THE IMPORTANCE OF WETLANDS IN SUSTAINABLE WATER MANAGEMENT

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ABSTRACT

Wetlands are extremely valuable ecosystems to society in ways that it can decrease flooding, filter and clean polluted water, recharge ground water, protect shore lines, provide habitats for wildlife, and serve important recreation and cultural functions. The Sabah Wetlands Conservation Society (SWCS) is a non-governmental organization responsible for the management of 24 hectares Kota Kinabalu Wetlands (KK Wetlands), a mangrove swamp conservation area located 2km north-east of Kota Kinabalu city in Likas. Surrounded by heavy industrialization and subjected to urban development pressures, the accessibility and location of the KK Wetlands poses threats on the management of the conservation area. This paper presents the water quality data of the wetlands and discusses the importance of a water quality monitoring programme to ensure sustainable water management of wetlands.

INTRODUCTION

Water

Water is a molecule consisting of hydrogen and oxygen atoms. It is extremely valuable to every living thing on this planet earth. The capability of water in dissolving a variety of different substances is better than other liquid, ranging from nutrients to industrial and domestic waste makes it a universal solvent. All living organisms are composed of cells that contain 60% of water since it is the main element needed in our life, both for the environment and for human development (Somaskanthan, 2012). However, in the world only 3% of the world water is fresh water and most of that is frozen (Ramsar, 2015). Yet, it is estimated that every human requires almost 20 to 50 litres of water a day for basic needs such as drinking, cooking and cleaning (Ramsar, 2015). All water is locked into a constant recycling process called the hydrological cycle. Wetlands have become important elements in water management as they have significant influence on the hydrological cycle.

Wetlands and Their Importance

According to the Ramsar Convention, wetlands are defined by type as areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters. Often misunderstood as a waste land, wetlands are ecosystems that have many benefits towards all organisms in the world.

Wetlands have many important hydrological functions. The hydrological cycle (also known as *hydrological processes*) that occur in wetlands consist of precipitation, surface water flow, ground water flow and evapotranspiration (Virginia, 2011). Thus, all these components make wetlands an important ecosystem in assisting and ensuring the continuity of sustainable water management. Wetland systems are directly linked to groundwater thus make it a crucial regulator of both quantity and quality of water found

below the ground. Consequently, it plays a vital role in providing drinking water to 1/3 of the world population (Virginia, 2011). Wetlands help in reducing the effects of both flood and drought conditions in a watershed. It acts like a sponge that helps in storing and releasing water relative to the amount of water around them. It also can slowdown rain runoff thus preventing the occurrence of flash floods. Some wetlands such as coastal wetlands act as a physical barrier to storm and tidal surges by reducing their intensity. Mangroves' roots also bind the shoreline together thus reducing tidal erosion. Wetlands are also bursting with biodiversity. Many of the animals depend on wetlands as these ecosystems are sources of food and habitats for wildlife. Wetlands also act as nutrient sinks and settling ponds. Water that enter the stream through this process is much cleaner than when it entered the wetlands due to the settling out of sediments by slowing down the flowing water. Vegetation, such as water hyacinths, are effective in absorbing and storing excessive nutrients such as nitrates and phosphate, harmful fertilizers and pesticides as well as heavy metal and toxic release from the industrial development (Bullock and Acreman, 2003). Wetland animals such as oysters are able in removing chemical contaminants when filtering water for foods. The mangrove roots are also able to trap solid waste like plastic bottle thus obstructing in polluting adjacent streams. Not only important in water management, humans depend on wetlands for their varied products. More than 2/3 of all fish consumed are dependent on coastal wetlands for spawning, nursery or feeding ground. Padi or rice, consumed as staple food by large part of the world's population, especially in Asia, is grown in managed wetlands. Statistically, scientists have discovered more than 100,000 known freshwater species alone and the number will grow every year (Ramsar, 2015). Supporting an abundance of unique flora and fauna, wetlands are ideal "natural laboratories" for research and an attraction for recreational activities.

There are direct and indirect impacts to wetlands caused by human activities. Direct impacts include dredging, filling and draining wetlands purposely including through the state and federal wetlands permitting process. Indirect impacts are those caused by an activities that alter the hydrology system, increase in pollutant loadings and buffer encroachment caused by development and urbanization. These impacts can be minimized and monitored with a rigorous water quality monitoring programme.

Water Quality

Poor water quality can critically impact wetlands. The information compiled from water quality analyses can be used to understand how human activities affect wetlands. The pH, mineral and nutrient content influence the abundance and diversity of the flora and fauna. All nutrients have different functions in wetlands ecosystem and promote pollution via eutrophication if the concentration is not monitored regularly. Some wetland plants have the ability to remove small quantity of nutrients, trace metals and other compounds from the soil water and incorporate them into plant tissue, which may later be recycled in the wetland through decomposition. There are 8 parameters measured in order to determine the water quality using Water Quality Index (WQI) (DOE, 1985). These parameters are pH, temperature, Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Turbidity, Total phosphorus, Nitrates and *E.coli*.

CASE STUDY - KOTA KINABALU WETLANDS, SABAH

Kota Kinabalu Wetlands (KK Wetlands) is a 24ha – mangrove forest managed by the Sabah Wetlands Conservation Society (SWCS). SWCS, a non-governmental organization, was founded by a group of environmentalists in 1980s. There were 200 houses built illegally in the area of the mangroves which led to the loss of mangrove habitats, waste disposal problems and low water quality caused by pollution. In September 1996, it was designated as a Bird Sanctuary and named as Kota Kinabalu City Bird Sanctuary for mangrove protection. In 1999, it received another layer of protection when it was gazetted as a Cultural Heritage Site for Conservation. In order to reflect its importance as a wetlands ecosystem, it changed its name from Kota Kinabalu City Bird Sanctuary to Kota Kinabalu Wetlands. In September 2013, KK Wetlands was nominated as the second Ramsar Site in Sabah.

Acting as a green lung and a buffer zone for the city, it is strategically located in the heart of Kota Kinabalu City which makes it highly accessible and affordable for both local and international tourists thus becoming one of the tourist destinations in Sabah.

KKWs unique natural landscapes give tourists a pleasant experience, to enjoy fresh air and tranquillity. Since its official opening in March 2000 up to December 2014, KK Wetlands has received more than 150,000 local and international visitors. KK Wetlands support abundant aquatic life and other wildlife, including more than 90 species of residential and migratory birds and more than 10 species of mangroves trees.

Emerging Issues & Challenges

Flora and fauna are highly dependent on water source. Situated in an urban setting, KK Wetlands is subjected to heavy industrialization and urbanization pressures, input of industry waste and pollutants from drains and rivers before flowing out to the sea. The river channel that is located within KK Wetlands connects the drains from housing estates and commercial areas leading to the sea. The water which contain pollutants such as oil spills, untreated sewage and physical rubbish causes devastating effects on life in the mangroves. As wetlands serve as sediment sinks, the amount of nutrients stored will increase until eutrophication occurs. Eutrophication of wetlands is usually caused by massive inflow of nutrients such as domestic sewage, fertilizers and herbicides. The high concentration of nutrients will spark a bloom of microscope algae. This algae bloom will use up most of dissolved oxygen and cause mortality to other aquatic organisms that depend on oxygen. Therefore, it is imperative to conduct water quality monitoring to identify the presence of parameters which degrade water quality. A water quality monitoring programme allows SWCS to strategize appropriate mitigation measures to reduce water pollution in KK Wetlands for the conservation and sustainable management of the mangroves.

Water Quality Monitoring

Water quality monitoring in KK Wetlands is carried out by KK Wetlands officers, researchers, and groups of students who participated in the water quality monitoring workshops sponsored by Shell Malaysia Limited. The objective of conducting water

quality monitoring is to assess the current status of water quality in KK Wetlands. The results of the water quality analysis in 3 years (2012 – 2014) are shown in Figure 1.

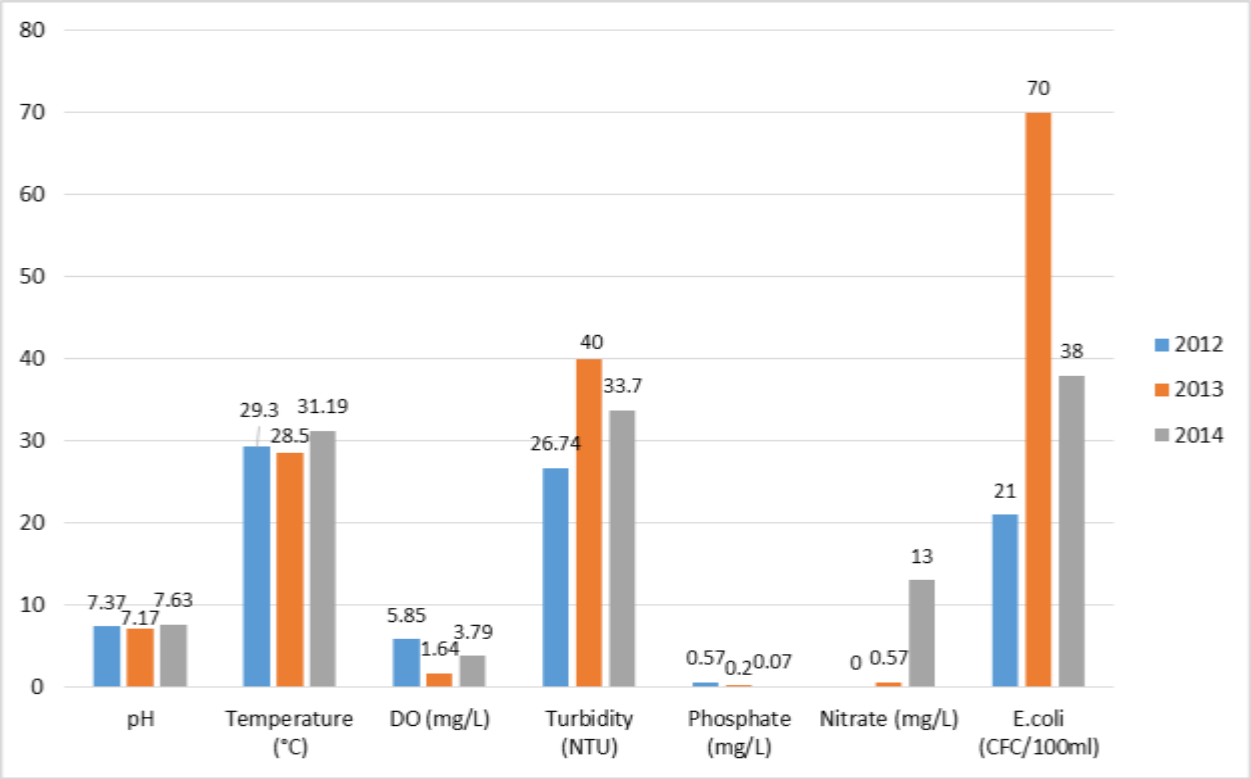

Figure 1.0: Mean values of water quality parameters over 3 years (2012-2015).

Based on the water quality analyses, the Water Quality Index (WQI) of 70.7 in 2012 decreased to 55.4 in 2014 indicating that the water quality has deteriorated. Based on the WQI, the water quality of KK Wetlands is Class III of the Environmental Water Quality Index Classification (DOE, 1985) suggesting that the water falls in the category of “slightly polluted”. An intensive treatment is required for human water supply and it is liveable by common, economic value and tolerant species and also can be used for livestock drinking water.

pH is an indicator for existence of aquatic life. The pH values in 2012, 2013 and 2014 are 7.3, 7.1 and 7.6 respectively, which are near to neutral and within the optimum range for organisms, indicating that the water is in good condition and is suitable for marine wildlife.

Temperature can exert great control over aquatic communities. The temperature recorded ranged between 29.3°C in 2012, 28.5°C in 2013 and 31.2°C in 2014. Temperature above 30°C, is not suitable for benthic organisms such as clams, lobsters, crabs and other tiny organisms that live in the bottom sediments. High temperature may cause suppression of the organisms. Open space and direct sunlight towards the water may have contributed to the heat which increased the temperature of water. The amount of sunlight absorbed by the water are controlled by shading of trees, water surface area, water volume, turbidity, streambed colour and orientation to sun.

Dissolve Oxygen (DO) is a measure of the amount of oxygen dissolved in aqueous solution. The DO level was lowest in 2013 compared to the year 2012 and 2014, which is less than 2.0mg/L (1.64mg/L). This indicates poor water quality thus would have difficulty in sustaining many sensitive aquatic lives (Gary, 2013). This low oxygen may be the result of pollution discharged from industries, urban runoff, waste water and sewage treatment plants which often contain organic compounds that are decomposed by microorganisms using oxygen in the process.

Turbidity is the amount of particular matter that is suspended in water which can be caused by finely organic or inorganic nature. Throughout the monitoring programme of KKW, turbidity is seen to increase while the DO measurement decreased. This might be caused by organic particles, where excess nutrients available will encourage microbial breakdown, as this process requires dissolve oxygen. Besides that, suspended matter affects the amount of sunlight penetrating into the water to reach the aquatic plants and which then also affects the production of oxygen. Urban runoff, human activities such as fishing, active wildlife interactions also can cause high turbidity as it increase the possibility of mixing up the particles in water.

Phosphate and nitrate both are essential plant nutrients needed for growth and development. Excess of phosphates and nitrates in a water body can cause accelerated plant growth and algae blooms which then cause rapid oxygen depletion or eutrophication in the water. From the water quality analyses, phosphate concentrations is inversely proportional to the amount of nitrate. The nitrates might come from nearby

waterways sources such as runoff from animal feedlots and animal manure storage areas and fertilized lawns and farmland. It also can be caused by failing septic system.

The *slightly polluted* water in KK Wetlands may be due to the chemical reactions from the plastic debris stranded within the wetlands. Mangrove trees have complex aerial root system which allows the mangrove to trap sediments and solid objects effectively. The floating debris such as water bottles, plastic containers, polystyrene containers, rubber slippers and tubes brought in from water sources due to changes in tide. Average amount of floating debris found in KK Wetlands is 6 unit/10m^2 (Low, 2014).

Even though the data obtained shows no detection of heavy metals content and oil and grease (less than 10mg/L) were found in KK Wetlands, but the concentration of *E.coli* (*Escherichia coli*) content was high. The highest in 2013, 70CFC/100ml. *E.coli* is a type of faecal coliform indicator bacteria commonly found in human and animal's intestine. The presence of *E.coli* in water is not harmful in itself but higher concentration is an indicator of other harmful pathogens and presence of human and faecal contamination.

SUGGESTION & RECOMMENDATION:

The local community play an important role in protecting wetlands. Decline in wetlands number will alter the water supply as wetlands are essential for sustainable water management. In order to arrest the decline of the sustainability of wetlands such as the KK Wetlands, continuous campaigns should be held to educate the public, in particular the stakeholders, of the consequences of letting untreated waste water into the environment. Such irresponsible actions will push the mangroves to its limit in providing their services. Awareness also can be encouraged by participating in wetlands programmes such as World Wetlands Day and Mangrove Clean-Up. It is more cost effective to save wetlands every individual makes everyday decisions with the environment in mind. For example, use of recycle bags at the grocery store, recycle household trash, and ensure that batteries and other harmful wastes do not end up in landfills or in wetlands, take shorter showers, buy sustainably raised or caught seafood, organic produce and meat. Gardener also can select native plants and use organic fertilizer where possible. These will indirectly help to conserve wetlands for the future.

Communities and authorities can either revise existing ordinances or adopt new wetlands protection ordinance especially regarding zoning, erosion and sediment control and stormwater management. Managements plans must be developed as a guideline for planning and development of wetlands, such as KK Wetlands. This is also important to prepare KK Wetlands as a Ramsar Site. It is also recommended to have a sustainable development to control the discharge of waste and pollutants. Water quality monitoring should be done regularly, as water quality issues not only to the wetlands environment but also influences human health through the consumption of wetland products. A rigorous monitoring programme will enable us to recognize and prevent further degradation of KK Wetlands. Research and intensifying actions on the remediation of pollution that affects the life of KK Wetlands should also be done. If no action is taken immediately, the chance for eutrophication occurring is high thus resulting in major pollution consequences.

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