ZIBELINE INTERNATIONAL™ PUBLISHING
ISSN: 2710-6012 (Online)
CODEN: JWBMAO

Journal of Wastes and Biomass Management (JWBM)

DOI: http://doi.org/10.26480/jwbm.02.2022.68.72

RESEARCH ARTICLE

# IMPACT OF WASTEWATER ON SURFACE WATER QUALITY IN KENYIR LAKE BASIN, HULU TERENGGANU

**Noorjima Abd Wahab[a] , Mohd Khairul Amri Kamarudin[a,b], Hafizan Juahir[a] , Nur Ili Hasmida Mustaffa[a] , Muhammad Hafiz Md Saad[a] , Siti Nor Aisyah Bati[a] , Frankie Marcus Ata[c]**

**[a]East Coast Environmental Research Institute (ESERI), Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300, Kuala Nerus, Terengganu, Malaysia.**
**[b]Faculty of Applied Social Sciences, Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300, Kuala Nerus, Terengganu, Malaysia.**
**[c]Faculty of Social Sciences and Humanities, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia.**
***Corresponding author E-mail: mkhairulamri@unisza.edu.my**



**ARTICLE DETAILS**

***Article History:***

Received 25 April 2022
Accepted 28 May 2022
Available online 03 June 2022

**ABSTRACT**

Lake water ia an essential resource for livelihood things and the necessary for environment. Human activities affect of water quality, water quantity and alteration the ecosystem system.The sustainable use of lake water resource need more give attention and monitoring programs based on the systematic decision making and management tools. The purpose of this study was to assess the improper wastewater and its effluents discharged into surface lake water resources in Kenyir Lake Basin in order to determine the existing physical environment. A total 21 monitoring stations covering the study area (along the Kenyir Lake Basin) were selected for sampling fieldwork of three season from 2018 until 2019 (Wet Season (Augut 2018), Dry Season (March 2019) and Normal Season (July 2019). There are a few parameters for water quality characteristics were analyzed based on in-situ and ex-situ analysis. As a result, the mean values of mostly water quality paremeters more degrade during wet season compared dry season and normal season. This study proved the water quality status effects on the owing to lack of wastewater management along the lake basin but still in control situation. The policy, environmental knowledge and enforcement triggered for slowing the rate of ecosystem degradation. There are need for a precautionary approach in developing and implementing lake management interventions to protect them to sustain.

**KEYWORDS**

sustainable; wastewater; Kenyir Lake Basin

## 1. INTRODUCTION

Lake water is one of the important elements in the living things which is in tourism, agriculture, economics, domestics and for flora and fauna. Besides that, lake water resources play an important role in the environmental process specifically in plant ecosystems and for animals and humans for drinking water and others. The proper wastewater treatment management is very important in environmental sustainability management to strengthen the management of water resources for the public use especially to communities, economics, flora and fauna and social. The anthropogenic effects of human activities along the basin such as tourism, urbanization, deforestation, agricultural, domestic and residential causing specialized habitats to change and become may no longer be self-sustainable (Islam et al., 2018; Gidado et al., 2019; Asmara et al., 2019; Kamarudin et al., 2020).

The needs of involvement of relevant lake basin management institutions including government agencies and NGO take actions in the degradation of environmental management implications especially in wastewater treatment management (Sharip and Jusoh, 2010). The rapid development within lake catchments has significant effects on the quantity and quality of water in basins. Figure 1 showed a few types of wastewater such as domestic, industrial and stormwater runoff and these must be treated properly before it release into the environment especially in lake basin like Kenyir Lake Basin. The proper treatment management will prevent any harm or risk on the environment ecosystem and human health. Besides that, the proper wastewater treatment management aimed to prevent the environmental degradation such as disposal from domestic wastewater generated along the basin. In ancient years, there was no specific treatment management of wastewater channeled into waterways which eventually ended up in river basin, lake basin and ocean. However, the increasing of population and development of variety sectors along the basin as on of the reason in consideration of a more advanced technology treating the wastewater treatment management.

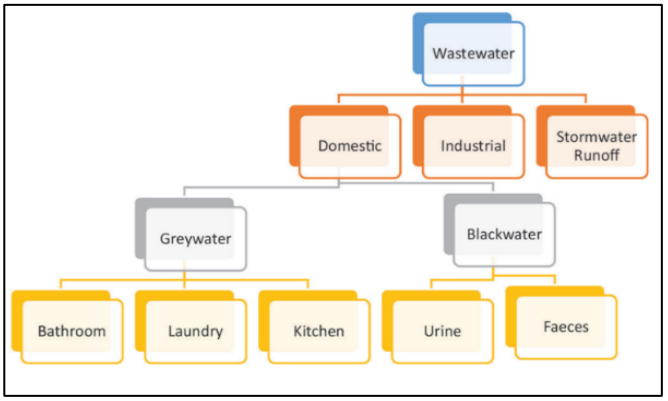


**Figure 1:** Type of wastewater (Edokpayi et al., 2017)

| Quick Response Code | Access this article online | |
|---|---|---|
| | **Website:** www.jwbm.com.my | **DOI:** 10.26480/jwbm.02.2022.68.72 |

Cite the Article: Noorjima Abd Wahab , Mohd Khairul Amri Kamarudin, Hafizan Juahir , Nur Ili Hasmida Mustaffa, Muhammad Hafiz Md Saad, Siti Nor Aisyah Bati, Frankie Marcus Ata (2022). Impact of Wastewater on Surface Water Quality in Kenyir Lake Basin, Hulu Terengganu. *Journal of Wastes and Biomass Management, 4(2): 68-72.*

Besides that, wastewater is defined as any water that has been negatively affected in quality by anthropogenic activities and natural factors along the river basins. Basically, in Asian countries the liquid and solid of wastewater probably discharged from industrialization sectors, agricultural facilities and farming land, domestic residential areas, construction and development areas. There are contains a lot of pollutants contaminants which are various concentrations such as ammonia, Sulphur, nickel and iron. There are three types of characteristics of wastewater such as physical characteristics, chemical characteristics and bacteriological characteristics due to pollutant contaminants. Figure 2 showed the three main characteristics of wastewater based on the physical, chemical and biological characteristics of the water (Pang and Abdullah, 2013).

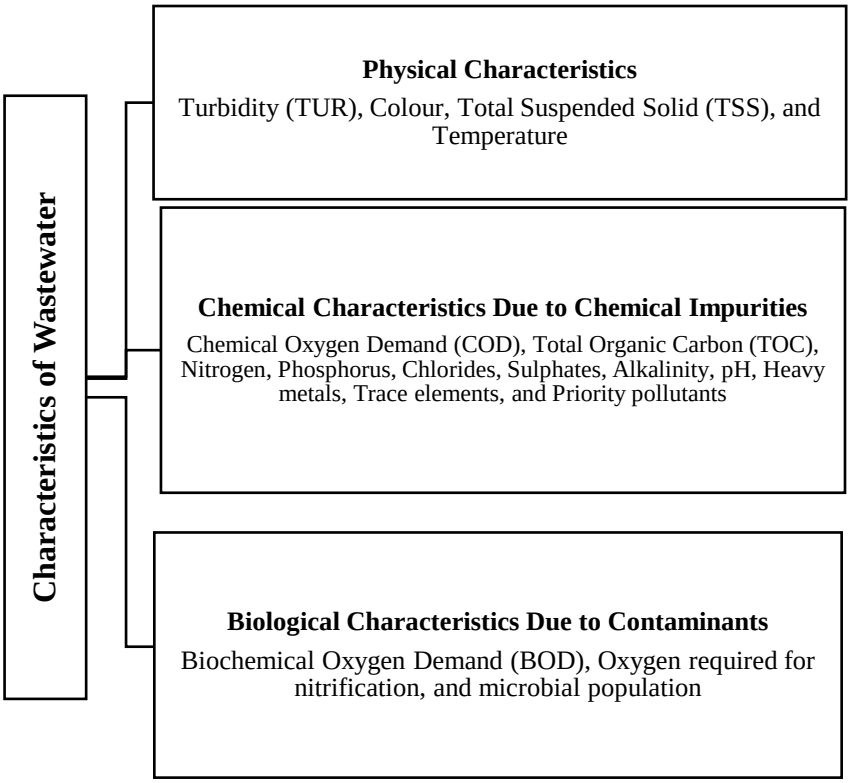


**Figure 2:** The Classification of wastewater's characteristics (Pang and Abdullah, 2013)

## 2. Study Area

The study area is in Kenyir Lake, Hulu Terengganu which one of the ecotourism areas in Malaysia and the largest man-made lake in Southeast Asia with a surface area of about 36,900 hectares. It lies at latitude 05°11'01.064"N until 05°07'34.463"N and longitude 102° 42'42.602"E until 102° 20'6.25"E receiving water inputs from main rivers as Terengganu River Basin. There are 21 sampling stations selected as 21 sub catchments in determination of hydrological and water quality characteristics of overall Kenyir Lake Basin. Table 1 showed the coordinates for each sampling stations for wet, dry, and normal season at Kenyir Lake Basin respectively.

**Table 1:** Sampling location for wet season, dry season and normal season at Kenyir Lake Basin, Terengganu

| Stations | Sampling Location (Coordinates) | River |
|---|---|---|
| S1 | 102° 42'42.602"E 05°11'01.064"N | Siput River |
| S2 | 102°39'49.705"E 05° 17'42.360"N | Petuang River |
| S3 | 102°38'19.879"E 05° 12'57.393"N | Tembat River |
| S4 | 102°37'46.486"E 05° 11'24.258"N | Terengganu River |
| S5 | 102°33'17.735"E 5° 03'30.462"N | Ketiar River |
| S6 | 102° 34'15.044"E 04°58'03.613"N | Besar River |
| S7 | 102° 33'09.379"E 04°56'16.506"N | Lepar River |
| S8 | 102°35'13.374"E 04° 54'38.067"N | Lawit River |
| S9 | 102° 42'04.9"E 04°52'32.0"N | Cenana River |
| S10 | 102°41'24.427"E 04° 50'36.340"N | Bewah River |
| S11 | 102°44'30.707"E 04° 47'42.302"N | Cicir River |
| S12 | 102°44'31.9"E 04° 47'16.9"N | Perepek River |
| S13 | 102°45'00.244"E 04° 46'28.235"N | Terenggan River |
| S14 | 102°42'32.595"E 4° 48'17.089"N | Cacing River |
| S15 | 102°48'00.5"E 4° 55'26.2"N | Pertang River |
| S16 | 102°50'22.510"E 04°57'54.633"N | Lasir River |
| S17 | 102°45'03.621"E 05° 02'21.528"N | Leban Terengganu River |
| S18 | 102° 46'42.443"E 05°04'58.079"N | Sauk River |
| S19 | 102° 20'6.25"E 05°07'34.463"N | Mandak River |
| S20 | 102°54'5.18"E 05° 0'40.01"N | Kenyir River |
| S21 | 102°54'40.34"E 05° 1'2.36"N | Berangan River |

## 3. Research Methdology

The water samples were collected from sampling stations from downstream to upstream areas along Kenyir Lake Basin. All the sample polyethylene was labeled as samping station's names and date before site collection and cleaned before sampling procedure. Three replicate samples were taken randomly at each station using these bottles and the samples were collected by directly filling the container from the surface body and by decanting the water from a collection device. Then, the collected samples were placed into the icebox (approximately temperature as 4°C) to reduce the metabolism of the organismes. After that, the samples were stored in the refrigerator in dark condition as laboratory process preparation (approximately temperature as lower than 6°C) (Juahir et al., 2011; Rashid and Romshoo, 2013; Khalik et al., 2016; Amneera et al., 2013; Awang et al., 2015). Furthermore, all the sample preparation and preservations conducted were following on the standard procedures provided by American Public Health Association (APHA) and United States Environmental Protection Agency (USEPA) Methods (APHA, 1999).

## 4. Result and Discussion

### 4.1 Surface Water Quality Impacts

The temporal and spatial distribution of the water quality parameters based on the Water Quality Index (WQI) from National Water Quality Standard (NWQS) in the water of the Kenyir Lake Basin and the mean values of the physico-chemical parameters (Table 2) (DOE, 1985; DOE, 2006).

### 4.2 Biochemical Oxygen Demand (BOD) Concentration Trends

The highest values of BOD concentration during dry season and normal season as 1.40 mg/L and 1.32 mg/L respectively. Then, Lepar River Station recorded the highest values during wet season compared to other sampling stations as 0.51 mg/L. The trends distribution of BOD showed higher concentration during dry season compare to wet season. According the metabolic activities of microorganism increased and the higher temperature thus causing considerable decrease in the level of water which are triggered the increasing of concentration BOD during dry season (Islam et al., 2012).

### 4.3 Chemical Oxygen Demand (COD) Concentration Trends

COD is one of chemical characteristic parameter functioned in determining the total concentrations of dissolved and suspended organic matter (Suratman et al., 2005; Suratman et al., 2009; Suratman et al., 2015; Salih et al., 2021). The yearly variation of COD level, upstream and downstream stations along the Kenyir Lake Basin revealed that the COD level was fluctuated from 2018 to 2019. The highest value of COD was in during wet season (10 mg/L), dry season (5 mg/L) and normal season (6 mg/L). Thus, the COD level for the wet season for Lasir River Station was classified within Class II and other stations classified as Class I. During dry season and normal season, the parameter shown the improvement to meet the permissible limit for Class I for all sampling stations. According to the high value of COD recorded at downstream areas affects from domestic sewage and othres anthropogenic activities along the basin (the COD values will increasing when the concentration of organic matters in the water increased) (Machiwal et al., 2011; Sutadian et al., 2017).

### 4.4 Dissolved Oxygen (DO) Concentration Trends

DO parameter used to determine the presence of oxygen available in river water. The DO value of a water body directly reflected the growth situation for aquatic organisms and pollution conditions. The Do concentration ranged from 58.17% to 89.10% (wet season), 75.17% to 88.84% (dry season) and 69.90% to 88.30% (normal season). These result indicate that the main contributing factors for DO values in the water such as decomposition rate of organic matter, photosynthetic and seasonal variables (climate changes).

### 4.5 Total Suspended Solid (TSS) Concentration Trends

There are factors which are triggered the high production of TSS such as increasing the velocity, flow of river water and river discharge trends. The critical increasing of TSS production in a river basin will be increase the sedimentation problems rate which adverse effects due to the hydrological and water quality changes include damage to the plant communities and aquatic ecosystems. The distribution of TSS in Kenyir Lake Basin from August 2018 until July 2019 recorded 18 mg/L (Cenana River) during wet season and the lowest concentration as 1.20 mg/L (Siput River) during dry season. Based on the TSS trends recorded, the variability in TSS concentrations was increased in going from the upstream stations to the downstream stations.

### 4.6 Ammoniacal Nitrogen (AN) Concentration Trends

The trend of AN was increased with the highest mean recorded in Berangan River as 0.58 mg/L (wet season), Ketiar River, Besar River, Lepar River and Lawit River as 0.1 mg/L (dry season) and Kenyir River as 0.42 mg/L (normal season). However, the concentration of AN at upstream was still below the permissible limit of Class I NWQS (0.10 mg/l). At midstream (Kenyir Lake Dam), the concentration of AN was slightly decreased especially during dry season. Based on the result proved all water samples collected for three seasons were found the AN values recorded as contain less than the maximum limit by the World Health Organozation (WHO) as 0.90 mg/L. However, the increasing waste of pollutants fertilizer and pesticides from agricultural sectors and domestic sewage production during wet season triggered the high input productions of AN into the river (Zakaria, 2003; Suratman et al., 2015; Wang et al., 2016; Soldatova et al., 2017).

### 4.7 pH Level Trends

Level of pH indicated for contamination and acidification. Low pH level allowed toxic elements and compounds to become mobile. The lower the pH, the higher the hydrogen ion (H+) activity and the more acidic is the water. The neutral pH is considered as 7.0. Unpolluted streams normally showed a near neutral or slightly alkaline pH level. Based on International Water Quality Standard (INWQS) stated the range of pH for Malaysian rivers is from 5.00 to 9.00. The lower level pH values are found in natural waters which are rich in organic matters (Pham et al., 2017; Lee et al., 2017; Shafii et al., 2018).

**Table 2:** The range and mean values of the water quality parameters of different sampling station during Wet Season (August 2018), Dry Season (March 2019) and Normal Season (July 2019)

| Parameters | Wet Season (August 2018) | Dry Season (March 2019) | Normal Season (July 2019) |
|---|---|---|---|
| Biochemical Oxygen Demand (BOD) | 0.31-0.51 | 0.85-1.40 | 0.57-1.32 |
| Mean | 0.33 | 1.09 | 0.89 |
| Chemical Oxygen Demand (COD) (mg/L) | 2-10 | 1-5 | 2-6 |
| Mean | 4.95 | 2.76 | 3.24 |
| Dissolved Oxygen (DO) (%) | 58.17-97.10 | 75.17-98.30 | 69.90-96.54 |
| Mean | 88.83 | 88.84 | 88.30 |
| Total Suspended Solid (TSS) | 5.20-18.0 | 1.20-15.0 | 4.10-14.5 |
| Mean | 12,97 | 5.00 | 9.92 |
| Ammoniacal Nitrogen (AN) | 0.17-0.58 | 0.07-0.10 | 0.08-0.42 |
| Mean | 0.32 | 0.087 | 0.144 |
| pH | 6.04-8.1 | 7.6-8.6 | 7.2-8.4 |
| Mean | 7.05 | 8.06 | 7.7 |
| Turbidity (TUR) | 6.65-19.87 | 2.25-15.22 | 5.12-15.55 |
| Mean | 14.25 | 5.75 | 10.85 |
| Total Dissolve Solid (TDS) | 7.69-21.9 | 2.89-16.15 | 6.66-16.56 |
| Mean | 15.53 | 6.65 | 12.06 |

### 4.8 Turbidity (TUR) Concentration Trends

The values of average turbidity concentration during August (wet season) recorded as ± 6.65 NTU to ± 19.87 NTU, during March 2019 (dry season) recorded as ± 2.25 NTU to ± 15.22 NTU and during nomal season recorded as ± 5.12 NTU to ± 15.55 NTU. These results showed the TUR distribution trends are significantly same as the TSS distribution trends. This trends showed the higher values in the downstream and middle - stream of the Kenyir Lake Basin than the upstream part. Besides that, the TUR distribution higher level during the wet season than dry and normal season caused by climate changes, anthropogenic, geomorphology and hydrological factors around Kenyir Lake Basin. The increasing suspended sediment load in river basins could lead to increased turbidity, high alkali content in water, emission of unpleasant odours, water discolouration, shallow flow and reduced penetration of sunlight negative effect to the process of photosynthesis by aquatic plants.

### 4.9 Total Dissolve Solid (TDS) Concentration Trends

Total Dissolve Solid (TDS) concentration mainly consist of inorganic minerals and organic matter. The concentration levels of TDS, in a broad sense, reflect the pollutant burden of the aquatic system especially in lake basin areas. It is important to study water quality parameters for water resources safety especially in tourism areas like Kenyir Lake Basin. The excessive nutrients stimulate the growth of primary producers and turbidity water state increased. Therefore, the levels of nutrients are major indicators for eutrophication, which might exclude a reservoir. The dsitribution trends of TDS recorded in Kenyir Lake Basin were ± 7.69 mg/L to ± 21.9 mg/L (wet season), ± 2.89 mg/L to ± 16.15 mg/L (dry season) and ± 6.66 mg/L to ± 16.56 mg/L (normal season). TDS concentration trends of the water samples collected in three seasons were within the permissible limit as stipulated by the WHO.

## 5. Conclusion

These may include restrictions on water utilization especially during wet season, dry season and normal season to enhance wastewater treatment management on surface water quality. There are usually difficult to influence the natural factors of the imbalances in the water quality characteristics' prediction. Rivers and streams, however, can be subjected to regulate by well-established practices through the use of dams, storage reservoirs, and diversions. It is mainly through these controls that efforts are made to make the most efficient usage of water as a resource. Several activities to rehabilitate and conserve Kenyir Lake that have been carried by local people are by reporting any pollution or encroachment in the lake to the authority, dealing with authorities to apply for assistance to clean lake, educate residents and visitors to maintain cleanliness and prevent them from polluting the areas, and carrying, recycling or handling wastewater management systematically. These activities taken up by local people would increase their level of awareness, understanding and strengthens their capability to manage their resources sustainably. Thus, there is a need to raise the community level of awareness as well as to promote more local participation or to get involved in this conservation and rehabilitation process of Kenyir Lake Basin areas.

## References


Amneera, W.A., Najib, N.W.A.Z., Yusof, S.R.M., Ragunathan, S., 2013. Water quality index of Perlis river, Malaysia. International Journal on Civil and Environmental Engineering, 13 (2), Pp. 1-6.

Asmara, S.M., David, G., Abdullah, M.T., Din, W.I.S.W., Abidin, A.F.Z., 2019. Self-organizing map (SOM) for species distribution modelling of birds species at kenyir landscape. International Journal of Electrical and Computer Engineering, 9 (6), Pp. 5235.

Awang, H., Daud, Z., Hatta, M.Z.M., 2015. Hydrology properties and water quality assessment of the Sembrong Dam, Johor, Malaysia. Procedia-Social and Behavioral Sciences, 195, Pp. 2868-2873.

Department of Environment Malaysia (DOE), 1985. Development of Water Quality Criteria and Standards for Malaysia.

Department of Environment Malaysia (DOE), 2007. Malaysia Environmental Quality Report 2006. In: Chapter 3: River Water Quality, Sasyaz Holdings Sdn Bhd, Pp. 24.

Edokpayi, Joshua N., Odiyo, J.O., and Durowoju, O.S., 2017. Impact of wastewater on surface water quality in developing countries: a case study of South Africa. Water quality, 10, Pp. 66561.

Gidado, K.A., Kamarudin, M.K.A., Hammad, M., Ghurah, S.A., Wahab, N.A., Saad, M.H. M., and Potikengrith, T., 2019. Application of Ca-Markov Model for the Analysis of Urban Growth in Kenyir Basin. International Journal of Academic Research in Business and Social Sciences, 9 (2), Pp. 449-458.

Islam, M.S., Ismail, B.S., Barzani, G.M., Sahibin, A.R., Ekhwan, T.M., 2012. Hydrological assessment and water quality characteristics of Chini Lake, Pahang, Malaysia. American-Eurasian J. Agric. & Environ. Sci., 12 (6), Pp. 737-749.

Islam, S., Elfithri, R., 2018. The potential impacts of anthropogenic and climate changes factors on surface water ecosystem deterioration at Kenyir Lake, Malaysia. International Journal of Engineering & Technology, 7 (3.14), Pp. 67-74.

Juahir, H., Zain, S.M., Yusoff, M.K., Hanidza, T.T., Armi, A.M., Toriman, M.E., Mokhtar, M., 2011. Spatial Water Quality Assessment of Langat River Basin (Malaysia) Using Environmetric Techniques. Environmental Monitoring and Assessment, 173 (1-4), Pp. 625.

Kamarudin, M.K.A., Abd Wahab, N., Abd Jalil, N.A., Sunardi, S., Saad, M.H.M., 2020. Water Quality Issues In Water Resources Management At Kenyir Lake, Malaysia. Jurnal Teknologi, 82 (3).

Khalik, W.M.A.W.M., Abdullah, M.P., Amerudin, N.A., Padli, N., 2013. Physicochemical analysis on water quality status of Bertam River in Cameron Highlands, Malaysia. J. Mater. Environ. Sci, 4 (4), Pp. 488-495.

Lee, I., Hwang, H., Lee, J., Yu, N., Yun, J., Kim, H., 2017. Modeling approach to evaluation of environmental impacts on river water quality: A case study with Galing River, Kuantan, Pahang, Malaysia. Ecological Modelling, 353, Pp. 167-173.

Machiwal, D., Jha, M.K., Mal, B.C., 2011. GIS-based assessment and characterization of groundwater quality in a hard-rock hilly terrain of Western India. Environmental monitoring and assessment, 174 (1), Pp. 645-663.

Pang, Y.L., Abdullah, A.Z., 2013. Current status of textile industry wastewater management and research progress in Malaysia: a review. Clean–Soil, Air, Water, 41 (8), Pp. 751-764.

Pham, H., Rahman, M.M., Nguyen, N.C., Le Vo, P., Le Van, T., Ngo, H., 2017. Assessment of Surface Water Quality Using the Water Quality Index and Multivariate Statistical Techniques–A Case Study: The Upper Part of Dong Nai River Basin, Vietnam. Journal of Water Sustainability, 7 (4), Pp. 225-245.

Rashid, I., Romshoo, S.A., 2013. Impact of anthropogenic activities on water quality of Lidder River in Kashmir Himalayas. Environmental monitoring and assessment, 185 (6), Pp. 4705-4719.

Salih, S.Q., Alakili, I., Beyaztas, U., Shahid, S., Yaseen, Z.M., 2021. Prediction of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand using hydrometeorological variables: case study of Selangor River, Malaysia. Environment, Development and Sustainability, 23 (5), Pp. 8027-8046.

Shafii, H., Miskam, N., Yassin, A.M., Musa, S.M.S., 2018. Status Kualiti Air Sungai Di Beberapa Kawasan Luar Bandar, Di Negeri Johor Dan Kesannya Kepada Kehidupan (The Status Of River Water Quality In Some Rural Areas, In State Of Johor And Its Effects To Life). Asian Journal of Environment, History And Heritage, 2 (1).

Sharip, Z., Jusoh, J., 2010. Integrated lake basin management and its importance for Lake Chini and other lakes in Malaysia. Lakes & Reservoirs: Research & Management, 15 (1), Pp. 41-51.

Soldatova, E., Guseva, N., Sun, Z., Bychinsky, V., Boeckx, P., Gao, B., 2017. Sources and behaviour of nitrogen compounds in the shallow groundwater of agricultural areas (Poyang Lake basin, China). Journal of contaminant hydrology, 202, Pp. 59-69.

Suratman, S., Ali, A., Ting, L.T., 2005. Penilaian indeks kualiti air di lembangan Sungai Ibai, Terengganu. Sains Malaysiana, 34 (2), Pp. 55-59.

Suratman, S., Awang, M., Ling, L.A., Tahir, N.M., 2009. Kajian indeks kualiti air di lembangan Sungai Paka, Terengganu. Sains Malaysiana, 38 (2), Pp. 125-131.

Suratman, S., Hee, Y.Y., Tan, H.S., 2015. A Preliminary Study Of The Distribution Of Phosphorus And Silicon Compounds In Tasik Kenyir, Hulu Terengganu, Malaysia. Journal of Sustainability Science and Management, 10 (2), Pp. 35-41.

Sutadian, A.D., Muttil, N., Yilmaz, A.G., Perera, B.J.C., 2017. Using the Analytic Hierarchy Process to identify parameter weights for developing a water quality index. Ecological Indicators, 75, Pp. 220-233.

Wang, W., Liu, X., Wang, Y., Guo, X., Lu, S., 2016. Analysis of point source pollution and water environmental quality variation trends in the Nansi Lake basin from 2002 to 2012. Environmental Science and Pollution Research, 23 (5), Pp. 4886-4897.

Zakaria, N.A., Ab Ghani, A., Abdullah, R., Mohd. Sidek, L., Ainan, A., 2003. Bio-ecological drainage system (BIOECODS) for water quantity and quality control. International Journal of River Basin Management, 1 (3), Pp. 237-251.