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Review

Integrated River Basin Management for Sustainable Development: Time for Stronger Action

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Abstract: Malaysia has numerous policies, institutions, and experts with foresight and vision for its development. Nevertheless, river basin management has been lacking due to several factors such as insufficient proactive leadership roles of institutions, as well as locally authorized bodies. Reviewing of stakeholders' role in the PENTA-HELIX partnership model (i.e., government, business, academia, community, and NGO) reveals that individuals and institutions with proactive and effective leadership roles along with top-down and bottom-up approaches can create a more strategic policy implementation resulting in better outcomes in river basin management. Local authorities with proactive leadership roles should be encouraged to use a creative and innovative key performance indicator system accompanied by mentoring and training, as well as education, to inspire a passive to active attitude change. A local authority with sound leadership roles can develop proper partnerships with its many stakeholders to improve awareness with more multitasking activities. These can be achieved by motivating all the related stakeholders towards more commitment to creating a sustainable environment. Identifying and recognizing local authorities to manage the rivers will result in more powerful actions in river management. It is essential to ensure quality control and quality assurance at various levels to bring sustainability science at the multi-stakeholders' platforms towards an integrated river basin management to achieve a better living quality for everyone.

Keywords: leadership roles; local authority; river basin; sustainable development

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1. Introduction

Rivers are the main source of drinking water supply in Malaysia. Subsequently, rivers offer approximately 95% to 98% raw water resource primarily utilized for drinking and irrigation systems [1]. Accordingly, the government has developed the National Integrated Water Resources Management Plan, Strategies, and Road Map (Volume 1 and 2) through the Academy of Science Malaysia (ASM) for the administration of the nation's 189 major river basins, which also includes the Langat River Basin in Peninsular Malaysia. Integrated Langat River Basin Management is significant in light of the fact that the Langat River is among the essential primary water sources for drinking for about 33% of the population of the Selangor state, Malaysia [2]. Even though an integrated river basin management (IRBM) could potentially result in safe water supply for the household, the closure of the water treatment plants (WTPs) in the Langat river basin is the unfortunate outcome of contaminations particularly in the form of chemical pollution from both the point and non-point sources of the river [2,3]. Malaysia has sufficient policies, expertise, and institutions alongside the Foresight Institute to deal with water resources. Nevertheless, the fundamental issue related to river contamination is the deficiency in implementing these policies. In Malaysia, for example, managing rivers is the responsibility of the state government even though the federal agency, namely the Department of Irrigation and Drainage (DID), leads the management of the river basin. Surprisingly, the DID is not supported by the constitution of Malaysia in dealing with the river basins particularly in managing pollution [4]. DID was set up as a specialized technical agency to help the federal government for the purpose of flood control and irrigation [5]. The trans-boundary Langat River Basin shares its borders with the Selangor and Negeri Sembilan states as well as the Federal Territories of Kuala Lumpur and Putrajaya. Due the fact that the mandate given to the DID is inadequate in terms of managing the Langat River, the Selangor state government has established the "Lembaga Urus Air Kuala Lumpur" or the "Selangor Water Management Authority" (LUAS) in 1999 to manage the water bodies within the state including the Langat River. However, difficulties remain in the implementation of those policies for river management, especially pollution management along with the collaboration and cooperation among the federal and state government agencies, particularly due to the absence of agencies like LUAS in the Federal Territories and Negeri Sembilan State.

Therefore, the proactive leadership roles of the seven local authorities (i.e., four in Selangor state, and one in Negeri Sembilan state and in the Federal Territories of Kuala Lumpur and Putrajaya each) in the Langat river basin are crucial due to their mandate in policy implementation using the Local Government Act 1976 [6]. Observing the frequent chemical pollution at the river, it can be assumed that the capacity and capability of the local government officials for river management can be enhanced via multi-disciplinary training from the disaster risk reduction perspective. The customized training can also enhance their real-time decision-making process using technologies such as artificial intelligence (AI) [7], GIS-based risk map [8], etc. especially for the early warning systems at the river basin level [9,10]. Capacity building of local government on hydrological monitoring and early warning system (EWS) can contribute to sustainable and fair water management against water-related disaster risks such as floods and drought. Moreover, the use of AI and GIS-based river basin risk map by local authorities can enhance their holistic and integrated approach to managing Water–Energy–Food (WEF) nexus challenges to meet sustainable river basin management. Watersheds in natural ecosystems, especially forests and wetlands, produce cleaner, purer water than those from agricultural or industrial areas. Some municipalities pay to support the management of protected areas because they provide a cost-effective water supply; others remain virtually unaware that their water comes from a protected area [11]. Such benefits contribute directly to SDG 6, Clean Water and Sanitation, which aims to achieve "universal access to safe and affordable drinking water" and "protect and restore water-related ecosystems". While the Sustainable Development Goals (SDGs) are broadly framed with 17 goals, the goals and their targets inherently connect with each other forming a complex system. Actions supporting one goal may influence progress in other goals, either positively (synergies) or negatively (trade-offs). Therefore, the effective management of the synergies and trade-offs is a prerequisite for ensuring policy coherence, particularly at the river basin level [12].

In September–October 2016, the Sungai Langat and Cheras Mile 11 water treatment plants (WTPs) encountered a few shutdowns on the grounds that the conventional coagulation of the water treatment technology was not able to treat the chemically polluted river water alongside high turbidity [3,13]. There were also several shutdown incidents of WTPs such as Sungai Semenyih WTP, Bukit Tempoi WTP, and as such at the Langat River Basin during the last three years [14–17]. Thus, the government through SPAN (Suruhanjaya Perkhidmatan Air Negara/National Water Services Commission) produced the standard operating procedure (SOP) in managing WTP in relation to odor contamination in raw water to avoid plant shutdowns [18]. Needless to say, without satisfactory safe water, it would be difficult to accomplish many of the universally concurred objectives, for example, the Sustainable Development Goals (SDGs), particularly SDG target 6.1 of having clean water for drinking. Consequently, the capabilities of major agencies in dealing with the Langat basin may be improved through the proactive positions of leadership to connect to all the stakeholders through the methodologies of integrated river basin management (IRBM) in accordance with the integrated water resource management (IWRM), the integrated lake basin management (ILBM), and the integrated coastal zone management (ICZM) [19]. Additionally, the global network of river basin management contended that the engagement of a river basin organization (RBO) relies upon the mandate (geographic inclusion and assignments), authority (formal and informal), and capability (financing and resources) of the state [20]. In any case, the achievement of RBO depends on the interconnectivity among the performance of the RBOs, relationship of the stakeholders, leadership roles, and political cooperation [21]. Accordingly, NGOs could assume an essential function in raising awareness among all the important stakeholders in the management of the river basin. NGOs can carry out environmental awareness projects using courses, campaigns, etc. for the public. However, inadequate coordination has been reported among the stakeholders of the Langat River Basin Management [22].

Subsequently, the execution of water policies at the local level should be guaranteed to lower river contamination and the local government is the most suitable authority to actualize these policies since they have been given the mandate with the Local Government Act 1976 [23] in Malaysia. For instance, the National Agenda on Water Sector Transformation (WST2040) is a Malaysian government initiative to accelerate the implementation of IWRM via the 12th Malaysia Five Year Plan (2021–2025) [24]. Moreover, WST 2040 is an ambitious project of government over the period from 2020 to 2040 in order to contribute to national GDP and to achieve this, WST2040 has highly emphasized the proactive leadership roles of multi-stakeholders, especially of the local government in the developing nation. Local authority with proactive leadership roles will be able to execute these policies and collaborate better with the related agencies and stakeholders. The local authorities are in a position of influencing these approaches from top-down and bottom-up ways to deal with multi-stakeholders' structure to perceive the closest organizations for innovative solutions of the water and wastewater treatment plants and as such. Therefore, this study explored the leadership roles of the local authority in attempting to diminish river contamination to contribute accomplishing the Integrated Langat River Basin Management.

2. Methods

In every form of management, there must be challenges that make policy implementation difficult in management initiatives. River basin management by the local government in Malaysia is also not exempt from the dilemma when various obstacles and challenges often make it difficult for them to implement river basin management activities [25]. This study, based on the thorough analysis of full text, identified a total of eight research articles that fully met the search criteria. Based on the Web of Science (WOS) and SCOPUS databases, articles with the following characteristics were extracted: (i). published between 1970 and 2023, (ii). terms contained in the title, abstract, and keywords were 'river basin management', and 'local government', and (iii). focused on Malaysia. Table 1 summarizes the methodological approaches in river basin management in Malaysia.

Table 1. Various methods of integrated river basin management in Malaysia.

Title (Year)	Objective	Method	Results
Sustainable management of rivers in Malaysia: Involving all stakeholders (2005) [26]	This paper discusses how all stakeholders can contribute by working together in smart-partnerships with government towards effective and sustainable management of rivers in Malaysia.	Literature review to explore sustainable river management in Malaysia.	All stakeholders need to start taking proactive actions, even sacrifices, to manage, protect, conserve, and restore our rivers so that their resources can be sustained for future use.

Table 1. *Cont.*

Title (Year)	Objective	Method	Results
Steady data flow tracks floods (2008) [27]	Aims to understand the flood events, and provided a vital foundation for planning for upcoming floods.	Literature review to explore flood management initiatives in Kuala Lumpur Malaysia.	Data from the SMART project are also helping scientists and officials better understand the local river system.
Perspectives and initiatives on integrated river basin management in Malaysia: A review (2011) [28]	This study attempts to focus on the current situation of water issues in Malaysia in particular on perspectives and initiatives pertaining to Integrated River Basin Management (IRBM).	Literature review was conducted to explore the current status integrated river basin management in Malaysia.	The complex process of decision making for sustainable management of water and river basins needs an integrated and holistic approach involving many stakeholders and disciplines.
Institutional challenges for integrated river basin management in Langat River Basin, Malaysia (2011) [29]	This paper reports on a study of the institutional challenges and factors affecting policy processes and outcomes of integrated river basin management (IRBM) in the Langat River Basin (LRB), Malaysia.	A case study approach using institutional analysis and development (IAD) framework was used, and field observations and interviews with local stakeholders of LRB.	Polycentric institutional arrangements under the Federal administration are likely capable of coordinating and integrating river basin management by extending the scope of an iterative learning through participation of individual stakeholder at the lowest appropriate level.
Resolving Water Disputes via Interstate Co-Operation and Stakeholders' Engagement: A Case Study from Muda River Basin (2017) [30]	This paper highlights the current environmental and political challenges related to water resources in Kedah and Penang.	Qualitative methods are applied to find out solutions to resolve the water disputes and maximise benefit-sharing of water use using a model developed through stakeholders' engagement.	This case study can serve as an important foundation for accessing the negotiations between Kedah and Penang and fostering interactive interstate water co-operation not just in Muda River Basin but other shared watercourses.
Applying a system thinking approach to explore root causes of river pollution: A preliminary study of Pinang river in Penang State, Malaysia (2018) [31]	This study applied a system thinking approach to investigate root causes of pollution in the Pinang River.	Qualitative methods have been applied to explore the system thinking in Pinang River Management.	A causal loop diagram was produced that illustrates the relationship between the local community and the government with regards to improving the water quality of the Pinang River.
Integrating Structural and Non-structural Flood Management Measures for Greater Effectiveness in Flood Loss Reduction in the Kelantan River Basin, Malaysia (2020) [32]	This review explored the flood management in the Kelantan River Basin, Malaysia.	Reviewing government-centric top-down approach focused on flood-control technologies via structural measures.	A combination of structural and non-structural measures is the way forward for Kelantan State as it ensures that government structural measures are effectively supported by public-engaged non-structural measures.
Identification of Water Pollution Sources for Better Langat River Basin Management in Malaysia (2022) [33]	This study explored the pollution sources in the Langat River to suggest an integrated river basin management (IRBM).	Quantitative methods to find the chemical pollutions in Langat River.	The implementation of policies should be effective at the local level for pollution management, especially via the proactive leadership roles of local government for this transboundary Langat River to benefit from IRBM.

Based on the literature review, it is noted that collaboration and cooperation among the stakeholders, i.e., government, non-government, business, academia, and NGO/community sectors, are crucial for successful river basin management towards sustainable development. Therefore, this study, based on the literature review, maps the stakeholders for the Langat river basin management following the modified Penta-helix multi-stakeholder partnership on social innovation framework by Calzada [34]. The Penta-helix multi-stakeholder framework has the advantage of determining the roles and responsibilities of each stakeholder over the triple and quadruple-helix framework model to minimize their overlapping roles [26]. Forss [35] also reported that Penta-helix collaboration works well at the local level in a governance-related model for Penta-helix cooperation when there are proactive leadership roles of each stakeholder especially via citizen-driven processes. Similarly, the Penta-Helix partnership model is useful for natural resources management especially water resources management [36,37] because of its ability to bring sustainable innovations in management initiatives. The literature review also found the challenges faced by the local government in Malaysia for their proactive leadership roles towards river basin management. Man-made disasters and impacts of climate change pose uncertain threats to river basin management when cooperation and collaboration are inadequate among the stakeholders. Therefore, the effective leadership roles of institutions as well as individuals along with their commitment especially by local government are the keys to better coordination of Penta-helix stakeholders for river basin management.

Moreover, information related to the operation of water treatment plants (WTPs) along with effective technological solutions for safe drinking water supply at the household level were collected from the water treatment plant (WTP) authorities i.e., Puncak Niaga Sdn. Bhd., Sungai Semenyih WTPs Authority and Loji Rawatan Air Sg. Labu in the Langat River Basin. Accordingly, the coordinates of the nine drinking water treatment plants (WTPs) were recorded using the GARMIN (GPS, GARMIN, GPSMAP 76CSx, Kansas, MO, USA) machine to produce the map of the WTPs in the Langat Basin using the GIS software.

3. Significance of the Langat River Basin, Malaysia

Approximately 2986 river basins can be found in Malaysia, but only 189 of them are viewed as significant basins dependent on the region of the basin that is >80 km^2 [38]. IRBM has many cross-cutting concerns, thus accomplishing a sound IRBM will connect practically all the Sustainable Development Goals (SDGs) [39]. Langat is the UNESCO HELP (Hydrology for the Environment, Life, and Policy) River Basin in Malaysia [40], and distinct in its attributes because of its flow through three distinct constituencies. Langat River Basin is among the HELP basins from the 91 river basins globally, 26 river basins in the Asia Pacific region, and 3 from the south-east Asia region [41].

3.1. Jurisdiction of Langat River Basin

The Langat river basin ranges around 1815 km^2, and the river's major course is 141 km, located about 40 km east of Kuala Lumpur. It is geographically located from 02°40′152″ N latitude to 3°16′15″ N and 101°19′20″ E to 102°1′10″ E longitude with the most elevated peak at 820.8 m (2691 ft) [42]. Strikingly, about 75% of the catchment area is located on an uneven landscape with a normal slant of 6–9″ and another 25% of the region is under 6″ with a few swamps by the river [41]. The significant tributaries of the Langat River are the Semenyih, Beranang, and Labu rivers; nevertheless, around 40 smaller tributaries are flowing into Langat [43]. A few development projects are being carried out in the transboundary Langat River Basin, which shares the Selangor State (78.14%), Negeri Sembilan State (19.64%), and the Federal Territories of Kuala Lumpur (0.33%) and Putrajaya (1.90%) (Table 2).

Table 2. Percentage area of Langat River Basin among the district councils and states.

State	City/District Council	[1] Area of Langat Basin (%)	[2] Population	[2] Household
Selangor	Majlis Perbandaran Klang	35.39	842,146	201,994
	Majlis Perbandaran Kuala Langat	26.27	220,214	49,798
	Majlis Daerah Hulu Langat	3.39	1,138,198	288,508
	Majlis Perbandaran Sepang	13.09	207,354	49,005
Negeri Sembilan	Majlis Perbandaran Nilai	19.64	200,988	48,430
Federal Territory of Putrajaya	Perbandaran Putrajaya	1.90	68,361	19,511
Federal Territory of Kuala Lumpur	Dewan Bandaraya Kuala Lumpur	0.33	1,588,750	419,187
	Total	100	4,266,011	1,076,433

Note(s): Source: [1] [44]; [2] [45].

The Langat River Basin holds a population of 1,184,917 in the year 2000 with a rate of growth of 7.64% [41]. In 2013, the population grew to 4,266,011 based on the report by the Department of Statistics Malaysia [45]. Langat River is among the basin's primary drinking water sources, it provides drinking water to an incredibly significant number of people in Selangor state including VVIPs residing in Putrajaya, the central federal government city of Malaysia, which also holds the Prime Ministers' Office. Langat River Basin is among the quickest-growing regions in the nation, where a few huge socio-economic development projects have taken place or are in the process of completion [41]. Additionally, the raw water of Langat is utilized for industrial, horticultural, and transportation activities.

3.2. Changes in Land Use Pattern in Langat River Basin

Incidentally, the land use trend has had a major transformation in the Langat River Basin because of rapid development. The development areas around the basin expanded by 23.5% in 2013 contrasted with 2.4% in 1974 (Table 3). Thus, both the farming and forestry areas have reduced in 2013 in comparison to 1974, while the peat swamp and mangrove regions have radically diminished to 9.4% in 2013 compared to 25.7% in 1974. As such, the accessibility to water in the Langat area has been hampered including the loss of biodiversity. Moreover, the fast growth has additionally expanded the chemical and biological contamination of the river which requires treatment prior to drinking.

Table 3. Land use changes of the Langat River Basin, Malaysia during 1974 to 2013.

Land Use Type	1974 (ha)	%	1991 (ha)	%	2001 (ha)	%	2013 (ha)	%
Forest	52,579.7	17.9	50,906.4	17.3	45,071.9	15.4	48,285	16.5
Mangroves and Peat swamp	75,252.6	25.7	37,014.5	12.6	25,630.7	8.7	27,560.8	9.4
Agriculture	155,249	52.9	170,705	58.2	164,841	56.2	142,387.9	48.5
Developed Area	7022.8	2.4	28,510.7	9.7	51,502.8	17.5	69,056.1	23.5
Water body	3267.3	1.1	6401.5	2.2	6207.1	2.1	6009.1	2
Total	293,370.3	100	293,340.5	100	293,253.6	100	293,298.9	100

Note(s): Source: [41].

3.3. Sources of Pollution at Langat River Basin

LUAS [44] has pinpointed the areas of point sources in the Langat River Basin, Malaysia (Figure 1). There are a few industrial areas around the basin in the Nilai industrial area in the state of Negeri Sembilan. Subsequently, the release of illegal effluents in the area is a genuine contamination threat to the river based on the inadequate execution of the Environmental Quality Act 1974 and its revision with the Environmental Quality (Industrial Effluent) Regulations 2009 [2].

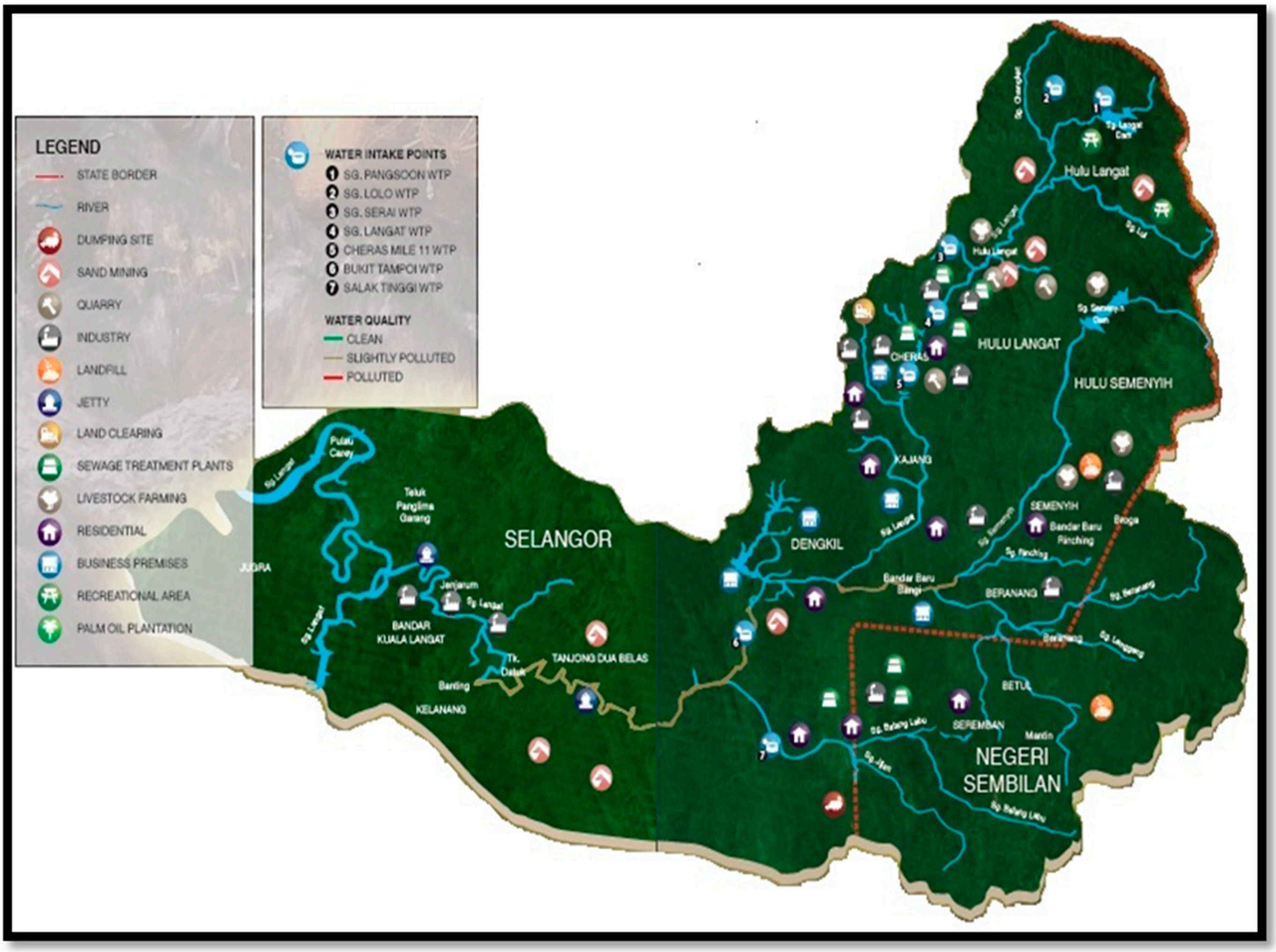

Figure 1. Location of point sources of pollution in the Langat River Basin, Malaysia [44].

The DOE in 2013 detailed that the food industry at 79% is the principal polluter of the Langat River with sewage releases contributing a further 10.8%. Even though industrial waste release decreased to 9.09% in the Langat River in 2013 contrasted with 84.09% in 2002 [42], it still remains a crucial source of chemical contamination in the river in addition to the contamination from the food industry sector. In spite of the fact that sand mining/quarry is liable for just 0.24% contamination in the Langat River [46], there are 86 sand and gravel extraction locations in the Langat Basin out of 198 extraction locations throughout the Selangor state (81 locations) and Negeri Sembilan state (5 locations). Additionally, 43 earth material extraction locations, 21 granite quarries, 2 clay pits, as well as 1 kaolin pit operational site were found in the Langat River Basin [47]. In the meantime, Aris et al. [48] revealed that the mining operations fundamentally increased the predominance of Cu, Sn, Fe, Au, etc. in the surface water of Langat River.

3.4. Impact of Climate Change in Langat River Basin

The contamination of Malaysian rivers based on climatic and anthropogenic issues is a major concern. Numerous studies have already detailed flood occurrence due to heavy rainfall in Malaysia [49–51] and the situation is worsened due to landslides into the riverbank, lack of proper drainage systems, and elevated spring tides [50,52]. Thus, flood is now the most crucial natural disaster as a result of its recurrence and degree in the 189 river basins in Peninsular Malaysia, Sabah, and Sarawak [51]. Flooding has a serious effect on 9% of land in the nation (29,720 km^2) and on 21% of the population (4.915 million) that costs the country about 915 million MYR annually with the extra financial consequential cost of 1.83 billion MYR [51]. Moreover, the frequency and intensity of the recurrence of floods have expanded fundamentally in Malaysia in light of climate change rainfall trends [53].

The quantity of flood occurrences in the Langat River basin has grown from 2006 to 2016. The highest number of floods was recorded at 85 incidents at the river basin in 2015; it was only 36 flood occurrences in 2005 [54]. In addition, 20 dangerous hill slopes have been noted in Selangor, which is in danger of landslides if nothing is carried out to maintain the slopes properly [55]. The Selangor state and Federal Territories Minerals and Geoscience Department reported approximately 1000 hill slopes with potential risk in the Klang Valley [55]. Essentially, the high tides from 21 September to 5 December 2017 at the Langat River Basin were also cause for concern which could result in severe flooding. Residential areas in Selangor, for example, Klang, Kuala Langat, Sepang, Kuala Selangor, and Sabak Bernam were expected to be in danger of flooding with tides as high as 5.5 m to 5.6 m [56]. Additionally, a few landslides were reported from 1999 to 2011 in the Langat River Basin due to the sliding/streaming of soil debris from the hills during overwhelming rainfalls, deforestation, the collapse of river banks, and retrogressive slope downfalls [2], further contributing to the contamination of the Langat River.

4. Shutdown Incidents of Water Treatment Plants (WTPs) at Langat River Basin

The Langat River Basin holds nine drinking water treatment plants (WTPs) (Figure 2) and these WTPs treat the raw water of the Langat River and its tributaries to supply drinking from the basin [57,58].

Figure 2. Water treatment plants at Langat River Basin, Malaysia.

Even though these WTPs supply treated water to Selangor, Kuala Lumpur, and Putrajaya, they were required to shut down a few times during 2006–2019 primarily due to chemical contamination found in the raw water, flood episodes, etc. For example, Sungai Semenyih WTP was closed down multiple times in 2016 as a result of odor contamination from the Nilai and Semenyih industrial zones (Table 4). In addition, floods caused a few shutdown episodes at the Sungai Langat WTP because of higher turbidity in 2012, and the basin, particularly in the greater Kuala Lumpur region, endured the most with its consumable water supply. The WTPs are not able to treat raw water when there is expanded mudflow/turbidity in the river because of floods as there will be a lot of spillover from the substantial downpour [2]. Conversely, the WTPs are also not able to treat raw water when there is a higher concentration of chemicals and circumstances such as drought, anthropogenic operations, etc. In a drought, when there is less water flow, the chemical concentration in the river increases significantly [59].

Table 4. Some shutdowns of water treatment plants (WTP) in Langat River Basin, Malaysia.

Year	WTP	Type of Pollution	Source of Pollution	Affected Area
2019 [9]	Sg. Semenyih	Odor pollution	Private sewage treatment facility in Bandar Mahkota (4th times)	Petaling district, Hulu Langat, Kuala Langat, and Sepang
2016 [1]	Sg. Langat	Odor pollution	Industrial effluent in Semantan river, Pahang mixed in Serai river.	Kuala Lumpur, Petaling Jaya, and Hulu Langat
2016 [1]	Cheras Mile 11	Odor pollution	Industrial effluent in Semantan river, Pahang mixed in Serai river.	Kuala Lumpur, Petaling Jaya, and Hulu Langat
2016 [2,3]	Sg. Semenyih	Odor pollution	Effluent from Nilai and Semenyig industrial area polluting Sg. Buah and Sg. Semenyih	Hulu Langat, Kuala Langat, Sepang, and Petaling
2015 [4]	Sg. Semenyih	Low pH, Manganese, and Ammonia	Leachate from Sanitary Landfill	Bangi and Kajang
2014 [5]	Cheras Mile 11	High Ammonia Concentration	Private Sewage Plant	Hulu and Kuala Langat
2014 [5]	Bukit Tampoi	High Ammonia Concentration	Private Sewage Plant	Hulu and Kuala Langat
2013 [4]	Sg. Semenyih	Bad Smell/Odor, High Turbidity	Leachate from Sanitary Landfill, flood	Bangi and Kajang
2012 [6]	Sg. Langat	High Turbidity	Flood/mudflow	Kuala Lumpur
2012 [6,7]	Salak Tinggi	High Ammonia Nitrogen	Chicken Farm, Industrial Effluent	Hulu Selangor, Sepang
2012 [6]	Cheras Mile 11	Diesel	Quarry	Kuala Lumpur
2012 [4,7]	Sg. Semenyih	High Ammonia Nitrogen (>7.0 mg/L)	Leachate from Sanitary Landfill	Bangi and Kajang
2012 [6]	Cheras Mile 11	High Fluoride (0.25–1.11 mg/L)	Unknown	Kuala Lumpur
2011 [4]	Sg. Semenyih	Diesel	Unknown	Bangi and Kajang
2010 [4]	Sg. Semenyih	High Ammonia Nitrogen (>7.0 mg/L)	Leachate from Sanitary Landfill	Bangi and Kajang
2009 [4]	Sg. Semenyih	Diesel	Unknown	Bangi and Kajang
2009 [8]	Cheras Mile 11	High Ammonia Concentration	Unknown	Cheras and Balakong

Table 4. *Cont.*

Year	WTP	Type of Pollution	Source of Pollution	Affected Area
2009 [8]	Salak Tinggi	High Ammonia Concentration	Effluent from Nilai Industrial Areas	Sepang
2006 [8]	Salak Tinggi	High Ammonia Concentration	Effluent from Nilai Industrial Areas	Sepang
2006 [4]	Sg. Semenyih	High Ammonia, Turbidity, Diesel	Leachate from Sanitary Landfill	Bangi and Kajang

Note(s): Source: [1] [13]; [2] [3]; [3] [60]; [4] [61]; [5] [62]; [6] [63]; [7] [64]; [8] [65]; [9] [66].

Conventional Water Treatment Method in Langat River Basin, Malaysia

The absolute capacity of the 33 WTPs in the state of Selangor is 4476 MLD (million liters per day); however, the 9 WTPs in the Langat Basin contain 1110.80 MLD structured capacity and 1329.4 MLD highest capacity to treat water [67] (Table 5). Subsequently, the structured and maximum capacities are 24.8% and 29.7% contrasted to the absolute capacity of all the WTPs in Selangor and these WTPs offer drinking water to 33% of the Selangor population [2].

Table 5. Description of water treatment plants (WTPs) in Langat River Basin, Malaysia.

WTP	Location	Water Source	Supply Area	Treatment Process	Design Capacity (MLD)	Max. Capacity (MLD)	Filter Performance (Hours)	Water Losses (%)	Water Quality Compliance (%)
Sg. Pangsoon [1]	Batu 24, Kuala Pangsoon, Hulu Langat	Sg Pangsoon	Batu 24, Kuala Pangsoon-Bt. 15, Bukit Kundang, Hulu Langat.	Conven-tional (Partial and Full WTP)	1.8	1.8 [2]	Continuous Filter	N/A	99.9
Sg. Lolo [1]		Sg. Lolo	Batu 24, Kuala Pangsoon- Bt. 15, Bukit Kundang, Hulu Langat.	Conven-tional (Partial and Full WTP)	1	3 [2]	N/A	N/A	100
Sg. Serai [1]	Batu 11, Jalan Hulu Langat, Hulu Langat	Sg Serai	Batu 9, Cheras-Bt. 13, Bukit Nanding, Hulu Langat.	Conven-tional (Full WTP)	1.7	0.9 [2]	8	N/A	99.9
Sg. Langat [1]	Batu 10, Jalan Hulu Langat, Cheras	Sg. Langat	Klang, Petaling Jaya, Kajang, Nanding, Bangi, Beranang, Cheras, Hulu Langat.	Conven-tional (Full WTP)	386.4	456	56.76	6.45	99.9
Cheras Mile 11 [1]	Batu 11, Jalan Cheras, Kajang	Sg Langat, Sg Raya and Sg Sering	Balakong	Conven-tional (Full WTP)	27	26.2	72	4.4	100
Bukit Tampoi [1]	Jalan Dengkil-Bukit, Changgan, Dengkil	Sg. Langat	Part of Kuala Langat and Sepang	Conven-tional; vertical flow	31.5	34.5	56	2.98	100
Salak Tinggi [1]	Jalan Kg Giching, Sepang	Sg. Labu	Salak Tinggi and part of Sepang	Conven-tional	11.4	5	72	10	99.9

Table 5. *Cont.*

WTP	Location	Water Source	Supply Area	Treatment Process	Design Capacity (MLD)	Max. Capacity (MLD)	Filter Performance (Hours)	Water Losses (%)	Water Quality Compliance (%)
Sg. Labu [3]	Lembah Paya, Salak Tinggi, Sepang	Sg. Labu	Sepang	Conventional	105	120	-	-	-
Sg. Semenyih [4]	Presint 19, Putrajaya	Sg. Semenyig	Kuala and Hulu Langat, Sepang, Putrajaya, Cyberjaya, Seri Kembangan, USJ and Puchong	Conventional	545	682	-	-	-

Note(s): Source: [1] [57]; [2] [63]; [3] [68]; [4] [61].

All the WTPs in the Langat Basin follow the typical coagulation water treatment approach, and the steps include air circulation, substance blending, coagulation, flocculation, filtration, and post-chemical inclusion prior to the supply reaching the end users (Figure 3). Sg. Pangsoon, Sg. Lolo, Sg. Serai, Sg. Langat, Cheras Mile 11, Bukit Tampoi and Salak Tinggi WTPs (Table 5) are managed by Puncak Niaga Sdn. Bhd.; Sg. Labu WTP, which is managed by Konsortium Air Selangor Sdn. Bhd. [68]; and Sg. Semenyih WTP, which is managed by Kumpulan Darul Ehsan Berhad [61], similarly utilize this typical technique for raw water treatment. Out of all the WTPs, the Sg. Semenyih WTP is the most significant plant providing drinking water to 1.5 million people of Selangor and Putrajaya [69].

The WTPs in the Langat River Basin utilize a typical water treatment method that is not capable of expelling trace metals and radionuclides from raw water properly [70]. Thus, a high-pressure reverse osmosis membrane technology could be applied in the WTPs to expel trace metals and a wide range of radionuclides (for example, effectiveness is >90%) from raw water; and the USEPA has recorded this technology as the Best Available Technology (BAT) and the Small System Compliance Technology (SSCT) [71] (Table 6). In addition, worldwide, the average water treatment cost (USD/m^3) for the reverse osmosis approach is the lowest contrasted with other water treatment processes, particularly in the USA, for example, 0.0002–0.0004 USD/m^3 [72], though the average cost of ion trade and lime relaxing is in the scope of 0.08–0.21 USD/m^3 in the USA [73]. Essentially, the average typical water treatment cost in Malaysia is 0.53 USD/m^3 [74].

Table 6. Water treatment technologies approved by the USEPA for radionuclides removal [71].

Treatment Technology	Designation	Customers Served (SSCTs)	Treatment Capabilities				Source Water Considerations	Operator Skill Required
			Radium (Ra)	Uranium (U)	Alpha (G)	Beta/Photon (B)		
Ion Exchange (IX)	BAT and SSCT	25–10,000	√	√		√	All ground waters	Intermediate
Point of Use (POU) IX	SSCT	25–10,000	√	√		√	All ground waters	Basic
Reverse Osmosis (RO)	BAT and SSCT	25–10,000 (Ra, G, B) 501–10,000 (U)	√	√	√	√	Surface waters usually requiring pre-filtration	Advanced

Table 6. *Cont.*

Treatment Technology	Designation	Customers Served (SSCTs)	Treatment Capabilities				Source Water Considerations	Operator Skill Required
			Radium (Ra)	Uranium (U)	Alpha (G)	Beta/Photon (B)		
POU RO	SSCT	25–10,000	√	√	√	√	Surface waters usually requiring pre-filtration	Basic
Lime Softening	BAT and SSCT	25–10,000 (Ra) 501–10,000 (U)	√	√			All waters	Advanced
Green Sand Filtration	SSCT	25–10,000	√				Typically ground waters	Basic
Co-precipitation with Barium Sulphate	SSCT	25–10,000	√				Ground waters with suitable water quality	Intermediate to Advanced
Electro dialysis/Electro dialysis Reversal	SSCT	25–10,000	√				All ground waters	Basic to Intermediate
Pre-formed Hydrous Manganese Oxide Filtration	SSCT	25–10,000	√				All ground waters	Intermediate
Activated Alumina (AA)	SSCT	25–10,000		√			All ground waters	Advanced
Coagulation/ Filtration	BAT and SSCT	25–10,000		√			Wide range of water qualities	Advanced

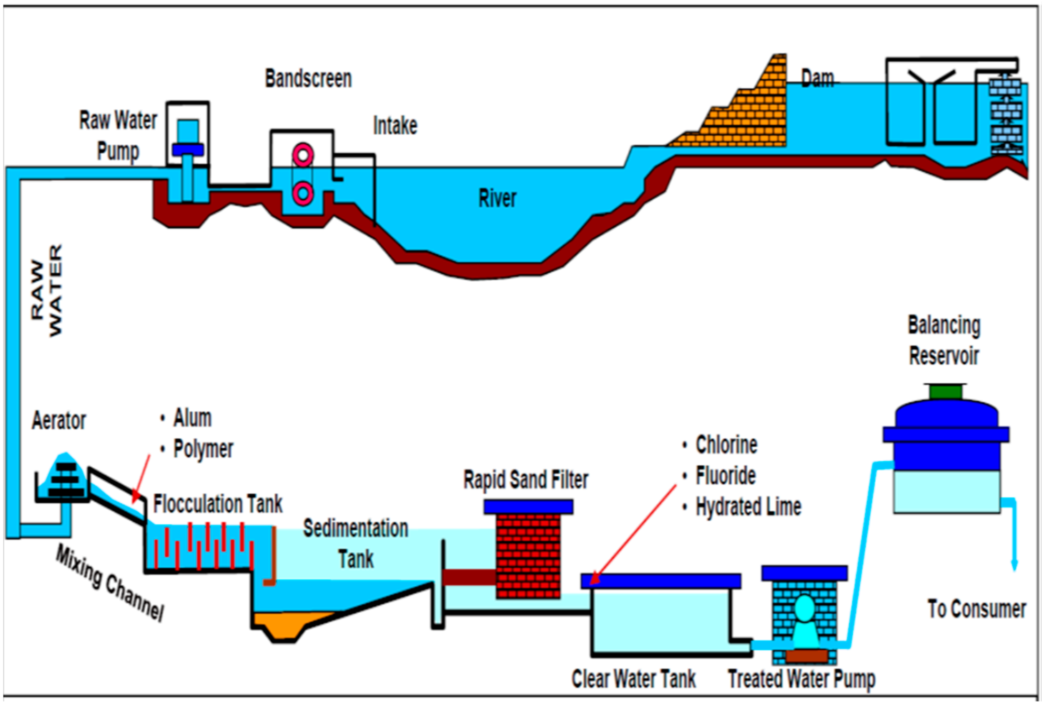

Figure 3. Conventional water treatment plants at Langat Basin, Malaysia [74].

In theory, RO is able to remove about 0.0001 μm molecule size and many of the metal particles measuring 0.0001–0.001 μm [70] in the water such as Al 0.000143 μm [75]. Consequently, the typical water treatment technique at the Langat River Basin plants cannot remove the Al concentration completely. Plant specialists add aluminum sulfate in the treatment of raw water for sterilization due to the frequent transformations of turbidity in raw water in tropical climates. Thus, metal concentration such as Al concentration in the plant's treated water and the household's supply water needs to be resolved to examine the effectiveness of the plants in eliminating the metal particles and the water contamination in the water pipeline distribution process. The RO system needs higher power and its filtrated water yield efficacy is less than other innovations; notwithstanding, with the progression of the membrane technology, the RO cost will also reduce. In 2006, a RO unit cost (300–1000 USD), ion exchange (400–1500), and distillation (300–1200 USD) was a lot more compared to the price in 2017 [72]. In 2017, the RO's unit cost was 150–300 USD, ion exchange was 50 USD, and distillation was 150–250 USD [76].

River contamination is not just an issue in Malaysia; researchers and policymakers globally are considering river water quality since it is the primary source of drinking water. In addition, all around, scientists and policymakers are worried about the nature of the waterway water because at present, it is the significant wellspring of drinking water. Incidentally, the commitment of the stakeholders, for example, GO-NGOs, the private sector, and the community-based organizations in river management has been considered the best methodology.

The entire WTPs in Langat Basin utilize the typical water treatment strategy and the customary molecule filtration technique at the household level can eliminate a molecule size of about 0.5 μm [77], while the Pb particles and other metal particles could be <0.000174 μm [70,78,79]. On the other hand, the particulate elimination efficacy using reverse osmosis (RO) film innovation is 0.0001 μm [79]. In addition, H20 established that the thin film composite RO membrane technology has the most noteworthy metal elimination efficacy from the water supply, for example, Arsenic 94%, Cadmium 98%, Chromium 88%, Lead 99% [70].

5. Policy, Institute, and Expert's Nexus for Integrated River Basin Management

Although strategic policies, plans, institutions, expertise, and visionary organizations exist in Malaysia, the integration and execution of these policies and institutions are not sufficient due to the lack of constitutional support from the government to empower the main authority, the Department of Irrigation and Drainage Malaysia, in managing the water resources. The limitations of river basin management are a major issue given the fact that the majority of the staff only have mono-disciplinary training. Consequently, there are insufficient capacity-building programs of water resource management agencies and multi-stakeholders as well as inadequate participation of the stakeholders. Mokhtar et al. [22] determined the inadequate coordination among the stakeholders for the integrated water resources management in the Langat River Basin.

Inefficient endeavors from the individual level could be a direct result of inadequate training of mid- to lower-ranking officials. Quality assurance (QA) and quality control (QC) are not assured in most of the steps in the management of the Langat River Basin. The stakeholders as well as the individuals are waiting for others to tackle the issues. This individualistic perspective impedes the recognition of the right stakeholders or organizations to deal with the Langat River Basin management and the contamination issue. The differences in political interests between the state and federal government may have additionally been an essential issue in the execution of policies [80].

The lack of cooperation from the stakeholders because of deficient iterative social adapting has just been accounted for in the Langat River Basin Management; in any case, the federal government is equipped for polycentric planning to organize the different stakeholders [30]. The Selangor Water Management Authority (LUAS) is the primary authorized organization of the Selangor State Government to oversee water bodies in

Selangor which includes the Langat River which gives drinking water to about 33% of the populace in the state [42,81]. Langat River Basin shares four distinct constituencies of Selangor state, the Federal Territories of Kuala Lumpur and Putrajaya, and Negeri Sembilan state. As such, river management, especially contamination control, has been a huge challenge. The Department of Environment (DOE) Malaysia screens the quality of the water from the river, which includes the Langat River; nevertheless, there is no particular agency such as LUAS in Negeri Sembilan and Federal Territories. Thus, river management particularly concerning contamination has been crucial since the rivers are located in a particular state or states and the administration falls under the state's responsibility. Consequently, Mokhtar et al. [22] claimed that even though there are numerous policies, institutions, and expertise in Malaysia on river management, LUAS could not coordinate the management of the Langat River Basin among all its stakeholders sufficiently. Thus, the leadership function of the local authority in view of the Local Government Act 1976 can better oversee the rivers in Malaysia including the Langat River Basin through viable execution of water policies such as the national agenda of water sector transformation 2040 (WST2040) and creating workable partnerships with GO-NGOs, businesses, the scholarly world, and civil agencies (Figure 4).

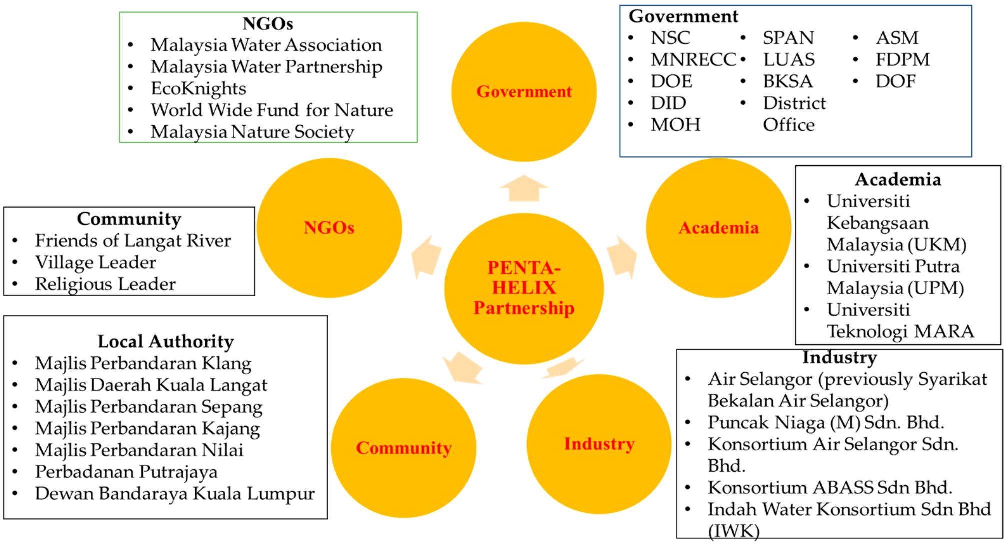

Figure 4. PENTA-HELIX stakeholders at Langat River Basin Malaysia. Note: Government: NSC (National Security Council). MNRECC (Ministry of Natural Resources, Environment and Climate Change). DID (Dept. of Irrigation and Drainage). DOE (Dept. of Environment). MOH (Ministry of Health). SPAN (National Water Services Commission). LUAS (Selangor Water Management Authority). BKSA (Badan Kawal Selia Air Negeri Sembilan). ASM (Academy of Sciences Malaysia). FDPM (Forestry Dept. of Peninsular Malaysia). DOF (Dept. of Fisheries).

The Department of Environment (DOE) Malaysia claimed that 17% of electronics/metal, 50% of paper, 33% of textiles, and 25% of food industries along the Langat River Basin do not comply with the Environmental Quality Act (EQA 1974) as they continue to release effluents into the river [62]. The DOE and MOH (Ministry of Health Malaysia) are accountable for guaranteeing the standard and quality of the river and the treated water. As such, an efficient execution of the Environmental Quality Act (EQA) 1974 and the Environmental Quality (Industrial Effluent) Regulations 2009 in relation to chemical release into the environment is lacking [2].

The Academy of Sciences Malaysia was set up to deliver better policies and to make plans for water and various segments to assist the policymakers as well as the government. Essentially, the Malaysian Industry–Government Group for High Technology (MIGHT) is advancing the public–private partnership to align government policies and strategies. The Malaysian Foresight Institute is additionally helpful in the integration and execution of the government's policies and plans. The Foresight Institute has just utilized suitable techniques to discover new trends in the fields of education, health, technology, etc. to assist in policy-making for the government [82].

The National Integrated Water Resources Management (IWRM) Plan (Volume I and II) set up by the Academy of Science Malaysia is a phenomenal guide to water resource management in Malaysia followed by the National Agenda of Water Sector Transformation 2040 (WST2040) from the year 2020 to 2040. This plan includes water resource management in line with the national economic, food, environment, health, and energy policies as well as advocacy, awareness, and capacity building to accelerate the implementation of IWRM. Moreover, the Integrated Water Resources Management Framework emphasizes aspects of social improvement, monetary advancement, and environmental assurance. Nevertheless, the general model of IWRM concentrates on value by empowering the environment (policies, enactments); enabling environmental sustainability using institutional models (between local and central government, public and private river basin management), and monetary efficacy through management (information, evaluation, assignment, instrument) and a balance of 'water for living and water as an asset' by investing in water infrastructures [83,84]. In addition, the Academy of Science Malaysia announced a 15% increment in consumable water demand (9291 MCM/year) by the year 2050 compared to the 5277 MCM/year water demand in 2010 [85].

Mokhtar et al. [22] recommended polycentric institutional strategies under the federal government for better integration and coordination in the Langat River Basin Management. In addition, polycentric institutional strategies could be successful through the potential utilization of iterative learning procedures. Thus, this methodology could more readily manage the institutional difficulties of versatility and ecosystem-based administration in the Langat River Basin. According to Mokhtar et al. [66], iterative learning would be able to guarantee better cooperation among the stakeholders, even at the lowest suitable level. There should likewise be an iterative learning component inside the inter-organizational network for Integrated Langat River Basin Management as there are a few administration segments on specific rules and agencies (Table 7).

Table 7. IRMB laws and agencies for Langat River Basin; state agency (S), federal agency (F).

Management	Statute	Agency
Pollution control	Environmental Quality Act 1974 Drinking Water Quality Standard Street, Drainage and Building Act 1974 Local Government Act 1976 LUAS Enactment 1999 Water Services Industry Act 2006	D. of Environment (F) D. of Health (F) Local government (S) Local government (S) LUAS (S) Water Commissioner (F)
Catchment area	National Forestry Act 1984 LUAS Enactment 1999 Local Government Act 1976	D. of Forestry (S) LUAS (S) Local government (S)
Land use drainage	Land Conservation Act 1960 Town & Country Planning Act 1976 Local Government Act 1976 Drainage Works Act 1954	Land Office (S) Local government (S) Local Government (S) DID (F)
Flood control	Ministerial Function Act 2008 LUAS Enactment 1999	DID (F) LUAS (S)
Water services	Water Services Industry Act 2006	Water Commissioner (F)

Note(s): Source: [86].

5.1. Raw and Drinking Water Quality of Langat River Basin

The typical coagulation water treatment technique relies upon the physiochemical qualities of raw water. The physiochemical qualities of raw water in the tropical atmosphere are extremely vital in light of its continuous changes because of too much precipitation, unexpected flash floods, dry seasons, landslides, etc. Nevertheless, the experts in water treatment plants mainly rely upon the assurance of physiochemical fixations to blend chemicals in the raw water for the purpose of treatment. Thus, the incessant checking of raw water is extremely fundamental for the typical water treatment technique in light of the regular changes. However, two hour intermittent raw water samplings are not adequate to decide on the physiochemical attributes for treatment purposes. Accordingly, at times, the typical treatment strategy cannot keep up with the treated water quality standard recommended by the World Health Organization (WHO) and the Ministry of Health Malaysia (MOH).

The state authority and concessionary organizations in Malaysia, since the privatization operation of 1987, are accountable for the supply of drinking water at the household level. In spite of the fact that the water is inspected regularly in the drinking water treatment plants before going to the household level through the pipeline, there is potential for natural and chemical pollution in the water supply while being transferred and stored. Thus, local authorities dependent on its mandate can more readily facilitate among the Ministry of Health, Department of Environment, SPAN (water controller), WTP authority, and SYABAS (currently Air Selangor—water supplier) for supervising raw and drinking water at the Langat River Basin. The general water quality index (WQI) of the Langat River and its tributaries demonstrated that a greater part of the tributaries is in Class III [28], which shows that intensive treatment is required before drinking [87].

Despite the fact that the Ministry of Health Malaysia (MOH) does not screen for aluminum (Al) in the river water, it does screen for the degree of Al in treated water and the standard fixed level for Al in drinking water is 200 μg/L [88]. Shockingly, there is just one study on Al concentration in the supplied water from the Langat River Basin, for example, 148 ± 76 μg/L [89]; however, a high Al concentration of 990 ± 1520 μg/L [90], and 210 ± 41.50 μg/L [91] was documented in the drinking water in Johor state, Malaysia. In addition, certain researchers have discovered a relationship between Alzheimer's disease and consuming drinking water with Al over a period of time [92]. Correspondingly, a higher concentration of Pb was documented at 32.5 μg/L in Bandar Sunway [93], basically as a result of corrosion in the piping systems of the old structure. Moreover, the Pb concentration in Bandar Sunway was over the highest limit for the standard of drinking water quality at 10 μg/L as proposed by the Ministry of Health Malaysia (MOH), World Health Organization (WHO), and European Commission (EU), and 15 μg/L as recommended by the United States Environmental Protection Agency (USEPA). Research discoveries of late on water supply systems demonstrate that lead (Pb) is a critical contaminant of grave concern with toxic exposure happening from drinking water [94–96]. In any case, past examinations on arsenic (As), cadmium (Cd), and chromium (Cr) in the drinking water from the Langat River Basin did not cross the limits recommended by the MOH.

Sewage treatment plants, small and medium businesses, residential zones, townships, palm oil plantations, and companies along the downstream of the Langat River Basin are the main sources of Bisphenol A (for example, 1.3 to 215 μg/L) in the raw water. Hence, it might be liable for the endocrine disruption in people in the Langat Basin area, although, in the tap water from Langat River Basin, the concentration of BPA was extremely low, for example, 3.5 to 59.8 μg/L [97]. Correspondingly, individuals are likewise aware that tap water is not totally clean and may comprise microorganisms even though the water is treated in the plants prior to reaching households in the Klang Valley, Malaysia. Likewise, the tap water is chlorinated before reaching the houses. Subsequent to boiling, a concentrated degree of chlorine in the water may represent a huge medical problem, with obscure signs and manifestations [98]. In addition, the Ministry of Health Malaysia in 2002 detailed that in some states in Malaysia, the fluoride concentration in the drinking water crossed the Malaysian drinking water standard because of the synthetic fluoridation of drinking water and it led to high frequencies of dental fluorosis in the individuals [99].

Constructed wetlands in the Langat River Basin would help reduce water contamination from effluent releases by industries. Putrajaya Lake in the Langat River Basin is one of the 32 Ecohydrology Demonstration Sites of UNESCO-IHP Ecohydrology Program (EHP) internationally since 2010 and has been designated as an Operational Demonstration Site. It is the first man-made wetlands in Malaysia and the largest freshwater wetlands in the tropics at 600 hectares [26]. Then again, the Hybrid off River Augmentation System (HORAS) venture was set up for execution by the Selangor state government to satisfy the water needs over the dry seasons. The first HORAS venture (HORAS 600) is presently under development. When it is finished, it will be able to supply 600 million liters of water daily (MLD). The second HORAS venture (HORAS 3000) will be able to provide 3000 million liters of water daily (MLD) [100]. Stormwater could be a significant resource if it is satisfactorily treated [101]. As such, the developed wetlands could be helpful for stormwater maintenance and purification. Likewise, stormwater ought to be treated by the wastewater treatment plant (WWTP), and the management of stormwater ought to consider solid waste management because of its overflow into the water body. Thus, there ought to be appropriate dumping locations for solid waste.

5.2. Global River Basins

There are 263 transboundary river basins globally covering approximately 50% of the Earth and the incredible five river basins including the Congo, Niger, Nile, and Zambezi river basins share boundaries with nine to eleven nations [102]. In addition, thirteen river basins share five to eight riparian countries. Even though 145 countries involving 40% of the global populace [103] are living inside these 263 transboundary river basins, the political limits of twenty-one nations are completely inside these international basins. As such, the Danube River drains through the region of eighteen countries in Europe [86] and it has a practical basin management structure; in any case, the greater part of these transboundary river basins does not have a sufficiently cooperative administration system [103,104].

The International Center for Water Cooperation (ICWC) contended that the harmonious and peaceful settlements among neighboring nations and their growth mainly rely upon transboundary river management [103]. In any case, thirty-seven transboundary water management clashes have been settled since 1948, even though around 295 transboundary river management memorandums were achieved from 1948 to 2015 [105]. Water shortage and a lack of a proper water management structure could have likewise created clashes between the states and regions. UNESCO [106] claimed that 158 river basins out of a total of 263 transboundary river basins do not have a proper framework for river management. Even though 105 river basins as well as river management institutions share more than three riparian states, only 20% of the river basins have multilateral water management arrangements. The modest number of bilateral and multilateral water management arrangements by those involved demonstrate the lack of potential shared advantages because of the absence of strategies, political will, and resources to oversee the shared water resources [106].

Some Best Practices of River Basin Management

Danube River Basin, Europe: Danube River Basin Management by the European Union is among the most commendable river basin management globally as 19 nations share the basin with over 81 million populations of various cultures. The International Commission for the Protection of the Danube River (ICPDR) under the EU is liable for the sustainable and fair utilization of surface and groundwater in the basin. ICPDR and professional management groups, hydrology, and financial task groups manage the development operations at the basin and adhere to the Danube River Protection Convention for the execution of such operations involving the various stakeholders [107].

Murray-Darling River Basin, Australia: Internationally, the Murray-Darling River Basin, Australia (MDBA) is the pioneer river basin authority under the Water Act 2007; the basin shares four states and federal territories in Australia. The Murray-Darling River

Basin Authority (MDBA) is an independent and authorized organization according to the direction of the government. MDBA is liable for sustainable water resource management and development at the basin [108].

6. Proactive Leadership Roles of Local Authority at Langat River Basin

In the Langat River Basin, proactive and successful leadership roles by the local authority are a crucial prerequisite for an integrated and holistic Langat River Basin management, particularly for the safety and availability of the drinking water supply to the household level. To be proactive, four components, namely mandate, financial, human resource, and support are needed for the local authority. At the same, the local authority has the full direction to supervise the rivers and drinking water taken from the Langat Basin under the Local Government Act 1976.

There are additionally money and human resources with the local authority, but the finances are lacking since there is insufficient training of the lowest ranked staff to improve the capacity to perform various tasks and take on a proactive leadership role. Nevertheless, the lack of joint effort among the various stakeholders gives rise to critical issues in managing the Langat Basin by LUAS in collaboration with related organizations, including the DID, DOE, MOH, etc. However, the local authority could do a better job by organizing the various stakeholders' platforms and utilizing the PENTA-HELIX partnership framework by networking with private and public sectors as well as the civil sector to manage and monitor the quality of raw and drinking water.

STEM (science, technology, engineering, mathematics) and SSH (social science and humanities) data on quality assurance (QA) and quality control (QC) will assist in producing a better strategy while refreshing existing policies with the current database. A compelling QA and QC at numerous levels will guarantee the exactness and precision of information and data. Subsequently, individuals will get the best verifiable information which will impact and rouse them to act right and to take the lead in carrying out beneficial work by utilizing their own intelligence. In spite of the fact that the leadership position of the local authority is vital for the administration, nonetheless, without framing a multi-stakeholder platform and without having expertise from various segments, for example, STEM and SSH, river and drinking water management at the Langat Basin will stay fragmented. Thus, the accompanying three-finger, mentor–mentee, multitasking, and mimicking concepts may cause people to be proactive, away from their complacent state, and carry out leadership functions.

6.1. Three-Finger Concept

Individuals generally reprimand others for not completing any task effectively. Thus, the question in this case would be "who do we blame?" for not carrying out the obligations and duties. Furthermore, who will take on the position of leadership in finding solutions related to river basin management and accomplishing the SDGs? At the point when individuals point their index finger at others for not carrying out their responsibilities and obligations effectively, the remaining three fingers—center, ring, and little finger—point at them. Therefore, it implies that individuals ought to carry out their obligations and duties and be fearless to take on a position of leadership to manage tasks and roles within their domain before attempting to blame others for not doing their jobs.

6.2. Mentor–Mentee Concept

Officials and individuals at the local, state, and federal levels ought to be sufficiently courageous to take on the leadership positions. As per the degree of the individual, he/she should create a formal or informal team in the area of environmental management in his/her neighborhood or favored area and get followers to support the mentee so as to stay dynamic in river basin management. The work priority to deal with river management or the environment ought to rely upon the local team/committee's ability and capacity. The team ought to embrace and adapt sustainable river or environment management methodologies for use at the local level and seek help from the closest research/scholarly establishments. The great thinking of the team/committee, particularly the individuals, will motivate others to cooperate as well. Thus, mentors should have successors to proceed with the work development when they retire.

6.3. Multitasking Concept

Individuals or officials should be multitasking to carry out multi-levels of management tasks. Thus, individuals ought to be engaged at the neighborhood-level administration committee in addition to his/her main job. He/she can join NGOs to share his/her capability in improving the welfare of the general public. Subsequently, upon retirement from one's primary job, the individual need not rot at home but rather be an active member at the local level of environmental management. There ought to be preparation, training, and learning in changing the behavior of a person to be agreeable, community-oriented, and committed. Aristotle expresses that virtues are habits and they are manifested in action [109]. Likewise, Durant [110] states that we become what we repeatedly carry out; thus, greatness is not a demonstration but rather a habit. Therefore, the act of performing various tasks linked to environmental management will be changed into an extraordinary habit.

6.4. mimiC Concept

The concept of 'mimiC' depends on an individual's capacity to duplicate the best administration practices (Figure 5). The 'm' in 'mimiC' represents the execution of these management practices with the goal of learning and adapting them to fit in the local culture. The 'i' in mimiC represents the implementation of these practices by the individual and 'm' additionally represents the monitoring of the practices alongside 'i' which represents the improvement of the present practices. Notwithstanding, the capital 'C' represents 'change' and this 'C' represents the person who has the capability and capacity to learn and adapt to the management practice changes.

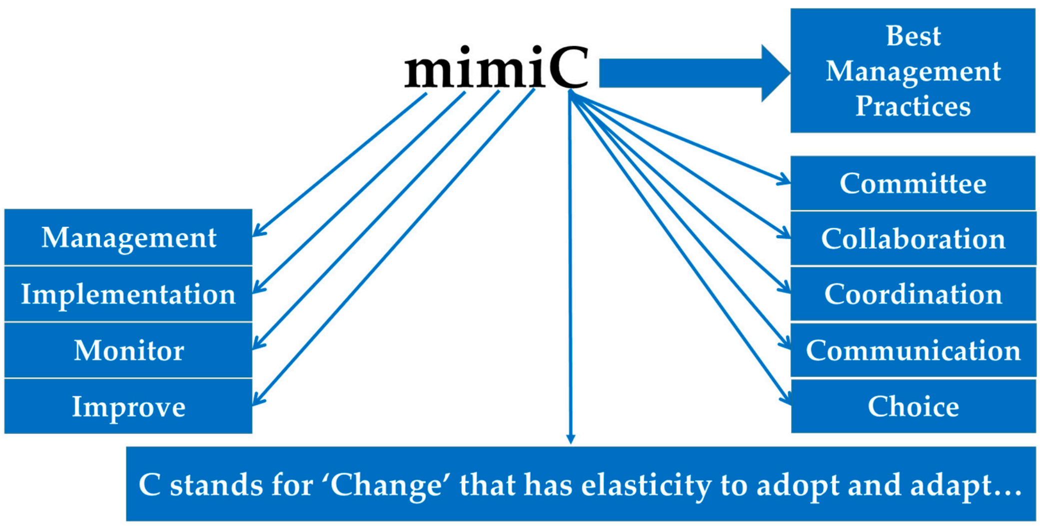

Figure 5. Dynamic perspectives of individual for IRBM.

7. Conclusions and Recommendation

Holistic and integrated Langat River Basin management (ILRBM) depends on the successful implementation of policies at the local level because many beautiful policies already exist in Malaysia along with experts and institutions. Langat is a transboundary river, so the coordination among the local authorities and district offices are very crucial for effective Langat River Basin management due to their mandate in policy implementation as well as revenue generation from the natural resources such as land, water, and forest, respectively. Therefore, the proactive leadership roles of local government officials along with the effective collaboration and cooperation among the Penta-helix multi-stakeholders must exist in real-time decision-making for river basin management. Moreover, the decision-making of local government officials both during the disaster and normal periods should be based on validated data and information from science and technology as well as social science and humanities disciplines; and it should incorporate the technologies such as artificial intelligence for the early warning system. Thus, the Integrated Langat River Basin Management must adhere to the National Agenda of Water Sector Transformation 2040 (WST2040) to accelerate the implementation of the integrated water resources management (IWRM) plan due to its detailed data to speed up the accomplishment of sustainable growth in Malaysia through better execution of water policies.

The capacity building of the local government officials along with other stakeholders can be enhanced using the customized training module produced via the Malaysian National Water Sector Transformation (WST2040) project, and the capacity building will assist them in ensuring quality assurance and quality control at different levels to screen the related stakeholders accountable for water resource management and safe drinking water supply at the household levels. The training alongside creative and innovative key performance indicators (KPIs) will empower them to coordinate with the river polluters, including small and medium enterprises (SMEs), to inspire and bind them legally to eliminate river contamination. Moreover, to prevent shutdowns of water treatment plants (WTPs) and to guarantee safe drinking water supply at the household level, reverse osmosis (RO) water treatment mechanism rather than the present typical coagulation technique would be successful, as based on the United States Environmental Protection Agency (USEPA), it can eliminate contaminants such as radionuclides and metals > 90% from the treated water. On the other hand, the RO filtration technique can be introduced at the house's tap and maintained at a more affordable moderate pond sand filtration at the WTPs, as treated water pollution is apparent in the water pipeline from the WTPs to the households. Subsequently, the introduction of the tow-layer water filtration method at the Langat Basin will be able to guarantee the achievement of the Sustainable Development Goals 2030 (for example, Goal 6.1: By 2030, to accomplish universal and equal access to safe and reasonably priced drinking water for everyone), as well as to reach a healthy living goal for humans. Likewise, safe drinking water will propel Malaysia to achieve its National Transformation to be one of the top 20 countries internationally.

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