

The paradigm of the diachronic Greek stilt house type as an answer to the climate change

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Abstract. As a matter of fact, climate change is transforming the contemporary way of building. Stilt houses constitute another yet glamorous mystery of prehistoric “small/big world”. It is about permanent human constructions in water areas (usually lakes or lagoons), which appeared 8.000 years ago. People live up to now, in such a dwelling type, located on shallow water areas such as seaside, lakes or rivers worldwide. Although in Greece, the first stilt settlements appeared in the Neolithic era, the later stilt settlements in Mesologgi Lagoon area, are also important. The aim of this research is to discuss how this Greek diachronic stilt house type, in Mesologgi Lagoon area, will be the solution to the climate change constructions. Nowadays, stilt or floating architecture is linked to the usable land’s deficiency for building structures, which due to residential evolution, economic growth and transportation, belongs to the most important environmental pressures on landscapes worldwide, especially in urbanized areas. According to climate change progress and temperature increase, usable land in urban areas will be limited due to the continuous development expansion for residence. Concluding, the stilt house type is the future worldwide type of residence, as an answer to the climate change and the environmental damage.

1 Introduction

As the demands of 21st-century society are completely different from those of previous centuries, the growing urgency of tackling climate change has stopped efforts to develop new construction paradigms concerning housing. Increased flooding events and the threat of rising global sea levels from human activity, as well as increasing global temperatures, have led to coastal areas becoming more unprotected from extreme weather events of climate change. Raising structures on stilts, above the expected levels of flooding and ocean level rise, increases the safety of populations living in coastal areas and on flood plains.

Stilts have been used in stilt houses constructions, since ancient times to elevate buildings above water or ground level. They are commonly used on water areas on shallow depth (such as lakes or lagoons), flood plains and on unstable ground to protect structures from damage by waves, rising water, and shifting sand and soil. Also, stilted architecture has traditionally been used in the tropical regions of Southeast Asia and South America and the coastal regions

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of Oceania and Europe for millennia. Stilted architecture has traditionally been used for many reasons, depending on the region where it is located. For example, in coastal areas, lagoons and close to large rivers, it is used in constructions to provide protection against flooding. It has been also used in other areas buildings, like in the dense tropical forests, where it serves a practical purpose for deterring large animals, thieves, and providing added ventilation [1].

In Greece, the first stilt settlements appeared in the Neolithic era, about 5.000- 3.000 B.C., and only one of them has been excavated and located in Dispilio, near Kastoria ‘Fig. 1’, ‘Fig. 2’. This was an extensive lake settlement of the Middle and Late Neolithic era, one of the most important and oldest of its kind in Europe [2]. Additionally, the later stilt settlements in Mesologgi Lagoon area, are also important. These dwellings’ stilts are not nailed down to the deep sea, but they are knit with bulrush and constitute a floating construction on the water.



Fig. 1. The Neolithic settlement, in Dispilio, near Kastoria, Greece.



Fig. 2. The first type of housing in in Dispilio, Greece.

2 Historical stilt or floating structures worldwide

Even though, the first stilt houses appeared 8.000 years ago, people live up to now, in such a dwelling type, located on shallow water areas such as seaside areas, lakes or rivers worldwide. So, in Sumerian period there were many floating buildings which were built by the Madan people in the swamps of Mesopotamia, at the junction of the Tigris and Euphrates rivers, Iraq. [3,4]

It's a fact that stilt houses have prospered in various forms and in different parts of the world, like the stilt villages in the Cambodian lakes where large communities are engaged with aquaculture and fishing. Also, Vietnam, Indonesia, Thailand, China, Peru and Bolivia have a history of stilt dwellings, which may either appear like normal houses and huts or may exist in the form of house boats. In China, there are many floating villages along the coasts which have been inhabited by the Tankas tribe for centuries. Sandu'ao, the largest community on the sea in China, is a floating village, where most of the residents live on fishing and ocean farming. In South America, between Peru and Bolivia, there is Lake Titicaca at high altitude, where the Urus tribe constructed settlements in floating islands, because they could be moved in case of threat. [5]

The functions of these historical buildings comparing to the conventional structures, have the following advantages: avoidance of water damage, moisture and surface organisms, provision of an open space with shelter, reduction in costs in modifying terrain and use as cultural elements.

3 The paradigm of diachronic Greek stilt house type in Mesologgi Lagoon

The Mesologgi Lagoon is one of the most important wetlands, the largest Lagoon in Greece and an extraordinary landscape of natural beauty. A narrow 3km strip of land, which was constructed in 1884, connects the central town of Mesologgi with Tourlida. Until 1885, Tourlida was a small island, where it got its name from the "turlids", a specific species of seabird. Everybody crossing this long road can see on the right and left the Lagoon and the fishermen using all of their fishing tools and techniques, such as the "gaites" (fishermen's boats) 'Fig. 6', the "ivaria" (fences inside the Lagoon where the fish are trapped thus forming a natural fish farm) and the "stafnokari" (a square net stretched by two stakes that sinks to the bottom capturing the fish).



Fig. 3. Stilt “pelada” in Mesologgi Lagoon area, in 1920.



Fig. 4. Traditional stilt house “pelada” in Mesologgi Lagoon area, Greece.



Fig. 5. Many times, the “pelada” was extended to the one side.

4 Greek Stilt House Type Architecture and Typology

The traditional stilt fishing huts in Mesologgi Lagoon area, which are called “pelades” or “pilades ‘Fig. 3’ are not only a piece of history and a monument to the traditional activities of the region”, but also the characteristic structural element the Lagoon's landscape. These stilt wooden houses of traditional Greek folk architecture in Mesologgi countryside ‘Fig. 4’, is the first type of housing which was developed during the 16th century, when first sailors and fishermen settled in the area. These Lagoon huts ‘Fig. 5’ offered all the necessary

amenities to the fishermen, as they were functional, providing warmth in winter and cool shading in summer.

They were usually set up on the banks so that the “gaita” ‘Fig. 6’ their traditional boat in the Mesolloggi Lagoon without a keel, could immediately park there. Many times, the “pelada” was extended to the one side ‘Fig. 5’, in order to house the “gaita” as well. For over three centuries these stilt settlements ‘Fig. 7’ were used by fishermen throughout the lagoon and constituted the permanent homes for their families, until their boats became motorized and local roads were built. There, fishermen stored their tools and equipment and most of them used to stay alone during the winter period, while in the summer some of them would bring their families from the city. [6]

As a place of work and temporary residence of fishermen in the Lagoon, “Pelada”, the stilt house, is usually a wooden structure on stilts at a small height, above the lagoon water surface or even the land to be ensured against flooding. The load-bearing frame and the floor are wooden, but the filling elements, as well as the roof, are made of reeds and waterproof grass. The entire construction is light, earthquake resistant, providing insulation and adapts to the environment, perfectly. This stilt house type is timeless and is not classified in a specific period. [2-6]



Fig. 6. “Gaita” fishermen's boat, in Mesolloggi Lagoon, Greece.



Fig. 7. The “pelada” a traditional stilt fishing huts in Mesolloggi Lagoon area

5 Greek Stilt House Type Construction

The “pelades” were built sometimes individually and sometimes in groups, in strategic points of the Mesolloggi Lagoon (such as Turlida, Plostaina, Kleisova, etc.), where the above purposes would better be served. All “pelades” were constructed with materials from the local natural environment and built on vertical piles driven deep into the soft organic mud to distribute the weight. Stilts were of elm trees and the footing supports of tamarisks. The framework of the masonry was made of thick cane and tied with a bunch of wickers. The wall cladding and ceiling covering was made of woven wicker, fine reeds, seaweed and burla. The wicker, after drying in the sun and having the appropriate treatment, had the role of the rope for these constructions. In the beginning, these stilt houses constituted by only one room, while later, the modern ones, became wooden with separate rooms. There are only a few “pelades” that are now constructed in the traditional way, as today most of them are reconstructed and transformed to country houses. So, apart from the stilts on the building base, the rest of the hut has the form of a detachable prefabricated house with clapboard cladding and a roof made of “elenite” a type of roof or tiles [6].

Nowadays, the Municipality of Mesolloggi constructed one “pelada” using traditional materials and techniques in order to preserve this popular architecture, because there are very few of these traditional stilt huts. Moreover, these characteristic stilt settlements for

fishermen preserving them from flooding, constitute cultural heritage constructions of this region, although a lot of them have been re-constructed with contemporary materials and are now used as vacation houses by their owners ‘Fig. 8’.

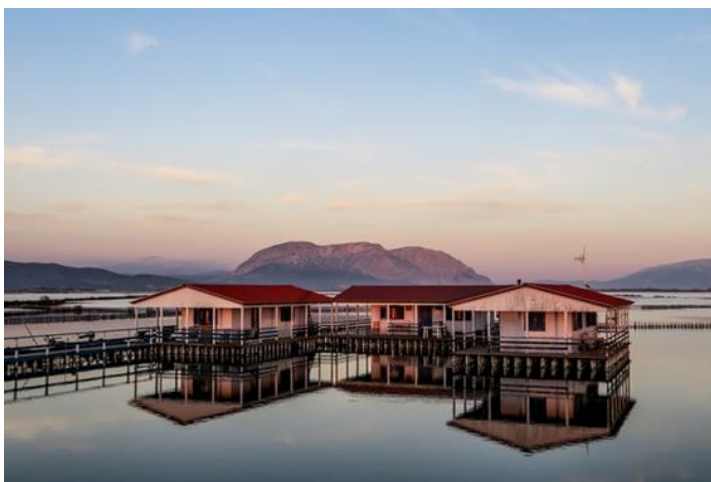


Fig. 8. Reconstructed stilt houses in Mesologgi Lagoon area, today.

6 Stilt buildings in modern times

Stilted architecture revived in the 20th century, getting over its traditional functional and regional form. It was about in 1920's, when Le Corbusier, one of the most famous architects, urban planners, and writers, infused stilted architecture with a renewed vitality in his architectural concepts of *The Five Points of a Modern Architecture*: a) The Pilotis (les pilotis): Pillars are used to empty the first floor, so that the main floor is off the ground. b) The Roof Terrace (le toit-terrasse): Instead of sloping roofs, outdoor spaces are built on flat roofs. c) The Free Plan (le plan libre): Steel or reinforced concrete columns are used instead of load-bearing walls. d) The Ribbon Window (la fenêtre-bandeau): Because the walls are no longer used to support the house, windows can be used for receiving better natural light and have better views. e) The Free Facade (la facade libre): Similarly, because steel or reinforced concrete columns are used instead of load-bearing walls, the facade can be designed more openly [7]. So, Pilotis, the first of Le Corbusier Five Points of a Modern Architecture, are columns, pillars, or stilts that elevate a building above ground or water. Even though, stilts were used in the past for practical purposes in fishermen's huts across Asia and Europe, in modern constructions had an aesthetic application. By raising levels of the building off the ground, space that would otherwise be occupied by internal walls and corridors, is now dedicated to a variety of functions like parking areas, pedestrian pathways and green spaces.

A lot of modern constructions have been based on renewed 20th century architecture, until present [8]. Hoisting buildings up on pillars allows them to occupy otherwise uninhabitable sites i.e. lakes, steep slopes and craggy coastal outcrops, bringing inhabitants closer to nature while treading lightly on the surrounding environment. Here are some examples of modern and innovative raised residential architecture, showcasing how it can slot into different contexts from Chile to the Czech Republic:

6.1 Modern stilt house in coastal England

A modern and innovative stilt house construction is the detached house located in the coastal salt marsh of St. Osyth, England [9]. The area suffers from frequent floods, so the most suitable option for this house construction was a stilt structure. This particular house is built of the innovative hybrid material CLT and is supported by a metal steel frame with three metal steel columns, which is at a distance of 2.7 meters from the ground surface ‘Fig. 9’.



Fig. 9. Untreated oak boards and cork panels protect this cross-laminated timber, Redshank, UK.

6.2 Stilt summer house in Helgeroa, Norway

This stilt summer residence ‘Fig. 10’, is set on the cluster of various small rocky islands close to the settlement of Helgeroa, Norway and is only accessible by boat [10]. The rocky surface and the proximity to the coast, imposes a durable construction, such as the stilt house, protected from the various weather phenomena that prevail in the area. Thus, the overall volume of the building resembles a "box" supported on solid galvanized steel piles ‘Fig. 11’.



Fig. 10. This summer home is set on a small island off the Norwegian coast.

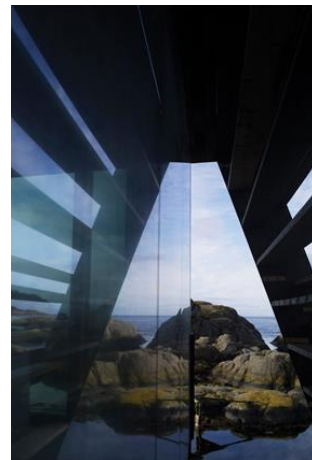


Fig. 11. Hagem finished the interior in raw concrete to reflect the rugged natural environment.

6.3 Stilt complex resort in Manshausen Island, Norway

Another example of modern stilt architecture is the Manshausen Island Resort ‘Fig. 12’, in Norway. This resort is located on the Manshausen island, in the Steigen Archipelago off the northern coast of Norway [11]. The architect was inspired by the magnificent view of the landscape, so placing three stilt geometric volumes in the water, thus offering to visitors a unique view landscape experience. Buildings stilts are made of galvanized steel metal, in order to protect them from corrosion, which can be caused by sea water. Also, these pillars contribute to the stilt buildings, so as to be protected from the sea level rise, a result of the upcoming climate change. The materials used for this construction are sustainable, such as the innovative hybrid material CLT, aiming to the minimum footprint for the area. ‘Fig. 13’.



Fig. 12. These raised holiday cabins are set on an island in the Arctic Circle, Norway.



Fig. 13. The three cabins are also staggered so they don't overlook each other.

6.4 Stilt residence in Prague, Czech Republic

A distinctive example of modern stilt architecture is the bulbous three-story house on the outskirts of Prague, Czech Republic [12]. It is a special residence located in an orchard and the aim of the architect was to harmonize the building with the environmental area. Its particularity consists in the fact that the entire construction rests on a single central pillar made of reinforced concrete, resembling a plant. Concerning the building structure, it has a wooden frame, which is clad with plywood boards and is supported by the unique concrete pillar. The whole building is covered with a layer of polyurethane in order to achieve uneven surfaces ‘Fig. 14’.



Fig. 14. This bulbous three-storey home in an orchard on the outskirts of Prague.



Fig. 15. The Dock House is located in the town of Pichicuy in Chile's Valparaíso region.

6.5 Stilt coastal residence in Pichicuy, Chile

The Dock House is another example of modern stilt residence architecture. Specifically, it is located in the city of Pichicuy, in the mountainous and coastal region of Valparaíso in Chile [13]. The main volume of the house rests on diagonal wooden piles, which are set on concrete surfaces in the ground. The highest height of the pillars reaches 3.75 meters, as the site is rocky and sloping. The overall construction of the building, such as external walls, beams and columns, are made of sustainable materials, specifically of pine wood. Additionally, this wooden structure is in fact the main characteristic of this type of house, which at the same time harmonizes with the environmental in terms of colour. Because of the land on which the Dock House is located is a short walking distance from the Pacific Ocean coast, and the risk of sea level rise is quite high due to climate change, this stilt house construction will provide security for its residents in the near future 'Fig. 15'.

7 Climate change "unavoidable" hazards in the build environment

In recent decades the planet has been going through an extensive climate crisis, which has caused various effects on humans and natural systems on all continents. The temperature in the atmosphere is rising, the permafrost in the Arctic and Antarctic is melting, the surface of the seas is rising, there are heat waves in Greenland, deadly fires in Siberia and the Amazon, droughts in East Africa, unusual rains and heat waves with devastating effects, longer duration and more intense heat waves.

However, there is a differentiation in the climate change effects, depending on the particular geomorphological and bioclimatic characteristics of each region. Near the poles the ice is melting and the sea level is rising, not only due to ice melting, but also the water expansion with heating. As a consequence of the sea level rise, there are floods and erosion on the coasts and low-lying coastal areas, as well. And while some regions are hit more often by rainfall, others are tested by intense heat waves and droughts [14].

As it is widely known, climate change is going to create huge problems in the housing sector worldwide. Cities, especially those which are located in coastal areas, are not prepared to face this urgent phenomenon, as architects and city planners should focus on resilient design solutions. Building, for example, houses on stilts or creating floating settlements in coastal areas is a targeted response to the housing problem of these areas, due to rising sea levels from climate change.

It is a fact that extreme weather events, such as storms, heatwaves, droughts, floods, have caused serious damage to the ecosystem and to people's health in recent years on planet earth. The rapid growth of populations, as well as the urban island phenomenon, especially in cities, exacerbates the risks caused by climate change and cannot be addressed in time by the authorities of a place. However, it has been pointed out that the existing built environment can, with appropriate interventions by architects and urban planners, be redesigned and upgraded, adding more green areas to the urban environment and using naturally renewable energy sources [14].

Global warming as a product of climate change should be countered at city level by equipping homes with passive cooling technologies such as wind turbines, solar shading and white or green roofs. In this way, the cooling of the interior spaces of the houses will be achieved, without the use of air conditioners with high gas emissions that negatively burden the atmosphere. Also, city infrastructures should be built according to "nature-based solutions", which are more affordable and flexible. To make cities more flood resilient, an underground tunnel system should be created under the sidewalks to absorb storm water immediately. At the same time, the increase in urban fabric green spaces could act protectively during intense storms.

8 The Greek stilt house effects in 21st century architecture

Flooding will now be a fairly frequent phenomenon of climate change, due to global warming, and it is estimated by scientists that by 2050, approximately one billion people worldwide will be affected by rising sea levels. Thus, stilt houses will be a solution to build resilient houses to flooding and sea level rise as well. So, the type of traditional Greek stilt house in Mesologgi Lagoon, seems to be a diachronic paradigm on viable solutions in 21st century architecture, including elevating houses on stilts and creating floating residence structures that can float on the surface of rising floodwater in coastal regions.

Today, a modern house on stilts must meet certain specifications regarding the height it will be raised from the ground 'Fig. 16'. The floor level of the lowest level of the building should be built higher than the likely flood level [15]. The height of the building floor in such structures is calculated from accurate predictions of flood levels to ensure property protection.

Bricks, concrete, steel and wood are the materials that can usually be used in elevated structures [16]. In many regions, the materials used in the construction of raised houses can be local, meaning that material is available in the wider area, as it has happened in traditional huts in Messolonghi Lagoon construction, or even the building materials can be determined by the flood risk. Also, the water flow plays an important role in such buildings constructions, because it can be a dangerous effect on the building's stability, if the resistance from the hydrostatic pressure exerted on it, is not calculated correctly.

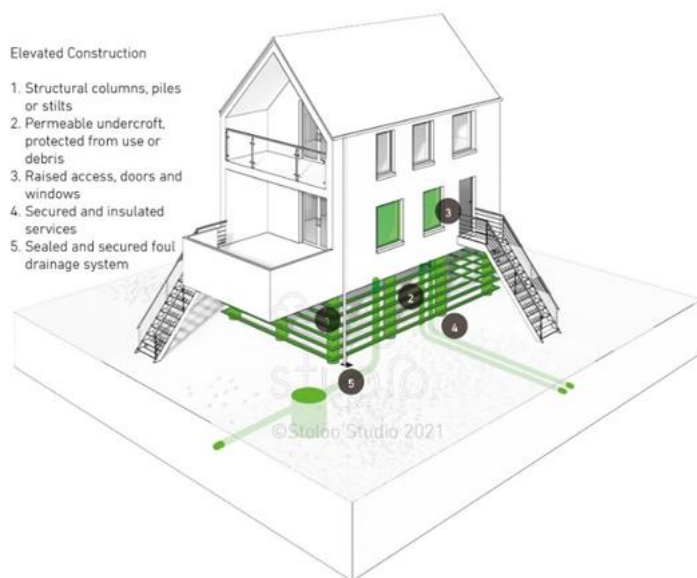


Fig. 16. Full Elevated Construction in 21st century architecture.

A major problem arising from elevated structures is the difficulty of building accessibility, especially for people with mobility problems. While the elevated building provides safety from hazardous weather events such as flooding, there is no direct communication with ground level even under normal conditions. This is more evident when the building is raised more than half a floor above ground level, where access becomes more difficult and contact with the surrounding environment can still be lost. The communication difficulties with the city were also evident in the fishermen's huts in Mesologgi Lagoon, due to the lack of easy access to them, which were located almost in the middle of the lagoon.

9 Conclusion

The challenges of climate change have led 21st century architecture to radical and innovative changes, in order to create sustainable and resilient housing communities. With increasing temperatures and rising water levels, modern architects have adopted stilt constructions aiming to create elevated cities for better future living conditions.

Using stilts for modern buildings provides practical and aesthetic advantages for populations worldwide, even though the history of this architectural idea has its origins in ancient times. Despite this design challenge, stilted, raised architecture is undergoing a revolution worldwide, providing also, environmental sustainability.

Concluding, the stilt house type which appeared in water settlements for the first time, in lakes and lagoons areas in Greece during the Neolithic era, and later in Mesologgi Lagoon, is the type of residence, which can be used worldwide, as an answer to the climate change and the environmental damage. Also, it is not difficult to conclude that stilted architecture may be one of the most persistent architectural ideas in human history.

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