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Resilient housing for Lake Macquarie City Council Area

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Abstract

Lake Macquarie is a coastal local government area located on the East Coast of Australia. Lake Macquaire City Council is at the forefront of climate change mitigation and adaptation. As part of Council's approach to climate change, Edge Environment was commissioned to produce development guidelines for resilient and adaptable residential buildings in response to sea level rise and flooding risks. An adaptable building is one which can be easily re-configured to respond to a change in hazard, if and when required. It allows the building to function safely over a range of scenarios, and the investment in additional risk mitigation can be timed to coincide with the increase in hazard, which may occur faster or slower than predicted. The Guidelines are based around four principles of resilient housing: site analysis and design, relocation, raising of floor height and redundancy. The Guidelines will be inserted into the development application process and give developers direction on what is an acceptable solution for building in areas impacted by predicted sea level rise.

Keywords

Building and construction, Climate change adaptation, Flood risk, Resilient housing

1. Introduction

Lake Macquarie City is a coastal local government area (LGA) situated in the Hunter region of NSW, Australia, with a population of around 200,000 across 75,000 households. The City surrounds Lake Macquarie, a tidal lake with a permanently open outlet into the Pacific Ocean via the narrow and shallow Swansea channel. It is one of the largest coastal lakes in eastern Australia with a foreshore over 174km in length, which is substantially urbanised. Approximately 85% of the lake perimeter is within the Lake Macquarie LGA and approximately 15% is contained within the Wyong LGA to the south.

Lake Macquarie City Council (LMCC) is at the forefront of climate change mitigation and adaptation and operates in a dynamic council and community environment where best practice and sustainability are pursued. LMCC recently adopted the Lake Macquarie Waterway Flood Risk Management Study and Plan 2012 (the Flood Study (WMAwater, 2012)) for the Lake Macquarie catchment, examining the current flood risk from rainfall events, as well as the increased flood risk and tidal inundation from projected sea level rise.

Along with other local governments, LMCC already require new homes in areas affected by lake flooding and sea level rise to be constructed with raised floor levels. LMCC is considering other methods of design and construction to provide homeowners with alternative or additional measures to reduce the risk from flooding and future sea level rise. These alternative methods of design and construction need to be incorporated into the development process now to avoid the public and private costs that will accompany abandoning unadapted buildings in high-risk areas.

Edge Environment was commissioned to prepare resilient housing guidelines to support LMCC Development Assessment officers to ensure that the development assessment process adequately addresses the potential impacts of tidal inundation and flooding from predicted sea level rise. The current housing stock and development trends were reviewed in order to determine trends in housing development within the LGA. Flooding and sea level rise risks were then assessed along with existing measures to deal with these risks. Local case studies within the LGA, national and international literature were reviewed in order to determine four resilient housing principles and performance criteria to assist Development Asessment officers in the asssesment of new housing proposals. A broad range of stakeholders were engaged to provide feedback on these principles including representatives from industry, government, local residents and academia.

2. Housing stock, flooding and sea level rise risks

Lake Macquarie foreshore development is at risk from increased flood and tidal inundation. It is a high-growth region with trends towards development intensification around the lake. Analysis of existing housing stock and engagement with stakeholder indicates that currently building method is predominantly slab on ground, brick veneer.

The Flood Study has provided the data for LMCC to start mitigating future risk. It adopts benchmarks for sea level rise relative to 1990 mean sea levels of 0.4m by 2050 and 0.9m by 2100. The benchmarks acknowledge that there is uncertainty about the timing of sea level rise impacts, but that there is also time to plan for the risk (WMAwater, 2012). The main hazards created by sea level rise and associated flooding are:

- **Increased height for severe flooding:** As lake levels rise, the flood heights for a severe flood (for example 1:100 year ARI) will increase, flooding more properties and increasing the flood depth in areas already affected by flooding. In Lake Macquarie the projected level for a 1:100 year flood is 1.5m AHD at current levels, but will increase to 2.32m AHD with a 0.9m increase in lake level.
- **Increased frequency of minor flooding:** As lake levels rise, the frequency of flooding for a given water level will increase. In Lake Macquarie the current 1.21m AHD flood (1:20 year flood) will become a 1:5 year flood with 0.4m rise in lake level, and will be close to a monthly event with a 0.9m rise.
- **Permanent inundation and recession of low-lying areas**: Areas below 1.0m AHD are projected to be permanently inundated with a lake rise of 0.9m, and those up to 1.2m AHD are likely to be inundated by monthly high tides. Tidal inundation will introduce saltwater into affected areas. Erodible foreshores are also projected to recede, roughly in a 1:5 to 1:20 ratio to rises in water level.
- **Rising groundwater and reduced drainage:** Rising lake and sea levels will cause aquifers in foreshore areas to rise, immersing below-ground structures and infrastructure such as footings, water and sewer pipes, road-base and drains. Decreased drainage will result in surface pooling for extended periods, saturated soils and reduced absorption of stormwater in small rain events.

3. The resilient housing Principles

LMCC is already leading the way in managing future sea level rise and flooding risk and has a procedure in place for assessing new developments on land within the defined lake hazard areas. There is scope for additional resilience guidance to be implemented in order to achieve the required risk mitigation without sterilising land or creating legacy housing issues. Coastal development that is resilient to increased flood events and rising sea levels has multiple benefits:

- Local governments can show they have acted within their duty of care and limit future legal liability
- Insurance can remain more affordable because some of the risk has been mitigated
- The economic cost of abandoned buildings is limited
- The health safety and amenity of future communities is safeguarded.

There are several approaches available to LMCC to manage the tidal inundation and sea level rise risk, and the preferred approach will be dependent on the particular development being assessed. Resilient housing that is based on adaptability and flexibility allows for buildings to respond to changing uses and hazards over time. The concepts of flexibility and responsiveness are well ingrained internationally with research projects focusing on new ways to live with water and cost-effective ways to build with the end in mind – whether that be deconstruction, disassembly or relocation. Key features of resilient housing include:

- Appropriate site design and protection works
- The ability to raise floor heights and floatable foundations
- Inbuilt redundancy (such as two-storey homes)
- Modularity
- The ability to deconstruct the building

Based on stakeholder engagement and local and international literature review the following principles for Resilient Housing in Lake Macquarie have been developed:

1. Site analysis and design
2. Relocation
3. Raising of floor height
4. Redundancy

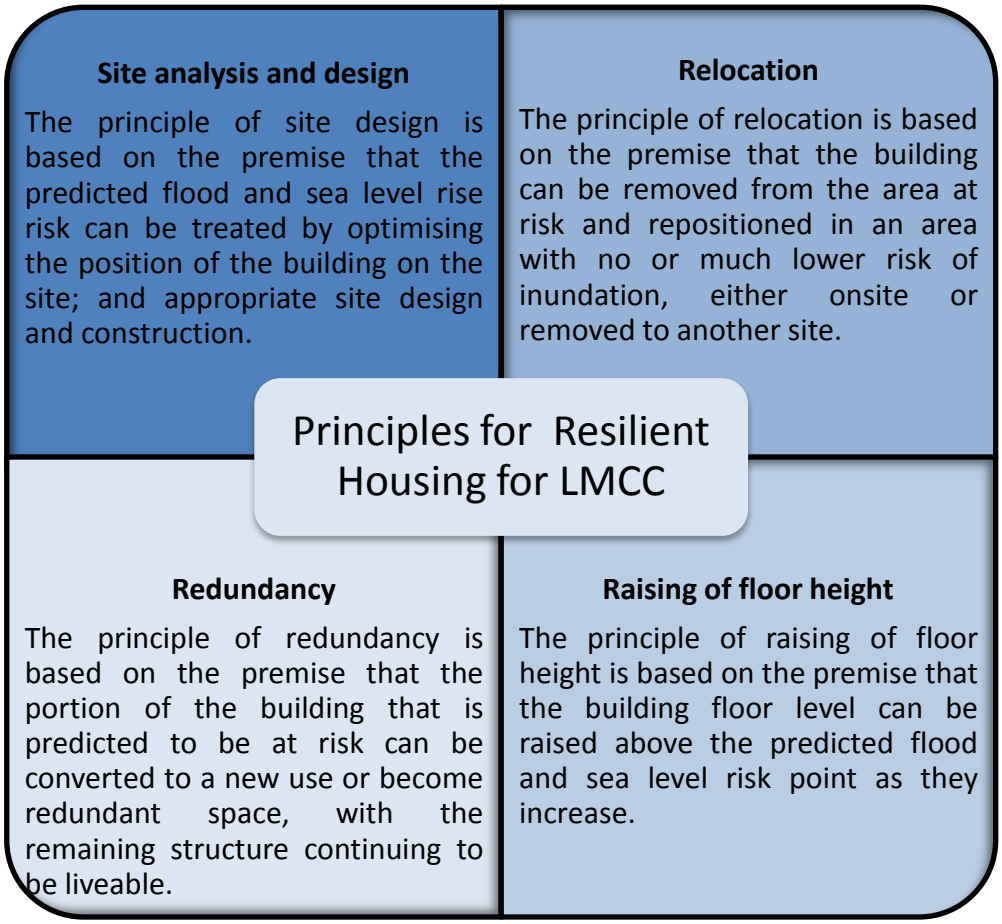

Figure 1. The four principles for Resilient Housing developed for Lake Macquarie City Council

3.1 Site analysis and design

The principle of site design is based on the premise that the predicted flood and sea level rise risk can be treated by optimising the position of the building on the site and through choosing appropriate site design and construction methods.

Site analysis and design is a principle common to all resilient houses in response to sea level rise and flooding. It is intended that Principle 1 be applied to all developments in combination with the other principles as appropriate and desired. The basis of site analysis and design is utilising the site appropriately and designing for inundation impacts. A resilient home can be built by ensuring that the site will maximise the way water will enter and flow across the property and minimise impact on the building. These factors need to be considered:

- Site analysis: assess the site soil type and structure, surface water run-off or ponding, safest point of the site for building, drainage measures and appropriate outlets
- Site design: utilise the safest part of the site, design appropriate protection works

3.2 Relocation

The principle of relocation is based on the premise that the building can be removed from the area at risk and repositioned in an area with no or much lower risk of inundation, either onsite or removed to another site.

The need to relocate onsite can be avoided by siting new developments on the lowest risk area of the site. However, this is not always possible due, for example, to connections to infrastructure, relationship to neighbouring developments, or structural dependence on existing structures. The ability to remove a building from the hazard zone when the risk threshold is reached allows for development to occur on at-risk coastal land, knowing that the building can still be utilised due to its inbuilt ability to be deconstructed and reconstructed as required. Research indicates that modular buildings and pre-fabricated buildings are quite common for purposes other than removing from a hazard and there is a large body of knowledge and prototypes for designing around removability.

Designing a building to be relocatable results in specific requirements to:

- Ensure adequate structural integrity
- Ensure safety and amenity are not compromised
- Ensure building materials selected are practical and affordable for relocation, for example, brick veneer cladding limits the ability to pick up parts of a building and move it with ease
- Ensure a route and access for removal
- Give consideration to the site for relocation

3.3 Redundancy

The principle of redundancy is based on the premise that the portion of the building that is predicted to be at risk can be converted to a new use or become redundant space, with the remaining structure continuing to be liveable.

In particular, long-lived assets such as multi-residential buildings should include lower floors that allow change of use when required, for example, from residential to car parking or storage. A structure has a better chance of surviving future higher than anticipated loads if the structure is technically redundant, that is, it has more elements than strictly needed.

3.4 Raising the floor height

The principle of raising of floor height is based on the premise that the building floor level can be raised above the predicted flood and sea level risk point as they increase.

Raised floor heights are a common approach to managing flood risk and sea level rise risk for new buildings. In northern NSW large numbers of existing wooden buildings have also been raised subsequently to reduce flood damage. The principle of the ability to raise the floor height in future is about allowing development to occur at the same floor level as other buildings and connect to existing services while the risk level is acceptable, but incorporating the ability to raise the floor height when the flooding risk becomes unacceptable. Three alternative construction solutions are considered as acceptable solutions to raising of floor height:

1. Bearer and joist construction on piers and piles.
2. Increasing the height of concrete slab foundation.
3. Floatable foundations.

3.5 The Principles in practice

Performance criteria identify how the four Principles can be achieved. Each principle has both specific performance criteria and core performance criteria. Figure 2 shows the framework for performance criteria.

Specific Performance Criteria: Each principle has performance criteria that outline how that particular Principle may be achieved.

Core Performance Criteria: All the Principles have core performance criteria that need to be included to ensure the practicality and functionality of adaptable buildings. These core performance criteria are considered essential for a building to be acceptable and reasonable to the community and industry

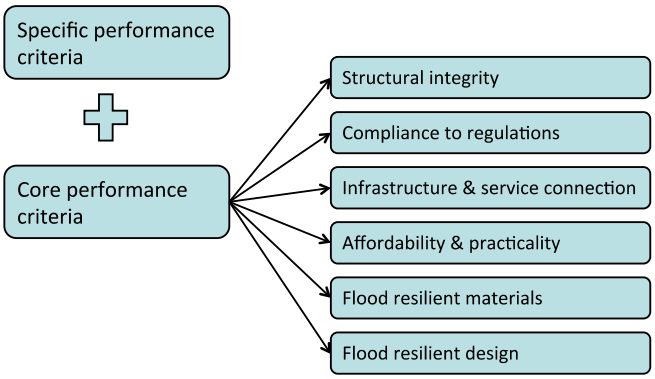

Figure 2. Each principle has performance criteria that are specific to the principles and core performance criteria that are relevant across all principles.

These Principles, along with a set of performance criteria and suggested acceptable solutions, are designed to guide the industry, homeowners and LMCC staff on how best to plan for the future and develop resilient housing. The Guidelines are intended for new developments as opposed to retrofitting existing houses. For renovations or additions to existing buildings, increases in floor area of a building up to 50 square metres or 25% of the existing building floor area (whichever is lesser) will also trigger application of the guidelines. Multiple additions over time that would increase the floor area of the building by more than 25% are not to be considered minor additions.

4. Conclusion

Resilient housing that is based on adaptability and flexibility allows for buildings to respond to changing uses and hazards over time. The Guidelines prepared for LMCC provide principles and performance criteria to help assess the resilience and adaptability of residential developments to flooding and sea level rise risks.

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Edge Environment is an innovative consultancy based in Manly NSW, founded on the principle of bringing best available science to environmental assessments. Our main services are Life Cycle Assessment (LCA) for products and services, Sustainable Procurement and Supply Chains, Eco-labelling and Adaptation and Resilience to Climate Change.

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