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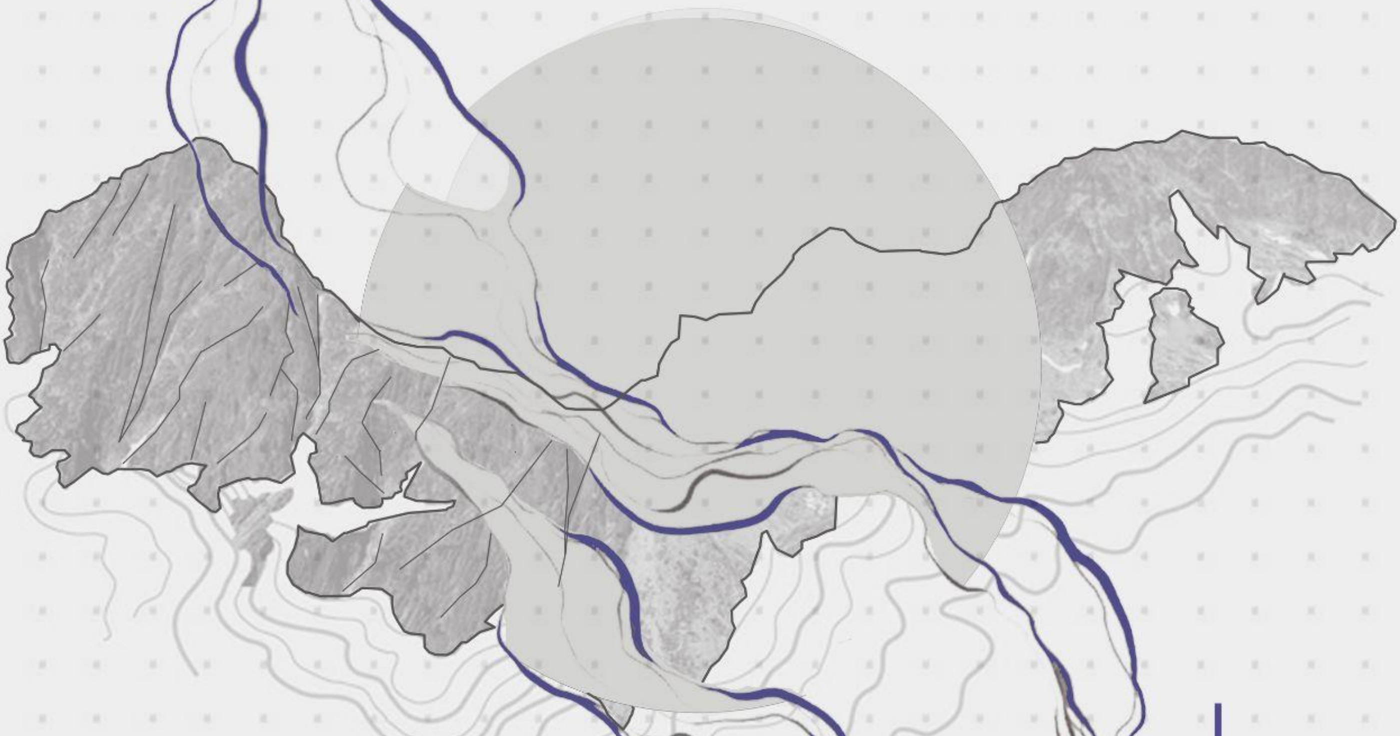

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SHARINGS

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**Nature-Based Solutions for Stormwater Management Resilience: Estimation of Peak Discharge to Detention Pond at Tasik Iskandar, Perak**

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## Abstract

Stormwater management is a critical aspect of urban planning, particularly in the face of increasingly frequent and intense storm events. Nature-based, sustainable approaches can be utilized to enhance stormwater management and improve resilience against storm events. However, the current stormwater management systems in Tasik Iskandar indicate limited implementation of Nature-based and sustainable approaches. Thu s, this study aims to estimate the peak discharge, Q, that flows into the detention pond at Tasik Iskandar. The peak discharge, Q, was calculated using the coefficient of runoff, C, which is highly influenced by the characteristics of the flow area. Hence, quantitative data will be used for this research, applying the Rational Method formula $Q=CiA$ to estimate peak discharge, where Q is the peak discharge, C is the runoff coefficient, I is the rainfall intensity (mm/hr), and A is the surface area (ha). Hydrological data and site-specific parameters were analyzed to ensure accurate estimation based on local conditions. The results of the study showed that the peak discharge of Tasik Iskandar is 0.0067 $m^3/s$. Thus, the nature-based solutions, such as the implementation of vegetated swales, rain gardens, and detention ponds at Tasik Iskandar, Perak, are recommended to reduce the peak discharge, thereby enhancing the system’s ability to manage stormwater more effectively and achieve greater environmental sustainability.

***Keyword***: Stormwater Management, Nature-Based Solutions (NBS), Peak Discharge, Detention Pond, Rational Method

## INTRODUCTION

Stormwater management in urban areas has become a significant challenge due to the rapid and unplanned growth of urban areas, the removal of vegetation, the decline in the effectiveness of drainage infrastructure, and climate change (Raghu et al., 2022). However, as cities face more stormwater challenges, planning to build a detention pond could help reduce peak flow rates entering downstream water bodies. Detention ponds are also designed to temporarily store excess stormwater runoff, reducing the risk of flooding and encouraging controlled discharge into natural water bodies (Stormwater Detention: How It Works, 2016).

Indeed, the main factors affecting peak discharge include rainfall characteristics such as duration, amount, intensity and pattern. Accurate estimation of peak discharge entering such detention pond is essential for effective design, capacity planning, and flood mitigation strategies (Cheah et al., 2019). Hence, Nature-Based Solutions (NBS) provide positive alternative by employing natural processes, such as conservation of wetlands, supplemental vegetation, and soil infiltration, to manage stormwater runoff. The integration of nature-based solutions (NBS) in stormwater management contributes to several United Nations Sustainable Development Goals (SDGs), such as SDG 11 (Sustainable Cities and Communities), and SDG 15 (Life on Land). Incorporating Nature-Based Solutions (NBS) into urban land management can enhance resilience in both urban and rural areas, safeguard biodiversity, improve quality of life, and promote the sustainable use of natural resources. These practices not only reduce the peak discharge that flows into detention ponds but also yield other environmental benefits, including improved water quality, increased biodiversity, and enhanced climate resilience.

Tasik Iskandar faces several issues related to stormwater, including stagnant water accumu lation around the study area, which demonstrates poor drainage and the potential for localized flooding. These problems are likely a function of low detention capacity and increased runoff from nearby development. Therefore, this study will estimate the peak discharge, Q, into the detention pond at Tasik Iskandar using rational methods. To determine that the detention pond at Tasik Iskandar can withstand various storm magnitudes, the estimation of peak discharge, Q, the highest volume of water entering the detention pond during a storm event, is required. Besides, the integration of NBS can contribute to reducing peak discharge rates without being a detrimental approach to stormwater management. Through the evaluation of these natural solutions, this study will present an integrated stormwater management strategy that not only expands the detention pond capacity but also enhances the resilience of the local ecosystems.

## LITERATURE REVIEW

### *Stormwater Management*

Urbanization has significantly altered the natural hydrological cycle through the replacement of permeable surfaces with impervious structure such as pavements, roads, and buildings. This replacement results in decreased infiltration, increased surface runoff, and increased frequency and intensity of urban flooding events (Weng, 2001). Traditional stormwater management systems that are primarily focused on quick conveyance and disposal of runoff through engineered drainage networks have been seen to fall short in addressing the sophisticated challenges of contemporary urban hydrology (Shuster et al., 2005).

The growing frequency and severity of serve weather events, combined with older drainage infrastructure, makes the case for more resilient and sustainable stormwater management techniques more urgent. As noted by Fletcher et al. (2015), not only must future stormwater infrastructure deal with flood mitigation, it must also promote water quality improvement, urban biodiversity, and contribute to climate adaptation.

### *Detention Ponds*

Detention ponds are components of stormwater management facilities that function by temporarily storing runoff and releasing it at controlled rates to minimize flooding and erosion. In Malaysia, the design of these facilities to prevent flash floods, especially in urbanized catchments with extensive impervious surfaces, is dictated by the Stormwater Management and Drainage Manual (MASMA) (Harun, 2006). Studies have established that detention ponds are effective in reducing peak flow rates, thereby mitigating downstream flood risks. A study in the Segamat River Basin, for example, concluded that the installation of detention ponds reduced peak discharges by approximately 1% for high-flow events, which signaled their role in flood mitigation (Azmi et al., 2021).

### *Nature-Based Solutions (NBS) in Stormwater Management*

Nature-Based Solutions utilize natural processes and ecosystems to reduce environmental issues, such as stormwater management. These solutions involve practices such as green roofs, permeable pavements, rain gardens, and constructed wetlands, all of which are designed to promote water all of which are designed to promote water infiltration, reduce surface runoff, and improve water quality (Barton et al., 2015). The "sponge city" concept is an example of this strategy, aiming to design urban spaces to absorb and hold rainwater, lowering flood risks and recharging groundwater. Sanya, China, has been successful in adopting similar measures, combining green spaces and permeable surfaces to effectively deal with stormwater (Yu, 2024). However, for this research, the role of NBS help to reduce the volume and intensity of stormwater runoff into detention ponds significantly. By enhancing natural infiltration and storage, NBS can slow peak discharges, reduce their magnitude, and improve overall detention system performance (Fletcher et al., 2013). For instance, green roofs and permeable pavements have been associated with a 30% - 40% reduction in peak discharge rates in urban catchments (Gersonius et al., 2013).

In Tasik Iskandar case study, incorporating NBS such as constructed wetlands and riparian buffers can provide additional storage in addition to attenuating runoff flow before it enters the detention pond. Beyond reducing peak discharge, this is also a solution that enhances water quality by eliminating pollutants through filtration (Bernhardt et al., 2017). Moreover, incorporating multifunctional green spaces that not only manage stormwater can increase public acceptance and facilitate the sustainability of such programs (Ahern, 2011).

### *Rational Method*

The Rational Method is one of the most used methods for determining peak discharge in small urban catchments. The formula is $Q = CiA$, where C is the runoff coefficient, i is rainfall intensity, and A is the catchment area (Maidment, 1993). Due to its simplicity, it can be applied to early stormwater design, particularly in areas that are rapidly becoming more urbanized. In Tasik Iskandar, Perak Tengah, the method is applicable due to the increasing impervious surfaces resulting from urbanization. Using volume estimation methods, Mohd Noh et al. (2025) investigated the capacity of detention ponds and emphasized the need to find accurate peak discharges. The inclusion of the Rational Method effectively aids in planning and flood prevention in urban areas.

The approach is a useful tool for assessing the hydrological effects of various land uses, such as pervious parklands, asphalt roads, and impermeable commercial zones, because it depends on land surface features of the runoff coefficient. Based on Nature-Based Solutions (NBS), which use ecological design interventions to promote infiltration and decrease surface runoff, this sensitivity to land cover is crucial. In this way, the Rational Method not only measures runoff but also assists in determining the important surface types that have the greatest impact on peak discharge. This information is essential for suggesting NBS such as permeable pavements, green roofs, or bioswales (Fletcher et al., 2015).

***Runoff Coefficient Table***

In this study, the runoff coefficient table was used to calculate the peak discharge, Q, where the C, coefficient was derived from the runoff coefficient table, which in turn was determined by the surface characteristics, and to estimate the amount of water runoff that would flow into the detention pond in the study area.

| DESCRIPTION OF AREA | RUNOFF COEFFICIENT |
|---|---|
| Business | |
| Downtown | 0.70 - 0.95 |
| Neighborhood | 0.50 - 0.70 |
| Residential | |
| Single-family | 0.30 - 0.50 |
| Multiunits, detached | 0.40 - 0.60 |
| Multiunits, attached | 0.60 - 0.75 |
| Residential (suburban) | 0.25 - 0.40 |
| Apartment | 0.50 - 0.70 |
| Industrial | |
| Light | 0.50 - 0.80 |
| Heavy | 0.60 - 0.90 |
| Parks, Cemeteries | 0.10 - 0.25 |
| Playgrounds | 0.20 - 0.35 |
| Railroad yard | 0.20 - 0.35 |
| Unimproved | 0.10 - 0.30 |
| CHARACTER OF SURFACE | |
| Pavement | |
| Asphaltic and concrete | 0.70 - 0.95 |
| Brick | 0.70 - 0.85 |
| Roofs | 0.75 - 0.95 |
| Lawns, sandy soil | |
| Flat, 2% | 0.05 - 0.10 |
| Average, 2-7 % | 0.10 - 0.15 |
| Steep, 7% | 0.15 - 0.20 |
| Lawns, heavy soil | |
| Flat, 2% | 0.13 - 0.17 |
| Average, 2-7 % | 0.18 - 0.22 |
| Steep, 7% | 0.25 - 0.35 |

**Figure 1: Runoff Coefficient Table**
*Source: Chegg.com, 2020*

Based on Figure 1 above, the runoff coefficient table helps estimate the volume of water that will runoff over time, which depends on the type of land cover in the study area. By using this tool, the study was able to calculate the peak discharge more accurately and gain a better understanding of how well the pond could handle stormwater during heavy rain events.

Several studies have emphasized the importance of using runoff coefficients that are tailored to local conditions, as runoff behavior is strongly influenced by factors such as regional rainfall intensity, soil texture, and land management practices (Cheah et al., 2019; Mohd Noh et al., 2025). Applying general or non -site-specific values can lead to either underestimation or overestimation of runoff volumes, which in turn may compromise the design efficiency and performance of stormwater infrastructure like detention ponds. Recognizing this, the present study refers to a standardized runoff coefficient table but applies it thoughtfully by considering the actual land use characteristics and surface conditions specific to the Tasik Iskandar catchment. This ensures that the discharge estimation is not only methodologically sound but also more reflective of the real-world hydrological response of the study area.

## RESEARCH METHODOLOGY

This study employs a quantitative methodology, utilizing an experimental approach, to measure the peak discharge (Q) using the Rational Method and assess the effectiveness of Nature-Based Solutions (NBS) in enhancing stormwater resilience within Tasik Iskandar, Perak. The methodology encompasses site selection, data collection to estimate the volume of water run over time for each identified characteristic, and scenario analysis that incorporates NBS interventions.

### *Site Selection*

This research will be conducted in a mixed development area near Tasik Iskandar, located in Perak Tengah, Malaysia (4°21'45"N, 100°57'36"E), with a site area of 58.90ha, as shown in Figure 2. This area was chosen due to its proximity to a new development, which highlights the importance of managing local stormwater effectively. Its position and the potential for implementing Nature-Based Solutions (NBS) make it an ideal case study for evaluating flood mitigation, improving water quality, and enhancing watershed resilience.

**Figure 2:** Location plan, Seri Iskandar, Perak
*Source: Google Earth 2024*

### *Detention Pond of Tasik Iskandar*

The detention pond at Tasik Iskandar is built to help manage stormwater during heavy rain. When there is a lot of rain, it holds the extra water for a while and then releases it slowly into the river nearby Sungai Seluang, which helps prevent flooding in the area. This is especially helpful in towns and cities where roads, buildings, and other paved surfaces prevent water from soaking into the ground.

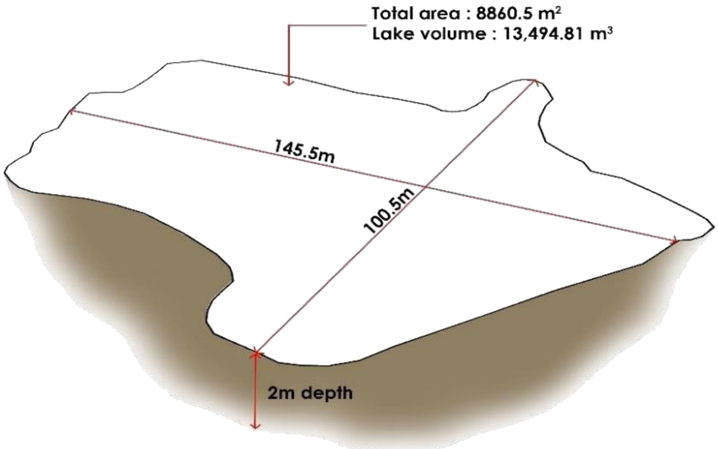


**Figure 3: Tasik Iskandar, Perak**
*Source: Author (2025)*

Figure 3 shows the estimated lake volume of 13,494.81 m³ for Tasik Iskandar, Perak. Using the Average End Area Method (AEAM) to estimate the pond's storage capacity, offering a practical and reliable way to understand how well it can handle stormwater during heavy rain (Hui, 2018). By calculating the volume based on the pond's cross-sectional dimensions, AEAM helped to assess whether the detention pond is sized appropriately to manage peak discharge and meet design storm requirements.

However, the detention pond at Tasik Iskandar represents more than just a flood control structure. As a nature- based solution, it also supports important ecological functions by slowing down runoff, encouraging groundwater recharge, trapping sediments, and providing a space that blends with the natural landscape.

***Equipment Tools***

The equipment utilized in this study was carefully designed to ensure accurate data collection and to support a clear and reliable analysis of how the treatment performed.

a) Measuring wheel b) Laser distance meter c) Phone camera

**Figure 4:** Equipment
*Source: Author (2025)*

The data from this study were collected using measuring tools, such as a measuring wheel and a laser distance meter, to ensure the accurate representation of the site's physical area. The measuring wheel helped confirm the pond's perimeter and surface dimensions, ensuring that the data used in rational methods accurately reflected the actual ground conditions. This was important for estimating peak discharge and planning effective stormwater management. The laser distance meter was handy for measuring lengths and depths inhard-to-reach areas, such as the deeper parts of the pond or spots covered with thick vegetation. Using both tools helped reduce the risk of errors that might occur if relying only on maps or satellite images

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a) Impervious surface b) Culvert system c) Detention pond Tasik Iskandar d) Measurements of the road surface

**Figure 5:** Site Observation and Photography Documentation
*Source: Author (2025)*

Figure 5 shows the photographs, taken to capture features such as vegetation cover, existing drainage infrastructure, visible signs of soil erosion, and locations prone to water accumulation or stagnation. These visual records served as valuable references for site analysis, supporting observations made during fieldwork and providing a clearer picture of site conditions and how water interacts with the surrounding environment.

## RESULTS & DISCUSSION

### *Peak Discharge Estimation, Q*

The peak discharge (Q) was estimated using the Rational Method, which incorporates the runoff coefficient (C), rainfall intensity (i), and surface area (A). The calculation was performed using the standard rational formula. (Russo, 2009; Budianto et at.,2017)

$$Q = CiA$$

The runoff coefficient (C) is a dimensionless value determined by various characteristics of the drainage area, including soil type, slope, and vegetation cover. The rainfall intensity (i) is measured in millimetres per hour (mm/h), while the surface area (A) is expressed in hectares (ha). Therefore, Figure 6 below illustrates the surface characteristics of the study area, which is crucial for understanding how the catchment responds to rainfall, particularly when estimating peak discharge, Q

.


**Figure 6:** Land use and surface characteristics

*Source: Author (2025)*

**Table 1:** Peak discharge, Q estimation in the study area

| Surface Characteristic | Coefficient (C) | Intensity (i) | Area (A) | Q |
|---|---|---|---|---|
| Business districts | 0.72 | 0.12mm/hr | 0.99ha | 0.00024 $m^3/s$ |
| Residential (Medium Density) | 0.40 | 0.12mm/hr | 10.05ha | 0.0013 $m^3/s$ |
| Pavement (Asphaltic) | 0.82 | 0.12mm/hr | 9.66ha | 0.0026 $m^3/s$ |
| Parks | 0.17 | 0.12mm/hr | 2.62ha | 0.00015 $m^3/s$ |
| Unimproved | 0.20 | 0.12mm/hr | 35.58ha | 0.0024 $m^3/s$ |
| | | | **Total of peak discharge, Q** | **0.0067 $m^3/s$** |

*Source: Author (2025)*

Table 1 outlines the estimated peak discharge values (Q) for different surface characteristic types within the site study, based on the Rational Method. An average rainfall intensity of 0.12 mm/hr was used, where the data for May 2025 were retrieved from the official website of Public Infobanjir and applied in the calculation. Runoff coefficients (C) were tailored to reflect the specific characteristics of each type of surface. The surface characteristics encompass a mix of urban and natural areas, including business districts, medium -density residential zones, asphaltic pavements, parks, and unimproved land.

The result shows that pavement (asphaltic) with the highest runoff coefficient, C = 0.82, leads to the highest peak discharge, Q = 0.0026 $m^3/s$, compared to other surface areas, even though the surface area of pavement (asphaltic) is less than 10 ha. This finding, supported by scholar Ghani (2010), highlights that impervious surfaces, such as roads and pavements, typically result in high runoff due to their minimal infiltration capacity, even in relatively small areas. Similarly, Abdul Latif et al. (2024) observed that built -up commercial zones tend to generate substantial runoff volumes, driven by surface conditions rather than size alone. Meanwhile, unimproved land with 35.58 ha and a runoff coefficient (C=0.20), yet it contributes a second higher peak discharge, Q=0.0024$m^3/s$. According to Iskandar et al. (2014), larger areas of natural or open land, despite lower runoff coefficients, can still yield notable discharge rates when exposed to uniform rainfall, particularly in tropical regions.

The findings indicate that the volume of water runoff over time varies based on surface characteristics, as different surfaces have varying coefficients of runoff. Surface characteristics play a vital role in controlling water runoff, regardless of the area's size. This relationship between land cover type, permeability, and areal extent is also well-documented in national design standards, such as the Urban Stormwater Management Manual for Malaysia (DID, 2012), which advocates for differentiated runoff coefficients based on land use and surface characteristics.

***Relationship between the Volume of water runoff to the Detention Pond Tasik Iskandar***

The total estimated peak discharge, Q = 0.0067 $m^3/s$, from the study area will be directed to the detention pond Tasik Iskandar, which has a storage capacity of approximately 13,494.81 $m^3$. From this data, it was found that the detention pond at Tasik Iskandar can contain runoff for five hundred fifty-five (555) hours of continuous rain, corresponding to a below-light rainfall intensity category.

However, if the rainfall intensity reaches the highest level recorded on the official Public Infobanjir website for the Seri Iskandar station at 0.7 mm/hr, the peak discharge can reach 0.114 $m^3/s$. At this rate, the lake can reach full capacity in less than 36 hours. If the area receives rainfall within the moderate intensity category (11– 30 mm), there will be at least half a day before the lake overflows. Moderate rainfall can cause flooding if it persists over an extended period. Although the rainfall may not seem heavy, a sustained rate means water continues to flow into the pond without enough time for it to drain or evaporate. As a result, the pond may fill up gradually and eventually exceed its detention capacity (its ability to hold water), leading to overflow or flooding. Furthermore, if rainfall intensity increases to moderate or higher levels a scenario that is becoming more likely due to climate change and extreme weather events the time required for the pond to reach capacity would be drastically reduced.

Understanding the relationship between runoff volume from the study area and the detention capacity of Tasik Iskandar is required for effective stormwater management. The ability of the detention pond to accommodate continuous runoff under light rainfall intensity demonstrates the potential of integrating nature-based solutions (NBS) to complement existing infrastructure. Given the surface characteristics of the study area, which likely consist of a mix of impervious surfaces (such as roads, buildings, and paved areas) and limited pervious ground, runoff is generated rapidly, thereby increasing peak discharge during rainfall event.

By recognising this hydrological behaviour, implementing NBS such as bioswales, rain gardens, green roofs, and permeable pavements can help reduce surface runoff. These strategies enhance infiltration, delay peak flow, and reduce the pressure on detention facilities like Tasik Iskandar. Moreover, preserving and enhancing natural landscapes within the urban fabric supports resilience against more intense storm events driven by climate change. Therefore, the runoff-storage relationship serves as a crucial foundation for advocating nature- based, low-impact development approaches that align with sustainable urban water management objectives.

### *Nature-Based Solutions (NBS) for Sustainable Stormwater Management*

Nature-based solutions (NBS) are environmentally sustainable approaches that utilize natural systems or processes to manage water, mitigate flood risks, and enhance ecosystem services in urban environments. According to the International Union for Conservation of Nature (IUCN, 2016), NBS aim to protect, sustainably manage, and restore natural or modified ecosystems to address societal challenges effectively and adaptively.

The findings of this study demonstrate that, particularly in areas with high runoff, such as impervious surfaces like asphalt and business districts, require support for stormwater control through green infrastructure is warranted. The findings were supported by Ghani (2010), who emphasized that imperviousness in urban landscapes significantly alters hydrological responses, increasing runoff volume and peak discharge. In addition, green infrastructure practices such as green roofs, permeable pavements, and vegetated swales substantially reduce runoff and improve infiltration in urban areas (Fletcher et al., 2015; Zölch et al., 2016)

**Table 2:** Recommended Nature-Based Solutions (NBS) in study area

| Surface Characteristic | Finding | Recommended NBS | Expected Impact |
|---|---|---|---|
| Pavement (Asphaltic) | • High peak of discharge, Q<br>• High coefficient, C<br>• Small size area, 9.66 ha<br>• Impervious surface<br>• Low infiltration | • Permeable pavement. | Reduce peak discharge and increase infiltration. |
| Unimproved | • High volume water runoff<br>• Low coefficient, C<br>• Large size area, 35.58 ha<br>• Pervious surface | • Vegetated buffer zones. | Delay runoff and filter overland flow before detention. |
| Residential (Medium Density) | • Moderate water runoff<br>• Medium coefficient, C<br>• Green patch area | • Rain gardens.<br>• Bioswales. | Filter and absorb runoff locally. |
| Business districts | • High water runoff<br>• High coefficient, C<br>• Impervious surface<br>• Compacted surface | • Green roof<br>• Green wall | Delay runoff and improve water reuse, potentially |
| Parks | • Low water runoff<br>• Low coefficient, C | • Tree planting buffer | Enhance evapotranspiration and improve retention. |

*Source: Author (2025)*

Table 2 presents the recommended Nature-based solution for the study area, based on the study's findings. Introducing NBS, such as permeable pavements, rain gardens, vegetated swales, and green roofs, can support in delaying water runoff, reducing peak discharge, and increasing infiltration before it reaches the detention pond. This will help extend the detention time and enhance the long-term sustainability. Therefore, there are a few key benefits of Nature-based solution implementation in the case study through the stormwater management system, which are reducing the volume and speed of surface runoff, improving water quality through natural filtration, especially at Tasik Seri Iskandar and support biodiversity and urban cooling,

### *Stakeholder Roles and Institutional Responsibility*

This study highlights the importance of involving key stakeholders in improving stormwater management at Tasik Iskandar. The local community stands to benefit most, particularly through reduced flood risks, cleaner water, and better public spaces resulting from the use of Nature-Based Solutions (NBS) (Fletcher et al., 2015). The primary responsibility for implementing these strategies lies with Majlis Daerah Perak Tengah (MDPT), the local authority overseeing planning and infrastructure. MDPT significantly contributes to integrating NBS into development plans, ensuring more sustainable and resilient stormwater systems. Their leadership, combined with support from academic institutions, government agencies, and community groups, is crucial to successfully adopting and maintaining these solutions over the long term (Oral et al., 2021; Palerma et al., 2023)

## CONCLUSION

This study set out to estimate the peak discharge flowing into the detention pond at Tasik Iskandar using the Rational Method and to explore the potential of Nature-Based Solutions (NBS) for enhancing local stormwater management resilience. Through the application of quantitative analysis and detailed site-specific data, the peak discharge was estimated at $0.0067m^3/s$, confirming that land surface characteristics, particularly the degree of imperviousness, have a direct and significant impact on runoff volumes. Surfaces such as asphalt pavements and business districts, despite covering smaller areas were found to contribute disproportionately high volumes of runoff due to their low infiltration capacities. Conversely, even larger expanses of pervious land contributed significantly to discharge, demonstrating how surface characteristics must be considered in hydrological planning.

This relationship highlights that it is not just the extent of development that influences stormwater behavior, but also the type and functionality of the surfaces involved. For instance, the pavement area, which measured less than 10 hectares, generated the highest peak discharge (0.0026 $m^3/s$) due to a high runoff coefficient (C = 0.82), illustrating how urban surfaces intensify runoff even in smaller footprints. Similarly, the umimproved land, although having a low runoff coefficient (C=0.20), produced the second highest discharge (0.0024m3/s), primarily due to its extensive coverage of over 35.58 hectares. These findings reflect a broader hydrological reality in rapidly urbanizing areas, such as Tasik Iskandar.

The findings highlight the need for a new approach in stormwater management from purely engineered solutions to a more integrated approach that harmonizes built infrastructure with ecological systems. While the current detention pond infrastructure at Tasik Iskandar demonstrates sufficient capacity to tolerate six hours of light-intensity rainfall, its long-term resilience in questionable considering urban expansion, climate variability, and increasing storm frequency. The study therefore recommends adopting a hybrid approach, in which NBS such as permeable pavements, bioswales, rain gardens, vegetated buffer zones, and green roofs are integrated with existing detention systems to delay runoff, promote infiltration, and reduce peak discharge at the source.

These nature-based interventions not only address the physical dimension of stormwater management but also provide multiple benefits, including enhanced water quality, support biodiversity, urban cooling, and improved aesthetic and recreational value for the community. Furthermore, the implementation of NBS resonates strongly with broader global commitments such as the UN Sustainable Development Goals, particularly SDG 11 (Sustainable Cities and Communities) and SDG 15 (Life on Land). o realize these benefits, coordinated efforts among key stakeholders including Majlis Daerah Perak Tengah (MDPT), urban planners, researchers, and the local community are essential. The role of MDPT is especially critical in ensuring that NBS are embedded within municipal development guidelines and that local planning supports adaptive, low-impact strategies. Institutional commitment, coupled with public awareness and academic contribution, can create a robust governance ecosystem for implementing sustainable stormwater practices.

In conclusion, this research advocates for a resilient, sustainable future for Tasik Iskandar through the adoption of Nature-Based Solutions strategies that not only manage stormwater runoff effectively, but also contribute to ecological restoration, climate resilience, and urban liveability. By embracing green infrastructure such as bioswales, permeable pavements, and rain gardens, Tasik Iskandar can move beyond reactive flood control toward a proactive, adaptive, and inclusive approach to water management. These interventions, while addressing hydrological needs, also support biodiversity, reduce urban heat, and improve the quality of public spaces bringing multiple benefits to both the environment and the community. With strong institutional support and cross-sectore collaboration, Seri Iskandar can position itself as a forward- thinking township that blends ecological integrity with infrastructure efficiency, setting a local example of how cities and towns can thrive in harmony with nature, not in opposition to it. This study emphasizes that resilience is not just about preventing floods, it’s about reimagining urban environments as interconnected, living systems that work with natural processes for the well-being of current and future generations.

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