# A study on water quality from Langat River Selangor using QUAL2K

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ABSTRACT: The Langat River is vulnerable to contamination from the point and non-point sources as the Selangor states grow rapidly. Therefore, this study presents a robust approach to forecast and assess the water quality state in the mainstream of the Langat River using QUAL2k software. An extensive water quality index (WQI) analysis of the Langat River was examined for six water quality parameters (i.e., Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and Ammoniacal Nitrogen (AN)) to represent the overall status of the river and its tributaries. Water sampling was conducted at three points, namely Kajang (upstream), Dengkil (midstream), and Banting (downstream), to represent the activities contributing to the pollution in the Langat River. It was found that the average WQI of Langat River Basin upstream is 51.5, which is categorized as Class IV (polluted); meanwhile, the average WQI for the midstream and downstream are 56 and 57.3, respectively, which both are categorized as Class III (slightly polluted to polluted). These low WQI values were due to human activities (e.g., construction, mining, and agriculture). The water quality parameter data from laboratory work was used as baseline to simulate a scenario, i.e., pollution discharge from a new proposed sewage treatment plant using a calibrated and validated QUAL2k model. The QUAL2k model can improve the water quality classification to be within the range of Class II (clean) and Class III (slightly polluted to polluted). The QUAL2k model developed in this study emerged as reliable predictors to various stakeholders and authorities in identifying problematic areas to improve the Langat River water quality.
**Keywords:** *water quality; QUAL2K; Langat River Selangor*

## 1. INTRODUCTION

Langat River is a crucial source of raw water in the state of Selangor for drinking water, recreation, industrial, fisheries, and agriculture [1]. Since Selangor state has been undergoing rapid growth of urbanization and the population, it has induced growing human interest in using the riverbank [2]. It has a significant adverse effect on the river basin. Studies have indicated that urbanization has had a big impact and changes the hydrology of an area [1][2]. It is also evident that the ecosystem of the Langat River is under stress from the effluent discharge, especially domestic sewage.

Water quality simulation tool, such as QUAL2k (Ver 2.11b8, USEPA) is a more robust approach than standard statistical methods to identify core pollutants and classify rivers. The QUAL2k model can assist in identifying problem areas and determining the percentage of changes in water quality parameters for river basin quality improvement on the simulated scenario. Therefore, this study aims to analyze the Langat River basin's extensive water quality index using an extensive water quality parameter, classification analysis, and simulate the pollution discharge scenario of a new proposed sewage treatment plant using QUAL2k software.

## 2. METHODOLOGY

### *2.1 Sampling for water quality data and land use activities surrounding sampling points area*

This study's water quality data were obtained from three (3) different sampling points representing the upstream (Kajang), midstream (Dengkil), and downstream (Banting). The samplings were done four (4) times with intervals of every two weeks from mid-February to the end of March 2021. The collected samples were analysed in the laboratory for six parameters; DO, BOD, COD, $NH_3$-N, pH, and TSS using Standard Methods for the Examination of Water and Wastewater (APHA). The WQI analysis based on these parameters was used to identify the overall pollutant in the river basin and classification of the river sections, using Department of Environment (DOE) WQI classification, and DOE water quality classification based on WQI.

Land use activities have a substantial influence on water quality. Based on the information obtained from the Selangor Town and Country Planning Department, two types of land use dominate the basin, which is forests and shrubs (28%) and urban land use with 42%. Meanwhile, other land uses were from agricultural and animal farming (20%), open land and recreation (6%), and water bodies (4%). Land use differences are factors that will affect the fluctuations in the value of water quality parameters for the sampling point.

### 2.2 Water quality modelling

Water quality modelling was conducted using QUAL2K software to predict the acceptable conditions for discharge of industrial/mixed effluent for future development of the Langat River. The QUAL2k water quality model was calibrated and validated using TSS, pH, BOD, and $NH_3$ collected and analyzed during field and laboratory measurements done in mid-February to the end of March 2021. The water quality parameter data from laboratory work was used as baseline data, meanwhile the Standard B characteristics of effluent discharge stipulated by Environmental Quality (Industrial Effluent) Regulation 2009, under Environmental Quality Act 1974, was use as simulation data to simulate a scenario, i.e., pollution discharge from a new proposed sewage treatment plant. The hydraulic input data for this study are based on the Department of Drainage and Irrigation Malaysia. The hydraulic parameters used during calibration were the same as for validation. The model was then used in simulation using the calibrated and validated QUAL2k model. The discharge of the STP's with standard B is suggested to be located 12 kilometres after the upstream. This scenario was selected to identify the effect of pollution discharge on the water quality index classification. The performance was evaluated based on the correlation coefficient ($R^2$) between the observed and simulated data.

## 3. RESULTS AND DISCUSSION

### 3.1 Water quality and classification

This section includes the detailed results and discussion on the current water quality conditions in the Langat River Basin and extensive water quality modelling using QUAL2K. The water quality of the Langat River varies based on the sampling date and location of the sampling stations. This study indicates that Langat rivers in Selangor were under two categories: Class III represent slightly polluted to polluted (midstream and downstream) and Class IV represent polluted (upstream). The main cause that contributes to the low WQI are urbanization overgrowing, construction activities, mining activities, sewage treatment plant from highly populated town, wastewater treatment plant discharges, industrial effluents, and agricultural runoff. A comparison between river classes and average pollutant concentrations is shown in Table 1.

Table 1 Average water quality and classification of Langat River

| Parameter / Location | Kajang (Upstream) | Dengkil (Midstream) | Banting (Downstream) |
|---|---|---|---|
| pH (at 25°C) | 6.74 | 6.66 | 6.71 |
| BOD (mg/L) | 6.5 | 5.35 | 7.25 |
| Total SS (mg/L) | 125.8 | 68.6 | 129.0 |
| AN (mg/L) | 1.19 | 0.91 | 0.73 |
| DO (mg/L) | 3.47 | 3.87 | 4.08 |
| COD (mg/L) | 57.0 | 31.9 | 13.14 |
| **Average WQI** | **51.1** | **56** | **57.3** |
| **Class** | **31.0 – 51.9 IV** | **51.9 – 76.5 III** | **51.9 – 76.5 III** |
| **Status** | **Polluted** | **Slightly polluted to polluted** | **Slightly polluted to polluted** |

### 3.2 Simulation of WQI parameters

QUAL2K simulates several hydraulic and water quality parameters. Thus, two model calibration stages have been done in this study (Figure 1), including hydraulic and water quality parameter calibration. Figure 1 illustrates the comparison between the observed data and simulated data for the main stream of the Langat River. The observed TSS, pH, BOD, and $NH_3$ patterns are comparable to simulated data.

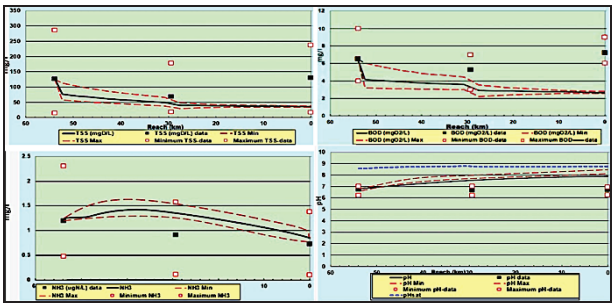

Figure 1 QUAL2K model of the observed data and simulated data for the mainstream of the Langat River

Developing a sewage treatment plant following standard B will decrease the existing water quality parameters. All the increments were monitored and analysed; the QUAL2K model improved the class to be within the range of class II and class III for the TSS, class III for the BOD and NH3, class I for the pH. The present study establishes a quantitative framework for detecting river quality of Langat River, Selangor using QUAL2K and lays the groundwork for future development following standard B of effluent discharge stipulated by Environmental Quality (Industrial Effluent) Regulation 2009, under Environmental Quality Act 1974.

## 4. CONCLUSION

QUAL2k model is stimulated to assess the current status of the Langat River. The findings were used as a basis to monitor and analyze the development of STP as in the case of the scenario simulation of this study, so that the WQI classification could be improved or at least to be within the range of allowable discharge limit by DOE. The QUAL2k model is able to improve the water quality classification to be within the range of Class II (clean) and Class III (slightly polluted to polluted) for the scenario simulation case of this study.

## REFERENCES

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