Float when it floods: Amphibious architecture as an alternative flood risk reduction strategy

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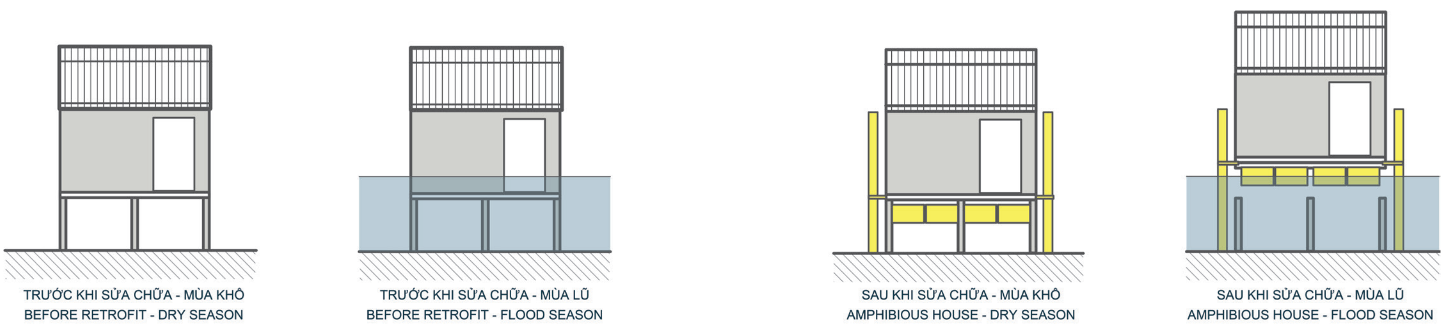

Figure 1: Response to flooding of a building retrofitted with a buoyant foundation

Louisiana origins

In late August 2005, storm surges from Hurricane Katrina swept into canals, broke through the levees, and pushed homes off their foundations. Much of New Orleans was steeped in brackish water for weeks. Elizabeth English, who was at Louisiana State University's Hurricane Center at the time, witnessed the devastation first-hand. In the aftermath, the US Federal Emergency Management Agency (FEMA) recommended that homes be elevated. Concerned that lifting homes would diminish community cohesion and create difficult access for residents, English sought alternative solutions.

In 2006, she founded the Buoyant Foundation Project (BFP) and began developing strategies to retrofit homes with amphibious foundations. The concept allowed otherwise-ordinary structures to float in place temporarily when flooding occurred. The first full-scale prototype, representing a typical New Orleans shotgun-style house, had a steel frame affixed beneath the floor, to which buoyant foam blocks could be attached. Vertical guidance posts inserted into the ground near the corners were then connected to the frame (Figure 1).

Fast forward to today and the BFP has two more recent prototype projects—one in rural Vietnam and another in Ontario. Located in vastly different contexts, both projects are teaching us more about best practices for designing buoyant foundations.

Figure 2: Retrofit of a new house with a buoyant foundation, An Giang Province, Vietnam

Figure 3: Retrofit of a traditional house with a buoyant foundation, An Giang Province, Vietnam

Designing for the Mekong Delta

The Mekong Delta is Vietnam's heart, both for its role in food supply and its rhythmic flood pulse. Flooding is an annual occurrence that, when allowed to flow naturally, replenishes the land. Farmers' homes are traditionally raised above ground to reduce damage from flooding; however, with flood events increasing in intensity, such static elevation is not always sufficient. Supported by the Global Resilience Partnership and the Z Zurich Foundation, the BFP and its local Vietnamese partners implemented four amphibious retrofit prototypes on two houses in An Giang Province and two in Long An Province.

The team constructed the amphibious retrofits in the summer of 2018. Monitoring equipment was installed to collect wind and motion data for calibrating buoyant stability. In the process, BFP taught local carpenters the basics of amphibious retrofits for existing houses using familiar carpentry skills, construction techniques and building materials. This training will position communities to expand this work on their own, initiating a scalable community-based bottom-up approach to flood risk reduction and climate change adaptation.

During the 2018 monsoon season, the floodscape surrounding the retrofitted homes was dotted with the tips of submerged rice stalks and partially submerged homes. In post-flood interviews, the beneficiaries expressed delight with the results. The retrofits enhance community resilience by allowing at-risk households to remain safely in place during flood events, providing them with greater opportunity to pursue their daily economic activities without social and physical disruption or the cost of repairs (Figures 2 and 3).

Ontario prototypes and design guidelines

Under a grant received from the National Research Council of Canada (NRC), the BFP is developing prototypes for retrofitting existing Canadian homes to become amphibious, with the goal of exploring buoyant foundation retrofits as a potential climate change adaptation strategy for First Nations communities.

To initiate the project, the BFP team has designed and constructed in Waterloo, ON, a wood frame pavilion prototype fitted with a buoyant foundation. Sited on a pond at the University of Waterloo (UW), the prototype provides a means of monitoring and analyzing the response of a buoyant foundation as it undergoes the freeze-thaw cycles typical of the Canadian climate. The pavilion was constructed at the UW School of Architecture satellite campus in Cambridge by graduate and undergraduate architecture students working with the BFP. The installation of the pavilion on the pond in early October 2018 and further monitoring in 2019 represent the first phase of the larger NRC project (Figure 4).

In fall 2018, the BFP team began a collaboration with the owner of a flood-vulnerable cottage in Minden, ON. The team is moving forward to design an amphibious retrofit solution for this cottage. The circumstances of the cottage provide a perfect opportunity to develop the second phase of the NRC project with the intent not only to demonstrate the appropriateness of amphibious retrofits for cottages, but also to provide an example of amphibious retrofit construction that can be visited and observed by leaders of flood-prone First Nations communities that might be considering adopting this approach.

Figure 4: A-frame pavilion prototype as constructed at the University of Waterloo School of Architecture (left) and as installed on site at the UW north campus (right).

The project will conclude in Phase 3 with a proposal for preliminary design guidelines, as a first step toward the future codification of amphibious construction.

Sustainability for the vulnerable

Amphibious retrofits have dramatically improved the lives of GRP's beneficiaries in Vietnam and have the potential to help other flood-prone, low-income communities. After our NRC prototype testing, we hope it will be only a matter of time before amphibious construction is introduced into the Canadian NationalBuilding Code. 'Building back better' with this technology can preserve valuable structures and maintain social cohesion, enabling communities to become more resilient against climate threats.

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