

Water Issues in Peninsular Malaysia: The Role of Rainwater Harvesting

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Abstract

Peninsular Malaysia is often described as water-rich because of its high rainfall and extensive river systems. Yet in reality, the region faces recurring water shortages, disruptions, and pollution crises. This paradox highlights that water abundance does not automatically translate into water security. The challenges include unsustainable consumption habits, widespread river pollution, high levels of non-revenue water, and frequent supply interruptions. Climate variability especially the influence of El Niño and the increasing intensity of rainfall has only made the situation more fragile. Despite these difficulties, solutions remain available. One of the most practical and underutilised is rainwater harvesting (RWH). By collecting rain where it falls, RWH reduces reliance on polluted rivers, helps communities cope with supply cuts, and even contributes to flood mitigation. This paper reviews the main water issues in Peninsular Malaysia and discusses how RWH can play a greater role in securing a sustainable water future.

Keyword: Water Issues, Peninsular Malaysia, Rainwater Harvesting, Sustainability, Integrated Approach

1. Introduction

On paper, Malaysia should not face water scarcity. The peninsula receives an average of 2,400 millimeters of rainfall annually, with more than 150 river basins feeding towns, villages, and industries (FAO, 2010). Per capita, this equates to thousands of cubic meters of renewable water every year well above what is considered adequate internationally (Chan, 2009). Yet despite this apparent abundance, Malaysians are no strangers to water rationing, sudden disruptions, and pollution-driven crises. The contradiction is striking: how can a country blessed with such rainfall still face water insecurity?

Part of the answer lies in how water is managed and consumed. Malaysians use between 201 and 234 liters per person per day, which is almost 40 to 60 liters more than the World Health Organization's recommended level (SPAN, 2020; Rahman, 2021). Low water tariffs, among the cheapest in the region, have encouraged wasteful behaviour. At the same time, about 35 percent of treated water is lost as non-revenue water (NRW), either through leakages in old pipes or illegal connections (The Star, 2020). This means that more than a third of what is treated never even reaches the tap.

Equally troubling is the reliance on rivers. More than 98 percent of supply in Peninsular Malaysia is taken directly from rivers (FAO, 2010). While convenient, this dependence has proven risky. Rivers such as Sungai Selangor and Sungai Langat have suffered repeated pollution incidents, forcing large scale treatment plant shutdowns. In Johor, the Sungai Kim Kim chemical spill in 2019 sickened thousands and closed schools for days, underlining how fragile the system can be when sources are poorly protected (Malay Mail, 2019; Ngah & Othman, 2011).

Overlaying these challenges is the factor of climate change. The El Niño event of 1997–1998, and again in 2014, brought prolonged droughts that reduced dam reserves and forced rationing in Selangor. At the other extreme, heavier downpours have increased the risk of flash floods in cities like Kuala Lumpur and Penang (WWF-

Malaysia, 2020). This mismatch between rainfall, storage, and demand means that even in wet years, water security is not guaranteed.

Given these recurring problems, Malaysia must rethink its approach to water. One promising option is rainwater harvesting (RWH). Although the practice is not new rural households have long used rainwater in jars and tanks it has not been widely integrated into urban planning. Properly designed systems can collect and store clean water directly from rooftops, reducing reliance on centralised supplies and offering a buffer during disruptions (Lee et al., 2016). This paper reviews the key water issues in Peninsular Malaysia and explores how RWH can be better incorporated into water management as part of a more sustainable future.

2. Methods

This paper is based on a desktop review of secondary data from published reports, journal articles, and government documents. Key sources included the Department of Environment (DOE), the National Water Services Commission (SPAN), and international organisations such as the Food and Agriculture Organization (FAO). Peer-reviewed studies were used to provide scientific insights into water quality, consumption, and the potential of rainwater harvesting. Media reports on major water crises such as the Sungai Kim Kim incident and repeated shutdowns in Selangor were also reviewed to illustrate the human and economic impact of water issues. The emphasis was placed on studies and reports published between 2000 and 2023, although earlier sources were included where they provided essential context.

3. Results and Discussion

3.1 Unsustainability of Water Resources

The unsustainable use of water is one of Peninsular Malaysia's most persistent problems. Domestic use is high, with Malaysians consuming far more water than their regional neighbours. In Singapore, average per capita use is around 141 liters per day, while in Thailand it is about 180 liters. Malaysia's average of over 200 liters reflects not only the affordability of supply but also the lack of strong conservation culture (SPAN, 2020; Rahman, 2021). As shown in Table 1, Malaysians consume significantly more water than their regional peers, exceeding both Singapore and Thailand and falling far above the World Health Organization's benchmark. This pattern reflects structural inefficiencies in pricing and public awareness, which in turn strain centralised supply systems.

Table 1 *Average Daily Domestic Water Consumption in Selected Countries (Litres per Capita per Day)*

Country	Average Consumption (L/cap/day)	Source
Malaysia	201–234	SPAN (2020), Rahman (2021)
Singapore	141	PUB Singapore, 2019
Thailand	~180	FAO (2010)
WHO Guideline	150	WHO Standard

On top of high demand is the problem of non-revenue water (NRW). With about 35 percent of treated water lost before reaching consumers, the financial cost is staggering. SPAN has estimated that NRW losses amount to hundreds of millions of ringgit annually. In some states, such as Kelantan and Pahang, NRW rates exceed 40 percent. By comparison, Singapore's NRW is around 5 percent, and Denmark's is under 10 percent (Chan, 2009). As illustrated in Table 2, states such as Kelantan and Pahang report NRW above 40 percent, which is among the highest in the region. Such figures highlight systemic inefficiencies in the distribution network and demonstrate why decentralised solutions like rainwater harvesting are urgently needed to relieve pressure on overstretched infrastructure.

Table 2 *Non-Revenue Water (NRW) Levels by Selected States in Peninsular Malaysia*

State	NRW (%)	Source
Selangor / KL	32	SPAN (2020)
Johor	27	SPAN (2020)
Pahang	42	SPAN (2020)

Kelantan	47	SPAN (2020)
National Average	35	SPAN (2020)
Singapore (for comparison)	~5	PUB, Singapore

It is worth noting that these losses and inefficiencies exist despite Malaysia's relatively advanced treatment infrastructure. What this shows is that infrastructure alone is not enough; management and consumer behaviour matter just as much. Here, rainwater harvesting offers a way forward. By diverting rain for everyday non-potable uses gardening, washing, flushing toilets households can cut their reliance on treated water by up to 30 percent (Lee et al., 2016). This might seem modest, but at the national scale it would mean millions of liters saved daily, easing pressure on overstretched distribution networks.

3.2 River Pollution and Catchment Degradation

If there is one issue that has repeatedly made headlines in Peninsular Malaysia, it is river pollution. Time and again, millions of residents in the Klang Valley have faced sudden dry taps because solvents, diesel, or ammonia entered rivers like Sungai Selangor or Sungai Langat. In 2019 alone, several shutdowns were reported, with some lasting days and affecting schools, hospitals, and businesses (Malay Mail, 2019). The Sungai Kim Kim chemical spill in Johor was even more alarming: toxic fumes sickened thousands of schoolchildren and forced the closure of dozens of schools (Ngah & Othman, 2011). These incidents demonstrate how vulnerable the water system is when nearly all supply depends on a few rivers.

Beyond pollution, catchment degradation poses another threat. Logging, quarrying, and unregulated development have stripped forests that serve as natural filters and regulators. In Kedah, the Ulu Muda Forest Reserve supplies water to three states Kedah, Perlis, and Penang yet logging continues to threaten its integrity (WWF-Malaysia, 2020). Deforested catchments increase sediment loads in rivers and reservoirs, raising treatment costs and reducing storage capacity.

Rainwater harvesting does not eliminate the need for river conservation, but it reduces the stakes. By capturing clean rain directly from rooftops, households and industries bypass polluted rivers entirely. Furthermore, widespread adoption of RWH reduces stormwater runoff, lowering the pollutant load carried into rivers. In other words, rainwater harvesting both lessens dependence on contaminated rivers and contributes indirectly to cleaner catchments (Lee et al., 2016).

3.3 Drinking Water Safety

Access to treated water is high in Peninsular Malaysia, with more than 95 percent of the population connected to piped supplies (SPAN, 2020). On the surface, this sounds like a success story. Yet the question of safety remains. While water leaving treatment plants often meets the Ministry of Health's standards, what happens along the distribution chain is more complicated. Old pipes, illegal connections, and poorly maintained storage tanks can introduce contamination before water reaches households.

Studies have highlighted these risks. Azrina et al. (2011), for example, found elevated levels of aluminium and other inorganic elements in tap water samples across several states. Qaiyum et al. (2011) reported that aluminium concentrations in Batu Pahat, Johor, could pose long-term health risks if consumed over time. Although these levels may not always exceed guideline limits, the presence of such contaminants undermines public confidence. It is therefore not surprising that many Malaysians choose to rely on bottled water or invest in home filtration systems (Chan, 2009).

Here, rainwater harvesting presents an interesting alternative. When collected from rooftops and passed through basic filtration and disinfection, rainwater can meet or even exceed the safety of piped water (Lee et al., 2016). Unlike rivers, which are exposed to sewage, industry, and agricultural runoff, rainfall starts out relatively clean. The main risk is microbial contamination from debris or animal droppings on rooftops, but this can be managed through simple measures such as first-flush devices and periodic tank cleaning. Countries like Australia and Japan already use rainwater for potable purposes under regulated conditions. While Malaysia may not be ready to make that leap nationwide, household-level RWH can still provide a safer, decentralised source of water for non-potable needs, and potentially for drinking with proper treatment.

3.4 Water Disruptions in Urban Areas

For residents of Klang Valley, water disruptions have become an unfortunate routine. Pollution incidents in Sungai Selangor and Sungai Semenyih have forced multiple shutdowns of treatment plants over the past decade. Each time, millions of people were left without water for days, prompting long queues at public tankers and panic buying of bottled water (Malay Mail, 2019). Businesses and schools also bore the brunt of these crises, with productivity losses estimated in the millions of ringgit.

Part of the reason disruptions are so severe is the low reserve margin in Selangor, which in recent years has hovered close to zero (SPAN, 2020). With little buffer between supply capacity and demand, any plant closure instantly creates a crisis. Pipe bursts, particularly in older parts of Kuala Lumpur, add another layer of disruption. Table 3 summarises several of the major disruption events between 2014 and 2020. The table illustrates that both climate variability (such as droughts during El Niño) and anthropogenic factors (such as illegal chemical dumping) have repeatedly triggered large-scale shutdowns affecting millions of residents.

Table 3 *Major Water Disruption Incidents in Peninsular Malaysia (2014–2020)*

Year	Location	Cause of Disruption	Population Affected	Duration
2014	Selangor / KL	El Nino drought; low dam level	~ 2 million	Weeks
2019	Johor (Sg. Kim Kim)	Chemical spill (Illegal dumping)	Thousand sickened, school close	Days
2019	Selangor (Sg. Selangor)	Solvent pollution	4 million	3-4 days
2020	Selangor (Sg. Semenyih)	Industrial waste	>1 million	2-3 days

Rainwater harvesting is not a silver bullet, but it can act as a cushion. If households had even small tanks storing rainwater, essential functions such as flushing toilets and cleaning could continue during outages. For institutions like schools and hospitals, having dedicated RWH systems would mean sanitation could be maintained even when piped supply is interrupted. Climate Variability and Changing Weather Patterns

Climate change is reshaping Malaysia's water landscape in ways that are only beginning to be fully understood. The El Niño of 1997–1998, followed by another in 2014, brought long dry spells that lowered dam levels and triggered rationing in Selangor and Negeri Sembilan (WWF-Malaysia, 2020). On the flip side, heavier downpours have increased the risk of flash floods in urban centers. Kuala Lumpur, Penang, and Johor Bahru have all experienced damaging floods in the past decade, overwhelming storm drains and paralysing traffic.

These extremes pose a double challenge. During droughts, the problem is not the absence of rain altogether but the inability to store enough when it does fall. During heavy rain, the issue is excess runoff, which causes floods and carries pollutants into rivers. Reservoirs and dams are part of the solution, but they cannot capture every drop, especially when catchments are degraded and sedimentation reduces their capacity (Ngah & Othman, 2011).

Rainwater harvesting fits neatly into this gap. At the household and community level, RWH acts as distributed storage, catching rainfall during wet periods and keeping it for later use in dry spells (Abdulla & Al-Shareef, 2009). In urban settings, it also reduces stormwater volumes entering drains, helping to mitigate flash flooding. Put simply, RWH strengthens resilience to both ends of climate variability whether it is too little rain or too much.

3.5 Institutional and Governance Challenges

No discussion of water issues in Peninsular Malaysia is complete without looking at governance. Water is a state matter under the Federal Constitution, yet water services are regulated federally through SPAN. Pollution control is handled by the DOE, while flood management falls under the Department of Irrigation and Drainage. This patchwork arrangement often leads to overlapping responsibilities and coordination gaps (Chan, 2009).

Privatisation of water services has produced mixed outcomes. In Selangor, the consolidation of water services under Air Selangor improved financial sustainability, but it did not prevent frequent disruptions caused by pollution or pipe bursts (Rahman, 2021). Public frustration remains high, and confidence in water authorities is fragile.

Rainwater harvesting has been written into policy but struggles in practice. The 2011 amendment to the Uniform Building By-Laws requires RWH in new developments in Kuala Lumpur and Selangor. However,

enforcement has been weak, and many systems are installed only in name, with little real integration into plumbing networks (Lee et al., 2016). Without stronger monitoring and incentives, RWH risks remaining a “paper policy” rather than a functional solution.

If Malaysia wants to mainstream RWH, governance must change. This means stricter enforcement of building codes, financial support for households and industries, and awareness campaigns to build public acceptance. Just as importantly, RWH must be woven into the larger framework of Integrated Water Resources Management (IWRM), where decentralised systems are seen as part of the solution rather than an optional extra.

3.6 Solutions and Policy Directions

The range of water issues faced in Peninsular Malaysia makes it clear that no single solution will be enough. Demand-side management, supply diversification, catchment protection, and governance reforms must all come together. Within this broader mix, rainwater harvesting (RWH) stands out as a practical and underutilised tool that can deliver immediate and long-term benefits.

At the household level, RWH can play a direct role in reducing demand. Research suggests that nearly half of domestic water use goes to activities such as flushing toilets, laundry, and cleaning uses that do not require high-quality treated water (Lee et al., 2016). By substituting harvested rainwater for these functions, households can significantly reduce their reliance on piped supply. Incentives such as rebates, subsidies, or tax deductions could accelerate uptake. As presented in Table 4, household uses such as toilet flushing, gardening, and cleaning together account for a significant share of daily demand, and these functions are highly suitable for rainwater substitution. Studies suggest that adopting RWH could reduce household reliance on treated supplies by up to 30 percent (Lee et al., 2016). In countries like Australia, government rebates for RWH tanks have driven widespread adoption, while in Singapore, new buildings are often required to incorporate water-saving measures as part of broader sustainability standards (Abdulla & Al-Shareef, 2009). Malaysia could adapt similar approaches.

Table 4 *Major Water Disruption Incidents in Peninsular Malaysia (2014–2020)*

Use Category	Share of Household Demand (%)	Suitable of RWH	Estimated Reduction if RWH Adopted
Toilet Flushing	30-35	High	Fully
Laundry	15-20	Moderate – High	Partially
Gardening / Outdoor	10-15	High	Fully
Drinking / Cooking	10-15	Low (unless treated)	Minimal
Cleaning / Washing Cars	10-15	High	Fully

For public institutions and community facilities, RWH should be considered essential rather than optional. Schools, hospitals, mosques, and government offices could all benefit from having their own backup water supply. During the Selangor crises of 2019, for instance, many schools were forced to shut down for several days due to sanitation issues, while hospitals scrambled to maintain critical services (Malay Mail, 2019). If such institutions had integrated RWH systems, the impact on public health and daily operations would have been less severe.

Industries, too, have a role to play. Manufacturing and food processing are particularly water-intensive, and they often rely heavily on municipal supplies. By adopting RWH, industries can lower their water bills and reduce strain on the public system. Recognition programs such as green certifications or awards for companies that integrate RWH—could encourage voluntary uptake (Rahman, 2021).

Policy and governance frameworks must evolve to support this transition. While the 2011 amendment to the Uniform Building By-Laws (UBBL) technically requires new developments in Kuala Lumpur and Selangor to install RWH systems, enforcement has been weak (Lee et al., 2016). Developers often install small tanks merely to comply on paper, without ensuring they are functional. Stronger enforcement such as inspections tied to occupancy permits would make a difference. State governments could also take the lead by mandating RWH in all new public housing projects and government buildings.

At the same time, catchment protection cannot be ignored. RWH reduces dependence on rivers, but rivers will remain central to Malaysia’s supply. Stricter enforcement of environmental regulations, higher penalties for illegal

discharges, and stronger gazettement of forest reserves are essential (Nghah & Othman, 2011). Protecting catchments ensures that both surface water and harvested rainwater remain viable for the long term.

Finally, Malaysia can draw lessons from international experiences. Singapore's "Four National Taps" strategy integrates imported water, desalination, recycled water (NEWater), and local catchments into a cohesive national framework (Lee et al., 2016). Australia, facing frequent droughts, has mainstreamed RWH at both the household and community levels with government support. These examples show that RWH works best when it is not left to individuals alone but is embedded in national water planning.

4. Conclusion

Peninsular Malaysia's water paradox abundance alongside scarcity reflects deep-rooted inefficiencies in consumption, distribution, and governance. High per capita use, excessive non-revenue water, polluted rivers, frequent disruptions, and the growing pressures of climate change have all combined to create a fragile water system (SPAN, 2020; Rahman, 2021). While infrastructure has expanded and access to treated water is high, the reliability and safety of that supply remain uncertain.

Rainwater harvesting offers a way to ease these pressures. It does not replace rivers or reservoirs, but it provides a decentralised layer of resilience. By capturing rain at the point of use, RWH reduces demand on central systems, offers a buffer during disruptions, and mitigates both drought and flood risks. At the household scale, it helps families cut bills and gain some independence from supply interruptions. At the institutional and industrial scales, it ensures continuity of essential services and supports sustainability goals (Lee et al., 2016).

For RWH to reach its potential, Malaysia must move beyond symbolic policies. This means stricter enforcement of building codes, financial incentives for adoption, mandatory use in public facilities, and strong awareness campaigns to build a culture of water conservation. Coupled with improved catchment protection and pollution control, RWH can become more than just an add-on it can be a cornerstone of water security.

Ultimately, securing Peninsular Malaysia's water future will require an integrated approach that balances centralised and decentralised systems, protects the environment, and engages the public. Rainwater harvesting alone cannot solve every problem, but without it, Malaysia risks continuing down a path of recurring crises. By mainstreaming RWH as part of a broader water strategy, the country can turn its rainfall abundance into genuine water security.

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Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this paper.

Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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