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# Nualgi Nano Biotechnology Approach to Remediate Eco-Symbiosis for The Conservation of Catchment Lake

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**ABSTRACT**

*Nualgi nano biotechnology, a natural biological treatment with the idea of eco-symbiosis is proposed in this research study for an in-situ treatment of the catchment lake. Nualgi nano nutrient was dosed into a catchment lake weekly for a consecutive of 6 weeks and the catchment lake water sample was collected periodically at downstream for chemical oxygen demand (COD), biological oxygen demand (BOD), pH, total suspended solids (TSS), dissolved oxygen (DO), total nitrogen (TN), and total phosphorus (TP) analysis. DO shows an increasing trend after 6 weeks of nualgi nano biotechnology treatment, indicating an activation of diatoms with vigorous photosynthesis reaction by nualgi. However, the water quality of the catchment lake downstream water still does not meet the Class IIB National Water Quality Standard at the end of the treatment process possibly due to insufficient dose of nualgi nano nutrient in promoting fast growth of eukaryotes and heterotrophic bacteria, therefore low consumption rate of nutrients. It is suggested to prolong the application of this newly developed green and sustainable wastewater treatment approach and at higher dosage to achieve success remediation of eco-symbiosis in water body while nourishing the needs of current and future generations.*

**Keywords:** Biotechnology, Eco-symbiosis, Lake Conservation, Sustainability, Wastewater Treatment

## 1. INTRODUCTION

Nualgi nano biotechnology is a new breakthrough in water and wastewater treatment. This new nanotechnology uses nano-scale micronutrients (5–100 nm) including silica (Si), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), magnesium (Mg), boron (B), calcium (Ca), molybdenum (Mo), sulphur (S), and cobalt (Co) to stimulate the aquatic food chain – diatom algae for in-situ treatment of wastewater [1][2]. Among those micronutrients, Si is the most essential element for diatom growth and development. It acts as the carrier for other nutrients and at the same time it is an important substance for cell wall formation [2]. Attributed to this reason, the concentration of Si in water body directly reflects the density of diatoms in natural habitats [3].

Diatoms are ubiquitous, widespread, single-celled eukaryotic microalgae in nano form with very large surface area to volume ratio. They are also a dominant group of phytoplankton which responsible for the removal of nutrients present in water body [1]. Kiran et al. [4] reported that all trace metals available in nualgi were able to trigger for the growth of diatoms in open water. Diatom algae could prolific photo-synthesize faster, longer, and produce net surplus oxygen

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accounting for respiration, having a symbiotic relationship as of aerobic bacteria [5]. The sustainable growth of diatom algae population with proper dosing of nualgi through nutrient intervention would restore the dissolved oxygen (DO) level in water due to fine oxygen bubbles generated by diatoms algae during the photosynthesis process. DO can facilitate aerobic bacteria that work 20 times faster than anaerobic bacteria, thereby quickly cutting down the biological oxygen demand (BOD) and chemical oxygen demand (COD) levels. Based on the reports provided by industry experts, it is quite normal to see 90-95% reduction in BOD levels within several weeks of nualgi nano biotechnology treatment [6].

The diatom algae are consumed by zooplankton and then by the fish. Fish are further consumed by birds where nitrogen and phosphorus are transferred out from the water. The reduction of nitrogen and phosphorus is beneficial for preventing toxic blue-green algae growth in the lake. Figure 1 shows the eco-symbiosis remediation cycle created by the nualgi nano biotechnology approach.

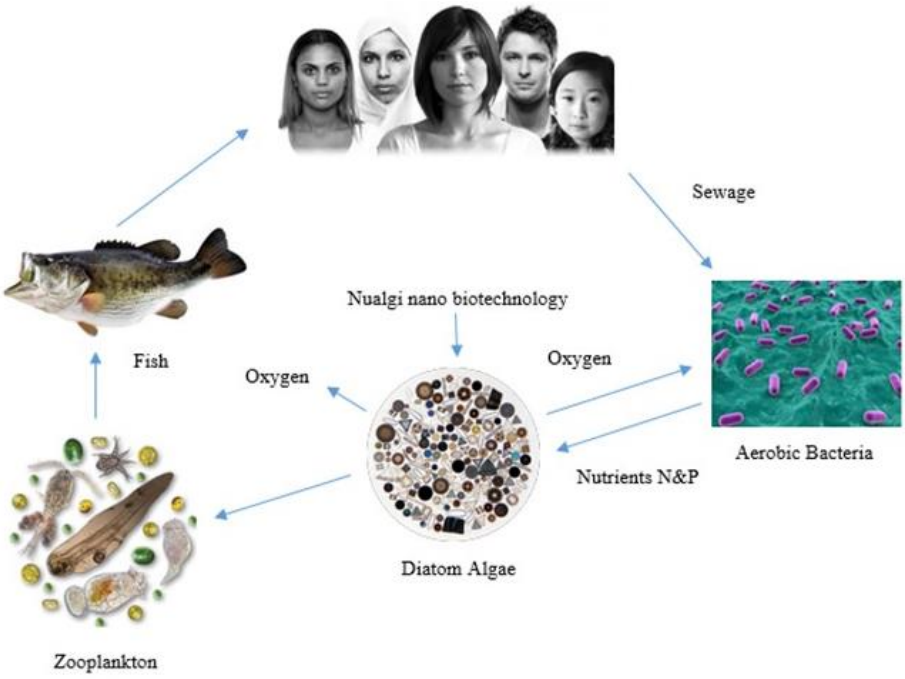



**Figure 1.** Eco-symbiosis remediation cycle created by nualgi nano biotechnology approach.

The bad practice of discharging the cafeteria wastewater or household chemical-contained effluents into the catchment lake or man-made recreation lake would provide adverse impact on water quality. The aquatic life in the course of time will suffer and die as water quality in their habitat experiences persistent pollution. Despite this environmental problem but with the advantages that diatom algae possesses in bioremediation, nualgi nano biotechnology treatment is seen as a virtuous solution to remediate eco-symbiosis for the conservation of polluted catchment lake or man-made recreation lake. The objective of this research study is to investigate the performance of nualgi nano biotechnology for the treatment of polluted catchment lakes. The application of this newly developed green and sustainable wastewater treatment approach is expected to be able to remediate eco-symbiosis in water body while nourishing the needs of current and future generations.

## 2. MATERIAL AND METHODS

### 2.1 Water Sampling

Catchment lake adjacent to the Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia with GSP coordinate of 2.923939°, 101.770787° as depicted in Figure 2 was selected as the study site for this research. Previously this catchment lake was a swamp area. It was modified into a man-made lake during the year 1998. The water flows from the upstream hill and is retained in the catchment lake. Overflow of water will flow out into the Langat river.


**Figure 2**. Satellite map of the catchment lake adjacent to Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (GPS coordinate of 2.923939°, 101.770787°).

### 2.2 Nualgi Nano Biotechnology Treatment

Nualgi nano nutrient was purchased from Nualgi Nanobiotech, India. Dosing of nualgi nano nutrient into the catchment lake was conducted weekly for a consecutive of 6 weeks. Prior to the dosing activity, 0.75 mL nualgi nano nutrint was diluted with 75 L of lake water and spray around the lake area. Catchment lake water sample was collected periodically downstream for analysis.

### 2.3 Water Quality Analysis

The catchment lake water sample before nualgi nano biotechnology treatment and after the nualgi nano biotechnology treatment were collected periodically at downstream and analyzed for the parameters of COD, BOD, pH, total suspended solids (TSS), DO, total nitrogen (TN), and total phosphorus (TP) followed the HACH standard method. COD was measured by preheat the sample at 150 $^{0}$C in HACH RBC 200 reactor digester (Hach Company, USA) for 2 hours before it was analyzed with DR3900 spectrophotometer. BOD of the water sample was analyzed using APHA:5210 B 5-Day test. pH was measured using HI 2550 pH Meter (Hanna, USA). TSS was measured by determining the weight of TSS retained on filter paper after filtering the sample with gravity vacuum apparatus. DO was measured on-site with YSI DO probe. TN was the summation of ammonia, organic nitrogen, nitrate, and nitrite, followed APHA Method 4500-N (org) B and APHA Method 4110 B. Meanwhile, TP was measured using APHA Method 4500-P B&D.

## 3. RESULTS AND DISCUSSION

The catchment lake located adjacent to Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia has an average width and depth of 10.75 m and 0.62 m, respectively. Several drains contained wastewater effluent from cafeteria next to the catchment lake and laboratories of Faculty of Engineering and Built Environment are confluence at the catchment lake. The outflow velocity from the catchment lake is measured at 0.042 m/s.

Sampling were carried out at the downstream of catchment lake before and along the nualgi nano biotechnology treatment from the 14th of March 2018 to the 25th of April 2018. The characteristics of the catchment lake downstream water before the nualgi nano biotechnology treatment are tabulated in Table 1. Since this catchment lake is completed with jogging track and exercise facilities, it is used for recreation purpose. Attribute to this, the water quality of the catchment lake water should comply with Class IIB National Water Quality Standard. Nevertheless, TSS content in downstream water of catchment lake had exceed the Class IIB National Water Quality Standard. The pollution of the catchment lake is possibly due to the soil erosion from nearby construction. On top of that, wastewater and biological waste released by the cafeteria next to the catchment lake and laboratories of Faculty of Engineering and Built Environment had also increased the nutrient and organic solid content of the catchment lake, causing a decrease of DO in water body and leading to eutrophication which modify the structure of aquatic communities and disrupt the functional continuum of the catchment lake system [7]. Hence, nualgi nano biotechnology treatment was carried out to remediate eco-symbiosis for the conservation of the catchment lake.

**Table 1** Characteristics of the catchment lake downstream water before the treatment

| Parameter | Average | Unit |
|---|---|---|
| pH | 6.77 | - |
| TSS | 47.17 | mg/L |
| COD | 19.98 | mg/L |
| BOD | 4.80 | mg/L |
| DO | 7.92 | mg/L |
| TP | 0.24 | mg/L |
| TN | 3.10 | mg/L |
| O&G | 0.45 | mg/L |

Table 2 summarized the characteristics of catchment lake downstream water for the consecutive 6 weeks of nualgi nano biotechnology treatment, Figure 3 shows the catchment lake water quality analysis for each parameter, whereas Figure 4 illustrates the photographs of the catchment lake water sample collected before nualgi nano biotechnology treatment and throughout the week of the nualgi nano biotechnology treatment. As presented in Figure 3, the results obtained from most of the water quality analysis parameter are seen to fluctuate throughout the nualgi nano biotechnology treatment period, except DO shows an increasing trend. The increase of DO in water body indicates the activation of diatoms by nualgi. Highly active diatoms will consume carbon dioxide and nutrients such Si, Fe, $PO_4$, and $NO_3$ while produce nano scale molecular oxygen through photosynthesis process whenever sunlight is available [4]. Attribute to this, the DO concentration in the water body will increase at longer nualgi nano biotechnology treatment period. The photosynthesis reaction of diatoms is shown in equation (1).

$$\text{Sunlight} + H_2O + CO_2 + \text{Nutrients} \rightarrow CH_2O + O_2 \quad (1)$$

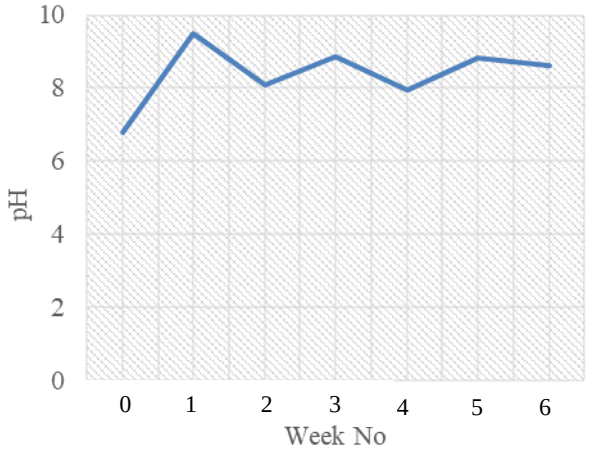
Diatoms are served as the base in the food web where they will consume higher eukaryotes and heterotrophic bacteria [8]. This hypothesis is supported by a study conducted by Kiran et al. [4]. Kiran et al. [4] explained that the oxygen produced by diatoms causes the native bacteria to

grow, which acts the same way when bacteria was dosed into bioremediation water sample. On the other hand, nano scale molecular oxygen produced during photosynthesis reaction of diatoms penetrated and disintegrated the sludge settling at the catchment lake bottom. Attribute to this mechanism, most of the water analysis parameters show an increasing trend during the 1st week of nualgi nano biotechnology treatment. This disintegrated sludge and organic matters are freely available to be digested by eukaryotes and heterotrophic bacteria.

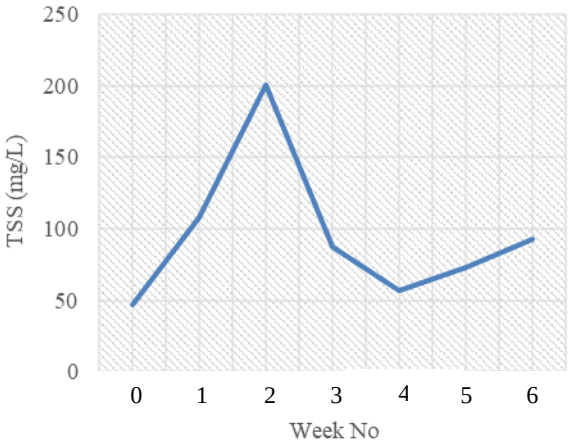
Unfortunately, after the consecutive 6 weeks of nualgi nano biotechnology treatment, the water quality of the catchment lake downstream water still did not meet the Class IIB National Water Quality Standard. This happened due to insufficient dose of nualgi nano nutrient in promoting fast growth of eukaryotes and heterotrophic bacteria, therefore low consumption rate of nutrients. Several reports in the past agreed that nutrient concentration, especially nitrogen to phosphorus ratio (N:P) has a significant impact on metabolic activity and growth rate of diatom algae. Schollhorn and Graneli [9] reported that N:P around 6-7 was optimal for diatom growth. Whereas a study conducted by Su et al. [10] found that N:P ratio at 7.3:1 was optimum for the growth of freshwater planktonic diatom and it will multiply at the fastest rate. However, the N:P ratio in the catchment lake downstream water before nualgi nano biotechnology treatment is 12.9:1, far beyond the optimum N:P obtained from Schollhorn and Graneli [9] and Su et al. [10]. Due to the imbalance of nutrient content, this leads to the inefficiency of diatoms that grow and bacteria multiply. As result, there are limited number of eukaryotes and heterotrophic bacteria to degrade and consume the nutrients present in the catchment lake, eventually causing the inefficiency of the nualgi nano biotechnology treatment.

**Table 2** Characteristics of the catchment lake downstream water for the consecutive 6 weeks of nualgi nano biotechnology treatment

| Parameter | Sampling Date | | | | | |
|---|---|---|---|---|---|---|
| | **Week 1** | **Week 2** | **Week 3** | **Week 4** | **Week 5** | **Week 6** |
| pH | 9.50 | 8.09 | 8.87 | 7.93 | 8.81 | 8.61 |
| TSS (mg/L) | 107.67 | 201.00 | 87.67 | 56.33 | 72.67 | 93.00 |
| COD (mg/L) | 52.33 | 26.00 | 49.00 | 25.00 | 42.00 | 36.00 |
| BOD (mg/L) | 5.41 | 2.10 | 4.74 | 5.30 | 4.09 | 8.03 |
| DO (mg/L) | 8.58 | 9.79 | 10.93 | 8.80 | 11.90 | 13.05 |
| TP (mg/L) | 0.52 | 0.43 | 0.58 | 0.37 | 0.42 | 0.48 |
| TN (mg/L) | 5.70 | 4.21 | 9.87 | 7.21 | 5.54 | 6.18 |
| O&G (mg/L) | 10.14 | 16.14 | 0.00 | 3.00 | 0.00 | 4.14 |



(a)



(b)

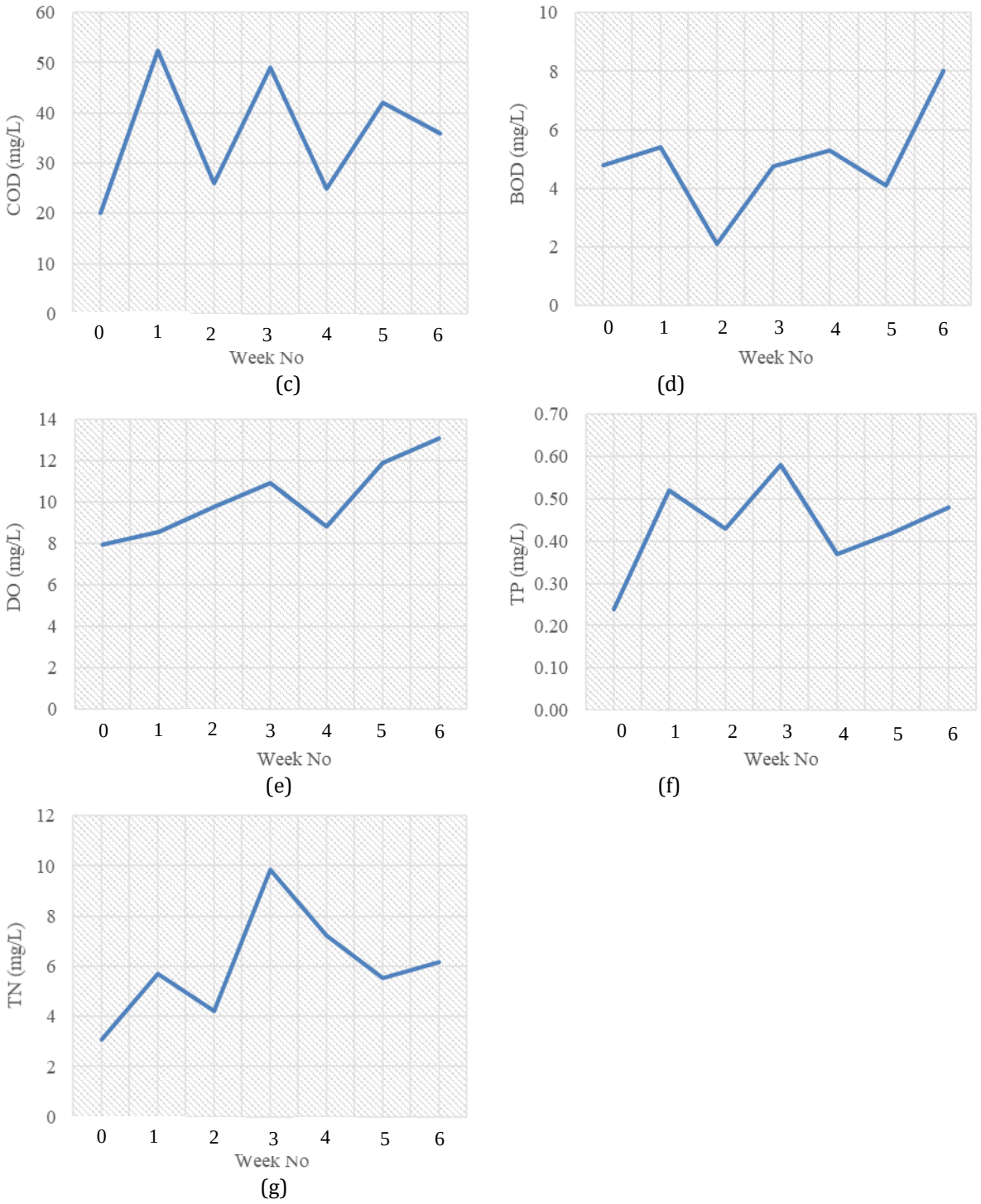



**Figure 3**. Catchment lake water quality analysis on (a) pH (b) TSS (c) COD (d) BOD (e) DO (f) TP and (g) TN.

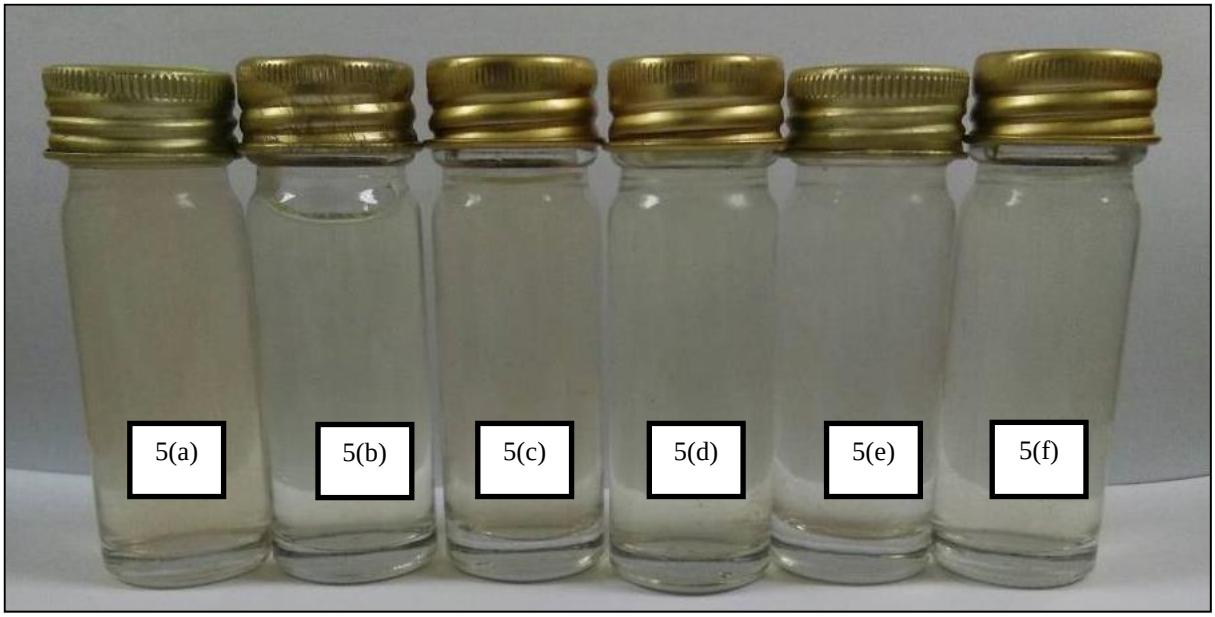



**Figure 4.** Photograph illustration of the catchment lake water sample collected (a) before the treatment (b) on the first week after the treatment (c) on the second week after the treatment (d) on the third week after the treatment (e) on the fourth week after the treatment (f) on the fifth week after the treatment.

## 4. CONCLUSION

Nualgi nano biotechnology is an eco-friendly approach with the idea to remediate eco-symbiosis for the conservation of polluted catchment lakes or man-made recreation lakes. DO shows an increasing trend after 6 weeks of the nualgi nano biotechnology treatment, indicating an activation of diatoms with vigorous photosynthesis reaction by nualgi. However, the water quality of the catchment lake downstream water still does not meet the Class IIB National Water Quality Standard at the end of the treatment process possibly due to insufficient dose of nualgi nano nutrient in promoting fast growth of eukaryotes and heterotrophic bacteria, therefore low consumption rate of nutrients. It is suggested to prolong the application of this newly developed green and sustainable wastewater treatment approach and at a higher dosage to achieve success remediation of eco-symbiosis in the water body while nourishing the needs of current and future generations.

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