Flood Risk Reduction in Historic Neighborhoods: A Visually Unobtrusive Approach

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WHAT IS AMPHIBIOUS ARCHITECTURE?

• Amphibious architecture refers to buildings that sit on dry land like ordinary buildings, except when there is a flood, in which case they are capable of rising and floating on the surface until the floodwater recedes.

• A buoyancy system beneath the house displaces water to provide flotation as needed, and a vertical guidance system allows the rising and falling house to return to exactly the same place upon descent.

• This is a proven strategy that has already been applied successfully in the Netherlands for twenty years and in rural Louisiana for more than forty years.

• Amphibious construction is an adaptive flood risk reduction strategy that works in synchrony with a flood-prone region’s natural cycles of flooding, rather than attempting to obstruct them.
Maasbommel, Netherlands
Maasbommel, Netherlands
LOUISIANA

For about 40 years, amphibious houses at Old River Landing in rural Louisiana have been rising and falling reliably with the level of flooding of the Mississippi River.

Average cost of buoyancy system is around $5,000.

Dry in September . . . The same house . . . Floating in February
Old River Landing, Pointe Coupee Parish, LA
Old River Landing, Pointe Coupee Parish, LA
Flood conditions at Raccourci Old River. The house in the foreground is amphibious.
After the spring 2011 flood. Amphibious house on left is undamaged. Note waterline on elevated house on right.
The same two camps photographed five years later in 2016. Previously flood-damaged house on right is now amphibiated.
Extensive damage to home on left. Undamaged amphibious home on right.
WHAT IS THE BUOYANT FOUNDATION PROJECT?

A Buoyant Foundation is a particular type of amphibious foundation that is specifically designed to be retrofitted to an existing house that is already slightly elevated off the ground and supported on piers or posts.

The system consists of three basic elements: buoyancy blocks underneath the house that provide flotation, vertical guidance posts that prevent the house from going anywhere except straight up and down, and a structural sub-frame that ties everything together.

Buoyant Foundations as currently designed are not intended for coastal regions subject to storm-surge inundation that includes wave action, or for high velocity flows.

They are best suited to large, flat floodplain areas, to regions that are protected by levees where flooding is due to overtopping, to coastal regions well-protected by barrier islands or peninsulas, and to similar flood situations where the water is primarily rising rather than fast-flowing.

IT’S NOT A ONE-SIZE-FITS-ALL SOLUTION!
BUOYANT FOUNDATIONS CREATE HOMES THAT FLOAT IN A FLOOD

Advantages

• Temporarily elevates house to exactly the height required to stay above water (no higher than necessary)
• House otherwise remains close to the ground
• More convenient for the elderly and disabled
• Accommodates both soil subsidence and rising sea level
• House looks essentially the same as before
• Preserves traditional architecture and neighborhood character
• Simple technology – easy enough for people to learn to do it themselves
• Inexpensive – amphibious retrofit is less than half the cost of permanent static elevation
TESTING THE PROTOTYPE AT LSU
BFP applied to a New Orleans shotgun house
SO WHY FIGHT FLOODWATER WHEN YOU CAN FLOAT ON IT?
LOUISIANA IS EXPERIENCING A COASTAL CRISIS

Predicted Land Change Over Next 50 Years

Potential to lose an additional 800 – 1,750 square miles of land over the next 50 years
A CASE STUDY IN LEEVILLE
LOSSES AVOIDED RATIO

The Losses Avoided Ratio is the ratio of the calculated Losses Avoided to the calculated Mitigation Cost.

Losses Avoided = Costs of building repair + contents damage + displacement
Losses Avoided Ratio = Losses Avoided / Mitigation Cost

The losses avoided ratio for a pre-mitigation flood depth of 0.5m
= $38,930 / $30,280
= 1.28

The losses avoided ratio for a pre-mitigation flood depth of 1m
= $62,430 / $30,280
= 2.06

The losses avoided ratio for a pre-mitigation flood depth of 1.5m
= $78,021 / $30,280
= 2.58

A ratio greater than one indicates that applying the mitigation strategy to the house in question is expected to be beneficial or that it has performed successfully.
PERMANENT STATIC ELEVATION AND INCREASED WIND VULNERABILITY
Permanent Static Elevation for Houses

Especially after Hurricanes Katrina and Sandy, the US Federal Emergency Management Agency (FEMA) has required many homeowners in flood-prone areas to elevate their houses in order to retain their eligibility for subsidized flood insurance policies from the National Flood Insurance Program (NFIP).

NFIP is critically important in the US housing market because banks require flood insurance as a precondition for providing mortgages to homes in flood zones.
Homes may be exposed to significantly higher wind speeds when elevated.
Disadvantages of Permanent Static Elevation

- Difficult access – especially for the elderly & disabled
- Very expensive
- Creates gap-toothed effect in a neighborhood
- Homes lose close relationship to the street (with loss of neighborhood character in an urban setting)
- Provides insufficient protection from extreme flooding
- Increases the home’s vulnerability to wind damage
Case Study – preliminary analysis

House with a 4 meter mean roof height elevated to a 10 meter mean roof height:

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Roof Mean Height</th>
<th>EAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current scenario</td>
<td>4 m</td>
<td>2.8%</td>
</tr>
<tr>
<td>Elevated scenario</td>
<td>10 m</td>
<td>4.9%</td>
</tr>
</tbody>
</table>

**Increase in roof height wind speed:** 11%

**Increase in wind pressure:** 19%

**Increase in expected annual loss (EAL):** 75%

This effect becomes more pronounced the higher the structure is raised above the ground.
FREEDOM HILL

Community established here by freed blacks in 1865. Incorporated as Princeville in 1885.
2016 - Before Flooding
https://www.google.ca/earth/
This Corner Stone is Erected in memory of the Radicue Primitive Baptist Church Founded by Elder Abraham Wooten and Members that came out from Churches at Otter's Creek, Sparta and Tyson's Meeting House, who were all dismissed by letters of good standing and in Full Fellowship. This Church was Organized by Elder John Bell of Fairfax Co. Va. on Friday before the first Sunday in August 1876. Elder Bell was a member of the Baltimore Association. Erected Oct. 1896.
FARNSWORTH AFLOAT

INVISIBLE INNOVATION:
AMPHIBIOUS RETROFIT FOR FLOOD RESILIENCE
1. Building without retrofit

2. Minor Flooding

3. Flooding without retrofit

4. Major flooding with amphibious retrofit
Floating rice conservation area (45ha)
AN GIANG PROTOTYPE

House owner: Nguyen Van Nao
Address: Vinh Phuoc Commune, Tri Ton District, An Giang Province.
Location of Long An Prototype
LONG AN – VINH CHAU A
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