Revista do Depto de Tecnologia Rural – Universidade Federal Rural de Pernambuco

Geama
Revista
Scientific Journal of Environmental Sciences

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Water quality in Una River Basin – Pernambuco

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Informações do artigo
Recebido: Agosto 19, 2017
Aceito: Outubro 21, 2017
Publicado: Janeiro, 2018

Todos autores contribuíram de forma igualitária

ABSTRACT

This study aimed to evaluate the water quality of the lower portion of Una River Basin, Pernambuco, by means of analysis of physical, chemical and microbiological parameters. The monitoring was conducted among October 2013 and March 2014. Sampling locations were in the cities of Catende, Palmares and Água Preta, selecting three collection points in each district. Parameters analyzed: temperature, electric conductivity, dissolved oxygen, biochemical oxygen demand, turbidity, potassium, pH, total phosphorus, thermotolerant coliforms, and *Escherichia Coli*. The results showed the water quality in the Basin Una River is outside of CONAMA standars Resolution 357/2005 for fresh water Class II parameters: dissolved oxygen, pH, phosphorus, thermotolerant coliforms and Escherichia Coli. Potassium concentration shows the discharge of effluents from the processing of sugar cane in the hydrous body did not affect the quality of the water. The main contamination source of water was the release of domestic sewage.

Keywords: CONAMA Resolution 357/2005, monitoring, water resources

Introdução

The monitoring of water quality is one of the main instruments to support a water resources planning and management policy, since it acts as a sensor that allows monitoring of the hydric bodies use process, presenting its effects on qualitative characteristics of hydric bodies, in order to subsidize environmental control actions (Guedes et al., 2012).

In the Northeast of Brazil, water resources come under reduction process of quality as a consequence of waste release from anthropic activities developed in their river basins. The main causes of water resources pollution identified in this region are the presence of slaughterhouses with discharge of untreated effluent, the deposition of solid waste on the banks and water body itself, and the surface runoff of agricultural areas with intensive use of chemical fertilizers and pesticides.

In Pernambuco, Una River is considered one of the main water bodies, with a length of approximately 270 km. Its watershed, which covers an area of 6.740 km^2, is limited to the north with the basins of Ipojuca and Sirinhaém; To the south, with the basin of the Mundaú River, the State of Alagoas, the group of small river basins 5 (GL5) and the group of small river basins 1 (GL51) rivers; To the east, with the Atlantic Ocean, Sirinhaém River Basin, the GL4 and GL5; And to the west, with Ipojuca and Ipanema river basins (Souza et al., 2011).

Una River Basin presents diversity of water uses such as irrigation and public supply. Of particular note is the use of water for recreation and tourism, especially in the municipality of Bonito, which has many waterfalls. Small water abstractions are also common for human and animal supply, industrial, domestic activities, recreation and fishing occurring in various locations (ITEP, 2011).

In the municipalities located in the downstream of Una River Basin, such as São Bento do Una, Bonito, Catende and Palmares, the use of water for agriculture, fishing, and supply is predominant. The sulco-alcoholic activity is highlighted in this region, a segment that presents significant production of agroindustrial residues with polluting potential (Torres et al., 2012).

In 1997, to reduce the polluting potential of anthropic activities and promote the sustainable use of water, Law No. 9433/97 was approved, known as the Waters Law, which creates in Brazil the National Policy of Water Resources. The Waters Law establishes in Art. 3 that the management of water resources should be integrated with environmental management, and Art. 9, that the water bodies will be classified into classes, according to the main uses of water, seeking to ensure the water quality resources with the most demanding uses for which they are intended, as well as to reduce the costs of fighting water pollution.

Resolution 357/2005, published by the National Council for the Environment (CONAMA), provides for the classification of water bodies and establishes environmental guidelines for their classification. In it, water intended for human consumption with conventional treatment, recreation of primary contact, and aquaculture and fishing activity, must present quality equal to or higher than Class 2 (BRASIL, 2005).

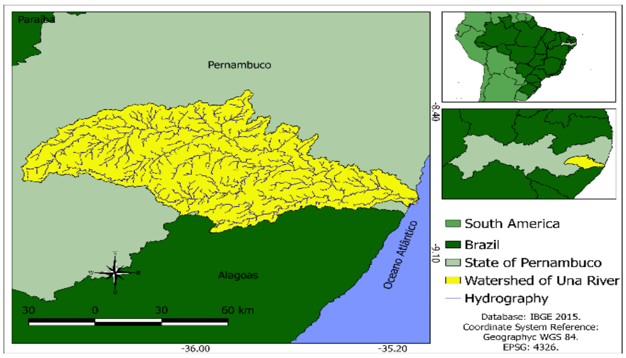
Thus, efforts must be made to avoid the degradation of water bodies that are still preserved and to improve those that are already degraded. It is necessary the development of researches to understand physical, chemical and biological processes that work in these environments in order to elaborate mitigating measures that may contain the advance of degradation (Nascimento et al., 2011).

In this context, the objective of this study was to evaluate the spatial and temporal variability of water quality parameters, classified as Class II, in the lower portion of the Una River Basin, through the monitoring of physical-chemical and microbiological parameters.

Material e Métodos

The research was developed in the Una River Basin located south of the Pernambuco State coast, between the parallels 08°17'31.5" and 09°0'0.77" south latitude, and meridians 36°42'24.03" and 35°5'54.68" west longitude (Figure 1).

Figure 1 - Location of the watershed of Uma River.



Source: Author, 2016.

In order to evaluate the water quality in the Una River Basin, monthly water samples were collected during a period from October 2013 to March 2014. All samples were collected in the morning. The section of the hydrographic basin delimited for the accomplishment of the monitoring contemplated the low portion of River Una (Figure 2). The collection sites were defined considering soil use and occupation, ease of access and safety of sampling (Table 1).

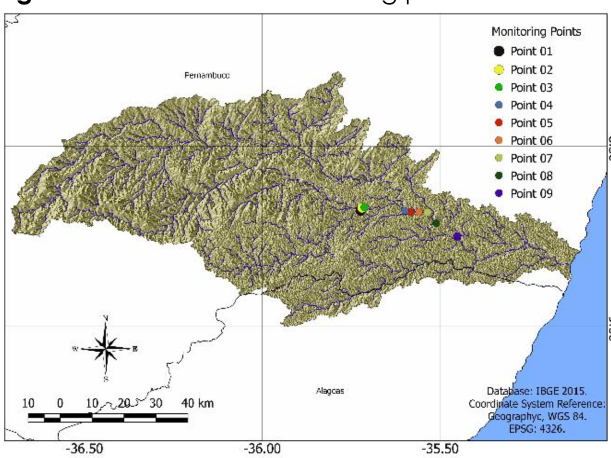
The method for collecting, packaging, storing and preserving the samples were performed in accordance with the requirements of NBR 9897, which describes the sampling procedure for liquid effluents and receiving bodies, and NBR 9898 which specifies the procedure for the preservation and sampling techniques for liquid effluents and receiving bodies, and the National Guide for collection and preservation of samples for water, sediment, aquatic communities and liquid effluents (CETESB, 2011).

In the collection procedure, polyethylene flasks with a volume of 5 L were used for the physico-chemical characterization. For the microbiological analysis, a sterile polyethylene flask with 100 m L volume was used. In the determination of dissolved oxygen (DO) and biochemical oxygen demand (BOD), a 250 m L glass vessel was used.

After sampling, the material was packed in a styrofoam box with an average temperature of 4 °C, and were taken to the Water Quality Laboratory of Federal University of Pernambuco and to Agrolab laboratory in Recife, PE. The analyzes started always on the same day of collection and, for samples preservation, the refrigeration technique was used for a maximum period of 5 days.

The parameters electrical conductivity and temperature were measured in the field at moment of sampling, with a multiparameter probe Instrutherm PH 1500. The laboratory analysis followed the standard methodology for water and sewage analysis of APHA (2005). The turbidity was determined by the standard methodology for water and sewage analysis - SMEWW 2130 B, and pH by potentiometry method - SMEWW 4500 B.

Figure 2 – Location of monitoring points.



Source: Author, 2016.

Table 1 - Location of monitoring points.

Point	City	Location	Coordinate
1	Catende	Near the bridge at the entrance of the city, coming from Palmares, upstream Catende – PE	S08º40'40.4" W35º43'21.9"
2	Catende	Next to the Catende Plant, in Catende - PE	S08º 40'16.3" W35º 43'8.5"
3	Catende	Near the Catende plant sheds, downstream from Catende – PE	S08º40'9.8" W35º 42'45.2"
4	Palmares Palmares	After the third bridge coming from BR 101, upstream from Palmares – PE	S08º40'42.9" W35º 35'52.4"
5	Palmares	Second bridge coming from BR 101, in the city of Palmares – PE	S08º40'56.2" W35º 35'1.8"
6	Água Preta	After Prison of city of Palmares - PE, downstream of Palmares – PE	S08º40'56.7" W35º 33'31.8"
7	Água Preta	In the Nova Água Preta neighborhood, upstream of Água Preta- PE	S08º40'58.5" W35º 32'4.1"
8	Água Preta	Center of Água Preta, in the city of Água Preta – PE	S08º42'52" W35º30'35.91"
9		First bridge after the Água Preta - PE, downstream of Água Preta - PE	S08º44'58.9" W35º27'2.1"

Resultados e Discussão

The results of physical, chemical and biological parameters are shown in Figure 3 and compared to the values of Resolution 357/2005 of CONAMA to verify compliance with the acceptable standards for Class II, which among other uses, are of water that can be destined to human consumption and supply after conventional treatment and the recreation of primary contact, such as swimming and diving, in which the public can have direct contact.

As established by Resolution 357/2005 for Class II, the DO contents must be at least 5 mg L^{-1} of O_2. According to the analyzes, it is noticed that collection points P5, P6 and P7 were below the established minimum limit. Similar to that observed by Souza et al. (2014), these results are directly associated to the point sources of domestic effluents that, due to their organic load, consume large amount of oxygen available for the oxidation process of organic and inorganic matter. In this way, it can be verified that in stretch of the Una River, located between the cities of Palmares and Água Preta, the condition of water quality is in accordance with the preponderant uses intended for a Class II freshwater river.

The pH values presented low spatial variability ranging from slightly acidic to neutral. In general, the mean pH value was at the lower limit of the range established by the CONAMA resolution (between 6 and 9). However, some collections, especially those made within the urban zone (points P2, P5 and P8), were outside the established range.

According to Von Sperling (2014), the major cause of water pH change in rivers is the release of industrial and household waste. Decaying organic matter produces humic acid which in large quantities can reduce pH. Barakat et al. (2016) also observed lower pH values at stations near the wastewater discharge points.

Potassium (K+) concentrations ranged from 1.2 to 3.2 mg L-1. This range of variation, below the values found by Lucas et al (2010), from 4.2 to 54.9 mg L-1, and Hillel et al. (2015), from 9.53 to 412 mg.l-1, discards the possibility of influencing the launch of agroindustrial effluent in the water quality of the Una River.

It is known that the sugar and alcohol industry is the main economic activity of the river basin and that in the process of production of sugar and alcohol, the main by-product is the vineyard, rich in K+. The peak concentration observed in October (Figure 4), beginning of the sugarcane milling period, corroborates the inference that the application of industrial wastewater had little effect on the water quality of Rio Una.

According to CONAMA Resolution 357/2005, for electrical conductivity in fresh water, the limit for Class I is 50 to 75 µS; Class II of 75 to 100 µS; Class III from 100 to 150 µS and Class IV greater than 150 µS. It is verified by the classification that in all points of collection the values of electrical conductivity are above the established limits. In view of the above, it can be said that the waters of the Una River Basin reflect high amounts of ions in solution. Again, the probable cause is related to the release of domestic and industrial effluents. Domestic sewage presents large amounts of NaCl, which in solution increase the electrical conductivity of the water. Sharif et al. (2015) attributed the extremely high levels of electrical conductivity, salinity and chlorides (Cl-) found in the Klang River basin, Malaysia, to anthropogenic sources, while Yu et al. (2016) found a correlation between Cl- concentrations with human activities, especially in urbanized areas.

Figure 3. Box-plot of temporal variability of pollution parameters in Una River (25th percentile ~ median ~ 75th percentile)

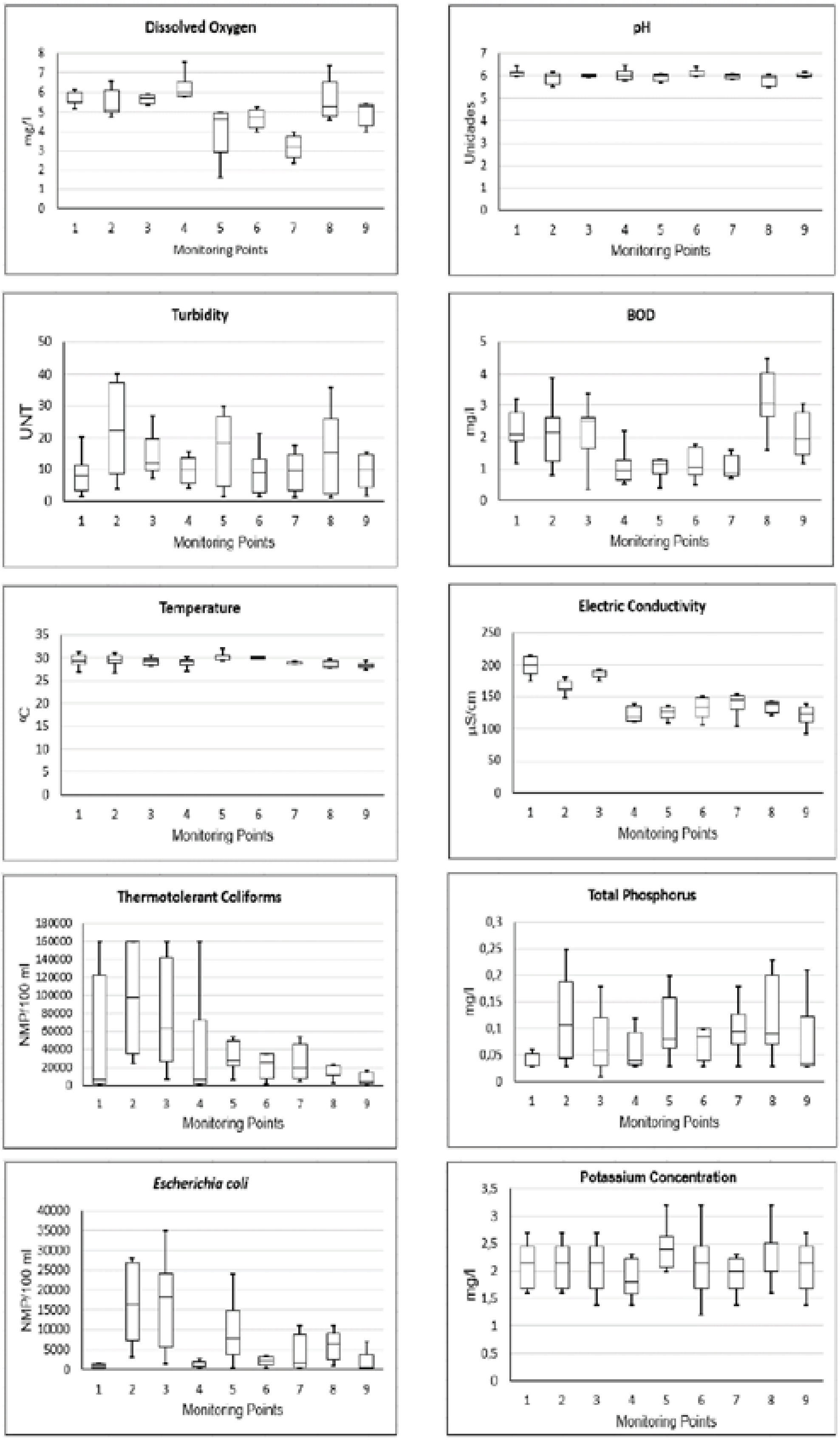
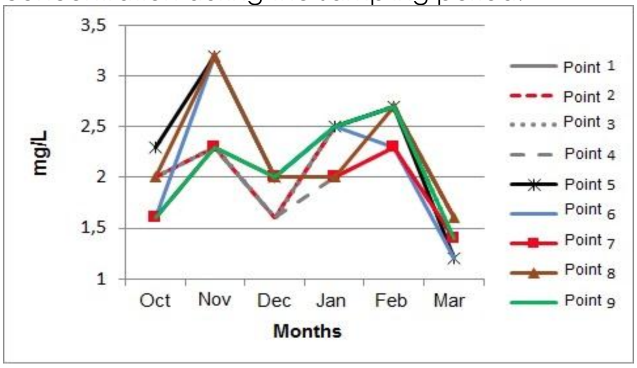


Figure 4. Spatio-temporal variation of potassium concentration during the sampling period.



The highest values of EC found at points P1, P2 and P3 reflect the hydromorphological influence of the river basin on water quality parameters. The proximity of these points to a more rugged relief area (Figure 2), the region's rainfall regime and agricultural activity may have favored the surface runoff of inputs and contaminants and promoted EC elevation.

Similar considerations were obtained by Wang et al. (2014) who reported that the characteristics of the river basin, such as topography and surface geology, although complex, should be considered because they influence the water quality of the rivers. The authors also reported that the increasing availability of Geographic Information Systems (GIS) and remote sensing techniques has enabled researchers to better quantify heterogeneous landscapes, generating a better understanding of the relationship between land use and water quality of a River.

The occurrence of high concentrations of total phosphorus also shows great contribution of nutrients from domestic sewage discharges in each river basin. According to Resolution 357 of CONAMA, the limit of total phosphorus concentration for Class I and II is 0.1 mg.L-1 for freshwater rivers. It should be noted that only station 1, located upstream of the three municipalities studied and which did not suffer interference from the domestic sewage discharge, presented values lower than the limit established by the resolution for Class II waters.

Chapman et al. (2016) quantified the emission of pollutants from point and diffuse sources on the Danube River, Europe, using the MONERIS model and identified that agriculture was the main source of nitrogen emissions while urban settlements were the main source of phosphorus pollution. Guanes et al. (2016) suggested that higher levels of nutrients (nitrogen, phosphorus, nitrates and nitrites) and total coliforms were more associated with urban area, population density and absence of riparian forest in the Xelaju River basin, Argentina.

The value of the bacteriological parameters for Class II should not exceed the limit of 1,000 thermotolerant coliforms per 100 ml sample. The contamination by thermotolerant coliform was high in all collection points throughout the study period, presenting nonconformity with CONAMA Resolution 357/2005. Buzelli and Cunha-Santino (2013) also obtained extremely high values of coliforms and attributed this source to the discharge of sewage, mainly domestic, without previous treatment.

It was expected that coliform contamination rates would be higher at collection sites P1, P2 and P3, because as the salinity of the water increases, the mortality rate of coliform bacteria also tends to increase (Boye et al., 2015). However, the optimum pH range for coliforms during the monitoring period, between 6 and 7 according to Solic and Krstulovic (1992), and water temperature stable and close to 30oC may have interfered with the mortality rate.

According to CONAMA Resolution 274/2000, waters considered suitable for human bathing are subdivided into: excellent (maximum of 250 fecal coliforms or 200 Escherichia coli per 100 ml), very good (maximum of 500 fecal coliforms or 400 E. coli) and satisfactory (Maximum of 1,000 fecal coliforms or 800 E. coli). The values obtained for these variables were superior to the established standards, classifying the Una River waters as unfit for direct and prolonged contact with water.

At all the points sampled, the turbidity did not exceed the permissible value of 100 NTU established in CONAMA Resolution No. 357/2005. The highest values were identified at points P2, P5 and P8 and are directly correlated with phosphorus values, indicating that the organic sediment load from the sewage system contributed to the maximum values observed during the monitoring period.

From the results, it was possible to observe that there was little variation in the concentration of the Biochemical Oxygen Demand (BOD) between the monitored points. Resolution 357/2005 of CONAMA establishes for the freshwater, Class II river, the limit of 5 mg L-1 O2 for BOD. As observed values were within the established standard for Class II freshwater, it can be inferred that the discharge of effluents has been contaminating the Una River waters, but this contamination is not interfering with aquatic life.

Thus, in a general overview, the results showed the waters quality of Una River is out of the acceptable standard for Class II of Resolution 357/2005 of the National Environmental Council (CONAMA). As the discharge of domestic effluents is the main source of pollution, it is necessary that measures be taken by the public power to implement sanitation networks to effect the improved water quality of the basin. It is also necessary to include in the monitoring program substances that are dangerous to human health and are commonly found in domestic sewage, such as pharmaceutical compounds.

Conclusões

The water quality in Una River Basin was not in accordance with CONAMA Resolution No. 357/2005 standards for Class II waters;

The parameters Biochemical Oxygen Demand and turbidity were in accordance with the standards established by the CONAMA resolution;

The main source of pollution in Una River was the dumping of domestic sewage;

The sugar alcohol activity did not affect the water quality of Una River.

Agradecimentos

The authors are grateful to Coordination for the Improvement of Higher Education Personnel (CAPES), the National Council for Scientific and Technological Development (CNPq) and the Foundation for the Support of Science and Technology of Pernambuco State (FACEPE).

Referências

APHA – American Public Health Association; AWWA – American Water Works Association & WEF - Water Environment Federation.Standard Methods for the Examination of Water and Wastewater. Eaton, A. D.; L. S. Clesceri; A. E. Greenberg (Ed.), 20th ed. Washington, D.C.: [s.n.], 2005.

BARAKAT, A.; BAGHDADI, M.E.; RAIS, J.; AGHEZZAF, B.; SLASSI, M. Assessment of spatial and seasonal water quality variation of OumErRbia River (Morocco) using multivariate statistical techniques. International Soil and Water Conservation Research, v.4, p.284-292, 2016.

BOYE, B.A.; FALCONER, R.A.; AKANDE, K. Integrated water quality modelling: Application to the Ribble Basin, U.K. Journal of Hydro-environment Research, v.9, p.187-199, 2015.

BRASIL. Ministério do Meio Ambiente. Resolução nº 357, de 17 março 2005. Dispõe sobre a classificação dos corpos de água e diretrizes ambientais para o seu enquadramento, bem como estabelece as condições e padrões de lançamento de efluentes, e dá outras providências. Brasília, 2005. 23 p.

BUZELLI, G.M.; CUNHA-SANTINO, M.B. da. Análise e diagnóstico da qualidade da água e estado trófico do reservatório de Barra Bonita, SP. Revista Ambiente & Água, v.8, p.186-205, 2013.

CETESB - Companhia Ambiental do Estado de São Paulo. Guia nacional de coleta e preservação de amostras: água, sedimento, comunidades aquáticas e efluentes líquidos. Companhia Ambiental do Estado de São Paulo; Organizadores: Carlos Jesus Brandão ... [et al.]. -- São Paulo: CETESB; Brasília: ANA, 2011. 326 p.

CHAPMAN, D.V.; BRADLEY, C.; GETTEL, G.M.; HATVANI, I.G.; HEIN, T.; KOVÁCS, J.; LISKA, I.; OLIVER, D.M.; TANOS, P.; TRÁSY, B.; VÁRBÍRÓ, GARBOR, Developments in water quality monitoring and management in large river catchments using the Danube River as an example. Environmental Science & Policy, v.64, p.141-154, 2016.

GUANES, R.L.; ESPINOSA, M.G.; MARCIAL, N.R.; MENDOZA, R.B.; JIMÉNEZ, F.; CASANOVES, F.; CASTILLEJOS, K.M. Human pressure on water quality and water yield in the upperGrijalva river basin in the Mexico-Guatemala border. Ecohydrology &Hydrobiology, v.16, p.149-159, 2016.

GUEDES, H. A. S.; SILVA, D. D. DA; ELESBON, A. A. A.; RIBEIRO, C. B. M.; MATOS, A. T. DE; SOARES, J. H. P. Aplicação da análise estatística multivariada no estudo da qualidade da água do Rio Pomba, MG. Revista Brasileira de Engenharia Agrícola e Ambiental, v.16, n. 5, p.558-563, 2012.

HILLEL, N.; GEYER, S.; LICHA, T.; KHAYAT, S.; LARONNE, J.B.; SIEBERT, C. Water quality and discharge of the Lower Jordan River. Journal of Hydrology, v.527, p.1096-1105, 2015.

ITEP - INSTITUTO DE TECNOLOGIA DE PERNAMBUCO. Resumo do Relatório de Impacto Ambiental- RIMA: Sistema de controle de cheias da Bacia hidrográfica do Rio Uma- Barragem de Serro Azul/ Instituto de Tecnologia de Pernambuco; Unidade Gestora de Projetos Barragens da Mata Sul.- Recife, 2011. 24f.: il. Available in: <http://www.itep.br/ProjetoBarragens/rimas/Resumo_Rima_Serro_Azul.pdf>. Acesso em: 01 ago. 2016.

LUCAS, A.A.T.; FOLEGATTI, M.V.; DUARTE, S.N. Qualidade da água em uma microbacia hidrográficado Rio Piracicaba, SP. Revista Brasileira de Engenharia Agrícola e Ambiental, v.14, n.9, p.937-943, 2010.

NASCIMENTO, R. F. F.; ALCÂNTARA, E; KAMPEL, M.; STECH, J. L. Caracterização limnológica do reservatório hidrelétrico de Itumbiara, Goiás, Brasil. Revista Ambiente & Água, v. 6, n. 2, p. 143-156, 2011.

SHARIF, S.M.; KUSIN, F.M.; ASHA´ARI, Z.H.; ARIS, A.Z. Characterization of water quality conditions in the Klang RiverBa sin, Malaysia using self organizing map and K-means algorithm. Procedia Environmental Sciences, v.30, p.73-78, 2015. doi: 10.1016/j.proenv.2015.10.013

SOLIC, M.; KRSTULOVIC,N. Separate and combined effects of solar radiation, temperature, salinity, and pH on the Survival of Faecal coliforms in Seawater. Marine Pollution Bulletin, v.24, p.411-416, 1992.

SOUZA, R. B., SOUZA, J.B., GOLDFARB, M. C., Determinação e análise do perfil longitudinal do Rio Una – PE. In: Anais do XIX Simpósio Brasileiro de Recursos Hídricos. Maceió, Pág 11, 12. 2011.

SOUZA, J.R. de; MORAES, M.E.M. de; SONODA, S.L.; SANTOS, H.C.R.G. A Importância da Qualidade da Água e os seus Múltiplos Usos: Caso Rio Almada, sul da Bahia, Brasil. REDE – Revista Eletrônica do Prodema, v.8, n.1, p.26-45, 2014.

TORRES, N.H.; SARTORI, S.B.; AMÉRICO, J.H.P.; FERREIRA, L.F.R. Indústria sucroalcooleira: gestão de subprodutos. Revista de Ciências Agro-Ambientais, v.10, n.2, p. 225-236, 2012

von SPERLING, M. Introdução à qualidade das águas e ao tratamento de esgotos. DESA/UFMG, ed. 4, Editora UFMG, Belo Horizonte – MG, 2014. 452 p

WANG, G.; XU, Y.A.Z.; ZHANG, S. The influence of land use patterns on water quality at multiple spatial scales in a river system. Hydrological Processes, v.28, p.5259-5272, 2014.

YU, S.; XU, Z.; WU, W.; ZUO, D. Effect of land use types on stream water quality under seasonalvariation and topographic characteristics in the Wei River basin, China. Ecological Indicators, v.60, p.202-212, 2016.