To Identify and Remediate Dead Zone at Jakkur Lake

2019-2020

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Background

Biome Environmental Trust (BIOME), Consortium for DEWATS Dissemination(CDD) and Jalaposhan together submitted a proposal for the Bangalore Sustainability Forum (BSF) small grant program to identify dead zones at Jakkur lake and to rejuvenate one dead zone using the vortex or any other appropriate system.

The scope of work defined in the proposal submitted by BIOME included:

- To identify dead zones in the lake and evaluate the potential of the vortex system or any other appropriate system to revive these dead zones

- To understand the role of the Wetland in Jakkur Lake with respect to its ability to improve water quality as well as biodiversity. To draw up a protocol for its management.

The wetland at Jakkur lake was designed to treat 10 MLD of secondary treated wastewater from the Jakkur sewage treatment plant (STP), however currently 15 MLD of treated water and 5-10MLD of untreated sewage enters the lake through the wetland. The excess discharge of secondary treated wastewater combined with untreated sewage entering the wetland does not allow for adequate retention time for absorption of nutrients leading to dead zones forming in the lake. Stagnant areas of the lake also create anoxic and anaerobic conditions in the lake allowing dead zones to form. In this project dead zones were identified in the lake and a solar aerator was used to try reviving a dead zone.

Identifying Dead Zones

Dead zones are areas without enough dissolved oxygen (DO) to support aquatic life, they can be caused naturally or by human activity, but the primary cause is excess nutrients entering the water either through surface runoff or wastewater entering lakes. Excessive nutrients in the water lead to algal blooms, which in turn cause depletion in DO levels in the early hours of the morning, since, overnight, the algae use up the oxygen that fish and other plants need to survive (during the day oxygen levels in the water may be higher as the algae photosynthesise and release oxygen). Click here to learn more about algal blooms.

A way to identify a dead zone is to measure dissolved oxygen (DO). DO levels of 4 mg/L and above indicate a healthy aquatic life and less than 4 mg/L indicate poor water quality and is considered detrimental to aquatic life. To learn more about fish and bird

kill, please refer to this blog. It should be noted that some fish can survive in water with low DO levels too.

To test DO levels we needed a portable DO meter, so that it could be used to measure various points in the lake. ATREE bought a YSI Pro20 Dissolved Oxygen handheld meter, and shared it with Biome to use for this project. It was purchased from Xylem Analytics, a dealer for YSI instruments in India.

Image 1: YSI Pro20 DO handheld meter

Measuring Dissolved Oxygen Levels at Jakkur Lake

To take DO measurements at the lake we needed to coordinate with ATREE for the DO sensor, we also coordinated with Jalaposhan to get the required permissions from BBMP and with the fishermen to coordinate the day and time. The DO levels were tested over 15 times from August 2019 to March 2020. DO varies with temperature, depth, and time of day. To ensure uniformity in our measurements we took the readings every morning around the same time, and at two depths: 6inches below the surface and 1m below the surface. The map below marks the various location points that we have measured the DO levels at. The data collected can be accessed here.

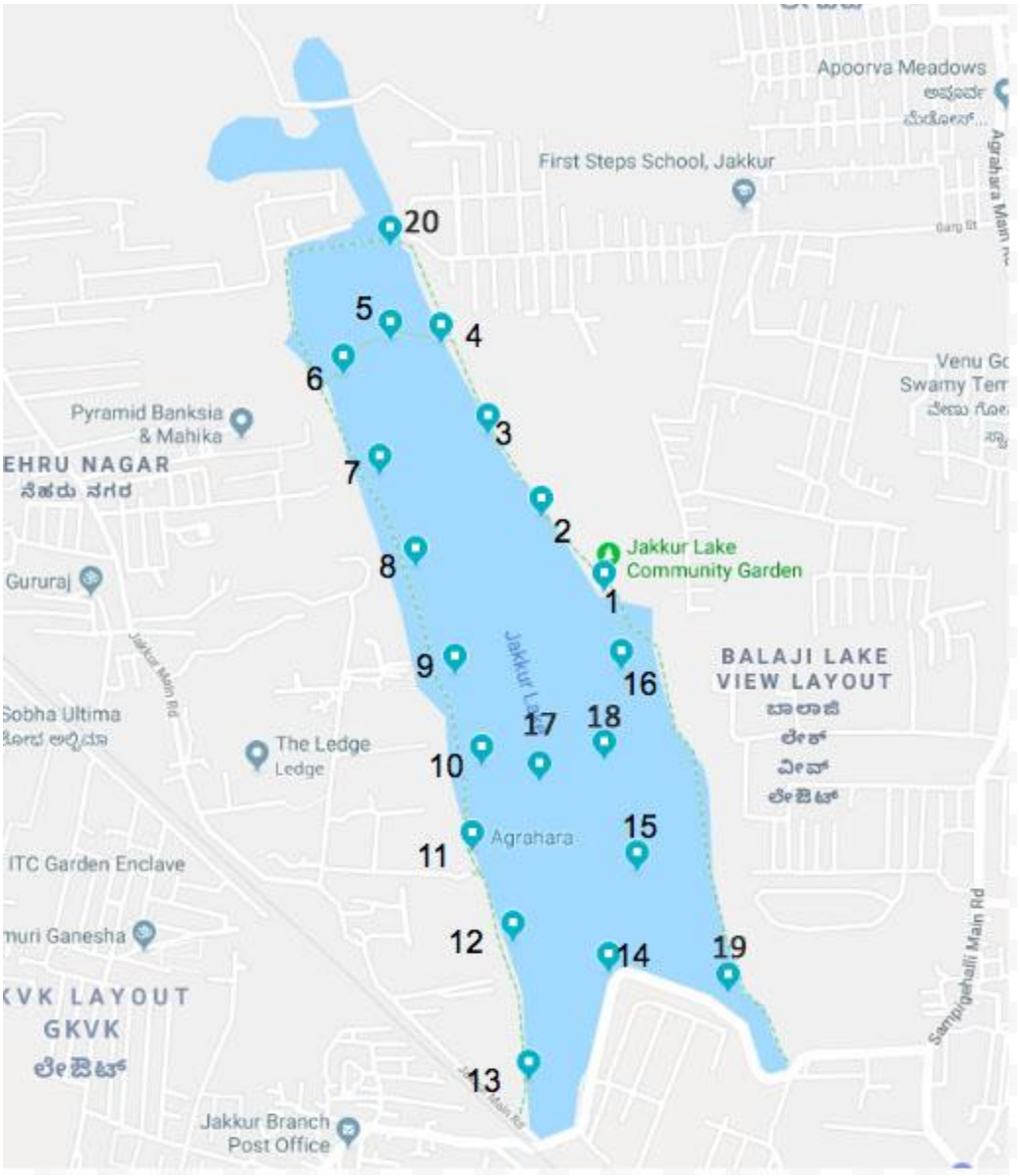
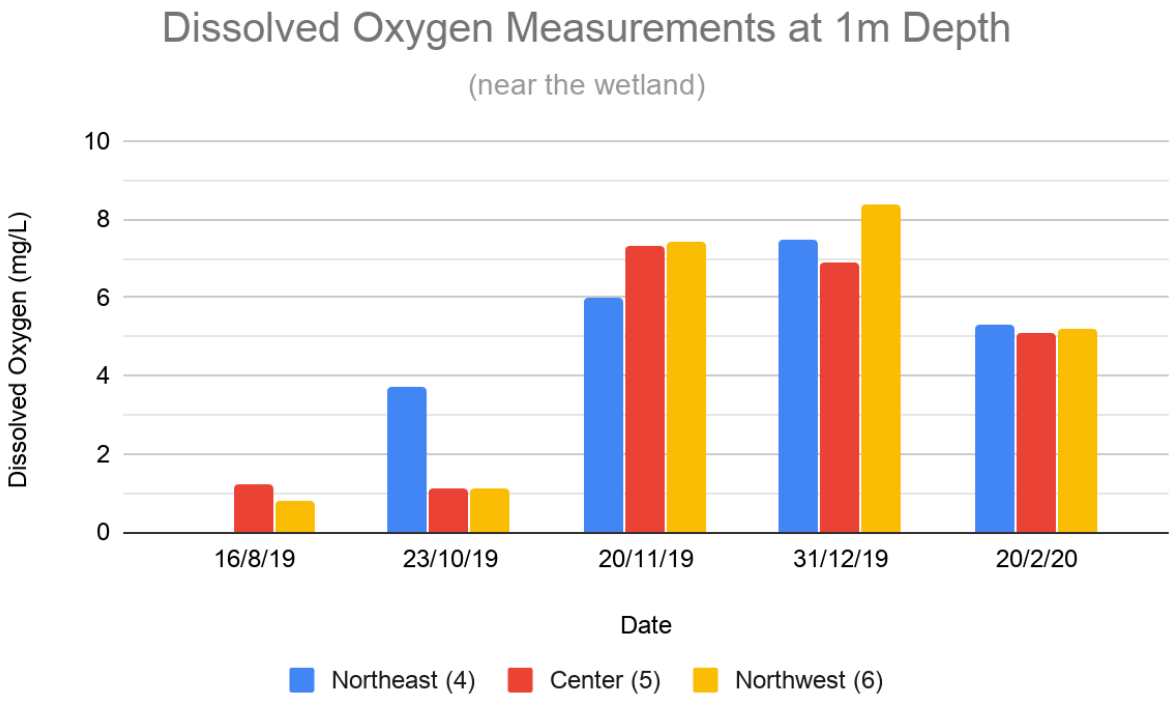
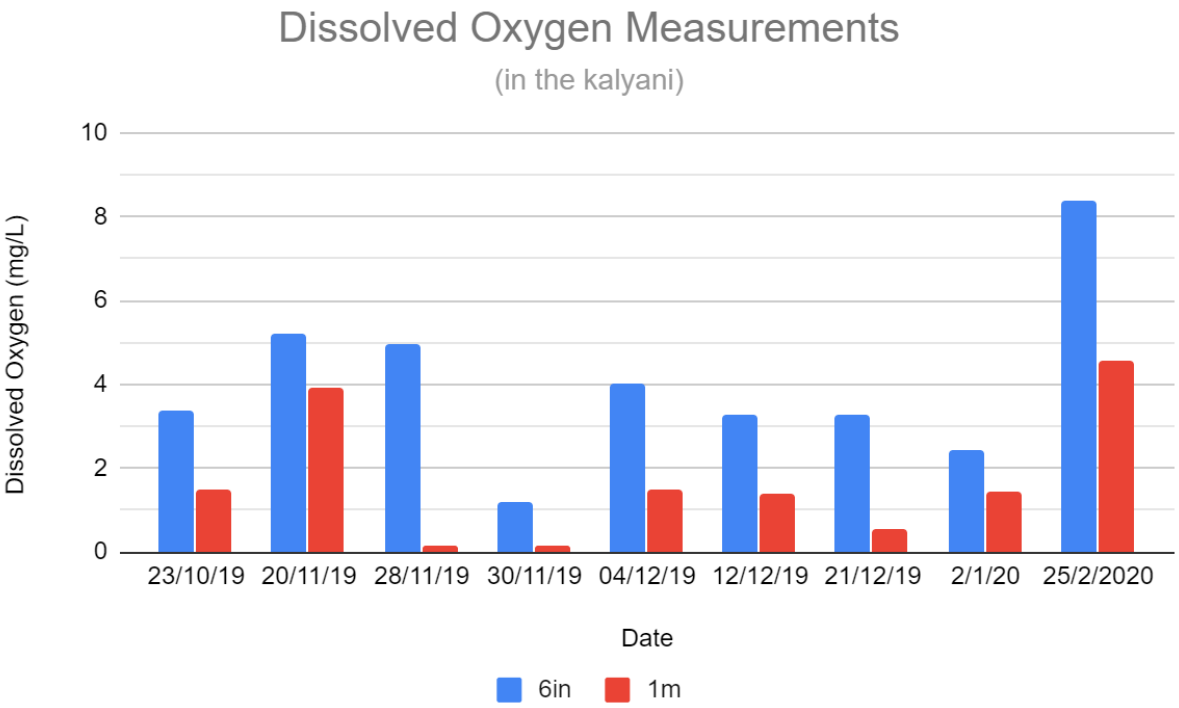


Image 2: DO testing locations

We observed DO measurements of less than 4mg/l at 1m depth near the wetland (point 5), the northeast and northwest corners near the wetland (points 4 and 6), near the western bank (points 7,8,9 and 10) and in the kalyani (as shown in image 3). The readings were taken over different seasons monsoon, winter and summer. We saw a lot of fluctuations in the DO readings between and within each season. One of the main factors that caused fluctuations is the quality of water entering the lake. Graph 1 below shows the measurements taken at points 4,5 and 6 at 1m depth. Graph 2 depicts the changes in DO that were monitored in the Kalyani.



Graph 1: DO measurements near the wetland at points 4,5 and 6



Graph 2: DO measurements taken at the kalyani

Reviving a Dead Zone at Jakkur

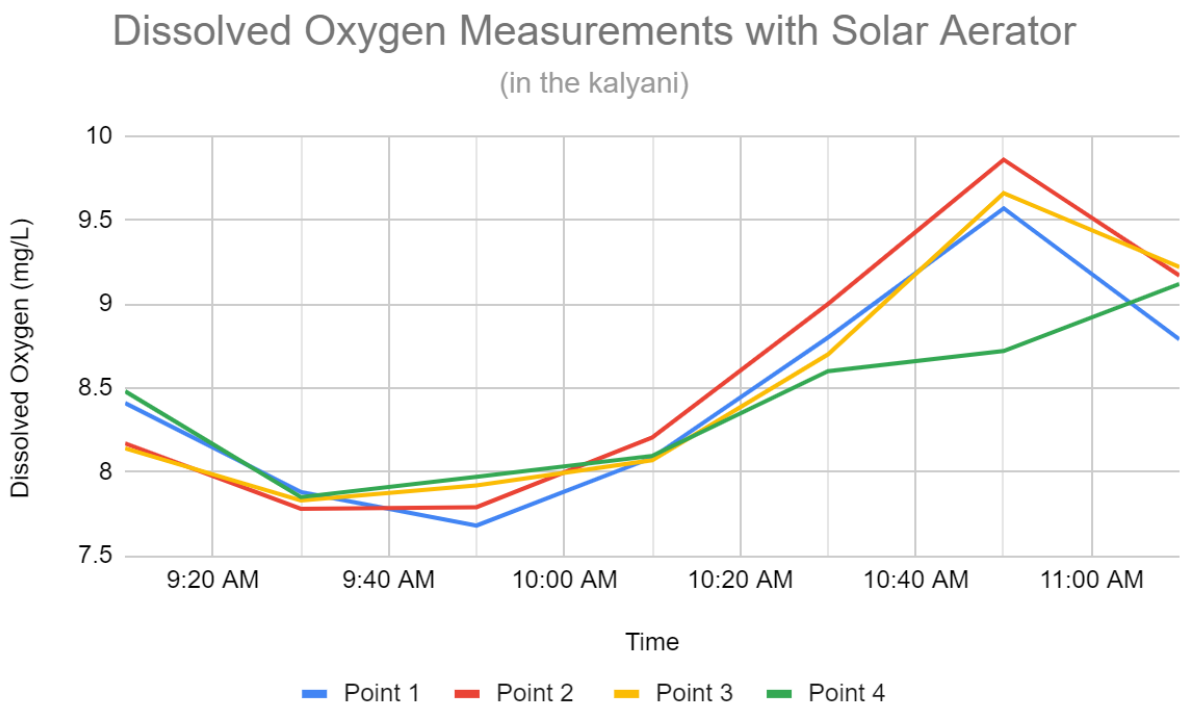
To revive the dead zone, we initially wanted to use a Vortex system, however we could not access the system. Hence, we started looking for alternative ways to improve the DO levels, we needed a system that could be portable and would not need electricity to function. After brainstorming, we decided to choose a system that relied on renewable energy such as solar or wind power. We contacted Mahesh from Sun Ray to design a solar aerator for the lake. As per discussions, he designed a system using 2 photovoltaic cell panels of 3ft by 2 ft dimensions, a 1HP motor and two pipes (an inlet and an outlet pipe).

Image 4: Testing the Solar Aerator in the Kalyani

For ease of testing we chose to test the solar aerators at the kalyani. Image 4 above shows the solar aerator being tested at the Kalyani in Jakkur lake. The water in the

kalyani is stagnant and water is occasionally pumped from the lake into the kalyani, and it is cleaned once a year after the Ganesha festival. We tested the aerator at the kalyani on Feb 25th and 26th at 4 points as shown below in image 5. The aerator was placed at point 2, point 1 is 5m to the right of the aerator, point 3 is 5m to the left of the aerator and point 4 is 10m to the right of the aerator.

Image 5: DO Testing Locations in the Kalyani



Graph 3: DO Measurements with Solar Aerator

We monitored the DO levels every 20 minutes for 2 hours and saw a small spike in DO levels near the aerator. The point 2 graph marked in red shows a small spike in DO where the aerator is placed.

Key Learnings

To better understand the effectiveness of the system, DO measurements will need to be taken for a longer period of time and the system could be modified for better results. Few modifications that can be made are:

- An **air pump** can be used to increase the aeration efficiency
- A **fountain/sprinkler** system can be designed using the existing system to increase the aeration efficiency.
- A **bubble diffuser** is an option**.** Since this will be submersible, maintenance of the system might be high.
- DO levels are lower at night and early mornings, but since solar aerators would need peak sunlight from 11-3pm to function, a **battery** backup system can be planned to ensure the device can be used at night and in the early mornings.
- Since DO changes continuously during the day**,** to accurately measure the DO especially at night and early hours of the morning it would be helpful to use a

sensor for **continuous monitoring** of the DO levels.

Engaging with the Community

Once we tested the aerator and realised that it can be improved to make it more efficient we requested interested Jalposhan community members to join us for a demonstration. 3 enthusiastic members joined us on a weekday at 9am. We worked with them and shared our learnings, and functioning of the aerator with them. We have left the aerator at Jakkur lake for them to take this project ahead. They shared ideas of using air pumps to improve the efficiency of aeration and thought of ideas on how to showcase the solar aerator such that other citizens passing by can also see and learn about the system.

One idea is to showcase the Solar aerator in the Kalyani and write a concept note for people to see, read and understand the use of such a system for improving the quality of water in the lake.

Image 5: Training session with Jalaposhan members

Instrumentality of Wetland

As per the proposal we wanted to study the instrumentality of the wetland but due to the quality of quantity of water that was entering the wetland, we decided not to go ahead with plant and fish analysis. However we collected water samples at the

- STP inlet into the wetland

- Sewage inlet into the wetland
- Outlet of the wetland
- Middle of the lake
- Outlet of the lake

The water samples were sent to Incep Bio for testing as per drinking water standards, click here to view the reports. To learn about water quality parameters and standards in a lake, click here.

Based on the data we see that there is a reduction in nitrate levels after water flows through the wetland. There is a slight increase seen towards the outlet of the lake however, within permissible limits . Overall based on the water quality test of the wetland inlet and wetland outlet samples we see that the wetland is functioning.

Summary

For this project we identify the collected dissolved oxygen readings over a period of 8 months. The data collected shows that areas near the wetland outlet, the northeast corner, the northwest corner and the western bank of the lake have low dissolved oxygen levels. While taking the readings we observed large amounts of water entering the lake, we saw algal blooms, and noticed bad odour near the wetland indicating fluctuations in the water quality. Other factors that could have affected the data are rainfall, and cloud cover. In order to revive the dead zone we needed a portable device that did not require electricity to function, after some research we decided to use a solar aerator to improve the water quality. To see a significant impact the readings using the solar aerator would need to be taken over a longer period of time. Due to the sudden changes in water quality and quantity of water entering the wetland it was difficult to study the instrumentality of the wetland.

References

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"Dissolved Oxygen." Environmental Measurement Systems, Fondriest Environmental, Inc, 19 Nov. 2013, www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/.

Dissolved Oxygen and Water. USGS, www.usgs.gov/special-topic/water-science-school/science/dissolved-oxygen-and-water?qt-science_center_objects=0#qt-science_center_objects.

“Solar Aeration for Lakes and Ponds.” Solitude Lake Management, www.solitudelakemanagement.com/solar-aeration-for-lakes-and-ponds-environmentally-friendly-aeration-solution.

Acknowledgment

We would like to thank the following people and organisations for helping us with the Dead Zone Project.

- Bangalore Sustainability Forum for funding the Dead Zone Project.
- ATREE for supporting us with the DO meter, training us how to use it and calibrating the sensor when required.
- Jalaposhan for coordinating with the fishermen, getting the required permissions from BBMP, assisting in water sample collection and engaging local members in our outreach program.
- Sena for taking us around the lake and helping us collect data
- Wipro for funding us for the solar aerator
- CDD for being our partner
- BBMP for giving us permission to work at the lake

Appendix

1. DO measurements
   https://docs.google.com/spreadsheets/d/1RxWopUJO_1hbzmhn-Jg7-47YW-oxNUlcrqFQ4xfvEY4/edit?usp=sharing

2. Water Quality Testings Report
   https://docs.google.com/spreadsheets/d/1xNKflfvtPH3bxyecD8aEZdkrYOjk4irrkkflbZ77qno/edit?usp=sharing