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Successful Approaches to Integrated Water ResourcesManagement: A Mini Review

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ABSTRACT

River basins must be handled in a comprehensive and integrated way. To achieve that, Integrated River Basin Management (IRBM) is a strong concept that will increasingly win discussions on natural resource management. IRBM focuses on the integration and coordination of policies, programs and practices. It focuses on problems relating to water and rivers. It advocates for improved skills and increased financial, legislative, management and political will. Many developed countries have expanded strongly functional and stable institutions for IRBM. These structural models have developed through the years, and are being gradually imposed and encouraged by policymakers and funders in developing countries. The main goal of this research is to identify and combine the main goals, concepts, effective practice examples and lesson learned of Integrated River Basin Management that emerged from the best practices management of River Thames in United Kingdom, European Unions' Water Framework Directive, IWRM Canada and Malaysia. This research's methodological approach compares the implementation structure of IWRM in four countries. The countries were chosen based on their numerous efforts in the field of water resource management. This is a practical water management framework focused on a holistic view of society's goals integrated into good governance and sustainable development concepts. It also explains the advantages of expanding the idea behind IWRM core concepts.

Keywords: Integrated water resources management; sustainable management; water resources, water governance

INTRODUCTION

Rivers have played a vital role in shaping and influencing the nation and the cultures of its people since civilization began. Almost all megacities worldwide are located beside a river. River as the earth's natural resources as the gift of God has provided transportation means, helped create ports and cities, opened up the hinterland, provided life for riverine citizens, irrigated the land, and created hydropower. However, many rivers are impaired by pollution and degradation, which reduces their capacity to offer various benefits to the surrounding populations as they were before. Owing to rapid urbanization, population development and economic forces, these megacities worldwide face rising water problems such as water shortage, water supply destruction, and climate-related threats (Abshirini & Koch 2016; Anderson et al. 2019; Delipınar & Karpuzcu 2017; Fang & Jawitz 2019; Hingray et al. 2015). What better way to solve this than to manage water resources effectively and efficiently. Since the regulation of water started during the earliest civilization, its complexities of managing water governance has led to the growth of IRBM (Brandeler et al. 2019). IRBM combines the biotechnological, biological, technological, social and political sciences for the preparation and execution of natural resource management activities (Delipınar & Karpuzcu 2017).

This paper reviews good operating practices of water resources management by western developed countries and also by South East Asia developing country that proves to produce successful results and outcomes. Good water governance will achieve successful water resource management, taken into account its key elements including equity, quality, sustainability, environmental and economic stability, stakeholder participation and empowerment, and responsiveness to socio-economic development needs (Bagheri & Babaeian 2020). As this paper addresses the problem, water conservation itself must also be equally integrated, without compromising economic and social wellbeing for the efficiency of the environment.

SUCCESSFUL APPROACHES TO WATER RESOURCES MANAGEMENT

Water Resources Management is currently implemented at various levels in various regions of the world. The United Nations states that Water Resources Management and Integrated Water Resources Management (IWRM) is

an empirical term focused on practitioners' experience. While several decades have passed since Mar del Plata's first world water conference in 1977, this concept has been the focus of intense debate only following Agenda 21 and the World Summit on Sustainable Development in Rio in 1992 (UN Water 2013). The Dublin Principles are the principles adopted by the IWRM at the 1992 International Water and Environment Conference in Dublin, Ireland (Dublin Principles 1992). The control of water supplies also involves the management of water hazards, including flooding, drought and pollution. Water security is one of the objectives of water resources management. Coupled with the rapid increase and urbanization of the global population, a water protection route is impossible to predict and prepare. This is because of the weather and climate uncertainty. Capacity, adaptability and flexibility need to be improved for the future planning and management of water supplies. IRWM approach focuses on three pillars under the Global Water Partnership, which are appropriate policies, strategies and legislation for the development and management of sustainable water resources, establish an operational structure to enforce programs, strategies and legislation and to develop the management instruments needed to carry out the task by the associated institutions (Jønch-Clausen 2004). Global Water Partnership also emphasizes that the art of IWRM is the selection, adjustment and application for a particular situation of the right mix of tools. Agreement on goals and timescales is the key to progress. It can be applied progressively, in terms of regional reach and reform sequencing and timing. Measurements scope, time and content can be adjusted based on experience. It is necessary to remember that the cycle of transition is unlikely to be swift in creating a plan and a mechanism for transition.

For policy-making and planning, it is important to consider different uses of water and the range of people's needs for water to achieve an integrated approach. Water planning and the management should be given a voice in policy and priority areas, while the consequences of water supplies, including the two-way relation between macroeconomic policies and water production, management and usage, should also be addressed. The decision on water at local and basin levels should be taken or at least should not contradict the achievement of larger national goals and the implementation of water planning and policies in wider social, economic and environmental goals (Al-Jawad et al. 2019; Palmer & Munnik 2018; Zinzani & Bichsel 2018). River restoration has also been internationally recognized recently, as an alternative way to safeguard ecosystem health and water quality (Funk et al. 2013; Kurth & Schirmer 2014; Wortley et al. 2013). The increasing number of restoration initiatives worldwide have been brought on by increased support for restoration projects in different countries through institutional changes in government policies (Kurth & Schirmer 2014; Wortley et al. 2013).

This section will discuss how the River Thames in United Kingdom, the European Union, Canada and Malaysia developed, produced and complete its river management plan that gained the government support. The plan was successfully implemented and integrated to address the river remediation goals in a sustainable manner.

RIVER THAMES

The story of success in London, United Kingdom has shown the efficacy of river management in the world, which in 1957 could turn the once dead Thames River into one of the world's cleanest rivers (Francis et al. 2008; Patil 2019). River Thames has undergone significant remedial measures, followed by improved water quality. Here are the important key points for the successful history recovery of the Thames River.

ESTABLISHMENT OF THE RIVER THAMES WATER POLLUTION RESEARCH LABORATORY

In the mid-20th century, the public was very involved in the quality of water in the Thames estuary. The government established a committee, led by Professor Pippard, in 1951 to investigate the impact of the various discharges on the sea quality. The Committee recognized that a detailed scientific study of water quality was required before recommendations on the necessary remedial steps to make changes could be made. The Water Pollution Research Laboratory 1964 conducted the research laboratory led by the Thames Survey Committee. It also identified several sources of pollution within the estuary and estimated each contribution to the total pollution load. The Pippard Committee recommended to the extent that water is no longer troubling public nuisance that improves water quality. Most nuisance was sulphide hydrogen smell. The Water Pollution Research Lab study found out that sulphide hydrogen will not formed when dissolved oxygen or nitrate was detected in the water. However, there is no chemical data to support the findings (Tinsley 1998). The indicator of high dissolved oxygen concentrations in the river was measured by the presence of a diverse fish fauna (Richardson & Soloviev 2021). The Committee also considered the need to further enhance water quality so that migratory salmonids could be transported, but found that the cost would significantly outweigh the benefits. After identifying the water quality target in the estuary, the Committee recommended actions that would be required to achieve the target. These included improving the main sewage discharging into the estuary (Tinsley 1998).

THE ROYAL COMMISSION'S COMMITMENT IN ENVIRONMENTAL POLLUTION

In the early 1970s, pollution in British estuaries and coastal waters was the focus of the Royal Commission of Environmental Pollution. It recommended exclusion from releases of toxic and non-biodegradable substances. The Pollutant Control Act of 1974 introduced a new organization named the Thames Water Authority, responsible for regulating water quality and managing London's leading

water treatment. Consequently, this newly created body was primarily entrusted with the analysis of the findings by the Royal Commission (Tinsley 1998).

SETTING UP WATER QUALITY OBJECTIVES AND CONTROL

The Thames Water Authority has undertaken to integrate the Royal Commission's recommendations into the Thames Estuary Water Quality Management Plan. Table 1 indicates the water quality management, where the estuary was initially divided in four reaches with a variety of water quality goals and guidelines developed for the concentration of the dissolved oxygen. The requirements were focused on dissolved oxygen concentrations in water as the most significant source of contamination was the release into the estuary of biodegradable organic matter and oxidizing ammonia, mainly from water treatments (Tinsley 1998).

TABLE 1. The reaches of River Thames water quality goals

The reaches	Water quality goals
Teddington to Barnes	Suitable for fish migrating, water is available after advanced treatment for drinking supply
Barnes to London Bridge	Suitable for fish migrating and the absence of anaerobic interference
London Bridge to Canvey Island	Suitable for fish migrating and the absence of anaerobic interference
Canvey Island to Seaward Limit	Quality should be adequate for all stages of marine life.

Souce: Tinsley (1998)

BUDGET ALLOCATION TO FINANCE POLLUTION COSTS

Surveys had taken place in different parts of the estuary and showed a minimum level of oxygen at about 28 km below London Bridge during the summer. Oxygen was recorded in various locations during the year. It was proposed that conformity with the various water quality requirements for dissolved oxygen in the estuary could be done by measuring the dissolved oxygen content, defined as a critically chosen site. The emission budget for the estuary was then defined at this crucial level in relation to the dissolved oxygen concentration. A way to divide the present budget between numerous pollutant inputs and a mathematical model was created, using the boundaries of different source releases that can have a crucial effect on the amounts of oxygen (Tinsley 1998).

EUROPEAN UNION: WATER FRAMEWORK DIRECTIVE (WFD)

The Water Framework Directive (WFD) is an aspiring piece of water regulation enacted by the European Union (EU). A structure for water management and environmental protection based on a river basin planning principle is the Water Directive developed by the European Union and still named as the European Union's most ambitious and comprehensive piece of environmental legislation to be implemented in the EU (Perni et al. 2020; Voulvoulis et al. 2017; Prieto 2009). The Community action framework for water policy lays down the European Directive on 23 October 2000. This framework presents the comprehensive strategy towards protecting, improving and utilizing rivers, lakes, estuaries, coastal waterways and groundwater in Europe in a sustainable manner. In order to comply with the directive, each Member State is required to amend its domestic water legislation (Fritsch et al. 2020). The WFD was approved after years of negotiation between the European Community and Member States were instructed to transpose it into their national laws by December 2003. The deadline and timing by the Directive is very strict: it was expected that good conditions might be achieved in 2015; but, the WFD provides for two more cycles of six years each following this first-time limit, from 2015 to 2021 and 2021 to 2027 (Pellegrini 2007).

EU'S APPROACHES AT THE RIVER BASIN MANAGEMENT LEVEL

The WFD has been widely recognized as the mode of implementation and vessel for Integrated River Basin Management (Giakoumis & Voulvoulis, 2018). The WFD has brought remarkable changes in the legislation on the water by incorporating new standards and criteria, institutions (districts and administration of the river basin) and planning procedures in Europe for waters. For the first time, the focus was on the excellent condition of all water bodies, including internal bodies of water, transitional water and coastal water. The WFD's creative features are its river basin management and planning activities, which includes river basin management strategies for each river basin district. It applies to the inland surface waters, ground waters, and transitional (estuaries) and coastal waters and the combated water pollution control system which included the emission limit values and water quality objectives. Following the introduction of the WFD, Member States were obligated to take a river basin approach to better water resource preservation and management. More specifically, EU countries were required to divide their national territories into River Basin Districts (RBDs). The planning process that Member States should conduct at the river basin level, the major output of which are the River Basin Management Plans (RBMPs), is key to achieving the ambitious WFD targets. The monitoring of RBMP is a constant process made up of four steps including the assessment of the current qualitative and quantitative status of water bodies, the establishment of specific environmental objectives for each water body based on the status assessment, identification of measures to achieve the environmental objectives established on water bodies and evaluation of advancements in measure implementation and improvements in water body status (Directive, 2003). The implementation of economic concepts such as the polluter pays, strategies and techniques

such as cost-effectiveness and water pricing are also used as measures to make sure the consumer bears the real cost of water supply and usage as set out in the cost recovery theory. The WFD also provided public engagement in decision-making on water quality (Pulido-Velazquez & Ward 2017). Water agencies are encouraged to involve stakeholders and the general public in decision-making processes and to organize hydrological rather than organizational planning and management operations (Fritsch et al. 2020).

WFD IN GREECE: TRANSBOUNDARY RIVER BASIN MANAGEMENT

The waters from four international river basins are discharge into the North Aegean Sea, Greece. The European Environmental Agency classifies the EU into 202 River Basin Districts (RBD). This is due to the location of the Greece region and topography features in the Southern section of the Balkan Peninsula as shown in Figure 1. Conflicts of contemporary concern about managing these common surface waters are linked to issues such as the absence of cooperation agreements between riparian countries, the water quality and quantity condition especially towards the downstream countries and restricted means for exchanging data (Skoulikaris & Zafirakou 2019).

The River Basin Management Plan (RBMP) is a detailed study that recommends solutions for meeting water quality targets at an RBD scale. One of the most important WFD improvements implemented by the EU is this transition from political boundaries to river basin management (Jager et al. 2016; Skoulikaris & Zafirakou 2019). The results of

FIGURE 1. Four transboundary river basins flowing into the North Aegean Sea, Greece
Souce: Skoulikaris & Zafirakou (2019)

the implementation of the Water Framework Directive and especially the River Basin Management Plans and data are investigated and proposed as instruments for sustainable waters management and for the resolution of possible conflicts between riparian countries at the European level, including Greece (Ison et al. 2007; Newig & Fritsch 2009; Skoulikaris & Zafirakou 2019). The WFD objectives can only be realized by the parties situated in a transnational river basin (EU and non-Member States) in view of the transboundary character of water management. This is one of the most demanding tasks in the Directive and calls for a comprehensive and sensitive approach since it is unclear if Member States may be held accountable because of reasons they are not fully controlled for not attaining the goals (Mianabadi et al. 2020). In addition to adequate water resources management from a politically-driven point of view, cooperative hydro-political approaches and collaborative integrated management certainly make it necessary for both the riparian countries to address the water problems in this region. A unique data source that may even replace bilateral data exchanges provides the process and result of the WFD implementation, since all information per EU Member State is openly available over the internet. Politicians, scientists, water experts, and stakeholders should further utilize this source of information to produce a road map of the challenges that put the integrated management of basin-based fluvial and the sustainable development of those regions at risk. In addition, since it encourages sustainability in the management of shared water bodies, both EU and non-EU nations, the WFD can serve as the guidance for international co-operation, by adopting water political events and Social Network Analysis (X. Wang et al. 2020). What the WFD has done may promote the collaboration and confidence of the States and seek assistance from international organizations will help remove disputes and improve EU and non-EU nation's collaboration.

WATER RESOURCES MANAGEMENT IN CANADA

Canada shared its best practices to achieve and addresses obstacles to the implementation of IWRM successfully. All Canadian provinces and territories have developed specific strategies and management models to obtain feedback on this topic (Shrubsole et al. 2017). Canada has experienced three major water quality risks, which are inadequate processing of wastewater, industrial effluent and fertilizer runoff from agricultural fields. All of the provinces and territories in Canada have established specific strategies and governance models in response to these threats that guide decision-making in IRBM. Canada learns how to prepare and manage water with reference to its water frontlines.

THE WAKEUP CALL FOR CANADA

Canada's concern with water resources controls begins with contamination by water supply systems in Walkerton, ON in 2000, and Saskatchewan in 2001, North Battleford. The *Escherichia coli* O157:H7 bacteria killed seven people

and infected over 2300 in Walkerton, while a parasite, *Cryptosporidium*, sickened thousands in North Battleford. Kashechewan (on western James Bay in Ontario) reported unsafe bacteria levels in its drinking water. Water quality was found to be significantly lower in several Aboriginal communities' settlements. Almost 1700 boil water advisories were issued in 2008, with most in Aboriginal regions. This event boosted public awareness of water supply protection. Protecting water supplies was made more visible. The federal government recently promised to abolish boil water advisories in all Aboriginal communities. This special issue may help the government achieve its goal regarding boil water advisories. (Shrubsole et al. 2017).

CANADA'S APPROACHES IN INTEGRATED WATER RESOURCES MANAGEMENT

Through establishing and sustaining partnerships and creating a sense of duty and transparency between water stakeholders, Canada had solved the problem with an integrated approach. Though the good water management strategy involves continuous challenges, Canada was still committed to it. The three levels particularly at watershed level, taken into account are the integration of natural, economic and social interactions, knowing the relations between resources and how humans will influence natural systems in future. The second level is the application covering both the quality and quantity of water, water and groundwater and related soil resources and the impact of human activities. While the third level is coordinating responses within the context of the system or projects involving combining decision to address the issue, including information and training, technical assistance, financial support, legislation, taxes, acquisition of property and cost-benefit separation (Marshall et al. 2017; Scott et al. 2017; Veale & Cooke 2017; K. Wang et al. 2019). Under water resources policy, Canada has pursued proactive initiatives and strategies. It began by recognizing and understanding the bigger picture and focusing on the most important issues of watershed and land resources to help people in shoreline get enough attention and resources such as human, political and financial for tailor-made solutions (Scott et al. 2017; Stewart 2019).

Integrated strategies are set by these important key elements and strategies. Front-line staffs claim that prioritizing local issues helps minimize the time needed to complete plans and achieve local support and participation. In order to effectively monitor water resources, people are increasingly being requested to participate in the planning, implementation, and follow-up phases implementation and monitoring. Representatives were invited to join other organizations' training activities. Collaborations with other organizations and post-secondary institutions have provided funds and resources to monitor the outcome of the watershed programs and initiatives situations. This is because watershed monitoring is a resource-intensive activity that often exceeds watershed authority capacity. Standardized protocols provide adequate training to citizens for this need. Water data and information were generated by professionals and citizens, which were then used to identify and evaluate alternative priorities. Although database management and GIS can help data collection and analysis, it can pose a logistical challenge to organize monitoring operations of multiple sources effectively and efficiently. The implemented program and project results had also become a common practice to regularly monitor Canada watershed agencies monitor. Observations have been made of how agencies continue to involve citizens in long-term monitoring activities. The watershed agencies constantly seek to define their role clearly in the resolution of water problems and ideally increase public and key decision-makers' confidence. It included the elaboration of an overall perspective and the implementation of a system approach focused on answering the key questions of who to pay for planning and execution. Medium multi-stakeholder planning and implementation monitoring are better aligned with communication between planners and practitioners. The watersheds often have a coordinating and integrative role to play. Implementation is promoted as all participants had a commitment to the nature of the problems, the need for action, and who is best suited to coordinate solutions. The planning process was relatively less complex and longer than the nature of the problem that had to be solved. Knowledge of the need for planning to quickly transition into implementation and a deliberate effort to achieve short-term and visible advantages are often seen as a result of the process. The monitoring system helps to convey the progress, findings and impacts of implementation to the public and decision-makers. The websites and government data servers of the Watershed organizations promote information for the public. Community participation/engagement continues to be critical in the design and implementation of the project and the responsibility for preparing, executing, tracking and updating watershed programs is constantly shifted to local government or associations. In some states for example, Ontario and Manitoba, public involvement is now compulsory. All watershed agencies' activities are supported by a range of financial arrangements. Most other agencies report a blend of funding and self-generated revenues from provincial government agencies. The amount of funds varies greatly in accordance with the nature of responsibilities, payment capacity and willingness. Each has the capacity to tax owners or collect taxes on income (Shrubsole et al. 2017).

Canada has shared its water resources management expertise and has acknowledged that the implementation stage is difficult. To overcome this, Canada set up a structure of regulatory authority and legitimacy for a watershed organization. The structure, which currently governs the activity of the conservation bodies, was also strengthened. In addition, the need for resourceful funding frequently limits the ability of planning on a long-term basis. Finally, the fundamental lessons have been the ability to stay prepared to track what is being achieved, to consider the capacity to

continue to learn, to change and to adjust from experience and new knowledge (Lamoree & Steenbergen 2009; Roy et al. 2009).

INTEGRATED WATER RESOURCES MANAGEMENT IN MALAYSIA

The IWRM idea has first been launched in Malaysia in several forms since the 1990s. Significant progress has been made to implement IWRM in Malaysia, especially as the water legislation is being simplified and improved. The Water Services Industry Act and the National Water Services Commission Law, which came into force in 2006, have led to a positive reform of current water resource and water services management law (Elfithri & Mokhtar 2018; Hezri & Dom 2017; Khalid et al. 2013). Malaysia has adopted the IWRM idea and method as a policy response, with Department of Irrigation and Drainage, the Malaysian Water Partnership, Academy of Sciences Malaysia serving as significant contributors in the original IWRM movement in Malaysia (Hezri & Dom 2017). Apart from that, the IWRM idea also involves community involvement for an effective water management monitoring.

WATER RESOURCES POLICY AND INSTITUTIONAL ROLES

National Water Resources Policy (NWRP) has been formulated and endorsed in February 2021 by the government of Malaysia. Malaysia has shifted its water focus from the traditional technique of linking water management primarily on water supply for industry, to concentrating on the significant of water sustainability. The four key attentions on the water management efforts on NWRP are water for people, water for food and rural development, water for economic development and water for the environment (Hezri & Dom 2017). Since Malaysia's policy approach is primarily top-down and legalistic, the NWRP implementation needs to modernize the legal framework to promote sustainable water management (Khalid et al. 2013). Integrated water management in Malaysia remains a challenge since the States are the key players and policymakers in the country's water catchment. Whilst federal water resource management legislation has been drawn up, this legislation will have to be ratified by State Legislative Assemblies in accordance with the federal and state constitutional authority on water resource matters. Therefore, water resource governance encompasses a number of policy, social, economic and administrative institutions that need to be established for the sustainable development and management of water resources. Malaysian's water resource management is challenging as under the constitution, authority on water resources is shared between the federal and state governments. Federal and state water management authorities need to work together with institutions across the spectrum of local and basin levels. Therefore, such an organizational scheme might lead to a fragmentation of jurisdiction among different water management organizations, leading to the poor implementation of water-related regulations. In accordance to this, a National Water Resources Council was founded in 1998 as an apex water management authority. The Deputy Prime Minister leads the NWRC, and its members include Chief Ministers from all states and Ministers from all federal water-related ministries. Since its formation, the NWRC has taken decisions at the river basin level that are consistent with the principles and practices of IWRM (Hezri & Dom 2017). Several States also took the initiative to enact IWRM or river management legislations and set up the related institutions. The river authorities established at the state level are Sarawak Rivers Board, Sabah Water Resource Management Director, Selangor Waters Management Authority (LUAS), Malacca River and Coastal Development Corporation, Badan Kawal Selia Air (Pahang), Badan Kawal Selia Air (Johor), Lembaga Sumber Air Kedah, Perbadanan Bekalan Air Pulau Pinang and Lembaga Air Perak.

REGULATION OF DEVELOPMENT WORKS

Malaysia, with its growing urbanization, demands modern urban-based solutions for integrated water management. IWRM plan is supported by the Urban Stormwater Management Manual (MSMA) to emphasize possible flooding by presenting technical guidance for drainage and water quality management. It is also a form of low-impact development guideline that ensures earthworks are carried out in accordance with sustainable urban drainage principles (DID 2012; Hezri & Dom 2017). In addition, the federal government has also established various water resources management systems, such as the National Water Balance Management System (NAWABS) and the National Flood Forecasting and Warning System (PRAB), to assure the success of IWRM implementation at the river basin level. NAWABS is a complete river basin management tool used to evaluate current water availability and requirements at basin levels. It also provides water management methods to guarantee future water supplies are adequate. The fundamental components of NAWABS are hydrological, hydraulic, and basin assignment models (Husain et al. 2017). Meanwhile, PRAB is a comprehensive flood forecasting model designed to provide information on impending flood events in more than two days to notify the necessary authorities (Department of Irrigation and Drainage 2021).

COMMUNITY PARTICIPATION

Community involvement is generally regarded as a tool and as a critical component in water resources management. This includes encouraging responsible water consumption, utilizing fit-for-purpose water standards to decrease treatment demands, and supporting local water reuse. Strong and smart collaboration is required to produce win-win outcomes, with the community and stakeholders assuming their fair share of responsibility in managing water resources. Such participatory management techniques need time to establish, thus relevant public awareness campaigns and educational programs are also the core for a successful water resources management. Non-governmental organizations (NGOs)

plays a critical role in facilitating the activities of supporting and promoting the practice of IWRM. This includes assisting cross-sectional and multi-stakeholder dialogues at the local, river basin, state, and national levels.

REHABILITATION OF KELANA JAYA LAKE

From 2007 to 2009, restoration of the lakes in Kelana Jaya Municipal Park through the engagement of the community offered optimism that IWRM was not a dead idea with a difficult local application. The Kelana Jaya lakes are old tin-mining ponds in the Sungai Damansara river basin in Selangor. The lakes were previously a flood retention zones, but in 1996 they were built as part of a public park used for recreation and fishing. Prior to this, these lakes had degenerated as a result of rapid development on the surrounding area. The lakes were also contaminated by wastewater, solid waste and stromwater overflowing to the main lake. Due to poor water quality and the loss of wetland plants and animal life, these have fundamentally altered the ecosystem. The odor was also induced by the decomposition of the sludge created in the lake (Wei T.K. 2009). In response to the situation, local people organized a stakeholder group made up of 400 friends of Kelana Jaya Park and headed by a 15-member steering committee. An awareness campaign was launched at three schools to reach out to students, parents, and instructors. Communities and local governments were also brought together to explore the particular issues of lake cleanup. The team discovered an innovative sludge treatment technique and carried out the appropriate measures. After a few months, the amount of solid waste and wastewater from the lake drains was decreased by 60 percent. After rehabilitation work was completed, the quality of discharge from an oxidation pond improved, thanks to the efforts of NOGs and the local authorities. The lake's water quality increased as a result, helping the environment as well as the general public health of the communities (Husain et al. 2017; Khalid et al. 2013).

WATER USER GROUP

The formation of the Water User Group among paddy farmers in irrigated regions such as Kedah, Kelantan, Selangor, and Pahang, is one potential application of community strategies in the agriculture sector (Hezri & Dom 2017). The main objective of the Water Users Group is to create a group of farmers who manage water use in one specialized field areas efficiently and effectively. This is also part of a strategy to help farmers to further increase the yield of rice production. Water User Group is the smallest farmer institution formed based on borders and roads of an irrigation areas. This group has similar interests in terms of source of water supply, irrigation schedule, procurement and use of inputs agriculture (Integrated Agriculture Development Area 2021).

WATER WATCH PENANG

Water Watch Penang (WWP) is a non-profit organization, under the supervision of the Socio-economic & Environmental Research Institute (SERI) of Penang. It was established in November 1997 in the context of the Sustainable Penang Initiative. WWP educates parents who perform a key role of "water managers both at home and at business." Parents control the water budget of the household and teach their children about conserving water. To guarantee water resources are not wasted, but are maintained sustainably, WWP advocates Water Demand Management (WDM). Through WDM, there is a considerable amount of domestic savings and WDM can safeguard mega water projects for years to come. Domestic water control, as a WDM form, is becoming crucial policies to handle water shortages and other water issues in Malaysia, using recycling and conserving approaches. WWP is also working on decreasing high rates of non-revenue water, improving water treatment facilities, boosting awareness, public education and other major water-related concerns in cooperation with government and water service providers (Water Watch Project 2021).

RIVER RANGER

River Ranger is an integrated water resource management program focusing on the management of rivers and river basins. It stresses water contamination and all aspects of freshwater ecosystems, including the functions, values, biodiversity, and human benefits for local and school communities and schools. It also contains practical exercises such as pollution observation, pollution mapping and easy means of ensuring the river to remain clean. The training of River Ranger provides an overview and concept of integrated river basin management and includes on-site training in the practice field that exposes participants to the real situation at hand. It also teaches how to monitor the quality of water using three different methods: physical, chemical and bio-indicators. This specific exercise will increase the respect for the people living in the basin of rivers and water as valued and scarce natural resources. In addition to water quality investigations, rangers are taught about the River Health Check Card, which will include 10 evaluation categories and a river report card to evaluate the health of the river. A water review workshop will also concentrate on water preservation and how water consumption to be monitored at home or at school. The training session will take place along the river as part of this project, including additional activities such as river cleanup, river walking, mapping of pollutants and river bank beautifying. These efforts will help understanding where pollution sources originate from and the impact of river pollution and how the entire basin is affected. River Rangers are generally subjected to water protection, preservation, refurbishment and cleanup in the river and water inspections at home (Water Project 2021).

CONCLUSION

Looking at the achievements of the River Thames, the EU Water Framework Directive, IRBM Canada and Malaysia, it is clear that the key points of an effective approach to water resource management and implementation is to have a committed government advisory body on water management. A dedicated government would generate extensive water conservation preparation in all respects. This includes defining the role of all watershed agencies, improving the legislative, regulatory and policy structure regulating the administration and functions of the authorities and, most importantly, allocating pollution budget to cater to any circumstances. An integrated water resources management has been seen to be effectively carried out by planning and management at the river basin scale. A comprehensive and scientific water quality study can generate a personalized approach for solving water quality and quantity problems in that unique basin and sub-basin. Setting targets for water quality in each river is an important means of tracking the goals established in each basin. Public and stakeholder engagement is also the key factor of a successful implementation of IWRM. This will help by creating local concerns in each river basins in order to minimize time to complete plans and to obtain local support and participation. In partnering with other agencies and organizations, funds and skills will improve the protection of water supplies and help with the funding concerned. Furthermore, the websites and government portals of watershed organizations can provide related water resources information to the public more effectively. When all preparation is adequately arranged, monitoring and updates of IRBM plans actions can be done efficiently and effectively. Moreover, the understanding of river basin features such as physical, economic, social, and institutional context should also not to be overlooked. The findings of a successful and effective IWRM can be summarized as having policies concerning water resource management, a solid legislative structure, managing administrative framework and capacity, consistent assessment of water recourses, a workable plan of IWRM implementation, management of conflicts and developing instrument of regulatory, economic and social change as well as having the platform of exchanging river basin information and data. Table 2 defines the comparison of the IWRM framework for the findings discussed in this study. These best practice administrations that have been shared and exercised can be used as a guide to maintain a positive and well-organized IWRM.

TABLE 2. The comparison of IWRM framework between River Thames, European Union, Canada and Malaysia

IWRM Implementation	Main goals	Concepts	Practices	Lesson learned
River Thames	River and environmental management during the 20th century.	Remedial measures to improve water quality.	Establishment of river water pollution research lab, Royal Commission's commitment and budget allocation to finance pollution costs.	Strong political will and accountability will ensure river and environmental success.
European Union: Water Framework Directive	River and water management structure and framework.	Broad strategies towards effective river and water management in Europe.	Implementation of Water Framework Directive, a comprehensive environment legislation and transboundary river management.	Implementing a water framework requires firm commitment.
IWRM Canada	Governance models and strategies to guide IRBM decision making.	System approach on technical and database management, water resources monitoring and public engagement.	Monitoring operations of multiple sources are done with data base management such as GIS, public information is done through website and government data server, compulsory of public involvement in some states and financial arrangement supported by government agencies.	Integration of economic, social interactions and river database management system provides quick decision-making.
IWRM Malaysia	Water governance legislation, river awareness campaign and community participation	A well-defined water resources management rules and regulations at river basin level.	Water resources policy and institutional role between the federal and state level improved and strengthened, community involvement performed in certain states and implementation of technical guidance for drainage and water quality management at river basin level.	Federal-state water governance and jurisdiction must be clearly defined and justified.

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DECLARATION OF COMPETING INTEREST

None

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