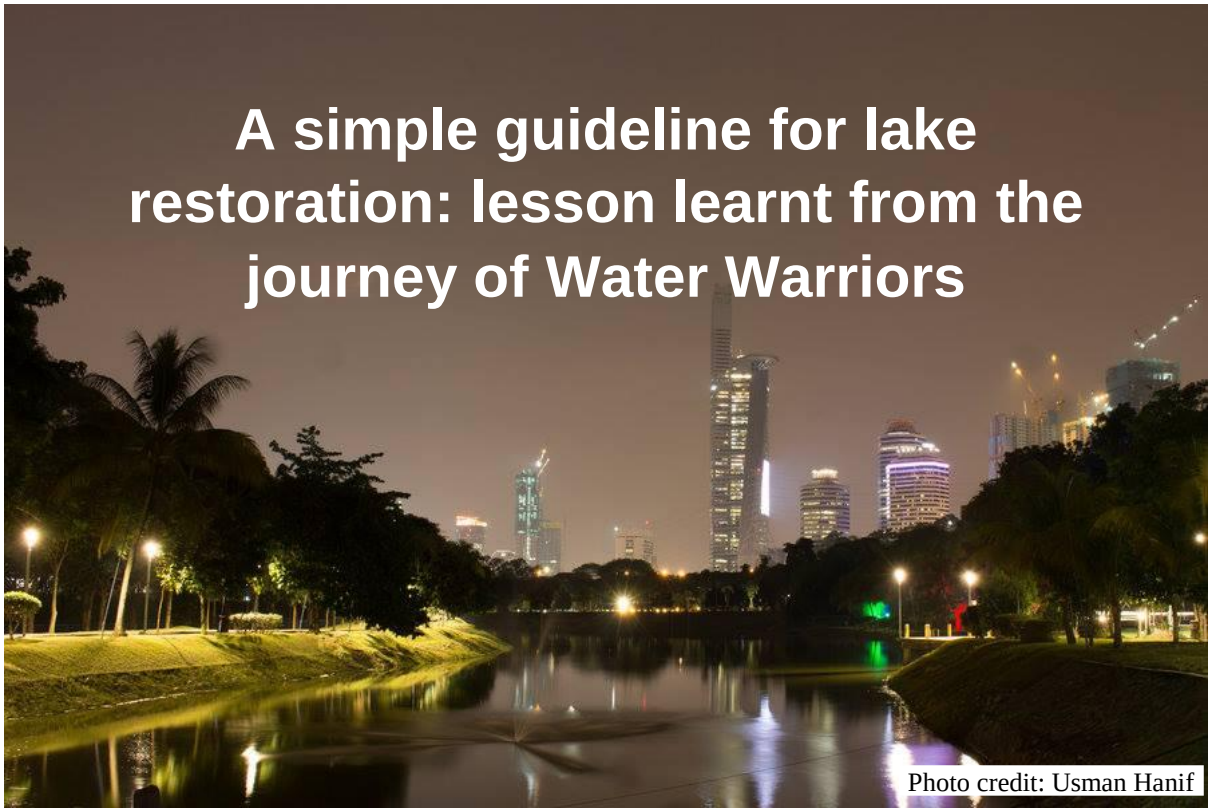
A simple guideline for lake restoration: lesson learnt from the journey of Water Warriors
Photo credit: Usman Hanif

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I. INTRODUCTION

This guideline is simply a sharing of experience as part of the lesson learnt based on our five years' experience managing Tasek Varsiti (Varsity Lake) in University of Malaya developed by university's Living Lab initiatives called Water Warriors[1].

1. What are Water Bodies?

Water body or a body of water is the accumulation of water on the Earth. This may refer to huge accumulations such as lakes, rivers, oceans, seas, and also smaller pools of water such as streams, ponds and wetlands.

2. What is a Lake?

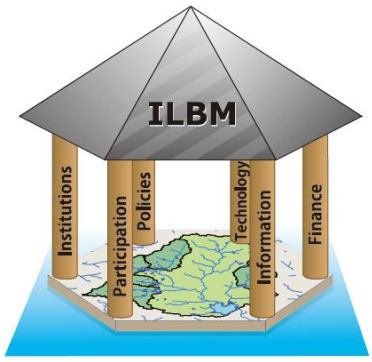
A lake is a body of fresh or salt water, surrounded by land. Lakes receive their water from rainfall, streams and groundwater. A lake can be in form of an open system (with an inlet and outlet) flowing like a river or a close system (without an inlet or outlet). In an urban setting, most lakes are manmade, whether for recreation purposes or leftover from mining industry.

II. LONG-TERM MANAGEMENT

In contrast to the 'quick fix" approach, a long-term lake management sets a higher priority on finding lasting solutions.

1. Integrated Lake Basin Management (ILBM)

The ILBM is an approach for sustainable management of lakes, which can be used as a reference for long-term lake management. ILBM[2] integrates institutions, participation, policies, technology, information and finance; forming the six pillars:



[1] For more information on Water Warriors, read our journal paper, "Heartware as a driver for campus sustainability: Insights from an action-oriented exploratory case study". Journal of Cleaner Production, Volume 196, Pages 1086-1096

[2] Read more about ILBM: http://www.ilec.or.jp/en/pubs/p2/ilbm-manual

III. RESTORATION

The restoration of any water body should be treated based on the needs of the place. In the case of Tasek Varsiti, the process was divided into three stages: Research, Fixing and Life. The following will elaborate more on these three stages.

1. Research

i. Point Source and Nonpoint Source Pollution

The research prior to its restoration can start with finding out the point source pollution and nonpoint source pollution. Point source pollution refers to any single identifiable source of pollution from which pollutants are discharged such as from pipe, drains or sewerage lines and are usually related to any buildings or factories nearby the water body. On the other hand, nonpoint source pollution can be caused by rainfall for example, which carries runoff water possibly polluted with human-made pollutants such as fertilizer and trash.

ii. Water Quality Monitoring

Checking the water quality is important to know the current state of the lake and to set the target for lake restoration. Water monitoring can be done either accurately in a lab or using low cost monitoring kit to provide a baseline data.

a. According to the National Water Quality Standards[3] for Malaysia, the best water quality for a lake with recreation use with body contact is at least Class IIB. The six parameters needed for this standard are Ammoniacal Nitrogen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, pH and Total Suspended Solid. To get an accurate data, water monitoring tests needs to be done in-situ (onsite) such as for dissolved oxygen and temperature and ex-situ (at the lab).

b. Several low-cost monitoring kits are available in the market such as La Motte Low Cost Monitoring Kit and Japan Kyoritsu Pack Test, Simplified Chemical Analysis Products for Water Quality. Though the result using these kits may not be so accurate, they provide an important baseline data to presented to the stakeholders.

2. Fixing

The "fixing" stage involves all the civil and hardscape work such removal of sedimentation, deepening of the lake, installing rip-rap for lake bank protection, converting part of the lake into a wetland area and many others. Again, the need for these fixing depends on the condition and needs of that particular water body.

[3] Read more about the National Water Quality Standards here: http://www.wepa-db.net/policies/law/malaysia/eq_surface.htm

3. Life

It is important to encourage the surrounding community to be part of the "life" stage. Carnival-like event could be hosted when the lake is restored, with various fun activities for the community to participate in such as competitions, exhibitions, games and others. Various flora and fauna was introduced and reintroduced to the lake. This includes local fishes (in contrast to invasive fishes) such as *kaloi*, *patin* and *sebarau* to provide a sanctuary habitat for them and ducks and geese which will give the visitors the enjoyment of watching their antics behaviour. New trees could also be planted during a tree planting ceremony. In addition to that, new attractions can also be initiated such as providing paddle boats, building jetty and a cool hangout place in the form of a treehouse.

IV. FACING THE CHALLENGES

1. Eutrophication

Sometimes lakes may appear to have green or brown (it worse cases, it would appear blueish) layer of substance on it – this is called algae bloom. It happens when the lake is eutrophic due to nutrient loading from fertilizers or human/animal waste. To reduce algae bloom, the nutrient inlet needs to be controlled, aeration needs to be provided using aerator or from recreation activity such as kayaking or you may even introduce zooplankton such as daphnia which feeds on the algae. There are also instances when weeds (*Najas* spp.) or wetland plants (water cabbage, water hyacinth) grows abundantly on the lake surface. This can be overcome by controlling nutrient loading, through manual harvesting or introducing new species which feeds on the plants such as releasing grass carp which feeds on Najas spp.

2. Invasive Species

Invasive species (such as non-local fish) poses a threat for local species who might not be able to compete with them. A drastic measure to overcome this is by draining the lake and capturing the fishes using nets (especially the fishes that bites). Another method is simply through giving awareness to the community.

3. Rubbish Management

The human habit of littering is difficult to solve sometimes. The following are some examples on how we tried to tackle this problem. The available dustbin at the lake was upgraded to a more convenient kind that has an opening in the front (so that the user won't need to pick-up the rubbish lid and dirtying their hands). Community program such as Responsible Lakers was initiated, where the community could use the kayak for free in return for picking the rubbish at the lake and complete a simple rubbish assessment.

V. HEARTWARE APPROACH

The heartware approach below as just some examples of the initiatives one can do to reenchant and capturing the community's *heart*.

1. History, culture & nature

Place attachment (human bond with nature) are usually related to the history, culture and nature of the place.

i. History and culture

Any water body would usually have its own history, whether related to the culture of the people living in the place or its geographical changes over time. Information about the history and culture of the water body can be obtained from the library, digitally in the internet or you may interview people who have lived there a long time (surely, they would have a lot to tell).

ii. Nature

It's a good idea to record any sightings of rare and interesting biodiversity in the area either through photography or video. You can even create a checklist for the visitors to the area.

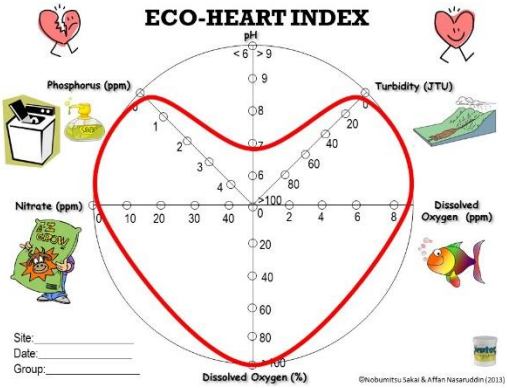
2. Citizen science

Citizen science is defined as community participation in a scientific research. Using the place-based approach, the *citizen* in the Tasek Varsiti case are the surrounding community who work or study in the university (they might not necessarily live here). Citizen science could make the community feel like they are included and part of the restoration work, hence giving them a sense of belonging to the area.

i. Eco-Heart Index

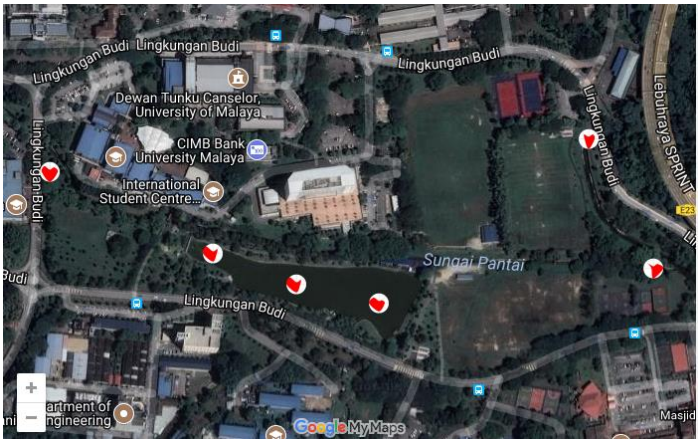
Prior to the Tasek Varsiti restoration, the community was engaged in doing citizen science on water quality monitoring. The results are then plotted in the form of Eco-Heart Index[4] – the plotting of water quality parameters to create a 'heart' shape.

[4] For more information on the Eco-Heart Index, read our journal paper: "Eco-Heart Index as a tool for community-based water quality monitoring and assessment". Ecological Indicators, Volume 91.



ii. Online mapping

The results of the monitoring can be archived and stored in the form of online mapping. This provides a platform for the stakeholder to access the information for any decision-making process and for the community to be aware on the state of the lake. Example of online mapping tools are Google My Maps and ArcGIS. Below is an example of online mapping for water quality monitoring using Eco-Heart Index using Google My Maps:



3. Education

i. Environmental Education Programmes

Water bodies provides many opportunities to be used as an open classroom for programmes such as citizen science, nature walk, nature hunt and outdoor lectures. Information about the program can be shared through social media or website.

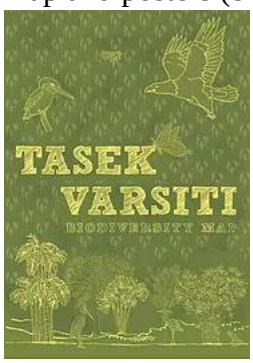
ii. Creative Publicity

a. Social Media
Facebook, YouTube, Instagram and Twitter are all useful social media to spread the information to wider audience. For example, the story of Tasek Varsiti was made into a video in YouTube titled “Tasek Varsiti, Universiti

Malaya: Dahulu & Sekarang." (Tasek Varsiti, University of Malaya: Now & Then).[5]

b. Lake Maps and Posters

Through consistent recording and archiving information about the lake, various publication can be produced such as biodiversity map, nature trail map and posters (birds, trees, wildflowers).



c. Art

Creating art is a form of communication to the public that has the ability to spark conversation and promote behaviour change concerning environmental issue. There are various kinds of nature art and trash art that you can create such as below:

iii. Interpretive Space

Information about the history, culture and biodiversity for example, could be presented physically in the form of an interpretive signages situated strategically at the lake to form a story about the place. The use of technology to further enhance this interpretive space such as website and virtual tour can also be incorporated.

iv. Park code

[5] The YouTube video can be streamed using this link: https://www.youtube.com/watch?v=ZqmPk3t2gRY

Park code can be developed through discussion with stakeholders on the needs of the place. Below is some example of the park codes for Tasek Varsiti:

a. Party responsibly. The lake is a beautiful place for you to set up a picnic basket but leave nothing behind (there's more than 17 dustbins around the lake for you to choose from!)
b. Share the beauty of nature with others; let flowers bloom. Plucking them will only make the bees upset.
c. Catching fish is only allowed if you're a fish, a bird or a lizard (unless they too, learn how to use fishhooks which are harmful when left behind).
d. We are trying to get our educated ducks to quit smoking, so please don't set a bad example for them.
e. The quality of our lake water depends on you. Washing vehicles near the lake will make the water soapy and oily, while throwing food inside the lake increases its nutrient content.
f. Your pets (fish, turtle, etc.) deserves better. Dumping them here can make them home-sick and also disturbs the ecosystem of the lake.
g. Safety vest can keep you safe (and make you float like a geese); always wear them when doing water recreation activities.
h. Most importantly, discover your lake: measure the height of a tree, train your eyes and ears to look out for birds, take awesome wildlife photographs, lift up logs and sift through soils to find all sorts of little wrigglers, make a collection of dried grasses, sketch a plant and stalk some insects! The lake is an open museum and there's so much to experience here!