Climate Change and Housing

Exploring a New Urban Model to Help Build Resilience to Climate Change

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Abstract

The environmental effects of climate change and the provision of affordable housing are seen as essential yet disparate issues in contemporary urban discourse in Aotearoa New Zealand. We argue that these two critical problems are actually linked through shared landscape-based conditions. We suggest that without careful thought, the provision of housing, especially in denser typologies, could exacerbate the environmental effects of climate change. We propose a new approach to urban planning, one that acknowledges the underlying landscape and the consequence of climate change within the contemporary city. We put forward a method using catchment mapping and GIS analysis to ensure the planning of safe housing.

To investigate this proposition, a collaborative design investigation between Aotearoa New Zealand government housing authority Kāinga Ora and students from the Unitec School of Architecture was conducted. The studio uses a real-life proposition, an 18-ha development site in the Tāmaki regeneration zone, as a study case. The site is susceptible to flooding and about to be intensively redeveloped, and thus exemplifies the two identified problems. Using the methods described above, students carried out a number of site investigations, shared interdisciplinary group analyses, and tested the effect of climate change (especially flooding) on the existing site and the impact of the intensified development in exacerbating flooding. The result was a new awareness by landscape architects and architects, that in the face of climate change, the two practices are irrevocably intertwined.

Introduction

Building resilience to the environmental effects of climate change and the need for affordable housing are two of the most pressing issues in Aotearoa New Zealand. The country is already experiencing the impacts of climate change; the recent flooding in Kumeū attests to the immediacy of the problem.[1] Alongside the threat of climate change is the long-running issue of affordable housing. This problem is prompting both social and economic questions.[2] Solving these two problems has become a critical issue for Aotearoa.

To address the problem of climate change, the government has established a Climate Change Commission,[3] is bringing specific legislation to direct resources into addressing sea level rise[4] and is investing 700 million dollars a year into

1 Nathan Morton, "West Auckland Floods: Kumeū Community Rallies as Recovery Begins," *Stuff*, September 1, 2021, https://www.stuff.co.nz/national/300396428/west-auckland-floods-kume-community-rallies-as-recovery-begins

2 "Housing Affordability Measure (HAM)," Te Tūāpapa Kura Kāinga – Ministry of Housing and Urban Development, accessed September 20, 2021, https://www.hud.govt.nz/research-and-publications/statistics-and-research/housing-affordability-measure-ham/

3 "He Pou a Rangi Climate Change Commission," Climate Change Commission, accessed September 20, 2021, https://www.climatecommission.govt.nz/

climate change research, most notably the Endeavour research projects.[5]

At the same time, housing affordability is of continuing concern as house prices are rising inexorably. The government's primary strategy to address this issue is to use the state housing authority, Kāinga Ora (KO), to build more houses.[6] As part of this housing drive, KO is actively investigating ways to build more intensively, breaking away from the traditional standalone state house. The Hobsonville development was one of the first examples of KO using the terrace-house model, followed by four-storey walk-ups.[7] The latest experiment is looking at the viability of apartment housing. Private enterprise is also part of the drive to build new housing with both long-established developers, such as Fletcher Living, and relative newcomers like Occam,[8] all building new housing in a range of different typologies from terrace housing to apartments.

Ensuring the safety of citizens from the effects of climate change and the provision of affordable housing is critical for the future safe development of Aotearoa New Zealand cities. How are these two problems related? The most obvious connection is increased flooding, such as we have seen around Aotearoa in 2021.[9] Flooding both damages property and affects the safety of housing residents. Less well understood is that the building of housing can increase flooding by reducing the amount of pervious ground that can absorb rainfall. By attempting to build more-intensive housing in an era of catastrophic flooding and sea-level rise, the results could be potentially fatal.

We argue that these two problems need to be considered together. In any intensive housing development design, an understanding of the effects of climate change on the building site should be undertaken. Our contention is that by considering both the location and magnitude of the environmental effects of climate change, a safe housing model for intensification can be developed.

An understanding of the implication of this project for mana whenua was essential. Students worked with Auckland Council's Te Aranga Māori Design Principles to understand how they as designers working in the urban realm can acknowledge their obligations under the Te Tiriti o Waitangi. In developing this project in Aotearoa, the principles of Mauri Tū (environmental health) and Taiao (the natural environment) are particularly relevant.

To explore these issues, a collective landscape and architecture studio at Unitec was initiated in collaboration with Kāinga Ora to investigate the building of a housing project in a flood-sensitive area in Tāmaki Makaurau Auckland. The critical question that guided the establishment of the studio project was: How can a housing development respond to the challenges of climate change?

The first part of this paper introduces the status and relationship of housing to climate-change issues in Aotearoa New Zealand. The second part discusses the design approach drawn from insights from urban ecology, helping to understand and frame remedial strategies. This is followed by a discussion of the design case study, the Maybury Street housing project, demonstrated by two design projects. The paper closes with a reflection on the development of a collaborative design process and how remedial climate-change practice and the associated housing design can lead to a new urban-planning model.

Problem: Climate Change and Housing

Climate change

One of the environmental results of climate change will be increasing rainfall. The increased volume of water cannot readily be absorbed in the ground or quickly directed to the nearest water body. The consequence of these sudden weather events can be catastrophic flooding such as the recent flooding in the Kumeū catchment,[10] flooding in Christchurch,[11] and flooding in South Napier in January.[12] Existing urban infrastructure can exacerbate these events and cause more flooding and pollution. Cities are primarily impervious; in sudden intensive downpours, rainfall quickly gathers, causing intensive flooding. As well as being unable to absorb flooding, the physical infrastructure of an existing city is often obstructive to the quick and effective discharge of flooding. Blocked flooding pathways will cause increased damage to the urban structure.

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4 "RMA Amended to Allow Consideration of Climate Change Mitigation," Adderley Head, accessed September 20, 2021, http://www.adderleyhead.co.nz/updates/2020/rma_amendment_climate_change_mitigation

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9 "New Zealand – FloodList," Floodlist, accessed September 20, 2021, https://floodlist.com/tag/new-zealand

10 Morton, "West Auckland Floods: Kumeū Community Rallies as Recovery Begins."

11 Stuff Photographers, "Canterbury Flooding in Pictures: Heavy Rain and Rising Floodwaters Make Big Impact," *Stuff*, May 31, 2021, https://www.stuff.co.nz/the-press/news/300320388/canterbury-flooding-in-pictures-heavy-rain-and-rising-floodwaters-make-big-impact

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Housing

Tāmaki Makaurau Auckland's population is growing and intensifying.[13] The housing crisis here is related to the lack of units and a growing number of residents who cannot buy a property. The city has the highest average home price in the country, increasing by nearly 35 percent in the past five years and almost three times in the past 15 years. Studies show that while new housing has been built in Tāmaki Makaurau Auckland, the developments are mainly either low-density suburban development on greenfield sites[14] that contribute to the notorious Auckland problem of sprawl, or "over-dense developments using inappropriate house types."[15]

The twin problems of building affordable housing that doesn't contribute to more sprawl while at the same time doesn't contribute to the worsening of flooding are going to become a fundamental concern in the development of cities in Aotearoa New Zealand.

Approach

Ways to address the environmental problems that will be occasioned by climate change or the provision of affordable housing have been extensively canvassed in the literature.[16] However, ways that are able to address both problems in a large-scale development have not been fully investigated.[17]

One way to understand these interactions and their implications for design practice is through the lens of urban ecology, which is a subject that focuses on the relationships between people and built and natural systems.[18] Housing- and climate-change-related issues can be integrated as part of the metabolism of the city.[19] These problems are closely associated with other urban issues such as social, cultural and utility infrastructures, and are often driven by similar economic and political forces.[20] The science of urban ecology considers the city a holistic ecological entity consisting of many interdependent systems. It focuses on the relationships among people, built systems and the dynamics of nature.[21] Unlike conventional landscape architecture or architecture approaches that consider the counterpart as a homogeneous background, urban ecology acknowledges the intimate nature of urban designs and heterogeneous patterns of the urban fabric.[22] It brings both natural and artificial systems to the forefront and emphasises the flows, exchanges and interactions between these two systems.[23]

Based on this view, there is a potential to shift conventional climate-adaptation interventions to a more progressive approach that acknowledges co-evolution and integrations between the built and natural systems.[24] This co-evolving system has the potential to provoke a radical shift from separate mitigation measures to reimagining both housing and environmental systems working together, achieving urban sustainability that accommodates more urban dwellers and is more resilient to climate change. The analysis of ecological patterns, processes and dynamics will help landscape architects and architects form a holistic view of the extent of the problem occasioned by climate change, thus promoting integrated solutions that can address both housing-and climate-change-related issues.

The design process to address these two issues is articulated in the book *Water City: Practical Strategies for Climate*

13 "Auckland Population May Hit 2 Million in Early 2030s," Stats NZ, accessed September 20, 2021, https://www.stats.govt.nz/news/auckland-population-may-hit-2-million-in-early-2030s

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Group Six

Group Three

Figure 1. Location and context of the Maybury Street project.

Change.[25] The process starts with the development site being placed into the catchment, and an environmental audit of the conditions is made. Identifying and protecting the existing hydrological structure of the catchment is essential; this can be done by using GIS mapping to identify catchments, overland flow paths and riparian margins. Mapping these corridors enables them to be protected from development pressures. The ability of a city to absorb rainfall by becoming more pervious is also critical. Making the city form more open and the building programme more compact by clustering buildings together are ways to achieve this goal. These two broad strategies, identifying and protecting existing riparian corridors and making the city more open and absorbent, can help the catchment become more responsive to climate change.

Maybury Street Housing: A Joint Studio Project

The collaborative landscape/architecture studio is a studio project between senior landscape architecture and architecture students that has been running for six years. An exploration of climatechange adaptive design projects has been investigated for the last three years. The Maybury Street project, developed in collaboration with Kāinga Ora, will be presented as a case study to explore the twin issues articulated in the first part of the paper.

The Maybury Street site (Figure 1) is part of a broader development strategy for the Tāmaki area (comprising Glen Innes, Panmure and Point England) undertaken by Kāinga Ora, the government housing development agency.[26] The Kāinga Ora brief for the Maybury Street redevelopment zone proposed densification of the area, constructing 3000 residential units. This represents a significant change in the space, today mainly occupied by detached houses and star blocks. In the face of the densification of the area, the existing Maybury Reserve represents an opportunity to act as a release of green space for amenities. The Kāinga Ora brief required "a high-density modern exemplar of apartment and terrace house communities centred around an uplifted town centre and connected through the Maybury Reserve to the coast."

The project was broken into two halves to understand the interaction between provision of intensive housing and the harmful effects of climate change. The first half was devoted to developing a new urban masterplan for the Maybury Street redevelopment that will be resilient to climate change while providing high-density housing. This part of the project was developed in a collaboration between architecture and landscape architecture students. The second half was devoted to individual architecture students and landscape architecture students exploring the consequences of the masterplan for designing a high-density residential building (architecture student) and creating a new public space (landscape architecture student).

To help address the Kāinga Ora brief, the 2021 Maybury Street studio developed four objectives:

1) Understand the relationship between the effects of climate change and urban development.

2) Explore the correlation between housing density and the provision of green space.

3) Identify appropriate climate adaptation strategies and correlating housing typologies.

4) Embed Te Aranga Principles throughout the design process.

25 Matthew Bradbury, *Water City: Practical Strategies for Climate Change* (London: Routledge, Taylor & Francis Group, 2021).

26 "Home | Tāmaki Regeneration," Tāmaki, accessed September 20, 2021, https://tamakiregeneration.co.nz/

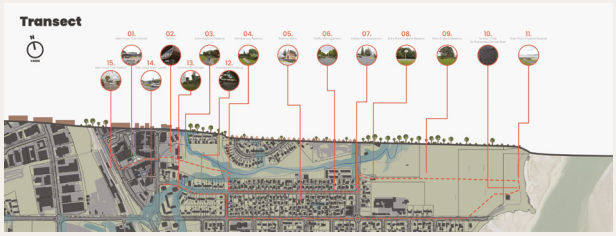

Figure 2. Transect from the town centre to the sea (Group Six).

Understanding the relationships between the effects of climate change and urban development

Understanding the impact of climate change, especially urban flooding, on housing development was critical. Students were asked to work in interdisciplinary groups. Each group started work by undertaking two forms of analysis. The landscape architecture students looked at the site using topographical and cadastral maps at several different scales. Using GIS mapping tools, students developed hydrological maps such as overland flow paths and flooding analysis to understand the effects of climate change on the site. Architecture students investigated different Auckland housing types, from standalone houses to apartment buildings. Students also investigated the dimensions of each dwelling unit, from houses to apartment blocks, and their relationship to the surrounding landscapes.

Combining this initial analysis with a site visit, all groups drew transects, situating the development site within the larger landscape, from the Glen Innes town centre to the Tāmaki Estuary. The transects helped students understand how the development site was located within an urban section from the town centre to the park, and a landscape transect along the Omanu Stream valley (Figure 2).

Exploring correlation between housing density and green space

The Maybury Street site is 18.2 ha; the overall dwelling units specified by KO have increased from the existing 307 dwelling units to 3081, more than ten times the dwelling density. Although this density is standard in many overseas cities, it is unprecedented in the Aotearoa New Zealand urban realm.

Each group was required to test at least six possible combinations of the required 3081 dwelling units and how the projected flooding might be remediated. Landscape architects were asked to build a catchment model to show the effects of different amounts of rainfall on varying levels of flooding and how stormwater could build up in the catchment. Landscape architects were then asked to test/model other remediation measures such as flood retention/detention zones, flood conveyance channels, and stormwater treatment options such as the provision of swales and wetlands. To help with this mapping and analysis, several experts from NIWA, Healthy Waters and Opus generously gave their time and expertise. Architecture students were expected to test density variations by building physical models to understand the location of housing within a 400-metre and 800-metre walking distance of the railway station and exploring different New Zealand building typologies.

Figure 3. Students work in teams to explore density and green-space relations. Photographs: Lúcia Camargos Melchiors

Using this analysis, each group was then expected to compare and contrast their six plan concepts and make a collective site model with the different landscape and housing options in three dimensions (Figure 3). This helped the students to form their final masterplan. The group modelling exercise was an opportunity to create interaction between the students and to contribute to the collaborative design process. Melissa Knight (from Group One) described it as "a good exercise for a visual representation of the flood paths and zones, and then good for our development planning." Students developed an understanding of new subjects from the group work and enlarged their perspective about the other discipline. Melissa described how she now understood the risks and potential damage that weather events can cause and "now think[s] differently." Melissa also emphasised the importance of "not building in a flood path or zone, but also not being afraid of these as natural occurrences that we must try to mitigate, but still may need to live next to."

Identifying climate adaptation strategies and housing typology

To explore the masterplan strategies at a finer scale, the second half of the project required students to focus on the public/private interface. Each student selected an area from the proposed masterplan for a detailed design in conjunction with other team members.

Figure 4. Creative process through physical modelling. Group Six and Group Three.

Landscape students chose a public space; architecture students chose an apartment block. While students were now working in their respective disciplines, they were encouraged not to lose the discoveries they had made in the masterplan stage of the project, and to stay in touch with their colleagues as they developed their projects. Landscape students started to create a public-space design that connected to the building programme, using sketches, diagrams, models and cross sections to show both environmental remediation and a new public space. Architecture students started developing an apartment design, including sketches, diagrams, volumetric models and cross sections to show the mass configuration of the building block (Figure 4).

Embedding Te Aranga Principles throughout the design process

Embedding Te Aranga Principles throughout the design process helps students to acknowledge the cultural values that connect the built form with the natural environment.

Te Aranga Principles have been formulated as a way in which stakeholders and designers who are working in the urban realm can acknowledge their obligations under Te Tiriti o Waitangi. Amongst the seven principles, Mauri Tū (environmental health) and Taiao (the natural environment) are particularly relevant to the development of Maybury studio. According to the Auckland Design Manual, the principle of Mauri Tū guides designers to protect, maintain and enhance environmental health, while the principle of Taiao advocates to protect, restore and enhance the natural environment. Students were asked to incorporate Te Aranga Principles in both the masterplan and individual projects. Their design work should demonstrate how the principles inform different housing typologies and environmental solutions.

Studio Design Outcomes

The respective design outcomes explored how both buildings and public spaces can respond to the challenges of climate change while at the same time creating an agreeable social space for both inhabitants and citizens. Students discovered that buildings and landscape could be spatially rearranged to densify the development zone, at the same time increasing ecological and hydrological resilience to climate change.

Omanu Stream Flood Retention Basin and Housing

Eloise Twaddle and Abigail Spence (Group One) worked together to develop a large flood-retention basin in the centre of Maybury Reserve, and an adjacent apartment building. Eloise commented, "The stream's centrality to the overall development invited it as the main axis along which residents and the public could move from sea (Tāmaki River) to suburb (Maybury Street) to city (Glen Innes township). Our project augmented this inherent logic through wide pathways which could accommodate people whether they were moving north–south or east–west. The circular bridge was where these paths met, and the bridge peeled away into a helix that could carry stormwater (via an inset conduit) or people down to the stream and its banks. In a storm event, the helix would disappear underneath the floodwaters, leaving only the uppermost revolution on which to walk." Abigail commented on the design of the apartment building: "Our architecture and landscape responses had to be able to hold and slow rainwater to decrease the amount of runoff caused by impervious surfaces, and to use the rainfall entering the site. Rather than hiding our response to rainfall, our architecture and landscape made the water collection and treatment process visible, even celebrated."

Integration of the landscape and architecture design solutions contributed to acknowledging the effects of climate change. The design of the apartment building explored a mix of public and private outdoor spaces, organised in terraces, balconies and a sequence of internal courtyards. Rainwater was collected and filtered to reduce the new impervious surfaces created by the apartment buildings. The remediated stormwater was contained in a structured rill that conducted the water to the flood-retention basin in the Omaru Stream, thus linking housing and climate-change remediation (Figure 5).

Figure 5. Omanu Stream Flood Retention Basin and Housing, by Eloise Twaddle and Abigail Spence.

Point England Road Wetland and Housing

Alexander Korolyov and Kahli Foote (Group Four) continued to work together as they developed an apartment building and a public space (Figure 6). Alex explained how he developed his public space: "I proposed a constructed wetland because it responds to the effects of flooding and stormwater that I mapped in the first part of the project and addressed Te Aranga Principles principally though stormwater remediation. A large, constructed wetland was proposed to collect stormwater runoff from the surrounding buildings, filter, clean and discharge the runoff into the Omanu Stream. An existing overland flow path was channelised and connected to the new wetland to serve as an overflow outlet to the treatment process."

Kahli commented: "The overland flow path ran through the middle of the designated building site. One option for me was to separate the building programme into two buildings on either side of the newly channelled stream. I explored the idea of two buildings by initially designing both buildings to mirror the stream shape. This created an organic curved structure that, in plan view, sat alongside the new stream. As the stream went through the middle of the building complex, the space became a central area for the public, and this was emphasised by the communal spaces on the ground floor of both buildings. A market space was also designed to allow for connection between the wetland and the apartments."

Amber Bray (Group Six), one of the landscape architecture students, commented on the overall development of the studio. "Climate change is now impacting how our

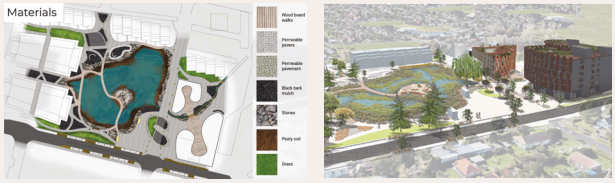

Figure 6. Point England Road Wetland and Housing, by Alexander Korolyov and Kahli Foote.

professions design, and being able to design in a way that will be resilient to issues such as flooding and increased stormwater is invaluable. The many lectures from different experts in climate change and flooding guided me to design thoughtfully, to combat the increasing amount of impervious surface in an ever-growing urban world. This base work on the landscape meant that our team could provide for the intended housing density while minimising the risk of climate change."

The Maybury Street project used several strategies to encourage collaborative design investigation to address building a safe housing development and remediating the effects of climate change. Building multidisciplinary teams was the first move; two design exercises helped the teams to understand the importance of extensive landscape-based conditions – drawing a transect and building a model. Firstly, drawing a transect helped students understand how their project brief was located within a gradient from Glen Innes to the Tāmaki Estuary. Secondly, building a large-scale site model helped the groups see the importance of the Omaru Stream catchment to their future urban configuration.

The utility of these two workshops was evident in helping the students develop collaborative design strategies in the final design stage. The student design work confirmed the research proposition, that climate change remediation and the provision of new housing are linked. The project Omanu Stream Flood Retention Basin and Housing, by Eloise Twaddle and Abigail Spence, showed these two conditions most clearly, building a flood remediation device in Omanu Reserve and the construction of the apartment building that acknowledges how buildings contribute to stormwater production through the design of several remediation features linked to the flood-retention pond. The project Point England Road Wetland and Housing, by Alexander Korolyov and Kahli Foote, demonstrates students' understanding of the need to remediate stormwater in a new building programme by allowing for open space, which is simultaneously a remediation wetland; the building programme acknowledges the new remediation structure by reducing the building footprint and using the remediation landscape as a new public space.

Conclusion

This paper presents two pressing challenges in Tāmaki Makaurau Auckland – affordable housing and the impact of climate change. To address these two intertwined issues and aid large-scale housing development, the authors drew inspiration from the science of urban ecology and proposed a new urban planning method to build resilience to climate change, particularly flooding. The joint studio promoted new design thinking that emphasised the interaction between built and natural systems and the co-design of the entire urban catchment.

The results of the Maybury Street studio project, described in this paper, demonstrate how this interactive approach aided students' learning process. By working closely in teams, landscape architecture and architecture students understood the relationships between climate change and housing across various scales from regional, to local, and to individual buildings. Through mapping and modelling, they were able to configure different combinations of housing density and green space. Embedding Te Aranga Principles throughout the design process, students could connect different housing typologies and environmental solutions with an acknowledgement of mātauranga Māori. The two design examples demonstrate the students' in-depth understanding of how the built and natural environments can be co-developed into more resilient forms.

While the focus of this paper is to explore the provision of high-density housing in a flood-sensitive area, in a tertiary learning environment, the interactive approaches demonstrated in this paper have several implications for the built and natural systems. This makes the findings highly relevant to professional practices for landscape architects, architects, urban designers and policymakers.

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Group Three. Sarah Ebbings (LA), Sharon Yang (Arch), Toby Lou (Arch), Zheng Wang (Ada) (Arch)

Group Four. Kahli Foote (Arch), Hanalei Kanter (Arch), Harshit Mehta (Arch), Alexander Korolyov (LA), Nikko Eichler (LA)

Group Five. Colin Cao (Arch), Jennifer Vuong (Arch), James Ximin Li (LA), Rooks Waedueramae (LA), Greg van Maanen (LA)

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