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WATER QUALITY INDEX FOR REDIU, CACAINA AND CIRIC RIVER IN URBAN AREA OF IASI CITY

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Key words: river, Iaşi urban area, water quality index, water quality standards

Abstract.Typically, reports on surface water quality include useful information for people, but the language used addresses rather specialists, which leaded to develop an mathematically index, like water quality index (WQI), very useful and efficient for assessing the suitability of water quality as well as for communicating the information to the concerned citizens and policy makers. The present study assessed the surface water quality for three rivers from northern part of Iasi city based on WQI. These water courses were not included into monitoring program, the area being highly populated, the citizens wishing to know the real state of the surface water resources in the area they live. For reaching this goal, there have been collected 19 samples, in June 2011, analysed in situ and in the laboratory. For the WQI were used six parameters (pH, turbidity, dissolved oxygen (DO), five days biochemical oxygen demand (BOD_5), phosphates (PO_4), nitrates (NO_3). The results have been statistically processed. The result showed that the WQI for each parameter fit into good status for pH, bad status for turbidity and oxygen indicators, excellent for phosphates and bad status for nitrates in Ciric and Cacaina river and good status on Rediu river. General WQI fall into medium status with variance between 53 for Ciric river and 67 for Rediu, with different values for each monitored point, Rediu being the only river that have two monitoring points that suit to good quality status.

Introduction

The surface water quality represent a provision of Water Framework Directive: maintaining a good ecological status is a necessity after EU accession, new approach for managing and improving surface water quality

The citizens have difficulties when they access a water quality reports, because these are written for specialists, showing survey data with emphasis on individual parameters. The developing of methods that integrate several variables related to water quality in a specific index are increasingly needed in international researches. A water quality index provides a single number that expresses overall

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water quality based on several water quality parameters, that is used in the flowing water quality assessment in the United States of America, Canada, Spain, France, Germany, Austria, Italy, Poland and Turkey (Islam, N., et.al. 2011, Jezierska K., et.al. 2011, Karbassi AR., et.al 2011, Monferran MV., et.al. 2011, Neal C., et.al. 2000, Panepinto, D., Genon, G., 2010, Pantelic M., et. Al. 2012, Song T., Kyehyun K., 2009, Srebotnjaka Tanja, et.al. 2012, Terrado Marta, et.al. 2010, Yidana, S.M., Yidana, A., 2010). Water Quality Index is a very useful and efficient tool for assessing the suitability of water quality. It is also a very useful tool for communicating the information on overall quality of water (Akoteyon, I. S. et al., 2011) to the concerned citizens and policy makers. A water quality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public. A single number cannot give all information about of water quality; there are many other water quality parameters that are not included in the index. However, a water index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea the possible problems with the water in the region (Yogendra, K., Puttaiah E.T., 2007).

The present study assessed the surface water quality for three rivers from northern part of Iasi city based on WQI.

1. Materials and methods

For the present study, three unmonitored rivers from the north part of Iasi was selected. Surface water samples were collected along Rediu, Cacaina and Ciric rivers from nineteen sampling points during the month of June 2011. In situ measurement was used to determine unstable parameters such as: pH, electrical conductivity, temperature, and total dissolve solids using Multi 350i/SET WTW multiparameter instrument, while the chemical parameter were analysed in the laboratory using standards methods for the examination of water and waste water (ISO; SR-EN-***). Winckler method were used for dissolved oxygen and biochemical oxygen demand, while spectrophotometric method were utilized for nitrates and phosphates, with phenol-disulphonic acid for nitrates at 410 nm and molybdate salt for phosphates at 550nm, the optical density of the solutions being was measured by Shimadzu UV 1601 spectrophotometer.

The following four steps are most often associated with the development of any WQI; depending on the sophistication being aimed at, additional steps may also be taken (Ott, W.R., 1978):

- Parameter selection
- Transformation of the parameters of different units and dimensions to a common scale

- Assignment of weightings to all the parameters
- Aggregation of sub-indices to produce a final index score

For WQI only six parameters were included: pH, turbidity, dissolved oxygen (DO), five days biochemical oxygen demand (BOD_5), phosphates (PO_4), nitrates (NO_3).

After creating the database, WQI was calculated according to the international formula:

$$WQI = \frac{1}{100}\left(\sum_{i-1}^{9} qi\, wi\right)^2$$

Were:

i - the quality parameter

q_i – registered value

w_i – the rank of implication of the parameter in the computation formula

pH – 0.11, Turbidity – 0.7, DO saturation – 0.17, BOD_5 - 0.11, PO_4 - 0.10, NO_3 – 0.11

The final WQI were calculated and revealing the status it fit according to the next table:

Legend	Status
91-100	Excellent
71-90	Good
51-70	Medium
26-50	Bad
0-25	Very bad

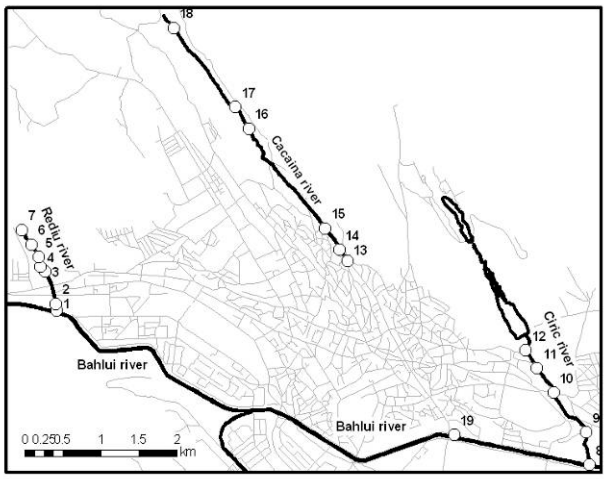

Fig.1- Sampling points location (2011)

3. Results and discussions

The monitored parameters include a great variety of physic-chemical and biological/ organic parameters, excepting the microbiologic parameter – Total Coliforms, because it is monitored in the sections where the water is destined for the potable use:

- Physical: turbidity
- Chemical: pH, nitrates, phosphates
- Biological as: BOD_5, dissolved oxygen

The value of various physicochemical parameters for calculating of water quality index are presented in figure 2.

Among all the physiscochemical indicators elected for WQI determination pH is very important to determine future water uses. In the present study pH mean values 7.694 ± 0.712, that fit into slight alkaline class, with neutral pH only for Rediu river, WQI (Figure 2, a) fall into good class, excepting two sample points that belong to the medium class, being located on the Ciric river first point after the lakes upstream supplied it with water, and Cacaina river at the last point before the confluence with Bahlui river, after it pass through a channeled section corresponding to C. A. Rosseti and T. Vladimirescu Bldv.

Turbidity was faound to be high, mean values 85 ± 133 NUT, with higher value registered on Ciric river, after a sewage output mobilized the sediments to the bottom of minor riverbed, with 268 NUT and Cacaina river with 581 NUTS, with the same cause as pH variation. WQI (Figure 2, b) fit into bad class, and three points into very bad one, mainly due to the rainfall period that preceded the sampling.

BOD_5 (Figure 2, c) represent a biological parameter that express the amount of oxygen required for microbial metabolism of organic compounds in water influenced by the temperature and nutrient concentrations, with mean value of 6.69 mg O_2/L. WQI fit into bad class for Ciric and Cacaina river, and with downward trend from source to confluence with Bahlui river, thank to the lower rate of urbanization of the area it cross, excepting the confluence area.

Dissolved oxygen saturation (figure 2, d) represent one of the most important parameter that sustain aquatic live, regulating the distribution of aquatic flora and fauna, with mean values 42.88 ± 1.95 %, that fit into bad class of WQI for all monitored river. This situation was caused by the explosive vegetation that cover the shores and the algae from the river water, specific to the warm season start when the temperatures during summer speed up the rates of photosynthesis and decomposition, with lower saturation values on rainy period with high turbidity levels.

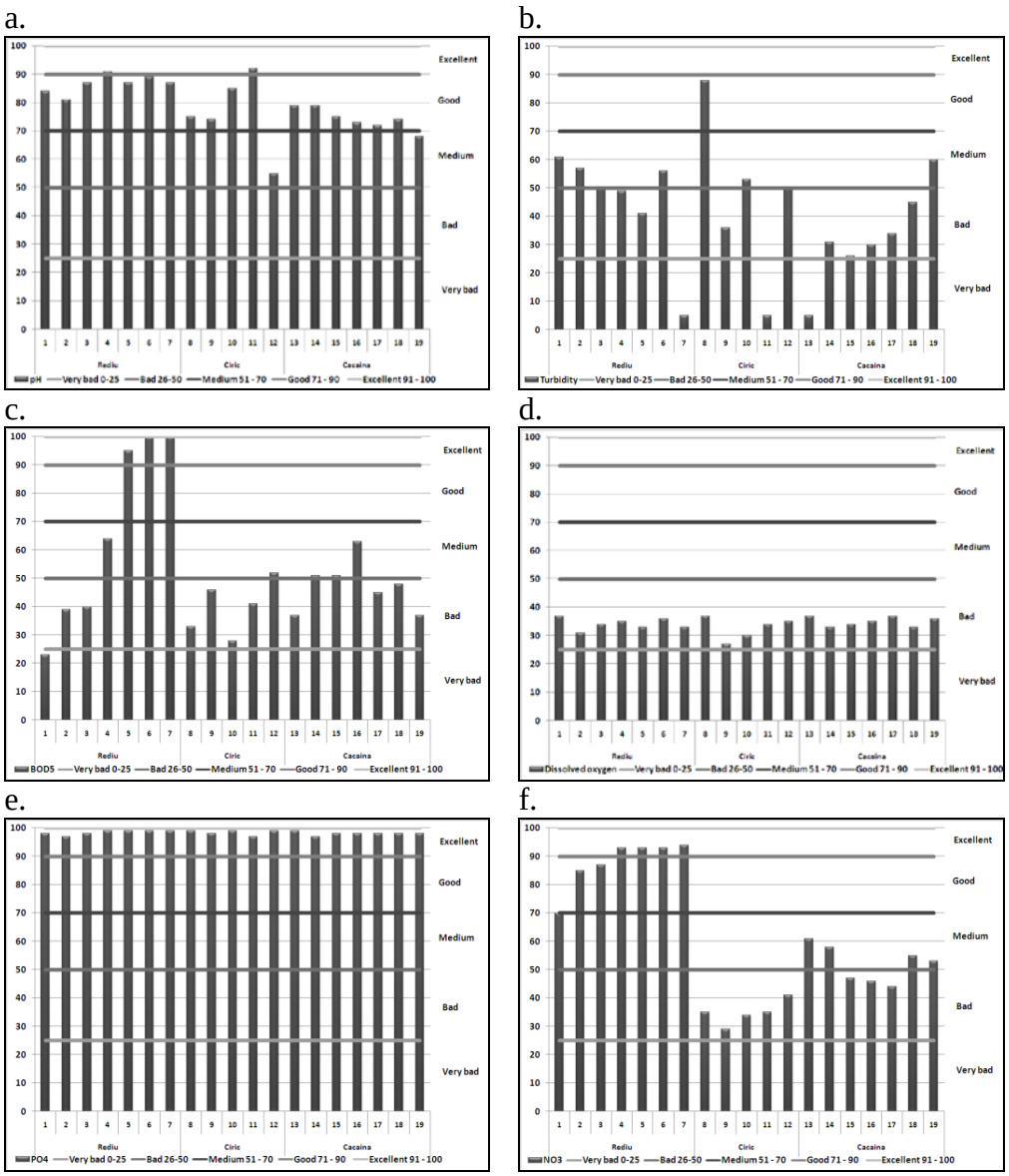

Figure 2: WQI values variation for each parameter:
a. pH, b. Turbidity, c. BOD_5, d. Dissolved oxygen, e. Phosphates, f. Nitrates

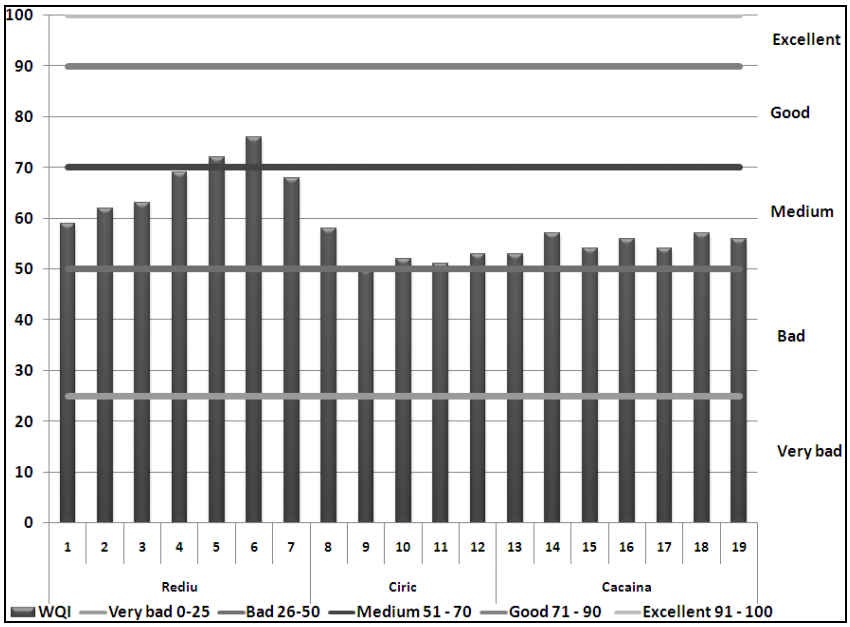

Figure 3: WQI for Rediu, Cacaina and Ciric river

From the anterior observations of the parameters, it can be observed that the water bodies presents high turbidity, high BOD_5, high NO_3 concentrations indicate the medium status of these rivers.

Water Quality final Index fall into medium class, with variable values for each river: Rediu river with WQI of 67, with two points (number 5 and 6) that were situated in good class, due to lower influence of urbanized area, Ciric river with a WQI of 53, the lower score of all analyzed rivers, with one monitored point (number 9) situated in bad class, due to the presence of lakes upstream and Cacaina river with WQI of 55.

The bad class fit for Ciric and Cacaina river is generated also by the area it cross, dominated by individual houses and a large number of sewage drains that fill into the river water, in addition of the waste that were spread out to minor riverbed by the inhabitants, therefore water quality being influenced by the anthropic factor.

The relevance of the WQI is given by the importance as instrument in the authorities management plans to improve water quality in the area, including the citizens information concerning the water resources quality in their living area.

Conclusions

The computation of water quality index and the analyze of the implication of the quality of surface water resources in the studied area highlight the following:

- Bring to the same measuring unit more parameters related to the water quality and include six different parameters in one number, easily to include in a water body status
- The citizens could be inform about water quality status, easy to understand, offering an clear image of the water usage degree in various purposes.
- The results reveal that WQI include river in good status, with variation of the three rivers monitored, with relevant problem concerning the turbidity, dissolved oxygen, and nitrates for Ciric river.

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References

Akoteyon, I. S., Omotayo, A. O., Soladoye, O., Olaoye, H. O., (2011), *Determination of Water Quality Index and Suitability of Urban River for Municipal Water Supply in Lagos-Nigeria*, European Journal of Scientific Research, Vol.54 No.2 (2011), pp.263-271

Barbu, N., Ungureanu, Al. (1987), *Geografia municipiului Iaşi*, Ed. Universitatii "Al. I. Cuza" Iasi

Benchea, Roxana, Cretescu, I., Macoveanu, M., (2011), *Monitoring of water quality indicators for improving water resources of Bahlui River*, Environmental Engineering and Management Journal, Vol.10, No. 3, p. 327-332

Bogdan, N. A. (2004), *Oraşul Iaşi, Monografie istorică şi socială, ilustrată,* Editura Tehnopress, Iaşi

Das, S., Majumder, M., Roy, D., Mazumdar, A., (2010), *Determination of Urbanization Impact on Rain Water Quality with the Help of Water Quality Index and Urbanization Index*, Impact Of Climate Change On Natural Resource Management Pages: 131-142 DOI: 10.1007/978-90-481-3581-3_7

Fulazzaky, M.A., (2009), *Water Quality Evaluation System to Assess the Brantas River Water*, Water Resources Management Volume: 23 Issue: 14 Pages: 3019-3033 DOI: 10.1007/s11269-009-9421-6

Fulazzaky, M.A., (2010), Water quality evaluation system to assess the status and the suitability of the Citarum river water to different uses, Environmental Monitoring

And Assessment Volume: 168 Issue: 1-4 Pages: 669-684 DOI: 10.1007/s10661-009-1142-z

Islam, N., Sadiq, R., Rodriguez, M.J., Francisque, A., (2011), *Reviewing source water protection strategies: A conceptual model for water quality assessment*, Environmental Reviews Volume: 19 Pages: 68-105 DOI: 10.1139/A11-001

Jezierska, K., Gonet, B., Podraza, W., Domek, H., (2011), *A new method for the determination of water quality*, Water SA Volume: 37 Issue: 1 Pages: 127-129

Karbassi, AR., Hosseini, FMM., Baghvand, A., Nazariha, M., (2011), *Development of Water Quality Index (WQI) for Gorganrood River*, International Journal Of Environmental Research Volume: 5 Issue: 4 Pages: 1041-1046

Monferran, MV., Galanti, LN., Bonansea, RI., Ame, MV., Wunderlin, DA., (2011), *Integrated survey of water pollution in the Suquia River basin (Cordoba, Argentina)*, Journal Of Environmental Monitoring Volume: 13 Issue: 2 Pages: 398-409 DOI: 10.1039/c0em00545b

Neal, C., Williams, R. J., Neal, Margaret, Bhardwaj, L.C., Wickham, Heather, Harrow, M., Hill, Linda, (2000), *The water quality of the River Thames at a rural site downstream of Oxford*, The Science of the Total Environment, 251/ 252, p. 441 – 457

Neamtu, M., Ciumasu, I., Costica, N., Costica, M., Bobu, M., Nicoara, M., Catrinescu, C., Becker van Slooten, K., De Alencastro, L., (2009), *Chemical, biological, and ecotoxicological assessment of pesticides and persistent organic pollutants in the Bahlui River, Romania*, Environ Sci. Pollut. Res., (Suppl 1), p. 76–85

Obreja, Al. (1979), *Dicționar geografic al județului Iași*, Editura Junimea, Iași

Ott, W.R., (1978), *Water Quality Indices: A Survey of Indices used in the United States*, EPA – 600\4-78-005, Environmental Protection Agency, Washington, D.C.

Panepinto, D., Genon, G., (2010), *Modeling of Po River Water Quality in Torino (Italy)*, Water Resources Management Volume: 24 Issue: 12 Pages: 2937-2958 DOI: 10.1007/s11269-010-9588-x

Pantelic, M., Dolinaj, D., Savic, S., Stojanovic, V., Nad, I., (2012), *Statistical analysis of water quality parameters of Veliki Backi canal (Vojvodina, Serbia) in the period 2000-2009*, Carpathian Journal Of Earth And Environmental Sciences Volume: 7 Issue: 2 Pages: 255-264

Sanchez, E., Colmenarejo, M. F., Vicente, J., Rubio, A., Garcia, M. G., Travieso, Lissette, Borja, R., (2007), *Use of the water quality index and dissolved oxygen deficit as simple indicators of watersheds pollution*, Ecological Indicators 7, p. 315–328

Schram Maria, Erhan Elena, (1978), *Contribuții la cunoaşterea potențialului natural al teritoriului municipiuli Iaşi, cu unele impluicații de ordin practic*, Analele ştiințifice ale Universității Al. I. Cuza, Iași, Secția II b, Tomul XXIV

Seliman, C., Plopa, O., Damian, C., Crețu, M.. (2009), *Urban environment influence on the surface water quality in the city of Iaşi*, Academic Journal of the Faculty of Agriculture, vol. 52, U.A.S.M.V. Iași, p. 461 – 466

Song T., Kyehyun K., (2009), *Development of a water quality loading index based on water quality modeling*, Journal of Environmental Management 90, p. 1534–1543

Srebotnjaka, Tanja, Carrb, Genevieve, de Sherbininc, A., Rickwoodd, Carrie, (2012), *A global Water Quality Index and hot-deck imputation of missing data*, Ecological Indicators 17, p. 108–119

Terrado, Marta, Borrell, Elena, de Campos, Sergio, Barcelo, D., Tauler, R., (2010), *Surface-water-quality indices for the analysis of data generated by automated sampling networks*, Trends in Analytical Chemistry, Vol. 29, No. 1

Yidana, S.M., Yidana, A., (2010), *Assessing water quality using water quality index and multivariate analysis*, Environmental Earth Sciences Volume: 59 Issue: 7 Pages: 1461-1473 DOI: 10.1007/s12665-009-0132-3

Yogendra, K., Puttaiah E.T., (2007), *Determination of Water Quality Index and Suitability of an Urban waterbody in Shimoga Town, Karnataka*, Proceedings of Taal, The 12th World Lake Conference, p. 342-346

*** Order no. 161/2006 – Normative regarding the classification of surface waters in orderto establish the ecological status of water bodie