

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

Teow Yeit Haan<sup>1,2\*</sup>, Abdul Wahab Mohammad<sup>1,2</sup>, Ho Kah Chun<sup>1,2</sup> and Maha Mohammad Hussein Al-Rajabi<sup>2,3</sup>

<sup>1</sup>Research Centre for Sustainable Process Technology (CESPRO), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor Darul Ehsan, Malaysia.

<sup>2</sup>Department of Chemical Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor Darul Ehsan, Malaysia.

<sup>3</sup>Chemical Engineering Department, School of Engineering, The University of Jordan, Amman, Jordan.

### 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 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 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]. Attribute to this reason, the concentration of Si in water body is directly reflects the density of diatoms in natural habitats [3].

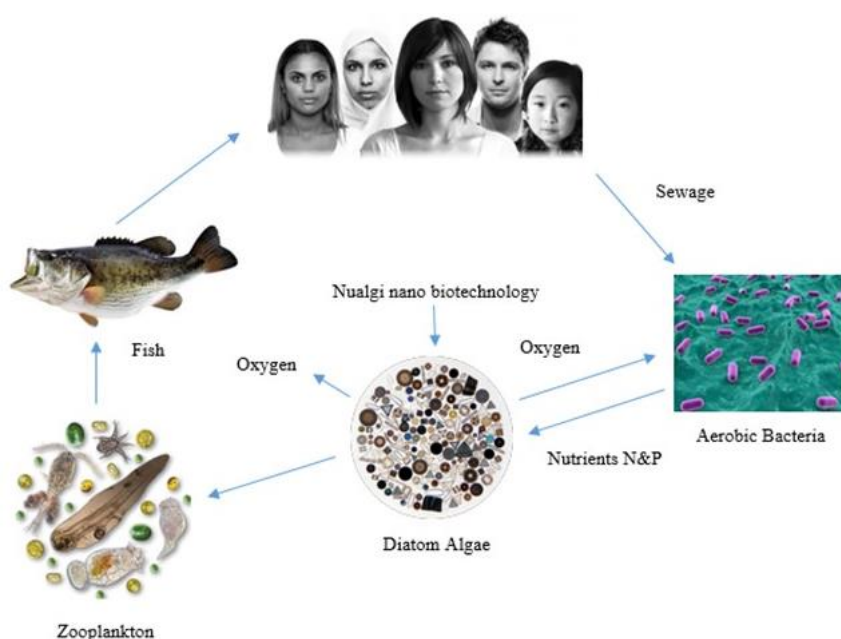
Diatoms are ubiquitous, widespread, single-celled eukaryotic microalgae in nano form with very large surface area to volume ratio. They are also a dominant group of phytoplankton which responsible for the removal of nutrients present in water body [1]. Kiran et al. [4] reported that all trace metals 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 accounting for respiration, having a symbiotic relationship as of aerobic bacteria [5]. The sustain 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

\*Corresponding Author: yh\_teow@ukm.edu.my

expert, it is quite normal to see 90-95% reduction in BOD level within several weeks of nualgi nano biotechnology treatment [6].

The diatom algae which had done their job are consumed by zooplankton and then by the fish. Fish are further consumed by birds where nitrogen and phosphorus are transferring 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 nualgi nano biotechnology approach.



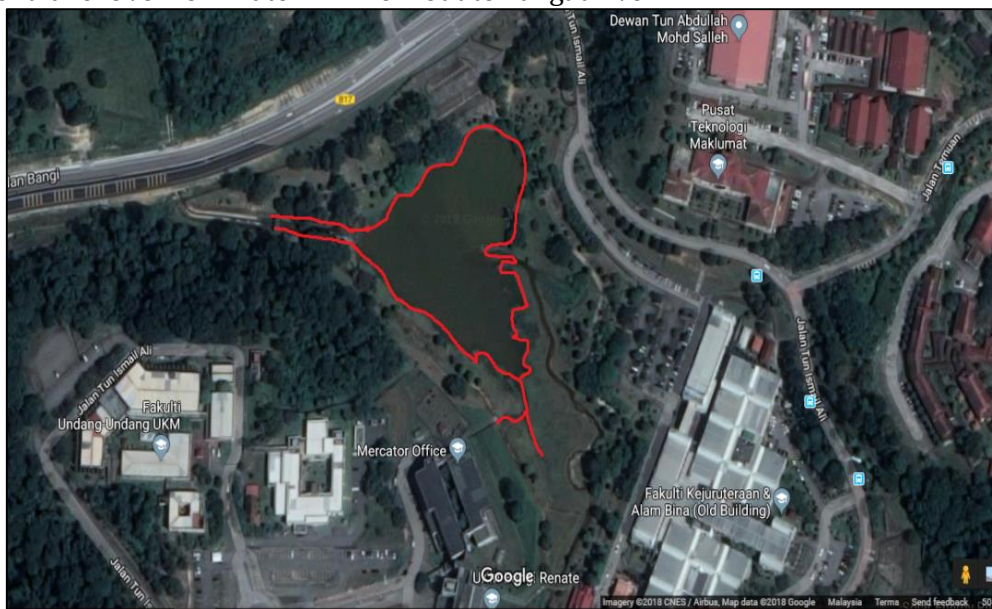
**Figure 1.** Eco-symbiosis remediation cycle created by nualgi nano biotechnology approach.

The bad practice of discharging the cafeteria wastewater or household chemical-contained effluents into 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 experiencing persistent pollution. Despite to this environmental problem and with the advantages possess by diatom algae in bioremediation, nualgi nano biotechnology treatment is seeing 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 lake. 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 Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia with GPS 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 year 1998. The water is flows from the upstream hill and retains in catchment lake. Overflow water will flow out to Langat river.



**Figure 2.** Satellite map of 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 catchment lake was conducted weekly for a consecutive of 6 weeks. Prior to dosing activity, 0.75 mL nualgi nano nutrient was diluted with 75 L of lake water and spray around the lake area. Catchment lake water sample was collected periodically at 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 °C in HACH RBC 200 reactor digester (Hach Company, USA) for 2 hours before 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 downstream of catchment lake before and along the nualgi nano biotechnology treatment from 14<sup>th</sup> March 2018 to 25<sup>th</sup> April 2018. The characteristics of catchment lake downstream water before 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 catchment lake is possibly due to the soil erosion from nearby construction. On top of that, wastewater and biological waste released by 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 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 illustrated the photographs of catchment lake water sample collected before nualgi nano biotechnology treatment and throughout weekly nualgi nano biotechnology treatment. As presented in Figure 3, the results obtained from most of the water quality analysis parameter are fluctuating 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<sub>4</sub>, and NO<sub>3</sub> while produce nano scale molecular oxygen through photosynthesis process whenever sunlight is available [4]. Attribute to this, the DO concentration in water body will increase at longer nualgi nano biotechnology treatment period. The photosynthesis reaction of diatoms is shown in equation (1).



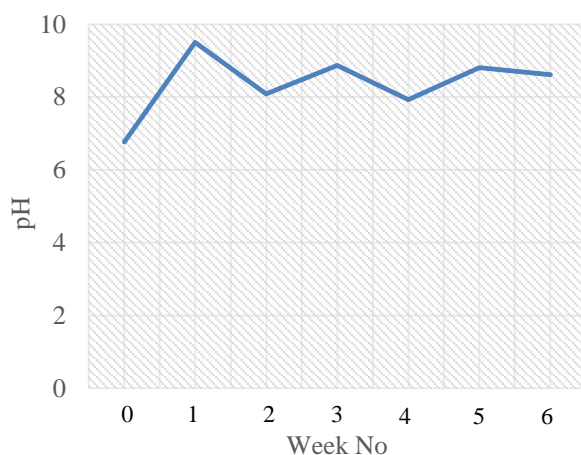
Diatoms are served as the base in food web where they will consume by higher eukaryotes and heterotrophic bacteria [8]. This hypothesis is supported by a study conducted by Kiran et al. [4]. Kiran et al. [4] explained that the oxygen produced by diatoms causes the native bacteria to grow, which act the same way bacteria were dosed into bioremediation water sample. On the other hand, nano scale molecular oxygen produced during photosynthesis reaction of diatoms was penetrated and disintegrated the sludge settling at catchment lake bottom. Attribute to this mechanism, most of the water analysis parameters show an increasing trend at 1<sup>st</sup> week of nualgi nano biotechnology treatment. This disintegrated sludge and organic matters are freely available to be digested by eukaryotes and heterotrophic bacteria.



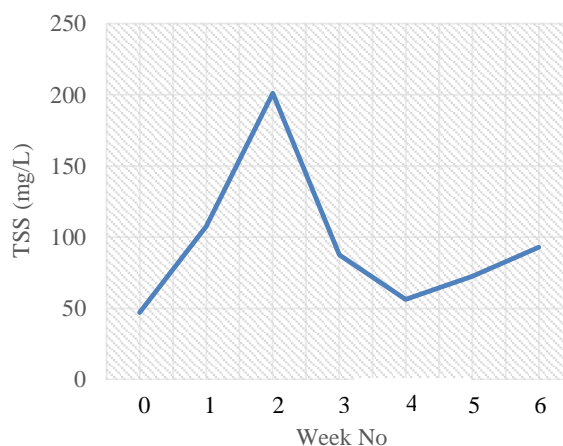
Unfortunately, after consecutive 6 weeks of nualgi nano biotechnology treatment, the water quality of catchment lake downstream water still does not meet the Class IIB National Water Quality Standard. This happened due to insufficient dose of nualgi nano nutrient in promoting fast growth of eukaryotes 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 grow of freshwater planktonic diatom and it will multiply at the fastest rate. However, the N:P ratio in 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 nutrient content, it leads to inefficiency of diatoms grow and bacteria multiply. As the results, there are limited number of eukaryotes and heterotrophic bacteria to degrade and consume the nutrients present in catchment lake, eventually causing inefficient of nualgi nano biotechnology treatment.

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

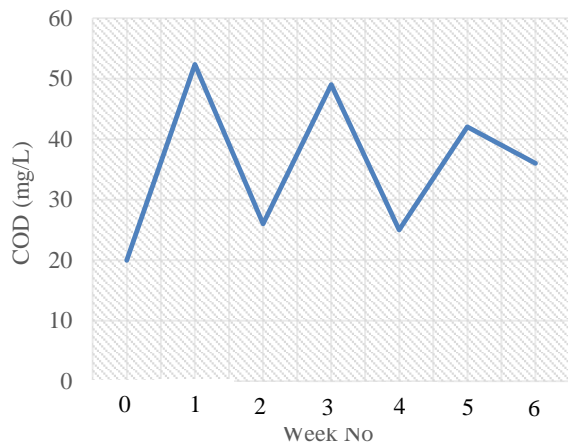
Parameter	Sampling Date					
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
pH	9.50	8.09	8.87	7.93	8.81	8.61
TSS (mg/L)	107.67	201.00	87.67	56.33	72.67	93.00
COD (mg/L)	52.33	26.00	49.00	25.00	42.00	36.00
BOD (mg/L)	5.41	2.10	4.74	5.30	4.09	8.03
DO (mg/L)	8.58	9.79	10.93	8.80	11.90	13.05
TP (mg/L)	0.52	0.43	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



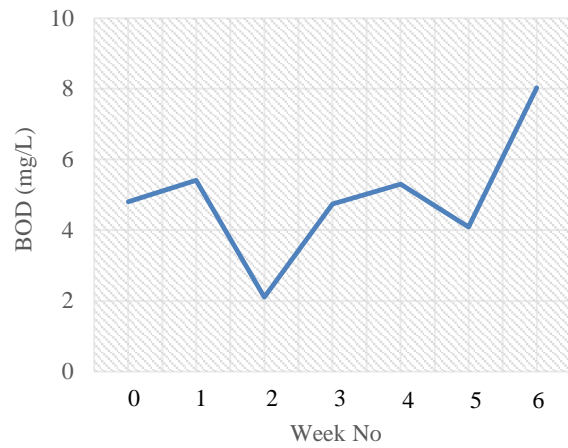
(a)



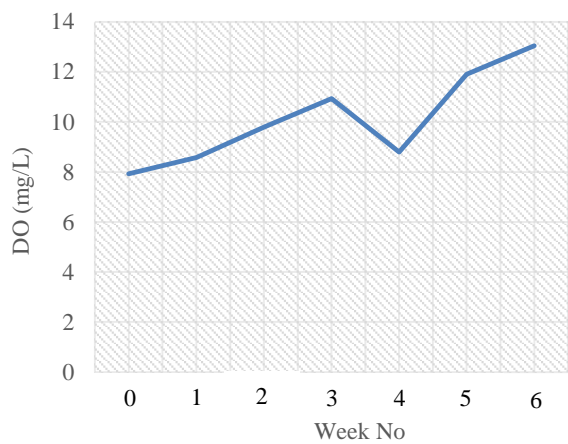
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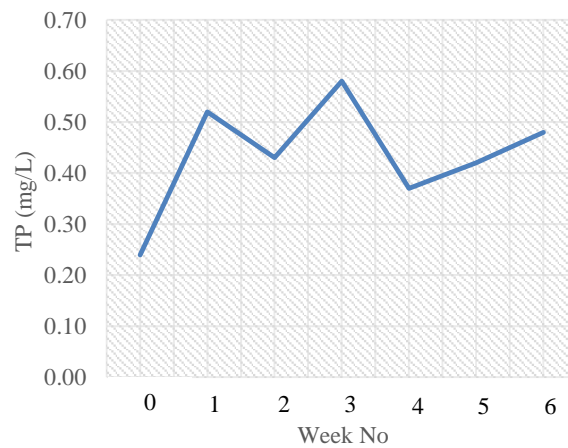
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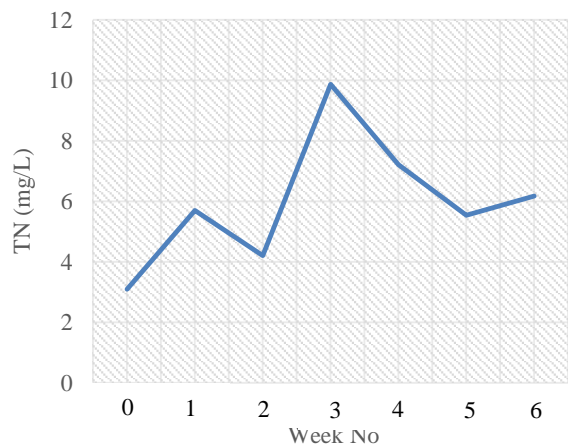
(d)



(e)

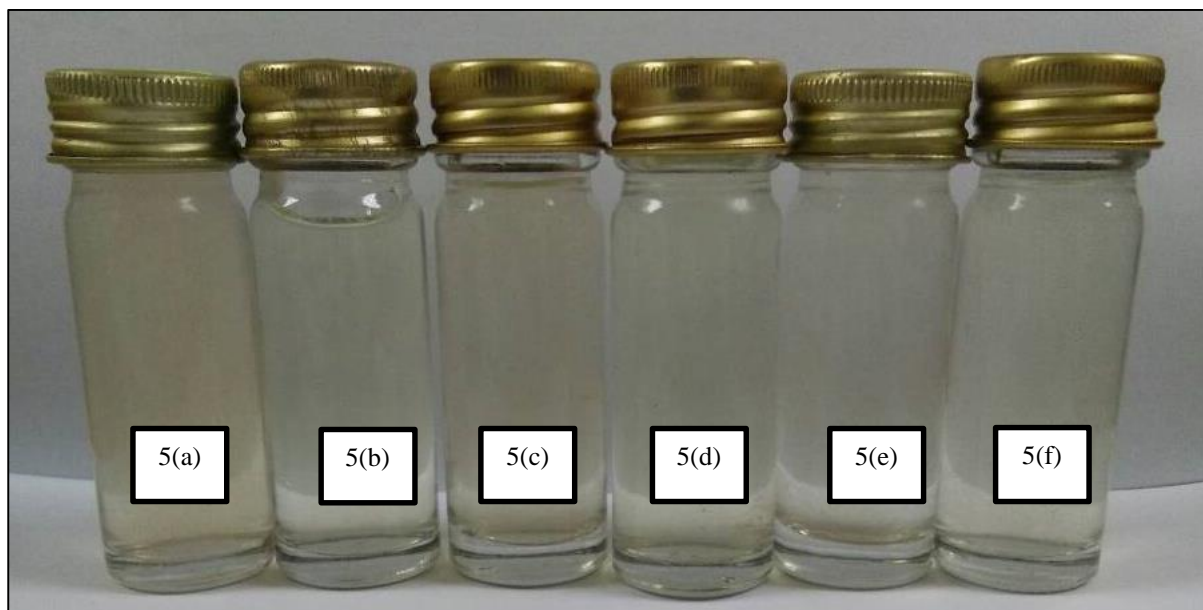


(f)



(g)

**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 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 lake or man-made recreation lake. 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 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.

#### ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the financial support of this work by Dana Penyelidikan Strategik (KRA-2017-06).

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