Research Journal of Agricultural Science, 47 (4), 2015

IDENTIFICATION AND ASSESSMENT OF POLLUTION OF SOIL AND WATER RESOURCES IN THE LOWER COURSE OF BÂRZAVA RIVER

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Abstract. *This paper aims at collecting, processing and interpreting the scientific information necessary for assessment of areas vulnerable to nitrates pollution in the lower course of Bârzava River and originates in the current scientific and practical concerns to identify and develop an integrated management of agro-ecosystems, agronomically effective and with low energy and financial resources and, at the same time, ecological and conservative for soil and environment. Data in this paper are the result of studies and researches carried out between* ***2014-2015****, in the lower course of Bârzava River and are part of the doctoral studies and research program POSDRU/159/1.5/S/137070 (2014) of the Ministry of National Education, Romania, co-financed by the European Social Fund-Investing in People, within the Sectoral Operational Programme Human Resources Development 2007-2013 with the topic "****Studies and Researches on Assessment of Pollutants' Impact on the Biodiversity in the Lower Course of Bârzava River****", researches being conducted simultaneously in the field and in the laboratory. The researches of this Project consisted in collection of scientific data regarding evolution of certain components in the productivity of agricultural ecosystems so as to ensure specialized technical support to government authorities, in the areas considered, for development of the "Local Action Plan regarding nitrates pollution from agricultural sources", this being a focal point of action in implementing the Nitrates Directive for soil and crops and in implementing advanced systems for the use of ecopedological and anthropogenically induced systems. Research of ecopedological conditions and ordering and processing of data are based on the "Development Methodology of Pedological Studies" (volumes I, II, III), prepared by I.C.P.A Bucharest (Bucharest Institute of Research in Pedology and Agrochemistry) in 1987 and the Romanian System of Soil Taxonomy (SRTS - 2003, 2012 respectively), while the maximum limit of nitrates in water is based on STAS No. 1342/77. The objectives and activities posed by this paper fall within the current concerns of international and domestic agricultural research and practice, intended for the study of relations between ecopedological conditions and agricultural land productivity. The novelty and importance of the topic addressed come from the need to set up a database regarding the risk of environmental pollution through various socio-economic activities, the risk management that contributes to the development of the national monitoring network and the identification of vulnerable areas, with rational use of natural renewable resources (soil, water, biodiversity).*

Keywords: *polluation, soil, Barzava River, biodiversity, pedology*

INTRODUCTION

Existence and economic development of any society, regardless of type, is unimaginable outside the material resources of the biosphere that have had and still have a decisive weight depending on the progress of society. The surrounding environment represented by water, air, soil, vegetation and fauna is a complex of spatial-temporal formations, functioning as cybernetic systems, creating permanent exchange of substance, energy and information, both between phytocenotic and zoocenotic elements and their exchange with the surrounding environment.

As part of these systems, soil and water resources are essential because they provide food and participate in cycles of ecosystems, while being the cradle of mankind and the source of existence. The act of appreciation and, later on, of determining the quality of natural resources, with particular reference to vegetation, soil and water, is as old as the preoccupation with producing goods necessary for living, by farming, attaching oneself to the landscape by use of the best lands for agriculture. Biological diversity or biodiversity is one of the key terms in natural resources protection and preservation, including richness of life and its various models. The Convention on Biological Diversity (CBD) defines biological diversity, thus the "*variability among living organisms of different environments, terrestrial, marine and other aquatic ecosystems and ecological complexes of whose part they are*". The natural capital represented by natural and semi-natural ecosystems form a "life support", providing resources and services underlying socio-economic development. Values of biodiversity form the natural heritage need to be used by current generations without endangering the chance of future generations to enjoy the same living conditions. Numerous national and international studies and researches have shown that between farming systems and crop technology and the level of economic development and quality of life, there are interdependencies (BORZA ET ALL., 2005, 209, COSTE ET ALL., 1997, DUMITRU ET ALL., 2000, HORN ET ALL., 2002, ROGOBETE ET ALL.1997, TEACI, 1980, 1995). Knowledge of these features is of special theoretical and practical importance. Theoretical, because it provides the specialist the possibility to interpret phenomena occurring within natural resources, and to forecast their development, in particular, and the environmental development, in general, and practical, because it warns the practitioner on what measures should be taken to bring these resources under optimal conditions for the growth and development of cultivated or spontaneous plants. Given these considerations, the present paper attempts to present some aspects of the use of information *relating to identification and assessment of pollution of soil and water resources in the lower course of Bârzava River,* an information that is the result of studies and researches conducted during 2014 – 2015, which are part of the PhD study and research program POSDRU/159/1.5/S/137070 (2014) of the Ministry of National Education, Romania, co-financed by the European Social Fund-Investing in People, within the Sectoral Operational Programme Human Resources Development 2007-2013 completed with a series of data from pedological studies and stored in the archive of O.S.P.A. Timişoara (Office for Pedological and Agrochemical Studies), mostly in classical copy, and also based on $SPED_1$ computer system (used by O.S.P.A. Timişoara as of 1988) and the BDUST-B system (implemented in the area by I.C.P.A. – Institute for Pedological and Agrochemical Research – Bucharest, as of 2003) . A range of information collected within Phare RO 2006/018-448.01.01.25 Project, with the topic "Management of Livestock Waste and Environmental Protection in Banat Plain Area" was also used.

MATERIALS AND METHODS.

The issue addressed concerns the area of 84997 ha, of which 77677 ha are agricultural lands located in the *lower basin of Bârzava River (table 1, fig. 1*), and for identification of anthropic activities impacting the quality of life (soil, water, flora...) the sampling points were established so that they can capture any hazards that may cause contamination of certain pollutants (heavy metals, nitrites, nitrates), depending on the major possible sources of pollution.

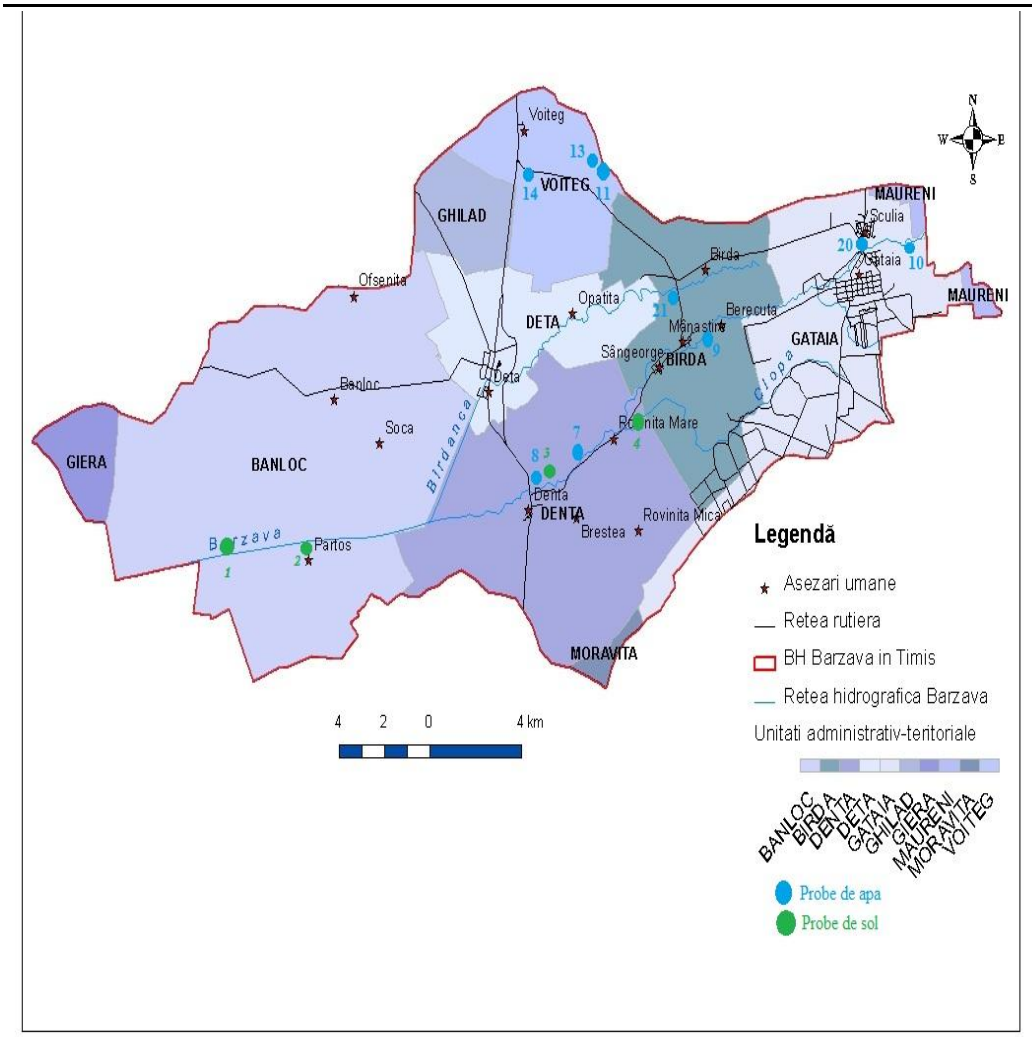

Figure 1 Administrative Territorial Structure, Location of Sampling Ar

Table 1

Situation of Lands in the Lower Basin of Bârzava River

No.	Locality	Arable	Pastures	Meadows	Vine yards	Orchards	Total Agricultural	Forests	Waters	Other Categories	Total Overall
1	Banloc+Livezile	12442	2816	214	0	9	15481	572	543	764	17360
2	Denta	7420	849	133	0	12	8414	195	158	373	9140
4	Deta	2379	463	56	0	6	2904	35	32	303	3274
3	Foieni	4728	931	151	0	6	5816	3	194	393	6406
4	Gătaia+Birda	15951	2694	830	17	4	19496	342	298	1117	21253
5	Ghilad	8223	2076	162	1	25	10487	41	352	547	11427
6	Giera	6446	2002	101	0	7	8556	6	278	335	9175
7	Voiteni	5438	932	151	0	2	6523	11	101	327	6962
Total		63027	12763	1798	18	71	77677	1205	1956	4159	84997

The research of ecopedological conditions was made according to the "Soil Survey Elaboration Methodology" (Volumes I, II, III) developed by ICPA Bucharest in 1987, supplemented by specific elements of Romanian System of Soil Taxonomy (SRTS - 2012). Analyzes and other determinations were carried out in the research laboratories of "OSPA-USAMVB" (Banat University of Agricultural Sciences and Veterinary Medicine) from Timişoara, 119 Calea Aradului Street, LI 1001/11.25.2013, the certified laboratory RENAR, according to National Standards and Rules approved by the Romanian Standardization Association.

RESULTS AND DISCUSSIONS

The topic of the study concerns the lands located in the *lower basin of Bârzava River*, till the country border with Serbia *(table 1, fig. 1*), namely the agro-ecosystems identified in the area concerned. Due to its location, natural conditions (relief, lithology, hydrology, vegetation) are specific to an interfluve made of low-lying plants where the main types of soil formed and evolved (represented by alluvisols, chernozioms, faezoms, vertisols, salsodisols etc.) that reflect through their geobiochemical and morphological features the main landscape features for defining and determining growth and fruiting of the main crops and spontaneous flora. Forming of plains in the area investigated is closely linked to the basic level with local specificity of Pannonian Basin in the Danube middle area, the numerous rivers coming out of the neighboring mountains and hills, the Eastern elevation and Western subsidence ground movements. The most important watercourses in the area investigated are: *Bârzava* and its tributary streams, Birda, and Lanca-Birda (fig.2).

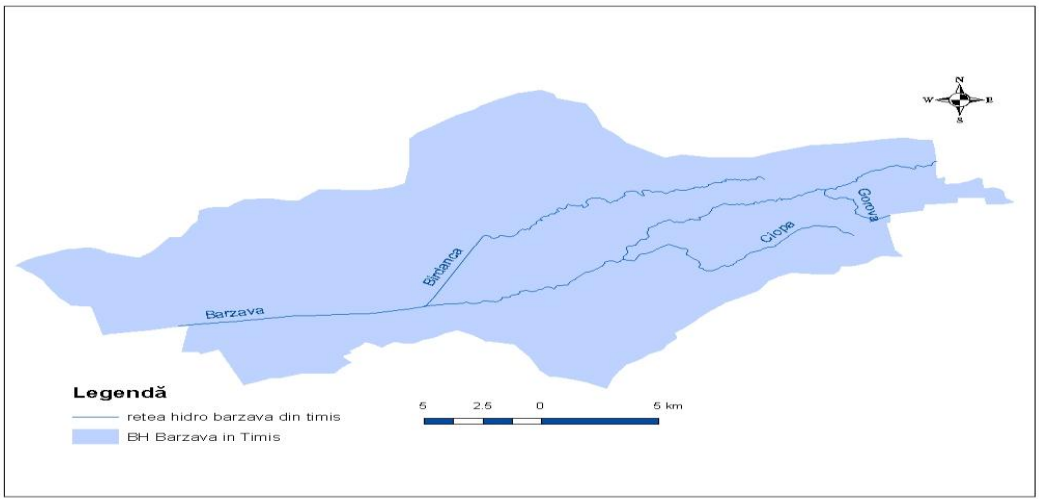

Figure 2 Hydrographic Network in the Lower Basin of Bârzava River

Water samples were collected from 9 areas and soil samples from 4 areas characteristic of the area investigated (fig. 1.) being processed and analyzed according to national rules and standards approved by the Romanian Standardization Association (A.S.R.O.), the values obtained – 12 soil samples (table 5) and 9 water samples (table 2 and table 3) – for the chemical elements determined, are shown herein below:

Table 2

Chemical Composition of Water Samples (April 2014)

Sample	Localization	pH	NO3	NH4	PO4	Ca	Mg
15176	7 Bârzava – channel (water area restricted for fishing)	7.36	16.94	0.23	0.22	48.09	29.18
15177	8 channel (water area restricted for fishing)	8.11	12.04	0.27	0.28	48.09	23.34
15178	9 Bârzava (Berecuţa)	6.30	12.93	0.39	0.15	50.10	16.05
15179	10 Bârzava (Pdt. Spital Gătaia)	7.06	25.42	0.22	0.21	41.68	20.18
15180	11 USAB Voiteni (creek)	8.14	19.42	0.46	1.58	84.16	110.14
15182	13 USAB Voiteni (water well)	7.22	92.32	0.35	0.43	68.53	151.75
15467	14 channel (bridge I Voiteni-Gătaia)	7.68	19.75	0.28	0.28	46.09	119.89
15473	20 Sculea bridge	7.80	18.28	0.26	0.00	86.17	8.26
15474	21 Pr. Birdanca-Birda	7.50	25.86	0.12	0.11	36.07	8.51

Table 3

Chemical Composition of Water Samples (June 2015)

Sample	Localization	pH	NO3	NH4	PO4	Ca	Mg
20755	7 Bârzava – channel (water area restricted for fishing)	7.31	7.021	0.049	0.595	36.07	26.75
20756	8 channel (water area restricted for fishing)	7.50	6.360	0,000	0.509	36.07	31.61
20757	9 Bârzava (Berecuța)	7.28	5.120	0.008	0.613	40.08	29.18
20758	10 Bârzava (Pdt. Spital Gătaia)	7.48	10.520	0.350	0.703	38.07	30.40
20759	11 USAB Voiteni (creek)	7.24	44.500	0.675	3.021	112.24	165.37
20760	13 USAB Voiteni (water well)	7.57	6.260	0.000	0.763	180.36	226.17
20761	14 channel (bridge I Voiteni-Gătaia)	7.34	4,000	0.603	0.429	84.16	175.10
20762	20 Sculea bridge	7.18	2.700	0.752	2.237	144.28	158.08
20763	21 Pr. Birdanca-Birda	7.22	5.300	0.000	0.630	32.06	29.18

Table 4

Water Samples Interpretation Levels (STAS No. 1342/77)

Features	Limits	Threshold
Ammonium NH_4^+ mg/dm^3	0.5-1	3
Nitrites NO_2^- mg/dm^3	0-0.3	0.4
Nitrates NO_3^- mg/dm^3	10-30	45
Calcium mg/dm^3	Max. 150	200
Magnesium mg/dm^3	Max. 50	100
Chlorides Cl^- mg/dm^3	Max. 250	300
Sulphates SO_4^{-2} mg/dm^3	Max. 200	250
Phosphates PO_4^{3-} mg/dm^3	Max.0,1	0.5
pH	5.5-7.4	

Maximum levels of nitrate in water (nitrate-reducing germ-free) internationally are: 20-40 mg/l for adults, 10-20 mg/l for youth and 5 mg/l for infants. It is specified that water containing 30-70 mg/l nitrates should not be used for feed preparation, as well as the water containing 70 mg/l nitrates should not be used for shelter or feed preparation in young animals, especially for industrial rearing complexes. In our country, the only indication of the maximum limit of nitrates in water is STAS No. 1342/77 of 45 mg/l, a limit hard to achieve in terms of rational use of nitrogen fertilizers on land, in the area investigated this limit being exceeded at the sample collected at point 13 (table 2), namely slightly below limit at sample 11 (table 3). At phosphates and calcium, the values recorded fall below the threshold, while at magnesium this threshold is exceeded in samples: 11, 13, 14 (table 2), and 11, 13, 14 and 20 (table 3), respectively.

Table 5

Chemical Composition of Soil Samples (April 2014)

No.	Profile	Depth	Lab No.	Nitrates (ppm)	Nitrites (ppm)
1	1 Banloc-Livezile Pumping Station	0-30	15158	11.26	2.47
2		30-60	15159	15.38	0.0
3		60-90	15160	13.61	0.0
4	2 Orezărie -Partoș	0-30	15161	9.09	0.0
5		30-60	15162	11.04	1.01
6		60-90	15163	10.36	0.0
7	3 Pș bridge-channel, Denta	0-30	15164	6.34	0.71
8		30-60	15165	10.67	2.80
9		60-90	15166	5.90	0.0
10	4 Roviniţa Mare	0-30	15167	0.54	0.0
11		30-60	15168	1.77	1.77
12		60-90	15169	1.41	1.41

Referring to mineral nitrogen, the specialty literature states that it is represented by salts of ammonium (NH_4^+), nitrate (NO_3^-) and nitrite (NO_2^-). It also appears as gases, like: molecular nitrogen (N=N), nitrogen monoxide (NO), nitrogen dioxide (NO_2), and nitrous oxide (N_2O). In the arable layer of unfertilized soils, the normal content of $N\text{-}NO_3$ is up to 20 ppm while, in the fertilized soils it ranges from 20 to 40 ppm, and in soils with horticultural use, it oscillates around 60 ppm (Lăcătuşu, 2003), a fact also mentioned by LIXANDRU et all. in 1990 (table 5).

Table 6

Interpretation Values of Soil Nitrogen Content
(Lixandru et all., 1981)

Supply Level	Field Crops $N\text{-}N0_3$ and $N\text{-}NH_4$ (ppm)	Intensive Crops of Vegetables, Fruit Trees and Grape Vines $N\text{-}N0_3$ and $N\text{-}NH_4$ (ppm)
Low	< 20	< 40
Average	21-40	41-70
Normal	41-60	71-100
High	61-100	101-130
Very high	> 101	> 131

Given these considerations, the values recorded for samples analyzed fully indicate normal values in terms of NO_3 content, i.e. under 20 ppm. The normal state of soil loading with various elements and their influence on the soil quality, was created out of practical necessities, through experiments and repeated explorations, so as to appreciate the soil's different loading levels of pollution because, as stated by De Haan in 1993 (DUMITRU ET ALL., 1994), of the three environmental components, water, air and soil, the latter undoubtedly gives the greatest difficulties in assessing its quality in a quantitative form.

CONCLUSIONS

Harmonious and durable development requires knowledge of a given area's natural conditions, particularly the lands' ecological potential (as defined by M.E.S.P.-ICPA Bucharest, 1987). In this respect, this paper aims to achieve a background of information regarding identification, inventory and assessment of possible hazards that can cause soil contamination by certain pollutants (heavy metals, nitrates). Therefore, after a brief presentation of the natural background (relief, lithology, hydrography, hydrology), in order to explain the phenomena that have happened and still happen in the soil, as well as the way these phenomena and processes may be influenced by humans in their activity of farmers (in the first stages), and in other social – economical activities etc., the main results obtained by processing of analysis of the 9 water samples and the 12 soil samples are presented, the values recorded in soil samples analyzed indicating normal values in terms of NO_3 content, while in the case of water samples analyzed, there were situations when such values exceeded the threshold. In respect to phosphates and calcium, the values recorded are below the threshold, in magnesium this threshold is exceeded at a number of samples differing from year to year, generally the same sampling points being found.

ACKNOLEDGEMENTS. This work was partially supported by the strategic grant POSDRU/159/1.5/S/137070 (2014) of the Ministry of National Education, Romania, co-financed by the European Social Fund-Investing in People, within the Sectoral Operational Programme Human Resources Development 2007-2013.

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