THE QUALITY OF MAROS RIVER WATER IN ROMANIA HUNGARY CROSS BORDER AREA

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Abstract . *The maintenance of good quality river water and the clean-up of polluted water are of major European concern. A major impetus for improving the riverine environment has been the introduction of the Water Framework Directive (WFD) that demands new approaches for managing and improving surface and groundwater quality across the European Union. Romania's main water resource is the internal rivers. Maros River is the longest of rivers and inland to the border with Hungary. The aim of this paper was to evaluate and to distinguish the influence of the impact of natural and anthropogenic inputs on the quality of Maros River water in Romania-Hungary cross border area because fit in Water Framework Directive, concerning managing and improving surface water quality across the European Union. The sampling of the Maros River water was carried during 1 year (spring 2012 – winter 2013), covering all seasons. This study involved 10 sampling points, situated in Romania – Hungary cross border area, 5 in Romanian part and 5 in Hungarian part. The water samples were tested for the main quality indicators. Nitrate and nitrite content values are very high due to an inadequate management of nitrogen fertilizer. Also, the phosphorus content is very high associated with the passing or crossing of Maros River nearby villages or small towns which don`t have plants for wastewater treatment. Zn content determined in water samples varied from 7.6 to 24.1$\mu g \cdot l^{-1}$, fitting the water in 4th and 5th class of quality. The presence of this trace element in water is connected with discharging of untreated domestic waters. As main sources of water pollution of Maros River occurs: wastewater from industry, agriculture and households. The pollution is especially serious in the urban settlements with greater number of inhabitants and with developed industry.*

INTRODUCTION

Different regions of the world are faced with different types of problems associated with the occurrence, use and control of water resources, which may endanger the sustainable development of these resources. The quality of surface waters is a very sensitive issue. Anthropogenic influences as well as natural processes degrade surface waters and impair their use for drinking, industry, agriculture, recreation and other purposes. (Sanchez et al., 2007)

The major factors that will affect the future of global water resources are: population growth, economic growth, changes in production and trade patterns, increasing competition over water because of increased demands for domestic, industrial and agricultural purposes and the way in which different sectors of society will respond to increasing water scarcity and pollution (Ercin et al., 2014).

One of the greatest challenges of the 21st century is to meet the demand for food of the growing population while reducing the adverse impacts of the production system on the environment (Godfray et al., 2010; Foley et al., 2011). Indeed, the demand for food is a major driver for global environmental changes and it is expected to increase in the next 40 years, exacerbating the competition for land, water and energy (Tilman et al., 2001). In particular,

agriculture has shown to be a major force affecting the environment through conversion of forest to cropland and the consequent loss of natural habitat and biodiversity, and by the intensification of practices, involving mechanisation and increasing use of mineral fertilisers and chemicals (Foley et al., 2005). These practices have in turn produced a degradation of soils and waters, through the significant loss of nutrients, nitrogen and phosphorus, in the aquatic system, contaminating surface and underground
water resources and causing eutrophication in coastal waters (MEA, 2005; Sutton et al., 2011, 2013). (Grizetti et al., 2013).

The maintenance of good quality river water and the clean-up of polluted water are of major European concern.

A major impetus for improving the riverine environment has been the introduction of the Water Framework Directive (WFD) that demands new approaches for managing and improving surface and groundwater quality across the European Union, with emphasis shifting from chemical towards ecological water quality standards (CEC, 2000). There is also a need to improve the water quality of groundwater under a proposed daughter directive (CEC, 2003). For rural and agricultural areas, there are major issues linked to water resources in terms of potability and amenity value. (Neal et al., 2006)

Romania's main water resource is the internal rivers. Maros River is the longest of rivers and inland to the border with Hungary, carries out bed on 761 km. It springs from Hasmasul Mare Mountains. The upper course area is bounded by Giurgeu depression and the gorge Toplita - Deda, the middle is the central region of Transylvania Plateau and the lower area is bordered by the Apuseni Mountains, Banat Mountains, Western Plain (between Lipova and Hungarian border). In hidrografic Maros basin, land use is varied. From the whole area, 31% are represented by forests, 28 % arable land, 16% pastures and 25% urban and industrial areas. Maros River crosses 16 towns (14 in Romania and 2 in Hungary.

It flows into the Tisza River in Hungary. Water quality monitoring of Maros River in Romania – Hungary cross border area, fit in Water Framework Directive, concerning managing and improving surface water quality across the European Union.

As a result of the development of the urbanization and industrialization, negative consequences are arising on the natural resources and the environment. As main sources of water pollution of Maros River occurs: wastewater from industry, mining and households. The pollution is especially serious in the urban settlements with greater number of inhabitants and with developed industry.

MATERIAL AND METHODS:

The sampling of the Maros River water was carried during 1 year (spring 2012 – winter 2013), covering all seasons. This study involved 10 sampling points, situated in Romania – Hungary cross border area, 5 in Romanian part and 5 in Hungarian part. The water samples were taken in four replicates and collected in glass flask. The water samples were tested for the main quality indicators.

pH was determine in situ, by conductometric method, using a portable Mettler Toledo pH-meter. After preserving, samples were transported to the laboratory, in order to determine the following parameters, according to the Standard Methods: phosphorus, nitrites, nitrates, K, Ca, Mg, Zn, Mn, Cu, Cr, Fe.

Phosphorus, nitrates and nitrites were determined by spectrophotometric method, using a Cintra 100 equipment at the following wavelengths: 520 nm (nitrite), 410 nm (nitrate), 640 nm (phosphate).

After acidification with HNO_3 followed by filtration, the water samples were nebulised into the air – acetylene flame of an Varian Spectra S atomic adsorption spectrophotometer, in order to determine the content of the acid extractable (specified above) metals.

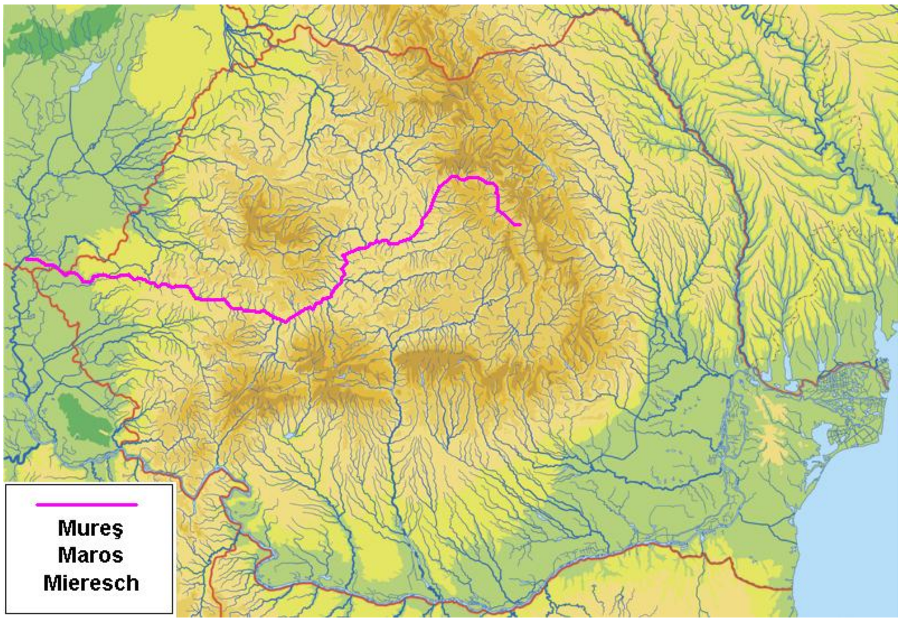

Fig.1 Maros River in Romania (sursa - ro.wikipedia.org.)

RESULTS AND DISCUSSIONS:

The purpose of this study was to evaluate the importance of water quality variables (major ions — K, Ca, Mg, PO_4^{3-}, NO_2^-, NO_3^-, and trace elements, Cu, Mn, Fe, Zn, Cr), throughout and to distinguish the influence of the impact of natural processes and anthropogenic input on the composition of Maros River water in Romania – Hungary cross border area.

The pH values (Fig.1) are mostly ranged in neutral domain. The lowest value, slightly acid (6,16) was determined in water samples taken from Romanian part of the river, in spring.

On the other side, the highest value, 7,67 was determined also in the samples taken from Romanian part, but in autumn.

Calcium content of Maros River water varies between 14,1 and 102 mg/l. The highest values were determined in samples taken from Romanian part, in all seasons. In the Hungarian part, the water contain less that 75 mg Ca/l, so is in the 1st class of quality. We appreciate that this high calcium content in water, is due to mineral dissolution (fig.2)

Magnesium content is ranged between 5,3 and 19,3 mg Mg/l. Again, in the Romanian part of the river, these values are higher than in the Hungarian part, due to dissolution of minerals. But all the determined values are less than 25 mg/l, so, the water can be classified in the 1st class of quality.

Nitrate content is very high, with values ranged between 7,5 and 27,3 mg/l, which classified Maros river water in the 4th (6 – 15 mg/l) and in the 5th (≥15 mg/l) class of quality.(fig.4) in the monitorized section. The highest values were determined in samples taken in autumn, from both Romanian and Hungarian part of the river. The pollution comes from diffuse sources – agricultural activities (Camargo and Alonso, 2006), (Milovanovici, 2007), (Zeliger, 2011).

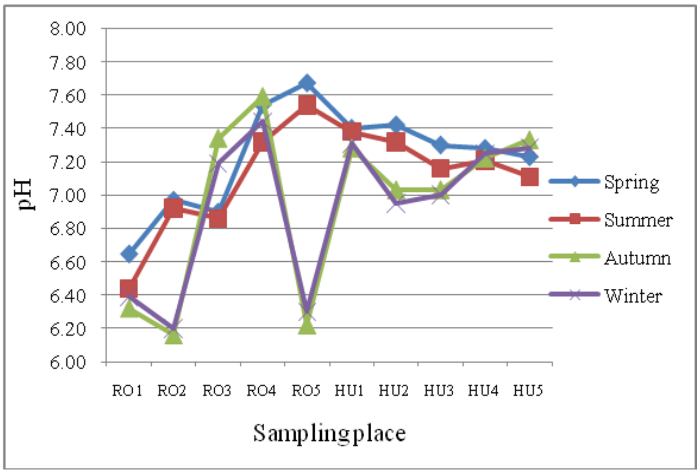

Fig.2 pH variation

The high nitrite content classify Maros river water in the 4th (0,12 – 0,3mg/l) and 5th (≥0,3 mg/l) class of qulity. The highest value, excedeeng 0,3 mg/l were determined in the samples taken from Romanian part of the river in autumn. In samples taken from Hungarian part, we observed a slightly decrease of nitrate content, but the water still remain polluted. The lowest nitrate content were observed in samples taken in winter, perhaps due to low temperature, the reduction of NO_3^- to NO_2^- by oxidation of inorganic matter is also low (Rozemeijer and Broers, 2007).

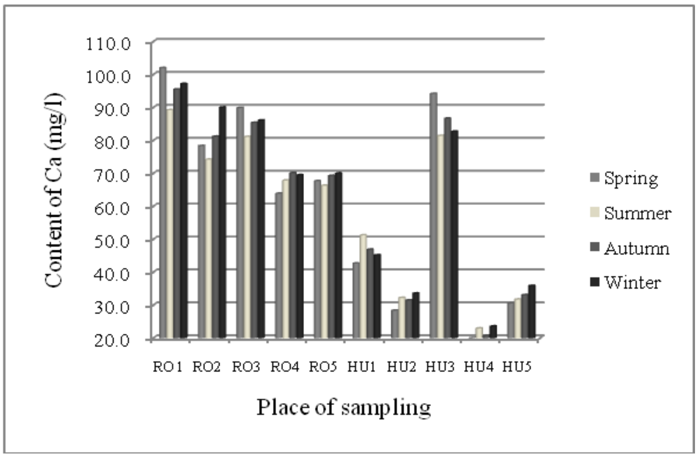

Fig.3 Calcium content of water samples

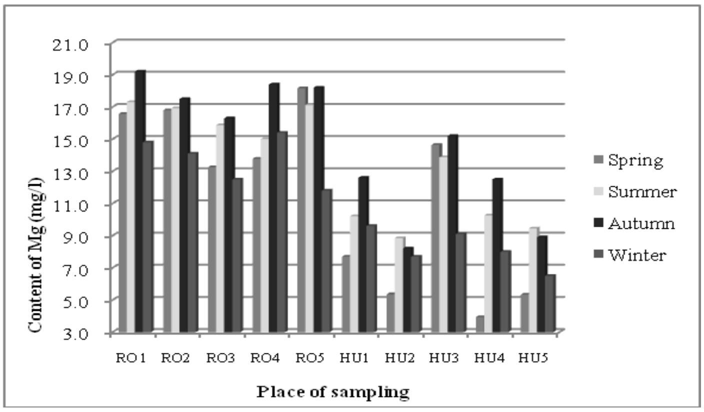

Fig.4 Magnesium content of water samples

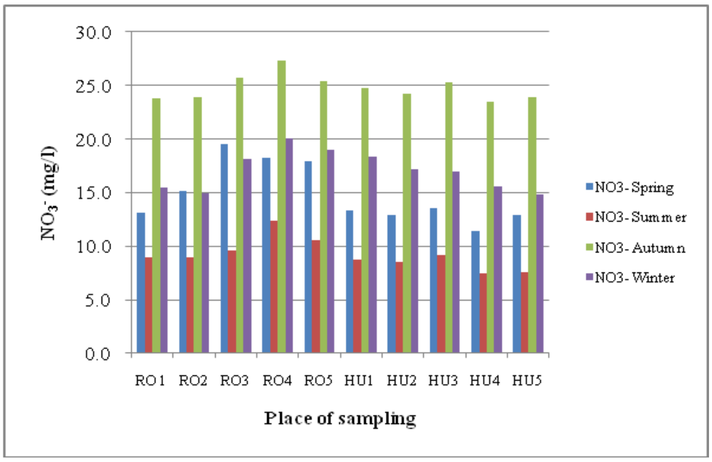

Fig.5 Nitrate content

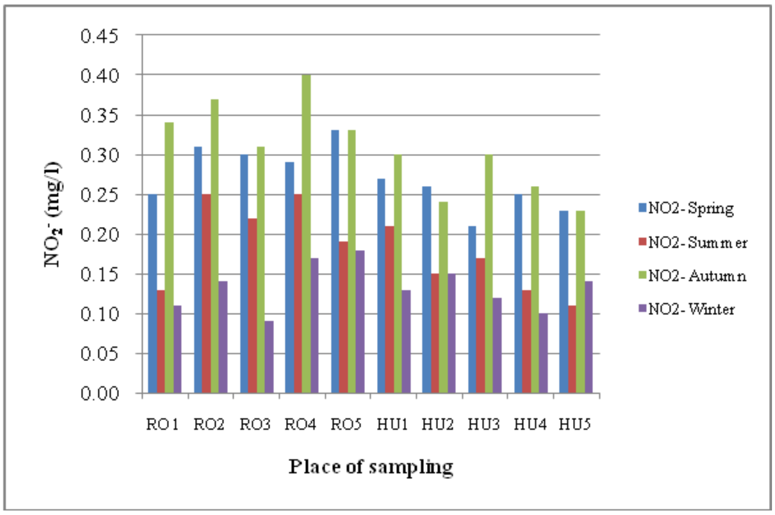

Fig.6 Nitrite content

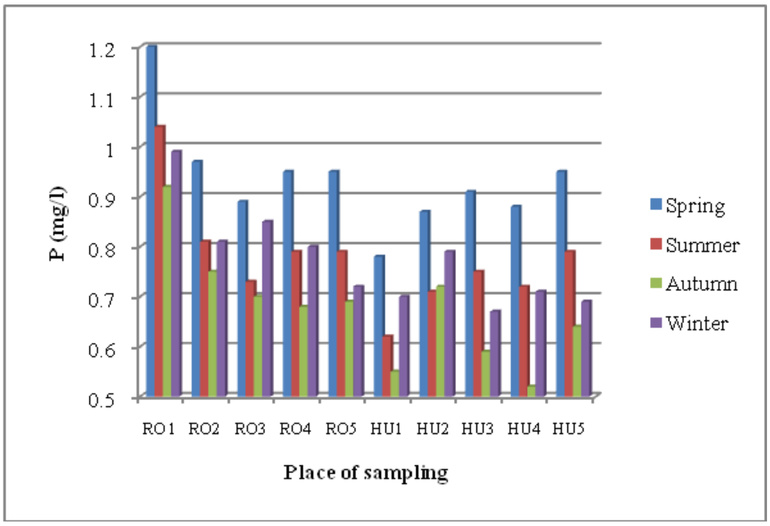

Fig.7 Phosphorus content

Phosphorus content determined in water samples was very high, exceeding 4 mg/l, the limit value for the 3rd class of quality. The highest value, 1.2 mg/l was observed in the sample taken from point RO1 in spring. The samples taken from this point had also the highest values for summer autumn and winter. The presence of phosphorus in water is associated with untreated domestic water discharging and agricultural practices (Zeliger, 2001). In the monitorized section, Maros River is crossing or passes nearby villages and small towns, which don`t have plants for residual water treatment.

Table 1

Concentration of potassium and iron, determined in Maros River water in Romania - Hungary cross border area

Place of sampling	K ($mg \cdot l^{-1}$)				Fe ($mg \cdot l^{-1}$)			
	Sprig	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
RO1	3,11	3,68	2,90	3,85	0,089	0,016	0,066	0,045
RO2	2,78	3,35	3,10	4,12	0,119	0,146	0,094	0,078
RO3	2,68	3,25	2,50	2,97	0,126	0,153	0,099	0,081
RO$	2,75	3,35	3,01	2,95	0,162	0,189	0,082	0,077
RO5	2,78	3,35	2,80	3,21	0,071	0,098	0,063	0,058
HU1	2,99	3,56	4,12	3,89	0,122	0,149	0,091	0,079
HU2	2,93	3,50	3,09	2,77	0,091	0,118	0,085	0,067
HU3	2,86	3,43	3,31	2,85	0,103	0,130	0,088	0,059
HU4	2,85	3,42	4,25	3,96	0,103	0,132	0,084	0,062
HU5	2,80	3,37	4,10	4,02	0,109	0,136	0,081	0,071

Table 2

Concentration of trace elements, determined in Maros River water in Romania - Hungary cross border area

Place of	Cu ($\mu g \cdot l^{-1}$)				Cr ($\mu g \cdot l^{-1}$)				Zn ($\mu g \cdot l^{-1}$)				Mn ($mg \cdot l^{-1}$)			
sampling	Spr	Su	Au	Wi	Spr	Su	Au	Wi	Spr	Su	Au	Wi	Spr	Su	Au	Wi
RO1	11	15	18	14	0,026	0,028	0,019	0,01	17,3	18,2	17,0	13,0	0,011	0,004	0,008	0,010
RO2	13	16	13	11	0,05	0,044	0,031	0,022	24,1	22,9	23,1	19,1	0,05	0,042	0,011	0,007
R03	12	11	12	14	0,068	0,059	0,036	0,029	15,6	17,1	19,0	17,5	-*	0,015	-	0,004
RO4	13	18	21	17	0,085	0,088	0,058	0,031	10,6	13,5	10,9	11,0	-	0,012	-	-
RO5	15	17	15	17	0,115	0,110	0,084	0,056	23,6	22,8	10,6	9,9	0,05	0,034	0,018	0,010
HU1	16	19	14	13	0,115	0,118	0,092	0,088	10,4	10,1	8,4	7,6	-	0,011	0,009	0,005
HU2	17	21	17	12	0,137	0,141	0,114	0,102	13,6	15,7	10,2	8,9	-	0,006	-	0,003
HU3	14	16	14	15	0,153	0,162	0,131	0,105	13,4	15,9	10,1	8,5	-	-	-	-
HU4	14	19	17	16	0,171	0,185	0,157	0,127	9,2	10,4	9,2	7,6	-	0,004	-	-
HU5	18	22	16	17	0,184	0,183	0,134	0,110	16,4	13,8	10,7	11,0	-	10	-	-

-* under the detection limit

Total iron content was situated between 0.016 and 0.149 $mg \cdot l^{-1}$, values who fit Maros River water in 1st and 2nd class of quality. The highest values were determined in summer related with the low level of water flow because of drought weather conditions (Valdes et all, 2008).

Chromium does not occur freely in nature. Chromium compounds can be found in waters only in trace amounts. The element and its compounds can be discharged in surface water through various industries. Chromium (III) oxides are only slightly water soluble, therefore concentrations in natural waters are limited. Cr^{3+} ions are rarely present at pH values over 5, because hydrated chromium oxide ($Cr(OH)_3$) is hardly water soluble. Chromium (VI) compounds are stable under aerobic conditions, but are reduced to chromium (III) compounds under anaerobic conditions..

In Maros River, chromium content is low, ranged between 0.01 and 0.87$\mu g \cdot l^{-1}$. Analyzing the dates presented in table 2 we can observe that Cr content raise from Romanian part of the river, to Hungarian part. The highest values were determined in the sampling points HU4 and HU5. So, we can observe a slightly accumulation of Cr in river water, due to untreated domestic waste waters discharge. The water is in 1st class of quality.

Zinc is released to the environment from both natural and anthropogenic sources; however, releases from anthropogenic sources are greater than those from natural sources. The primary anthropogenic sources of zinc in the environment (air, water, soil) are related to mining and metallurgic operations involving zinc and use of commercial products containing zinc. Water is polluted with zinc, due to the presence of large quantities of zinc in the wastewater of industrial plants. Zn content determined in water samples varied from 7.6 to 24.1$\mu g \cdot l^{-1}$, fitting the water in 4th and 5th class of quality. The presence of this trace element in water is connected with discharging of untreated domestic waters.

Copper is generally present in surface waters, with cupric ion (Cu^{+2}) as the primary form in natural surface waters. In freshwater systems, naturally occurring concentrations of copper range from 0.2 μg/L to 30 μg/L (Bowen 1985). The copper content of Maros River water varied between 11 and 21 $\mu g \cdot l^{-1}$. Slightly bigger values were observed in summer and autumn, due to drought conditions.

Additionally, copper is found in most municipal effluents due to the corrosion of copper plumbing.

Manganese is a mineral that naturally occurs in rocks and soil and may also be present due to underground pollution sources. Manganese is seldom found alone in a water supply. It is frequently found in iron-bearing waters but is more rare than iron In low concentrations it produces extremely objectionable stains on everything with which it comes in contact. In concentrations higher than 0.05 mg/l the manganese may become noticeable by impairing colour, odour, or taste to the water The manganese content values, determined in water samples, are low, under the limit of 0,05 $mg \cdot l^{-1}$, values which fit the Maros River water in the 1^{st} class of quality.

CONCLUSIONS:

The aim of this paper was to evaluate and to distinguish the influence of the impact of natural and anthropogenic inputs on the quality of Maros River water in Romania-Hungary cross border area.

Calcium and magnesium contents fit the Maros River water in the first class of quality.

Nitrate and nitrite content values are very high due to an inadequate management of nitrogen fertilizers, especially in our country.

Also, the phosphorus content is very high associated with the passing or crossing of Maros River nearby villages or small towns which don`t have plants for wastewater treatment.

The iron and chromium content values fit the water in the 1^{st} and 2^{nd} class of quality. We observe a slightly accumulation of chromium in water due to untreated wastewater discharge.

Zinc content values are very high, fitting the water in the 4^{th} and 5^{th} class of quality. The presence of this trace metal in water is related to the releasing of zinc to the environment from anthropogenic sources.

The copper and manganese content values fit Maros River water in the 1^{st} class of quality.

BIBLIOGRAPHY

1. CAMARGO A.J., ALONSO A., Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: A global assessment, Environmental International 32(2006), 831-849.
2. DELPLA JANIS, BAURES ESTELLE, JUNG VALERIE, THMAS O., Impact of rainfall events on runoff water quality in an agricultural environment in temperate areas, Science of the Total Environment, 409(2011), pp1683-1688

3. DIMITROVSKA OLGICA, MARKOSKI B., APOSTOLOVSKA TOSHEVSKA BILIJANA, MILIVSKI I., GORIN S., Surface water pollution of major rivers in the Republic of Macedonia, Landscape, Environment, European Identity, 4-6 November, 2011, Bucharest.
4. ERTUG ERCIN A., ARJIN Y.HOEKSTA, Water footprint scenarios for 2050: A global analysis, Environment International 64 (2014), 71-82.
5. GODFRAY, H.C.J., BEDDINGTON, J.R., CRUTE, I.R., HADDAD, L., LAWRENCE, D., MUIR, J.F., PRETTY, J., ROBINSON, S., THOMAS, S.M., TOULMIN, C., 2010. Food security: the challenge of feeding 9 billion people. Science 327, 812–818.
6. FOLEY, J.A., RAMANKUTTY, N., BRAUMAN, K.A., CASSIDY, E.S., GERBER, J.S., JOHNSTON, M., MUELLER, N.D., O'CONNELL, C., RAY, D.K., WEST, P.C., BALZER, C., BENNETT, E.M., CARPENTER, S.R., HILL, J., MONFREDA, C., POLASKY, S., ROCKSTROM, J., SHEEHAN, J., SIEBERT, S., TILMAN, D., ZAKS, D.P.M., 2011. Solutions for a cultivated planet. Nature 478, 337–342.
7. FOLEY, J.A., DEFRIES, R., ASNER, G.P., BARFORD, C., BONAN, G., CARPENTER, S.R., CHAPIN, F.S., COE, M.T., DAILY, G.C., GIBBS, H.K., HELKOWSKI, J.H., HOLLOWAY, T., HOWARD, E.A., KUCHARIK, C.J., MONFREDA, C., PATZ, J.A., PRENTICE, I.C., RAMANKUTTY, N., SNYDER, P.K., 2005. Global consequences of land use. Science 309, 570–574.
8. GRIZETTI BRUNA, PRETATO U., LASSALETTA L., BILLEN G., GARNIER JOSETTE, The contribution of food waste to global and European nitrogen pollution, Environmental Science and Policy, 33(2013), 186-195.
9. MILOVANOVICI MIMOZA, Water quality assessment and determination of pollution sources along the Axios/Vardar River, South Eastern Europe, Desalinisation (213)(2007), 159-173.
10. NEAL C., JARVIE P.HELLEN, NEAL MARGARET, HILL LINDA, WICKHAM HEATHER, Nitrate concentrations in river waters of the upper Thames and its tributaries, Science of the Total Environment 365(2006), 15-32.
11. PANAGOPOULOS Y., MAKROPOULOS C., MINIKON M., Decision support for diffuse pollution management, Environmental Modelling and software 30(2012), 57-70.
12. SANCHEZ E., COLMENAREJIO F.M, VICENTE J., RUBIO A., GARCIA G.MARIA., TRAVIESO LISETTE, BORJA R., Use of the water quality index and dissolved oxygen deficit as simple indicators of watersheds pollution, Ecological indicators 7 (2007) 315-328 (www.elsevier.com/locate/ecolind).
13. SANCHEZ-CHOLIZ J., DUARTE ROSA, Water Pollution in the Spanish economy: analysis of sensivity to production and environmental constraints – Ecological Economics 53 (2005) 325-338 (www.elsevier.com/locate/ecolecon)
14. SCHOUMANS O.F., CHARDON W. J., BECHMANN B.E., GASCUEL-ODOUX C., HOFAMSN G., KRONVANG B., RUBAEK G.H., ULEN B., DORIOZ J.M., Mitigation

option to reduce phosphorus loss: from agricultural sector and improve surface water quality: A review, Science of the Total Environment, 468-469, (2014), 1255-1266.

15. TILMAN, D., BALZER, C., HILL, J., BEFORT, B.L., 2011. Global food demand and the sustainable intensification of agriculture. Proceedings of the National Academy of Sciences of the United States of America 108, 20260–20264.
16. VAROL M., Dissolved heavy metal concentrations of the Kralkizi, Dicle and Batman dam reservoirs in the Tigris River basin, Turkey, Chemosphere, vol.93, Issue 6, October 2013, pp 954-962, www.elsevier.com.
17. VALDES J., ROMAIN D., ALVAREZ G., ORTLIEB L., GUINĚZ, Metals content in surface waters on a uppweling system of the northern Humboldt Current, Journal of Marine Systems 71 (2008), 18-30.
18. YI Q., DON X.D., HUANG Q.R., ZHAO X.Q., Pollution Characteristics of Pb, Zn, As, Cd, in the Bijiang River, Procedia Environmental Sciences 13 (2012) 43-52.
19. ZUBAIDAH I., Determining and comparing the levels of heavy metal concentrations in two selected urban river water, Measurement 46(2013) 4135-4144.
20. ZELIGER I., H., Water Pollution, Human Toxicology of Chemical Mixtures, (Second Edition), 2011, 65-95.
21. Xxx, River Basin Management Plans – Report on the Implementation of the Water Framework Directive (2000/60/EC) European Comision, Brussels, 14.01.2012.
22. Xxx, Standard Methods for Examination of Water and Wastewater, copyright 1999 by the Amerian Public Health Society, American Water Works Association, Water Environment Federation.