

Infusing ILBM into IWRM Framework towards water sector transformation – a case of Malaysia

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Abstract

Integrated Lake Basin Management (ILBM) initiatives have been undertaken by Malaysia since the mid-2000s. One of the important documents outlining the initiatives is the adoption of the strategic plan for sustainable lake and reservoir development and management that defines the vision and the policy framework. Malaysia is mainstreaming water in the national agenda with the integrated water resources management (IWRM) paradigm as its central policy towards country commitment to achieve the sustainable development goals on water (since 2001). Lake remains as an important component due to being a part of the river system and its strategic contribution as a resource and livelihood. In the context of water as a resource, lakes contribute towards supplying water for domestic and industrial growth as well as agriculture development besides regulating flood and drought. In the context of water as livelihood, lakes contribute as consumptive water uses through alternative water sources from stormwater and off-river storage ponds, and non-consumptive uses, namely hydropower development, freshwater fisheries and recreation and tourism expansion. The 12th Ma-

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Malaysia plan will accelerate IWRM in a shared prosperity initiative, encompassing three dimensions, namely economic empowerment, environmental sustainability, and social re-engineering. In the environmental sustainability dimension, specific focuses were given on IWRM (which includes ILBM), biodiversity conservation, climate change mitigation and adaptation, and valuing ecosystem services. Long-term programs, include research and development using innovation and industrial revolution technology (IR 4.0) towards the improvement of pollution monitoring, rehabilitation of degraded lakes, stakeholder and community collaboration in governance, and adaption to future climate changes to enhance lake resilience.

Keywords: *Integrated Lake Basin Management, Integrated Water Resource Management, lakes, sustainability, water sector transformation*

1. Introduction

Management of water resources has been the main agenda of Malaysia to ensure security of water for socio-economic development and living beings. Similar to the global environment, the main challenges of the water sector facing Malaysia were population increase and economic development, and climate change. According to Roser et al. (2013), the world population has increased from 984.94 million in 1800 to 7.87 billion in 2021 [1]. Similarly, the population in Malaysia has increase from 287,000 in 1800 to 32.78 million in 2021; the citizen growth rate remained stable at 1.0% [1, 2]. The gross domestic product (GDP) per capita of the world has increased from 457.7 in 1960 to 10,910.0 in 2020 [3]. Similarly, the GDP per capita for Malaysia has improved from 234.9 in 1960 to 10,412.3 in 2020 [3] The increase in population and economic growth cause an increase competition and conflicts for the water use and pollution at various levels and sectors.

Additionally, the impact of climate change on water resources is becoming more apparent; surface temperature in Malaysia is projected to increase to 1.85 – 1.93°C by the end of the century [4]. The projected average temperature of the planet could be between 1.1 to 5.4°C warmer in 2100 [5]. The extreme events such as long droughts associated with climate changes

increase the water resources conflicts. Fragmented management has been the biggest challenge in managing the water sector in Malaysia requiring a holistic, systemic approach namely the Integrated Water Resources Management implementation in the country [6,7]. The Federal Constitution describes that generally, water and other natural resources are under the responsibility of state governments, except for agriculture drainage and irrigation (FedConst 1957, and Water Service Industry Act 2006) [8,9]. Shared rivers between two or more states can be looked at by the Federal Government, if invited by the states involved [6, 7]. At the federal level, the governance of water is also sectoral-based; administration and development are being carried-out by different ministries and their agencies.

The governance of the lake, in particular, is very fragmented with different parts of the lake system being managed or operated by different agencies and authorities. For example, the dam structure is always managed by the federal agencies while the lake catchment or drainage basin is governed by state agencies. In general, natural lakes are mostly managed directly by the state government agencies. Man-made lakes such as reservoirs are being governed by different agencies, depending on their main users; water reservoirs are under the Department of Water Supply, Ministry of Water and Environment, irrigation reservoir under the Ministry of Agriculture and their agencies, flood mitigation reservoirs are under the Drainage and Irrigation Department, Ministry of Water and Environment and hydropower reservoirs are under the private sectors/govt.link agencies. Small urban lakes and ponds are being managed by the local authorities of each state. As the governance is too fragmented, the water quality status of these water bodies is seldom monitored by the agencies.

This paper reviews the process of infusing ILBM into the holistic IWRM framework. The aim was to examine how ILBM is mainstreaming within the national IWRM framework to support water sector transformation in Malaysia.

2. Management framework

2.1 Integrated Water Resource Management (IWRM)

The Integrated Water Resources Management approach was introduced and accepted during the ICWE Dublin and Earth Rio Summit in 1992. IWRM is defined by Global water partnership as “A process which promotes the coordinated development and management of water, land, and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” [10]. The overall framework of IWRM is based upon three thrusts namely management instruments, enabling environment and institutional framework.

Malaysia takes cognizance of the need to manage water sustainably based on the IWRM approach. Table 1 illustrates the key IWRM progress in Malaysia over the last 20 years. The formation of the National Water Resources Council was one of the earliest initiatives taken by Malaysia towards adopting the IWRM. Malaysia adopted the approach when the IWRM concept was included in the Eighth Malaysia Plan and Third Outline Perspective Plan in 2001. A national study for the effective implementation of IWRM in Malaysia was undertaken in 2005 followed by the implementation of IWRM Best Management Practices in 2009 [6,7].

One of the major milestones of IWRM implementation is the endorsement of the National Water Resources Policy in 2011 and launched in March 2012. The policy was based on three principles, namely water resources security, water resources sustainability and collaborative governance [11]. This policy document specifically spells out that Integrated management approach to be under undertaken for river, lake and coastal through Integrated River Basin Management (IRBM), Integrated Lake Management (ILM), Integrated Coastal Zone Management (ICZM), Integrated Shoreline Management Plan (ISMP) and Integrated Flood Management (IFM) approaches [11].

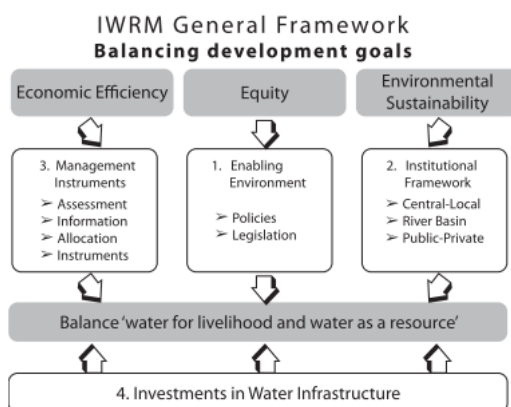
The Academy of Sciences Malaysia (ASM) took the initiative from 2008 to develop a nation-wide IWRM work plan with IWRM as the central thrust [6], in a series of publications. This initiative was summarized in the ASM

Table 1. Key IWRM progress in Malaysia.

Period	Initiatives
Before 2000	• Formation of National Water Resources Council
2001 - 2010	• Adoption of IWRM under 3rd outline perspective plan & 8th Malaysia plan • National adoption of IRBM • The establishment of Natural Resources and Environment Ministry • National study for the effective implementation of IWRM in Malaysia • Implementation of IWRM BMP's
2011 - 2021	• Endorsement and launching of National Water Resources Policy • Launched of National Integrated Water Resources Management Plan • Restructuring of MSAN to National Water Council (MAN) • The adoption of WST2040 in 12th Malaysia Plan

2016 publication, the “Transforming the water sector: National Integrated Water Resources Management Plan: strategies and road map” or the NI-WRMP. The document introduced the idea for Malaysia to transform its water sector. A total of eleven component plans were structured to the common IWRM framework as shown in Figure 1. The goals of the framework are to balance ‘water as a resource’ and ‘water for livelihood’ along the three IWRM thrusts.

Figure 1. IWRM General framework (source: Abdullah et al., 2016).



Despite IWRM policy approach being introduced since 2001, the status of IWRM implementation remains low. According to UNEP, the IWRM Status for Malaysia in 2020 scored 63 points, which is medium-high [12].

Malaysia scored low in two areas, namely the management instrument and financing.

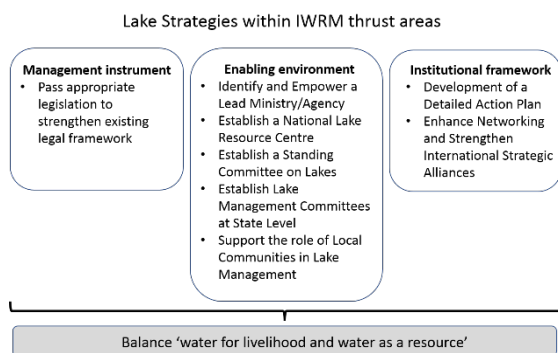
Two of the focused management subsets within the IWRM framework are the IRBM and ILBM. Being the most important freshwater resources, rivers are considered as the source of national economic developments. As such, ASM focused on the application of IWRM at the river basin scale. In fact the “love our river campaign” was probably the earliest initial milestone of IWRM implementation in the country. To date, Malaysia has 189 main river basins, covering 95% of its land mass. 26% are large with drainage areas of more than 1,000 km². About 57% of the river basins have a catchment area of less than 500 km². IRBM plans are being developed to support IWRM implementation. These plans will aid in the overall governance of each river basin. However, managing river basins also comes with various challenges. The main challenges in managing each river basin, are developing cooperation and collaboration among the agencies, at various Federal, State as well as Local Government levels, to ensure the health of the basin ecosystem [13].

2.2 Integrated Lake Basin Management (ILBM)

Lakes, due to their unique characteristics such as long retention time and complex response dynamic, require special management focus. Integrated Lake Basin Management (ILBM) is an approach that focuses on standing water bodies in lakes, reservoirs and ponds. ILBM approach is also considered a subset to IWRM with the goal to achieve “sustainable management of lakes and reservoirs through gradual, continuous and holistic improvement of basin governance, through sustained efforts for integration of institutional responsibilities, policy directions, stakeholder participation, information, technological possibilities, and funding” [6]. Malaysia has undertaken various initiatives in promoting sustainable management of lakes based on the ILBM approach since 2004. Earlier initiatives have been focusing on identifying issues and status of lakes in particular eutrophication and developing strategies for sustainable development and management in 2009 [14].

The national vision for Malaysian lakes in the strategic plan is “The sustainable use of lakes for their ecosystem services and economic values” while the policy framework identified is “Lakes and reservoirs will be sustained, restored and protected through the adoption of an Integrated Lake Basin Management (ILBM) approach” [14]. Eight strategies were formulated and categorised further in the NIWRMP based on the IWRM framework in Figure 2.

Figure 2. *Lake Strategies within IWRM General framework.*



Due to the importance of lakes in providing various services for the nation, National Water Research Institute of Malaysia (NAHRIM) commenced a study in 2020 to update the inventory of water bodies in the country. The most recent inventory of lentic water bodies in Malaysia identified a total of 379 lakes, reservoirs and ponds that provided various services such as water supply and fish products, flood mitigation and hydropower generation [15].

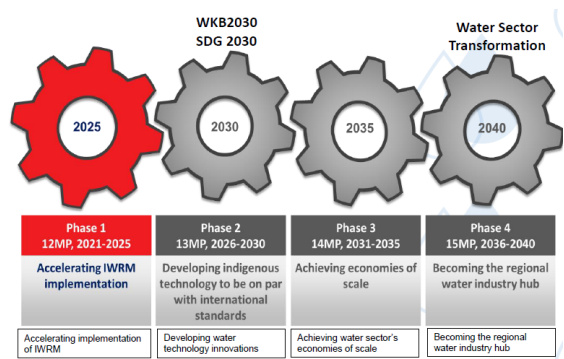
3. Water sector transformation and Twelfth Malaysia Plan

Water sector transformation (WST) is a national agenda by Malaysia to “transform the water sector into a dynamic & vibrant economic sector” which aims to contribute significantly to the national GDP, provide good quality affordable water to the public, and create new job opportunities by

facilitating resilient development of science and technology innovation and research [16].

The WST2040 spans over four phases and will be completed within 20 years or within four Malaysia development plans (Figure 3). It has two objectives namely (1) water security and sustainability (2) water as an economic opportunity. The phase 1 of WST2040 (2021-2025) is currently ongoing under the twelfth Malaysia Plan with the goal to accelerate the IWRM implementation. Phase 2 (2026-2030) aims to develop indigenous technology to be on par with international standards while Phase 3 (2031-2035) aims to achieve economies of scale. The last phase or phase 4 (2036-2040) aims to transform Malaysia into a regional water industry hub.

Figure 3. The four phase of WST2040.



The Twelfth Malaysia Plan (12-MP) which was launched last year aims to support the transformation of water sector in Malaysia. WST was included as a specific chapter in the Development plan to ensure the budget development allocation is in line with the government planning.

The key issues identified in the 12th MP that led to ineffective water resources management can be divided into five areas, namely people, governance, infrastructure, information and finance (Table 2, EPU 2021).

As such, the strategies mooted in accelerating the adoption of Integrated Water Resources Management (IWRM) will be based on a shared prosperity initiative, encompassing three dimensions, namely economic empowerment, environmental sustainability, and social re-engineering that includes

Table 2. *Key challenges in Malaysia in water resources management (EPU, 2021).*

Scope	Issues
People	• Lack of ownership and ability to protect and conserve water resources • Absence of a clear platform for inclusive local community involvement in water governance.
Governance	• Ineffective governance of water sector due to uncoordinated approaches in managing water resources at all levels and sectors • Poor enforcement and a lack of scope for punitive action.
Infrastructure	• Insufficient and unsustainable water infrastructure to support growth
Information	• Lack of data-driven and science-based decision making due to the absence of a centralised database to integrate water-related data and information on research, development, commercialisation and innovation (R&D&C&I) activities • Limited expertise among water technologists and scientific community
Finance	• Poor financial sustainability of water industry and high dependence on public funding

- 1) Empowering people as agent of change in transforming the water sector
- 2) Strengthening governance at all levels
- 3) Enhancing capability in data-driven decision making
- 4) Ensuring sustainable financing
- 5) Developing sustainable infrastructure with cost-effective technology

The goal of the 12-MP and thirteen Malaysia Plan is to ensure Malaysia will achieve its commitment towards Sustainable Development Goals 2030 and Shared Prosperity Vision 2030.

Lakes remain as important components due to being a part of the river system and its strategic contribution as a resource and for livelihood. As a resource, lakes supply water for domestic & industrial growth and agriculture development and regulating flood and drought. For livelihood, lakes function as consumptive water uses such as alternative water sources such as stormwater ponds and off-river storage. Lakes also function as non-consumptive uses such as hydropower development, freshwater fisheries, recreation and tourism expansion.

The lake initiatives and programs identified to support IWRM can be divided into three areas as follows:

3.1 Research and development (R&D)

Development of the R&D ecosystem is critical to enable science-based and data-driven decision making. Despite increasing public financing given for R&D activities over the last few Malaysia development plan, the public R&D development remains sporadic with water-related data and information scattered among different agencies and institutions [16]. Lack of coordination, monitoring and evaluation framework, commercialization, innovation and industrial linkages were reported to have hindered the effectiveness of the public R&D ecosystem in the country [17]. Limited expertise among water technologists and the scientific community were acknowledged as factors that could hamper sustainable management and development of water sector. As such, strengthening capability through research, development, commercialisation and innovation is emphasized under the WST2040 to ensure sound decision-making.

The WST2040 promotes the application of 10-10 Malaysian Science Technology Innovation Ecosystem Framework (MySTIE) which is based on current and leap-frogging technologies as well as the National Water Innovation roadmap (2021-2040). Concerning lakes, the blueprint for Lakes and Reservoir Research and Development was completed in 2015 to support integrated R&D activities. The blueprint specified the need to focus R&D activities at the lake basin or catchment scale. The research studies should be trans-disciplinary or interdisciplinary combining physical and social sciences aspects [18].

Improvement of pollution monitoring is outlined in the NIWRMP and 12-MP to support IWRM implementation. Research should be focusing on the carrying capacity of the water bodies based on total maximum daily load (TMDL) concept for lentic-lotic waters [6,16,18].

Rehabilitation and restoration of degraded lake ecosystems is an important enabling environment to ensure lakes continue to provide their ecosystem services [6]. Studies should be carried out to assess the level of degradation such as storage loss from sedimentation as well as eutrophication and other pollution levels [18].

3.2 Stakeholder and community collaborations in governance

The WST2040 emphasizes enhancing collaborations among all stakeholders, including the communities, for successful water sector transformation. This includes promoting advocacy, awareness raising and capacity building activities, i.e. public participation in caring for lakes and rivers. Collaboration can include engaging nearby lake communities or developing citizen science on lake monitoring and management. Both integrated management approaches such as IRBM and ILBM are an important program concerning water as a resource [6].

For successful ILBM implementation, the focus requires more than planning. This needs to include monitoring and evaluation. There is a need to review and update governance requirements at Federal, State and Local levels to ensure smooth transfer of management from and at all levels. Lake basins management that aims towards development, or conservation, requires not only plans and programs but also must be supported by appropriate management framework providing for continuous improvement [19]. According to RSCE - Shiga University, and ILEC (2014), sustainable lake basin management is achieved when both planning and governance are geared together [19]. Generally the ILBM emphasis on developing ILBM Platform Process is on continuous improvement in the governance pillars.

Since stakeholder participation is also one of the governance pillars in ILBM approach, implementing ILBM will support IWRM implementation in Malaysia. The overall goal is to create a shared means, agenda and/or place for the affected stakeholders and basin society as a whole to address conflicts [6, 19].

3.3 Adaptation to climate changes to enhance lake resilience

As climate change impact will affect the water sector, adaptation to climate changes is necessary to enhance lake resilience to climate change. WST2040 puts emphasis on promoting evidence-based and integrated approaches for

climate change adaptation and disaster risk reduction in development planning and R&D programs such as forecast and projection of climate change on water resources including dams [16].

The WST2040 recommends the construction of new dams to be multi-use or multi-purpose, such as for water supply, power generation, irrigation and flood mitigation under the 12-MP [16]. Additionally the function of flood retention ponds will be expanded for utilisation as raw water storage and/or aquifer recharge [16]. The role of the existing lake will also be enhanced to adapt to the changes in the effects of drought and floods. Development of new dams or man-made lakes such as off-river storage (ORS) is proposed along rivers to reduce the flood issues. This ORS will also function as a water resource alternative to support water for livelihood [16].

Additionally, the development of underground dams is being promoted in WST2040 under the 12-MP to enhance the use of groundwater as an alternative or conjunctive water source. Detailed feasibility studies on such underground dam developments especially in water-stressed areas will need to be undertaken to determine their exact potential, and hazards [16].

Development of nature-based solutions such as constructed wetlands is encouraged to alleviate the extreme events such as floods and droughts as well as addressing water pollution issues in all water resources including rivers and lakes [16].

4. Conclusion

In conclusion, ILBM is an important management mechanism for lentic water resources to support IWRM in Malaysia. IWRM paradigm as its central policy (20-year plan) towards country commitment to achieve the sustainable development goals on water. Enhancing capability in data-driven decision making – i.e. long-term programs, include research and development towards the improvement of monitoring and rehabilitation of lakes, stakeholder and community collaboration in governance, and adaptation to future climate changes.

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