Aquaritin
WATER SOLUTIONS

A Case Study of Sg (River) Gong, Malaysia

Significant Carbon, Nitrogen and Phosphorous Fixation through *Aquaritin* based Phyco Remediation– A Case Study of Sg (River) Gong, Malaysia.

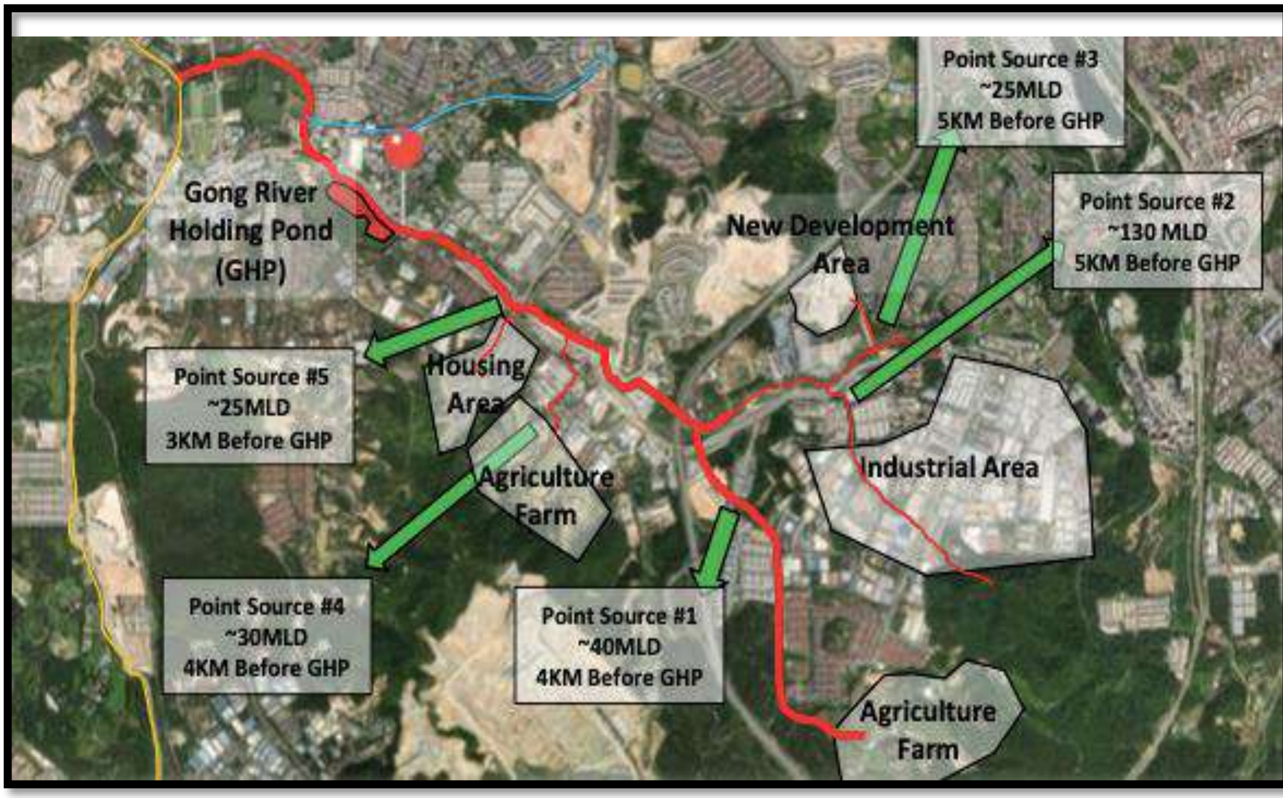
Executive Summary

The report highlights the Carbon, Nitrogen and Phosphorous fixation through Phyco Remediation. Phyco-Remediation of polluted waters through targeted Nano scale Nutrients is a novel technique for rapid, insitu remediation of lotic (flowing) wastewater bodies. The process involves high pressure dosing of Nano Nutrients Aquaritin and Microbial formulations in the waterbody in a ratio of 1:1. The process delivers improved water quality as well as nutrient assimilation by micro-organisms in water. The case study evaluates the nutrient assimilation achieved in the case study with focus on Carbon, Nitrogen and Phosphorous.

Sungai Gong (River Gong) is a 250 MLD River in Malaysia. It was deeply polluted with effluents from industry, agricultural farms, domestic wastewater, slaughter houses etc. A pilot trial leveraging the breakthrough technology from Aquaritin (AquaBio) was deployed for 3 months to assess the effectiveness against multiple point and non-point pollutants.

The trial was very successful as the Water Quality improved from Class IV to Class II as defined under Malaysian River Standards, within 12 weeks. Besides the improvement in water quality, aquatic life and aquatic biodiversity, the technology could fix 7 tons of Carbon, 1.7 tons of N and 0.5 tons of P per day. **Compared to trees on land, the fixation of Carbon at 7,000 kg per day is equivalent to carbon fixation by 120,000 trees per day**.

We believe that there is immense potential in the technology to decarbonize, eliminate algal blooms through prophylactic as well as curative action, mitigate acidification of oceans, eliminate mass fish kills, rebuild aquatic bio-diversity and even save imperilled coral reefs.



*Location of Sampling points and flow direction of Sungai Gong River

Challenges of Sg Gong River

	
Dark color water from nearby detention pond released into Sungai- Gong	Solid Waste Observed


Agricultural Run Off

Objectives

- To carry out the preliminary study on chemical, physical and biological Characteristics of raw water in Sg. Gong and Sg. Gong Holding Pond
- To implement the Raw Water Treatment System (RWTS) at Sg. Gong Holding Pond.
- To overcome the Issues of fuel /oil waste, chemical waste, and foul odor at Sungai Gong Holding Pond.

Our Target

- Comply with Requirements standard (Class II WQI) for e.g. Reduction of BOD, COD, Oil & Grease and elimination of odor before coming into GHP and discharged from GHP outlet.
- Improving physical condition and color of the Sg. Gong river.

Methodology

1. **Survey analysis –**

   The prime step is to conduct a preliminary testing of the water body. It includes testing of various physical, biological and chemical parameters to understand the water quality and treatment plan. The site is also surveyed.
   Parameters tested were:

   - Standard Water Quality Index such as Dissolved Oxygen (DO), Biochemical Oxygen Demand on 5 Days (BOD5), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (AN), pH, and Total Suspended Solids (TSS)
   - Other additional parameters such as TOC, DOC, Turbidity, Color, Odor, and Oil & Grease.
   - Phytoplankton Diversity – The dominant species from variety phytoplankton or microalgae such as Diatom, Cyanobacteria
   - (Blue-green algae), Green Algae, and Dinoflagellates.

2. **Dosing**

   Dosing of Aquaritin and bacterial formulation was done onto the surface of water body. It was continued till the water quality matched the prescribed standards. Feeding diatoms with silica based micronutrients will help to increase multiplications of diatoms population in water bodies. Due to sunlight exposure, nutrients and carbon dioxide, photosynthesis of diatoms occurs rapidly thus producing oxygen naturally in water system. Diatoms also assimilate nitrogen and phosphorous rapidly. Bacteria and microbes are activated by consuming natural oxygen in the water. Highly oxygenated water will help to degrade pollutant and organic matters thus improve water quality of the river. Symbiotic relation between diatoms and bacteria is a key factor to restore natural ecosystem as well as water quality improvement.

*Dosing in Progress in Sungai Gong River

3. Monitoring of water quality

Results

National Water Quality Standard- There was a significant improvement in terms of chemical parameters such as Dissolved Oxygen, BOD5, COD, Ammonia, Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC).

Diatoms and Their Contribution to Reduce Ecological Footprint

Diatoms are non-flagellated, unicellular algae that are surrounded by siliceous frustule. Diatoms have both ecological and biotechnological importance. In addition to light and temperature, nutrients are required for the growth of these microalgae.

- They require macronutrients- nitrogen and phosphorous. Nitrogen is required by the diatoms for the synthesis of amino acids, lipids, nucleic acids and some sugars and Phosphorous is a component of nucleic acids and ATP
- Trace metals like manganese, cobalt, magnesium, calcium, boron and especially iron and zinc are required for the growth of diatoms. Diatoms specifically require silicon for their growth as it is involved in making the outer cell wall.
- Vitamins such as thiamine, biotin and cobalamin are also required

During their growth cycle, diatoms absorb huge amount of these macronutrients and trace metals from the water, especially silica to make outer cell wall and zinc and iron for their physiological development.

Like other algae, diatoms perform photosynthesis with the help of CO2 and produce oxygen required for the survival of aquatic life. Diatoms are comparatively more efficient photo synthesizers thus they are able to add more oxygen to the water body. Diatoms also effectively take up these nutrients out-competing other BGA and green algae thereby help in maintaining the nutrient balance of water bodies.

Both single cells and chain forming diatoms play a major role in the biological carbon pump by their CO_2 assimilation and transport to the interiors of water body due to their fast- sinking rates.

Various species of diatoms like Chaetoceros spp or Asterionellaopsis gacialis have been seen to assimilate around 5.8×10^{-11} g/cell/day to 6.38×10^{-11} g/cell/day of carbon.

The role of carbon sequestration played by diatoms in water body is performed by trees on the land. Trees are very important for our ecosystem. They are also referred to as the lungs of the Earth as they sequester carbon and in return produce oxygen which is essential for our survival. According to various researches, a typical mature tree is able to sequester around 48 pounds of carbon every year. Thus a mature tree can sequester as much as 59.6-gram carbon per day.

Phytoplankton Diversity (Sg Gong)

In Sg. Gong freshwater ecosystem, generally there is about four class of phytoplankton or microalgae could be identified such as cynophyceae (blue-green algae), chlorophyceae (green-algae), bacillariophyceae (diatom), and euglenoidea. Freshwater phytoplankton is the phytoplankton occurring in freshwater ecosystems.

Cyanobacteria are adapted to low light environments and thus utilize light very efficiently. This is believed to be the result of the time period in which they evolved. About 3.8 billion years ago solar luminosity was ~30% lower than present conditions. Cyanobacteria were able to adapt to this low light and thrive off the nutrient dense conditions.

Green algae are a high-light adapted group. They utilize light relatively inefficiently and need high levels of light to live.

Diatoms are competitive in low light, however, they do not use light as efficiently as cyanobacteria. They are adapted to mixed conditions that consist of interchanging periods of low and high light.

Euglenoida or Euglenophyceae as shown in figure 16 are one of the best-known groups of flagellates, which are excavate eukaryotes of the phylum Euglenophyta and their cell structure is typical of that group. They are commonly found in freshwater, especially when it is rich in organic materials, with a few marine and endosymbiotic members.

Gong Holding Pond (GHP)

According to 4 Weeks of sampling and microscopic view at GHP, it takes about 4 weeks to reduce the population of Cyanobacteria (Blue-green Algae) at GHP from about 3,100,000 cell counts per mL on Week 1 to 650,000 cell counts on Week 4. It shows about 76 percent (%) of population reduction from Week 1 to Week 4.

Next, it takes about 4 weeks to reduce the population of Chlorophyte (Green Algae) at GHP from about 2,600,000 cell counts per mL on Week 1 to 950,000 cell counts on Week 4. It shows about 63 percent (%) of population reduce from Week 1 to Week 4.

Next, it takes about 4 weeks to reduce the population of Euglena at GHP from about 680,000 cell counts per mL on Week 1 to 190,000 cell counts on Week 4. It shows about 81 percent (%) of population reduce from Week1 1 to Week 4.

Next, it takes about 4 weeks to increase the population of Diatom at GHP from about 175,000 cell counts per mL on Week 1 to 670,000 cell counts on Week 4. It shows about 84 percent (%) of population increase from Week 1 to Week 4.

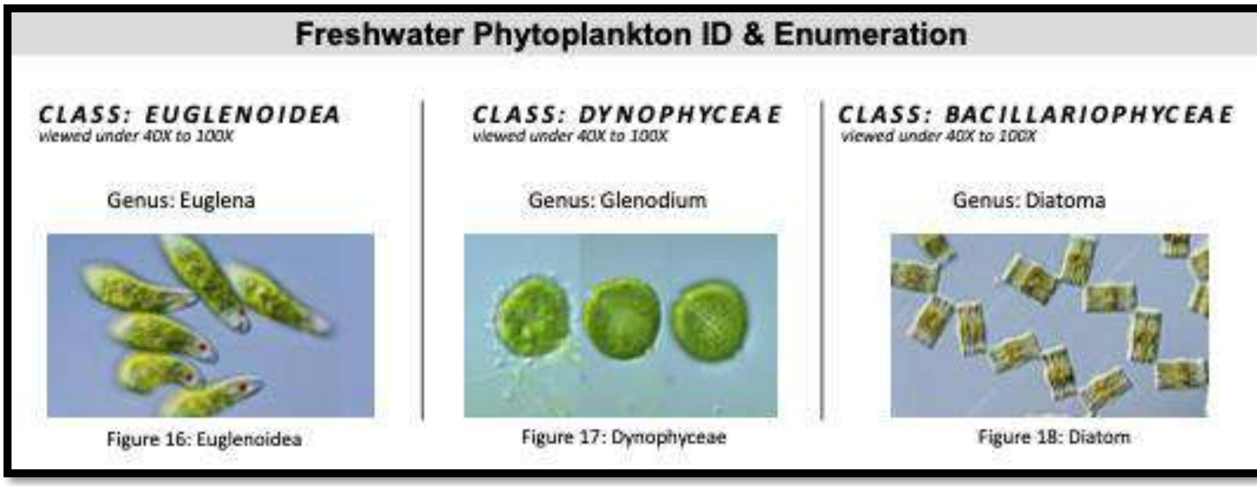


Figure 16: Euglenoidea

Figure 17: Dynophyceae

Figure 18: Diatom

Increase in Diatoms diversity - In Sg. Gong freshwater ecosystem, generally there is about four class of phytoplankton or microalgae could be identified such as cyanophyceae (blue-green algae), chlorophyceae (green-algae), bacillariophyceae (diatom), and euglenoidea. It took about 4 weeks to increase the population of Diatom at GHP from about 175,000 cell counts per mL on Week 1 to 670,000 cell counts on Week 4. It shows about 84 percent (%) of population increase from Week 1 to Week 4.

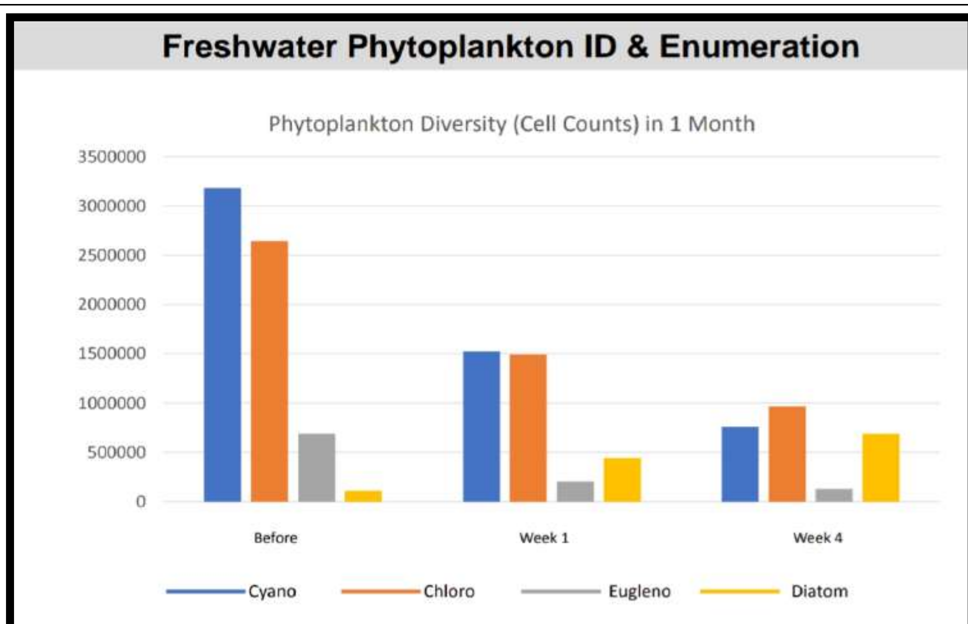


Figure 19: Phytoplankton Diversity

*This Bar Graph illustrates the enhancement of Phytoplankton species including diatoms after treatment.

CALCULATION ON THE BASIS OF SUNGAI GONG RIVER CASE STUDY, MALAYSIA

Carbon Sequestration

Cell specific carbon assimilation = 204 fmol $cell^{-1}$ hr^{-1}

= 5.8×10^{-11} g / cell/ day

Diatom enhancement due to Aquaritin in Sungai Gong river = 4, 90,000 cells per ml

Carbon assimilation per ml = 2.8×10^{-5} g/cell/ day

Volume of river = approximately 250 MLD

Total carbon assimilation = 7×10^{6} g / day= 7 tons C/day

Carbon Sequestration by using 1L of Aquaritin = Carbon Assimilation by total product used in a month/ Total Product Used in a month

= 210 Ton /288 L = 0.7 Ton/Liter

Nitrogen Assimilation

Cell specific nitrate assimilation = 42 fmol N $cell^{-1}$ hr^{-1}

= 1.39×10^{-11} g/ cell/ day

Diatom enhancement due to Aquaritin in Sungai Gong river = 4, 90,000 cells per ml

Nitrogen assimilation per ml = 6.8×10^{-6} g/cell/day

Volume of river = approximately 250 MLD

Total nitrogen assimilation = 1.7×10^{6} g/day = 1.7 tons N/ day

Nitrogen Assimilation by using 1 L of Aquaritin = Nitrogen Assimilation by total product used in a month/ Total Product Used in a month.

= 51/288 = 0.18 Ton/Liter

Phosphorous Assimilation

Cell specific phosphate assimilation = 6.5 fmol P $cell^{-1}$ hr^{-1}

= 4.68×10^{-12} g/ cell/ day

Diatom enhancement due to Aquaritin in Sungai Gong river = 4, 90,000 cells per ml

Phosphorous assimilation per ml = 2.2×10^{-6} g/cell/day

Volume of river = approximately 250 MLD

Total phosphorous assimilation = 5.5×10^{5} g/day = 0.5 tons P/ day

Phosphorus Assimilation by using 1 L of Aquaritin = Phosphorus assimilation by total product used/ Total product used

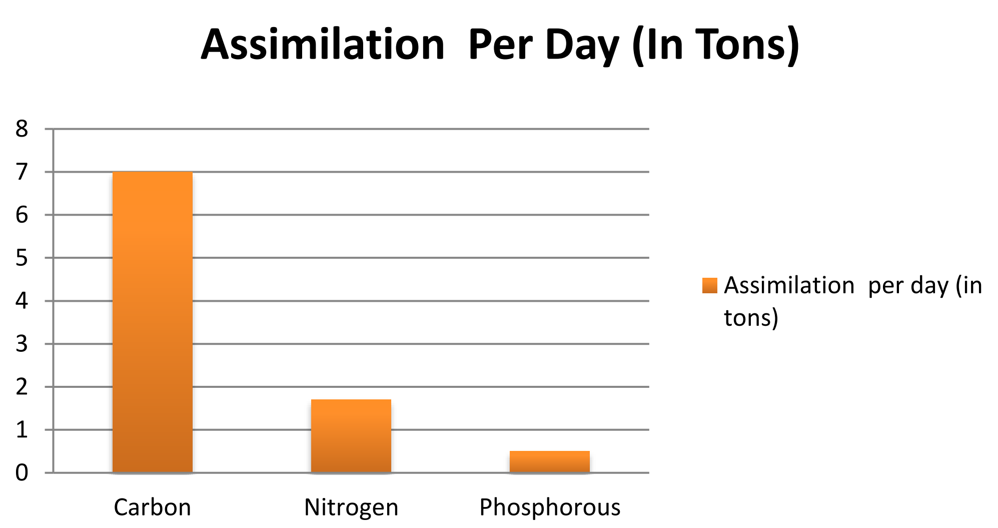
= 15/288 = 0.052 Ton/Liter

In this study, water samples were collected from various points of Sungai Gong River and were analysed. C:N:P ratios were determined during the time course of the incubations. This allowed us to examine the changes in N and P contents of organic matter during decomposition by the diatoms: -

C: N: P Assimilation ratio = 14:3:1

Table: Nutrient Assimilation by diatoms.

Nutrients	Assimilation per day
Carbon	7 tons
Nitrogen	1.7 tons
Phosphorous	0.5 tons



<u>Carbon sequestration comparison between 1 liter of Aquaritin and a mature tree-</u>

Carbon sequestration due to diatoms produced by 1 liter Aquaritin in one month = 0.7 tons

Carbon sequestration by one mature tree in one month = 59.6 × 30 =1.7kg=0.0017 tons

Thus the diatoms produced by 1 liter Aquaritin are able to sequester around 400 times greater than carbon sequester by one tree in one month.

<u>Conclusion</u>

Dosing of Aquaritin and bacterial formulation was successfully treated the water quality surface of water body. AQUARITIN is a nano nutrient formulation embedded in nano-silica. Feeding diatoms with silica based micronutrients helped to increase multiplications of diatoms population in the water body.

- Diatoms absorb all the nutrients delivered through Aquaritin and perform photosynthesis. This leads to increase uptake of CO_2 and release of oxygen. Increase in biomass of diatoms also result in increased assimilation of carbon.
- Diatoms compete efficiently with other microbes for nutrients like nitrate and phosphate. This leads to effective uptake of nitrates and phosphates and reduction in excessive nutrient load in the water body.

Global Water Partnership

This is to certify that

JS Water Energy Life Co. Pvt Ltd.

India

has become a Partner of the
Global Water Partnership

Date
2021-06-23

Darío Soto-Abril, Executive Secretary & CEO
Global Water Partnership

The Global Water Partnership's vision is for a water secure world. Its mission is to support the sustainable development and management of water resources at all levels. The network currently comprises 13 Regional Water Partnerships and more than 84 Country Water Partnerships in over 167 countries.

“We Are Also One of the Partner of Global Water Partnership”