A Solution to Water Shortage Issue in Shanghai, China Due to Water Quality

Addressing SDGs

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I. The Problems

The significance:

The Yangtze River Delta area including Shanghai and Suzhou, **has a population of more than 55 million and a GDP output of more than $2 trillion**. Clean-water shortage poses an immediate threat to the regional economic development and human health. Regional river networks through Lake Taihu are severely polluted by excessive waste discharge and eutrophication. Sources of pollution include industrial and household sewage, fertilizer runoff to the river. The pollutant discharge rate to the waterways is far beyond its self-purification capacity, resulting in **continuous water quality deterioration**, generating high amount of total ammonia, total phosphorus, petroleum pollutants and dissolved oxygen in the rivers, which is so-called **eutrophication of water bodies.**

Figure 1: where pollution comes

Figure 2: Outbreak of Cyanobacteria

The outbreak of Cyanobacteria:

Among the seven large reservoirs of Lake, three are in a mild eutrophic state, and the rest are in a medium eutrophic state. In recent years, Lake Taihu has had severe eutrophication problems. **Eutrophication of water bodies can lead to cyanobacteria blooms, whose toxins can kill organisms in the water. Accordingly, as the largest water source of Shanghai, Lake Dianshan is deeply affected.**

Figure 3: Lake Taihu and Yangtze River Delta

II. The Solution & Implementation

PART I. The Environment-Enhancing Energy (E^2-Energy)

What is E^2-Energy?

The Environment-Enhancing Energy (E^2-Energy), a scientific research led by Professor Yuanhui Zhang of UIUC, is a novel system for algal biofuel production that synergistically integrates algal wastewater treatment with hydrothermal liquefaction (HTL) of wastewater biosolids and algae into bio-crude oil.

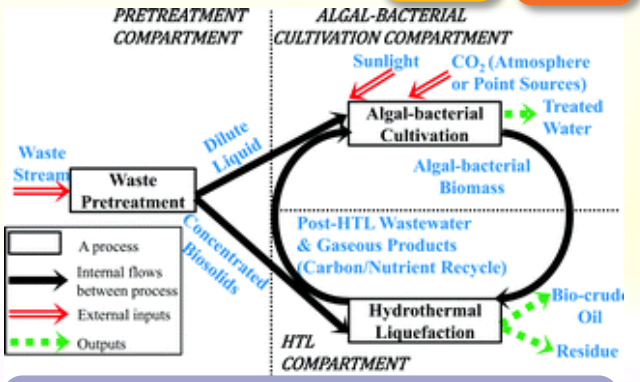

Figure 4: Simplified schematic of the Environment-Enhancing Energy process for integrated wastewater treatment and biofuel production. (Zhang 3)

Benefit:

This system maximizes the biofuel potential of sewage inputs by internally capturing and recycling carbon and nutrients. In this way we may turn the algae, which used to be disaster for production, into a useable fuel for human.

People can collect cyanobacteria form the sources annually as the Algal Bacteria for this project.

PART II. The green corridor-- Reed Bed

What is Reed Bed?

Reed bed is a pond filled with sand gravel, sand particles, and other fillers and planted with reeds. The sewage passes through the plant root zone and is degraded by **physical, chemical, and biological** reactions under the action of vegetation and microorganisms.

Why do we choose Phragmites australis (reed)?

- Lax requirements on soil.
- Long growth season, fast growth and high yield.
- Highly resistant to pollutants and salt.
- Native species, adapted to the local environment.
- Considerable decomposition and purification capacity for sewage.

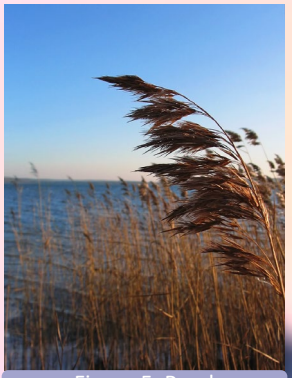

Figure 5: Reed

How does reed solve the problem?

In wastewater treatment, reed bed can be regarded as **a complex microbial reaction system**, which consists of microbes attached to the roots of reeds and gravel surface. When sewage passes through, the system can conduct aerobic or anaerobic metabolism, using organic and inorganic substances in the water to obtain energy and hence simultaneously remove pollutants of the water.

STEP1: Yangtze-Taihu Water Diversion

After the green corridor, water with lower quality will be led into the Yangtze River, while cleaner water from the Yangtze will be sent back to Lake Taihu through the Wangyu River. We try to centralize sewage discharge at the lowest level of Yangtze River at the year, during which close Wangting hydro junction and open Changshu hydro junction. The direction of Wangyu River will reverse, and sewage from the west will be discharged into the Yangtze River and then the ocean.

Figure 6: Yangtze-Taihu Water Diversion

Then, the water of high quality will enter Lake Dianshan, Shanghai.

STEP2: The separation of water at Lake Dianshan

We use **SPP (Separation, Protection, Prevention)** principle to deal with the change of water quality. When high-quality water comes, the rubber dam will be drained, and high-quality water enters. When sewage occurs, the rubber dam will be filled with air (and/or water) immediately and the sewage will be discharged from the lake-surrounding sewage channel.

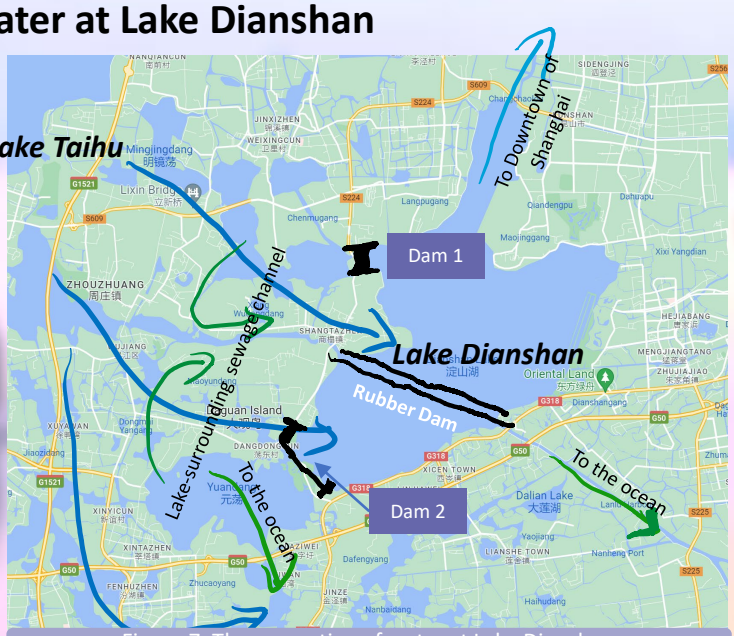

Figure 7: The separation of water at Lake Dianshan

Advantages:

- Satisfy the water usage for living and transportation.
- Avoid the outbreak of Cyanobacteria.
- Prevent the original lake water pollution and Improve water quality

Special mention for guidance: Professor Yuanhui Zhang

Reference:

[1]Yuhanhui, Zhang, et al. “A synergistic combination of algal wastewater treatment and hydrothermal biofuel production maximized by nutrient and carbon recycling”, *Energy Environ*. Sci., 2013, 6, 3765-3779
[2]马 云馨.长三角地区水环境面临五大问题——《2016年上海资源环境发展报告》指出.2016, www.pishu.cn/psgd/377766.shtml. Accessed 31 Oct 2022.
[3] Shu-Qing Yang,水质型缺水城市如何解决水资源、水环境问题-以上海为例.2014, www.researchgate.net. Accessed 31 Oct 2022.
[4]吴 浩云, 甘 月云,and 金 科.""引江济太”20年：工程实践、成效和未来挑战." *湖泊科学*34.05(2022):1393-1412.
[5]石 敏球, et al."芦苇床污水处理技术研究现状." *广东化工*44.01(2017):103-104.