SciMedCentral

JSM Environmental Science & Ecology

Short Communication

Kuala Sepetang Estuary: Current use and Long-Term Sustainability

Regina Leong Zhi Ling[1,2], Tennant Andrew[1], Lim Lai Huat[2], and Teo Swee Sen[1]*

[1]*Department of Applied Sciences, UCSI University, Malaysia*
[2]*Aquatic Science Student Association, UCSI University, Malaysia*

***Corresponding author**
Teo Swee Sen, Department of Applied Sciences, UCSI University, No.1 Jalan Menara Gading, UCSI Heights, 56000, Cheras, Kuala Lumpur, WP Kuala Lumpur, Malaysia, Tel: 603-91018880; Email: teoss@ucsiuniversity.edu.my

Submitted: 26 June, 2017

Accepted: 26 July, 2017

Published: 29 July, 2017

ISSN: 2333-7141

Copyright

© 2017 Sen et al.

OPEN ACCESS

Keywords

- Water quality
- Sustainability
- Aquaponics

Abstract

This short communication explores the causes and consequences of water quality on the ecological sustainability of the river and living organisms in the Kuala Sepetang estuary. Key causes identified include unrestrained development of aquaculture/mariculture, direct dumping of raw sewerage into the river, and poor solid waste disposal. However, direct links between the identified causes and declining water quality and the subsequent hypothesized impacts on fish and shellfish catches is not yet clearly established. An additional issue that was identified, and one with a potentially great impact, is the low awareness of the local villagers about water quality, rubbish disposal, and conservation. Given this situation, an educational approach to increase awareness of good sanitation and conservation practices was proposed. This is coupled with a concurrent water quality-testing programme to determine sources of impact and monitor future improvements. In addition, the use of aquaponics to enhance farming potential and reduce environmental impacts is suggested. This multifaceted and cohesive approach should result in an improvement of water quality and greater conservation of resources and environment. Overall, our research indicates the need to place an emphasis on the importance of marine biodiversity conservation and community education.

INTRODUCTION

Coastal and estuarine management is a worldwide concern. Human impacts on these rich biodiversity areas have been drastic in many countries. Malaysia is no exception to this and has lost a great number of its mangrove and wetland areas [1]. Kuala Sepetang is a coastal town located in Taiping, Perak. Formerly known as Port Weld, it was associated with tin mining in the Larut and Matang areas. Currently, it is primarily a small fishing village accessing the estuary that is rich in species of trees, birdlife and aquatic life [2-6].

The main jumping-off point of Kuala Sepetang is connected to the river mouth community of Kuala Sangga, a Chinese fishing community that focuses in fish, shrimp and cockle farming. Kuala Sepetang estuary is acknowledged as a world-class demonstration site of mangrove forestry management in Peninsular Malaysia [7]. A short distance from Kuala Sepetang is the access point to the largest preserved wetland remaining in Malaysia, the Matang Mangrove Forest Reserve. This mangrove forest is a well-managed and sustainably harvested mangrove ecosystem that sustains a richness of resources and natural wildlife that enables visitors to explore the wetlands and their resources which are now a well-known eco-tourism destination [8]. There are a variety of animals that can be found in and along the estuary of Kuala Sepetang including dolphins, eagles, swallows, clams and mudskippers [9-12]. For instance, the White-bellied Sea eagles, a popular tourist attraction, live and hunt for fishes in the river and the neighboring mangrove swamps [11].

The Kuala Sangga fishing village consists of traditional wooden houses on stilts sitting in the shallow water near the banks of the river [13]. Mariculture farm scan be found anchored on the shallower areas of the river catering for numerous species of marine crustaceans which include crabs, lobsters, shrimps, cockles, fishes and shellfishes [14]. Cockle harvesting and commercial fisheries are the main activities in Kuala Sepetang. These activities are the villagers' major sources of income. The water ways are alive with fishing and trawling boats transporting fish, cockles and mangrove logs [13]. Many tourists come specially to visit Kuala Sepetang for the freshly caught seafood. However, the catches of cockles, and other fish stocks, has significantly declined recently [15]. There are a number of possible factors that may be affecting the environment. These potential sources of ecological disturbance include waste from mariculture, algal blooms (caused by nutrient loading) and physical pollution caused by human waste such as plastic. As an example, the river of the village is now contaminated with rubbish (see Figure 1). Hence, the current focus on Kuala Sepetang is the water quality [15-17].

Figure 1 Shows the river bank of Kuala Sepetang is contaminated with rubbish and plastic.

CAUSES OF, AND IMPACTS FROM, POOR WATER QUALITY

Water quality is essential to maintain a healthy river and estuarine environment [18]. The ecological sustainability of the river water supports native fish populations, wetlands and birdlife [6]. Mangrove swamp forest is the major key to healthy coastal ecosystems as it provides habitats for animals, as well as protects coastal areas from erosion and reduces pollution. The strong root systems hold the soil together strongly and help prevent damage from storms and high tides. In addition, the reduction of mangrove will add to a reduction in water quality due to increased sedimentation. The amount of sediments in the river may fill the stream channels. Sedimentation also affects the turbidity of the water and prevents sunlight from penetrating into the water for aquatic plant photosynthesis [19]. Consequently, the fish populations die due to the sediments which cover their fish spawning areas and clogging the gills as they do not enough air to breathe that lead to suffocation as well as reduced food resources.

In Kuala Sepetang, the villagers use and depend on the water quality as a suitable source for drinking, fisheries and recreation. Nevertheless, lots of activities are not able to be carried out since the water quality in Kuala Sepetang is being affected. The most likely cause of the declining quality of water are destruction of mangrove swamp forest, fish farming and uncontrolled human activities including indiscriminant rubbish dumping and poor sanitation practices. Furthermore, the river of Kuala Sepetang must be prevented from being polluted by oil spills from routine shipping, dumping, and runoffs. Oil spill scan cause severe problems to marine wildlife and birdlife, as the oil cannot be dissolved in the water and forms a thick slick on the surface of the water, which can cause emulsification [20]. This also reduces the total amount of dissolved oxygen in the water and places stress on the growth of aquatic life.

Expanding farming industries also pose a threat to the mangrove forest [16]. Mari/aquaculture has been shown to be a significant factor in mangrove and wetland loss in Asia [1]. Impacts from this sort of farming activity include the digging of channels to provide water to the aquaculture ponds, the removal of vegetation to site the ponds and the use of chemicals and feed nutrients to keep the fish, cockles or shrimps healthy. These chemicals, and the resultant organic waste from food, can leach into the surrounding water and cause contamination. Although no research has been done to directly attribute these potential causes to any perceived environmental impact, local anecdotal information points to declining fish and shellfish stocks in the area. According to local cockle farmers the number and size of cockles available to be harvested has declined significantly in recent years and the farmers are unable to harvest fish, cockles and shrimps with the standard of 70 kilogram a bag required to make the industry economically viable [15]. This decline has led to the harvesting of the cockles in the early stages of growth when the size of the cockles is extremely small or mostly with empty shells. It is thought that that the decline in breeding numbers and increased early death rate, as attributed to the increasing number of empty shells, may be due to a decline in the water quality. It was believed that pollutants and sediments in river of Kuala Sepetang are the factors contributing to this observed change. A study in 2014 [7] found potentially pathogenic bacteria in the waters of the Matang estuary. It is hypothesized that the sources are from discharges of raw sewage, aquaculture waste, plastics and rubbish dumps. Another possible reason for decreasing stocks could be attributable to dragnet trawling damage to the seabed, although this is unsubstantiated at present.

From the available microbiological data reported by [7], it is apparent that uncontrolled human activities are a contributing factor to the poor water quality. Mostly the villagers are unaware of the importance of the natural environment to themselves, the marine and terrestrial organisms, and the ecosystem in general.

In the aspect of sanitation, the villagers do not have a proper way to eliminate their daily waste and rubbish. As an example, the toilets in the village are either direct free drop into the river or are directly connected to the river through sewerage drains. This waste is rich in nutrients such as nitrogen and phosphorus, and pathogens including bacteria, viruses and protozoa, helminthes. An increase in nutrients can lead to eutrophication, which is an excessive growth of marine organism and decay [21,22]. Marine plants such as algae often experience population increases (blooms) which reduce the amount of sunlight able to penetrate through the water and may also produce metabolic toxins that cause diseases to other aquatic organisms [23]. For instance, nitrate poisoning caused by a high level of nitrate in the water system. Excessive nutrients and organics in the water can affected the fish, especially immature fish that are very sensitive to nutrients and organics in high level and exposure to different level of nutrients and organics can cause shock to the fish [19].

Young adults and children are not being educated as to the correct methods to dispose of rubbish and as a result the riverbank near the village is an open dumping ground (Figure 2).

PLANNED FOR RESOURCES

In order to improve the water quality of Kuala Sepetang, some approaches have been suggested to improve long-term sustainability. One such approach is to institute regular water quality testing to support increased awareness of rubbish

Figure 2 Shows the incorrect methods to dispose of rubbish by the community.

disposal control and better control of human waste disposal. The initial objectives of the water sampling and testing are to baseline data to enable the institution of long-term monitoring of water quality. Long-term objectives are to determine whether the water quality is good or poor for use, to identify specific areas of suspected contamination and to determine any particular problem points. Water quality is referred as a measurement based on the chemical, physical, biological and radiological properties of water that have possible severity of issues which can be estimated to develop during long-term use [24-26]. The water quality parameters to be measured include salinity, pH level, hardness, suspended sediments, specific ion toxicity, turbidity, and nutrients [27].

In 2014 and 2015, the farmers in Kuala Sepetang formed collaboration with University Malaya and the Fisheries Research Institute based in Penang to identify the factors that were causing the fish and cockle population decreases by collecting water samples for testing. However, the results showed that the water is contaminated with some pathogenic bacteria [15]. In 2017, they invited Aquatic Science students from UCSI University to Kuala Sepetang to establish a research site to find out the reasons for their poor water quality. The students also encouraged the villagers, mostly young adults and children, to practice more appropriate methods of waste disposal. They provided information, knowledge and experience to enable the villagers to gain an awareness of the importance of conservation of their environment including the riverbank near the village as well as the wider rural community.

SUGGESTION FOR FUTURE RESOURCE PLANS

Declining water quality has become a global concern as human population's increase and place greater requirements on natural resources. In addition, development of industrial and agricultural activities as well as climate change threatens the hydrological cycle of streams, lakes and oceans [28,29]. Generally, the most dominant water quality issue is eutrophication. This is closely followed by sediment loading which can affect the flow of the river and the dispersal of nutrients. An approach to reduce the possible impact of mari/aquaculture on eutrophication and sediment loading is to build an aquaponic system at a safer site that is near the fishing village. This type of system can be located at a site that will have little, or no, impact.

The aquaponic system is a combination of aquaculture and hydroponic systems. It is designed to recirculation both systems together as the hydroponic system is built on the aquaculture system. The fish produce wastes which are then converted by microbes and worms into an organic food source for growing plants while the plants act as a natural filter for the water that return to the fish [30-32]. Microbes carry out nitrification which converts the fish waste into nitrates, a fertilizer source for plants [30,31]. Aquaponic systems would be an advantage to the farmers in Kuala Sepetang as they can reuse the resources that they considered as a waste. Likewise, the amount of water required is lower than that of the normal aquaculture and hydroponics systems. This system also allows for the practice of recycling water.

In the normal fish farming system, when the water is polluted with fish effluent, which contains a high concentration of ammonia, the fish are easily prone to diseases [33]. When the farmers are unable to harvest their fish in their fish farm, they can still have their income based on the aquaponic system to sustain themselves [34]. This, in turn, assists the aquaculture and agriculture industries by providing another revenue stream and may serve as a system to breed a variety of species of fishes and marine crustaceans for introduction into the larger scale systems.

By utilizing aquaponics systems, the problems of fish and crustacean population depletion, chemical usage, and production of healthy fishes can be solved. Aquaponics is ideal for urban farming and as there is no farm land use required it is the most sustainable practice for sites such as Kuala Sepetang, reducing the use of chemicals and transportation as well as dependency on fossil fuels [35]. However, water quality still remains crucial due to its significant effects on fish health in an aquaponic system. The quality of the water source stills remains doubtful and therefore more parameters must be investigated [36].

As most of the water quality issues seem to have a source in human actions, the improvement of the local inhabitants understanding and behaviors is a key to reduce the poor water quality and the potential diseases for humans as well as the environment. The emphasizing of their own influence and impacts to the villagers may be the most important factor in resource development as it can provide better understanding of natural resources and the importance of protecting the environment. Local authorities can engage more with environmental groups and academic institutions to offer some community education and awareness about protecting water quality and human health [37-39]. As a result of this sort of comprehensive and inclusive plan, the pollution of the surrounding environment can be reduced.

CONCLUSION

Overall, the findings and plans are useful for improvement of water quality. However, water quality testing should be

implemented regularly in order to find out the factors that influenced the status of water quality. Monitoring and observing the condition of the water is essential to determine significant changes that take place in the natural environment. For a better understanding of the water quality, a comprehensive study should be applied. Applying sustainable and effective aquaponic systems and instituting an educational approach for the next generation should ensure long-term sustainability of resource use in Kuala Sepetang. It should be noted that while several significant factors that should impact water quality have been identified, as yet no concrete data exists to turn any proposed links into a tangible reality. As such, a great deal of research will still be needed to enable the various improvement approaches to fully succeed.

ACKNOWLEDGEMENTS

We wish to thank UCSI University for the supports throughout the projects.

REFERENCES

1. Richards DR, Friess DA. Rates and drivers of mangrove deforestation in Southeast asia, 2000 - 2012. Proc Natl Acad Sci U S A. 2016; 113: 344-349.
2. Nordin DY. Towards sustainable coastal planning and policies from a Malaysian perspective. WIT Transactions on Ecology and the Environment. 2006; 88: 45-54.
3. Arifin K, Ibrahim MH, Kamaruddin MK. Kajian Perubahan dan Status Alam Sekitar Kawasan Sekitar Laluan Kereta api Lama dari Stesen Taiping Ke Port Weld, Perak, 1885-2020. Jurnal Perspektif Jil. 2014; 6: 82-91.
4. Jusoh WFAW, Hashim NR, Ibrahim ZZ. Distribution and Abundance of *Pteroptyx* Fireflies in Rembau-Linggi Estuary, Peninsular Malaysia. Environ Asia 3(special issue). 2010; 56-60.
5. Tech C O. Water's Edge Toursim at the Crossraods. In: Abduallah NFL, Pakri MR. Retracing Tradition for a Sustainable Future: The Malaysia Experience. Malaysia: University Sains Malaysia. 2013.
6. Boerema A, Meire P. Management for estuarine ecosystem service: A review. Ecological Engineering. 2017; 98: 172-182.
7. Ghaderpour A, Mohd Nasori K, Chew L, Chong V, Thong K, Chai L. Detection of multiple potentially pathogenic bacteria in Matang mangrove estuaries, Malaysia. Marine Pollution Bulletin. 2014; 83: 324-330.
8. Wijnen B. Mangrove Forest Reserve.
9. Alongi DM, Sasekumar A, Chong VC, Pfitzner J, Trott LA. Sediment accumulation and organic material flux in a managed mangrove ecosystem: estimates of land-ocean-atmosphere exchange in Peninsular Malaysia. Mar Geol. 2004; 208: 383-402.
10. Nuruddin AA, Fong UC. Biosocioeconomics of fishing for shrimp in Kuala Sepetang, Malaysia. Bay of Bengal Programme. Madras India. 1994.
11. Khaleghizadeh A. Shahrul A. Breeding landscape and nest spacing of two coastal raptors (Accipitriformes: White-bellied Sea Eagle *Haliaeetus leucogaster* and Brahminy Kite *Haliastur indus*) in Peninsula Malaysia. Ital J Zool.2014; 1-9.
12. Fernandez K. A place in Malaysia you've probably never heard of: Kuala Sepetang, Perak. 2016.
13. Yoon LW. Kuala Sepetang fishing village. 2014.
14. Ahmad S. Recreational Values of Mangrove Forest in Larut Matang, Perak. J Trop Forest Sci. 2009; 21: 81-87.
15. Chan L. Fishing out empty shells. 2017.
16. Rahimah A. Heavy Metals Distribution in Water, Sediment and Aquatic Species from Matang Mangrove Forest Reserve. University Malaya Perak. Malaysia. 2012.
17. Jusoff K. Malaysian Mangrove Forests and their Significance to the Coastal Marine Environment. Pol J Environ Stud. 2013; 22: 979-1005.
18. Zaidin NH, Nurhidayuh S, Faizaihakim M, Shafuan A, Gandaseca S, Kasim MRM, et al. Water Quality Characteristics in Different Mangrove Disturbance Levels, Matang mangrove Forest Reserve, Peninsular Malaysia. 3rd International Conference on Water Resources, Bayview Hotel, Langkawi, Malaysia, 2015.
19. Chong VC. Sustainable utilization and management of Mangrove ecosystems of Malaysia. Aquat Ecosyst Health Manag. 2007; 9: 249-260.
20. The Guide Network. 2003.
21. Pinckney JL, Paerl HW, Tester P, Richardson TL. The role of nutrient loading and eutrophication in estuarine ecology. Environ Health Perspect. 2001; 109: 699-706.
22. Hendry J, Sambrook H, Underwood C, Waterfall R, Williams A. Eutrophication of Tamar Lakes (1975-2003): a case study of land-use impacts, potential solutions and fundamental issues for the Water Framework Directive.Water Environ J. 2006; 20: 159-168.
23. Boesch DF. Causes and Consequences of Nutrient Over enrichment of Coastal Waters. In: Ragaini R, editors. International Seminar on Nuclear War Planet Emergencies. Singapore: World Scientific Publishing. 2002; 165-179.
24. Chang NB, Chen HW, Ning SK. Identification of river water quality using the Fuzzy Synthetic Evaluation approach. J Environ Manage. 2001; 63: 293-305.
25. Nwide LL, Oveh B, Okoriye T, Vaikosen NA. Assesment of the water quality and prevalence of water borne disease in Amassoma, Niger Delta, Nigeria. Afr J Biotechnol. 2008; 7: 2993-2997.
26. Elgert S. Water Sampling. 2006.
27. Ayers R, Westcot D. Water quality for agriculture. 1st edn. Rome: FAO. 1985.
28. Berndtsson JC. Green roof performance towards management of runoff water quantity and quality: A review. Ecoleng. 2010; 36: 351-360.
29. Jones JI, Murphy JF, Anthony SG, Arnold A, Blackburn JH, Duerdoth CP, et al. Do agri-environment schemes results in improved water quality? J Appl Ecol. 2016; 54: 537-546.
30. Cheryl E. Aquaponic system grow food sustainably. Malamalama. The light of knowledge. University of Hawai'i. 2011.
31. Chris S, Moti C, Edoardo P, Austin S, Alessandro L. Small scale aquaponic food production. Food and agriculture organization of the United Nations. 2014.
32. Japan aquaponics
33. *What is Aquaponics*. The Aquaponic Source. 2017.
34. Chakravartty D, Mondal A, Raychowdhury P, Bhattacharya SB, Mitra A. Role of aquaponics in the sustenance of coastal India - Aquaponics is a solution for modern agriculture in ecologically sensitive Indian mangrove Sundarbans: IJFAS. 2017; 5: 441-448.
35. Tinker-Kulberg R. Aquaponics: a new breed of sustainable farmers + social justice activists. Abundance. 2014.

36. Yildiz HY, Robaina L, Pirhonen J, Mente E, Dominguez D, Parisi G. Fish Welfare in Aquaponic System: Its Relation to Water Quality with an Emphasis on Feed and Faeces - A Review. Water. 2017; 9: 13.

37. Dufour A, Bartram J, Bos R, Gannon VPJ. Animal Waste, Water Quality and Human Health. WHO.1st edn. New York: IWA Publishing. 2012.

38. Gwenzi W, Dunjana N, Pisa C, Tauro T, Nyamadzawo G. Water quality and public health risks associated with roof rainwater harvesting system for potable supply: Review and perspectives. Sustainability of Water Quality and Ecology. 2015; 6: 107-118.

39. Barati A, Ghaderpour A, Chew LL, Bong CW, Thong KL, Chong VC, et al. Isolation and Characterization of Aquatic-Boarne *Klebsiella pneumonia* from Tropical Estuaries in Malaysia. Int J Environ Res Public Health. 2016; 13: 426-441.

Cite this article

Zhi Ling RL, Andrew T, Huat LL, Sen TS (2017) Kuala Sepetang Estuary: Current use and Long-Term Sustainability. JSM Environ Sci Ecol 5(3): 1051.