RETRACING CULTURE OF RAINWATER HARVESTING IN PONTIANAK RIVER CITY

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ABSTRACT

This paper investigates the origins and ongoing practices of rainwater conservation in Pontianak, West Kalimantan, asking how residential environments have adapted to the city's distinctive climatic and hydrological conditions through culturally embedded water practices. Situated on the equator within a tropical wetland environment, Pontianak is shaped by abundant rainfall, rivers, and peatlands. Its urban and domestic landscapes have developed through encounters and exchanges among Chinese, Dayak, Malay, and colonial communities, each leaving distinct traces in how water is inhabited, managed, and incorporated into everyday space. The paper examines how cultural practices and historical encounters have shaped residential rainwater harvesting systems in Pontianak, particularly how Chinese, Dayak, Malay, and colonial influences are reflected in the collection, storage, and everyday use of rainwater. Rather than viewing rainwater harvesting solely as a technical response to water availability, the study considers it as a culturally embedded spatial practice that has evolved within domestic environments. The findings suggest that Pontianak's relationship with water is embedded in a layered cultural landscape, where Chinese, Dayak, Malay, and colonial spatial practices intersect and remain visible in contemporary residential environments. Understanding these cultural traces provides an alternative way to read Pontianak's urban form. It offers insights for more context-sensitive approaches to housing, water management, and urban planning in tropical wetland cities.

Keywords: *Pontianak, Rainwater Harvesting, River City*

INTRODUCTION

The city of Pontianak originated along riverbanks and in wetlands at the heart of the equator. Like other Southeast Asian cities, Pontianak's river serves as the city's lifeblood, supporting trade, transportation, and domestic activities (Sutherland, 2007). Beginning with interactions among riverside communities, settlements in Pontianak gradually expanded inland, eventually shaping the urban form that defines the city

today. The city topography is divided by the Kapuas River, its tributaries, peatlands, and muddy wetlands. The tropical rainforest's high rainfall leads to soil saturation, which readily retains water. Consequently, many areas in Pontianak and Kalimantan experience flooding during the rainy season, dry conditions during the dry season, and high groundwater salinity, making it difficult to use for daily needs (Tilema, 1922; Alqadrie and Sastrowardoyo, 1984; Saputra, 2018).

These climatic and hydrological conditions result in an annual cycle of water abundance and clean water scarcity. Colonial archives reveal several rainwater harvesting models used by Pontianak's residents since the 19th century, as an adaptation to the limited access to clean water especially for drinking (Alqadrie and Sastrowardoyo, 1984; Sutherland, 2007) . It indicates that the initial traditional rainwater harvesting system was introduced by Chinese migrant settlers and later adopted by other communities. The system reshaped the major housing system to be more adaptive to stormwater, mainly by providing a water tank near the roof gutters. The case of rainwater harvesting in Pontianak serves as an important case study to investigate the relationship between the water cycle, housing system, and vernacular adaptability in the urban built environment, particularly by examining traces of the culture of rainwater harvesting in the tropical rainforest area. Given that over past years the world has experienced clean water and sanitation crisis with addition to factors such as climate change (Raman *et al.*, 2025), Pontianak offers architectural models of residents adapting to environmental constraints.

This paper investigates the history of rainwater conservation in Pontianak, its connection to the city's equatorial geographic characteristics, and how these shape residential housing adaptation. How did the culture of rainwater harvesting develop, and how has it persisted to this day? What factors are shaping the culture of rainwater harvesting, and what type of architectural and urban adaptations occurred in Pontianak? By examining archival records, maps, and literature, this the paper examines how cultural practices and historical encounters have shaped residential rainwater harvesting systems in Pontianak, particularly how Chinese, Dayak, Malay, and colonial influences are reflected in the collection, storage, and everyday use of rainwater. Field observations were also conducted to assess the current state of these practices. The findings highlight that Pontianak's strong relationship with water has played a fundamental role in shaping its unique urban form and domestic spatial arrangements. This underscores the importance of integrating traditional water management practices into future urban planning.

THEORY / RESEARCH METHODS

Water Conservation Culture in Pontianak: From Traditional to Current Practice

Pontianak was a prominent international trading hub in the Indonesian archipelago and West Borneo due to its strategic position within regional trade networks connecting Singapore, Malaysia, and Indonesia (Listiana, 2009). Before the establishment of permanent settlements began, the region was dominated by dense

forests with limited overland access. However, the extensive river network provides crucial routes for transportation and trade. It prompted several kingdoms to seize strategic positions to control trade, manage ports, and develop settlements along the Kapuas River (Alqadrie and Sastrowardoyo, 1984; Enthoven, 2013).

This historical relationship between waterways and settlement formation characterizes Pontianak as a river city, in which the river and the built environment continuously shape one another. The river has influenced urban development, infrastructure, livelihoods, ecosystems, and cultural practices, while human activities and urbanization have, in turn, transformed the riverine environment. This reciprocal relationship continues to evolve alongside urban expansion and technological development, which have altered the river's role and condition within the city (Padawangi, Rabé and Perkasa, 2025).

The first settlement establishment on the Kapuas Kecil riverbank marked by the construction of a bamboo hut by the Pontianak Sultanate under Sultan Syarif Abdurrahman in 1771, which later triggered the expansion of the settlement area along the Kapuas Kecil and Landak Rivers under the administration of the palace (Alqadrie and Sastrowardoyo, 1984; Rahman, Achmad and Muhadi, 2000). It is followed by the arrival of various communities, including Arabs, Malay, Dayaks, Bugis, Tambelans, Serasans, Banjars, and even a designated military village (Rahman, Achmad and Muhadi, 2000; Listiana, 2009; Asnaini, 2013).

Different communities have different gestures of cultural appropriation to adapt to the water environment in Pontianak (Alqadrie and Sastrowardoyo, 1984). Earlier maps of Pontianak illustrate the proximity of settlements to local environmental resources, showing traditional communities established along and around the river (Figure 1). The pattern suggests that the riverscapes are used not only as environmental resources but also as an organizational apparatus for spatial structures and everyday practices.



Figure 1. Map of the Square Boundary Government Territory at Pontianak with Nearest Perimeter
Source: Nationaal Archief, 1895

In the Malay community, rivers and canals serve as the main source of clean water, which is accommodated by *pelataran*, or open platforms, despite their poor quality, and the only connection between houses was the waterways (Tilema, 1922; Enthoven, 2013; Zain, 2016). This was attributed to a traditional house type called a *lanting* and the toilet known as *jamban* (Figure 2), in which is located at the front of the house, directly along the riverbank (Enthoven, 2013; Nurhidayati, Gionita and Herawati, 2024). Lanting also applied culture to the Chinese, Dayaks, and Bugis, especially in bathing, washing, and fishing (Lubis, Susanto and Harjoko, 2021).



Figure 2. *Jamban* in Tandjong, Borneo-Kapoeas
Source: Tillema, 1922

The riverine settlements were built on stilts, adapted to the river's ebb and flow and following the contours of the riverbanks (Nurhidayati, Gionita and Herawati, 2024). The construction of the slits house is deliberate for the Chinese, Dayaks, and Malay to withstand the floods that occur 2-3 days a month and to clean up the waste under the house. However, the toilet or *jamban*, was located far from the house (Tilema, 1922). During the New Order government, many floating houses were transformed into stilt houses due to the government's focus on land ownership (Nurhidayati, Gionita and Herawati, 2024). Thus, changes are evident in traditional settlements, such as rainwater harvesting in most Malay traditional houses (Zain, 2016) for cooking, drinking, and women's bathing, using water tanks.

The public-space domain can be observed from the Dayak typical housing. Their broader understanding of the landscape is one of their characteristics; rivers are a major part of conservation alongside forests, hills, and agricultural land, serving as a source of clean water that Dayak women collect every morning using water containers for cooking and drinking at home. They demonstrate an understanding of seasonal cycles, which is important for agricultural purposes. Thus, knowledge of resources, including water, is closely linked to their cultural landscape management practices (Murhaini and Achmadi, 2021; Magenda, 2024).

Chinese traders' and miners' houses typically face the river (Figure 3), with their backs to the hill, according to their cosmological beliefs (Pratiwo, 2010; Tvedt, 2010). It is strengthening the pattern of a river-oriented city (Enthoven, 2013) . In everyday life, rivers served not only as infrastructure for transportation and domestic activities, but also as communal spaces and settings for religious practices (Hegewald, 2002; Padawangi, Rabé and Perkasa, 2025). The Dutch colonial administration also established infrastructure across the river, marked by the construction of ditches and

tributaries for defense, transportation, and flood control, followed by forts and trading offices (Alqadrie and Sastrowardoyo, 1984; Listiana, 2009).



Figure 3. Chinese Camp in Pontianak
Source: Universiteit Leiden, 1890

When the roads gradually developed under colonial rule, the role of rivers as primary transportation routes diminished, transforming the relationship between water and the city, as well as settlement patterns and urban spatial configuration. The Sultanate area became relatively isolated due to limited road access and its surrounding network of disconnected waterways. At the same time, the western and southern parts of Pontianak developed rapidly from the 1940s onward, which forced the relocation of the administrative center. Although roads and rivers initially complemented one another in supporting economic activities, roads gradually became the dominant infrastructure, while the ditches were increasingly neglected and no longer corresponded to the city's direction of expansion (Alqadrie and Sastrowardoyo, 1984; Listiana, 2009; Enthoven, 2013). Nevertheless, rivers served as the initial spatial framework for both the Sultanate and colonial settlements, establishing the conditions from which Pontianak's subsequent urban development emerged.

In 1957, the Indonesian government began developing clean water infrastructure by distilling water from the Kapuas River. The company Établissements Émile Degrémont built a water purification facility on the south of the Kapuas Kecil River. Around the same period, the Regional Drinking Water Company (PDAM) was also officially established. This was followed by the construction of two water reservoirs by the city government (Purwana, 2004). In 1962, Water Installation No. 1 (Komp. IPA Imam Bonjol) was built and managed by the Drinking Water Channel Service (*Perumda Air Minum Tirta Khatulistiwa*, 2021) .It marks the new form of water management in the modern context. However, the volume of clean water was insufficient to fully meet the city's population needs (Marsela and Purnomo, 2024).

It is clear why the utilization of RWH, a traditional water conservation practice, continues to be widely used in the city. The distinction between traditional and modern water conservation adaptations can be understood by their reliance on locally available resources, relatively low financial and environmental costs, and capacity to adapt to changing climatic conditions (Sahani *et al.*, 2025). Besides their close relationship with the surrounding waterscape (Magenda, 2024), RWH practice also demonstrates how settlements and buildings adapt to local water conditions. As Sahani et al. (2025) explain, traditional water conservation practices are rooted in

generations of interaction with the environment, allowing communities to develop context-specific knowledge of natural cycles and resource management. Thus, it making them accessible and adaptable to local environmental conditions.

According to Zhou, Matsumoto and Sawaki (2022), the classification of traditional rainwater harvesting (RWH) can be traced to different scales of relationship: water-based settlement, public space, and household. The water-based settlement domain is evident in riverine settlements, which began with Malays (Alqadrie and Sastrowardoyo, 1984) and Chinese who arrived in Kalimantan with houseboats in the mid-1800s, later transforming into *lanting* houses and the development of floating markets (Lubis, Susanto and Harjoko, 2021). The Chinese row houses also adapted the stilt typology to local swampy conditions by using ironwood foundations. The house layout followed the typical pattern, with the house facing the water body due to cultural beliefs, yet modernisation led to spatial and construction adaptations. (Pratiwo, 2010; Andi Emilya Kalsum Zairin Zain Raja Norashekin Raja Othman Harun Siti Norlizaiha *et al.*, 2025).

The household domain, roof rainwater harvesting systems, is the strategy most adopted in drylands and urban areas such as Thailand, Vietnam, and China (Zhou, Matsumoto and Sawaki, 2023). The practice of collecting rainwater began to appear in the late 1890s, influenced by Chinese and Dutch communities (Figure 4), with rainwater collectors lined up in front of Chinese row houses and at the corners of European houses. This shift was driven by the expansion of the city and the increasingly unsuitable quality of water from the Kapuas River (Tilema, 1922; Enthoven, 2013).



(a) (b)

Figure 4. (a) Pontianak's Rainwater Collection in Chinese Residentials; (b) European Quarter in Pontianak
Source: (a) Universiteit Leiden, ca. 1915, (b) Universiteit Leiden, ca. 1920

Residents rarely adopted Rainwater Harvesting due to the cost and unfamiliarity with the required materials. Materials such as pipes, wooden or iron drums, and even simple items like nails were typically used only by Chinese or European communities. As a result, residents commonly relied on the Kapuas River for their daily water needs (Tilema, 1922; Enthoven, 2013). However, in Kromoblanda (Figure 5), a photograph shows a Malay house equipped with a basic rainwater collection system using bamboo pipes and small cans. This suggests that rainwater harvesting may have gradually gained popularity over time, particularly as

urban development expanded further away from the river. The typical three models of traditional Malay houses also feature water-related spaces, in the form of platforms, that connected to waterways located at the back or surrounding the houses (Figure 6). In contemporary houses, the RWH system has been incorporated into these spaces (Zain, 2016).



Figure 5. Typical Melayu's House with Rainwater Collection
Source: Tilema, 1922

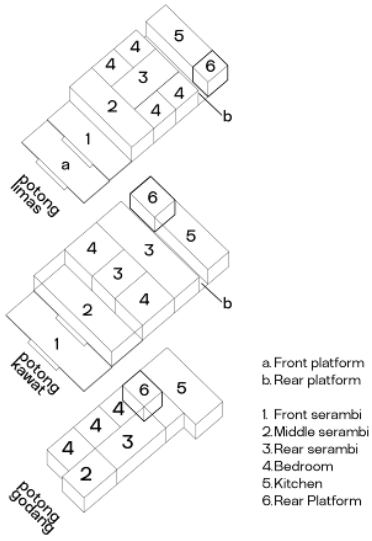


Figure 6. Typical Traditional Malay House
Source: Redrawn from Zain, 2016

The practice of collecting rainwater has become increasingly widespread and popular across all social groups. Nearly every household now has a rainwater collection device, typically using repurposed jars or drums of various sizes. These containers can also reflect the household's economic status. At the same time, residents continue to rely on river water for activities such as bathing and washing (Alqadrie and Sastrowardoyo, 1984).

The Dayak community has also adopted RWH, using affordable and accessible materials such as gutters installed along the roof and plastic water containers. This application does not alter the residential layout; in fact, the system becomes an attachable addition to the house (Figure 7). The traditional houses are also changing, for example, the Chinese row house (Andi Emilya Kalsum Zairin Zain Raja Norashekin Raja Othman Harun Siti Norlizaiha *et al.*, 2025) and the Malay house, especially due to material degradation, changing environment, and changing functions (Zain, Irwin and Andi, 2023).



Figure 7. The Corridor of the Longhouse in Sungai Utik, Kapuas Hulu, West Kalimantan
Source: Saputra, 2018

Research Methods

The research begins with the abduction method (Thornberg, 2022), using archival investigation and theoretical inquiry to shape the hypothesis about the origin and rationale of water conservation practice in Pontianak. The evidence from the archive and literature used as basic theory provides sufficient warrant that water conservation originally arose through the adaptation process of Chinese migrants to the hydrology and climatic context of the rain tropical forest situation (Tilema, 1922). Historical evidence also shows that Pontianak was originally a trade node in West Borneo, through which cultural intersection likely occurred (Listiana, 2009; Enthoven, 2013). These findings serve as primary data that were deductively synthesized with additional auxiliary assumptions (Little, 1993), which were later tested through a field survey comparing two houses equipped with rainwater storage.

The results from the field survey, in which parts confirm the early hypothesis, are then redrawn as an architectural diagram and compared with the traditional house of the colonial era, taking into account the objectivity of inductive confirmation (Thornberg, 2022). This diagramming process of different houses from different eras posits historical traces as well as underlying systematic performances of the buildings, providing provisional knowledge of the connectivity between water, housing, and the surrounding built environment.

The colonial archive is used to identify the different periods and cultural shifts in the development of Pontianak City and settlements. Colonial archives, such as Kromoblanda (1922) by Tillema, and websites like the KITLV at Leiden University

contribute significantly to research, not only through texts but also through historical photographs from the 1890s to the 1900s. Both documents are used to cross-reference the field conditions from that period. Books serve as key historical resources, providing comprehensive insights into cultural backgrounds. For instance, works that depict the Pontianak during the colonial period and its historical development have become critical references. Since specific sources addressing the city's water infrastructure development are scarce, these books fill an essential gap in understanding Pontianak's history.

The field research closely examined current water conservation practices in Pontianak and their connection to historical methods, specifically by observing houses that implement Rainwater Harvesting (RWH). The case includes Malay and Chinese settlements, two of Pontianak's oldest communities that evolved from riverine settlements into permanent ones. The study includes urban houses that rely entirely on RWH to analyze residents' acceptance of RWH, as well as the installed systems in Permata Khatulistiwa cluster and Jalan Sepakat 1, which are also located some distance from the waterways. Subsequently, a sample of riverine houses by Malays that are located near the river at Gang Peniti, and a Chinese stilts row house, based on research by Andi (2025), near a ditch on Jalan Gusti Situ Mahmud. This settlement represents the transformation of houses and water-related activities.

RESULTS AND DISCUSSION

Traditional Water Conservation

Based on the historical archive, water conservation in Pontianak settlements resembles the three types of water conservation in Zhou's (2023) domains within its water system: water-based settlement, public space, and household. However, there is no clear boundary between water-based settlement and public-space domains in Pontianak. Waterways are used for domestic and public spaces in some evidence, as seen in archives from 1890 to the 1900s.

Strong evidence of the use of RWH is recorded in the archives from the 1900s, specifically in the Chinese settlement area. In contrast, in 1890, water utilization was dominated by waterways, with minor RWH systems such as water tanks, pipes, and gutters. Water-related infrastructure, such as stairs, *gertak*, *lanting*, and boats, can be seen as the people's adaptation to their relationship with water across different periods and ethnicity (Figure 8). Additionally, a more organized RWH system is found in European-style housing, using more modern materials such as metal which imported from Netherland (Abubakar et al., 2019) and construction methods. Conversely, Dayak settlements are documented as traditional houses located some distance from the river (Magenda, 2024).

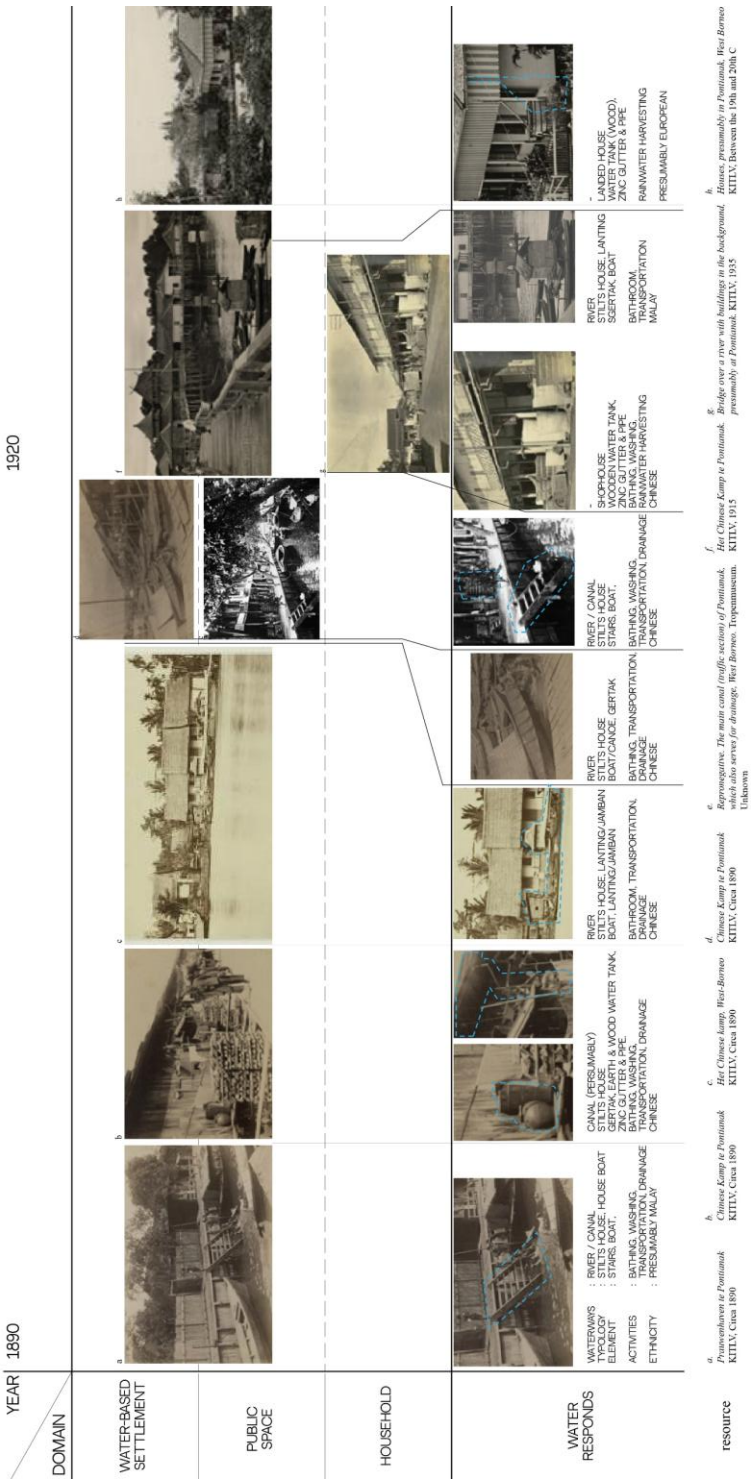


Figure 8. Water Conservation in Pontianak between 1890 – 19 C
Source: KITLV & Tropenmuseum

Practice of The Current Water Conservation

The current water conservation practices can be divided into two settlement contexts: riverine settlements and urban (landed) houses, with Malay and Chinese households as samples. The Malay and Chinese settlements in Kalimantan also share a similar development pattern, characterized by a linear expansion from the river towards the land, with no clear boundaries between houses (Gunawan and Mustikawati, 2025). Therefore, examining both riverine settlements, which represent traditional settlements, and land-based urban houses provides an opportunity to identify how water-conservation practices have adapted across different settlement contexts.

Water-based / Riverin Settlement

The riverine settlement directly responds to the river, with houses historically associated with fishing and connected by the river before *gertak* pathways were introduced. House zoning typically separates the bathroom and kitchen from the main living area, while water-oriented features remain visible in stair-like boat docks that adapt to fluctuating river levels (Nurhidayati, Gionita and Herawati, 2024) . Chinese vernacular shophouses, introduced by Chinese immigrants, similarly evolved from water-oriented settlements toward inland urban forms through vertical development, reflecting a gradual shift from river-based to land-based settlement and demonstrating their adaptability to changing urban conditions (Han and Beisi, 2015).

In riverine settlements, water-related activities are clearly evident (Table 1). Whether in public areas (streets, rivers, etc.) or even in houses, water-related activities are evident due to blurred boundaries. Not only their typology, but also activities such as RWH systems, domestic and transportation activities embedded in this place, can be seen clearly. For example, in the front and the back of the house of a riverine settlement, the adaptability towards the river provides space for washing, laundry, and drying areas (Rahman, Defiana and Ekasiwi, 2022).

Table 1. Condition of Riverin Settlement in Peniti 1, Pontianak

Settlement Environment	Household	RWH system	Water tank
			
Characterized by gertak as a pathway and stairs as a harbor for boats, and, for some, for bathing or washing activities, especially for kids.	Water tank with different volumes and materials. One of them connected to the roof gutter. Located near the toilet	Water tank with different volumes and materials. One of them connected to the roof gutter and was located near the toilet.	Clay water tank, which is no longer being used due to an alternative water tank, such as a PP

1. Malay Riverine Traditional House

Gang Peniti is located in Benua Melayu Subdistrict, a densely populated waterfront area. This area was developed from a Malay Village and is now home to multiethnic groups, including Malay, Chinese, Dayak, and others with houses represent (Tata Ihsan *et al.*, 2026). PDAM water is commonly used in this area, along with RWH (Nurhidayati, Gionita and Herawati, 2024) as the case study location is within 550 m of PDAM Tirta Khatulistiwa.

This house has been passed down through generations and remains part of the big family, so it cannot be sold. Therefore, rooms were added, and the building was extended to the back, away from the Kapuas River, to house multi-family units under one roof. The existing layout of the traditional Malay house has been transformed into the condition above (Figure 9). The main entrance is divided into two: the original condition and the entrance from the rear platform, serving different families. In the past, these entrances served as the front door, which oriented to the river to connect to the boat, and the rear door, which oriented to the road. (Based on an interview by the authors, 2024). Although now both entrances are still connected to their previous infrastructure, road, and *gertak*.

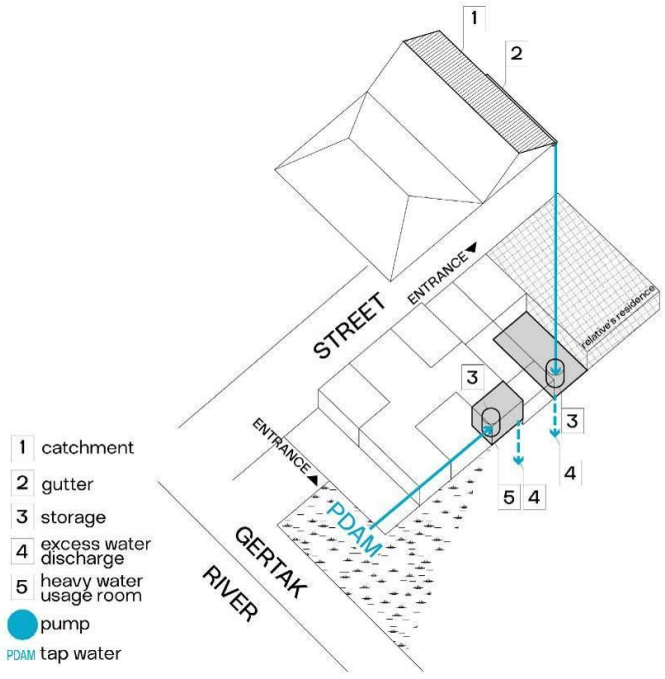


Figure 9. Malay Riverine House

The application of the RWH system is centralized on the rear platform, as in other Malay traditional houses (Zain, 2016). The existing main metal roof captured the water and delivered it to the typical blue PP tank, which is connected to a PVC pipe and a gutter. Therefore, this space serves as a washing area, with excess water flowing directly into the river. On the other hand, the PDAM water is installed in the

bathroom, which has the same drainage as the rear platform. Additionally, the black water flows into the pipe towards the ground.

2. Chinese Riverine Traditional House

The Chinese traditional house take a look on study sample by Andi (2025) (Figure 10) that is located adjacent to a ditch and near the Jl. Gst Situ Mahmud and also Kapuas river. A house of Tjong Tjen Tjan adapts the shophouse typology with narrow shapes and has a duality of commercial and residential. Yet its construction of stilts house and gertak adapting the local condition. The shophouse itself already represent the chines ethnic. According to Andi (2025), it is selected due to its originality compared to others, as building built in the early 1900s and has been passed down by the parents. Since it is two storeys building, the wet area and bathroom located on the ground. The photos documentation (Andi Emilya Kalsum Zairin Zain Raja Norashekin Raja Othman Harun Siti Norlizaiha *et al.*, 2025) showing a faucet installed by the pipe in the inner courtyard indicated PDAM system applies as clean water sources.

The documentation by Andi (2025) shows a RWH system inside the inner courtyard and there is no roof water tank installed. All the roof still based on the original shape, that the main roof that facing backwards straight connected to pipe. Compared to photo documentation around 1900s (Figure 8), where the rainwater tank with massive volume commonly installed in front of the house. With minimum intervention, this Chinese house depicts the probabilities to adapt with modernize water system. And possibility to mix and match clean water sources towards the house configuration.

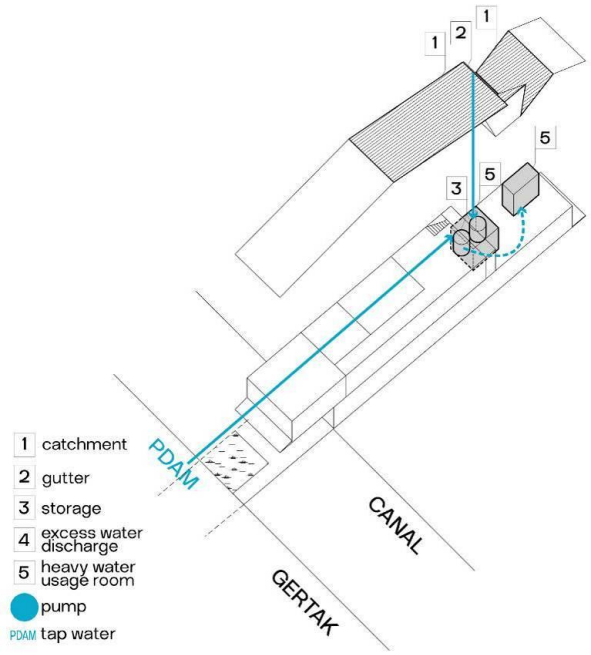


Figure 10. Chinese Riverine House
Source: Redrawn from Andi, 2025

Urban Settlement

Rainwater harvesting in urban areas typically uses a straightforward system based on housing units: roof – gutter – tank. As shown in Figure 11, technological advances mean water tank locations depend on the house and plot layout. Thus, the location can be in front (as the old settlement does), in the rear, or at the back of the house (so as not to interfere with the façade). This placement also corresponds to the roof orientation.



Figure 11. Urban Settlement in Pontianak: Samples of Different Residential Building that Adapts Rainwater Harvesting
Source: Developed from Google Maps, 2025

1. Urban Malay House

The house is located at Jalan Sepakat 1 within the education district. Sepakat was a traditional settlement that transformed into a peri-urban environment due to its location on the city's edge and the influx of migrants for educational and economic purposes. Its development started in 1980 and was extended by the university expansion in 2006 (Ginting *et al.*, 2020). The house is an extension of the parent house to the side, following the available plot of land. With the parent house in two storey and the case study in one storey. Based on Lim's (1991) matrix, Malay houses allow for flexibility and adaptation through variations in size and quality. They can be enlarged according to changing needs and functions, with extensions typically added to the back or sides of the house. The parent house is located on the left and the child house located on the right. Both connected with a backyard which also acts as RWH component system. Yet, the traditional Malay connected with a corridor to divide between the main house and the support house. The role of the house is already different.

The spatial zoning no longer adapts to traditional houses or to the cultural beliefs of Islamic philosophy, which are usually reflected in Malay traditional houses (Zaın and Andı, 2020). It can be seen from its permanent construction of concrete post-and-beam and brick walls. Therefore, it is affecting the water system by centralizing the RWH system at the back of the house. However, the house's design did not prioritize RWH (Figure 12).

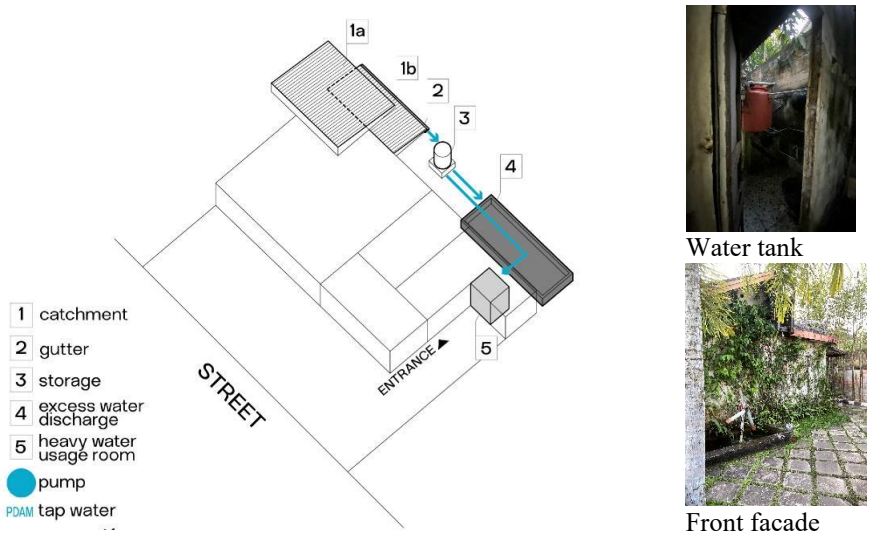


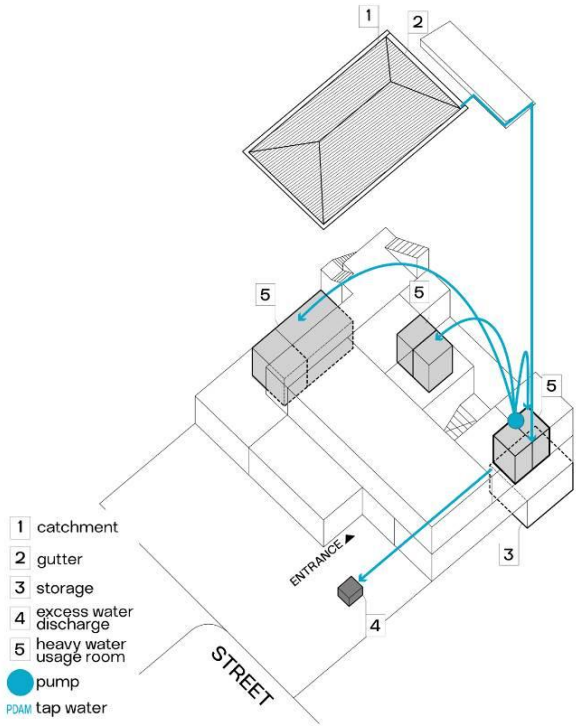
Figure 12. Malay Urban House

This house uses a simple RWH system that relies on gravity to supply water to the toilet and faucets. The elements consist of a zinc roof catchment, a fiber gutter, a 550L PP tank, and a PVC pipe. No pump is installed since the water tank is located higher than the faucet. Water filtration is also not installed on the faucet. As for drinking, the water will be boiled first. As for using RWH, there are no problems with water shortages or water-quality-related health issues. Previously, the house relied on PDAM water, but concerns about service costs and water reliability led them to adopt an RWH system instead (Author interview, 2024).

2. Chinese Urban House

This house is located in the Permata Khatulistiwa residential gated community. The house was constructed around 2014, while the cluster's development began in the early 2000s (Google Earth; Authors interview, 2024). As a new residential development, the land plot features a modern, typical cluster housing layout, with a larger plot size than its surrounding properties. This spatial characteristic contrasts with the houses developed within the traditional settlement, where the buildings are more densely arranged in a compact settlement pattern. However, the cluster's entrance gate and surrounding neighborhood are oriented toward the nearby river and the road development along it. Showing the traces of waterway utilization that developed into a road network (Figure 13).

The house layout and models are adapting to contemporary urban residential layouts. Adapting to the modernization of multi-story buildings involves concrete construction, as in the Malay urban house case study, but on a different scale. It is also affected by residents and activities, as well as economic conditions (Author interview, 2024; Leo, 2020).




Pipe from the main roof gutter


Pump and tank manhole positions


Underground water tank

Figure 13. Chinese Urban House

The RWH system is located at the back of the house, connecting the main roof to a 36 m^2 water tank underneath the garage, which serves as a service area. Thus, the system is hidden from the main façade. The underground water tank saves space, as conventional water tanks occupy valuable residential space (Kuok and Chiu, 2019) . Its positioning is also influenced by Feng Shui beliefs, avoiding the bad luck associated with a T-junction opposite the house. The rainwater is being used for full daily activities. Bathing and washing using a simple filter from the rainwater pipe to the water tank and drinking by connecting the faucet to the filtered dispenser.
The underground tank requires additional construction and costs, as well as a pump to distribute water throughout the house. The conventional PP water tank is no longer used due to prior mold issues. Although the overall RWH system remains largely unchanged, its configuration is adjusted to suit the house design and plot layout. This water relation also shows living standards and health (Skayannis, 2014)
in relation to cost and cultural factors.

The four case studies represent Malay and Chinese ethnic groups, each comprising a traditional and a contemporary dwelling. The contemporary houses (Figure 14, cases 1 and 2) are more road-oriented due to urban expansion, although waterways remain within a 1 km radius. These houses rely heavily on RWH for their water source. In contrast, Traditional houses are predominantly located along waterways (Figure 14, cases 3 and 4) that combine RWH with piped water supplied by PDAM. Furthermore, socioeconomic conditions influence the sophistication of the RWH system, such as the water tank and pump installation, as illustrated by the differences between case 1 and 2 (Figure 14).

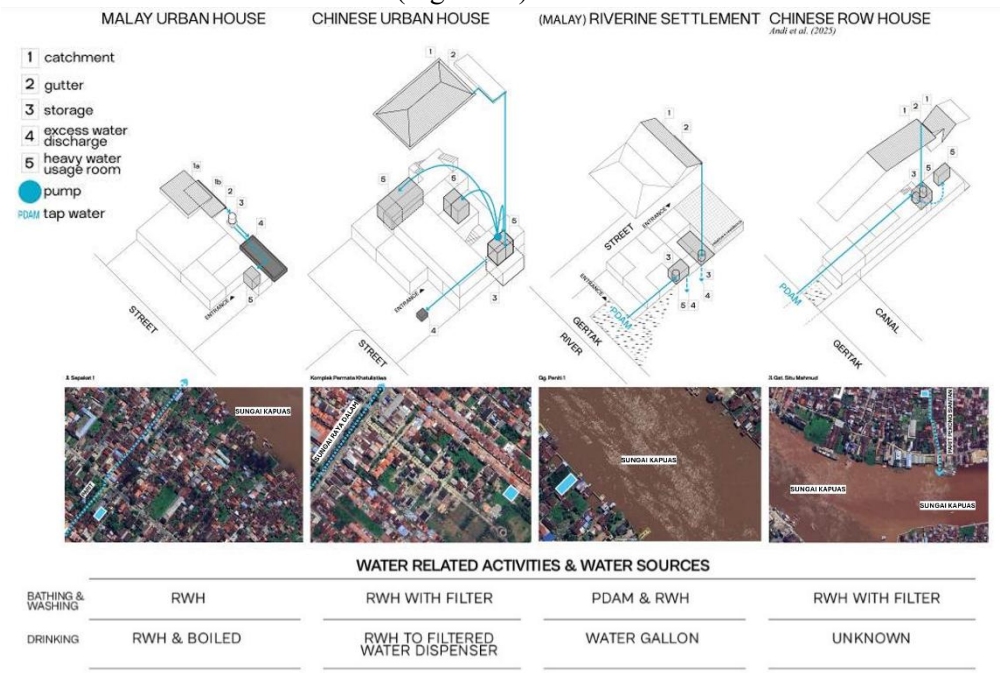


Figure 14. Case Study Summary

CONCLUSIONS

The relationship between water, settlement, and housing in Pontianak has transformed alongside changes in the landscape, urban development, water sources, and technological advancement. As community naturally seek different alternative sources to fulfil basic needs such as water, water management practices have continuously evolved from traditional to modern settlements.

RWH is therefore not solely rooted in inherited practices but reflects processes of cultural adaptation, including appropriation of Dutch and Chinese communities through technologies such as earth-based water tanks and zinc pipes, and has developed into diverse forms of domestic water management. Technological advancement has further expanded the possibilities for more efficient water collection, storage, pumping, and filtration, although these improvements also introduce

additional economic costs. Within the case studies, PDAM water and RWH have become the main clean water sources, while rivers and ditches only act as drainage due to declining water quality or river as water transportation, although some riverine households continue to use them for bathing and washing.

The variation in RWH systems, varied from simple above ground tanks to larger underground tanks equipped with technology such as pumps, filtered water dispensers, demonstrates how water infrastructure adapts to different spatial, economic, and cultural conditions. As more technological options become available, however, water management practices may gradually become detached from their cultural origins which previously have a strong relationship to the water. It reflects the broader tendency of modernization to standardize practices across different contexts that has simplified the relation between people and water with more convenient access to water sources. Nevertheless, the need to conserve water as inherited practices remains and is reflected in the application of RWH system

At the same time, the diverse house typologies, configurations, and settlement locations in Pontianak demonstrate that RWH has implications beyond the individual household. At the public and settlement scales, water collection, storage, and distribution can contribute to shared water resources and communal practices, linking individual buildings to the wider infrastructure and social organization of the settlement.

This suggests that RWH in Pontianak extends beyond the household domain into a broader settlement strategy by responding to contemporary change in water source options, infrastructure, technology and urban development. Which would prolong the idea of RWH application to the public and settlement domains, as in how the Pontianak communities utilized rivers and ditches communally in the past. Further research could examine households with 100% reliance on RWH to investigate whether similar or different cultural beliefs, motivations, and perceptions toward RWH persist under conditions of complete dependence. Therefore, an opportunity to examine reliability on RWH might influence spatial layout, house configuration, and other domestic water-related spaces. This can contribute to a broader awareness of how this relationship between water reliability, technological adaptation and the transformation of domestic and settlement space in Pontianak.

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