“SUSTAINABLE APPROACHES FOR BUILT ENVIRONMENT IN DEVELOPING COUNTRIES”

PROCEEDINGS

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"Sustainable approaches for built environment in developing countries"
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Learning from IJburg and Maasbommel Floating Houses: The Planning and Design Approach for Adapting Climate

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Abstract- Dutch landscape is currently highlighted by a new way of living on the water such as floating and amphibious houses to adapt to a sea level rise and floods. IJburg in Amsterdam is one of the examples, building up 55 pile and floating houses on a surface water reservoir. In Gouden Kurst, Maasbommel another innovative approach was taken in 1998; twenty amphibious housing that stood on the lakeside were constructed, these houses were designed in order to float during high water.

This paper is aimed at analyzing and describing the innovative planning and design approach that have been implemented in these two projects. Particular issues will be raised on 1) the background of the project especially relates to urban design and planning; 2) its spatial pattern (connection with land and water); 3) building design and structure (buoyancy, materials, and utilities); as well as 4) construction and delivery. Data were collected through field observations and literature studies. Maps, plan, section, and photos will be used as a major method to analyze and illustrate the design and concept.

Output of this study is intended to inform the cities and regions in Indonesia that face the same problem with floods, yet have a strong connection with water for years. Banjarmasin is one of the examples, it is well-known for a city of a thousand rivers and tradition living on water in floating houses (Rumah Lanting), however, there has been no new approaches taken to develop Lanting into a modern and sustainable lifestyle living.

Keyword: floating houses, climate change, adaptation, Netherlands

I. INTRODUCTION

Every city is challenged to increase the capacity to adapt their built environment to the vulnerable impacts of climate change such as floods and sea level rise. Netherlands as a low-lying country that highly exposes to the sea and 24% of land is located below average sea level (N.A.P) is constantly dealing with these issues since thousand years ago. The ‘war on water’ has begun from more than 2000 years ago (around 800 AD), highlighted by the construction of dikes, polders, pump stations, dams, canals and land reclamations [1]. In addition, the population growth had pushed the country to provide new lands for urban development; especially for housing.

These conditions have brought to the changing attitude toward water in Dutch society and also to the strategies and actions dealing with water. Dutch landscape is currently highlighted by a new way of living on the water such as floating and amphibious houses to adapt to a sea level rise and floods. IJburg in Amsterdam is one of the examples, building up 55 pile and floating houses on a surface water reservoir. In Gouden Kurst, Maasbommel another innovative approach was taken in 1998; twenty amphibious housing that stood on the lakeside were constructed, these houses were designed in order to float during high water.

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II. FLOATING HOUSES: PLANNING AND DESIGN ISSUES

A. Living on Water & Spatial Planning
Water and scarcity of land for urban development become two major driven factors in developing floating houses in the Netherlands. Spatial planning that was initially separated from water management, since late 1990s has been integrated with and accommodated within the national spatial policy. “Room for the rivers (2005)” and “Working together with water (2008)” are the new campaign in current Dutch urban development. Rather than pushing the water back to the sea or protecting the low-lying lands with higher dikes, water is as much as possible be accommodated in urban areas and the surrounding landscapes [1][2]. While providing enough water storage, the water space also offers new land use for...
urban functions such as the establishment of water-based dwellings or ‘dual space use’[3].

In 1988, Ministry of Housing, Spatial Planning and the Environment released Fourth Report on Spatial Planning Extra (Vinex - Herde Nota Ruimtelijke Ordening Extra). One of the policy output was to develop Vinex Districts - large outer city areas for massive new housing development during the period of 1995-2005 with 61% sites are located outside but close to a city (outlying sites) and 39% at inner urban sites. In 2005, the spatial planning memorandum was released and required the integration of water management into spatial planning; where the government has stipulate that new residential neighborhoods in Vinex districts must provide a minimum of 10% surface water for storage during high water[1][4].

De Graaf [5] adds the use of surface water for urbanisation, as floating urbanisation. He underlined that in 2005 the Minister of Spatial Planning has designated a 15 areas for innovative housing experiments (so called EMAB Locations). In these areas, constructing houses in the floodplain is allowed if innovative building methods are applied.

Although living afloat on boat houses has been a tradition in the Netherlands for thousand years as well as Dutch society has gained confidence in ‘back to water’ supported by Dutch Government policy in the Netherlands in general have positive attitudes toward living on water; a new typology of water-based dwellings such as floating house or neighborhoods remain a new entity in current spatial planning; it still exposes to difficulties in the future development due to the present laws and regulations that do not fit into this new typology of water dwellings [3].

Furthermore, Mutia [6] found that the geographical distribution of new water-based dwellings in the Netherlands, that range from fixed water-side living to floating houses, majority is distributed at the peri-urban areas, except for Borneo-sponenberg and Ijburg which part of Amsterdam waterfront regeneration and one of the most urbanized Vinex district (Ijburg). Since the location is in suburban area, preferable typology and design that have been developed mostly free-standing and semi-detached houses with one to three storeys.

Types of water in the Netherlands that become a possible locations for water-based dwellings are categorized into six, those are the sea, the lake, shallow lakes and channels, canals and waterways; and flood relief areas [3]. Due to its open location that exposes to the wind and tide, there is no permanent buildings allowed in seaside, especially on the dikes of North and Wadden sea. For the rivers, they are subject to frequent water fluctuation during heavy rain and drought, the river basins face a risk of flooding if there is no protection such as dikes. Moreover, the shipping transportation and strong currents carry risks for development along the riverbank. Floating and amphibious housing that give space for water are considered the alternative solution for the riverbed areas. Lakes are another preferable areas for developing floating houses. Lake water level is subject to seasonal variation, depended on the water supply from the rivers, precipitation as well as the government policy that regulate the required water level for fresh water supply.

Water level in lake is highly controlled, so that, it is an advantage for floating houses and also recreation. Shallow lakes and channels are usually dug by developers to make water surface and drainage. However, they tend to be just a few metres deep and mostly are not connected to rivers. This type of water can accommodate a small scale water-based dwellings. Canals and waterways in the Netherlands are men-made and managed; they linked to waterways network by locks and used mainly for transportation and recreational links. Many traditional boathouses in big cities such amsterdam are mooring along the canals with certain permitted zone, but not for water dwellings. The last type of water is flood relief area. It is usually located at rural area and subject to get overflooding from rivers only at exceptional cases [3].

Nillesen & Singelenberg [3] also divide the water-based dwellings and its relation to the water into three different relations [fig.1]: land-based houses (the house on the edge of bank and water), floating houses (entirely on water, connected by jetties or bridges) and amphibious houses (stood on the land, afloat during high water).

B. Floating House Design

According to Olthuis & Keuning [7], floating houses have dual functions for adapting to climate changes (floods and sea level rise) and further as an alternative dwelling to reduce congestion in urban area. He highlights the main advantage of floating buildings is its flexibility for relocation and multipurpose use at different time. On the other hand, floating buildings also has drawback in stability, especially adapting building to the fluctuated water. The design of floating house usually is equipped with mooring posts (poles) from concrete or metal to keep the building on place when it glides up and down. The proportion of building also contributes to its stability; the height of the building should be shorter than its length.

In developing modern floating houses, it needs to become equal to traditional house on land at every aspects, those are in comfort, quality and price. Comfort means that the stability and building physic are the same with those on land, availability of exterior space such as garden and parking and accessibility increases the comfort. In the term of quality, the materials and maintenance of floating house as well as durability and foundation resemble the common landed houses. Floating houses still has a niche market, the price is higher especially in a single project. Therefore, in order to make it competitive with landed house, the project should be built in larger scale [7].

How the floating houses works on water is the same as a boat, it is based on the Archimedes rules, which said that
an object in a fluid experiences an upward force equal to the weight of the fluid displaced by the object. Therefore the buoyancy and weight of the building become a critical considerations of floating houses. Currently the materials used for foundation are made from concrete, steel and polystyrene foam, each of them has advantages and drawbacks [7].

De Graaf [5] underlines that within the water regulation in the Netherlands that only allowed a 1.5 metres depth below water for floating houses make the application of concrete foundation limited to a small scale house in canals or lakes. On the other hand the new polystyrene (flexbase) material which lighter and provide higher buoyancy offers more flexibility in form and size, yet higher in cost.

![Concrete and Polystyrene](image)

(a).Concrete  (b). Polystyrene (flexbase)

**Fig.2 Foundation materials for Floating house**

III. IJBURG AND MAASBOMMEL FLOATING HOUSE PROJECTS

A. Floating Houses at IJburg, Amsterdam

IJburg is a residential and mix-used development built on artificial islands at IJmeer (IJ Lake), east part of Amsterdam. It is the most urban location of Vinex District in the Netherlands. Part of the development is Steigereiland Neighborhood, which allocated for pile and 55 floating houses that make use of surface water reservoir, built during 2006 – 2011 (Fig.3). The water for the project is an enclosed water equipped with a lock to control the water level. The site divided into Waterbuurt Oost (Fig.4) and Waterbuurt West (Fig.5).

The pile and floating houses at west part is designed by an architect, Marlies Rohmer; and constructed by a boathouse builder ABC in Urk. The east side of the site is allocated for self-built plots on water, where individual can design their own floating house. This project is the only one floating dwellings that by government is regarded as a 'real estate' property, not as usual moveable property (boat), where the regulation on a landed house is also complied with this project such as safety, maintenance, utilities, public access and so forth.

![Masterplan Steigereiland Neighborhood](image)

**Fig.3 Masterplan Steigereiland IJburg Floating Houses**

![Site Plan](image)

**Fig.4 Design of Floating Houses (Waterbuurt Oost)**
Currently, there are 36 self-designed floating houses occupied the water plots at the Waterbuurt Oost, the rest is still vacant. The connection to the house from the land (street) is linked by the jetties, in addition people also can get off from a boat on water that linked to IJ Lake. Besides used as a circulation and access to the houses, jetties also provide a link for utilities (fresh water, electricity, sewage) to existing infrastructure on the land.

At waterbuurst Oost, a building envelope measuring 7 by 10 metres, 7.5 metres above and 1.5 metres below water. This came from the water regulation and a size of the lock on water that limit the size of floating houses. The 3-storeys floating houses design to resemble the standard amenity of a landed house such as balcony and floating garden and terrace. However, according to Olthuis & Keuning [7] it is found that after the house sits on site (water), due to the size of the building makes it instable and needs extra buoyancy.

At Waterbuurst West, there are piles and floating houses built on water linked by jetties. Besides its similarity in design and materials, the architect provides 3 types of floating house to give choices, those are a single unit (Vancouver type), a double unit (Sydney type) and a triple unit (Seattle). All of them are a three-storeys floating house attached each other and that are accessible from water. The concrete jetties act as a public space and circulation and are fitted with cables and pipes for utilities. For safety standard, there are railings and fire walls; a bridge at perpendicular position to jetties functions as escape routes in case emergency (Fig.5).

B. Floating Houses at Gouden Ham, Maasbommel

Maasbommel is a rural area in Gelderland Province. The project is located at Gouden Ham, a recreational lake (flood relief) linked to Maas river; a river which is known for its seasonal flooding. The floating houses Gouden Ham is the first big scale amphibious houses project in the Netherlands; designed by Factor Architecten and built by DuraVermeer during 1998 – 2006.

There are 20 amphibious houses and 14 floating ones, under the EMAB project (experiments in adaptive housing). The site is located outside the dikes in area that was intentionally chosen for its regularly high level water. The houses will float during floods (NAP +5.10), they are built on concrete floating bodies with a coupling construction. At low water level (NAP +2.60), the houses rest on a concrete foundation. The Dutch have realized that building higher dikes to keep out the sea is no longer the solution. Here, the water gives more space by allowing the building to adapt during floods/high water (Fig.6).

The design of the house used a hollow concrete foundation that supported by iron piers at the bottom. To maintain the stability of the building size and shape, the house constructed in a couple unit. Two mooring posts that attached to the buildings and platform allow the house to rise without drifting. And light timber construction helps to keep the house stable (Fig.6).

C. Stability and flexibility of design

Building the floating house on water needs to consider stability and flexibility of the construction, due to the fluctuation of water level and also the fixed (jetties) and unfixed (building) components that attached each other. From the case of floating houses in IJburg and Maasbommels, both design use two mooring posts for each unit to maintain the stability so that the house keep in place when up and down. Other detail that also important is the connection between the jetty and the house as well as the pipes and other utilities that should be flexible following the movement of water (Fig.8).
D. Construction and Delivery

The two projects (IJburg & Maasboommel) have a different method in construction and delivery of the floating houses. The ones in IJburg, they are entirely fabricated, built in factory; usually by the builders that have experiences in making boat houses. After finished, the houses towed by tug boat through the waterways from a small fisherman town in Urk to IJ Lake (IJburg). It because the house must pass through the lock of the water, which the size is limited to 7 metres, the width of building should follow this measurement (Fig.9). On the other hand, floating and amphibious houses in Maasbommel were constructed on site especially the concrete foundation and the posts, the building itself uses timber prefab materials (Fig.10).
Learning from IJburg and Maasbommel floating houses projects, there are some principles that can be underlined in order to develop floating houses and the built environment that can adapt to climate change, especially floods and sea level rise.

Firstly, there should be an integration of water management and spatial planning by national/municipal policy and strategic actions, thus, urban development can go paralel with the attempt to protect water and environment from the vulnerability of climate change. Water is as much as possible given space in our urban environment. In this case the policy that required Vinex districts to provide a minimum of 10% surface water for storage and strategies to develop innovative housing provision (so-called EMAB Locations) in Maasbommel are the example. Secondly, from both cases, the preferable location for floating houses is at the lake, the area where the water level controlled and predictable. Rivers and open seas that expose to currents, wind, and unpredictable floods are less encourage due to safety reason. It is also important in designing the site for floating house neighborhood to provide accessibility from water land as well as an emergency escape.

Third, there are some technical design that should be comply with the floating houses, especially about the stability and flexibility, include here the proportion of building, the materials, and utilities (pipes & cables), that will make the house resilient and float better. The last, light and prefab material such as timbel, steel, glass are commonly used for floating houses as they are easy and fast to construct and deliver everywhere. A hollow concrete foundation is used in these two projects, either for fabricated or on site construction, as it is still more economical for small scale housing projects.

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REFERENCES


