

ARCHITECTURAL TYPOLOGY OF WATER INFRASTRUCTURE: CASE STUDY OF GREEN OPEN SPACE AND HERITAGE SITE OF PERIGI PEKASEM IN BANGKA BELITUNG

TIPOLOGI ARSITEKTURAL INFRASTRUKTUR AIR: STUDI KASUS RUANG TERBUKA HIJAU DAN SITUS CAGAR BUDAYA PERIGI PEKASEM, BANGKA BELITUNG

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ABSTRAK

Indonesia merupakan negara peringkat 10 tertinggi dalam eksploitasi air tanah telah tertinggal dalam memenuhi kebutuhan infrastruktur pelayanan dasar penyedia air minum. Secara nasional, hanya 35.15% masyarakat yang telah mendapatkan akses infrastruktur air minum. Sebagaimana kasus di Provinsi Bangka Belitung yang menyumbang angka terendah sebesar 17.26% pelayanan memiliki permasalahan-permasalahan lingkungan dari eksploitasi air bersih untuk kepentingan domestik, industri, dan khususnya pertambangan timah. Meskipun infrastruktur air selalu menjadi elemen penting dalam sejarah lingkungan terbangun manusia seperti jembatan air Romawi, Sumur tangga India, dan sumur Puquios masyarakat Nasqa. Di Indonesia, studi arsitektur untuk meningkatkan pelayanan infrastruktur air di Indonesia masih sedikit. Sebagai respon terhadap SDG nomor 6 tentang air bersih dan sanitasi, Penelitian ini bertujuan untuk berkontribusi dan mempopulerkan diskusi tentang infrastruktur air di diskursus arsitektur dengan menganalisa dan mengidentifikasi tipologi dan elemen desain dari situs heritage Perigi Pekasem di Bangka Belitung sebagai studi kasus. Identifikasi desain dan tipologi lansekap budaya perigi kedepannya bisa digunakan untuk memperkaya diskusi arsitektur dan kosakata desain pada struktur ruang perkotaan dan berkontribusi dalam memenuhi perkembangan capaian SDG.

Keywords: Infrastruktur air; Tipologi Arsitektur; Cagar Budaya, SDG 6; Lansekap Budaya Melayu.

ABSTRACT

Indonesia as the top 10 countries in extensive groundwater extraction, has fallen behind in providing basic water services infrastructure. While the water utility in Indonesia only provides 35.15% coverage nationally. As case, Bangka Belitung as the lowest province in water management provision with only 17.26% coverage faces tremendous sustainable issues because of its massive exploitation of water usage for domestic, industrial, and especially tin mining activities. Indeed, in spite of fact that water infrastructure is always an essential part of the history of the built environment such as the Roman aqueduct, India's Stepwell, and Nasqa *Puquio*. *In Indonesia* has shown that the number of architectural studies focused on improving the water services is small. In response to Sustainable Development Goals number 6

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on clean water and sanitation, this study aims to contribute and mainstream the discussion of green infrastructure in the architecture discourse by analyzing and identifying its typology and design elements using the heritage-built environment of Bangka Belitung's *perigi* as the case study. The result of identified design elements and typology on the cultural landscape can further be used to enrich the architecture discussion and design vocabulary on Indonesian cities' urban fabric and contribute to the expected achievement progress on sustainable development goals.

Keywords: Water Infrastructure; Architecture Typology; Heritage, SDG 6; Malayan Cultural Landscape.

INTRODUCTION

During the pandemic outbreaks, society around the world rise the concern about health issues in the built environment. Infrastructures and public domains are being re-worked to facilitate the sanitation of spaces: handwashing spots, well-ventilated rooms, outdoor settings, and even the utilities for providing sufficient running water. These implementations aim to improve the access to safe drinking water, sanitation, and hygiene which are fundamental in protecting good health and well-being: promoting essential basic services to end preventable deaths from water and sanitation-related diseases [1].

Clean water and sanitation are one of the prioritized international agendas that are being pushed by Sustainable Development Goals number 6. In Indonesia, the concern on delivering basic water services and access (SPAM) to the society is legally framed and justified in the constitution law 11/1974 about waters [2] that are entrusted to the Ministry of Public Works, state-owned enterprises (BUMN/BUMD), and to some extent local/customary government. Around 543 service companies and establishments nationwide in 2020 mobilised more than 5 million meters cubic of water resources for residential, industrial, and other usages [3].

However, only 35.15% of users have piped water services coverages nationally [4], while the other depends on other sources, especially groundwater. The massive exploi-

tations that put Indonesia as the top 10 countries in groundwater extraction bring forth various environmental problems such as destruction of habitats, seawater intrusion, land subsidence, and further deplete the general availability of water [5]. In Bangka Belitung Province where water service provision only has 17.26% coverage and ranked at the bottom among all other provinces [6], unmanaged and extensive domestic, industry, and tin mining water usage engenders various sustainability issues: water crisis, damaged watershed ecosystem, and water contamination by heavy pollutants [7]–[9]. Even further, the suburbanization trends and housing development paradigm in Bangka Belitung that divides the water capture environment into private housing lot without integrated services bring forth the sustainability issues closer to the population.



Figure 1. Housing Development Paradigm in Pangkalpinang.

Source: Author's documentation (2022).

[Pictures of sellable land in a recent housing development that divides the environment into a private lot without the appropriate allocation for public spaces and common infrastructures.]

While the water services provision falls behind the national standard, the suburbanization and land commercialization trends of the Bangka Belitung shown in figure 1 spread even further disturbing the green open spaces without a clear allocation for public infrastructure development. While the role of developing amenities and services such as road, sewerage, water management, and even public transportation arguably falls into the responsibility of private developer in exchange for the profit opportunity [10], The private housings developer in Bangka Belitung has a very a limited design vocabulary and ignores the vernacular typology that shapes the spatial identity of tropical communities. However, the forested cultural landscape that once become the key for the Southeast Asian *kampung* settlement's morphology to ensure the availability of fresh water, environmental conservation, and harmonious coexistence with the tropical context [11] reserves the potential built environment typology that not only counterbalances the destructive urban sprawl development but also gives an architectural answer to the dire water situation in Bangka Belitung.

Despite the inseparable connections between infrastructure and spatial design and quality, studies on water infrastructure in Indonesia mostly cover either the general correlation with socio-economic and development study [12], [13] or technical examination on the mechanical/filtration performance [14], [15]. The concern in architectural discourse usually focused on place-making, social programming, and designing aspects of the water-related building or public space [16], [17]. Only a few studies unfold the architectural typology of water infrastructure discussion directly: for example the development of water springs and sustainable Balinese architecture for water source design [18], [19].

Reflecting the study on vernacular architecture which provides design vocabulary deduced from historical experience [20], the inherited *Perigi Pekasem* from the old and perished Malayan settlements of *Kampung Dalam Tuatunu* in Bangka Belitung offers a learning

opportunity and design alternatives for the water infrastructure discourse. As Malayan water well, *perigi* relies on the relationship between the water access structure and its surrounding landscape and water catchment areas. The vernacularity of *perigi* embedded in the know-how of the local Malayan mason can enrich the building and landscape design vocabulary of the Bangka Belitung's architectural discourse, adding the reason to elaborate on the typology in the academic discussion. However, despite its nationally acknowledged heritage site status, the scholarly discussion regarding the *Perigi Pekasem* is nearly unavailable and in-depth information is still yet to be documented from the local elders.

Therefore, this study that aims to expand the built environment discourse with water infrastructure typology is not only raising the alternative design language to Bangka Belitung's housing development and urban fabric but also fills the gap in the scholarly discussion regarding the heritage sites of *Perigi Pekasem*. Parallel with Yori Antar's comment, a leading figure in Nusantara Architecture who conveys the critics that national infrastructure projects should respect and explore the cultural identity and sustainability beyond the usual concrete jungle intervention [21], This study aspires to ignite a deeper discussion in water services and infrastructures from the design typological perspective. In doing so, this paper is structured into several segments: (1) the typology analysis methodology on the case study of Bangka Belitung's water infrastructure heritage site; (2) the typology study on historical precedence and previous water infrastructure; and (3) the design elements analysis recorded from *Perigi Pekasem* site and its position as a Malayan cultural landscape. The result of heritage typology and design elements of water services can further be used to mainstream the architectural discourse contribution to the water service provision and sustainability of our built environments.

METHOD

Architectural typology analysis is a central method in this research. This study of type consists of comparative analysis and various built environment classifications to present the architectural type recognition and complementary relationship perspective on the spatial forms [22]. Reflecting Cipta Karya's drinking water infrastructure classification of production and water source site, distribution mechanism, and service facilities [23], the discussion in this research is initially elaborated by categorizing the historical water infrastructure into a precedence study. The identified architectural programs further contextualize the design elements association of the *Perigi Pekasem* case study with the potential role of the typology in providing water services.

There are two rationales for the selection of Pangkalpinang's heritage site as a case study. Firstly, Bangka Belitung province where greater than 80% of its population has not yet been covered with the water infrastructure system has dire water-related environmental situations. With a long history of land use frontierization for tin mining that enabled the world industrialization through packed food mobilization and plating steel, the ecological brunt from the altered forests, rivers, and hinterlands of this "tin isles" of Southeast Asia engender the major social and environmental upheaval [24]. The ex-mining lake (*kulong*) and disrupted watershed became a prevalent colonial and industrial world legacy for Bangka Belitung. The recent development exacerbates the water issues even further from the housing and informal mining expansion that triggers manmade disasters such as 2016's flooding [25]. This situation requires spatial intervention that provides land use alternatives.

Secondly, the rising discourse of urban landscape infrastructure among spatial design disciplines that combine infrastructure and landscape systems might provide an-

swers to the such degraded environment: Perigi or water well of the Malayan landscape. Reflected from various old Hikayat Melayu manuscripts study, the existence of perigi as one of the Malay garden legacy on the land-scape furniture for pleasant resting areas enhances the uniqueness and synchronization of tropical environmental settings [26]. This source of water also shapes the landmark and holds the cosmological element for Malayan communities, as proven by the reconstructed "Perigi Hang Tuah" in Riau Archipelago that become the prayers and pilgrimage site for the society [27]. Included in the heritage tourism route of Bangka Belitung [28], the Perigi Pekasem heritage site as one of the provincial strategic tourism areas, therefore, presents an opportunity to explore the landscape infrastructure discussion for the environmentally challenged region. Analysis of such cultural landscape can further expand the infrastructure typology focused on multi-functionality, ecology, and social-social inclusive fabric in the urban infrastructure [29].

To explore the typology of Perigi Pekasem, this study elaborates on the precedence of both the historical water buildings and contemporary infrastructure and complements it with the concept of green infrastructure and cultural landscape as an ontological framework. Principals on the landscape architecture discourse for understanding landscape as three-dimensional construction, history, scale-continuum, and process [30] bring forth the values in studying the Perigi's typology which is often overlooked by the modern design discipline as a mere insignificant water-well. This study on Perigi is also explored from the green infrastructure perspective, broadening the planning strategies and design classification of green open spaces typology based on spatial scale and dimension, land use purpose, accessibility, and biophysical surfaces of the open spaces [31]

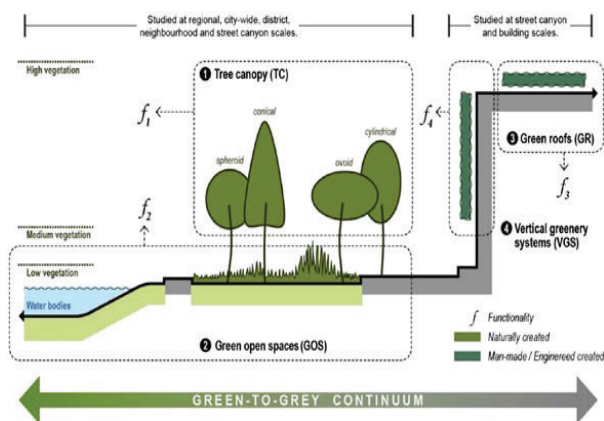


Figure 2.

Green-to-Grey Infrastructure Continuum diagram. (Typology classification of green infrastructure ranges from green open space and intervention on the building. Perigi Pekasem as landscape design enriches the discussion on the green open spaces and tree canopy classification.)

Source: Bartesaghi Koc et al, (2017).

RESULTS AND DISCUSSION

Typology of water infrastructure precedence

The availability of water is always the core of human civilization. While in the ancient world, great cities such as Uruk, Mohenjo-Daro, Babylon, Nineveh, Memphis, and Thebes would not prosper without the abundance of water from the river [32], access to water is still an essential precondition for the sustainability of the built environment in the modern world. Water as a prerequisite factor in meeting basic human rights, productive activities, and functioning ecosystems demand local and international stakeholder's cooperation and participation to achieve the SDG 6 targets: (1) access to drinking water, (2) access to sanitation and hygiene, (3) water treatment, (4) water-use efficiency, (5) integrated water management, (6) and water-related ecosystem protection [1].

However, the situation where many parts of the water infrastructure are out-of-sight and out-of-mind renders the subject often neglected [33]. The interactions between

humans and water which are concealed by the deep-well water pump, pipe network, and covered drainage cast the public attention away from the continuous environmental degradation caused by the unsustainable man-made water cycle. Hence, the discourse on the legibility of the built environment where the identifiable design such as visual sensation, tactile elements, and even collective memories play an important role to complement the technicality of the infrastructure [34]. The challenge to design the urban pattern of the common land that preserved the connection between humans and access to water [35] raises the necessity to elaborate on the typological approach and its vernacular morphology developed by the culture of its society [36].

For the discussion on the urban typology, plenty of historical water-related structure precedences on the world heritage list can be taken as design vocabulary and provide categorization that is useful for the typology analysis: (1) the design and intervention around the water source; (2) infrastructure for water distribution; (3) and the services from the surrounding landscapes. Firstly, on the fabric of water source infrastructure, the longstanding best practice in the history of civilization is the Indian stepwell. The manifestation of Indian cosmology on water shapes the architectural heritage for multi-purpose water-related functions in the built environment: social space for ceremonies, meditation, bath, and taking the water; environmental indicators for water table level during the dry and rainy season; and artistic and architectural expression for such underground temple [37]. Another great example of water source intervention is *Nasca Puquios* in Southern Peru. On the contrary with Indian stepwell that focused on improving vertical accessibility to the underground water, *Nasca Puquios* use an infiltration gallery to the well by digging an underground horizontal channel as filtering tunnels made of fluvial pebbles and waterproof clay to transport the water into the reservoirs. This centuries-old

technology has enabled the *Nasca* community to live and irrigate their crops in an arid environment with extreme water scarcity and low rain precipitation [38].

Secondly, in addition to the intervention on the water sources, the spatial quality of a city is determined by its mechanism for distributing the water. One of the best examples of water distribution infrastructure is the monumental construction of aqueducts that enable Rome to grow and prosper. Along with other magnificent Roman works of paved roads and sewers, Roman Aqueduct distribute the water from the lake and spring to the bathhouse, ornamental fountains, gardens and household purposes in the fabric of the Roman city. The amount of engineering for the construction and maintenance of the water supply not only generated the beautiful arch and arcade structure for the aqueduct, but also inherited the vast technological development for drains, sewers, and sanitation which is necessary to support the built environment [39]. In addition to the physical construction, the functioning governing institution is also essential for the water distribution, one of the reasons why Balinese *Subak* as an indigenous tradition and farmer organization is listed as a UNESCO World Heritage Site. The practice of Balinese *Tri Hita Kirana* philosophy that underpin the water management through water temple, series of rituals and offerings, and irrigation system sustains a harmonious relationship of the society with god-fellow human-environment: a living culture from the 12th century that was recently challenged by land-use transformation, tourism development, and cultural mobility [40], [41].

Lastly, the urban design of the water infrastructure's surroundings plays an essential role in improving the spatial quality and cultural appreciation of the value of water. For example the Japanese Onsen Town of Ginzan. The utilization of hot water sources is facilitated through bathing house inns and facilities design which is carefully placed around the town's main feature of the thermal river using natural material qualities such as

Chines stone, Bamboo, Shoji paper, or Hiba Timber. Public footbath, pedestrian bridges, street lighting, and other geothermal river atmosphere trigger the performative interaction of the visitor with architectural spaces of water, signifying the spiritual therapeutic experience that has been celebrated in Japanese culture since Kamakura Period between 1192 and 1333 [42]. Another great example of water infrastructure urban design from Indonesia is Romo Mangun's Marian pilgrimage site in Yogyakarta. The unique terraced retaining wall along the river functions as a visitor's sitting area to enjoy the natural vegetation and the religious tranquillity. While the spring water is distributed among the landscape for refreshment purposes, the facility manager of the pilgrimage site carefully maintains the natural river ecosystem [43]. A fabric design not only improves the spatial quality of the landscape but also ensures the conservation and maintenance of the water cycle.

Most of the precedence above are listed as the UNESCO world heritage sites that represent various human creativity geniuses: landscape design, tangible cultural tradition, technology, ecosystems, and many other aspects [44]. From the aforementioned heritage water infrastructure categorization, Perigi Pekasem as Pangkalpinang's heritage site offers a similar design vocabulary for the intervention of the water sources and their surrounding landscape. Parallel with the precedence categorization presented in figure 3, *Cipta Karya* as a department under the ministry of public works (PUPR) which is specifically responsible for developing drinking water infrastructure provides a useful modern engineering specification and classification that enrich the discussion on the typology: Raw water unit, treatment plant unit, a distribution unit, and services unit. Within this realm of civil engineering, infrastructural reliability become the key element of the design: hydrological correct structure, appropriate material selection, protected water network, and adequate treatment facilities [45]. The complex engineering requirement for accessing, processing, distributing,

and supplying the water exhibit the necessity for inter-disciplinary approaches to achieve similar significance to the other heritage water infrastructure predecessor: a remark for

conveying the spatial discipline's cultural landscape discourse where landscape, infrastructure, culture, and spatial design are comprehensively intertwined.



Figure 3. Typology study diagram.

A comparative study of water infrastructure typology between the historical and the contemporary infrastructure precedence.

Source: Author's analysis (2022).

The Malayan cultural landscape of Perigi Pekasem: a design vocabulary for Bangka Belitung's development

The significance of exploring the Malayan cultural landscape of *perigi* is evident when taking the account Bangka Belitung's recent residential development trends that encroach on the last green enclosure it has: urban sprawl and modern residential trends that challenge the preservation effort of the tangible and intangible heritage of the previous *genius loci* [46]. A similar paradigm in expanding the tin mining and palm plantation through the natural landscape is adopted by the housing developer, maximizing the profit

by changing the land use into sellable areas. Take the example of the residential master-plan around the Perigi Pekasem site seen in figure 4, the division of pattern is solely appointed for the privatization of land where the only public domain is the street. While the private green area regulation is commonly neglected by the homeowner, the lack of green space on a residential scale represents the environmental issues in Pangkalpinang's housing developer trends that trigger yearly disasters of flooding [47].



Figure 4. Spatial condition around the Perigi Pekasem. New residential development plan around the heritage site (left), the buffer between Perigi Pekasem site and cleared land for residential (middle), and the perigi position in the old kampong (right). Source: Author's documentation (2022).

The role of perigi expands from simply water access into a green open space infrastructure that provides land use protection for the water source and public spaces. The role as green open space can be examined from the middle image in figure 3 taken on the west side of Perigi Pekasem, showcasing the distinct ground figure between the planned residential area and the green cover that is protected by the heritage sites. The forest canopy which is often valued for its carbon sequester and environmental carrying capacity supplies the localized benefit of a water catchment area, fresh air, and natural elements for the surrounding residents. Moreover, the role of perigi as public spaces can be derived from its contribution that shapes the spatial identity of the Malay garden [48]. Historically, perigi as a common term for Malayan water well is an essential landscape function that not only serves as water access but also social space. Taken from the old kampong in the eastern part of Perigi Pekasem, the right image in figure 3 exhibits the spatial organization of such a water well and its relationship with the building around it. On contrary to modern design that put the utility on the private and hidden area of the building, the water well in the front of the building is not only integrated with the facade of the house but also activates the social activity and other life it created between the building. Without any partitions and fences, the perigi is constructed in the semi-public space of the parcel that is easily accessible by the community around it.



Figure 5. Condition of Perigi Pekasem. Front facade of Perigi Pekasem (left), Heritage structure of Perigi Pekasem (middle), and the garden area inside the site (right). Source: Author's documentation (2022).

Perigi Pekasem is one of the currently 14 nationally registered heritage perigis which are classified as heritage buildings, struc-

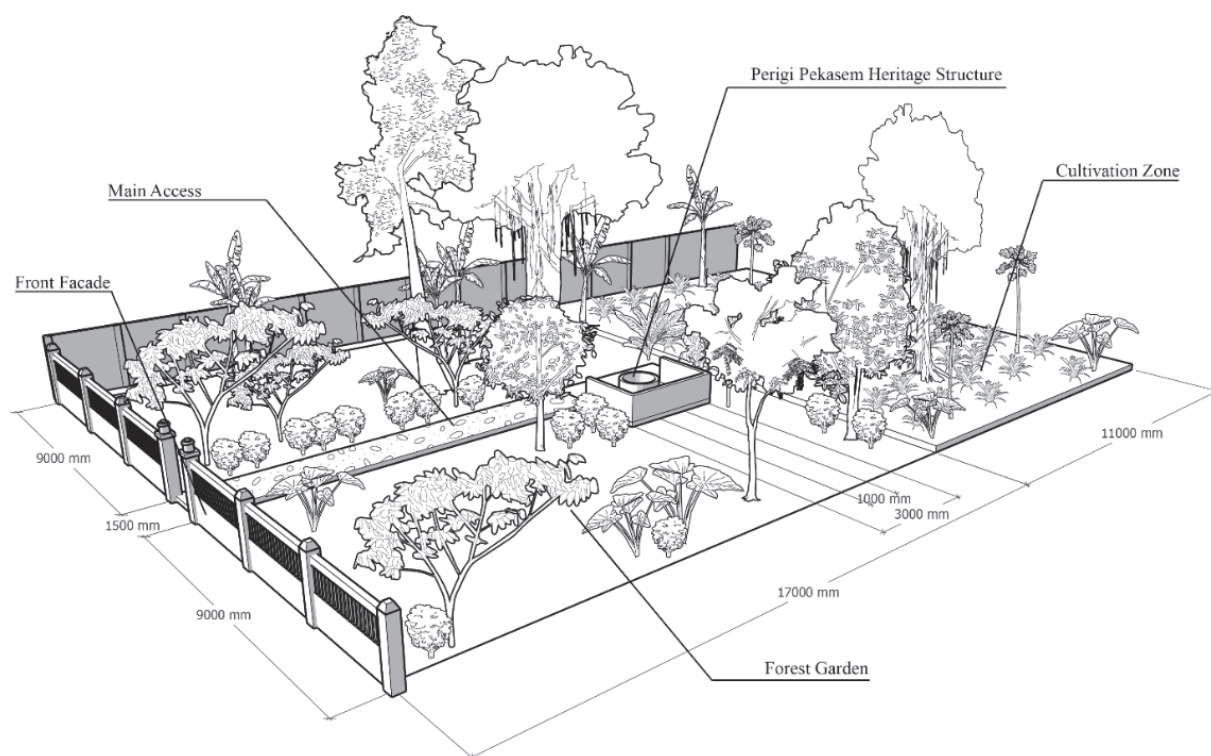


Figure 6. 3D model representation of Perigi Pekasem
 The spatial organization of the heritage site is divided into heritage structure, forest garden, main access, and cultivation zone.
 Source: Author's analysis (2022).

tures, or sites [49]. From the in-depth interview with the local Tuatunu elder who is entrusted with the maintenance of the site, the history of the now dried water well possess the historical process of one of the oldest *kampung* in Pangkalpinang. Starting as common water well for the Malayan community, the 18th-century religious conflict due to the Islamic practice differences among the inhabitants had brought a change in the Perigi's surrounding landscape. The continuous tension motivated the migration of the community member, leaving the wooden stilt-house and cultivated area into a vacant neighbourhood. The neglected built environment was steadily covered by tropical vegetation, concealing the Perigi Pekasem with a dense forest. Later in the 20th century, a decolonization struggle between the local independence military activist (Tentara Keamanan Rakyat) and the Dutch troops change the landscape even further. The already vacant *Kampung Dalam*

which believed is functioned as a den for the independence activist was burned down by the Dutch, removing the relic of the old Tuatunu settlement. On the other hand, TKR fight back by killing any strangers that enter the Kampung and throwing the suspected spy's bodies into the perigi, hence the name Pekasem which means meat preservation technique. The horror story behind the perigi and its surrounding jungle fabricates a mystified narration that preserves the area even further from the land transformation and development. Until recently appointed as a heritage site in the previous decade, only a few courageous young folks utilize the perigi as a naughty teenager's headquarters.

Responding to the mandate for management, preservation, and protection of heritage objects in National Statute 11/2010 [50], Pangkalpinang city enlists Perigi Pekasem as a protected area along with green open space and flood-prone area in their spatial planning













					
Mindi <i>Melia Azedarach</i>	Banyan <i>Ficus Benjamina</i>	Sengon <i>Albizia Chinensis</i>	Green Sawo <i>Chrysophyllum cainito</i>	Mangosteen <i>Garcinia mangostana</i>	Matoa <i>Pometia pinnata</i>
					
Banana <i>Musa sp.</i>	Papaya <i>Carica Papaya</i>	Tasbih Flower <i>Canna Indica</i>	Taro <i>Colocasia Esculenta</i>	Aralia <i>Polyscias sp.</i>	Pineapple <i>Ananas sp.</i>

Figure 7. Vegetation elements of Perigi Pekasem.

List of greeneries inside the protected site ranging from the urban forest canopy, aesthetic garden plant, and cultivated fruit and food forest products.

Source: Author's analysis (2022).

and territory document [51]. The regulatory framework for perigi conveys a strong spatial justification in advocating the maintenance and propagation of such landscape features in the spatial fabric of the city. Parallel with the previous categorization for water source intervention and surrounding landscape improvement, several Perigi Pekasem's design elements can be classified through the spatial organization, vegetation elements, and relationship to the scale-continuum of the area.

Spatial organization of perigi's typology

The spatial organization of Perigi Pekasem consists of several zones: the main water well as the heritage structure, the forest garden with various vegetation, and the cultivation area where the community utilize the land for food products. Behind the 20 meters front facade of the heritage site, around a total of 570 m² area is covered with diverse vegetation species ranging from the low shrub to the forest canopy that provides shading for the green spaces. After 12 meters of the stone pathway, visitor can see the 3 meters deep water well that no longer reach the subsided water table. The well that reserves the historical decolonization memory is claimed to be

a place to hide the enemy spy's corpse during the fight against the Dutch [52]. Despite the terrifying story, the cultivation area behind the well presents around 192 m² of beautiful food forest scenery where pineapple, banana, taro, and papaya plants are mixed under the shade of several high trees.

Role of perigi typology as green infrastructure for water cycle

The gardening operational and heritage site maintenance role taken by the local's elders preserves the environmental role of the *perigi*. With a fixed schedule from dawn to eight in the morning, the local gardener has participated in the shaping of the landscape design with various urban and food forest vegetation. The land acquisition process by the city government gives the legal justification for the heritage site to supply public needs in the form of green open space. The urban forest role of the Perigi Pekasem provides the nature-based solution for the city's growing sustainability issues in the form of environmental services through urban heat island effect and air pollution mitigation, stormwater retention and water infiltration, and habitat for a variety of species [53].

With the rising academic and professional appreciation for the city's vegetation values, green infrastructure maintenance and conservation is an essential collaborative effort in answering the challenge of ecosystem services delivery [54]. Each vegetation unit in Perigi Pekasem contributes to the realization of the city's protection zone in Tuatunu's urban forest. The tree canopy species in the heritage site range from the simple high tree of banyan, mindi, and sengan, to the food forest species that can be harvested such as sawo, mangosteen, and matoa trees. Moreover, the cultivated plants such as banana, papaya, taro, and pineapple that are utilized and maintained by the community complement the aesthetic values of the garden vegetation of tasbih flower and aralia species. The physical attributes of the greenspace provide the important function of water catchment that signify the Perigi Pekasem's role as water infrastructure.

Scale continuum relationship

Align with the Pangkalpinang's planning document that designates most of the Tua Tunu Indah in the Gerunggang sub-district as a water catchment and protection zone for the city [51], the Perigi Pekasem heritage site provides synergized urban design typology and best practice precedence for the city. Agglomerated with other heritage and cultural centre of Akek Bandang and Malay's adat building, Perigi Pekasem exhibit the spatial and cultural identity of the Bangka Belitung society. Its position on the edge of suburbanization stands as a reminder and potentially urban design guideline to limit the sprawling residential development that introduces a generic subsidized housing design typology that disregards the heritage value of Malayan kampong spatial quality. In addition, the landscape of *perigi* can also provide wildlife protection as the uncontrolled residential development and palm oil plantation transforms the area even further.

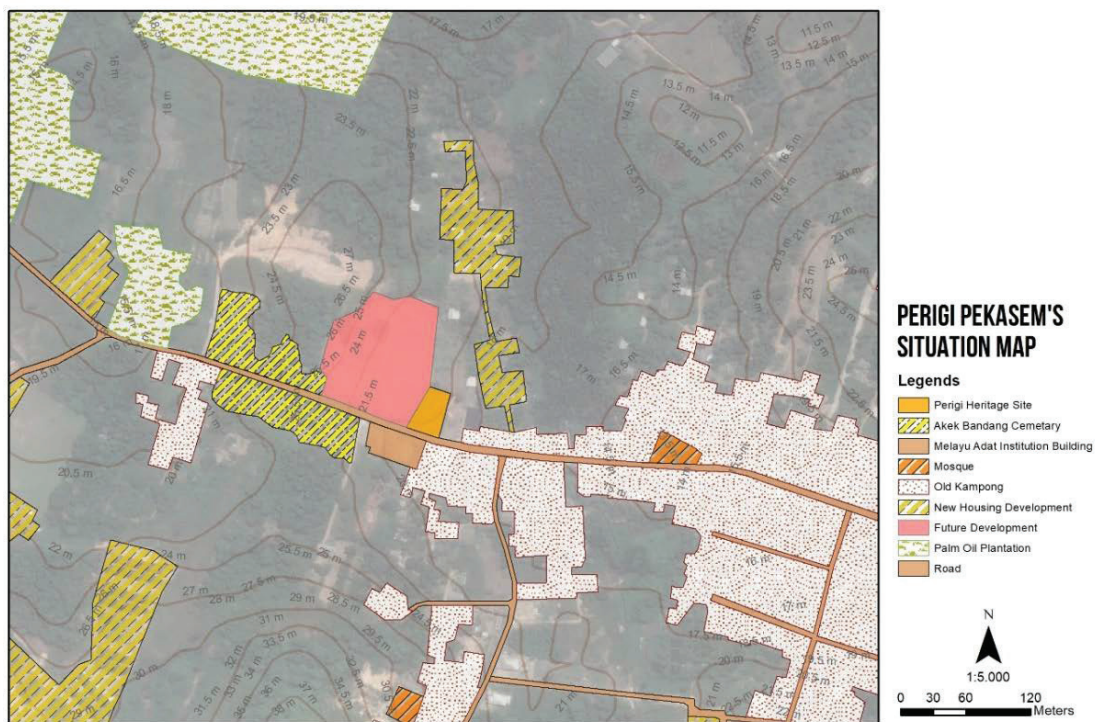


Figure 8. Situation map of Perigi Pekasem
 Perigi Pekasem's inter-scale relationship on the residential scale, an agglomerated heritage site that bridges the old kampong with the new residential development.

Source: Author's analysis (2022).

Table 1.
Recorded 360° mapping of Perigi Pekasem

Segment	360 Mapping Documentation
Front Facade	https://goo.gl/maps/f7qoS7dnV5fAHUWWA
Heritage structure of Perigi Pekasem	https://goo.gl/maps/Jp8azgEzZyYafxTY7
Forest Garden	https://goo.gl/maps/btMuHe3DywuyW7YVA
Cultivation Zone	https://goo.gl/maps/houHL2srwnpazHxTA

Source: Author's documentation (2022).

Condition assessment of 360° mapping

With the growing availability of recording technologies for 360° mapping, a fundamental phase of condition assessment helps to identify the situation and analysis of historic buildings and sites [55]. Through the compilation of published geotagged virtual reality in table 1, the visual assessment for Perigi Pekasem paves multi-discipline attention to expand the discussion on the conservation and spatial design of the heritage landscape. Within this research, the author was able to discuss the vegetation species with the forestry expert via the captured scene on each spatial segment. With the immersive characteristic of such a novel approach, a further time series of the 360° mapping condition assessment would complement other heritage site modelling methods namely 3D modelling, photogrammetry, and laser scanning.

CONCLUSION

The typology elaborated in this study thrives to enrich the design vocabulary in the future development of Bangka Belitung's cities. With the identified design elements of Perigi Pekasem that represent the spatial identity of the Malayan cultural landscape, the city can use an additional vernacular feature in the sprawling residential development to improve the sustainability of the city's fabric. The simple spatial organization surrounding the heritage object, the cultivated vegetation as an urban food forest, and its environmental protection role on the bigger scale signify the necessity to elaborate such green infrastructure typology further in the spatial discipline discourse. As was already

mentioned in the city's planning documents, further improvement on strategic perigi typology on the urban design guideline documents and public development projects in Bangka Belitung will increase the spatial legibility of the archipelago city.

In comparison with other amazing UNESCO world heritage sites of the Roman aqueduct, Indian stepwell, or Japanese onsen, the existence of Perigi Pekasem might not provide a similar construction and aesthetic monumentality for the architecture discussion. However, accounting the role of Perigi Pekasem as a nature-based solution that provides a green infrastructure's remedy for the water cycle, the preservation of such a heritage site has its merit in balancing the concurrent Bangka Belitung's land use transformation and ecosystem degradation due to the expansive suburbanization, tin mining, and palm oil plantation. When aquifer groundwater extraction has become a popularized practice in fulfilling water needs, public space with water access features that can inform the situation of the water table may improve societal sustainability awareness towards the environment. The limitation on design examination in this article requires further research on biological diversity and environmental carrying capacity to improve Perigi Pekasem's significance. However, simply comparing the water infrastructure typology with the abandoned mine pit, the acidic lake of *kulong*, and the vast monoculture plantation, it is clear that typology propagation of such intervention and protection of water source is necessary for the built environment of Bangka Belitung.

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