

# Design And Prototype Development of Low-Cost Flood-Resilient Floating Houses

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**Abstract**—With the increasing frequency of extreme rainfall and floods due to climate change, traditional housing in flood-prone areas faces significant risks. This paper presents a sustainable and economical solution: a house designed with a buoyant foundation that rises and falls with water levels. The study analyzes rainfall data from 1998 to 2019 for the Kolhapur region to highlight the growing flood risk, particularly focusing on the catastrophic events of 2005 and 2019. A prototype was developed using low-cost materials like Thermocol and cardboard, demonstrating stability and buoyancy during simulated flood conditions. The results indicate that amphibious architecture is a practical and scalable solution for protecting human lives and property in vulnerable regions.

**Index Terms**—Amphibious architecture, buoyant foundation, flood mitigation, rainfall analysis, sustainable housing.

## I. INTRODUCTION

Flood-resistant floating houses are innovative structures designed to rise and fall with water levels, preventing structural damage during inundation. These houses are typically anchored to the ground but float on water using buoyant foundations. As floods continue to become more common due to climate change, rising river levels, and extreme rainfall, such housing solutions have become a necessity rather than a luxury [1].

In regions like the Netherlands and Bangladesh, floating housing has already been successfully implemented to manage rising water levels [1]. In the Indian context, especially in rural and urban areas near riverbanks, there is an urgent need for low-cost, flood-resilient structures. This project focuses on a sustainable, eco-friendly, and economical design that

can help communities return to normal life quickly after a disaster.

Floating houses can be built in many types of places, including cities near water, rural flood-prone areas, and regions that face natural disasters. Their ability to adjust to changing water levels makes them very flexible and useful. They not only provide safety but also offer a modern and comfortable way of living [1].

## II. OBJECTIVES

The primary objectives of this research are:

- To design a simple and functional model of a flood-resistant floating house.
- To demonstrate buoyancy using lightweight materials like Thermocol.
- To create a waterproof model environment using a box and plastic lining.
- To analyze historical rainfall data (1998-2019) to justify the need for such housing.
- To test the stability and movement of the model during simulated flooding.
- To understand how floating houses can reduce damage during floods.
- To present an eco-friendly and practical housing solution using low-cost materials.

## III. LITERATURE REVIEW

The study of amphibious architecture has gained momentum globally. According to Mohammad et al. [1], strategies such as floating houses and elevated structures are essential for community resilience. The research reviewed literature from four leading countries—Netherlands, United States, Australia, and the United Kingdom—to identify effective strategies.

The Netherlands focuses on integrated water management and amphibious housing, while the United States promotes elevated homes and resilient building codes after Hurricane Katrina [1].

Rao et al. [2] highlighted that amphibious houses normally stay on the ground but float when water levels rise, utilizing principles like Archimedes' principle. The design focuses on a buoyant foundation using materials like Expanded Polystyrene (EPS) and lightweight concrete [2].

Furthermore, Dayton Marchese et al. [3] discussed the balance between resilience and sustainability in environmental management, noting that integrating advanced technologies with traditional architectural practices provides a cost-effective solution for reducing flood damage. Research by Polpat Nilubon et al. [5] in Bangkok and Pieter Ham [6] in the Philippines further confirms that modular amphibious structures are a catalyst for adaptation in flood-prone municipalities, especially in typhoon-prone regions like Hagonoy [6].

#### IV. RAINFALL DATA ANALYSIS

To understand the flood risks in the target region (Kolhapur district), rainfall data for five major Talukas—Hatkanangle, Shirol, Panhala, Shauwadi, and Radhanagari—was analyzed from 1998 to 2019. The data reveals a significant increase in extreme precipitation events over the two decades. A comparison between the two most significant flood years, 2005 and 2019, shows a clear upward trend in precipitation intensity.

In August 2005, Shauwadi recorded 844 mm of rainfall, which was nearly double its normal level. However, in August 2019, the intensity increased further, with Shauwadi recording 1063.8 mm against a normal of 445.2 mm (238.9% of normal). Similarly, Panhala recorded 961.5 mm in 2019 compared to a normal level of 400.2 mm (240.3% of normal).

Table 1: Comparative Rainfall Trends (August 2005 vs. 2019)

Taluka	2005 Actual	2019 Actual	Growth
Hatkanangle	348.0 mm	365.7 mm	+5.1%
Shirol	184.0 mm	253.6 mm	+37.8%
Panhala	713.0 mm	961.5 mm	+34.8%
Shauwadi	844.0 mm	1063.8 mm	+26.0%

The persistent trend of "Actual Rainfall" exceeding "Normal Rainfall" by large margins necessitates the adoption of flood-resilient housing. Traditional fixed-foundation houses in these areas are susceptible to structural failure when the water level rises beyond 1-2 meters, a threshold frequently crossed in the last decade.

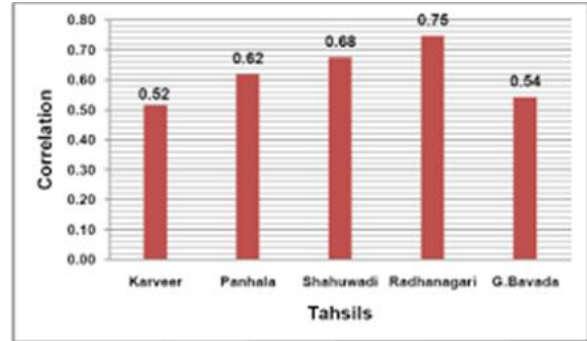


Fig 1. Pre-Flood Management Practices in Western Maharashtra Region.

#### V. METHODOLOGY

The methodology focuses on the practical demonstration of buoyancy using a scaled prototype and a simulated flood environment.

##### 5.1. Environment Setup

A rectangular container of size 28 × 20 × 9 cm was prepared to serve as the test environment. The interior was lined with high-density plastic paper to prevent leakage and ensure a controlled water level during testing. To create a realistic landscape, mountains and river features were simulated using a mixture of cement and cloth. These were shaped and allowed to dry for eight days to ensure structural integrity.

##### 5.2. Model Construction

The model house was constructed using cardboard, which represents the superstructure. For the buoyant foundation, Thermocol was selected due to its high buoyancy, ease of fabrication, and lightweight properties. The Thermocol was precisely cut to match the base dimensions of the cardboard house and secured using waterproof adhesive.



Fig 2. Preparation of Model

### 5.3. Working Principle

The system relies on the Pontoon concept and Archimedes' principle [2]. The house remains on the ground during dry conditions. As water enters the container, the buoyant force ( $F_b = \rho g V$ ) eventually exceeds the total weight of the structure, causing it to rise. Vertical guidance poles (represented by dowels in the prototype) ensure the house moves only along the vertical axis, preventing lateral drift or capsizing due to water currents [2].

## VI. RESULTS AND DISCUSSION

The prototype testing yielded positive results. When the container was filled with water to simulate a flash flood, the cardboard house rose steadily without any water entering the living space.

### 6.1. Buoyancy and Stability

The Thermocol base provided sufficient displacement to lift the total weight of the house. The use of the vertical guidance system ensured that even when the water level reached its maximum height in the container, the house remained centered and stable. This proves that the "amphibious" approach is viable for rural housing where low-cost materials are required.

### 6.2. Cost-Effectiveness

While the initial construction cost of a buoyant foundation might be 20-30% higher than a traditional foundation, the long-term benefits are substantial. Analysis shows that residents in flood-prone areas spend significant amounts on post-flood repairs every 3-5 years. A floating house eliminates these recurring costs, making it a more economical choice over a 20-year lifespan [2], [4].

## VII. DISCUSSION

Floating houses are a practical solution for flood-prone areas. The use of simple materials like Thermocol in the model demonstrates the basic working principle, while real structures can use stronger materials like EPS and lightweight concrete [2]

The project also highlights the importance of proper anchoring. Without vertical guidance, a floating house becomes a hazard to other structures. Furthermore, utility connections (water, electricity, sewage) must be modified with flexible piping to accommodate the vertical movement [2]. These design considerations are essential for scaling the prototype to a full-sized residence.

## VIII. CONCLUSION

This project successfully shows how a flood-resistant floating house can be designed using simple and low-cost materials. The model proves that a house can float on water and remain stable during flooding. The analysis of regional rainfall data (1998-2019) confirms that traditional housing is no longer sufficient for areas facing extreme weather and climate change. Floating houses provide an eco-friendly and sustainable alternative that can adapt to the environment rather than fighting it. They help protect people, reduce damage to property, and support a more sustainable way of living. As floods continue to become more common, floating houses will play an important role in providing safe and secure homes for many communities around the world.

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