River Pollution in Malaysia: Conservation Instead of Endlessly Cleaning Works

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Abstract
River systems are vital components of the natural environment that offer a public good important to all life. Many of the rivers in Malaysia are categorized as slightly polluted or polluted despite numerous efforts by the government to rehabilitate the water sources. The government depends on technological solutions and contracted workers to conduct regular clean-up activities. These programs are costly and only effective in the short term. Adopting conservation practices that support the active and direct involvement of the community in environmental protection is critical to minimizing water pollution and maintaining water quality in the long term. Conservation efforts increase public awareness about their role as environmental stewards, motivating them to adopt positive behavior changes to protect water sources for the current and future generations. Public educational and awareness campaigns, strict enforcement of environmental regulations, community monitoring, and incentives are effective conservation efforts to facilitate Malaysia's sustainable use and protection of rivers. The paper proposes that conservation is more effective, cheaper, and capable of minimizing river pollution in the long run compared to endless river clean-up programs.
Keywords: River Pollution, Malaysia, Unsustainability, Cleaning Works, Conservation

Introduction
The United Nations lists water as a priority in the United Nations' Sustainable Development Goals (SDG) – SDG 6 'clean water and sanitation, to ensure a clean water supply for all in attaining a sustainable future (University of Nottingham, 2023). Rivers are essential water ecosystems that influence a country's environmental, social, and economic development, potentially impacting the livelihood of those in surrounding communities directly. Globally, rivers contribute to economic growth, food security, and population well-being, with approximately two billion depending on water sources (University of Nottingham, 2023). A source of fresh water for fish and other aquatic animals, in some nations, rivers are also used to generate energy, for recreational purposes, and as routes for transportation. Today,

Malaysia is considered one of the wealthiest countries in terms of availability of water sources, which have been used as a foundation for the country's socio-economic development over the past decades. Estimates indicate that rivers and streams with no impounding reservoirs contribute 98 percent of the water used in Malaysia (Fao, 2020). Unfortunately, reports show that many individuals are not taking care of rivers, leading to serious water system degradation. The result is severe pollution of 5% of the river basins, and 42% are polluted, leaving only 53% of the sources classified as clean (Gec, 2023). Despite various initiatives and enforcement conducted by government agencies, most river conservation interventions are not sustained, hence the extreme pollution levels. The current approaches rely primarily on solutions, such as clean-up projects, that treat the symptoms of river source pollution and not the root causes. Instead of overlying on endless clean-up projects, the focus should be conservation, which is cheaper and more effective in reducing pollution in the long run.

River Water Quality

The quality of water and pollution control are urgent matters that need to be addressed since 98 percent of the total water use in Malaysia originates from the rivers (Fao, 2020). The pollution continues, and concentrations of existing pollutants increase, resulting in quality water scarcity. Pollution leads to a decline in good-quality water and a subsequent increase in water treatment costs due to new pollutants. Also, the ecological health of water sources and surrounding natural ecosystems degrades, impacting the quality of life, aquatic life, and recreational activities.

The current initiatives of development, including the features of the natural environment and outcomes of past interventions, determine opportunities for future development and the need to restore and enhance water quality. Camara et al. (2019) defined water quality as a measure of water use for various purposes, including drinking, recreational, industrial, agriculture, and habitation. The quality of river water plays a critical role in all areas of living organisms. It has attracted the attention of researchers, with evidence suggesting that the quality of rivers differs according to location, weather, and types of pollutants. However, preserving water quality is a challenging process primarily due to the presence of point and non-point sources (NPS) of pollution. According to Camara et al (2019), the NPS entails a natural process that cannot be eliminated. Human activities, however, play a substantial role in the increase and decline of pollution rate at the water source. In dealing with NPS sources, the problem is identifying activities resulting in substantial water quality degradation and creating control interventions to reduce problems. Camara et al (2019) summarized the works of previous researchers. They described NPS pollution to include NPS sources spread and covering important areas and operating in response to human activities, land management, and geological activities that change periodically, the ones produced as part of the hydrological cycle, urban runoffs containing solids, metals, fats, and related variables, those associated with agricultural pollutants such as pesticides and organic substances. Point sources are discharges in flowing rivers at specific areas, such as industrial pollutants, disposed waste from animal farms, landfills, markets, plantation activities, and sewage treatments. There are more than 1,600,000 water pollution sources in Malaysia, and they comprise approximately 5,000 manufacturing industries, 9,900 sewage treatment areas, excluding individual plants, 800 animal firms, and more than 200,000 food service establishments (Huang et al., 2015).

In addition, changes in land use due to rapid urbanization, industrialization, and commercial agricultural activities change the features of watersheds that impact water quality and quantity. Literature suggests substantial associations between land use and indicators of water quality (Camara et al., 2019). These findings on the correlation between land use and water quality through various methods have provided approximation and comprehension of water quality in rivers associated with pollutants. A high percentage of land use attributed to human activities and economic development in watersheds is often correlated to high volumes of water pollutants, and undeveloped regions, including natural forests, are associated with good-quality water.

In Malaysia, monitoring of water quality is done by the Department of Environment (DOE) Malaysia. The DOE (2018) observed 233 water monitoring stations established in different states of Malaysia and another 86 programs to monitor the 73 islands. The monitoring project entails measurements of water quality indicators, including pH, dissolved oxygen, temperature, salinity, and turbidity, and analytical analyses of indicators such as copper and concentration of industrial chemicals. The monitoring activities offer critical insights into the water quality of various sources, including rivers. Among the 477 rivers that underwent monitoring by DOE, 33 rivers are listed as polluted, and a further 168 are categorized as slightly polluted, Table 1 (Chee et al., 2018).

Table 1
Monitoring of Water Quality

Year	No of rivers monitored	Clean	Slightly polluted	Polluted
2012	477	278	161	38
2013	477	275	173	29
2014	477	244	186	47
2015	477	276	168	33

Further monitoring in 2017 showed that the percentage of clean rivers was decreasing, with data showing that 219, 207, and 51 of the 477 supervised rivers were clean, slightly clean, and polluted respectively, figure 1 (Goi, 2020).
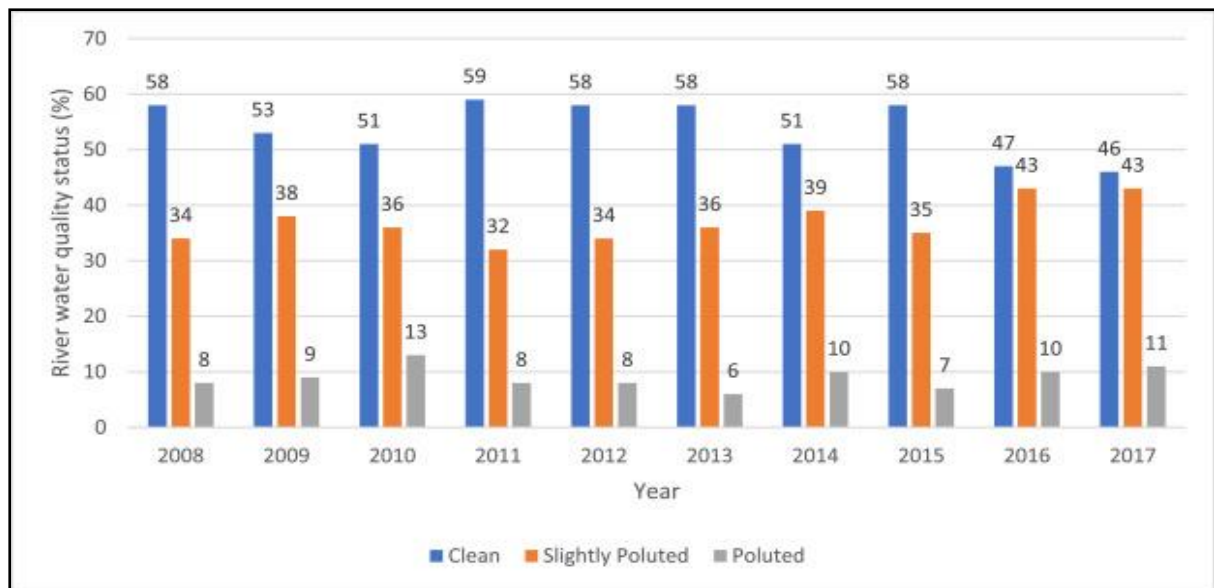
Figure 1: Pollution condition of rivers
Author: Goi (2020)

The effects of continued water pollution are diseases, destruction of natural systems, eutrophication, and adverse impacts on the food chain (Mauludi, 2020). Consuming polluted water results in devastating effects on health, such as the development of cholera, typhoid, and other health conditions. Ecosystems are dynamic and impacted by minor environmental changes, and water pollution can cause the entire ecosystem to collapse. Also, chemicals in water provide for the growth of algae, which, when fed by bacteria, results in a decline in the amount of oxygen in the river, adversely affecting aquatic life. Aquatic animals consume toxins in polluted river water, leading to a disruption in the food chain.

Current Water Management Strategies: Clean-Up Projects
Countering river pollution and the identified effects of water pollution requires appropriate management and infrastructure plans. The Environmental Quality Act of 1974 supports implementing policies and intervention projects to reduce river pollution and enhance water quality. Section 25 of the Act contains restrictions on pollution of inland waters, prohibiting people from releasing environmental hazards into the rivers, and liabilities to individuals and companies found responsible for emitting pollutants into water sources (Mauludi, 2020). Traditionally, the management of rivers is the sole responsibility of government agencies but owing to the increasing complexities of water-related issues and the need for stakeholder involvement in environmental conservation, an integration of various agencies, including non-governmental organizations, has been incorporated into water management. One of Malaysia's most commonly used approaches to preserve water quality is water clean-up exercises. There have been numerous projects and campaigns by government agencies, including the 'Love Our River' program initiated a decade ago. The campaign aimed to create public awareness and sensitivity towards the need for cleaner rivers. The Department of Irrigation and Drainage (DID) implements the program and entails concerted efforts to clean up rivers countrywide. However, reports suggest that much of the responsibility is left to the government, with limited support from the public, yet individual people and communities are responsible for pollution in rivers. The clean-up programs are one-off initiatives and cost the government approximately RM100mil yearly to clean rivers in

Malaysia (Kaur, 2022). Also, the authorities have spent considerable amounts to maintain the rivers and collect rubbish. Waste keeps getting dumped into drains and rivers, and the government addresses the issue by holding clean-up activities. In an article by DID on the state of Malaysian rivers since the launch of the 'Love Our River' campaign, the authors comment about the Batu River, where contract workers wade through the waters downstream to clear the trash trapped in the logs while clad in shorts and boxes (Kaur, 2022). The river is so dirty that no aquatic life can survive, yet the workers wade through without protective gear. The company is responsible for removing the trash, claiming that people dump feces, food waste, and other substances into the rivers, and the employees are required to do the clean-ups. Sometimes, people throw furniture and branches, which cause minor injuries to the workers. The workers claimed that many people treat the rivers like disposal sites, and since it is the responsibility of the company contracted to clean up the rivers, they do their job without complaining. A study by *The Star*, a media outlet, found that people dispose of motorcycle helmets, tree branches, and tins on Klang River (Tan, 2022). As a result, the DID reported to have collected an estimated 205 tons of waste from the Klang River and its many tributaries, 60 tons from log booms, and 70 tons from manual cleaning.

The river cleaning process is completed using several methods, including installing river traps, such as gross pollution traps, log booms, and trash rakes, and manual cleaning involving contract workers and machinery (Tan, 2022). Gross pollution traps are offered at the downstream end of drains of engineered waterways, which discharge to sensitive rivers, urban lakes, or even water control ponds. In Klang, the authorities launched the River of Life project to transform the river corridors into vibrant economic zones. DID leads the program with the support of 26 agencies across the government ministries. The government also allocated RM114Mil for the clean-up activities to rehabilitate rivers under the 'One State Program (Tan, 2022).' The Ocean CleanUP, a global program that focuses on removing trash from rivers, supports rehabilitation programs. The goal of the project is to tackle the 1000 most polluting rivers in the world, using a variety of technological innovations that are customized to the specifications of a particular river.

Despite the clean-up efforts, studies show that most of the rivers in Malaysia are polluted, Figure 1. The effects of the pollution are incredibly alarming. According to Goi (2020), several events in 2018 and 2019 related to water pollution affect the sustainability of cities, particularly regarding social, economic, and environmental. For example, in 2019, the water treatment plant ceased operations four times due to incidents of contamination of raw water sources in the Semenyih River. The disruption in water supply affected over 204 regions and thousands of people. In addition, several industries were inspected by the Department of Environment after the illegal disposal of toxic waste into a sewerage system by irresponsible individuals (Goi, 2020). The event caused Semenyih water treatment to stop operations, impacting the well-being of more than 320,000 people. A similar incident occurred in Pasir, Kim-Kim, and Johor, where water treatment facilities were impacted due to the illegal dumping of toxic waste. The events affected at least 6000 people, and more than 2000 people were hospitalized for consuming contaminated water (Chia, 2019). These incidents suggest that there is a need for a sustainable water rehabilitation solution that involves all stakeholders, especially the public and business enterprises, which are responsible for most of the pollution occurring in rivers.

The Case for Conservation as a Sustainable River Rehabilitation Solution

Malaysia should invest in conservation instead of endless river clean-up initiatives to reduce pollution and maintain the quality of the water sources. The clean-up intervention is based on a top-down approach that focuses on supply management and places the responsibility of water rehabilitation on authorities. This situation reduces public participation and goodwill in managing natural resources (Leng et al., 2019). To address the issue of river pollution, the starting point is getting direct community participation, as they live near the water sources and detect water pollution sooner relative to others. To achieve this, rehabilitation programs must be underpinned by the phenomenon of conservation, which Leng et al (2020) described as a state of harmony between humans and nature. The process entails evaluating actions, behavior changes, devices, enhanced design, or implementation of new tactics to reduce water waste and increase the quality of rivers. Scholars argue for social and science-led approaches to conservation through which river ecosystems are preserved. The rivers inevitably impacted by human activities are safeguarded by authorities and communities, which combine top-down and bottom-up approaches to management by providing for the involvement of all stakeholders in restoring water sources. As an increasing number of individuals are impacted by river pollution, as exemplified by the incidences of water treatment in Malaysia, a shift in water restoration towards an integrated approach that involves all actors, including local inhabitants, is required. The choice for conservation is based on the fact that the ultimate source of stressors leading to river pollution is the people using the rivers. Yet, each person depends on the sources for consumption, business, and other needs. Consequently, the poor water quality of Malaysian rivers is a result of thousands of institutions and millions of individuals making decisions that impair the quality of their water and the health of the rivers (Sweeney & Brain, 2016). Hence, the proposed strategy is community-based conservation to help preserve rivers and enhance the water quality in Malaysia.

System Thinking

The conservation strategy is based on the system's thinking model. Chee et al. (2018) described system thinking as an interdisciplinary research model applied to discover the relationships between various factors or elements in a system. The framework is widely used in fields such as environment. For example, the research by Tan et al. (2017) was based on a systems model, which was used to study the effects of subsidies on the incidence of climate-sensitive buildings in Malaysia. Systems thinking is classified into problem structuring and dynamic modeling, and the former explains the need for community-based conservation to rehabilitate rivers in Malaysia. Casual loops demonstrate the relationship between the state government's efforts to manage river pollution problems and community involvement in river management. The lack of community participation in conservation efforts is the leading cause of pollution. Theoretically, local communities' desire for clean water is supposed to create balancing feedback characterized by individual efforts to protect the rivers – Figure 2. A decline in river quality increases the gap between the desired and the actual river quantity.

Along with the associated negative impacts on the health and welfare of residents, this change is supposed to increase community voice and participation in river conservation. However, the low awareness of the residents of the risks and lack of incentives hinder community efforts to protect the rivers. This aspect minimizes the efficacy of the feedback loop in rehabilitating the river.
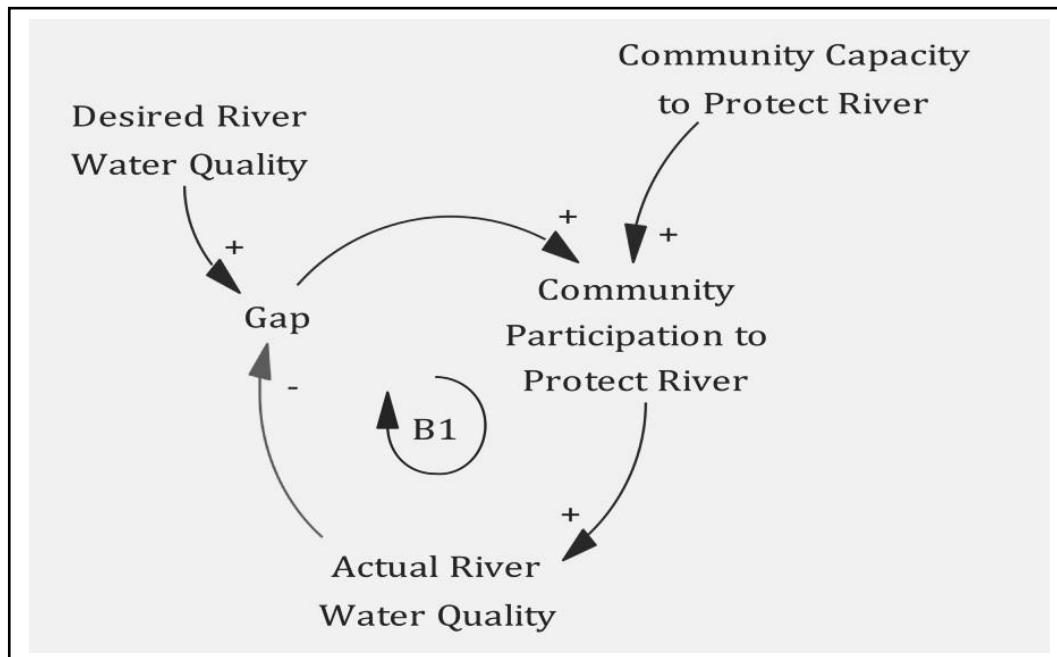
Figure 2: Feedback loops resulting from relationships between community stakeholders. Source: Chee et al (2018)

The high pollution levels of Malaysian rivers have devastating consequences for the economy. Local communities turn to the government to address the solution, hence the development of the clean-up activities. These projects are effective in the short term. These initiatives create the perception that the responsibility of protecting the environment is by the government, reducing community participation and support to address the problem. The need to focus on conservation compared to endless cleaning activities can be explained in terms of the economic and technological implications of the initiatives.

Economical

The government spends millions of dollars doing clean-up activities. For example, approximately RM114 million was used between the years 2006 and 2014 to rehabilitate rivers through clean-up initiatives (DID, 2023). Although the program effectively removes trash and other contaminants that destroy the quality of the rivers and their ability to perform the intended purposes, not much progress has been achieved. The authorities have heavily invested in the program, yet the country continues to experience losses concerning revenue generated from recreational activities, fishing, and related economic activities. Most of the funds set aside for conservation are used to treat problems resulting from the failure of the government to address the root causes of the problem. This is evidenced by the water treatment incidences that disrupted everyday business and household activities of several residents in some regions that experienced extreme pollution (Johor, 2020; Chia, 2019). A study by Chee et al (2019) noted that tourism activities declined in rivers Dipang, Kepar, and Reas due to pollution by waste disposal attributed to mining activities in the upstream areas. The direct emission of water sludge into the rivers made the water sources turbid. The rivers are known for their fishing activities and clean water, and the pollutants make it difficult to conduct daily business activities that contribute to government revenue. The pollution issues are attributed to the community's belief that the government is primarily responsible for river management through clean-up activities.

Environmental conservationists contend that the best approach to address pollution is through the concept of the polluter pays principle. The precept is founded on the notion that whoever causes pollution must pay to clean it up in one way or another. The principle could propel tanker owners to take out insurance covering the cost of oil spill clean-ups, for instance. It also means consumers pay for grocery bags to increase shopping costs and minimize waste often disposed of in rivers. The strategy could also be employed by formulating a policy that requires factories to have inlet water pipes downstream of their outflow pipes so that if they cause pollution, they are the first people to suffer. The principle was designed to prevent people from polluting the environment by making it less expensive to behave in environmentally friendly ways. Compared to the clean-up program, which makes the government responsible for water rehabilitation, reducing the accountability of the community and industries to the river sources, conservation fosters the utilization of the polluter pay principle, a sustainable approach to river rehabilitation.

Technology

The clean-up programs are supported by various technological tools that remove trash and clean the rivers. The pollution issue and its devastating impacts on the country led the government to devise quick and efficient initiatives to rehabilitate the rivers. Technological equipment has clear procedures and timelines. Hence, it seems more attractive in regard to addressing the pressing pollution problem. The utilization of the technology creates a balancing loop, which, according to Chee et al (2018), works to enhance river water quality. One example of a technological solution is the installation of trash traps in rivers and their tributaries. However, installing these traps has not helped reduce pollution as depicted in Figure 1. The technologies encourage dumping in the rivers since residents believe the waste will cause any damage. Overdependence on technological solutions also suggests that local communities play a secondary role, and often, no role at all, in rehabilitating the rivers. The government mainly implements the solutions without involving the residents to get their input about the programs and the pollution issue. The perception shifts regarding who is responsible for the rehabilitation of rivers, given that only complex and well-funded institutions like the government can implement such technological solutions (Chee et al., 2018).

Consequently, the root causes of pollution still need to be addressed, as the cycle of pollution and clean-up activities continues without getting observable benefits. In the long term, the paradigm of the water sources as a responsibility of the community is undermined, creating feedback that worsens the prevailing problem (Figure 3). The benefits gained from the technological solutions are subsequently undermined, and though the solutions can keep up with pollution, the economic, social, and environmental costs of execution continue to grow, making the programs unsustainable.

Community-Based Conservation

Employing system thinking principles in conservation provides for the consideration of the socio-economic features of a river and comprehension of how the entire system is connected to manage and restore river sources effectively (Chee et al., 2018). The advantage of this approach is that all stakeholders, including the government and public, are involved such that each player becomes responsible and accountable for the quality of river sources. The conservation strategy is founded on the premise that communities residing along rivers or people using water from rivers must take responsibility for reducing pollution and monitor

and report all river pollution issues to the authorities for immediate redress. Leng et al. (2020) defined community-based conservation as an approach to environment rehabilitation that intentionally entails a range of practices that directly or indirectly relate to conservation. Regarding natural resources, Vossler et al (2023) observed that ecosystems can be conserved or improved through role practice. The current clean-up programs have undermined the public's role in conserving the environment, and authorities can change their perception by creating strategies that increase awareness about water rehabilitation and motivate people to actively participate in reducing river pollution.

Education

Participation of the community and the general public in managing river pollution increases awareness and acceptance of river rehabilitation measures, thus increasing their effectiveness. Notably, 98 percent of the water used by Malaysians comes from rivers. That means all stakeholders are directly affected by the pollution issue, and hence, the government can effectively appeal to companies and individuals about conservation and receive widespread buy-in. In order to react effectively to the issue and respond appropriately, citizens need to be informed and trained. According to Sweeney & Blaine (2017), it is the most essential element of a long-term environmental strategy. However, inspiring individuals to take responsibility for natural ecosystems is challenging. Education about the environment is based on the premise that there is a linear correlation between a person's knowledge, perception, values, and attitudes towards the environment. Educators focus on comprehending the learning procedures and capabilities of people and communities required to help address challenging socio-ecological problems. The insights are necessary to encourage individuals to develop the capacity to make critical and ethical decisions, creatively appraise emerging environmental problems, make informed conservation decisions, and develop the commitment to behave in ways that maintain and improve the environment. Government agencies and humanitarian organizations implement educational campaigns to offer helpful information such as the value of freshwater, strategies to protect water from pollution, the effects of river pollution on the community, and the need to take personal responsibility to protect the ecosystems. The change agents can also use simulating games related to river conservation and get the community involved as participants in the game so that they can directly experience the issue and have fun.

One of the most effective educational initiatives the government can deploy is to support conservation cleaning-up programs. Compared to the current clean-up projects, which are solely done by government agencies and contracted companies, the cleaning-up initiative is part of the public awareness program to promote conservation within the community. Community members are involved in removing solid waste from the rivers while benefiting the local government by reducing the cost of cleaning upriver pollutants.

Digital technology tools can support the strategy to ensure that different consumer groups are involved in the project. Instead of focusing on the people residing near rivers, the educational campaign should involve all stakeholders to ensure all citizens of Malaysia participate in rehabilitating the rivers. First, the government creates an online campaign on different social media sites to reach out and engage with a diverse population. The process involves creating content relating to river conservation, including videos, blogs, and images showing polluted rivers, clean rivers, and people participating in cleaning activities. The government can take advantage of all the available social media sites, including Facebook, X, TikTok, Instagram, and other sites that attract different demographic groups. The agencies

engage with local influencers and community leaders to spread the message and get more people involved in the educational program. For example, TikTok attracts adolescents and young adults fascinated by short, entertaining videos. The project team can engage with several local people to create videos shared on the platforms to create program visibility and encourage public participation. In addition, the government can liaise with business owners to set aside a few hours within the week when employees can collectively participate in rehabilitating a local river. The advantage of digital technology is that it can reach many people at a time and ensure that the message reaches all stakeholders. Educational campaigns are also launched in educational institutions, religious institutions, and related places to allow conservation advocates to tailor the messaging to the demographic needs of the population. For example, it is more effective to empower parents and adults about disposing of household waste since they make most of the decisions and, hence, have the power to influence their children to make informed conservation decisions.

The empowerment initiatives increase consciousness towards river pollution and water quality. For example, the clean-up activities are fun initially but exhausting when conducted regularly. The activities force people to stop doing other productive activities, which affects their ability to achieve personal and business targets. For example, when businesses are asked to let their employees spend a few hours of the week engaging in clean-up activities, they lose income. Hence, the campaign creates a heightened level of consciousness that propels business owners to include conservation efforts as part of their business activities, such as taking responsibility for educating new workers on environmental conservation to ensure that the ecosystems are clean and avoid losing productive hours on clean-up activities.

Community Monitoring

Another evidence-based initiative is empowering communities living close to rivers to monitor water quality to ensure that local authorities take immediate action and protect the rivers from further degradation. In an interview with a DID officer on conservation, Leng et al. (2019) established that residents living along water sources are responsible for monitoring river water conditions to report suspicious activities that may endanger the lives of people and the community. For example, some of the water treatment incidents that occurred due to irresponsible people disposing of toxic waste in rivers could have been prevented if the community had been sensitized about the issue and the collective responsibility of addressing river pollution. One of the tactics to empower and motivate communities to monitor the river sources is offering a free communication medium where people can easily report pollution activities. That can be achieved by utilizing a door-to-door intervention whereby government employees visit households and talk to people about monitoring and offer contact details they can use to reach the agencies quickly. The residents are also informed about the available DID officers, where they can get information and report pollution issues. The strategy is effective given that people and companies will avoid partaking in activities that may cause pollution now that anyone can report them without consulting. The monitoring initiative supports the clean-up program by increasing the responsibility of the stakeholders who are responsible for polluting the environment, and the result is a reduction in the number of government-initiated clean-up initiatives and subsequent costs. The government directly works with the community by sharing information. The residents are responsible for 'river watchdogs', which reduce pollution because of human heuristic attributes (Leng et al., 2019). The residents feel guilty and afraid of disposing of waste in the rivers since many people monitor their illegal acts.

Legislation and Incentives

Legislation is an effective method of generating environmental stewardship practices. Essentially, the Environmental Quality Act 1972 and different enforcement across the country are meant to create a community conservation culture. However, although there is legislation at national and local levels, enforcement has lagged because of a lack of political will and, most importantly, the public perception that clean-up activities are the government's responsibility. The fact that the government is quick to address a pollution issue rather than the root cause of pollution has reduced public commitment to conservation. Mr. Hanati, an executive at the Malaysian Water Partnership organization, noted that Singapore is more successful at mitigating pollution because of strict enforcement. The government should use the legislation to enforce compliance with environmental protection. People should be reminded that the water they drink comes from the rivers, and the government cannot maintain water quality without their help. A nationwide campaign creating awareness of the legislation can help sensitize the public by ensuring that Malaysians understand their obligations towards water protection. The awareness campaign can be done in schools, professional forums, religious institutions, and other social events where the agencies can target a large audience. The campaigns detail the provisions of the various legislations concerning their effects on individuals and enterprises. For example, the Environmental Act states that those who contravene the legislation are guilty of offenses and, hence, liable to a fine not exceeding one hundred thousand ringgit or imprisonment. The information is critical to ensure that all individuals comprehend their responsibilities to help the agencies responsible for environmental conservation enforce the rules. The legislation can be supported by incentive programs to promote good environmental behavior. Scientific data and technological innovations now make it possible to utilize positive incentives, including increased rental payments, tax rebates, and better organic certification programs to foster environmentally friendly practices. For example, the government can offer tax breaks to companies participating in river rehabilitation programs, such as clean-up activities.

Recommendations and Conclusion

Educational empowerment programs targeting different stakeholders, community monitoring programs, and legislation are effective and efficient strategies to rehabilitate rivers. Studies indicate the possible reasons for the failure of the 'Love Our Rivers' and related government-funded river clean-up programs include lack of enforcement, public participation, and monitoring and continuous improvement. The government relies on quick, technological solutions, which are effective but costly in the long run. The technologies ensure that rivers are cleaned up immediately if there is an extreme pollution problem to help the community attend to their daily lives. Also, the government has contracted several companies to conduct daily or periodic clean-up activities to remove waste and ensure the rivers are clean. However, as shown in Figure 1, the efforts have not yielded positive, sustainable results. That is because the authorities have not been keen on enforcement. Hence, most of the pollutants are attributed to consumer activities. Business enterprises and individuals continue throwing waste into rivers, knowing that the contract workers will clean the rivers. Also, the government has not invested in continuous, widespread sensitization campaigns to ensure every Malaysian understands its role in rehabilitating natural ecosystems. Therefore, the recommended strategy is conservation, which provides for a change of perception in the population about the relationship of humans with the environment. The stakeholders,

including communities close to river sources, must understand their responsibility toward water conservation and promote positive behavior changes.

The benefits of adopting conservation as the primary water rehabilitation strategy are evidenced by the outcomes of the Movement of Control Order (MCO) implemented during the COVID-19 pandemic. The order involved restricting activities, including the prohibition of gatherings and mass movements, sanctions over traveling, closure of child centers, closure of educational institutions, and other activities that increased the risk of spreading the disease. Although the country lost over RM 2.4 million daily due to the restrictions, the MCO benefited the environment (Goi, 2020). The decline in human activities led to a significant improvement in the quality of water sources. For example, Kim Kim River, which is popular for having extreme chemical waste pollution, began to recover after implementing the order. There was also a drastic increase in the water quality index in the country, although there was an increase in waste and a decline in recycling activities. The MCO led to a change in norms in people's lives.

The initiative was delivered in relation to improving the quality of the environment since implementation required public participation and strict law enforcement. The government agencies worked with various stakeholders, including business executives and school administrators, to enforce the rules and protect the public from the coronavirus crisis. Although MCO was enforced to protect the country from a global health issue, it exemplifies the role of public awareness and strict government legislation in promoting socially beneficial practices. The only difference between MCO and the proposed strategy is that the conservation program is a long-term initiative embedded in the community's daily activities, including the activities that were restricted to implementing the initiative. While people were not allowed to participate in social gatherings or attend physical classes during the MCO, the current initiative will become an integral part of people's lives and be implemented daily. Therefore, the most significant tactic that will ensure conservation becomes ingrained in the community is appealing to the public's emotions by changing their perceptions and attitudes concerning environmental conservation. That means authorities must create content and empowerment activities, such as simulation games and online engagement initiatives, to reach different stakeholders and ensure everyone understands their role in protecting the environment. In addition, the government will strictly enforce current environmental legislation and offer incentives to government enterprises to promote positive environmental behaviors.

In addition to technological river rehabilitation solutions, public awareness and active participation in conservation efforts are critical in promoting water quality. Many rivers in Malaysia are listed as polluted or slightly polluted, yet the government spends millions of dollars annually implementing river clean-up activities. The programs effectively remove waste from the rivers but are not economically or environmentally sustainable. Most of the pollutants in rivers result from human activities, including household waste and chemicals from commercial activities. Instead of investing in costly, endless clean-up activities, the government should focus on conservation programs that involve all stakeholders in the country and ensure that the issue of river pollution becomes a public responsibility. Educational empowerment campaigns, community monitoring, legislation, and incentives are evidence-based approaches to promoting sustainable use and rehabilitation of rivers.

Both empirical and theoretical findings contribute to the understanding of the difference between cleaning works and conservation efforts. The findings suggest that involving various stakeholders in conservation efforts is more sustainable in water

conservation efforts compared to endless cleaning work. The main theoretical contribution is the application of case study strategy and interpretative approach utilized for analysis. By comparing various water conservation strategies, this paper finds that the general public, including business enterprises, community members, and students is responsible for the preservation of river sources and related natural features like the government. Although the government holds more power pertaining to the enactment and legislation including allocation of resources, it is only by involving the people using the water sources that these policies become effective. The methodology and conclusions can help develop further studies seeking to identify alternatives to conserve river sources. In the context of governance, the paper finds that the government must work directly with members of the public to implement water conservation legislation effectively. In the context of conservation, the study establishes that governments are mediators in stakeholder management, and community involvement is central to the conservation of water sources in Malaysia.

References

Camara, M., Jamil, N. R., & Abdullah, A. F. B. (2019). Impact of land uses on water quality in Malaysia: a review. *Ecological Processes*, *8*(1), 1-10.

Chia, G. (2019). Johor Gas Poisoning Victims Now at 2,775, but PM Mahathir Says the Situation Is 'under Control.' *Business Insider*. Retrieved from https://www.businessinsider.my/johor-gas-poisoning-victims-now-at-2775-but-pm-mahathir-says-the-situation-is-under-control

Chee, H. L., Tan, D. T., Chan, N. W., & Zakaria, N. A. (2018). 21st Congress of International Association for Hydro-Environment Engineering and Research (IAHR), Asia Pacific Division (APD). In *21st Congress of International Association for Hydro-Environment Engineering and Research (IAHR), Asia Pacific Division (APD),*. IAHR-APD.

Fao. (2020). Malaysia water vision: The way forward – the Malaysian water partnership. *FAO*. https://www.fao.org/3/AB776E/ab776e02.htm

Global Environment Center. (2023). River care programme. *Global Environment Center*. https://www.gec.org.my/index.cfm?&menuid=333

Goi, C. (2020). The river water quality before and during the Movement Control Order (MCO) in Malaysia. *Case Studies in Chemical and Environmental Engineering*, *2*, 100027.

Huang, Y., Ang, S, Lee, K., & Lee, T. (2015). Quality of water resources in Malaysia. *Research and practices in water quality*, *3*, 65-94.

Kaur, M. (2022). Rubbish lay waste to waterways. *DID*. Retrieved from file:///C:/Users/USER/Downloads/Star25072016Ourdyingrivers.pdf

Leng, S., Weng, C. N., & Samat, N. (2020). Community Awareness and Involvement in River Conservation in Pasir Mas, Kelantan. *European Proceedings of Social and Behavioural Sciences*.

Malaysia DOE. (2018). Marine and water quality monitoring https://www.doe.gov.my/portalv1/en/info-umum/pemantauan-kualiti-air-dan-marin/303.

Mauludi, M. (2020). River pollution in Malaysia. https://enviro2.doe.gov.my/ekmc/wp-content/uploads/2020/05/River-Pollution-In-Malaysia-26.4.20.pdf

Sweeney, W., & Blaine, J. (2016). River conservation, restoration, and preservation: Rewarding private behavior to enhance the commons. *Freshwater Science*, *35*(3), 755-763.

The OceanCleanup. (2023). Tackling trash in rivers. *Ocean CleanUp.* https://theoceancleanup.com/rivers/

Tan, R. (2022). Plastic and polystyrene clogging up Klang River. *DID.* file:///C:/Users/USER/Downloads/Star25072016Ourdyingrivers.pdf

University of Nottingham (2022). UNM calls for local efforts in local river management. *University of Nottingham Malaysia*. Retrieved from https://www.nottingham.edu.my/NewsEvents/News/2022/UNM-calls-for-more-efforts-in-local-river-management.aspx

Vossler, C., Dolph, C., Finlay, J., Keiser, D. Kling, C., & Phaneuf, D. J. (2023). The Clean Water Act After 50 Years: Innovations in Measuring the Social Benefits of Water Quality for Research and Policy: Valuing improvements in the ecological integrity of local and regional waters using the biological condition gradient. *Proceedings of the National Academy of Sciences of the United States of America*, *120*(18).