

ICH 2019**International Conference on Humanities****A CRITICAL EVALUATION OF RIVER MANAGEMENT
MODELS IN MALAYSIA**

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Abstract

Rivers are important natural resources of a country as they provide a wide range of ecosystem services. However, the problem is that rivers in Malaysia are badly degraded due to mismanagement, neglect, pollution and abuse. River management in Malaysia is largely based on the government-centric top-down model which is sectoral-based. This model is ineffective as it has no private sector, NGO and public engagement and support. This paper aims to examine various types of river management models to identify the ones that can be effective in Malaysia. The methodology used a mixture of literature review of existing river management models, secondary data on published journal papers, reports and books on river management. Results of selected river management conferences are also studied, examined and findings synthesized. Primary data is also compiled with selected in-depth qualitative interviews with key government officers, managers of private companies, NGO officers and village heads. Results show that the government (various levels) is traditionally the responsible party in managing rivers, but increasingly, the public, NGOs, businesses and other stakeholders are actively involved. Results also show that holistic river management with active engagement of all stakeholders is necessary. In Malaysia, rivers are found to be intricately intertwined with all aspects of development. It was concluded that the Public-Private Partnership (PPP) model is an effective river management model in Malaysia as it conserves the river and its environment, and brings together all parties for building their capacities in river management towards achieving many Sustainable Development Goals (SDGs).

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Keywords: River management model, stakeholders engagement, non-governmental organisations, sustainable development goals, public participation.



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1. Introduction

Great civilizations in history are born near rivers (Clayton & John, 1973; Rector, 2016). Rivers are usually the places of beginning of civilizations (Chan, 2004; Chan et al., 2016a). Civilisations rise and fall with rivers and in the modern day, rivers feature prominently in nation building via the fulfilment of various development needs. However, degradation to river systems have let to economic losses and degradation of human quality of life as a whole (Azwad, n.d.). Globally, most of the world's rivers have undergone the degradation (Chan, 2005). However, modern developments in industry, agriculture, mining, energy, logging, transport, fishing and other needs have negatively stressed rivers to the point of irreversible damage. In Malaysia, though rivers provide a multitude of resources for life to flourish, such as water supply, irrigation and transportation they also bring disasters and death in terms of floods, droughts, water pollution and other related woes (Keizrul Abdullah, 2002). Other than the benefits to humans, rivers also have ecosystem benefits, hydrological functions, and sediment balance (Sinha & Ahmed, 2014). In rapidly developing Malaysia, rivers have shown to be of vital importance (Chan, 2012; Keizrul Abdullah, 2002). Rapid development in all spheres, notably agriculture, industrialisation and urbanisation, over the last half a century in Malaysia have transformed the country from one of mainly natural rainforests to agricultural plantations, urban, commercial and industrial centres (Ahmad Hussaini, 2014). Rivers have been overstressed by human developments (Zakaria et al., 2013).

Historical records and the literature provide a wide range of stories on the importance of rivers to civilisations. In ancient Mesopotamia, the two rivers of Euphrates and Tigris are even worshipped in their spiritual and functional roles (Finkelstein, 1962; Pollock, 1999). In Egypt, the Nile River is closely tied to the country's history. It is considered the lifeblood of the ancient Egyptian civilization and is currently still vitally important as the country is dependent upon it (Butzer, 1976). In China, the Hwang Ho or Yellow River is often considered the cradle of Chinese civilization. It is China's second longest river and is an enigma as it brings both happiness and sorrow (Zhang et al., 2000). The Yangtze River is the longest river in China and also the largest water system in the country. Its importance in China is seen historically, economically and culturally. Significantly, the Three Gorges Dam is the biggest hydropower project in the world. In China, the Yangtze River is the boundary between North China and South China demarcating differences in geography, climate, and human life (Hara et al., 2014). In India, the Ganga River is considered sacred (Das, 2001). Kumar (2017) documented the influence of the Ganges River on the historical, cultural and socioeconomic aspects. Elsewhere, rivers are the hub of life. Despite their vital importance, humans have not looked after rivers but neglected, abused and mismanaged them all over the world. It is reported that more than half of the world's major rivers are polluted, bringing about degradation of river ecosystems that threatened the livelihood of people who depend on them (World Water Council, 2004). It has not changed much as more recently, the Guardian reported that a global study found that hundreds of rivers around the world are polluted with high levels of antibiotics (The Guardian, 2019). Mismanagement of land and water resources in river basins has resulted in severe degradation of rivers, resulting in losses in river habitats, ecosystem services, aquatic life, livelihoods and environmental disasters (International River, 2019).

Rivers in Malaysia are also polluted to various degrees, some irreversible and dying (Povera, 2017). Chan (2012) also documented that managing urban rivers was problematic in Malaysia as the water quality

was poor and there were political, social and economic issues hindering effective management. The problem on why rivers degenerate and cause huge problems to human society can be seen in the way rivers are managed in countries worldwide. Overall, the most popular management strategy is via a government-centric approach. Under this approach, neither the private sector (which has the funds) nor NGOs (which have the commitment) and the public (which is a root cause that gives rise to pollution and stress to rivers) are involved. In order to achieve sustainable river management for economic development, sustainable tourism and healthy environment, many have found that it is necessary to engage all stakeholders (Chan, 2005; Chan et al., 2016b). This paper examines the effectiveness of river management models in Malaysia, specifically documenting the pros and cons of each model and how they can help towards achieving a holistic river management approach that balances environmental conservation.

2. Problem Statement

Rivers are important natural resources of a country as they provide a wide range of ecosystem services that are beneficial to human society (Chan, 2002). However, the main problem is that rivers in Malaysia are badly degraded due to mismanagement, neglect, pollution and abuse. River management in Malaysia is the responsibility of government whereby a top-down model which is sectoral-based is employed. This model is ineffective as it has no private sector, NGO and public engagement and support.

3. Research Questions

Several research questions are asked in this study as follows:

- What are the current existing river management models in practice in Malaysia?
- How effective is the top-down government-centric river management model in Malaysia?
- How effective is the bottom-up NGO-centric river management model in Malaysia?
- Which river management model is most appropriate and effective in Malaysia and why?

4. Purpose of the Study

The purpose of the study is to identify the current existing river management models in practice in Malaysia, and to evaluate their effectiveness. As such, several objectives are formulated in this study as follows:

- To identify the current existing river management models in practice in Malaysia?
- To evaluate the effectiveness of the top-down government-centric river management model in Malaysia.
- To evaluate the effectiveness of the bottom-up NGO-centric river management model in Malaysia.
- To study and find out which river management model is most appropriate and effective in Malaysia and why.

5. Research Methods

Two methods of study are used in this study to generate the data results. The first method is a comprehensive literature review of existing river management models in practice in Malaysia and elsewhere. The second method is based on primary data compiled from selected in-depth qualitative interviews with key government, private sector, NGO and village leaders. The two methods complement and support each other in terms of the evaluation of river management models.

5.1. Literature Review of Major River Management Conferences in Malaysia

The first method is based on a comprehensive literature review of existing river management models currently in practice in Malaysia and elsewhere. Secondary data on selected published papers of four major river management conferences in Malaysia were selected. Papers related to river management models are identified, and the conclusions and results of the papers summarized and synthesized to identify the effective models. The findings from the conferences are synthesized to find best management practices/models in river management. The four river management conferences are as follows: (i) National Conference on Rivers '99: Towards Sustainable Development, 14-17 October 1999 (58 papers with 19 papers related to river management models), Universiti Sains Malaysia, Penang; (ii) 1st International Conference on Managing Rivers in the 21st Century : Issues & Challenges, 21st - 23rd September 2004, Penang, Malaysia (75 papers with 38 related to river management models); (iii) 2nd International Conference on Managing Rivers in 21st Century: Solutions towards Sustainable River Basins (Rivers'07), Kuching, Sarawak, Malaysia, 6th -8th June 2007 (92 papers and 39 related to river management models); (iv) 3rd International Conference on Managing Rivers in 21st Century: Sustainable Solutions for Global Crisis of Flooding, Pollution and Water Scarcity (Rivers 2011), Penang, Malaysia, December 6-9, 2011, Penang, Malaysia (117 papers and 43 papers related to river management model).

5.2. Primary Data from Selected Indepth Qualitative Interviews with Key Stakeholders

Primary data is also compiled with selected in-depth qualitative interviews with key officers of the Drainage and Irrigation Department Malaysia (1 key officer), Department of Environment Malaysia (1 key officer), officers of Municipalities (1 Key officer from City Council of Penang Island and 1 Key Officer from Seberang Perai Municipal Council), managers of private companies (1 Key Officer from Penang Water Corporation, 1 key officer from a Private Consulting Company dealing with river conservancy), NGO officers working on rivers (1 key officer from Water Watch Penang and 1 key officer from Friends of Ulu Muda), and the village heads of riverine communities (2 village heads in Penang). The transcripts of interviews were summarized and synthesized and conclusions drawn. An interview with a key stakeholder was typically between 30 minutes to an hour. A set of questions on river management and views on the type of river management model was asked. The respondents were informed that the research results would be summarised and would be anonymous as no names would be mentioned. Transcripts of interviews were compiled, analysed and summarised. General conclusions were then drawn from the results of the interviews.

6. Findings

Globally, the literature shows that rivers can be managed by many management models, some effective, some not so effective and some failures (Chan, 2005). Each country with its peculiar characteristics, politics, social and economic conditions and context may require a specific model. The best model depends on politics, local conditions and availability of resources. In this study, results of both the four rivers conference study and indepth qualitative interviews with key stakeholders show that the model that is widely used in Malaysia is the Government-Centric Top-Down River Management Model. This model has been run successfully in many developed countries which have extensive funds, a high level of transparency and minimal obstruction from politics. For example, the Cheonggyecheon River in Seoul (South Korea) is considered a world's famous river that is managed almost totally via a Government-centric top-down management model. This river restoration project is almost single-handedly managed by the Seoul Metropolitan Government. Another popular model identified in this study is the bottom-up NGO model. This model is gaining in importance as civil society becomes more and more informed but the model lacks funding sources and human resources, and is generally not regarded by the masses as official or important. However, NGOs are committed, works well on very little funds, and are volunteer based. If the NGO model is combined with government and private sector participation, it can be an effective model. Two other models identified are the privatisation model and the public-private-NGO partnership model. The former model is not acceptable to the public as people generally do not want to pay for visiting a river park or for river cleaning. The private sector also finds it difficult to make any profits in managing a river. The public-private-NGO partnership model is perhaps the most acceptable model since it involves all major river stakeholders. Under this model, government provides the legitimacy and jurisdiction. The private sector provides the funding, and the NGOs provide the human resources. The Integrated River Basin Management (IRBM) Model was the least appreciated and the least popular. The Malaysian government governance structure is based on sectoral management, with each sector operating on its own. This has resulted in dis-integrated management of rivers culminating in the poor state of rivers in the country.

In Malaysia, Keizrul Abdullah (2002) and Ahmad Hussaini (2014), two previous director-generals of the Drainage and Irrigation Department (DID) Malaysia, have documented that managing rivers in Malaysia is carried out solely by the government and hence rivers should be solely managed by the government (through the DID). In the past, rivers in the country did not need much management as human impact was minimal. Rivers could also cleanse themselves easily as pollution loads were small. Every season when the Monsoon rains came, rivers flushed away sediments and pollutants easily, and rainforests regenerate. As such, during historical times, the top-down government-centric model was found to be effective. However, since the colonial period, much of the rainforests were cleared for plantations, tin mining, settlements, roads and railroads (Chan, 2002). Deforestation without mitigation measures during the colonial period has resulted in severe damage to forest habitats, loss of biodiversity, loss of water catchments and severe damage to rivers (sedimentation, pollution and disturbance to hydrological regimes) (Douglas, 2002). During the colonial period, river management, though haphazard, was a top-down government-controlled activity. This approach has been passed down to the Malayan government in 1957. This structural approach employs a government top-down model. Such an approach is not effective because it does not involve people (Chan, 2002). Interviews with key stakeholders on the effectiveness of various

river management models showed that the preferred model was not any single-body managed model but a management model comprising partnerships of key stakeholders (Table 01). Results of the interviews also show that the key stakeholders, especially the NGOs and village heads, complained that the government cleaning of rivers is ineffective if litterbugs keep dumping garbage into them. This is the case of most rivers in the country including the Kelang River, Pinang River, Juru River, Melaka River and Miri River. The top-down approach is also ineffective due to dispute between federal and state governments over rivers. Other than government respondents in this study, most of the other respondents are of the opinion that a combination of politics, unplanned development and rapid urbanisation, together with ineffective management, have resulted in many rivers in the country being grossly polluted.

Table 01. Rating of Various River Management Models by Key Stakeholders

Key Stakeholder	Top-Down Government Centric Model	Bottom-Up NGO Model	Privatisation Model	Public-Private-NGO Partnership Model	The Integrated River Basin Management (IRBM) Model
Government 1	7	2	5	7	7
Government 2	8	3	5	7	6
Government 3	8	3	5	7	5
Government 4	7	4	6	6	4
Private Sector 1	5	2	9	6	3
Private Sector 2	5	3	8	7	3
NGO 1	3	9	2	8	3
NGO 2	4	8	1	8	3
Village Head 1	4	6	5	8	4
Village Head 2	5	7	5	7	4
Average Rating	5.6	4.7	5.1	7.1	4.2

Rating Value Low (1-3), Rating Value Moderate (4-6), Rating Value High (7-10)

Moving on to the analysis on papers presented during the four river management conferences, it was found that the top-down approach had more negative feedbacks than positive ones. Ang et al. (2013), lament that although there have been some fragmented efforts from the authorities for river restoration and rehabilitation, mostly carried out by the Drainage and Irrigation Department to clean up the country's major rivers, few have been successful. Chop and Juhaimi Jusoh (2002) document the case of the Kelang River clean-up of solid waste and silt, towards improving its water quality to Class III (recreational purposes without body contact) but once the funds ran out, the water quality deteriorated back to Class IV. Hence, the Government-centric Top-down Model has limited effectiveness. Clearly, all stakeholders of the river must be engaged and be actively involved in its management (Chan, 2005).

Interestingly, although NGOs are viewed negatively by government as "trouble makers", results from this study showed that the bottom-up river management model has more supporters than non-supporters. Increasingly, the role of NGOs in river management is gaining importance. In the Philippines, more than 30 NGOs collaborated to ensure effective management of the Pasig River (Clean & Green Foundation Institution, 2016). NGOs were found to be the most hardworking stakeholder at the ground level, always engaging with the communities who lived in the river basin. NGOs consistently work with

local communities as well as government and private sector. Only NGOs were able to engage public participation in the project. In the Pasig River, which was described as “dead” in 1990, the 15 years NGO run program has yielded significant results. The main achievement is that the NGOs were very successful in their advocacy to influence and convince government, private sector and the public that the river needs to be restored. Another success story is the NGOs ability to successfully harness community participation in a difficult program of river management. Lastly, via this project, NGOs got the government’s attention and respect and since then NGOs have become the consistent partners of the government in restoration of the Pasig river.

In the case of Malaysia, NGOs were frowned upon since independence in 1957 as they were seen to be anti-establishment and anti-development. In the area of education, Chan et. al. (2016c) examined university-community engagement as a community-based platform to manage rivers and found that it benefits all parties as university has the expertise, private sector has the funds and community has the needs. This kind of smart-partnership enhances river and water education and involves a university, the private sector and an NGO. The NGO involved is Water Watch Penang (WWP) which has made huge contributions not only to river management but also in the area of integrated water resources management (Chang et al., 2004; Water Watch Penang, 2019). WWP has raised awareness on river, water catchments, water education and other aspects related to water (Chan et al., 2011).

The Integrated River Basin Management (IRBM) Model is coordinated management of river basin by all stakeholders consensus. There is no denying that when properly implemented IRBM is effective in managing a river and its basin. However, success is not always achieved due to many reasons. Amongst these reasons are politics, international disputes in the case of international rivers, sectoral disputes amongst agencies with different aims, overlapping jurisdiction and inter-state disputes. For example, any polluting activity taking place upstream of the river will eventually have severe downstream. Different agencies opt for different priorities. While the forestry department wants logging, the tourism department wants to push tourism development and the water department wants water catchment gazettement. All these different needs and aims will eventually lead to disintegrated development of a river basin. Hence, IRBM is a difficult model to implement, especially in Malaysia where there are too many authorities that have jurisdiction over certain aspects of the river and its basin (Chan, 2012; Keizrul Abdullah, 2002). These are the reasons why key stakeholders rated the IRBM model the lowest due to problems in its implementation.

In Malaysia, disintegrated river basin management due to the sectoral approach has always impeded the realization of IRBM. There was no central agency solely in charge of rivers with the exception of Selangor State. In the state of Selangor, Malaysia, a central agency Lembaga Urus Air Selangor (LUAS) or Selangor Water Management Board was created in 1999 by order of the then Prime Minister. LUAS is effective in implementing Integrated River Basin Management (IRBM) within the framework of Integrated Water Resources Management (IWRM). In order to achieve the said objective, good coordination between federal and agencies in providing technical support for model development and river basin management guidelines. This IRBM project addressed pollution problems in river basins in Selangor. This project managed to reduce pollution in the many rivers and rid them of poor water quality, toxic wastes, and loss of biodiversity in catchment areas. Most importantly, the entire development cycle in the state of Selangor

now follows a process of coordinated development by consensus from all stakeholders under LUAS leadership (*Lembaga Urus Air Selangor*, 2016).

7. Conclusion

Rivers can be managed by many management models, some of which are effective while others are not. Each country with its peculiar characteristics, politics, social and economic conditions and context may require a different model as no one model fits all. The best model depends on politics, local conditions and availability of resources. A successful river management model is not necessarily one that brings about the most development and benefits to human society. Neither should it be one that maintains the river ecosystem in its natural state without any form of development. Clearly, a model that balances development and conservation is needed. This is because a sustainable river management model is a pre-requisite for not just a healthy economy, but also a thriving society and sustainable environment, all of which contributes towards a country's development and achievement of Sustainable Development Goals (SDGs). Without an effective model, rivers will tend to be neglected, over-stressed and abused, rendering many rivers to the extent of being labelled as "dead rivers". In fact, a good river management model will also take into account the need to restore degraded and disturbed river ecosystems via rehabilitate and restoration. Although government has traditionally been responsible for managing rivers, other stakeholders such as the private sector, NGOs, and communities are beginning to play a bigger role. The Government-driven top-down model is no longer acceptable in the modern day context due to lack of public funds, the need for transparency and public participation. The NGO model is also not suitable as they do not have the jurisdiction, expertise or the funds. In the context of Malaysia, cooperation between various levels of government and all stakeholders is vital. Education is a vital tool to sensitize people towards love and respect for rivers which will in turn lead to commitment and good governance towards the sustainability of rivers. In conclusion, a suitable river management model for Malaysia would be a comprehensive Public-Private-Participation (PPP) Model (as shown by the Government-Private Sector-NGO Participation Model) whereby all stakeholders contribute via a smart-partnership approach towards good governance and sustainable management of rivers. As rivers are intricately intertwined with all aspects of development, it is concluded that effective river management will help achieve many SDGs on the road towards arriving at sustainable development.

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References

- Ahmad, H. (2014). A comprehensive urban stormwater management approach in combating flood in Malaysia: An indispensable link for safer, greener and more liveable urban environment. Keynote Paper presented at the 13th International Conference on Urban Drainage (2014), Kuching, Sarawak, Malaysia.

- Ang, S. C., Chan, N. W., Mashhor, M., Narimah, S., & Lai, S. H. (2013). Cabaran dalam kemampanan pengurusan sungai di Malaysia [Challenges in sustainable management of rivers in Malaysia]. In M. J. Jamaluddin, R. R. Muhammad, A. Kadir, R. Zuliskandar, S. Abdullah, & Emrizal (Eds.), *Prosiding Seminar Serantau Ke-2: Pengurusan Persekitaran di Alam Melayu Pekanbaru, Provinsi Riau* (pp. 96-106).
- Azwad, M. N. (n.d.). *Threats to rivers*. Retrieved 26 July, 2019, from http://www.wwf.org.my/about_wwf/what_we_do/freshwater_main/freshwater_conserving_river_basin/s/threats_to_rivers/
- Butzer, K. W. (1976). *Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology*. Chicago University Press.
- Chan, N. W. (Ed). (2002). *Rivers: Towards Sustainable Development*. Penerbit Universiti Sains Malaysia.
- Chan, N. W. (2004). Sustainable river management in Malaysia: involving all stakeholders. *Rivers '04 Proceedings of the 1st International Conference on Managing Rivers in the 21st Century: Issues & Challenges* (pp. 35-61).
- Chan, N. W. (2005). Sustainable management of rivers in Malaysia: Involving all stakeholders. *International Journal River Basin Management*, 3(3), 147-162.
- Chan, N. W., Ang, S. C., Hong, C. W., Chuah, C. Y., & Ong, K. S. (2011). The role of Water Watch Penang in protecting water resources in Malaysia. *Proceedings of the National Conference on Society, Space and Environment (MATRA 2011)* (pp. 154-165).
- Chan, N. W. (2012). Managing urban rivers and water quality in Malaysia for sustainable water resources. *Internasional Journal of Water Resources Development*. 28(2), 343-354.
- Chan, N. W., Masazumi, A., Nor, A. Z., Aminuddin, A. G., & Zullyadini, A. R. (2016a). Chapter 38: Rivers and cities. In N. W. Chan, I. Hidefumi, N. Akihiro, & A. Masazumi (Eds) (2016). *Sustainable Urban Development Textbook* (pp. 248-258). Water Watch Penang & Global Cooperation Institute for Sustainable Cities, Penang, Malaysia.
- Chan, N. W., Hong, C. W., Lai, C. H., Lim, H. K., & Tang, S. K. (2016b). The role of the university in community engagement for environmental and water education: The example of Universiti Sains Malaysia. *Proceedings of 1st International Conference on Society, Space & Environment 2016* (pp. 1-7).
- Chan, N. W., Hong, C. W., Lai, C. H., Lim, H. K., & Tang, S. K. (2016c). The role of the university in community engagement for environmental and water education: the example of Universiti Sains Malaysia. *Proceedings of the 1st International Conference on Society, Space & Environment 2016* (pp. 1-8).
- Chang, W. F., Chan, N. W., Hajar, A. R., & Khor, H. T. (2004). Approaching integrated water resources management (IWRM) via smart-partnerships with government, industry and other NGOs: The role of Water Watch Penang. In Aminuddin A. G., Nor A. Z., Rozi A. & Mohd. Sanusi S. A. (Eds) “*Rivers '04 Proceedings of the 1st International Conference on Managing Rivers in the 21st Century: Issues & Challenges*” (pp. 302-313).
- Chop, A. K., & Juhaimi, J. (2002). The Klang River cleanup programme. In Chan, N. W. (Ed) *Rivers: Towards Sustainable Development* (pp. 378-389). Penerbit Universiti Sains Malaysia, Penang.
- Clayton, P. A., & John, D. (1973). *The Ancient River Civilizations: Western Man & the Modern World*. Elsevier Science.
- Clean & Green Foundation Institution (2019). *NGO Initiatives on water resources management: The pasig river experience*. [Power Point Slides] Retrieved 27 October, 2016 from http://www.wepadb.net/pdf/0710philippines/12_Clean%20and%20Green%20Foundation.pdf
- Das, M. (2001). *Of myths and legends – Rivers*. The Hindu, Sunday Magazine 1 July 2001.
- Douglas, I. (2002). Sediment: A major river management issue. In N. W. Chan (Ed), *Rivers: Towards Sustainable Development* (pp. 15-22). Penerbit Universiti Sains Malaysia, Penang.
- Finkelstein, J. J. (1962). Mesopotamia. *Journal of Near Eastern Studies*, 21, 73–92.
- International River (2019). *The state of the world's rivers, international rivers*. Retrieved 2019, August 7 from <https://www.internationalrivers.org/sites/default/files/worldsrivers/> (Accessed 7 Aug 2019).
- Hara, K., Da, L., Fujihara, M., & Tomita, M. (2014). Landscape change and sustainable development in the Yangtze River basin, China. *Landscape and Ecological Engineering* (pp. 123-124).
- Keizrul, A. (2002). Integrated river basin management. In N. W. Chan (Ed) *Rivers: Towards Sustainable*

- Development* (pp. 3-14). Universiti Sains Malaysia Press, Penang.
- Kumar, D. (2017). River Ganges: Historical, cultural and socioeconomic attributes. *Aquatic Ecosystem Health & Management*, 20(2), 8-20.
- Lembaga Urus Air Selangor (2016). Retrieved 25 October, 2016, from <http://www.luas.com.my>
- Pollock, S. (1999). *Ancient Mesopotamia: the Eden that never was*. Cambridge University Press.
- Povera, A. (2017). Many rivers in West Malaysia considered 'dead'. *New Straits Times*. Retrieved 9 September, 2017, from <https://www.nst.com.my/news/nation/2017/09/277284/many-rivers-west-malaysia-considered-dead>
- Rector, R. K. (2016). *The Early River Valley Civilizations (The First Humans and Early Civilizations)*. Rosen Publishing.
- Sinha, R. K., & Ahmed, B. (Eds.). (2014). Rivers for life. *Proceedings of the International Symposium on River Biodiversity: Ganges-Brahmaputra-Meghna River System, Ecosystems for Life, A Bangladesh-India Initiative*.
- The Guardian (2019). *World's rivers 'awash with dangerous levels of antibiotics'*. <https://www.theguardian.com/society/2019/may/27/worlds-rivers-awash-with-dangerous-levels-of-antibiotics>
- Water Watch Penang (2019). Retrieved 7 August, 2017, from www.waterwatchpenang.org
- World Water Council (2004). Retrieved 20 January, 2004, from <https://www.worldwatercouncil.org/>
- Zakaria, N. A., Aminuddin, A. G., Abdul, T. S., Chan, N. W., & Mohamed, D. M. N. (2013). Urban water cycle processes, management, and societal interactions: Crossing from crisis to sustainability. *World Environmental and Water Resources Congress 2013* (pp. 1240-1246).
- Zhang, X., Yu, M., & Yang, G. (2000). Flood in Jing Jiang reach of Yangtze river. In K. D. Nguyen (Ed.), *Ecosystem and Flood 2000* (pp. 11-21). Hanoi: European Commission (DGXII).