

Tropical Wetland Valuation: An influence of local knowledge in Malay traditional ecosystem for human well-being

Farah Mastura Rosli², Anizah Salleh², Widad Fadhullah³, Mahamad Hakimi Ibrahim³, and Norizan Esa^{1*}

¹School of Educational Studies, Universiti Sains Malaysia, 11800, Pulau Pinang, Malaysia

²Faculty of Technical and Vocational, Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak Darul Ridzuan 35900, Malaysia

³School of Industrial Technology, Universiti Sains Malaysia, 11800, Pulau Pinang, Malaysia

Abstract. Tropical wetlands are among the most productive ecosystems on earth which provide vital services and consist of various types of plant and animal communities that live in the water and on land. However, this golden area is one of the most undervalued ecosystems and the awareness on protecting the areas is still lacking among communities. The aim of this study was to review the wetland services in a tropical climate which functions to complete the ecosystem. In particular, this study will i) explore the values of wetland ecosystem towards human well-being in tropical culture and ii) to design a complete wetland ecosystem with respect to the local knowledge in a tropical climate. This study indicates that the new millennium of ecosystem services provided by tropical wetland has been disaggregated into provisioning of goods; regulating services, cultural development and supporting the process by considering the influence of Malay traditional wetland. Therefore, a complete tropical ecosystem is designed by imitating the natural wetland for societal well-being.

1 Introduction

Wetlands play a vital role in human societies, accommodating a habitat and source of food for various types of plants and animals, supplying clean and retaining water naturally. Wetlands also serve as reservoirs for flood abatement and perform as a carbon storage. Due to rapid development worldwide, more than half of the original wetlands in the world are degraded. In 2005, the area of wetland that covered the earth's surface is 9%. But in 2011 the total area has decreased to 6% [1, 2]. Human activities such as dredging, installation of the drainage system for agriculture, and extensive agricultural activities near the water body have caused various environmental problems. The loss of wetlands vegetation threatening fisheries, damaging water quality and triggering eutrophication problem for which ultimately leads towards hypoxia and a dead zone for wetlands.

According to the most widespread definition, wetlands are defined as lands transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface or the land is covered by shallow water [3]. However, according to Ramsar Convention on Wetlands define wetlands as areas of marsh, fen, peatland 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 metres [4]. Through layman language, wetlands are shallow or sporadically flooded ecosystems such as swamps, bogs, marshes, and sedge meadows [5].

Wetlands are critically important ecosystems, providing significant social, economic and ecological benefits such as regulation of water quality and quantity, habitat for water flow, fish and amphibians, resources to meet human needs, recreation and tourism. Many commercially important fishes and shellfish such as crabs, prawns, catfish, oyster, tilapia fish, and shrimp call wetland as their home. Several types of wetlands are known to act as hydrological buffers. For example, floodplain wetlands store water when rivers over-top their banks, reducing flood risk downstream [6]. The value of these services may be considerable and often technical alternatives to regulate the quantity of flow are much more expensive. The maintenance of many, complex, biological processes involving soils, water, plants, animals, and microorganisms, is necessary to sustain these ecosystem services. The functioning of a wetland ecosystem gives rise

to a wide diversity of species as they support important levels of global biological diversity, including over 10,000 species of fish, over 4,000 of amphibians, and numerous species of waterfowl [7,8].

The effort to conserve and restore wetland ecosystems led to the creation of laws, regulations, and plans to restore and protect wetlands around the world. In the United States, the protection of wetlands is clearly fallen under The Clean Water Act of 1972, which permits for dredging and filling activities is required and to monitor the standards of water quality. However, there is no comprehensive legislation that relates to wetland conservation as a whole [9]. However, the resolution to conserve the wetlands in Malaysia have been spearheaded by Malaysia's oldest and largest environmental conservation group such as Malaysian Nature Society (MNS) under Wetland Program, Flyway Campaign and Wetlands Education, Resource and Training Centre for Communities [10].

Accordingly, this paper reviews the importance of wetland for human well-being, wetland valuation for a sustainable ecosystem, and how people can appreciate wetland by creating a mini wetland. We also provide a method to create Malay wetland design by using our adapted plants and animals to complete an ecosystem in a wetland.

2 Wetland as an ecosystem services

2.1 Wetland services

Wetland ecosystems provide important services that benefit people for their well-being. The Millennium Ecosystem Assessment has proposed four classes of services provided or derived by wetland by considering benefits obtained by people [11]. These include (1) provisioning services such as water and food; (2) regulating services such as erosion regulation, hydrological flows, mitigation of climate change, and water purification and waste treatment; (3) supporting services such as distribution of biodiversity, soil formation and nutrient cycling; and (4) cultural services such as recreational, spiritual, religious, and education purposes.

The loss of wetland areas affecting the lost of the key ability of ecosystem services. One of the services of wetland is it provides clean water for domestic, industrial and agricultural use which is underlined in provisioning services. Other than that, wetlands also contribute a large amount of protein such as fish. However, human activities have led to reducing their quality services. For example, water quality degradation by human activities especially by agricultural activity has led to eutrophication, which is one of the common problems for the wetland [12]. This phenomenon occurred by an excessive amount of nutrients from the use of fertilizer in agricultural activities which will stimulate the growth of algae in the water bodies. The decaying process of algae demands oxygen from the water body which will reduce the oxygen concentrations and ultimately kill fishes and disrupts aquatic organisms. Without mitigation measures, it will lead hypoxia to occur, where it is occasionally toxic to humans.

Flood is one of the natural hazards occurs which highlight the importance in maintaining the ecological function of wetlands. By flooding phenomenon, the organic matter is able to be transported into wetlands naturally which could sustain other important services such as food supply to the aquatic organism and water regulation [13]. Lakes, large river, estuary, and floodplain are the good example to attenuate the potential of flooding. The diminishing area of wetlands increases the risk of floods occurring. For an example, soil erosion affected by deforestation near the wetland can increase in soil content in the river and ultimately the wetland become shallow. When heavy and long rainfall happens, the river cannot support the amount of water coming in. Thus, it causing flood disaster.

Human intervention near the wetland modifies the energy and materials flow in the bank. This modification can affect the stability of food web in the wetland [14]. Migration of invasive species and deletion of adapted species in the wetland may lead to the energy inefficiency. Accordingly, it impacts the productivity of higher trophic level of the food web and destabilizing food web characteristics in the wetland [15,16]. Ultimately, it threatened the biodiversity of the wetland ecosystem.

As for cultural service, wetland also acts as one of recreational and education area for communities. For example, Shah Alam Lake in Selangor has become a recreational park. Various activities can be done by locals such as jogging, cycling, and canoeing near the lake. Other than that, Kenyir and Temenggor lake also have become as tourism area. Additionally, many researchers from higher institution in Malaysia conducted their research in the wetland [17, 18].

2.2 Wetland valuation for sustainable ecosystem

There are two most important wetland ecosystem services affecting human well-being involve fish supply and water availability. In a tropical wetland, freshwater fish species have higher demand compared to marine species. For example in Cambodia, 60-80 % of protein source was obtained from rivers for rural communities [11]. Besides cooked fresh, there are many commercial fish products in the market that become basic needed in cooking such as fish oil, fish sauce, dried fish and processed food.

Other than that, the wetland is known as a major source of clean water supply to the community. Clean water supply is important for the operation of a nation. In Malaysia, it is estimated that 76% of water was used for agriculture, 11% for municipal water supply and 13% for industries and only less than 1% of available water resources is used for drinking water supply [19]. Malaysia is drained by a dense network of rivers and stream which supply major clean water source. Construction of dam to collect and restrict water from tributaries and their source to the river as a method to collect clean water supply. Almost 56 dams were constructed around Malaysia such as Temenggor Dam, Bakun Dam, and Kenyir Dam [19].

2.3 Why wetland are needed in a garden?

There are three reasons to add wetland into a garden:

- a) An attractive feature for recreation garden:
A garden with wetland can create ecosystems which invite wildlife species such as birds and frogs. Green surrounding with birds and nature sounds can create a calm atmosphere that suitable for recreation activities. People prefer to hang out with family and friends after work in the afternoon to relax and it ultimately can improve their lifestyle. Parents also can educate their children to appreciate nature with exposure to natural surrounding at their young age.
- b) Could reduce water bills
By adding a wetland into the garden, and provide a good design to collect water runoff and rainwater, it could reduce the household water bill. Grey water from wetland can feed the garden and slash the water bills.
- c) Create wildlife habitat
Other than fish that can live in the wetland, frogs also attracted to the water areas. Frogs are one of the most threatened species on earth, according to the EWT Threatened Amphibian Programme. Mini wetlands could help provide safe havens for endangered frogs. Birds also attracted to wetland as it provides water and also provides food such as fish and aquatic insects in the wetland.

3 Design of Malay Traditional Mini-wetland

3.1 Site selection

As a method to appreciate the wetland, the practice of wetland creation in the garden or backyard is one of the effort to conserve wetland ecosystem. It offers the same benefits as natural wetlands. In Malaysia, the practice of creating mini wetland and appreciating the wetland is still lacked among communities. Wetland contributes a major proportion of fixed carbon in biosphere which ultimately will affect climate if most of the wetland degraded.

A sustainable mini-wetland can be developed in a garden as recreation, education and spiritual site or in a backyard for stormwater management. In order to build a mini-wetland, there are few factors need to consider in selecting a site for a sustainable mini-wetland. Water source and energy supply are basic needed in creating wetland ecosystems. The best spot for wetland development is at the place where the water is readily available, or in existing wet area and drainage area. In a garden, the wetland area should be placed in the lowest plain so the runoff water from rainwater will be collected there. Likewise, rainwater from a downspout or from a paved area can be directed towards the bog garden by a 'dry riverbed' consisting of a plastic-lined channel filled with pebbles. This can be one of the effort to conserve water resource to ensure a sustainable future.

Sunlight-available as energy supply in the mini-wetland area needs to consider to ensure the mini-wetland can undergo chemical interaction such as nutrient supply. Large trees near the wetland can increase the maintenance as the leaves will need to be removed from the wetland to prevent them from fouling the water as they decompose. Safety concern for the wetland also should be considered as it can harm neighborhood such as their properties by excessive moisture and also their children.

3.2 Creating a mini-wetland

Once the location is selected for a site, the shape of mini-wetland must be decided in considering organism that will live in or near the area. Mark out the required shape with string or sand and dig a trench about 1 m deep with sloping sides. To make part of mini-wetland like natural wetlands, the trench of wetland can be lined using the clay-lining method. This method used bentonite as the liner as it is partially natural to create a sustainable wetland.

There are few factors need to consider in choosing the plant's type. The homeowner needs to consider the type of vegetation that fits into the rest of the mini-wetland. Plants in or near wetland provide oxygen to the ecosystem, prevent erosion and it helps in increasing the water clarity in the mini-wetland. In some instances, maintaining plants that already adapt in the wetland area is the best way to create a wetland. Usually, homeowners or gardeners used plants that are not adapted to the site or modify the site by introduced new plant species, when it would be more effective to use plants suited to the conditions. The amount of time and interest of the homeowner want to spend and care for the plants should determine what type to install. If the homeowner is not interested in gardening, then select only from the list of basic or low care plants. The more time and care the owner can commit to maintenance, the more variety and color can be designed into the wetland. Numerous landscape plants are well adapted to wet conditions and will provide beauty as well as wildlife habitat.

Select plants that are hardy for the wetland and provide the desired wildlife habitat and aesthetics such as plant marsh or bog-loving plants (bamboo reed (*Elegia capensis*), dekried (*Chondropetalum tectorum*), peacock flower (*Dietes bicolor*), arum lily and the wild iris (*Dietes grandiflora*). Plants that grow in the wetland also need to be identified as it can provide food sources that attract animals, like scabiosa and *Hypoestes aristata*, which attract butterflies. To attract birds, set aside an exclusion area that is far away from the living areas and blocked off from any pets. Plants like water lilies need to be continually flooded. Provide artificial shelters or food sources, such as a feeding platform where kitchen scraps can be placed. Aside from these plants, the wetland will attract a variety of wildlife. Logs, leaf litter, rocks, compost heaps and stone walls can provide shelter for a range of small animals, such as frogs and lizards. The presence of insects, such as dragonflies, and frogs to the wetland is a good indication that the wetland water is healthy.

4 Conclusion

As a conclusion, the value of Malay traditional ecosystem provided by wetland is it is one of the ways of urban communities to improve lifestyle and quality of life, and it increases awareness on protecting local wildlife. The design of Malay traditional wetland can create a sustainable environment in the scope of Malay style. Besides, plants and habitat in the design are introduced, maintained and adapted in our local areas. Lastly, it can give awareness on protecting threatened local species. The idea allows urban communities to practice traditional gardening with the use of local plants in order to preserve heritage species.

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