REDEFINING WAYS OF LIVING WITH WATER BY ADOPTING TRADITIONAL SUNDANESE KNOWLEDGE

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ABSTRACT

In many rapidly growing cities of Indonesia, including Bandung, the areas of informal settlements are increasing. They are erected on hazardous lands, often in flood-prone areas. The communities struggle with an inadequate water supply and uncontrolled water flows during heavy rainfalls. The problem of water management rises with a decrease of open land and a lack of infrastructure.

The heavy rainfalls are typical for the tropical climate zone. Traditional Sundanese communities developed water systems based on landscape characteristics to protect their hamlets from flooding and ensure freshwater supply. They adapted the settlements and living units according to the climate and the presence of water.

This paper investigates the traditional ecological knowledge embedded in Sundanese settlements by studying the water-related characteristics of landscapes, hamlets, and living units of Kampung Naga and Baduy Hamlet. The research shows sustainable ways of living with water and provides guidelines to develop settlements with traditional water systems and preserving nature.

KEYWORDS: LOCAL KNOWLEDGE, SUNDANESE TRADITIONAL ARCHITECTURE, TRADITIONAL ECOSYSTEM, WATER MANAGEMENT, WATER ADAPTABILITY

1. INTRODUCTION

1.1. Background

Urban migrations, triggered by the pursuit of economic opportunities, are causing the cities of the global south to grow. The rising number of inhabitants entails an increase in the demand for housing, which results in the formation of temporary settlements on the outskirts of cities. The traditional, sustainable ways of building houses using available materials and craftsmanship are replaced by poor quality, homogenous shelters erecting in peri-urban areas.

Informal housing emerges in unplanned open spaces, often in flood-prone zones (Minnery *et al.*, 2013). The communities living in these areas struggle with water-related problems caused by deluges, lack of infrastructure, sanitation, and freshwater supply (Dovey, Cook and Achmadi, 2019). In Indonesia's West Java province, the informal villages would often erect along the Citarum Riverbank, connecting them with the water corridor.

West Java region is prone to frequent flooding caused by the tropical monsoons typical of tropical climates. The presence of abundant water and establishing the settlements near the water source was crucial for crop irrigation in the early settlements (Boomgaard, 2007).

The Citarum, the longest river running through the West Java region, gave rise to the ancient Civilization of West Java in the 4th century. Nowadays, the river continues to play a significant role in safeguarding energy and food for the region (Cakrawijaya *et al.*, 2019). The upstream of Citarum, including the part belonging to the Bandung Metropolitan Area, is a key element in managing the level of water flows in West Java and influencing the settlements placed along the nearly 300km long riverside.

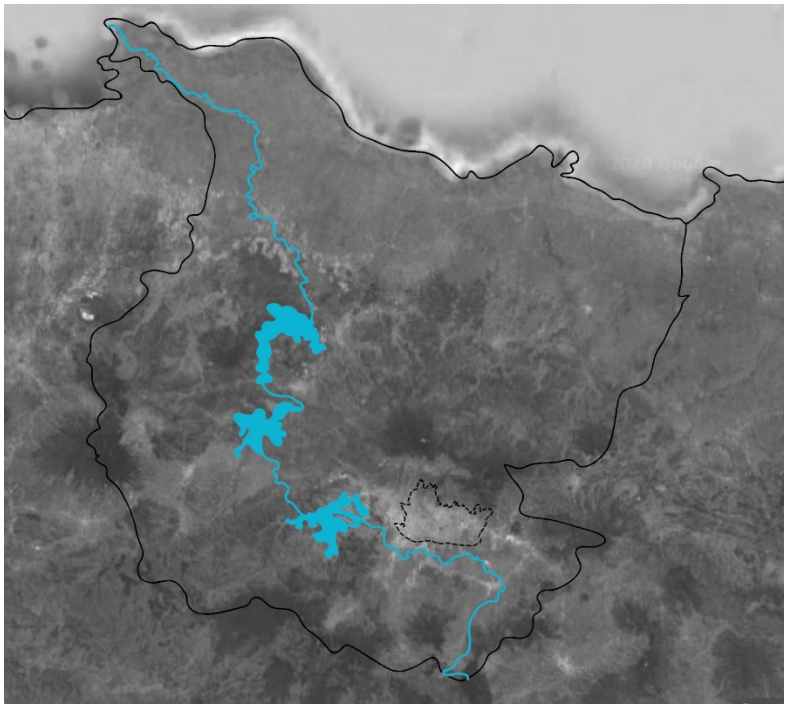

Figure 1. Map of West Java region, showcasing the Citarum River and boundaries of Bandung. Source: the author, based on Google Maps.

Over the years, the perception of the Citarum River and the impact of the floods have changed. The area of open lands that provided a threshold for rising water levels decreased with urbanization, diminishing absorptive capacity of the soil. The Citarum, previously used as a source for irrigation and fresh drinking water, is now perceived as drainage and backbone for industrial activities (Cakrawijaya *et al.*, 2019). The settlements located alongside the crucial river are struggling due to negative consequences of water pollution, groundwater over-extraction, and land subsidence.

Before the colonialization period, followed by the bloom of the industry and expansion of city borders, the native communities of West Java lived at one with nature and safeguarded the river. In this region of Indonesia, the largest ethnic group was the Sundanese community (Oliver, 1997). The traditional Sundanese ways of building proposed a climate-responsive housing typology, resilient to the heavy rainfalls and rising water. The close-knit communities developed vernacular principles followed while constructing the self-build houses and maintaining the ecosystem.

1.2. Research question(s) / problem statement

The upper part of the Citarum River, where Bandung lies, is a mainstay in water flows management in West Java. Over the years, the southern part of the city, including the banks of the Citarum, changed dramatically, becoming an industrial area (Minnery *et al.*, 2013). The growing city boundaries gradually absorbed the rural villages located alongside the river, changing their tissue and character and urbanizing the Citarum banks (Colombijn and Cote, 2014).

Further urban migrations led to the ongoing expansion of the hamlets and the establishment of high-density unplanned settlements along the river. Despite the exponential population growth, people continued to use primitive sanitation, incapable of performing properly on a large scale. The lack of appropriate infrastructure forced residents to use the river for waste disposal. The unethical industrial activities and using the river as a sewage channel caused groundwater contamination, posing public health risks and necessitating the bottled water purchase for drinking and cleaning. (Dovey, Cook and Achmadi, 2019).

The urbanization and dynamic growth of the West Java region, including the Bandung Metropolitan Area, disregarded nature by over-exploiting available resources. It led to a disproportion between urbanized, peri-urban settlements over natural habitats. The traditional Sundanese housing typology,

which was adapted to the climate and built with community help using the local materials, is replaced by monotonous shelters constructed with cheap materials, vulnerable to the weather conditions. Despite the lack of a water grid solution, the traditional ecological knowledge regarding the water supply and management of water flows is neglected and fades away. The excessive urban development disturbed the balance of the ecosystem, increasing the graveness of water-related problems.

Nowadays, the severely polluted Citarum River causes a threat to inhabitants of the riverbanks and the natural ecosystem. The way of using the river and building along its side needs to change to protect people and prevent environmental disasters, including life-threatening floods.

In my thesis, I investigate the sustainable ecosystems and building typology of traditional Sundanese communities to tackle the complex problems of living with water in the tropical climate. The main research question of the study is: '**Which lessons can be learned from traditional ways of living with water and how can this contribute to the design and development of water resilient settlement and housing typologies within flood-prone peri-urban areas?'**. To further explore the topic, the sub-questions are:

- What are the water-related aspects of the landscape and settlements of the Sundanese natural ecosystem?
- How is freshwater supplied in the traditional Sundanese hamlet?
- How is the water circulation and sanitation managed in the traditional Sundanese hamlet?
- What are the characteristics protecting the settlements and the traditional housing typologies from abundant water?

1.3. Traditional Ecological Knowledge

The indigenous people of the Sunda landscape lived in harmony with nature and its resources. They passed on their cumulative understanding of the natural systems through generations. This ecological knowledge included empirical knowledge on fauna and flora, the management systems of resources, social relations, and environmental perception (Iskandar and Iskandar, 2017).

Native communities perceived themselves as a part of the environment. The surrounding environment determined the values and believes of the Sundanese people. The local conditions were embedded in their developed ecosystems and housing typologies. The self-sufficient settlements based on available resources preserved an equilibrium between resource depletion and the ecosystem cycle (Woodley, 1991).

The Sundanese methods to balance out the human interference in the environment are based on low-tech solutions and have a limited capacity. They were implemented in the rural areas of Indonesia mostly, in a mountain area of West Java. The number of houses in the hamlet, as well as the boundaries of the settlement, were strictly limited, ensuring the space for nature.

This research uses the Traditional Ecological Knowledge of Sundanese tribes to create the guidelines for sustainable development of settlements along the Citarum River, created in harmony with nature by using the principles mastered by local predecessors and embedded in their architecture.

1.4. Case Study

To understand the traditional ecosystems and water-related aspects of native settlements of West-Java, the Case Study involved two Sundanese tribes. The cases of Kampung Naga and Inner Baduy provide rich information on the ways of living with water and their ecological principles (Nuryato, Ahdiat and Surasetja, 2018). Kampung Naga is a traditional rural village located in Tasikmalaya, West Java, Indonesia. It is recognized for its circular water management techniques. Baduy hamlet is one of three hamlets of Inner Baduy, located in Banten. The literature often presents Baduy as a case to analyse settlements of Urang Kanekes, which according to Sundanese people shows 'how Sundanese culture should ideally be practiced' (Barendregt and Wessing, 2008).

These native settlements hold onto traditional values and customs rooted in the ecosystem of Java (Sudarwani, 2016). Their traditional housing typologies reflect biophysical environmental aspects of

the process where ‘building a house can be seen as constituting the world on a local scale’ (Schefold, Nas and Wessing, 2008).

2. METHOD

The research method is qualitative, and the data is derived from the literature review and comparative case study. The research belongs to the ecology episteme. The study is restricted to desk research due to Covid-19 implications. The information was gathered by studying available literature, pictures, plans, and graphics.

The research method is based on the case study of two traditional settlements of Java representing the ecological knowledge of Tatar Sunda communities. The chosen case studies are Kampung Naga and Inner Baduy hamlet Cibeo. The purpose of the study is to identify and analyze traditional methods of water management and sustainable ways of living with water.

The data was analyzed and organized by the scope of intervention by studying the landscape, settlement, and housing unit scales. Afterward, it was examined and organized by themes, including water and climate-related characteristics of a traditional Sundanese ecosystem and its elements, flows of water and its management (water supply, circulation, sanitation), flood prevention and mitigation (including the abundant rainfalls or rising water) and water-related aspects of housing typology.

The landscape characteristics reflected on the positioning of the settlement, the pattern of the settlement, and natural elements related to the management of the local water resources. The freshwater supply, water circulation, and sanitation management are studied within the settlement area. The water characteristics protecting the settlements and housing units during the monsoon season are examined on all scale levels. The traditional housing typologies are investigated for their characteristics of water adaptability, including their form and material.

3. RESULTS

3.1. Water related characteristic of traditional ecosystem

3.1.1 Position of the settlements

The presence of water determined the location of the Sundanese settlements. According to Schefold et al. (2008), indigenous people believed in the sanctity of areas embraced by the river and the presence of spirits in these areas. The settlements often sit between two streams, at the confluence of waterways, or in the oxbow. This position ensured fertile soil, crucial for agricultural purposes. When it was not possible to situate a hamlet in this relation to water, people would dig canals (Schefold, Nas and Wessing, 2008).

3.1.2 Pattern of the settlements

The landscape characteristic and long-established rules influenced the arrangement of the traditional settlements of Tatar Sunda. The settlement consists of three zones based on the terrain level: The Outer area, The Inner area, and the Sacred area. Each is governed by certain rules and customs. The Sacred area is the highest area of the landscape (the hills and their resources), and it belongs to the spirits of nature and ancestors (Wessing, 2008). The Inner Zone is a clean area, including housing. The Outer zone lies in the lowest area of the landscape, and it is less conservative area with fewer restrictions or a dirty area (As’Ari *et al.*, 2019).

The size of the zones varies between the tribes. In Kampung Naga, all the zones are part of the settlement (figure 1), while in Baduy hamlets, the zoning covers whole hamlets and the land between them. The Inner Baduy includes three hamlets - Cibeo, Cikeusik, Cikertawarna, while the Outer Baduy consists of around 50 hamlets (Iskandar and Iskandar, 2017). The Inner hamlets are closer to the Sacred hill, and the rules applying to its inhabitants and visitors are stricter.

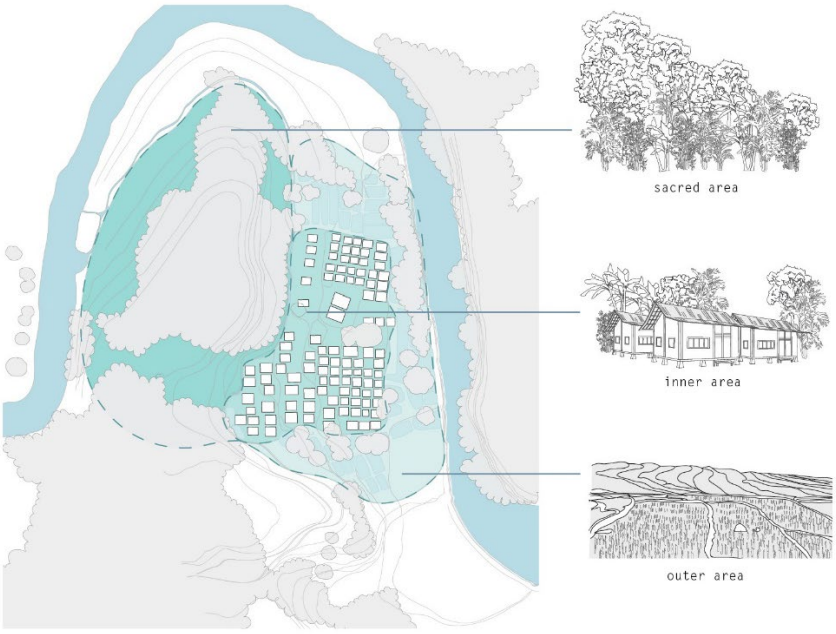

Figure 2. Zoning of the areas on the example of Kampung Naga. Source: the author.

3.1.3 Elements of the landscape and its function

A traditional Sundanese landscape is a combination of natural and man-made elements. The hamlet (kampung or lembur) belongs to the latter category while the swidden fields, forest, river, and garden fall in the first one (figure 2). Together they create an ecosystem, with each element having equal importance and function (Iskandar and Iskandar, 2017). The river serves as a water supply and sewage solution. To prevent mixing the fresh and sewage water, the system corresponds to the direction of water flow (Widayati *et al.*, 2019). The vegetation belonging to the inner area – mostly the swidden fields and gardens serve as a food and building material. The excess of the material can be resold to people outside the community, creating a link to the local economy (Iskandar and Iskandar, 2017). The vegetation of the forest plays an important role in maintaining the natural microclimate by protecting the soil and ensuring wildlife equilibrium. The settlement includes traditional houses arranged in rows, following the north-south axes, a meeting house, rice barns, and a pounding unit (Iskandar and Iskandar, 2017).

Figure 3. Elements of the landscape on the example of Inner Baduy hamlet Cibeo. Source: the author.

3.2. The management of water flows

3.2.1 Water supply

The natural character of the landscape and its water conservation qualities influenced the spatial arrangement of Kampung Naga. The hamlet laid on the mountainside, with a group of houses sited on the terraces, causing a highly compacted settled area. The build-up area lies between the founder's hill and the Ciwulan river (Wiryomartono, 2014).

In Kampung Naga, the water source is the Ciwulan River (As'Ari *et al.*, 2019). According to Schefold et al. (2008) the canals embraced the settled area, separating it from the spirit hill, the founder's grave, and rice fields. The waterways ran from the south to the north, which created the framework of settlement orientation and separated the build-up area of daily life from the world of the spirits (Schefold, Nas and Wessing, 2008). There are three water sources coming from the upper part of the river: river water directed to the irrigation channel and two springs (figure 3). The water of one of them is used for tanks in the latrines, whilst the water from the other one called Nyusu is used for drinking. The water from Nyusu is filtrated through the roots of the forest, ensuring its quality. The water system accumulated in the hill also ensures the needed quantity of resources regardless of the season (Prestasia and Boomi, 2020).

Figure 4. Circulation of the water on the example of Kampung Naga. Source: the author.

3.2.2 Water circulation and sanitation

The Sundanese hamlets are surrounded by dry and wet fields and fishponds (Schefold, Nas and Wessing, 2008). The irrigation channel, dug by the community, provides the water to the terraced crops. The separation between the channel and the river is ensured by stones. The terraces follow the topography of the hill, creating a height difference. This system provides water supply to all the crops using bamboo piping. The water level can be controlled manually by the community by through control channels placed in between the fields (Prestasia and Boomi, 2020).

According to Prestasia (2020), a similar system is applied between the latrine, rise husking station, and the fishponds, located in the lower part of the settlement. The wastewater is discharged to the ponds, where it is gradually purified by the fishes. From this area, the purified water is directed toward the lower part of the river (Prestasia and Boomi, 2020) (figure 4).

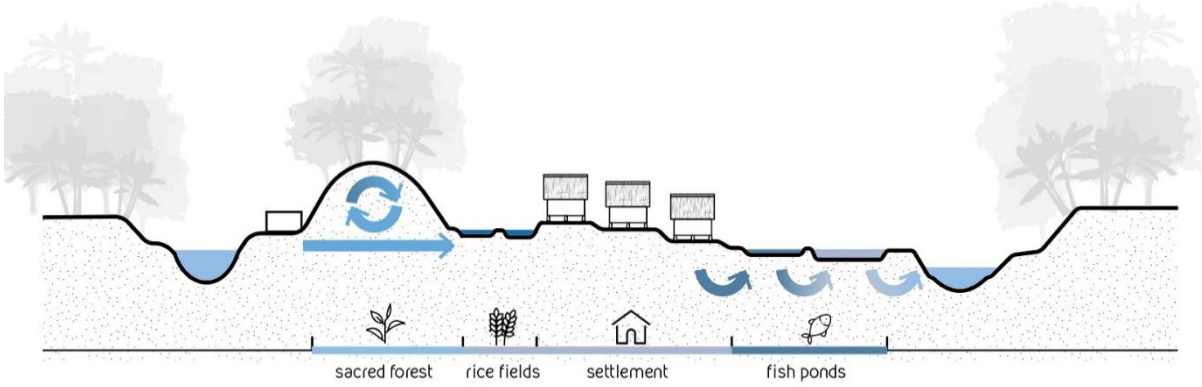

Figure 5. Water purification on the example of Kampung Naga. Source: the author.

The Baduy hamlet Cibeo lies in an oxbow of a river. The community uses different parts of the river for specific daily activities. The upstream serves for drinking and cooking purposes, the middle part is used for bathing and washing, and the limited part of the downstream serves for sanitation purposes. This system ensures that the drinking water is not contaminated (Widayati *et al.*, 2019). The rooting system of Sacred hill vegetation ensures infiltration and purification of drinking water. It is not clear if any purification system is used for wastewater treatment.

3.3 Adaptability to climate and presence of water

3.3.1 Management of rainwater and flood mitigation

Both analyzed hamlets lie in the mountain area, which creates natural protection against floods. The sloped terrain directs the water flows towards the river located in the lowest part of the settlement. The character of the landscape combined with the flora allows rainwater storage in the area. The vegetation helps regulating the amount of water flowing into the river and therefore decrease its velocity (Widayati *et al.*, 2019). The lush flora of the Sacred hills, located at the highest point of the settlement, is a reservoir of rainwater, enabling its filtration and storage (Prestasia and Boomi, 2020). The natural surface between houses and plants of inner gardens helps regulating the amount of water by absorbing it.

The layout of the Tatar Sunda settlement is rhythmic, based on a grid plan with alleys between the houses. The movement of the sun affects the orientation of the houses (Wiryomartono, 2014). The linear arrangement of units follows the path running from east to west. The inclined paths between the house rows serve as outflow during the rainfall. The gabled roofs ensure easy flow of water directly into the drainage (Sudarwani, 2016).

The elevation of living units protects the houses from the water. The river stones are used to redirect the water flows. In Baduy hamlets, the houses are surrounded by them, regulating the flow of the water, ensuring that the soil under the house is not washed out (Widayati *et al.*, 2019).

3.3.2 Form of the living unit

The architecture of Sundanese housing responds to the local humid climate. Its form and material are adjusted to the presence of water (figure 5). The light structure also improves the resistance to earthquakes. The typical house of Kampung Naga is a raised posted-beam construction (Wessing, 2008). Usually, the rectangular plan has dimensions of 6 x 8 meters. The self-maintaining H-shaped framework made of timber is enclosed by walls made of woven split bamboo. The joints between the structural elements are hinge type joints, allowing the structure for limited movements (Wiryomartono, 2014). The lightness of the structure ensures the stability of the house during unexpected weather events.

To ensure stability, the soil cannot be mushy. To protect the foundation from the water flows, in Baduy hamlets the river stones surround the house limit the access of water to the soil. The houses are elevated about 50 cm, and they stand on a foundation made of a single stone (Yani, Widaningsih and Rosita, 2016). The uplift from the ground level not only protects the wood from direct contact with the wet soil but also prevents it from insect attack. The open space underneath the house allows optimal airflow, preventing building material to remain wet (Sudarwani, 2016).

The rafters rest on the unit as a separate part, not tied to the timber frame. The roof is heavier and extends around 40 cm beyond the walls. The extensions create eaves, protecting the walls against the rainfall (Schefold, Nas and Wessing, 2008). The form of the gabled roof ensures that water can flow easily (Sudarwani, 2016).

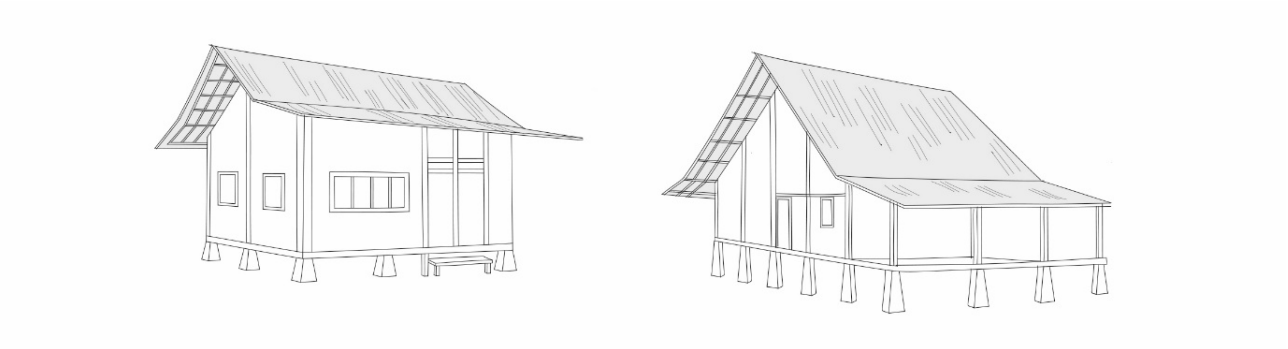

Figure 6. Typical living unit of Kampung Naga (left) and Baduy hamlet (right). Source: the author.

3.3.3 Materiality

The Sundanese use elastic and light materials for traditional houses. The communities depend on locally available materials for the construction. The resources are restricted by the limited richness of the man-made forest and the number of fruit trees owned by the families (Barendregt and Wessing, 2008).

The construction of the Kampung Naga frames from acacia wood improve their resistance to humid conditions (Sudarwani, 2016). The wood does not have direct contact with the wet ground as it resists on the large stone plinths (Schefold, Nas and Wessing, 2008). To improve the durability and strength of wood, the elements are soaked in water or mud for 40 days. After this process, the dried and cleaned wood is used for structural elements (Yani, Widaningsih and Rosita, 2016).

The roof is assembled without the use of nails, and it's covered with sago palm fibers or reeds (Sudarwani, 2016). The eaves protect the walls made of woven booths or plaited bamboo with a braids pattern from the rainwater. In Baduy hamlet, the wall patterns are visible both on the inside and outside. While in Kampung Naga, they additionally use external white covering. The gaps between the woven walls allow the air to flow through them. Flattened bamboo is used for the floor, and the open spaces between the platform and the walls also allow for cross-ventilation (Barendregt and Wessing, 2008).

4. CONCLUSIONS

To create water resilient settlements, they must become a part of the ecosystem that is responsible for regulating the flow of water. The design of the settlements must incorporate both natural and man-made elements and give them equal importance to preserve the ecosystem. Human settlements should not dominate or replace natural habitats, but they ought to become an integral part of the ecosystem.

Architecture-wise several characteristics of traditional Sundanese housing typologies should be considered while designing in water inclusive tropical environment, namely the gabled roof, pillars, and light construction. The eaves of an extensive gabled roof can protect the building from monsoon rainfalls by directing the water into the drainage. The system of water collection functions efficiently due to the linear arrangement of the houses and aliment of the roof ridges. During the heavy rainfalls,

the pathways between the houses are used as waterways. The semi-permeable surfaces absorb the water, while the soil underneath the house is protected by redirecting the flow of water with the help of the stones.

The characteristics of the houses should not only protect them against water but also mitigate the negative consequences caused by heavy rainfall and flooding. The light structure of the timber frame prevents the house from becoming unstable in the mushy soil. Raising the structure and placing woven walls protects the timber against water and allows cross-ventilation of the house, which helps in drying up the wet elements.

The self-reliant settlements limit human interference with the natural vegetation of the area, preventing over-exploiting the resources and environmental degradation. The limitations permit nature to flourish, and the scarcity of available materials entails its prudent use. Only the vegetation from the limited areas (Inner or Outer zone) can be used for construction and economic activities. The flora of sacred hill is preserved from human exploitation and the boundaries of the settlements prevent them from uncontrolled expansion.

The vegetation plays a crucial role in water management. The roots of the trees work as a filtration system by absorbing and storing rainwater in the area, ensuring a clean water supply during the dry season, and preventing excessive flooding of the river during monsoons. Regulating the water flow in the upper Citarum is crucial as problems arising upstream affect the rest of the river. Therefore, to preserve the riverbanks from erosion, there must be a balance between the natural vegetation and human settlements.

The natural waste in Sundanese hamlet is processed within the environment of the settlement based on the ecological cycle. The natural materials used for traditional constructions are biodegradable and can be recycled in the environment without causing harmful consequences. The fishpond systems serve as a source of food as well as water treatment processing the waste from sanitation and rice husking. The cleaned water is directed back to the river. This can result in a circular economy where the local resources and materials stay in the loop, giving back to nature as much as they take.

In the current situation of heavy pollution of the Citarum River with industrial and solid waste, natural water treatment systems are failing. Traditional systems will be useless if the perception of fauna and flora does not change. The approach to the environment must shift from exploiting nature to living in harmony with it. As humans, settlements, and nature are interdependent, and they must be given equal importance. The ecosystem should become an integral part of the design process for settlements to become water resilient.

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