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Towards Safe Cities & Resilient Communities

13 & 14 SEPTEMBER 2018

IMPIANA HOTEL, IPOH, PERAK

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Putrajaya Lakes Management: Sensitivity and Conservation Towards Sustainable Community

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Abstract - Lakes, natural or man-made, are important water resources for Malaysia. These inland water bodies cover an area of over 10,000 hectares and contain more than 30 billion cubic metres of water. In positive ways, lake managements are maintaining high level of effectiveness within the lake management. Putrajaya Lake is beneficial not just only to the aspect of water quality and quantity but also as a medium for education resource for the society. Putrajaya Lake is an important destination for recreation, sports and tourism in the country. Additionally, it provides a scenic and self-sustaining ecosystem. Putrajaya Lake has become an important filtering system that treats pollutants and storm water run-off before draining water into the Putrajaya Lake. The urban water body system with a total surface area of 400 hectares was designed and built so as to encircle the core island creating a complex morphometry. The design of the Putrajaya Wetland and Lake has taken into consideration of this hydrological impact. However, the rapid development and many activities surrounding Putrajaya Lake has significant effects on the quality of the water body. Therefore, the purpose of this study was to carry out the Putrajaya lake management towards sensitivity and conservation towards sustainable community. The research methodology was based on two (2) facets which is facet that included site inventory data collection, primary and secondary data. The second facet analysed the site analysis that included (i) water quality (ii) lake ecosystem and (iii) monitoring the activities at Putrajaya Lake. The findings were used in to assist Putrajaya Lake to improve its management and to have a better strategic plan and formulation of a long term lakes catchment development and management plan. This will help Putrajaya to achieve its inspiration of "City in a Garden". Besides, development of an integrated system of lake management that will ensure sustainability of community and ecosystems.

Keywords - Sensitivity, Conservation, Man-made, Lake Management, Ecological, Sustainability.

1 INTRODUCTION

Lake is an important source of water in Malaysia and it gives many benefits to our ecosystems. It is also as a main heart for landscape development to public or civil society in creating a healthy and multipurpose space. According to Povilaitis and Querner (2008), a lake is vital for protecting biological diversity and ecosystems. Also it provides a major contribution to the economy of the situated area. It's also as a main heart for landscape development to public or civil society in creating a healthy and multipurpose space. According to Povilaitis and Querner (2008), a lake is vital for protecting biological diversity and ecosystems. Also it provides a major contribution to the economy of the situated area. This study is to embrace the Putrajaya lake management in sensitivity and conservation towards sustainable community. The main objectives of this study are (i) to identify the Putrajaya lake management in catchment development and (ii) to monitor and assess the water quality at the Putrajaya lake for its suitability for recreational activities. In legislation, the management of lakes are subjected to various water and environment laws. At Putrajaya lakes, the laws or guidelines include the Lake Management guidelines, The Putrajaya Lake Use Master Plan, Environmental Management Guidelines, The Catchment Management Guidelines and Putrajaya Lake and Wetland Management and Operational System (PLWMOS). In Malaysia, the laws are related with lake management are Environment Quality Act 1974 and Environmental Quality (Environmental Impact Assessment) Order 1987 and also Town and Country Planning Act 1976. The act or laws is very important to lake management in measuring, promoting and also protecting the water catchment. In addition, it also control the lake pollution and conserve the biological diversity.

2 LAKES SENSITIVITY AND CONSERVATION

2.1 Water Sensitivity In Developed Community

Every planning in a community area needs to focus on several factors, especially about the environment and its contents. For example an existing leisure resource such as public park can be used as the pulse of the development of the social well being of an area. Each of these public parks is a good social system if it contains elements of water, air, land and others. This study is about the water sensitivity to be taken into account in every planning project in the City, especially in Putrajaya. Water management is one of a number of important elements that defines the sustainability, resilience and liveability of cities and towns. Based on Tony H F Wong (2007), the words 'water sensitive' is defined as a new paradigm in integrated urban water cycle management that combined with various fields and disciplines of engineering and environmental sciences that are associated with the provision of water services, including the protection of aquatic environments in urban areas. According to Australian Department of Industry, Innovation and Science (2018), water sensitive city interact with the urban water (hydrological) cycle in ways that:

1. Provide the water security essential for economic prosperity through efficient use of diverse available resources;
2. Enhance and protect the health of waterways and wetlands, the river basins that surround them, and the coast and bays;
3. Mitigate flood risk and damage; and
4. Create public spaces that collect, clean, and recycle water.

In Australia, Bio-retention swales, wetlands and raingardens are examples of the urban design of residential developments in the early 1990s that have been referred to as Water Sensitive Urban Design (WSUD). Furthermore, the inter-government agreement on a National Water Initiative defines (WSUD) as "the integration of urban planning with the management, protection and conservation of the urban water cycle that ensures that urban water management is sensitive to natural hydrological and ecological processes". Andrew Speers and Grace Mitchell (2000) asserted that sustainable water management leads to WSUD and it encompasses the integration of a number of levels in many different measures that have a range of suitable applications, resulting in many different realizations of this concept, depending on the site-specific conditions of the location.

2.2 Water Quality Standard in Malaysia

Water quality is very important in determining the level of community response and wellbeing as well as health in Malaysia. Monitoring of water quality through physical observations, biological monitoring and chemical monitoring can be useful in order to better monitor the water status. In the National Water Quality Standards in Malaysia (NWQS) it shows six parameters: pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonical Nitrogen (AN), Suspended Solid (SS) and Disolved Oxygen). Then it will be Indexes in Water Quality Index (WQI). Water Quality Index is a tool for evaluating the water quality. All the data then would be compared with the National Water Quality Standards fo Malaysia (NWQS) to determine its status. Refer Table 1.

2.3 The Roles of Lakes for Community and Cities

Water covers more than 70 per cent of the earth's surface. It covers the oceans, rivers, and lakes. If there is no water, no vegetation on land, no oxygen for animals to breathe and the planet would look entirely different than it does today. Water is necessary in keeping the human body and the environment healthy and should be valued and protected as a precious resource, which include: (i) Body Physiology: Water also helps in all major functions of the body like circulation, excretion, absorption, nerve conduction, respiration, reproduction and (ii) Plants Growth: water is important for plants nutrition, growth, and formation of food. Plants can make their food material by photosynthesis. As a result, this forms starch, that is a form of carbohydrate using water (from soil) and carbon-dioxide (from the air) in the presence of sunlight. The process of enzyme activity and energy production is initiated due to the presence of water. The seedling germinates out of the seed into a big

plant. Additionally, water also helps in loss of heat from plants by the process of transpiration through stomata.

A recent study on water quality governance in Brazil, Ecuador, and Malawi has identified four key challenges, which turned out to be critical in improving the governance in these countries (Kayser et al., 2015). The challenges identified include: insufficient data sharing and coordination between government offices, lack of monitoring and enforcement of water quality laws, unclear federal policies for surveillance of water quality, and administrative and technical management of the water services (Kayser et al., 2015). An estimated 20% of community sub-Saharan Africa was facing water systems that broke down. This highlights the importance to ensure that water systems are managed effectively and rehabilitations can be carried out quickly.

Table 1 Water Classification

DOE Water Quality Index Classification

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1

Water Classes And Uses

CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common, of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above.

DOE Water Quality Classification Based On Water Quality Index

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH_3-N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

2.4 Water Conservation and Sustainability Community

Due to the climate change, it is suspected that in 2050, there will be an increase of water stress globally. In addition, some country had already faced water shortage problem especially in drinkable water (Corral-Verdugo & Pinheiro, 2006:IPCC,2008 :Change, 2009). As the water scarcity is increasing, the water conservation strategies need to be focussed. This effort covers the environmental engineering and environmental psychology aspect to promote the sustainability development. Sustainability development is the key component in environmental management (Barrow, 1995). For sustainable water resource management in terms of environmental engineering, several attempts have been made for water management strategies such as recycling and treatment of greywater. Greywater is the wastewater from laundry, shower and sink (not included kitchen sink) as defined by Al-Jayyousi, (2003). Survey conducted by Corral-Verdugo and Pinheiro,(2006) reported that future

orientation that refers to the tendency of people for planning strategies for long term obligation is positively related to sustainable behavior. However from the study, it is also revealed that younger generation significantly has less future orientation than older people. Therefore, a study by Al-Jayyousi, (2003) concluded that the community support towards the opportunities of recycling greywater can be maximized using the environmental policies. Malaysia has enough freshwater sources. In fact, due to climate change, mismanagement and abuse, the water problem is now faced by Malaysia (Chan & Nitivattananon, 2007). As a developing country, Malaysia also tries to accept the sustainability in water management. For instance, Malaysia is supportive with water sustainability. This can be seen with joint partnership collaboration with water expert that represents the NGO'S especially for the lake reservoir.

3 METHODS

3.1 Site Study

Putrajaya Lake within the catchment area of 51.0 km^{2}comprises of surface area of 400 ha and an average depth of 6.6 m, while the wetlands comprise six arms with 24 cells, covering a total area of approximately 200 ha(Majizat et al. 2010 as cited by Sharip et al., 2016). Putrajaya Lake is largely located in the centre of Federal Territories of Purtajaya.Integrating the urban community development with natural element using environmental engineering approaches is the key component in designing Putrajaya Lake. The concept design of City in the Garden is to ensure for well-functioning biogenic environment and future health of the humanity (Sharip et al., 2016).

Figure 1 The main of water body at Putrajaya:Putrajaya Lake

3.2 Methodology

In this study the Lake Sensitivity and Conservation Towards Sustainable Community are discussed in two different facets. First is to study the lake catchment and management in the water sensitivity. Second is to review the maintanance activity conducted by Putrajaya Cooperation and Putrajaya Holding in providing the social activities on Putrajaya Lake (Refer Figure 2). Additional data such as land use and cultural development included. Meanwhile, the adaptation and review of landscape ecology in coastal lake were referred to the lake function and the water quality. Besides using the Lake Management guidelines, The Putrajaya Lake Use Master Plan, Environmental

Management Guidelines, The Catchment Management Guidelines and Putrajaya Lake and Wetland Management & Operational System (PLWMOS) were also used.

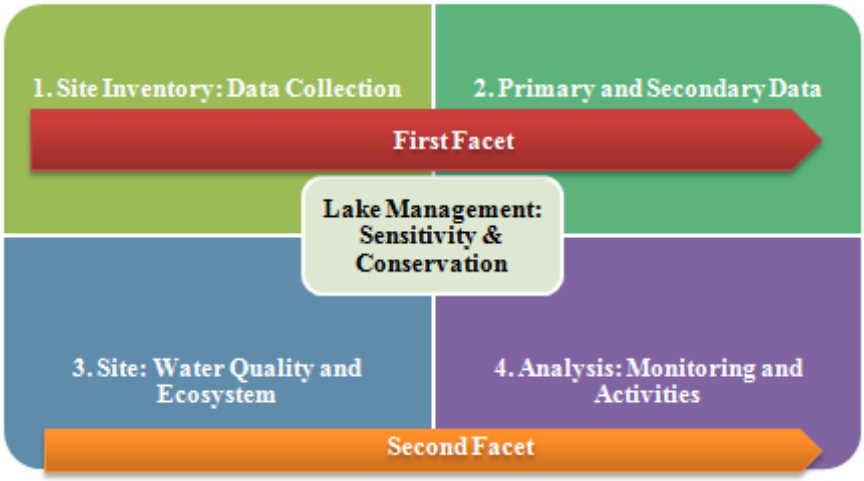


Figure 2: Flow chart for Research Design
Source: Author, 2018.

4 DATA ANALYSIS AND FINDING

4.1 Monitoring Activities for the Putrajaya Wetland and Lake Management

To make sure that the Putrajaya Lake and Wetlands run a balanced and useful urban ecosystem, an integrated catchment and water-quality management approach has been adopted. The approach encompasses comprehensive monitoring and assessment of the ecosystem's overall status (Majizat et al. 2010; Majizat et al.2016). The Putrajaya Lake and Wetland Management and Operational System (PLWMOS) are intended to serve as the main environmental database and spatial analytical tool for the current survey of hydrology, physic-chemical, and biotic parameters of Putrajaya Lake.

Based on the data collection and site analysis, the activities at Putrajaya Lake were permitted in only certain zone. The zones were divided into six (6) zones which are: zone 1, zone 2, zone 3, zone 4, zone 5 and zone 6. The study revealed that zone 2, 3, 5 and 6 were permissible for water activity. The activities of canoes sail boards and kayak were suitable for all zones (2, 5 & 6). According to Water Sensitive Urban Design (WSUD), the water at zone 4 are put under class IA and class IB. Water taxis and cruise boats are used to ferry residents and tourist between city destinations that are only suitable at zone 3. The factors that influence the zone 3 activities are water catchment, that is sendiment trapping, atmospheric and climatic fluctuations. The study found that the suitable activities for bush-walking, bird watching, jogging, cycling and relaxing were at zone 4. According to Water Sensitive Urban Design (WSUD), the water at zone 4 is under class I. The zone 4 is gazetted to preserve and conserve area for ecological. It is a land for habitat and bird mitigation. Besides, it is an area for maintanace of biodiversity of Putrajaya Lake.

The study also shows that zone 1 is not suitable and is not permited for any recreational water activities. The zone 1 is gazetted as Wetland area which is sensitive ecological area.

The study shows that monitoring programs is part of the management activities that is undertaken to ensure a fair assessment of the Putrajaya lake functions in relation to its ecological and management requirements as well as confirming the water quality status of the lake.

The study revealed that zoning of the lake and wetlands is an important start to control the possible activities that are permissible in or around the lake. The lake zoning system has been useful, particularly in guiding the appropriate uses and activities.

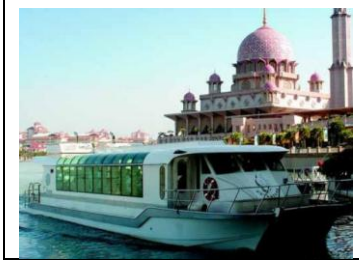
Zone 3 	Canoes, kayaks, rowing skiffs, and dragon boats for sporting events. Tour boats and Cruise boats. Vessels to comply with predetermined design and performance criteria. Water police and Emergency response boats. Lake maintenance vessels.

Figure 3 The zone 3 for water taxi and cruises boat activity at Putrajaya Lake

Zone 2	Model yachts/model power boats Sail boards Pedal powered leisure craft Canoes, kayaks Row boats Small electric powered boats
Zone 5	Model yachts/model powerboats. Pedal powered leisure craft. Small yachts and sailboards. Canoes, kayaks, row boats. Rowing skiffs, dragon boats.
Zone 6	Canoes, kayaks, row boats. Small powered boats complying with predetermined design and performance criteria. Powered leisure boats complying with predetermined design and performance criteria. Marine police and Emergency response boats. Lake maintenance vessels.

Figure 4 The zone 2, 5 and 6 for recreational activities

Zone 1	No recreational vessels permitted.

Figure 5 The wetlands of Putrajaya

Figure 6 The Lake Management Zoning Plan
Source: PLWMOS, 2016

4.2 Management and Conservation of Putrajaya Lake

Based on observation and primary data, the study shows that management of Putrajaya Lake is to ensure its aesthetics viability, sustaining good water quality while providing the viz-recreational activities, including water activities. Putrajaya Holdings Sdn. Bhd., the main developer in Putrajaya, is currently monitoring the water quality in the Putrajaya Lake. The monitoring and activities analysis also revealed that PJC (Putrajaya Cooperation) and PJH (Putrajaya Holding) are to ensure the environment, biodiversity and the biological aquatic life are sustainable to Putrajaya Lake.

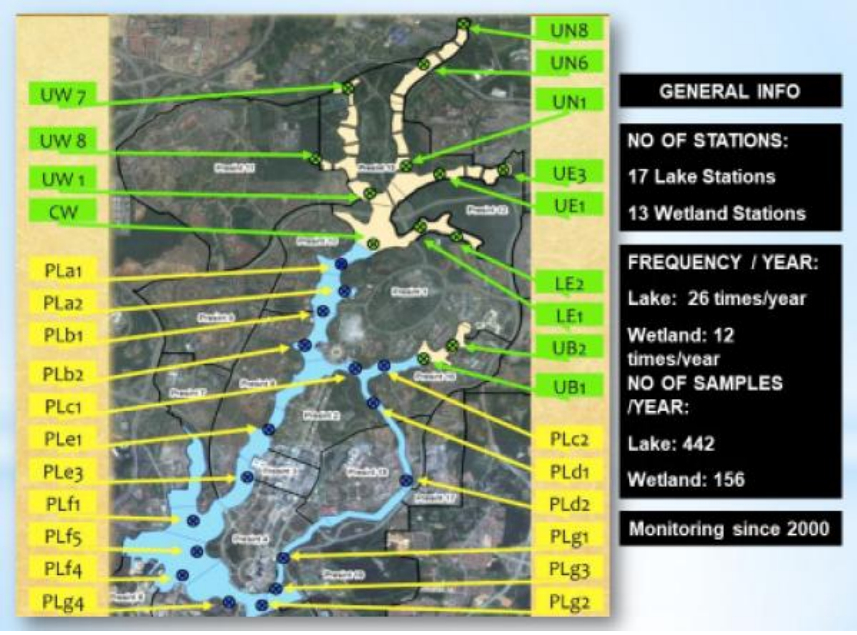


Figure 7: The management and conservation of water quality at Putrajaya Lake
Source: Alam Sekitar Malaysia Sdn Bhd, 2015

The study also shows that the Putrajaya Lake management are to (i) ensure the water quality in the lake meets certain quality standard (The Putrajaya Lake Water Quality Standards), which allow it to be used for recreational and suitable for body contact; (ii) achieve habitat enhancement and ecological functions improvement of the open space resources (biodiversity) of the lake and (iii) the urban setting surrounding it - attractive to biological, aquatic life and human. Guidelines such as Lake Management guidelines, The Putrajaya Lake Use Master Plan, Environmental Management Guidelines, The Catchment Management Guidelines and others, that are related in one way or another to the overall lake and wetland management, had been developed and introduced by management of Putrajaya Corporation to cover a wider scope of concern.

4.3 Conservation and Sustainability of Putrajaya Lake

Lake is an important water resource as it has multiple functions.Obviously, lake is a part of storage basins for municipal and industrial water supply, agriculture and hydropower (Sharip & Zakaria, 2008). Besides, lake has the richness of natural biodiversity and tourism potential as stated by Sharip and Zakaria, (2008). However, in urban context, mostly there are growing man made wetland and lake from storm water, groundwater and wastewater for an aesthetic, tourism and recreation function (Sharip et al., 2016) that are made for the community nearby. The findings show that activities that might adversely affect the quality and integrity of lake are the general amenity of parks and open spaces, residential neighborhoods and government institutional areas that are deemed as prohibited in the lake and wetlands area. Similarly, activities that cause damage to banks (e.g. as a result of wash of fast large craft) and the overall water quality of the lake are forbidden. One of the

case study provided this attention is Putrajaya Lake and wetland. The studied conducted by Musa, *et al*.(2016) regarding sustainable city related to the well being of the Purtajaya Resident confirmed the positive perceived of overall community happiness. This respectively covers the factors of well-being. social well-being and urban governance, and economic well-being within the study area.

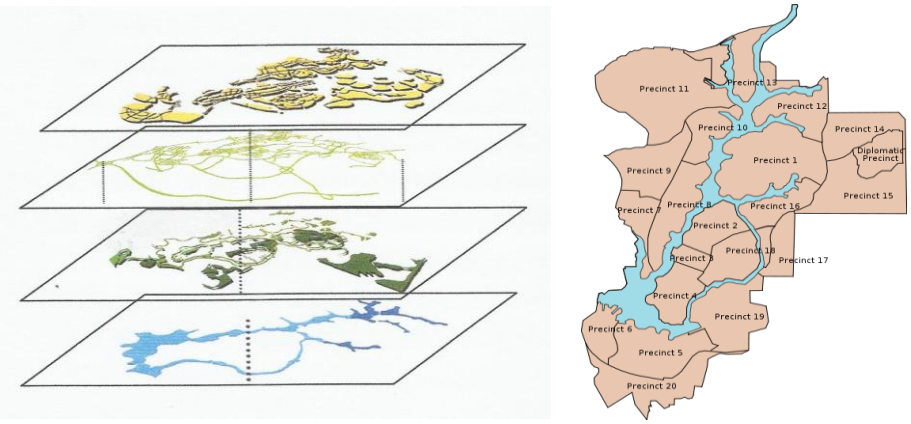


Figure 8: The planning and design evolution of Putrajaya Lake based on the theme of City in the Garden (Sustainability Concept)
Source: Putrajaya Cooperation, 2001.

5 SUMMARY

The management of Putrajaya Lake is comprehensive and formulated with Catchment Development and Management Guidelines. Putrajaya Cooperation Sdn Bhd and Putrajaya Holding are comprehensive in monitoring all programs that are related with corridor and surrounding of Putrajaya Lake. It is to ensure that there is no pollution and any disturbance to Putrajaya Lake and also to the Putrajaya Community. According to Zaharah (2007), Akashah (2005), the integrated program of monitoring and regulatory control were formulated and implemented at the pertinent Master Plan of Putrajaya (land-use, drainage and water sewerage and water catchment).

Putrajaya lake is used as an education resource, research and development for public and community participation within the lake management. However, in Malaysia the lake issue is crucial in Stakeholder's participation in strategising the lake management. Lake communities are an essential part of many lakes as they inhabit many of these natural or man-made systems. The understanding of physical, biological and characteristic of lake and its uses are important to community. Understanding the importance of community's participation, stakeholders including NGOs in colloquium and in many of the workshops, and their role which has been incorporated as one of the national strategies to sustain lake management. These committees should be promoted to assist in the management of the lakes and their landscape.

Furthermore, Putrajaya lake also has a tranquality centre for community which provides the ecotourism destination and recreational. The ecotourism supports the water activities at Putrajaya lake. Putrajaya appealing lies in the development of a series of green areas. Besides that, the buffer zones that implement the water body which merged to form a unique ecosystem is a vibrant corridor of local wildlife and vegetation.

The contributions of this study were the participants or stakeholder which are accountability and the individual or agency that takes action in lake management laws at Malaysia lake and reservoir. The details of the strategies and planning of lake management need to be designed for a better quality of water and ecosystem. A good lake management can improve urban fabric in preserving the health of community and aquatic lifeas well as protection for flora and fauna habitat enhancement for fishes. Lake management also improve our sustainability and quality of life.

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