

Exploring the Malay Landscape of Batam Traditional Malay Settlement through the Lens of Nature-based Solutions

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ABSTRACT

Every existing traditional settlement contains culture-specific identity or elements that can be tangible and intangible, one of which, if integrated, is the formation of cultural landscape. According to 2030 Agenda of Sustainable Development, it is essential for every state or community to safeguard their cultural heritage in achieving sustainable settlement and community while embracing modernity. This study aims to explore and unravel the key biocultural characteristics of vernacular landscape within a rural, traditional Malay settlement on Batam Island. Theoretical framework based on Nature-based Solutions (NbS) and cultural landscape principles are constructed as the basis for this study. Adopting an exploratory research design, qualitative fieldwork methods were employed for real-time data collection with Kampung Melayu in Batam, Indonesia selected as the case study. Findings highlight the undocumented local ecological practices and hidden roles of certain landscape elements shaped by Batam Malay community. Direct observation of twenty dwellings' current landscape identified six typological variants useful to implement NbS into modern landscape planning through Malay practices. Ultimately, this study provides substantial insights that not only conceptualize the vernacular landscape architecture of Batam Malay dwellings, but also expand the role of NbS in heritage preservation, in this context, preserving the Malay cultural landscape.

Keywords: Batam; cultural preservation; Malay landscape; nature-based solutions; traditional settlement

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INTRODUCTION

The human settlement has become part of communal needs and a universal component of developing a civilization. The establishment of settlement is done depending on the material and technology availability on that time. Similar to the present day in the field of engineering, the “trial and error” method was also used in establishing a building/dwelling

comfortable and safe for the community to reside in (Bowen & Gleeson, 2019), especially the traditional community in rural, traditional settlement where the place they settle in still have limited access and knowledge on advanced technology. The settlement itself is established with not only buildings as residence but also the built environment or landscape as the place for performing any types of social interaction.

In general, the majority of traditional settlements in rural area comprises community of homogenous ethnic group. The Malay is an ethnic group that have inhabited the Malay Peninsula and western part of Indonesia for a long time. This community has created an abundance of cultural elements to shape their identity, which of them are their architecture and landscape. The Malay community residing in a traditional settlement is also known to manage the environment surrounding their dwellings, forming a landscape that may be culture-specific (Baharum, 2019). Prior studies recorded soft and hard landscape elements found in the vicinity of traditional Malay dwellings in Malaysia (Zakaria et al., 2017) and the identified landscape elements were positioned typologically (Harun et al., 2017). In addition, ethnobotanical studies conducted in Kampong Bharu (Malaysia) and Sintang (Indonesia) neighborhoods revealed a strong cultural linkage between Malay community and vegetation, in which the plants are mostly used for performing rituals (Adnan & Othman, 2012; Suwardi et al., 2025). Although Hussain et al. (2025) argued that the existence of Malay cultural landscape was strongly reliant on an existing ecosystem and its natural elements, there is a lack of studies focusing on their cultural practices with certain landscape elements, either architectural or natural, within the Malay world that has the possibility to promote sustainability through nature-driven interactions. Furthermore, the evolution of their architectural identity has seen a shift towards a minimalist dwelling, where the changes are significantly different from the indigenous one, leading to degradation of cultural identity in the architectural aspect (Ju et al., 2012; Samat et al., 2024). The architectural shift affects their landscape settings as well and can result in loss of cultural value of the existing community if the cultural erosion persists.

Traditional settlements created by the indigenous community contain historical and cultural value, as well as influence of beliefs. In Batam, *kampung tua* is a local term referring to old/traditional village that has been established by homogenous community before 1970s, the beginning decade of massive urban development of Batam Island, Indonesia (Mayor of Batam City, 2004). Although Batam is a native land to the Malay community, other indigenous communities have also existed and culture-specific traditional settlements were established as well. Prior studies conducted in Batam explored the social aspect in forming a cultural landscape of the Suku Laut (Sea Nomads) community residing in coastal traditional settlement located in southern region of Mainland Batam (Chou, 2024; Suwarlan, Lai, & Said, 2024; Suwarlan, Lai, Said, et al., 2024).

The government of Batam City and Riau Islands Province issued specific local regulations in order to preserve Malay architecture in order to support local sustainability (Governor of Riau Islands Province, 2019; Mayor of Batam City, 2018). Despite the existence of these regulations, the characteristics of its nature landscape as part of the culture are not explicitly elucidated. Recent study emphasizes the importance of considering cultural dimension in sustainable settlement development, such as strengthening the community's local identity, including ecological elements, through culturally inclusive preservation practices (Ibrahim et al., 2025). Additionally, another related comparative study found the significant connection between cultural aspect and local ecological practices, with the traditional villages demonstrate stronger values than non-traditional villages (Luo et al., 2025). Therefore, the aforementioned issue, if remained unaddressed, will cause confusion to the local government in drafting new heritage-related regulations specifically for *kampung tua* as Batam's cultural heritage. This poses a challenge in Batam that might put the long-established Malay settlements at risk as urbanization progresses rapidly. This may also pose life-changing threats to the Malay community, such as land disputes (de Jong et al., 2021), exploitation of local traditional knowledge (Disemadi & Sudirman, 2023), or in the worst case, it is possible for their cultural identity, including landscape elements and local ecological practices, to become history in decades or so.

Addressing both aforementioned literature gap and local challenge, this research aims to explore the human-involved landscape elements and their biocultural characteristics in rural areas of Batam Island. Later with known principles or elements in constructing landscapes within a culturally specific built environment, ideas (research objectives) are obtained for authors to investigate the undocumented nature-based practices the Malay community routinely performs and their cultural significance embedded in the Malay landscape elements, as well as examine the typological landscape layout variants of Malay dwellings shaped by them in a rural traditional Malay settlement. The findings are expected to be a reference for the local government to adopt these into their subsequent policies, particularly regarding Malay landscape architecture characteristics and the evidence-based local rural settlement development. By this, *kampung tua* as local cultural heritage can be safeguarded and cultural continuity of the Malay architectural identity, including their landscape-related local practices, in Batam can be maintained as well. Hopefully, this study will also provide a representative insight into Malay cultural landscape in Batam for landscape architecture and social science scholars worldwide.

LITERATURE REVIEW

Landscape, Cultural Landscape and Its Preservation

In general, human settlement, particularly in rural areas, contains dwellings, supporting buildings and the landscape. The rural or vernacular landscape is fundamentally an open

space rich in vegetation, which is then traditionally modified by the local community to meet their daily needs by utilizing the available land for agricultural purpose and public space for communal interaction between villagers, making it a part of social-ecological system (J. Fischer et al., 2012; Pratiwi & Ikaputra, 2024). The space of landscape intervened by human actions are loaded with numerous manmade products representing their cultural backgrounds and local knowledge. This interference creates an outdoor space that contains implicit interior (Marlor, 2021), cultural values and the presence of existing wildlife and greenery (Boyle, 2008; Chen et al., 2023) that is later known as cultural landscape (Rapoport, 1992).

United Nations (2015) introduced “2030 Agenda for Sustainable Development”, a global sustainability framework to assist all states in addressing issues they have been struggling with. The framework contains seventeen goals in achieving sustainability, in this context, safeguarding cultural and natural heritages as stated in one of Sustainable Development Goals (SDG) 11’s targets. As the United Nations announced the jointly accepted framework, there has been a surge of research covering cultural landscape across the world (Medeiros et al., 2021; Zhou et al., 2024). Theoretically, there are four types of landscape based on the significance contained within a rural settlement: natural landscape (geographic features), agricultural landscape (agriculture), human landscape (history and culture), and living landscape (economy) (Kang & Liu, 2024). In addition, Medeiros et al. (2021) stated that sustainability or ecology studies covering environmental landscape mostly involved interdisciplinary approaches and evaluate numerous indicators related to ecology/ecosystem, land use, economy and history/culture.

Furthermore, UNESCO World Heritage Centre (2008) mentioned that cultural landscape represents a combined works of nature and of man that has significant cultural values that need to be protected by the local society. However, impacts of globalization and modernization enable the disappearance of the built environment, resulting in the erosion of cultural identity (Agnoletti, 2006; Boyle, 2008). Consequently, this will bring adverse outcomes to specific ethnic community in the long term and endeavors are critically required to safeguard their cultural landscape. Assuming cultural landscape as built heritage of such ethnic community (Blake, 2000), ecosystem-related solutions with traditional and conventional technologies are implemented to conserve it for the continuity of their culture (Frantzeskaki et al., 2019; Min, 2025). In contemporary lens, Ibrahim et al. (2025), based on their findings in selected cities, stated that preserving or conserving community’s natural landscape elements, including vegetation and water bodies, as their cultural identity constitutes a part of sustainability endeavors, as this benefits the community not only in economic terms but also in social and cultural dimensions, ensuring cultural continuity. Therefore, as stated above, it is noteworthy that

cultural heritage preservation also plays a role in sustainable settlement development rather than being a secondary concern.

Understanding how a landscape is shaped requires fundamental notions on cultural landscape. Specifically for landscapes in zones rich in cultural values, Solymosi (2011) stated these indicators in identifying a vernacular cultural landscape: 1) distinct cultural community; 2) geographic setting for agricultural practice; and 3) isolation in certain contexts, mainly cultural, economic and infrastructural aspects. In a narrower perspective, human-altered landscape demonstrates the inherent interplay between forms (any physical features), practices (activities, processes) and relationships (intangible values) (Stephenson, 2008). For instance, the existence and conservation of native forests exemplify the cultural landscape serving not only as socio-ecological stabilizer but also as their cultural, ancestral heritage to preserve their identity (Lyver et al., 2017; Wadley & Colfer, 2004). Additionally in a smaller scale and residential context, lawns or home gardens are considered a cultural landscape shaped by the community's cultural norm in landscaping their yard (Harris et al., 2012; Mohri et al., 2013). These imply the presence of nature-inspired cultural values within a well-maintained landscape, highlighting its potential to inform nature-based local policy for conserving both ecosystem and heritage.

Nature-based Solutions and Its Relevance to Cultural Landscape

Mass industrialization accelerates the ongoing urbanization, potentially exacerbating both global and local ecosystems. This issue poses multifaceted threats that affect the continuity of both nature and society so that the loss of biodiversity may occur in the future. To cope with this, Nature-based Solutions (NbS) were introduced to guide planners and policymakers.

NbS, first introduced by International Union for Conservation of Nature (IUCN) in 2009, constitutes a concept comprising actions with the aim to protect, restore and sustainably manage/conservate existing ecosystems that address societal challenges (Cohen-Shacham et al., 2016). Albert et al. (2017) added that NbS, if are about to be implemented, must address socio-ecological challenges and alleviate universally known environmental impacts caused by climate change, so that the approach is able to provide societal, natural and economic benefits to any context. Categorically, NbS in human-involved social-ecological system mainly comprises green, blue and grey infrastructures (Depietri & McPhearson, 2017).

IUCN proposed eight interconnected principles for planners and policymakers in implementing NbS, from embracing natural conservation norms to address context-specific challenges (Cohen-Shacham et al., 2016). Sowińska-Świerkosz and García (2022) simplified the concept into four main points, namely that Nature-based Solutions

1) are inspired and powered by nature, 2) address societal challenges, 3) provide multiple services/benefits related to ecosystem, and 4) are strategies with high effectiveness and economic efficiency. Regarding ecosystem services, there are numerous subservices that can be categorized into four main services society or local community can gain benefits from: provisioning services, regulating services, cultural services and supporting services (Mohri et al., 2013). Figure 1 shows the brief summary and examples of each subservice within the ecological services.

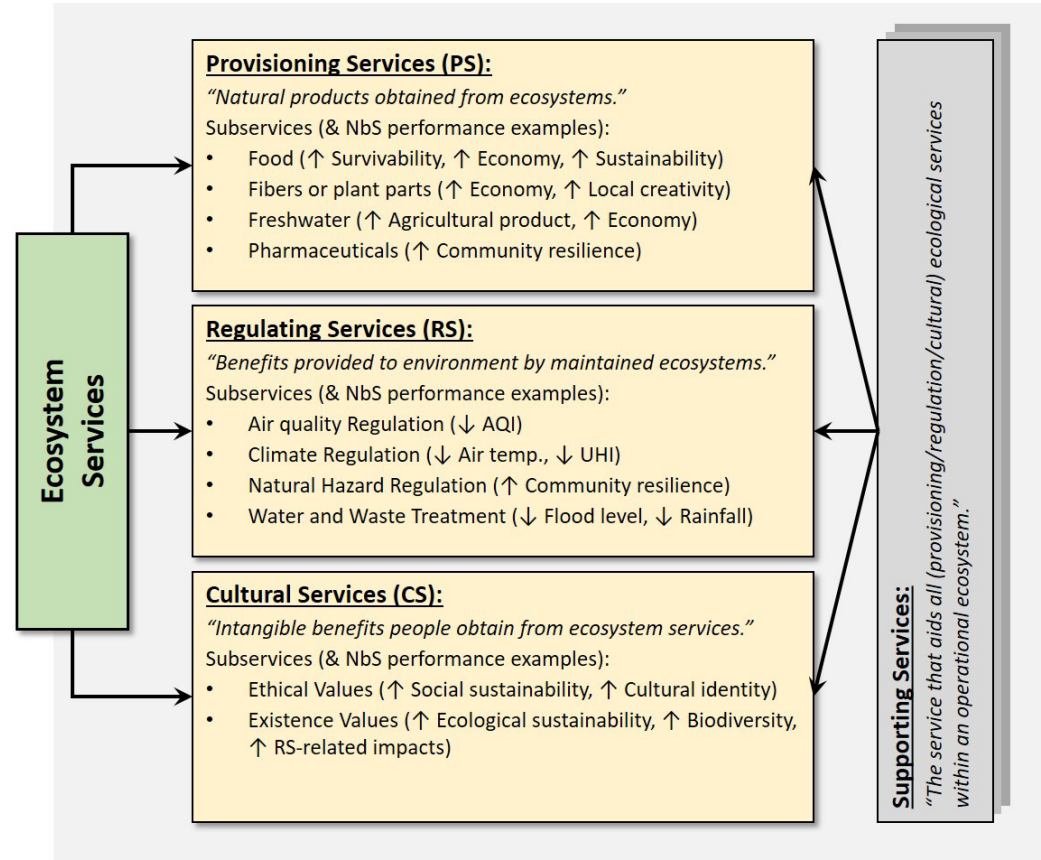


Figure 1. Categories of ecosystem service and their respective subservices and NbS-related performance
Source: Brears, 2020

NbS prioritizes the application of abundant biodiversity elements on existing landscapes. If the landscape is about to be artificially constructed or modified, the implementation of NbS should be contextually specific based on its geographic region (L. K. Fischer et al., 2018; Lechner et al., 2021). In addition, some studies argue that the implementation of NbS can draw lessons from local or cultural context (Delevaux et al., 2025; Tornel-Vázquez et al., 2025), especially the ethnic group residing in rural areas where local knowledge usually plays the pivotal role in shaping the community.

A study in traditional settlements unraveled the strong practical linkage between NbS as modern concept and indigenous construction technique as local wisdom (Luo et al., 2025). Regarding biodiversity as part of green infrastructure, studies revealed that there may be a biocultural relationship between vegetation and culture (Suwardi et al., 2025; Teixeira et al., 2022; Zhang et al., 2020). For instance, recent studies in rural regions explored the profound NbS-related local knowledge and traditional practices of indigenous communities on biodiversity elements in home gardens and surrounding landscapes (Mallick et al., 2024; Sangha et al., 2025). These indicate that traditional practice in rural built environment, such as cultural landscape, can be conceived as the early form of NbS and, therefore, the concept has the potential to be utilized for strategizing cultural heritage preservations (Coombes & Viles, 2021).

Despite the growing body of literature, a critical gap remains at the intersection of NbS and Malay cultural landscape studies. Existing research has predominantly focused on identifying landscape elements or cultural erosion, with limited attention to their ecological functioning as integrated NbS systems. Studies are also predominantly Malaysian-centered, leaving Batam significantly underexplored. This study addresses this gap through an NbS-focused cultural landscape framework applied to a Malay *kampung tua*.

METHODOLOGY

Theoretical Approach to NbS-focused Cultural Landscape Preservation

Official reports and recent studies encompassing landscape, cultural landscape, the preservation of cultural heritage and NbS are retrieved and reviewed for understanding definitions and identifying characteristics, principles, categories, indicators, of each topic used by scholars in their studies. Rapoport (1992, 2008) opined that as long as an ethnic group still exists and that community has been residing in a dwelling or settlement established collectively by them, a cultural landscape always emerged around it in any shape. Therefore, adapted from Stephenson's (2008) "the Cultural Values Model", the concepts and principles of NbS, landscape and cultural landscape drawn from reviewed studies are integrated and constructed within the form of a theoretical framework. This framework will then serve as the basis for this study, including guidance for data collection and elucidation of the collected data.

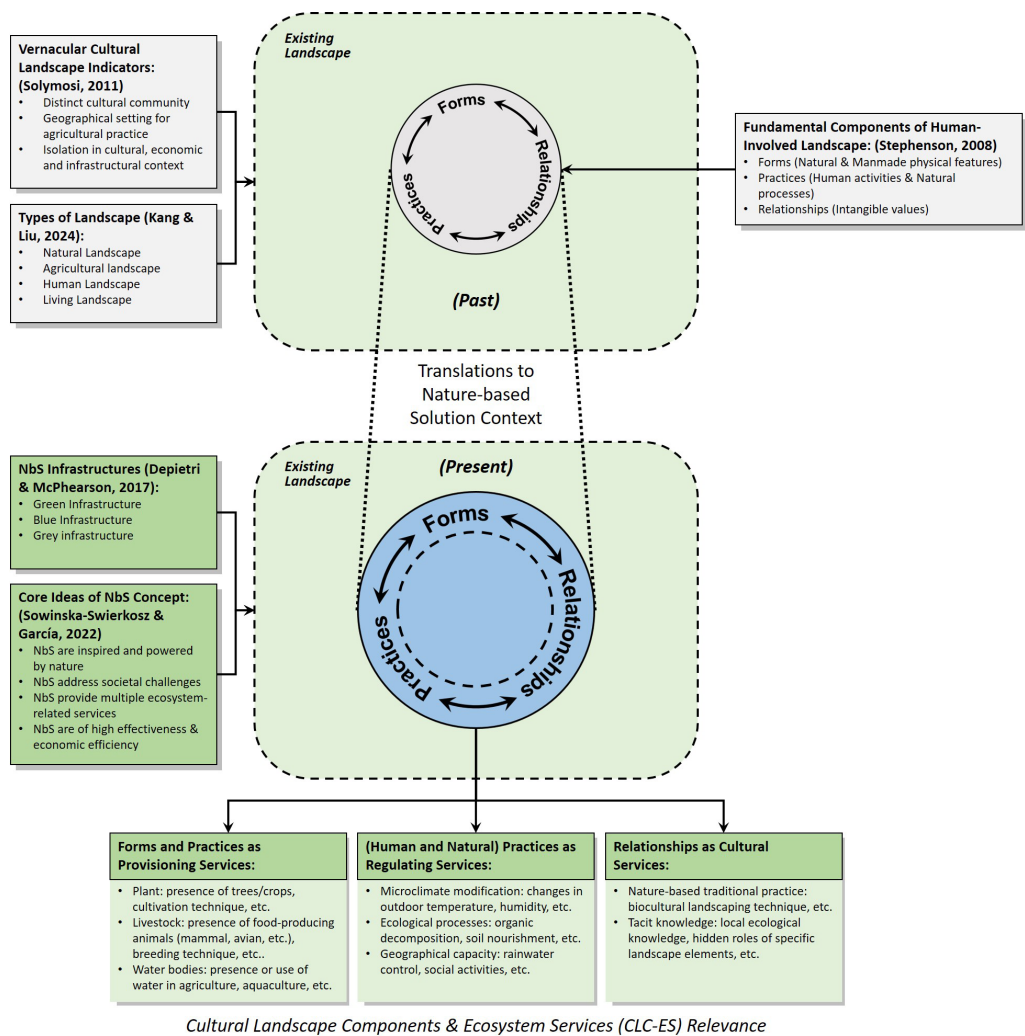


Figure 2. Theoretical framework of NbS-focused cultural landscape
Source: Authors, 2025 adapted from Stephenson, 2008

Research Design

This study employs a one-site case study with exploratory qualitative approaches by utilizing in-depth direct observation and semi-structured interview to identify the unknown NbS characteristics of Malay cultural landscape in the selected *kampung tua*. Direct observation in this study comprises exploring current living environment of the settlement, as well as capturing photographic images of dwelling yards (home gardens) with the presence of landscape elements allowed by homeowner for documentation. Although the landscape can be described after observing the place and several existing dwellings, the findings need to be corroborated with homeowners' responses and cross-referenced with other samples to strengthen the arguments and, therefore, can be generalized. The

interviews were undertaken with seven elderly homeowners of selected dwellings as key informants to obtain ethnographic understanding, including their knowledge on Malay-specific landscape architecture and/or its cultural landscape in the context of Batam society. Informal but respectful conversations were also undertaken with local residents to obtain additional information regarding cultural traditions and functioning ecosystem services within the Malay world.

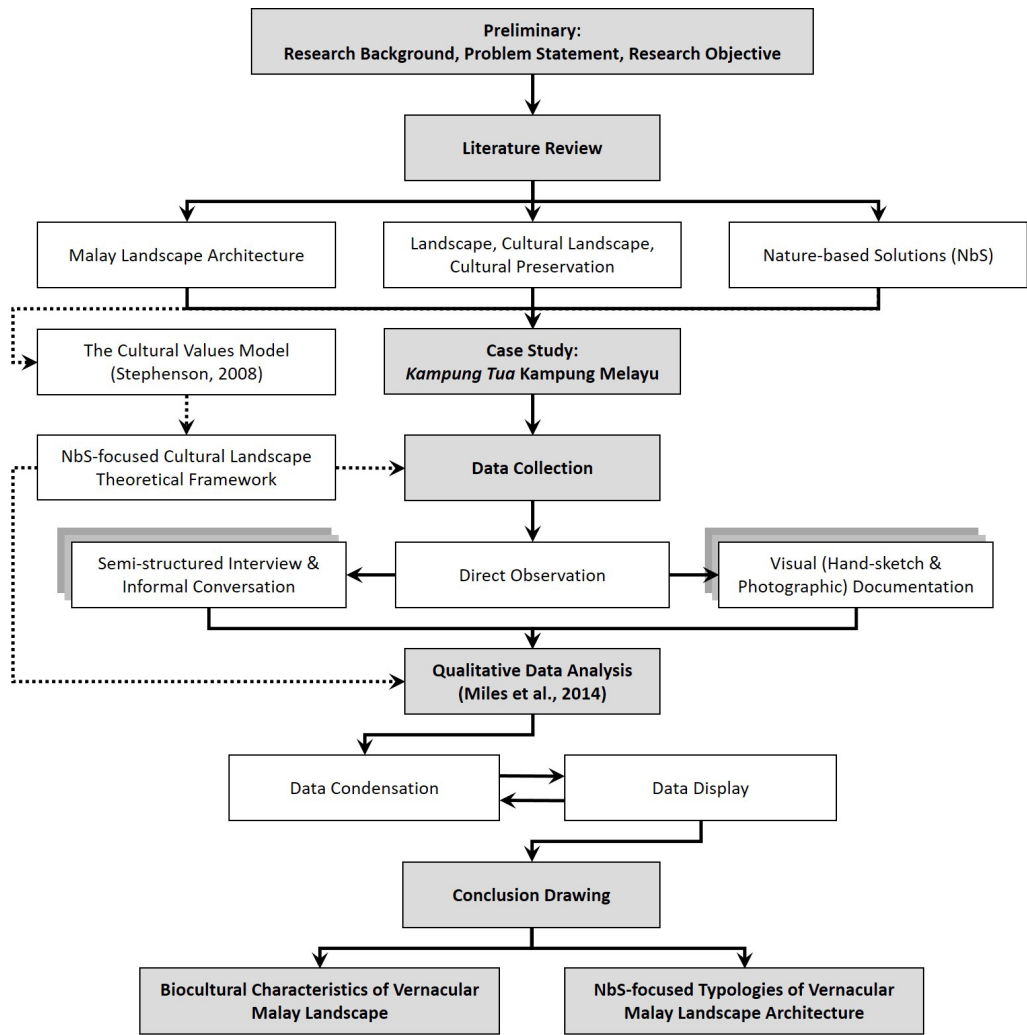


Figure 3. Research flowchart

Batam Island has numerous *kampung tua* that have existed for a long time before the beginning of mass urbanization regulated by Indonesian central government. Kampung Melayu in Batam, Riau Islands Province, Indonesia is selected as a representative case of this study because most existing *kampung tua* in Batam have been urbanized and heavily

industrialized toward modern residences with diverse community and typical suburban climate, making it complicated to observe and find cultural and biodiversity elements of vernacular Malay landscape. The geographic aspect is also one part of reasons as the selected settlement is situated in rural and near-coastal areas, the region that is covered with abundant biological resources and built environment rich in traditional values, compatible for conducting landscape elements investigation.

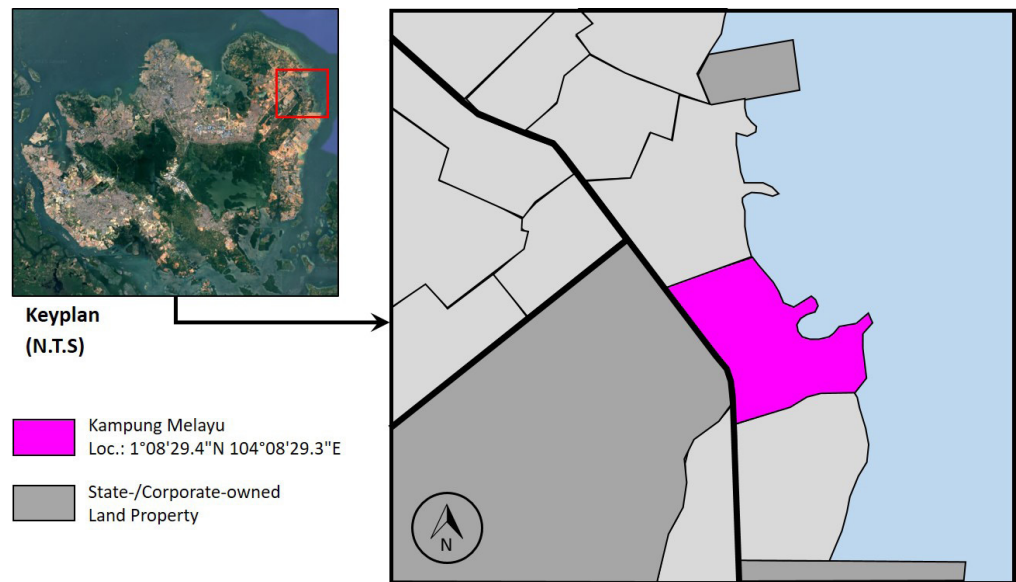


Figure 4. Map of Kampung Melayu in Batam Island, Indonesia

Source: Google Earth, 2025 with Author's modification

There are large amount of existing functional buildings in Kampung Melayu, approximately 900 units including dwellings as of early 2025. Due to this population-related constraint, the study utilized non-probability sampling method, meaning only dwellings that feature prominent landscape elements and erected separately (detached) from other dwellings will be selected for architectural landscape examination. Subsequently, landscape elements found in each dwelling within the settlement will be analyzed, triangulated and descriptively explained through qualitative data analysis, guided by the constructed framework as shown above. Three steps were carried out during the analysis: 1) data condensation, 2) data display, and 3) conclusion drawing (Miles et al., 2014).

RESULTS

Landscape Elements Findings in Kampung Melayu Vernacular Landscape

Rural landscapes tend to contain ecosystems rich in ecological resources. Field observations undertaken in Kampung Melayu discovered that local residents carefully maintain existing ecosystems in their traditional settlement landscape and home gardens.

In line with current state of settlement's ecosystem, most homeowners, regardless of yard or private-owned landscape sizes, have routine activities related to ecosystem: plants and livestock.

Informal conversations were undertaken with several residents regarding their nature-related local practices. Residents who have resided for decades in Kampung Melayu stated that existing flora and fauna have helped shape their cultural identity, with certain characteristics manifested in architectural or spatial practices. Fruit-bearing trees and non-fruit-bearing plants are dominant natural landscape elements in most home gardens or landscape surrounding the building. Regarding hard (manmade) landscape elements, henhouses and potted plants are positioned dynamically within their private lot or communal residential cluster. In certain architectural context, Kampung Melayu dwellings built in a cluster tend to have a wide, shared yard that is frequently used for hosting local events, such as wedding and cultural gathering. In addition, due to minimal presence of hardscapes, plants not only are able to grow on-site but also play several roles in both private and communal landscape regarding plant ownership and outdoor spatiality. Furthermore, numerous conversations revealed that landscape elements and biodiversity entities in Kampung Melayu, specifically within their home gardens, serve specific functions and are expounded in the subsequent section.

Landscape Ecological Services Assessment

Seven elderly homeowners were interviewed along with Malay residential yard surveys to undertake the ecosystem services assessment, as well as corroborate the collected observational data. The questions to homeowners encompass how their cultural identity, such as local traditions and cultural norms, has been shaped and practiced in the form of landscape elements to fulfill their individual needs and address environment-related societal challenges in order to understand Malay-style local NbS and their biocultural characteristics.

Provisioning Services: The interviewed homeowners own both floral and faunal entities within their home garden, reflecting their engagement in ecological conservation. Several stated that conserving existing creatures benefits them in terms of individual needs. In this case, livestock animals such as chicken and rarely ducks are taken care of by several local residents for both biological and economic purposes. Harvesting hen eggs and further raise them to sell livestock products exemplify these integrated purposes, addressing local needs by providing food sources to buyers and generating income for homeowners as both farmers and sellers.



Figure 5. Private yards in enclosed (left) and open outdoor spaces (right)

Regarding plants as part of the ecosystem, coconut, mango, papaya and banana are the most prevalent fruit-bearing trees within Kampung Melayu dwelling yards. Other fruit-bearing trees such as guava and cassava exist as well, although their presence are significantly rare. Interview outcomes identified that they harvest not only the fruits as small-scale plantation output but also other plant parts and process them for particular purposes, with the coconut palm leaves and trunks being the most utilized parts. For instances, its leaves, typically the young ones, are generally processed for making decorative lanterns and parasols for wedding event and wrapping *ketupat* (compressed and steamed rice cake), while its trunk is utilized as an alternative wood material for crafting *perahu jong*, a small-sized boat used for annual traditional sport undertaken in nearest beaches. Banana leaves, according to several informants, also provide versatile benefits because of their large size, predominantly for packing cooking ingredients to maintain hygiene of the products. These relationships imply the strong dependence of Malay community on locally available natural resources to address their necessities.

Regulating Services: Interview outcomes obtained distinctive responses regarding how landscape elements and characteristics maintained by the homeowners environmentally affect their vernacular yard or outdoor residential space. Three informants expressed unfamiliarity on environmental influence of landscape elements aside from providing agricultural and livestock products. Four other informants, however, claimed that existing elements within their yard benefit them environmentally, depending on their architectural contexts. Home gardens or yards with minimal concrete paving in distinct

informants' dwellings serve as rainwater or seawater absorption. This landscape approach is shaped because several dwellings in Kampung Melayu were constructed near the coastal area and has not had drainage canal system fully installed across the settlement, signifying a soil-dependent climatic hazard mitigation method.

Moreover, potted plants that are placed on-ground or suspended from terrace canopy, according to them, act as microclimate regulators by reducing the outdoor air temperature around the dwelling yards. In addition, abundant trees grown in specific positions within the yard help in blocking or preventing solar radiation from increasing the surface temperature of the exterior walls closest to them, as well as surrounding air temperature. As shown in Figure 6, these spatially-oriented approaches promote thermal comfort for occupants, especially when undertaking landscaping and outdoor-related activities.



Figure 6. Abundant plant species planted and positioned to moderate microclimatic condition

Cultural Services: Aforementioned practices and benefits highlight the function of biodiversity entities as both sources of food, environmental regulation, as well as natural suppliers of goods for local, customary needs. Certain landscape elements were revealed to contain hidden meanings within the local context to address social needs, reflecting Malay local knowledge through their landscaping practices. According to three informants, vegetation planted within the owned land might act as the traditional land boundary in Kampung Melayu dwellings. Trees such as coconut and banana trees are the most prominent natural signifier and most dwellings with spacious open yard implement this local approach to assert occupants' land ownership, as shown in Figure 7. Besides placing fences made of timber or conventionally available steel, shrubs, long-shaped

bushes and/or potted ornamental plants alternatively serve the same function, with the plants typically positioned along the edge of lot boundaries. These findings signify the hidden role of plants as spatial indicator in rural Malay residential areas.



Figure 7. Vegetation as spatial indicator of land ownership

Similar ecological practices related to fruit-bearing trees are highlighted aside from their role in asserting land ownership. In several clusters where shared yards exist, the fallen, ripe coconut fruits will be gathered in one spot near or within their yards until they start to sprout. Some trees that have grown too old pose a threat to surrounding dwellings as the trees, especially palms, have weakened and will likely fall naturally. To prevent this incident, homeowners collectively chop down the old tree and put a sprouting coconut as its replacement (Figure 8), allowing plant cultivation at the same spot. Moreover, several private lots have not been entirely used by the landholders to construct or expand their dwelling, leaving them as open spaces. Despite the transparent ownership, those sites are temporarily utilized by nearest neighbors and sometimes owners themselves as small-scale plantations consisting mainly of mango, papaya and banana trees (Figure 9). Therefore, the community makes use of outdoor yards and existing unused lands not merely as empty spaces to be developed soon for residential use but as productive green spaces for undertaking agricultural activities.



Figure 8. Sprouted coconut fruits (left) and a young coconut tree grown below an older one (middle and right)

Various statements from informants were extracted when asked about the meanings and functions within each landscape element in selected Batam *kampung tua*. These are clues worth to be ascertained if these practices are related to or based on Malay cultural norms. Informants stated that the conservation practices, especially nurturing and maintaining local vegetation, are parts of their intergenerational domestic habit that has been undertaken since their grandparents began residing in the place. In addition, prolonged interviews revealed no indications of plants and their certain parts being used to supply the needs associated with performing traditional belief rituals, indicating the strong adherence of local community to religious principles.



Figure 9. Unused residential spaces utilized as fruit-bearing tree farms

Malay Landscape Values and Architectural Analyses

This study, aligned with its research aim and objectives, seeks to understand Batam Island’s Malay cultural landscape, with an emphasis on nature-based solutions or practices culturally undertaken by the Malay community within residential spaces, especially outdoor dwelling yards. Based on the assessment above, it is evident that its vernacular landscape holds rich NbS significance, with certain landscape elements serving not only specific but also multiple services. Table 1 outlines the aforementioned findings as landscape values contained in Malay home gardens in selected traditional settlement.

Table 1
Vernacular landscape elements, values and NbS significance in Kampung Melayu Malay dwellings

Landscape Elements	Categorical Roles	Societal Functions*	NbS Relevance
Fruit-bearing tree (including fruit)			
Coconut	Agricultural; Spatial	Food provider; land ownership signifier	Utilizing nature to assert land ownership, ensure food sufficiency and balance ecological stability
Banana	Agricultural; Functional; Spatial	Food provider; land ownership signifier; Solar heat barrier	Utilizing nature to assert land ownership, ensure food sufficiency and reduce heat extremes
Mango	Agricultural	Food provider	Utilizing fruit to ensure food sufficiency
Papaya	Agricultural	Food provider	Utilizing fruit to ensure food sufficiency
Cassava	Agricultural	Food provider	Utilizing fruit to ensure food sufficiency
Guava	Agricultural	Food provider	Utilizing fruit to ensure food sufficiency
Parts of plant			
Palm leaves	Cultural	Cultural service provider	Utilizing leaves to craft goods for cultural necessities
Palm trunk	Cultural	Cultural service provider	Utilizing leaves to craft goods for cultural necessities
Banana leaves	Miscellaneous	Multipurpose	Utilizing leaves as natural packages
Bushes or shrubs (Ginger, <i>Hibiscus sp.</i> , <i>Syzygium sp.</i> , etc.)	Functional; Spatial	Land ownership signifier; microclimate conditioner	Utilizing nature to assert land ownership, cool outdoor temperature and for medicinal uses
Potted plants (Garden croton, Snake plant, etc.)	Functional; Spatial	Land ownership signifier; microclimate conditioner	Utilizing nature to assert land ownership and cool outdoor temperature
Henhouses (including avian livestock)	Functional	Food provider	Utilizing livestock to ensure food sufficiency
Yard soil (minimal paved surface)	Functional	Disaster risk mitigation	Utilizing existing soil to absorb excessive water

*Including ecological, environmental and/or cultural purposes/meanings.

Furthermore, understanding the architectural and spatial aspect of vernacular Malay landscape is essential to rightfully implement local-style NbS so that the preservation of *kampung tua*, including its landscape characteristics, can be effective. Numerous landscape investigations in Kampung Melayu dwellings detected various layouts and architectural forms that are distinct from each other. In this study, a total of 20 dwellings featuring abundant landscape elements within home gardens or residential yards were examined. Freehand sketches were also made as several homeowners were hesitant about the documentation of their belonging, ensuring that their privacy was respected. The

obtained data that includes photographic and hand-drawn images, will then be reimagined in 3D digital modelling. Due to dynamic architectural and spatial characteristics in each dwelling and its yard, buildings and outdoor layout details are geometrically simplified and scaled proportionally (not an actual scale).

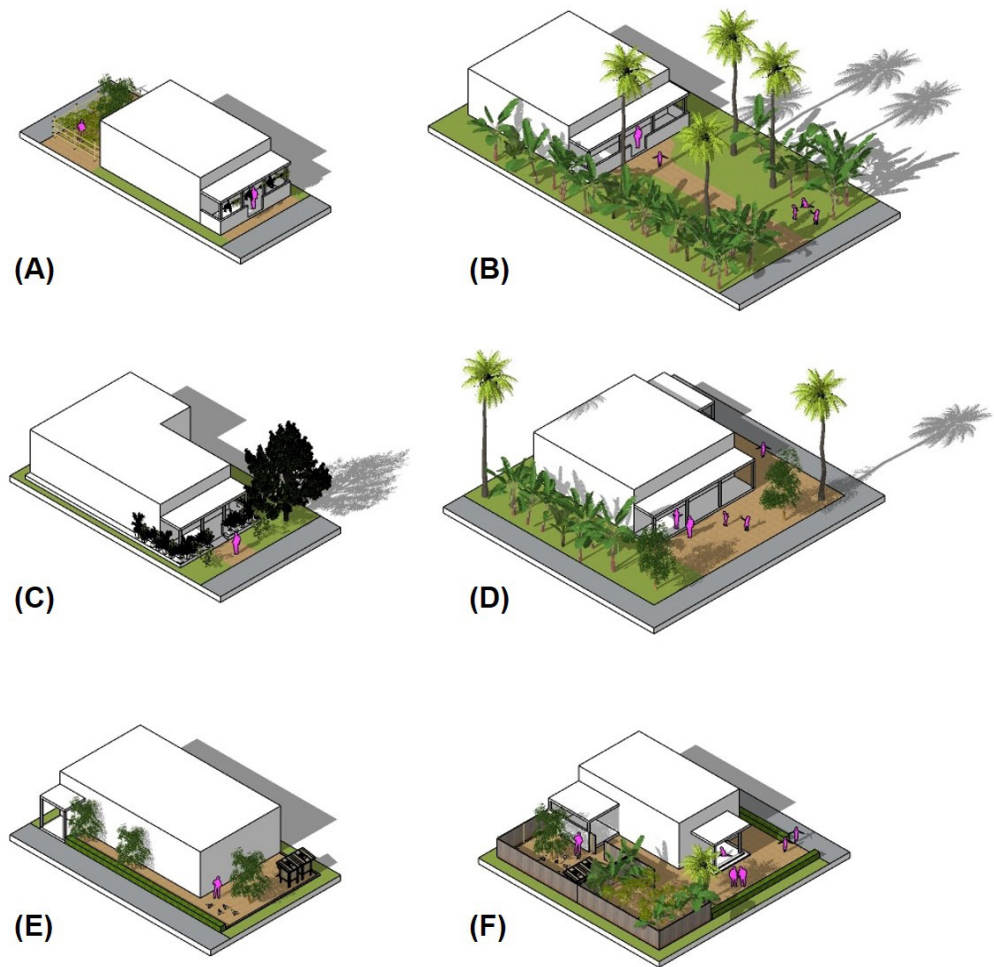


Figure 10. Typological landscape layout variants in Kampung Melayu Malay dwellings

Figure 10 illustrates the landscape layouts and element placements of Malay dwelling in Kampung Melayu based on 20 samples consolidated into six typological variants. These layouts each feature predominantly soft or hard landscape elements in dwelling yard depending on site context.

Spatially, Variants A and C represent the dwelling with very limited outdoor space. From the architectural aspect, the landscape of variant C cannot serve optimally as an open yard, while other architectural variants, A, B, D, E and F, have sufficiently spacious outdoor

areas to be utilized as both yards and productive spaces, as seen in Figures 5-9. Variants B and D, although might appear spatially similar in the real-world context, convey different landscape-related socio-spatial meanings. While variant B uses trees positioned along the edge of lot boundaries to assert occupant's land ownership, homeowners of variant D employ the same but with fewer trees and situates them at yard's corners. Variants E and F not only utilize shrubs or bushes as their lot boundary, but they also tend to functionally shift the yards as productive spaces comprising plantation and livestock farm, maximizing the potential of outdoor space. Regarding hardscapes, henhouses built to keep livestock animals are generally situated in a deeper architectural space, as illustrated in variant F to ensure their safety from prey, while potted plants are placed almost everywhere within private landscape, as shown in variants A and C (hanging and on-ground potted plants, respectively).

Discussion

Findings of the study highlight the nature-based landscape architectural and ecological practices undertaken by the Malay community in a traditional settlement situated in rural Batam. Stephenson (2008) stated that the built environment maintained by local communities holds intangible values emerged from any forms and processes through their cultural activities, aligning with the definition of cultural landscape. In addition, Harris et al. (2012) argued that cultural norms can be conceived through the dwelling yard forms, coupled with homeowners' preferences in landscape management. Investigated dwellings in Kampung Melayu demonstrate that local homeowners rely on both natural (soft) and manmade (hard) landscape elements in shaping their home gardens or dwelling yards, with vegetation, fruit-bearing trees and ornamental plants, strongly influencing their landscaping preferences. Interpreting intangible values in a landscape as benefits of the operational ecosystem, landscape and biodiversity elements featured in these dwelling yards provide multiple advantages to homeowners and other local residents. The benefits drawn from ecosystem assessment include provision of natural resources for food security, income generation and cultural needs, as well as utilization of landscape elements, such as vegetation and potted plants, for microclimate control and land ownership assertion. Prior study assessed the ecosystem services of culture-specific home garden systems within traditional Javanese, Sri Lankan and Vietnamese dwelling yards (Mohri et al., 2013). This study thus fills the discourses in landscape architecture and human ecology covering home garden system of Malay dwelling yards that is also productive and ecologically functional by utilizing context-specific outdoor spaces — homeowner's private yard and landholder's unused residential space — as small-scale farming areas, signifying the existence of Malay-style NbS in the form of landscaping practices.

Evaluating these practices against NbS criteria by Sowińska-Świerkosz and García (2022) — powered by nature, addressing societal challenges, providing multiple ecosystem services, and economically efficient — reveals that not all vegetation-based practices qualify equally. Permeable yard soil addresses flood risk (criteria 1–3); coconut tree replanting satisfies all four; ornamental plants qualify modestly for criterion (3) only. This differentiation ensures NbS claims are evidence-based, not assumed.

Furthermore, the landscape layouts, as illustrated in Figure 10, offer a range of benefits based on spatial arrangement and architectural placement of landscape elements. For instance, the abundance of vegetation in all layout variants is heavily preferred by local residents as the plants, especially the proportionally large trees such as banana and coconut trees, help blocking solar radiation during daytime, reducing outdoor air temperature. Given that the samples examined in this study are detached dwellings, these findings agree with landscape-related studies by Yahia and Johansson (2014) and Gomaa et al. (2024) which reported that strategically and proportionally implementing vegetation, such as trees, in the residential space reduces outdoor air temperature. In addition, a shared yard in a residential cluster, if implemented with abundant vegetation, can greatly reduce surrounding mean radiant temperature, promoting outdoor thermal comfort for the occupants (Baruti et al., 2024).

Several Malay studies covering landscape as part of their cultural identity were conducted by Malaysian and Indonesian scholars. Study by Adnan and Othman (2012) explored the inherent relationship between the Malay culture and local plants, pioneering global discourse on Malay cultural landscape. Later studies focused on the typological placement of landscape elements within traditional Malay dwelling yards to strengthen the identity of the Malay culture in terms of landscape architecture (Harun et al., 2017; Zakaria et al., 2017). This specific topic further expands into the interrelated fields of human ecology and ethnobotany, as outlined in Table 2. Despite novel insights, the qualitative research on Malay landscapes remains limited in terms of theoretical approach, indicating the underexplored significance. In this study, ecological landscaping practices performed by Kampung Melayu residents such as coconut tree replanting and vegetation as spatial indicator of land ownership, as well as microclimate regulator emerge as valuable insights regarding functions of landscape elements within vernacular Malay landscape. Regarding the spatial role of vegetation, this specific finding empirically supports the content-analysis study by Hussain et al. (2025) which argues that larger trees and long-shaped bushes within traditional Malay dwellings' vernacular landscapes tend to deliberately be positioned near land boundaries as natural fences, or in other words, to assert their land ownership. Other findings from the ecosystem services assessment further support the study by Ramli et al. (2021) which reported that the Malay community commonly utilize local plants for dietary and medicinal purposes. However, this study is contradictory to

the study by Suwardi et al. (2025) on ritual plants practiced by the Malays, as Malay residents of Kampung Melayu exhibit strong adherence to religious principles, leaving no indications of animistic elements in their culture.

Table 2
Analytical summary of prior studies on Malay cultural landscape and ethnobotany

References	Related Research Scope (and Methods)	Limitations
Adnan and Othman (2012)	Relationship between plants and the Malay culture in urban village (Qualitative observation and interview)	Selected traditional settlement as study locus is an urban village rather than a rural one
Zakaria et al. (2017)	Landscape elements identification within Malay residential landscape (Qualitative observation)	Research aim strongly focused on landscape elements
Harun et al. (2017)	Malay traditional landscape architecture characteristics (Qualitative observation and interview)	Research aim strongly focused on reasons of cultural erosion of Malay traditional landscape architecture
Hussain et al. (2020)	Elements in shaping the Malay cultural landscape (Review)	Information collected and reviewed was sourced only from Malaysian regions
Ramli et al. (2021)	Traditional knowledge of plant use in Malay-origin home gardens (Mixed-method observation and interview)	Study primarily focused on individual benefits of local plants for Malay community in their traditional home garden
Suwardi et al. (2025)	In-depth biocultural relationship between the Malay culture and plant species (Mixed-method questionnaire and interview)	Study primarily focused on cultural (spiritual) benefits of local plants for Malay community in their neighborhood
Hussain et al. (2025)	Sociocultural interaction between Malay community and traditional Malay landscape elements (Qualitative content analysis)	Study was conducted with a historical, autobiographical comic as the main source.

Source: listed in “References” table column.

The significance in this study encompasses biological, environmental and socio-spatial aspects in the vernacular Malay landscape, in this case, Malay dwelling yard and home garden system that are not only ecologically sustainable but also spatially just. The aforementioned collective approaches — the coconut tree replanting and utilization of unused outdoor spaces as green productive spaces — ensure both food and livelihood sustainability (Opoku et al., 2024) as these particular conditions are vital for the traditional community residing in rural settlements. Coupled with prior Malay landscape-related studies, this study helps define Malay cultural landscape as a form of local-style NbS, a heritage in the form of landscape architecture and ecological practice worthy of conservation. As evidenced above, this study not only contributes new knowledge on Malay cultural landscape, but also develops a new framework for preserving a cultural landscape through the lens of NbS.

Limitations

This study is subject to contextual limitations. In the local context, limited numbers of dwelling samples and local homeowners as key informants emerge as research limitations, restricting the generalizability to other Malay *kampung tua*. Exploring cultural landscapes of other Malay *kampung tua* in rural Batam with larger sample sizes can provide fresh perspectives on how landscapes within Malay settlements are shaped and managed. Moreover, global research on vernacular Malay landscape employing quantitative approaches is only limited to ethnobotany studies. Other quantitative studies covering human well-being topics, such as thermal comfort, in vernacular Malay landscape remain scarce. Although several interviewed homeowners in this study claimed that the plants are environmentally beneficial in reducing outdoor temperatures, this finding requires numerical validation. Future research evaluating the effectiveness of soft landscape elements in regulating microclimate of vernacular Malay landscapes through experimental assessments can provide quantitative, data-driven insights whether specific plants within available spaces are able to improve outdoor thermal comfort depending on meteorological and geographic contexts.

CONCLUSIONS

This study, aligned with research aim and objective, seeks to address two challenges: 1) to fill the identified gap on Malay cultural landscape studies and 2) to inform new heritage-related local regulations concerning the vernacular Malay landscape as part of Batam Malay heritage. Present findings reveal that the Malay cultural landscape in Kampung Melayu, a Batam traditional Malay settlement in rural Batam, contains not only the community's intangible cultural values but also rich ecological values embodied through landscaping or landscape architectural practices within residential areas, reflecting their biocultural characteristics. The documentation and responses, as recorded in the ecosystem services assessment and illustrated in Figure 10, denote the NbS traditionally undertaken individually and collectively by Kampung Melayu Malay residents to address their complex necessities: meeting dietary needs, creating goods for cultural needs, and utilizing biodiversity entities for specific purposes, as outlined in Table 1.

The study sheds light on cultural landscape discourse by developing an integrated framework incorporating and synthesizing Stephenson's (2008) the "Cultural Values Model" and principles of NbS, emphasizing that the formation of cultural landscape constitutes an early form of NbS in preserving both ecological and cultural aspects of sustainability through nature-inspired practices. In addition, research findings suggest that related stakeholders, such as heritage preservation policymakers, can utilize this framework to preserve existing historic landscapes as cultural landscape or local heritage in other settings by inventorying landscape elements, as well as undertaking an ecosystem

services assessment of the underexplored landscapes. By undertaking said ecological assessment to document NbS implementation, it is evident that the Malay community values surrounding ecosystem as it provides significant benefits to both the population and the built environment, implying that biodiversity entities, especially vegetation in regulating environmental heat, are active ecological assets rather than mere decorative elements (Elshabshiri et al., 2025). Harris et al. (2012) argued for including residential yards or home gardens as cultural landscape. Thus, this study contributes an insight from another locational perspective — Kampung Melayu — to help define cultural landscape as an NbS-oriented landscape system that is ecologically functional and climate-responsive.

Furthermore, this study offers actionable knowledge that supports the achievement of SDG 11, particularly Target 11.4 stating the urgency of safeguarding natural and cultural heritage in order to achieve sustainable settlements. Within the context of Batam Island, the aforementioned practices and landscape system are not evidently immortalized in local heritage-related regulations. Therefore, it is essential to preserve the landscape architectural identity of *kampung tua* or similar rural settlements worldwide through rural settlement development utilizing local-style NbS in the form of ecological landscaping practices. As NbS originating in a traditional settlement, these cultural practices suggest potential applicability to modern settlement landscape design for promoting culturally appropriate and ecologically sustainable urban environments.

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