

Learning from the past about water and architecture: Case of Kampong Ayer, Brunei

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Abstract

Water is the most important source of life and livelihood for the continuity of life. Throughout history, in city planning, architecture and interior architecture, which form the shell of life, different solutions have been produced to meet the needs of people with water. While the changing needs of life add new meanings to live with water, we witness the changing borders between sea and land. Although habitats on water seem like an alternative due to extreme climate changes, actually living with water is not a new concept. However, with the number of extreme climatic events as a result of human activities and the changing of the planet's climate, some issues and sensitivities have emerged in the evaluation of water. Not only extreme climate changes, but also increasing density, economic trends and sustainability issues have led to an increased focus on living with water. In this study, the example of Kampung Ayer in Brunei, which is one of the largest water neighbourhood that has survived to the present day and where life still continues, has been discussed and evaluated as a source that can provide inputs for the design of water cities, which are seen as an alternative among the cities of the future, by trying to understand their positive features and possible problems. In this context, considering historical process and population density, the features that can be considered as a water city with public functions such as education, health and transportation have been effective in the selection of the sample. The guiding and instructive features of these examples from the past, which will provide a sustainable and healthy collective life, to the floating architectural examples of the future are discussed. As a result, by learning from the historical water villages, findings and suggestions are included to be an input for future designs. The originality of this study is the use of water villages, which have many post-use experiences of

life on water in history, as a learning tool in floating architectural designs.

Key Words: *Living with Water, Floating Architecture, Traditional Floating Villages, Climate Change, Cultural Sustainability.*

1. Introduction

The features in traditional architecture that have survived until today constitute important facts in the development of social life (Rapaport, 1969). Civilizations around the world have developed around bodies of water, where vital needs such as drinking water, irrigation and fishing could be met. Even in modern times, port cities continued to emerge near water bodies. Thus, relations with water have emerged in different forms such as fountains, bridges, arches, pools, and alike, and in architectural context, unlike land formations, water cities continue their existence on water rather than on land next to the water. These settlements, known as floating villages, have developed on the surface of inland water bodies for cultural and functional reasons in different parts of the world. Quantity and quality that meet the four basic human needs (drinking water for survival, water for human hygiene, preparing water and food for sanitation services, for modest household needs) constitute 'basic water requirements' for people to maintain healthy life cycles. Regardless of the economic, social or political status of the individual, there is a basic water requirement of 50 liters per person per day for the needs of a person. Apart from this, water is needed to grow food and protect natural ecosystems (Gleick, 1996). There is an increase in the need for additional housing and construction sites due to rising populations in some countries, especially in Europe and Asia, and rising sea levels in the context of worldwide climate change. Looking at water cities in many examples of the world, Asia has a much longer his-

tory of floating architecture (Stopp & Strangfeld, 2010). The concept of floating architecture includes the space or spaces where basic needs are met on the water and can move from one point to another when necessary (Yıldırım, 2017).

In the future, there are scientific indications that the habitats on terrestrial surfaces will be depleted due to climate change, increasing population density, and reduction of terrestrial resources. Extreme climate events are becoming more numerous due to the planet's climate transforms as a result of human activity. Designers and engineers around the world are working to develop flexible, adaptable, durable solutions in response to coastal flooding in the form of extreme natural events. Not only extreme climate changes but also rising density, economical trends and sustainability problems caused a growing focus on living with water. Except from the countries which have the risk of flood, or rising sea levels, the other countries have also the probability to be affected by the climate changes and therefore taking into consideration water-based solutions. Also, the flow of the capital and changing human lifestyle requirements direct us to the water as an alternative living space. As a respond to the world's sustainability problems, from both economical, socio - cultural and also the ecological, it is required to understand the importance of living with water. As the designers and engineers of the "climate change generation" they have the responsibility to look at the past, present and the future and ask the opportunities of water that they could apply, inform and transform to their designs. Although the concept of living with water is not a new concept, some sensitivities related to water have been included in our lives, especially the way we evaluate water in the process after Covid 19. The subject of water adaptation to cities stands out as a topic that needs to be evaluated from a different perspective today. Solutions are being sought to adapt the water to the city and to ensure the life cycles of the settlements in harmony with the water due to the already rising water levels in some regions. At this point, considerations of designing with water becomes even more important. Because life on water is different from terrestrial life, and it is necessary to consider design solution in this context. For our architectural, interior architecture and design disciplines learning to design

with water, which was previously dominated by our terrestrial life-based teachings, the data to be obtained from historical water settlements are an instructive resource that also includes vital experience (Shaaban, Yıldırım, 2019)

At the present time, when it comes to floating architecture, examples built and designed in hi-tech style are common, and in most cases supply and waste are handled through terrestrial infrastructure. To develop a self-sufficient sustainable floating community inhabited by thousands of people requires economical and environmentally friendly products, including infrastructure, prior to the application of new construction ideas and new materials. The floating architecture, which involves researching and solving unconventional problems, includes themes of water balance, fire protection, energy supply and smart application of environmental resources, protection from ice formation and use. In the scope of this paper, integration of water with spaces from a vernacular model of floating cities will be discussed. In addition, the solutions and problems covered by the study are aimed to provide information to designers who do not have experience in designing life in water for future water cities. Moreover, the article attempts to show how theoretical perspectives can be applied constructively to innovative floating architecture.

2. Literature review

Due to extreme natural events, climate change, increasing population density in the terrestrial area and decreasing resources, we come across many innovative projects and ideas for vital solutions on seas and water surfaces, coastlines and river regions. Advocating the necessity of transferring the floating settlement into practice, Stopp et al. (2016) also draws attention to many problems which are later referred to technique, management and user's social behavior in operating floating equipment. Scientist and futurists from all over the world are indicating the solutions for living with water and predict that the relationship between human and water will increase.

Many studies also discussed problems and possible solutions of overwater settlements. For example, Bosselmann, P. C. et al. (2010) studied a group of water villages that will be a part of the existing

city extension within the scope of urban expansion to former agricultural lands in the Pearl River Delta and incorporation of villages into urbanized areas in Chinese cities, which have experienced intense growth and transformation in recent years, and the morphological analysis of settlement patterns, used in conjunction with stream morphological analysis of the water system. Another study is Olajuyigbe, Rotowa, Adewumi (2012) which evaluated the clean water supply to the water city of Lagos in Africa. In their work, which includes identifying water supply sources, assessing patronage levels among households, and identifying problems related to their operations, they examined the role of water vending machines in domestic water supply, independent of the mainland, with internal solutions. Liu (2019) et al. have archived the traditional Chinese village, which is best adapted to the climatic and environmental characteristics of the region, using local methods, accepting it as a large data source. In addition, they argued that by extensively researching the spatial design of water villages, they would set an example for the rapid urbanization in contemporary cities and their design to prevent the construction of buildings with lower cultural value and high energy consumption. In his study, Jones (1997) evaluated the historical water village of Kampun Ayer, by addressing the increasing development pressures and the desire for better living conditions in Brunei, and the replacement of most of the original building forms with modern replicas by making changes on the physical and social fabric of these settlements to overlap with traditional architectural styles. On the other hand, Stopp & Strangfeld (2010) stated that floating architecture could be a future solution to the current problems in many districts, cities and landscapes. Ahmad (2013), in the context of tourism history related with water, talked about the use of water cities as tourism objects as attraction elements and their contribution to cultural continuity. Yildirim (2017), on the other hand, emphasized that the perception of people and space on water is different from terrestrial structures and that the characteristic structure of the floating architecture phenomenon should be understood, and design solutions should be produced. Although post-occupancy evaluations that will provide input to the design cycle in terrestrial architecture have been applied in almost every building type, they found this gap in floating archi-

tecture and obtained significant feedback on the designs of floating structures in their research, where they conducted the first Post Occupancy Evaluation (POE) study in floating architecture (Duman, Zengel, 2016). As can be seen from the literature, water cities have been examined as examples of floating architecture that embody the relationship of human and life on water from many different perspectives. However, there are only few studies on learning from past for future aquatic environments, which are discussed with an architectural approach, the aspects of cultural continuity are discussed, and possible solutions to future water cities.

3. Method

In this study, the Case Study method of analysis over the sample was applied. In sample selection, it is important that each sample has an ongoing process throughout history and still maintains continuity. The data obtained have been selected according to their potential to provide input to new designs in terms of sustainability of water cities.

3.1. Case Study: Kampung Ayer

Brunei is a country located on the north coast of the island of Borneo in Southeast Asia. Kampung Ayer is the World's most populous and important traditional water village in Bandar Seri Begawan, the capital of Brunei, built on pillars in the water, stretching up the Brunei River. (Photo 1).



Photo 1. Location of Kampung Ayer Water Village https://commons.wikimedia.org/wiki/File:Kampung_Ayer,_Brunei_from_OpenStreetMap.png

'Kampung Ayer', still in use as the primary name of the place, is the ancient Roman spelling of the Malay term 'Kampung Air', meaning 'Water Vil-

lage'. Its past is evident from the narrative of the Italian explorer Antonio Pigafetta, who described the settlement as built entirely on salt water during his visit to Brunei in 1521 as part of the Magellanic fleet. (Photo 2). "Twenty-five thousand families live in houses, all made of wood and built on high pillars". (Antonio Pigafetta, European Sources for the History of the Sultanate of the Sultanate of Brunei in the Sixth Century, p. 11).



Photo 2. Historical living in water village Kampong Ayer http://3.bp.blogspot.com/_BHQXYbtdBiE/SLXZbQvy_wI/AAAAAAAAABM4/kekQoAT1x0E/w1200-h630-p-k-no-nu/gambar_kampong_ayer_1950s.jpg

Olivier van Noort, according to history of Brunei Darussalam in the sixteenth century in European sources, stated that traditional houses built on columns on the Brunei River consist of neighborhoods with schools and mosques and that these houses can be moved from one side of the river to the other when necessary, for this they are built on light piles of wood. Being able to move to another place when necessary has also ensured that Kampong Ayer is protected from natural disasters (Nicholl, 1975). On an urban scale, wooden walkways on the water span a total area of 30 km, connecting the 30 villages that make up Kampong Ayer. Transportation is provided by motorboats on the streets where the walking paths are not connected to each other due to the fact that they are separated by wide waterways. Boats are usually made of wood and in the traditional local style and are often referred to as 'water taxis'. Shared services including electricity, water, telephone lines, internet access and television services are delivered to the floating village by suitable methods, if possible, wirelessly.

The established heritage of Brunei is the history of urban settlements, especially water villages, which are among the oldest settlements in the

region. Considered one of the largest and oldest Malay water settlements in the world, the water villages in Kampong Ayer set an example with their characters and cultural features that still maintain a rapidly disappearing lifestyle. (Jones, 1997). Traditionally made of wood on stilts above the water, the houses in Kampong Ayer have adopted the style of traditional Malay houses as their architectural style. The houses are up to two floors. Most of them were built as special designs, just like in traditional design approaches. For this reason, individual original architectural styles come to the fore. (Photo 3 and 4).



Photo 3. Traditional Malay House style on water



Photo 4. Kampong Ayer have adopted the style of traditional Malay houses. <https://cdn.idntimes.com/contentimages/community/2021/11/koutsarsky-cixrwfdhqne>

Whereas, houses built by public housing initiatives, specifically in Kampong Bolkiah and as part of the pilot rejuvenation project in Kampong Lurong Sikuna, have a more uniform style similar to land-based housing estates (Photo 5). As for the logistics

of Kampung Ayer, a floating settlement, it appears that it has an extensive network of walkways on stilts and footbridges that connect houses and other buildings. People travel by boat and water taxi. It causes Kampong Ayer to be compared to the “Venice of the East”. (Photo 8). They are made of wood, concrete or with metal legs. Mosques, schools, post office, restaurants, police stations and fire brigades are located on the pillars descending into the water. The secondary school in Kampong Ayer, Awang Semaun Secondary School, is the only school of its kind where its buildings are built on water (Photo 6). However, Seyyidina Umar Al-Hattab Secondary School, built on the land, also has service area in some villages of Kampong Ayer.



Photo 5. As part of the pilot rejuvenation project in Kampong Lurong Sikuna uniform style similar to land-based housing estates https://commons.wikimedia.org/wiki/File:Kampong_Ayer_BSB1.JPG



Photo 6. Kampong Ayer, Awang Semaun Secondary School. https://commons.wikimedia.org/wiki/Category:Awang_Semaun_Secondary_School

Incidents of fire are common in Kampong Ayer and the main reported causes include faulty wiring and proneness to fire as many of the buildings are made of wood, so a fire station is important for overwater placement. (Photo 7).



Photo 7. Fire station for floating settlement https://commons.wikimedia.org/wiki/File:Sungai_Kebun_Fire_Station.jpg



Photo 8. Kampong Ayer, Venice of the East. <https://i.pinimg.com/originals/75/21/64/7521642ef108afeb86bed92a3e5cd4e7.jpg>

The water supply of the floating houses is provided by pipes next to the walking paths. The cables at the top bring the electricity. As with most floating habitats, a problem that needs to be resolved in order to ensure the sustainability of a healthy life in Kampong Ayer is related to waste management. Although modern sewage systems are available at most points to connect with systems on the mainland, it is recognized that the pollution is not solely from settlement, but also from waste flowing down the tributaries into the Brunei River, as upstream garbage management is not fully effective (Mail, 2016).

3.2 Case study: Traditional Malay housing analysis

The local residences of the Malays are considered as assets that maintain the cultural value in the region with their roofs suitable for the tropical climate, traditional architectural forms and harmonious proportions with decorative elements. However, these buildings require significant maintenance.

nance compared to modern structures, such as the difficulties of protecting their main material, wood, from the rotting effects of tropical weather and termite infestation. All houses are made of wood and thatch with nipa leaves. While urban regeneration has wiped out nearly all Malay urban districts, settlements displaying this vernacular architecture have survived and there is an ongoing effort to preserve indigenous architectural styles, mostly in water villages. Most of the Malay Houses are built from wood. They are very vulnerable to fire and the risk of fire spreading. For this reason, most of the houses float in the water to form a raft with wooden pieces connected together. If a fire breaks out at some point, every home owner can disconnect from other homes and get away from the fire. As a result, houses placed above water are better protected from fire. Also, when the resident feels dissatisfied with a particular place, they can move to a different neighborhood of the city (Saunders, 1994). The characteristic elements of local residential architecture, which Malay houses try to maintain in floating villages, can be listed as follows: 1. Pillars, 2. Stairs, 3. Divided rooms, 4. Traditional roof, 5. Decorations containing local colors and motifs. Most Malay houses are built on pillars or piles as Rumah Panggung “stage houses” (Photo 3, 4). This characteristic, which is the main feature of a typical Malay kampung house and is maintained in its aquatic structures, provides solutions such as avoidance of wild animals, floods and ventilation. Thanks to these pedestals, the house can be raised above the flood surface. Stairs are structural elements that form the identity of the traditional Malay house and are built to reach the elevated interior. Usually stairs connect the land front of the house to the *ceramambi* (porch or veranda). Stairs are usually molded decoratively and furnished in colour. Renewable natural materials such as wood and bamboo are used as construction. Joint details in dwellings are usually built in a prefabricated house logic, without the use of metal, including nails, instead using pre-cut holes and grooves to fit the wooden elements together. Since flexibility is an important requirement, especially in above-water structures, nails have been used later, but this use has been limited to non-structural elements of houses such as windows or panels. Wooden constructions made without nails or fixed metals and, movement in the water and reconstruction in

a new location are made possible. Although Malay homes have various styles according to each state and sub-ethnic, there are common styles and similarities between them (Vlatseas, 1990). Many of the ancient Malay peoples of Southeast Asia sought to preserve the form of the self-regenerating environmental culture that emerged in their terrestrial areas, and the contemporary architectural design principles they used for shading and ventilation in their above-water structures.



Photo 9. Rumah Lontik with curved roof and boat-like structure. A Malay traditional house of Kampar Regency, Riau. The replica is located at Riau Pavilion, Taman Mini Indonesia Indah, Jakarta. File: TMII Riau Pavilion Malay House 04.jpg - Wikipedia

Looking at the interior design, which speaks the same language as its terrestrial structures, houses are consisted of rooms called *serambi* (patio), living room and bedrooms. Two important criteria guided the interior design. One of these; sensitivity to human scale, and the second is privacy. It is said that the distances between the footrests follow the width of the arms of the wife and mother of the family of the house, as an indicator of harmony with the human in proportions. To ensure privacy, the house consists of two parts, the main house (*ibu*) called *Rumah Ibu* and the simpler *Rumah Dapur* separated from the main house. The gable roof, an elongated frame with ornaments on the sides that covers the house, is designed to protect from heat and rain and to provide ventilation (Nasir, Theh, 1997). While each Malay region, state, or sub-ethnic group has its own regional or group style with preferred details, the local Malay roof is built to be suitable for hot and humid tropical climates. The different design

styles of the gable roof appear in some homes as a sloping roof in the form of a pyramid or as a curved roof with a boat-like structure on pillars. Rumah Lipat Kajang features flat roof structure with intersecting edges forming an “x” peak at the corners of the roof. The larger structure with a similar cross-corner roof is called Rumah Limas (Photo 9).

4. Findings

In this study, which analyzes traditional water houses in Brunei, which is the oldest and still preserved example of floating architecture, as an important historical and cultural heritage, it is seen that there is a tendency of settlement in the same style when the settlement on the water is compared with the village. In fact, it is observed that houses come together, neighborhoods are formed, and public buildings are positioned, similar to the urban formation in the inland city. In this context, the positive and negative aspects of the given example, the opportunities and threats it contains are given in the findings in the form of a SWOT analysis (Table 1).

In Kampung Ayer water village, which is an example of a sustainable life on water, the factor that provides originality and can be seen as its strengths is that such a large historical living settlement on the water still continues. It stands out with the contribution of the architectural construction on the water to the cultural continuity. In addition, changing the position of the structures against floods and other natural

disasters is an important factor. However, knowing the weaknesses of these settlements and developing them in later designs will make them more energy efficient and environmentally friendly. For example, it can be difficult for the aquatic habitat to stay in balance continuously due to wastes and chemicals from life. Garbage and sewage waste are an ongoing problem despite important measures and initiatives taken by the government and non-governmental organizations. Uncontrolled flows of waste from other water sources also negatively affect this problem. Vital wastes can pollute the water over time, and they can also be a threat to the natural life in the water. Over the last few years, the overall population has been shrinking as residents migrate and relocate to the land under the influence of modernization. Hence, it threatens the survival of Kampung Ayer and its customs and traditions. On the other hand, there are aspects that can be turned into opportunities in the design of life on water. Water is used as a natural air conditioning element and a visual natural landscape element in buildings. Since the houses placed on the water can be better protected from fire, they positively affect the sustainability of traditional houses. Malay houses on the water contain a lot of data on fire protection and the durability of wood on water for many years. An above-water use, exemplary of traditional Malay floating architecture, is pemantung, a stationary piece of wood that can be from about 300mm to 450mm high or higher, located above the finished floor level at the main door entrance to en-

Table 1. SWOT Analysis of Kampung Ayer

Strengths	The fact that such a large historical settlement on the water still continues Cultural continuity for the future generation Framework for sustainable livelihoods Being mobile when needed
Weaknesses	Waste problem Harmful effects of water Maintenance Security
Opportunities	Visual natural landscape element Natural air conditioning Preservation of traditional architecture Expansion of settlements without harming natural environment of the land (forests green area etc.)
Treaths	Unstable environmental conditions due to water level change Population growth Consumer aspect of tourism Fire

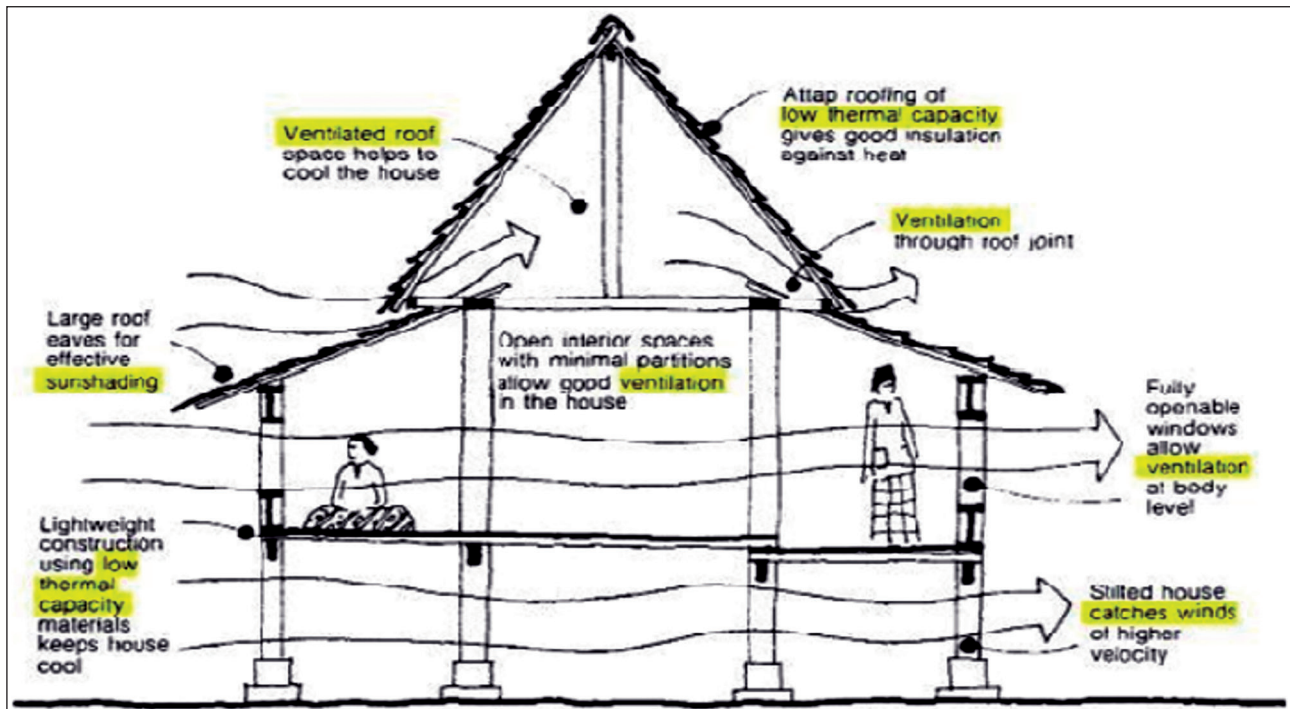


Figure 1. Learning from the elements of traditional Malay House (Yuan, 1988).

ter the house. The door is lifted above this level. The aim here is both to classify the barrier of the exterior and interior of the house (public and private) and to strengthen the boundary line of interior and exterior. Thus, it is to reduce the risk of falling into the water, which can be a source of danger for small children, and to prevent them from going out. This traditional solution to the danger of falling into the water, which creates a problem around floating houses, is an idea that can be applied to today's examples. The cross pillars beneath the traditional Malay dwelling mitigate the effects of the flood, while allowing the breeze to cool the house (Hosseini, et.al.,2012). Although the placement of the columns seems to be accidental, they form architecture that naturally fits the tropical conditions. If the placement logics of these columns can be associated with parametric architecture, flood protectors and wave preventers can be produced that other floating structures can also benefit from. The high pitched roofs and large windows not only allow for cross ventilation, they are carved with intricate organic designs. The connection types to be obtained from traditional Malay overwater residences, which are built completely without nails, contain lesson details for future designs.

As seen in the Figure 1, the space at the top of the roof helps to cool the house by providing ventilation on the roof. While the roof covering with a

low heat capacity provides a good insulation against heat, ventilation flow is realized thanks to the roof joint gaps. Wide roof eaves provide effective protection from the sun. Good ventilation in the house is ensured by open interior solutions with minimal partitions. The windows can be opened completely, thus providing ventilation at body level.

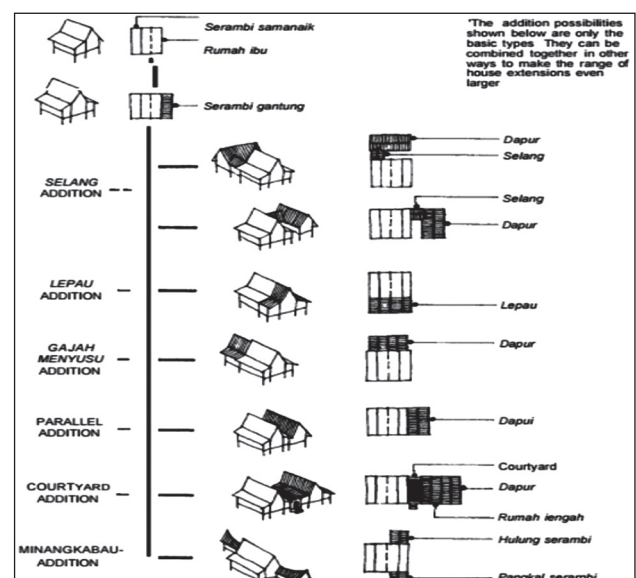


Figure 2. Yuan, J. L. (1988). The Malay House

Due to the low thermal capacity materials used in the traditional Malay house, the lightweight structure keeps the house cool. It is also a lesson in the concept

of a lightweight result building, which is one of the most important criteria of floating architecture. Elevated house on stilts catches higher speed winds and softens the effect of water. Furthermore, the modular design approach in traditional Malay residential architecture allows many houses to come together in different ways to form collective living units (Figure 2). Only the basic types of articulation possibilities are shown in the figure. They can be combined in other ways to further expand the range of home extensions. Modules are crucial in product design to speed up the production process, make products better, and ensure efficient assembly, a concept that exists in traditional Malay housing (Zainol, et al. 2013).

5. Conclusions

The statement that life will be widespread on the waters in the future has gone beyond being solely prediction. Focusing on the historical developments and challenges in traditional water living and conservation in the water village of Kampong Ayer, Brunei, this study reveals the many environmental, social and cultural frameworks that have shaped the development of local water architecture. As a result, economic development and population growth and changes in urbanization practices significantly affect water settlements in rural areas. The necessity of a holistic approach to protect sustainable land use and water management in the rural water village of natural and cultural structures emerges. Ongoing investments in tourism and urban infrastructure need to be implemented in a way that gives greater priority to sustainable goals that will support the village and help it develop in the future. Flexible planning and design approach represent one of the key words of architecture on water and predicts change over time. With Progressive design on water, it is possible to reach design and planning decisions that provide flexibility and adaptability over time. Considering the possibility of rising water level, planning studies should be gradual and have the ability to change according to conditions. Showcasing and sharing Kampong Ayer's settlement will help preserve and revitalize its community's socio-cultural heritage.

In this study, Kampong Ayer is evaluated as an example of maintaining the cultural heritage in constructing structures on water. Water settlements such as Kampong Ayer should be modernized by equip-

ping them with up-to-date technologies, taking into account their cultural sensitivities. Opening a traditional Malay house for accommodation on the water for tourists to experience, that the water coming from the city flowing from the river passes through the filter dam, the use of alternative energy sources (solar energy) instead of the cable system of electricity consumption, the internet provider stations provide distribution from certain main points in the campus, the tourist entrances and exits are limited and within certain routes. It is proposed to achieve the goals needed for sustainability. On the other hand, many new problems must be found regarding the physical and chemical effects of water on floating architectural structures. New materials and structures should be developed to withstand the different effects of water. The harmony between architecture and nature should be discussed. Finally, city-scale and regional-scale adaptation plans are suggested in order to guide the designs created in the historical process to successful designs on the water to be built today. Standards, zoning laws, building codes are tools that need to be reconsidered to ensure compliance.

It is seen that traditional architecture has changed with the rapid spread of technology and the discovery of new materials. In this research, the question of how we can maintain our architectural identity on water in the future by taking lessons from traditional construction methods in floating architecture has tried to be answered with the example of Kampong Ayer. Brunei Architecture has been examined not only with its forms and motifs, but also with its plan and social aspects, while reflecting the modern architectural thought on the water and reflecting its changing functions to the identity. In today's world, structures and concept projects on the water are trying to produce concepts based on forced forms with a new look, away from the traditional style. In floating architecture, although the forms that try to go beyond the traditional appearance are featured in the media with their utopian and imaginary aspect, it is believed that the message and elements of local architecture can be combined with the cultural identity and traditional solutions, water-specific design and art understanding, and read in a different way on the seas. This understanding will turn any building on the water out of the concept of a floating structure into a successful architectural structure. By establishing a region-wide viewpoint between design and

installation with the viewpoint connected with tradition and the past, viewpoints can be implemented in some way according to the floating architecture being considered. Analyses show a strong connection between culture and contemporary architecture. This perspective implies the importance of the region, tradition and history as a bridge between the past and the future. We cannot ignore this importance in floating architectural examples.

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