ASPECTS OF THE PHYSICAL AND CHEMICAL PARAMETERS INFLUENCE ON THE TROTUŞ RIVER WATER QUALITY

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Abstract

This paper deals with changes in indicators of quality physical-chemical, selected to prezent the mani environmental impact of existing pressures in the Trotuş River. For a mor accurate assesment of the Trotuş River water qualitz there is required a monitoring and a physico-chemical verification of the indicators not to exceed the qualitz standards. The Trotuş River water quality is influenced by the presence of fretice in the area, through accidental leakage of oil products and water intrusion that indicate the presence of a high level of salinity. On the basis of manitoring concentrations carried out to set indicators, their evolution in time, grade in which fit over the water. Thery determined with ststistics program by analysing and interpreting the values of the parameters or values determine the standard of reference. The main use of water originating from the Trotuş River basin is the water supply of the population, a percentage of the industry declined and the irrigated areas. Because the water of the rivers is vulnerable to pollution sources, in particular the collection of domestic and industrial waste water is needed in the monitoring of bodies of water. As a result of statistical analysis, Trotuş river water quality in the upper category I corresponds to quality, and as a result of insufficient purified waste water collection, water quality degrades River and falls within category II of the quality. In the section control, water quality downstream Adjud Trotuş River falls within category III of the quality. Trotuş River has particular importance due to the presence of nimerale and ensuring water supply of the population.

Key words: water quality monitoring, water pollution, pollution sources

This study identifies data and information requirements, pinpoints difficulties the impact of pollution source, analysis of water quality and monitoring control.

The main measures to reduce emissions to the Siret River were calcium, ammonium, hydrogen sulfide, residue fixed, salinity, sodium, chorine, free detergent and municipal wastewater treatment, concentrated on point emissions. (Behrendt and Bachor, 1998; Laane et. al., 2002). The aim of this analysis is to find a correlation between land uses, industry, urban, forest, mining and agriculture, for the defined diffuse source of the variation indicators physical-chemical and to deliver strategic guidelines for water protection.

The EU Water Framework Directive (WFD) prescribes to achieve a good status of surface waters by 2015 (European Parliament, 2000). To keep this deadline of a new three level surveillance, operational and investigative, monitoring systems is required including hydro-morphological, biological and chemical elements. (Balazs L., et. al., 2006). In consequence, the physical-chemical status of European river should be evaluated and investigated before the year 2015 for a good improved.

This is a strategy for assessing the physical-chemical status of Siret River by using multiple indicators by observed deviation from the expected natural condition. The methodological focus used in this study offers a more global, complete view, as seen in other paper where the use of multiple parameters of analysis of water quality (Roth et. al., 1996, Lammaert and Allan, 1999, Griffth et. al., 2005, Freund and Petty, 2007). In the process of pollution, rivers in a watershed play a major role in assimilating or carrying off municipal and industrial wastewater and runoff from agricultural land (Alexander et al., 2000; Singh et al., 2005). Thus, it is imperative to prevent and control river pollution. Spatial and temporal variations in water chemistry and the locations of the most significant contributors to pollution in a river basin must be clearly identified; this usually requires a monitoring program that will provide a representative and reliable estimation of the quality of surface waters (Alexander et al., 2000; Simeonov et al., 2003). Identification of the point source and non-point source pollution in a watershed with complex river

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network is an environmental conundrum. Different multivariate approaches offer powerful means of understanding a large environmental datasets and the physical-chemical status of study systems (Simeonov et al., 2003; Singh et al., 2005; Zhou et al., 2007).

The control of diffuse pollution is very important in this paper there for we analyze the effect of some land uses agriculture, urban, forest, mining, industry, responsible for different impact source of water quality. Where agriculture cause point pollution, the level of irrigation impact it is not responsible for high values of the parameter analyzed. Urban often causes is the most important source of diffuse pollution point in the Siret basin. The wastewater discharged is the source responsible of water quality.

Some autors have suggested that the influence of the land uses on water quality must be analysed at the catchment scale (Omernik et. al., 1981; Richards and Host, 1994; Roth et. al., 1996), where others have argued that land uses located closer to stream are more important. (Harding et. al., 1998; Nerbonne and Vondracek, 2001). Many studies suggest a multiple spatial scale approach could be a framework and important source of diffuse pollution. (e.g. Chamg, 2008; Tran et. al., 2010). The effect of urban in TSS, NH_4, RF, Cl, SO_4, Na, Ca river concentration was also in the Siret basin.

MATERIAL AND METHODS

Study area

The indices of water quality have to be developed considering the local properties and pollution status of the ecosystems. There are different tools that affect watershed management and to control. Water Quality Index is a very important tool in the management of watersheds in this sense. Therefore this study has the potential to provide interesting results for researchers in water quality sector. The study area is Siret River Basin, Administration (ABAS), Romania area that includes the upper and middle reaches of six large river Bistrita, Moldova, Suceava, Siret, Şomuzu Mare, Trotus and Tributary River (Fig.1). The Siret River Basin, which is the largest basin in Romania, with a 47,610 square kilometers area of which 42890 km on Romanian territory. In this basin area, Siret River Basin Administration Bacău manages 27,402 km. The density of the river network is 0.35 km/sq. km. Siret River, rises in the Carpathian Woody Mountains, in Ukraine enters in Romania near the city of Siret and flows into the Danube, upstream the Galati city. The total length of the Siret River is 726 km, of which the territory of Romania, 559 km. The main tributaries of the Siret River are Suceava River, Moldova River, Bistrita River, Trotuş River, Bârlad River, Putna River, Ramnicu Sarat River and Buzau River, which together with other smaller tributaries, contribute to a multi-annual average flow of Siret River upstream the confluence with the Danube, approximately 240 m3/s corresponding to a multi-annual average stock of about 7.6 billion cubic meters.

The total length of the river system of the Siret River Basin, is 15836 km, of which on the territory of Romania, 15157 km, and managed by Siret River Basin Administration of 10280 km.

Main water courses from the Siret river basin are effluents of Siret river that collects all the waters on the eastern side of the Carpathians rivers namely Suceava, Moldova, Bistrița, Trotuş, Putna and Ramnicu Sărat, Buzău River. In the surface water resources of the Siret River Basin there are two lakes, one freshwater and one saltwater, their water not being used to meet requirements of water using.

Water pollution is reduced substantially from its initial value due to its self-purification capacity. Treated or untreated wastewater, after evacuation processes are subjected to physical, chemical and biological processes that lead - finally - to water self-purification of the receptor. The objectives were to determine which scale of landscape variables accounts for most variation of parameter physical chemical, geographical position, catchment, whether natural or human induced physical setting, impact pollution. Was obtained by Geographical Information System (GIS) software (ESRI ArcMap 8.2). The GIS has been using the more recent database from regional and national sources. The category land uses data is: urban, forest, mining and agriculture. Land use data were obtained from the Corine Land Cover (CLC, 2000). Land cover classes characterized in CLC were reclassified intro the following category (Table 1). Areas to agricultural (AGR), urban and industrial land covers (URB), natural and forested vegetation (FOR), mining and extractive mining (MIN) and water (WAT). Urban land use was also split intro three categories: industrial, wastewater discharged and urban, expected to have o low impact on quality water of Siret River.

Physical – chemical analyses

Water pollution is reduced substantially from its initial value due to it's self-purification capacity. Treated or untreated wastewater, after evacuation processes are subjected to physical, chemical and biological processes that lead - finally - to water self-purification of the receptor. The main source of pollution of the Trotuş River is due mainly to disposal of wastewater and usually directed by inappropriate treatment. Pollution of the Trotuş River, the urban sewage treatment station downstream of city, due to sewage discharged and improperly purified by the purge station. In this situation the water quality is influenced by the presence of Ca, N-NH_4, RF, Na.

This fact demonstrates the strong influence of urban in stream water Ca, N-NH_4, RF, Na level within the study area. The main sources of pollution in the catchment area have influenced the state of its river water quality.

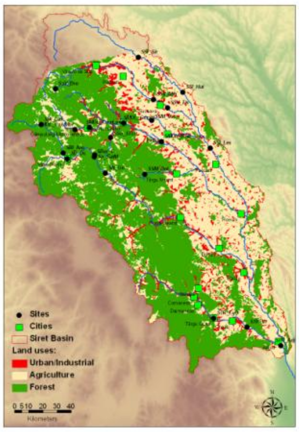

Figure 1 **Study area Siret River Basin the boundaries of river and land use**

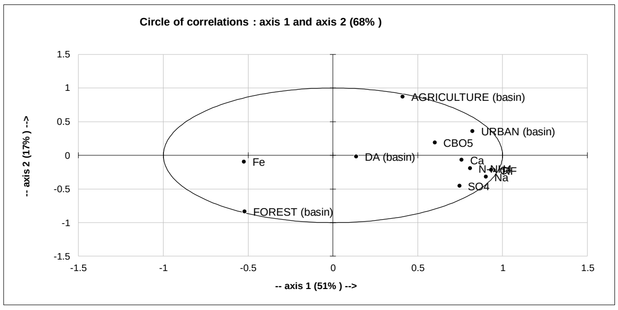

Figure 2 **Correlation of non-point pollution sources of river and land use**

Table 1

Description of land uses analyzed Corine Land Cover categories

Code	Description	Corine Land Cover categories	Code
Urban	Urban; Industrial; Wastewater discharged	1. Artificial areas	Urban
Mining	Extractive mining industry; Construction sites; Mining water; Dump sites	2. Artificial areas	Mining
Agriculture	Cereals, legumes, fruits trees	3. Non-irrigated arable land; Agricultural areas	Agriculture
Forest	Areas with natural vegetation	4. Forest and semi-natural vegetations areas	Forest
Water	Water courses Salinas	5. Water bodies	Water

Table 2

Correlation and PCA analysis with coefficient type Sperman's

SIRET RIVER (basin)	URBAN (basin)	AGRICULTURE (basin)	FOREST (basin)	DA (basin)	N-NH4	RF	CBO5	Cl	SO4	Ca	Na	Fe
URBAN (basin)	1	0.5720	-0.7064	0.2772	0.5042	0.6601	0.5483	0.7391	0.4433	0.5404	0.6228	-0.4458
AGRICULTURE (basin)	0.5720	1	-0.9774	-0.0435	0.2084	0.2174	0.3123	0.1925	-0.0220	0.2445	0.1078	-0.2532
FOREST (basin)	-0.7064	-0.9774	1	-0.0073	-0.2874	-0.3145	-0.3992	-0.3123	-0.0627	-0.3055	-0.2151	0.3001
DA (basin)	0.2772	-0.0435	-0.0073	1	-0.1225	0.0198	-0.0864	0.1372	0.1350	0.1316	0.0898	-0.4142
N-NH4	0.5042	0.2084	-0.2874	-0.1225	1	0.8622	0.5020	0.7267	0.6307	0.5720	0.7945	-0.2024
RF	0.6601	0.2174	-0.3145	0.0198	0.8622	1	0.5031	0.9334	0.7628	0.7357	0.9413	-0.4554
CBO5	0.5483	0.3123	-0.3992	-0.0864	0.5020	0.5031	1	0.5234	0.2332	0.3529	0.4975	-0.1160
Cl	0.7391	0.1925	-0.3123	0.1372	0.7267	0.9334	0.5234	1	0.8114	0.6556	0.9300	-0.3961
SO4	0.4433	-0.0220	-0.0627	0.1350	0.6307	0.7628	0.2332	0.8114	1	0.5155	0.7956	-0.3701
Ca	0.5404	0.2445	-0.3055	0.1316	0.5720	0.7357	0.3529	0.6556	0.5155	1	0.6160	-0.4876
Na	0.6228	0.1078	-0.2151	0.0898	0.7945	0.9413	0.4975	0.9300	0.7956	0.6160	1	-0.3656
Fe	-0.4458	-0.2532	0.3001	-0.4142	-0.2024	-0.4554	-0.1160	-0.3961	-0.3701	-0.4876	-0.3656	1

Statistical analyses

Statistical analyses were performed using STATISTICA StatSoft v.10 and XLSTAT. Statistical software was used for all statistical treatments such as basic statistic, analysis of variance and correlations. In this case we calculate Sperman's rank correlation coefficient for each scale dataset. Basic statistical analysis has been conducted in order to gain some insight into the structure of the dataset. For the estimation of statistical properties of the data, the missing values have been temporarily ignored and the dataset has been scaled. According to the characteristics of their special distribution, the pollution sources are classified as point sources, non-point sources and internal sources discharged into rivers and lakes. Point pollution sources mainly include industrial and domestic wastewater from urban areas. Non-point pollution sources comprise of the pollutants from surface runoff from agriculture lands, town lands, woodlands, meadows and so on (Wang C. et.al., 2005). The urban point pollution sources are the principal sources, the non-point pollution sources take the second place, and the internal pollution sources are less significant. So wastewater treatment plants in cities and towns along the main route should be built as soon as possible to ensure the water quality in Water Framework Directive (WFD) (2000/60/CE). The pollution loads of urban point source are non-point sources. It indicates that the amount of Ca, N-NH_4, RF, SO_4, Na, CBO_5 from urban point sources is about 68% of the total (Fig.2). So point sources are overwhelmingly and should be the priority for control and abatement. Non-point pollution sources should also be paid adequate attention.

RESULTS AND DISCUSSION

Inasmuch as the discharge of urban wastewater is an important cause of pollution of Siret Rivers, one should expect a negative relationship between urbanization and river water quality. The preliminary results of the model, however, did not show such a relationship (Fig.2) and (Table 2). A closer examination of the data suggested a relationship between urbanization and water quality. The water quality deteriorates as urbanization goes up, but beyond a stage further increases in the level of urbanization tend to be beneficial (Bishwanath G. and Nandini B., 2004).

The best results that could be obtained in respect of the urbanization variable are shown as model estimate in Table 2. The coefficient of urbanization has a negative coefficient while the agriculture, forestal of this variable has a positive coefficient. Both coefficients are statistically significant. An increase in urbanization causes deterioration in river water quality. However, the results do hint at an adverse effect of urbanization on river water quality up to a stage.

Because the water of the rivers is vulnerable to pollution sources (the collection of domestic and industrial wastewater of city) in the drainage basin of the River Trotuş were delineated four "zones of protection" related over the surface. In the drainage basin of the River Trotuş importance are mineral waters. Critical areas that require improvement in the quality of the water in terms of ecological status.

Disturbing sources are presented based on the critical areas of the basin in which it appeared that the impact of the degradation of water quality. Due to the fact that industrial objectives were developed in urban centers, municipal sewage may comprise of a mixture of household waste, waste water, industrial and waste water from various activities, including public water from precipitation and, in the area of the river basin was used notably Trotuş channeling in the system unit.

Thus, on the variation of concentrations of chlorides can affirm that they grow significantly from upstream to downstream, source of chlorides being Tg.Ocna area, where natural resources are occupied by salt, taking place in Vrânceni comparative strengths with the Tg.Ocna, but which fall within the category III water quality of (WFD) the Trotuş River.

Industrial production without adequate regard for environmental impacts has increased water and air pollution, and has led to soil degradation and large-scale global impacts such as acid rain, global warming, and ozone depletion (Seth S.M., 2003).

Many studies have discussed which physical-chemical elements are apporiate for defining (Wang C.et. al, 2005; Shuguang L.et al, 2011; Y.C. Lai et.al., 2011; Jinzhu M. et.al., 2009; Akkoyunlu A and Muhammed E.A., 2012).

In the present study we used physical-chemical elements to study the impact of quality water Siret River Basin.

According to the European Environmental Agency, in many catchments the main source of N-NH4, Ca, RF, SO4, Na, CBO5, Cl and Fe pollution is form urban land and discharges from wastewater treatment (EEA, 2003). The relationship between land uses and N-NH4(> 0,3 mg/l), RF(>500 mg/l), SO4(>150 mg/l), Na(>50 mg/l), CBO5(>5 mg/lO2), Cl (>100 mg/l) and Fe (>0,3 mg/l) and Ca (>300 mg/l) concentration in this study produced important conclusions. Urban use increased showed negative correlation correlations whit N-NH4, RF, SO4, Na and Cl. Ammonium was correlated whit urban use, thus indicating high industrial and population densities.

The urban sewage also produces serious pollution in some rivers studied, for example in the Siret River Basin, which receives high urban and industrial inputs of pollution from the Trotuş River. Between 1993 - 2003 there were 184 pollution incidents, with a minimum of 10 pollution in 1996 and a maximum of 28 in 2001. of the total pollution accidents occurring in this period 46.2% were recorded Trotuş River and its tributaries, 26.1% were recorded on Bistriţa River and its tributaries, and 9.8% were registered on the Siret River. The central objective of the Water Framework Directive (Directive 2000/60/EC) is to achieve "good status" for all water bodies, both the surface and those of groundwater, except bodies and heavily modified artificial, which defines "good ecological potential."

CONCLUSIONS

The paper investigated determinants of water quality Trotuş River, particularly the effectiveness of informal regulation in controlling pollution of rivers. Data on water quality (water class) for 3 monitoring points for six years (2006 – 2011) were used for the analysis. Given the nature of the water quality data, an ordinary regression analysis could not be applied. The statistical analysis was therefore carried out by using a StatSoft v.10 program. The results indicated a positive relationship between land use and water quality in rivers.

A significant negative relationship was found between the levels of industrialization and urban the water quality in the monitoring point falling in the district. A significant positive relationship was found between agricultural, forest percentage and water quality. The results also indicated a positive relationship between the water quality in rivers flowing through and mining.

These results may be taken as indicative of a significant favorable effect of WFD water quality rivers in Trotuş River Basin.

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REFERENCES

Allen, A.P., Whittier, T.R., Larsen, D.P., Kaufman P.R., O’Connor R.J., Hughes R.M., Stemberger R.S., Dixit S.S., Brinkhurst R.O., Herlihy, A.T., Pausel, S.G., 1999 - Concordance *of taxonomic composition patterns across multiple lake assemblages: effects of scale, body, size and land use.* Canadian Journal of Fsheries and Aquatic Sciences, 56, 2029-2040.

Alexander, R.B., Smith, R.A., Schwarz, G.E., 2000 - *Effect of stream channel size on the delivery of nitrogen to the Gulf of Mexico*. Nature 403 (6771), 758-761.

Akkoyunlu, A ., Akiner, M.E., 2012 - *Pollution evaluation in streams using water quality indices: A case study from Turkey’s Sapanca Lake Basin.* Ecological Indicators 18, 501–511.

Basnyat, P., Teeter L.D., Lockaby, B.G., Flynn, K.M., 2000 - *The use of remote sensing and GIS in watershed level analses of non point source pollution.* Forest Ecology and Management, 128, 67-73.

Behrendt, H., Bachor, A., 1998 - *Point and diffuse load of nutrients to the Baltic Sea by river basins of North East Germany (Mecklenburg-Vorpommern).* Water Sci.Technol. 38 (10), 147–155.

Carter, J.L., Fend, S.V., Kennelly, S.S., 1996 - *The relationships among three scales and strem benthic invertebrate community structure.* Freshwater Biology, 35, 109-124.

Chang, H., 2008 - *Spatial analysis of water quality trends in the Han River basin, South Korea.* Water Research 42, 3285-3304.

Fred, J.G., Petty, J.T., 2007 - *Response of fish and macroinvertebrate bioassessment indices to water chemisty in a mined Appalachian watershed.* Environ. Manage. 39, 707-720.

EEA, 2003 - *Europe’s water: An indicator-based assessment, topic report No1/2003.* European Evnironvent Agency, Copenhagen.

European Parliament and the Council of the European Union, 2000 - *Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy.* OJL 327, 1–72.

Gamze, K., Figen, U.E., Hikmet, K., 2003 - *Water quality and impacts of pollution sources for Eymir and Mogan Lakes (Turkey)*, Environment International 29, 21– 27.

Griffith, M.B., Hill, B.H., McCormick, F.H., Kaufmann, P.R., Herlihy, A.T., Selle, A.R., 2005 - *Comparative application of indices of biotic intergrity based on periphyton, macroinvertebrates, and fish to sourthern Rock Mountain streams.* Ecol. Indicators 5, 117-136.

Lammert, M., Allan, J.D., 1999 - *Assessing biotic integrity of streams: effects of scale in measuring the influence of land use/cover and habitar structure in fish and macroinvertebrates.* Environ. Manage. 23, 257-270.

Lääne, A., Pitkänen, H., Arheimer, B., Behrendt, H., Jarosinski, W., Lucane, S., Pachel, K., Räike, A., Shekhovtsov, A., Swendsen, L.M., Valatka, S., 2002 - *Evaluation of the implementation of the 1988 Ministerial Declaration regarding nutrient load reductions in the Baltic Sea catchment area.* The Finnish Environment 524, Helsinki.

Harding, J.S., Benfiled, E.F., Bolstad, P.V., Helfman, G.S., Jones, E.B.D., 1998 - *Stream Biodiversity: the ghost of land use past.* Proceedings of the National Academy of Sciences of the United States of America 95, 14843/14847.

Helming, J., Reinhard, S., 2009 - *Modelling the economic consequences of the EU Water Framework Directive for Dutch agriculture.* J. Environ. Manage. 91, 114–123.

Lai , Y.C., Yang , C.P., Hsieh C.Y., Wua, C.Y., Kao, C.M., *Evaluation of non-point source pollution and river water quality using a multimedia two-model system.* Journal of Hydrology 409, 583–595.

Li, J., Herlihy, A., Gerth, W., Kaufman, P., Gregory, S., Urquhart, S., Larsen, D., 2001 - *Variability in stram macroinvertebrates at multiple spatial scales.* Fresh-water Biology, 46, 87-97.

Luca, M., 2004 - *Considerations on the phenomenon of pollution induced by mining dumps. International coference "Polluation and Disaster Monitoring",* Science, Performantica, Gh Asachi Tehnical University, ISBN 978-973-730-406-3.

Luca, M., Mănescu, A., 2010 - *Considerations on the evolution of the Siret River water quality monitoring section Huţani,* Bulletin of the Polytechnic Instituite, Iaşi, Romania, Tomul LVI(LX), Fasc.4, 2010, 63-70.

Manel, S., Buckton, S.T., Ormerod, S.J., 2000 - *Testing large-scale hypotheses using survery: the effects of land use on the habitats, invertebrates and birds of Himalayan river.* Journal of Applied Ecology, 37, 756-770.

Meybeck, M., 1996 - *River water quality. Global ranges, time and space variabilities, proposal for some redifinitions*. Verhandlungen der International Vereinigung fur Theoretische und Angewandte Limnologie 26, 81-96.

McDonnell, R.A., 2000 - *Hieratchical modeling of the environmental impacts of river impoundment based on a GIS.* Hydrological Processes, 14, 2123-2142.

Monteagudo, L., Moreno, J.L., Picazo, F., 2012 - *River eutrophication: Irrigated vs. Non-irrugated agriculture through different spatial scales.* Water Research XXX, 1-13.

Moreno, J.L., Navarro, C., De las Heras, J., 2006 - *Abiotic ecotypes in Routh-central Spanish rivers: Reference conditions and pollution.* Enivironmental Pollution 143, 388-396.

Nerbonne, B.A., Vondracek, B., 2001 - *Effect of local land use on physical habitat, benthic macroinvertebrates, and fish in the Whitewater River, Minnesota, USA.* Environmetal Management 28, 87-99.

Palui, K., Sumergen, S., Inswiasri, S., Austina, L., Nunik, S.A., Sunarya, W., Quraisyn, A., 2000 - *River water quality study in the vicinity of Jakarta.* Journal Water Science andTechnology 31, 17-25.

Richards, C., Host, G., 1994 - *Examining land use influence on stream habitats and macroinveterbrates: a GIS approach.* Journal of American Water Resources Association 30, 729-738

Roth, N.E., Allan, J.D., Erickson, D.L., 1996 - *Landscapes influence on stream biotic integrity assessd at multiple spatial sacles.* Landscape Ecol. 11, 141-156.

Seth, S.M., 2003 - *Human impacts and management issues in arid and semi-arid regions.* In: Simmers, I. (Ed.), Understanding Water in a Dry Environment – Hydrological Processes in Arid and Semi-arid Zones. IAH-ICH 23, Balkema, Rotterdam, pp. 289–341.

Shuguang, L., Sha, L., Cuiping, K., Wenrui, H., Wujun, C., Jianle, Z., Guihui, Z., 2011- *Water quality assessment by pollution-index method in the coastal waters of Hebei Province in western Bohai Sea*, China, Marine Pollution Bulletin 62, 2220–2229.

Simeonov, V., Stratis, J.A., Samara, C., Zachariadis, G., Voutsa, D., Anthemidis, A., Sofoniou, M., Kouimtzis, T., 2003 - *Assessment of the surface water quality in Northern Greece.* Water Research 37 (17), 4119-4124.

Singh, K.P., Malik, A., Sinha, S., 2005 - *Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniquesea case study.* Analytica Chimica Acta 538, 355-374.

Omernik, J.M., Abernathy, A.R., Male, L.M., 1981 - *Stream nutrient level and proximity of agricultural and forest land to streams: some relationships.* Journal of Soil and Water Conservation 36, 227-231.

Tran, C.P., Bode, R.W., Smith, A.J., Kelppel, G.S., 2010 - *Land-use proximity as a basis for assessing stream water quality in New York State (USA).* Ecological Indicators 10, 727-733.

Wang, C., Wang, Yan-Ying, Wang, Pei-Fang, 2006 - *Water quality modeling and pollution control for the eastern route of south to north water transfer project in China.* Journal of Hydrodynamics, 18, 253-261.

WATECO (Working Group WATer Framework Directive Economics), 2003 - *Policy Summary to Guidance Document No 1: Economics and the Environment* – The Implementation Challenge of the Water Framework Directive. Common implementation strategy for the Water Framework Directive (2000/60/EC).

http://www.apesiret.uvp.ro.
http://data.freshwaterbiodiversity.eu/shapefiles.html
http://hydrosheds.cr.usgs.gov.