
6	Bacau	946	4.67	40,372	1.77
7	Vrancea	157	0.77	6,272	0.27
Total		20,267	100	2,277,678	100

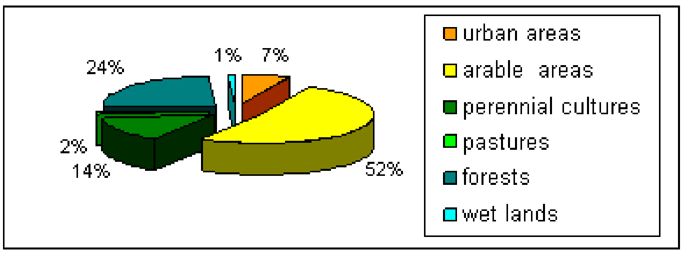

Figure 5. Land use in the Prut River Basin

The main agricultural activities developed in the counties included within the Prut river basin are depicted in Table 2, and the major agricultural/ zootechnical/winery related polluters are presented. The average values of the quality indicators concentration that overcome the MAC values are highlighted and the frequency of the measurements are presented in bold. The most common crops related to these activities are the grapes (5 of the analyzed wastewater discharging units have vinery and vineyard activities), sugar beat (1 analyzed production unit), grain (1 analyzed production unit), maize, potatoes and vegetables.

Table 2. The agricultural/zootechnical activities evaluated in the EIRA

No.	Waste-water discharg-ing unit	Mean discharge (frequency)	Mean concentration (range of values)							County
			detergents	NH_4^+	TSS	BOD	COD	TN	TP	
		(m^3/h)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	
Reference		-	0.5	2	35	25	125	10	1	
1	Zootech-nics and food process-ing 1	1.8 (3)	0.11 (0.09÷0.13)	2.4 (2÷2.8)	68 (10÷127)	6.4 (0.1÷18.9)	32.4 (3÷60.8)	-	0.54 (0.07÷1.55)	Botosani
2	Zootech-nics and food process-ing 2	2.62 (18)	0.31 (0.05÷1.78)	21 (2.89÷45.66)	104.8 (23-354)	60.7 (21.5-202.9)	163.6 (64.28-733)	24.7 (16.24-62.36)	3.65 (0.22-12.55)	Botosani
3	Zootech-nics and food process-ing 3	15.12 (7)	0.053 (0.02÷0.08)	2.49 (0.43÷8.44)	36.3 (15÷73)	36 (25÷42.12)	99.5 (60.3÷132)	4.8 (6.3÷77.4)	2.5 (0.65÷6.25)	Botosani
4	Zootech-nics and food process-ing 4	2.52 (4)	0.04 (0.126-0.32)	25.8 (14.82÷46.15)	226.3 (74÷423)	123.6 (30.4÷170.4)	302.3 (112.2÷451.4)	55.36	3.95 (2.25÷5.08)	Botosani
5	Poultry production	1.44 (8)	2.54 (0.12-6.48)	11.4 (0.19-34.3)	78.6 (9.7-182)	72.5 (9-213)	218.1 (25-500)	-	1.2	Iasi
6	Vineyard and vinery 1	9.72 (25)	1.38 (0.008÷6.4)	9.29 (0.05÷70.7)	407.8 (4-÷782)	937.9 (13÷2400)	2191 (37÷4789)	108.9 (2.65÷122)	2.1 (0.06÷10.8)	Iasi
7	Vineyard and vinery 2	0.54 (3)	0.7 (0.06÷1.54)	8.41 (0.37-28.8)	622.5 (354÷891)	105.75 (11-256)	437.25 (50.5-1045)	-	0.192	Iasi
8	Zootech-nics and agricul-tural unit	21.6 (4)	0.86 (0.44÷1.67)	8.98 (0.23÷22.5)	381 (79÷729)	1176.75 (380÷2830)	2559.7 (1124-÷5210)	102.9 (88.37÷117.5)	19.9 (8.19÷26.2)	Iasi

No.	Waste-water discharg-ing unit	Mean discharge (frequency) (m^3/h)	Mean concentration (range of values) detergents (mg/l)	NH_4^+ (mg/l)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	TN (mg/l)	TP (mg/l)	County
Reference		-	0.5	2	35	25	125	10	1	
9	Vineyard and vinery 3	1.36 (3)	0.19 (0.05÷0.34)	0.18 (0.032÷0.33)	83.5 (17÷150)	15.65 (11.8÷19.5)	56.6 (49÷64.2)	-	0.05 (0.103÷0.15)	Vaslui
10	Vineyard and vinery 4	0.72 (6)	0.67 (0.21÷1.67)	7.66 (4.06÷23.9)	433.58 (34÷475)	1860.1 (320.4÷4543.1)	6043.3 (930.3÷14061)	-	3.37 (1.37÷9.42)	Vaslui
11	Vineyard and vinery 5	75.6 (6)	0.17 (0.11÷0.23)	12 (10.74-13.26)	199 (102-296)	430.3 (398.8-461.9)	1598.4 (1497.6-1699.2)	-	0.156	Galati
12	Grain crops unit	7.2 (7)	0.108 (0.016÷0.237)	0.88 (0.37÷0.88)	66.16 (57÷140)	36.39 (23.01÷177.75)	119.3 (91.2÷307.2)	-	0.16 (0.056÷0.32)	Galati
13	Sugar production	108 (21)	0.08 (0.015÷0.45)	1.77 (0.21÷3.81)	75.8 (24÷184)	60.4 (19.36÷144.26)	217.9 (91÷470)	-	0.13 (0.042÷0.21)	Galati

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