The role of landscape architecture in designing for urban transformations and adaption after disaster: a design-directed inquiry within the context of post-earthquake Christchurch

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By Nicki Copley

Millions of urban residents around the world in the coming century will experience severe landscape change – including increased frequencies of flooding due to intensifying storm events and impacts from sea level rise. For cities, collisions of environmental change with mismatched cultural systems present a major threat to infrastructure systems that support urban living. Landscape architects who address these issues express a need to realign infrastructure with underlying natural systems, criticizing the lack of social and environmental considerations in engineering works. Our ability to manage both society and the landscapes we live in to better adapt to unpredictable events and landscape changes is essential if we are to sustain the health and safety of our families, neighbourhoods, and wider community networks.

When extreme events like earthquakes or flooding occur in developed areas, the feasibility of returning the land to pre-disturbance use can be questioned. In Christchurch for example, a large expanse of land (630 hectares) within the city was severely damaged by the earthquakes and judged too impractical to repair in the short term. The central government now owns the land and is currently in the process of demolishing the mostly residential houses that formed the predominant land use. Furthermore, cascading impacts from the earthquakes have resulted in a general land subsidence of .5m over much of eastern Christchurch, causing disruptive and damaging flooding. Yet, although disasters can cause severe social and environmental distress,

they also hold great potential as a catalyst to increasing adaption. But how might landscape architecture be better positioned to respond to the potential for transformation after disaster?

This research asks two core questions: what roles can the discipline of landscape architecture play in improving the resilience of communities so they become more able to adapt to change? And what imaginative concepts could be designed for alternative forms of residential development that better empower residents to understand and adapt the infrastructure that supports them?

Through design-directed inquiry, the research found landscape architecture theory to be well positioned to contribute to goals of social-ecological systems resilience. The discipline of landscape architecture could become influential in resilience-oriented multi-disciplinary collaborations, with our particular strengths lying in six key areas: the integration of ecological and social processes, improving social capital, engaging with temporality, design-led innovation potential, increasing diversity and our ability to work across multiple scales. Furthermore, several innovative ideas were developed, through a site-based design exploration located within the residential red zone, that attempt to challenge conventional modes of urban living – concepts such as time-based land use, understanding roads as urban waterways, and landscape design and management strategies that increase community participation and awareness of the temporality in landscapes.

Keywords: landscape design; landscape architecture theory; disaster; resilience; infrastructure; social-ecological systems; community; adaptive capacity; transformation; flooding; sea level rise.

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Preface

This research was prompted by my urge to respond to the events and continuing effects of the Canterbury earthquakes. I was born in Christchurch and spent the first twenty years of my life here – learning, playing and exploring the city's landscapes. During what I thought was a temporary visit to New Zealand in February, 2011, I experienced the power of earthquakes. At 12.51pm on February 22nd, 2011, after only just ordering lunch at an upstairs café in Cathedral Square, a magnitude 6.3 earthquake hit the city, destroying many buildings and killing 185 people. I will never forget the experience of trying to walk calmly down the stairs to the outside public space, only to be faced with thick dust, people crying and a collapsed cathedral. Further unforgettable experiences involved helping shovel deep liquefaction from around people's broken homes with the student army.

I left the city after my visit of four months had ended, but a series of events and decisions found me back here in 2012, with the goal of studying towards a Masters of Landscape Architecture. During my time at Lincoln, the effects of the earthquake were often present in studio briefs – a temporary accommodation camp for Filipino construction workers employed in the Christchurch rebuild, a village centre proposal to encourage new activity in an area which lost a treasured heritage building. Although for some students, the ever present earthquake effects grew tiring and unglamorous, for me, each served to further inspire me to consider the potential of landscape architecture in responding to disaster and severe landscape change.

In my first year at Lincoln, I was involved in a rapid tree audit in the residential red zone, an area I hadn't visited since I shovelled liquefaction back in the early days after the February quake. The large scale abandonment shocked me. Weeds overcoming driveways, bare sections where houses once stood. The emotional and physical effects of the disaster were, and still are immense. When it came time to decide on a research question, my experiences and questions, along with the turbulent landscape of the residential red zone, instilled in me a need to respond to the issues confronting Christchurch – to explore and question meanings of resilience and investigate what opportunities the experience of disaster could bring to goals of increasing urban adaptability.

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Chapter 1 Introduction

How might landscape design be utilised to increase adaption to the numerous challenges facing urban communities in the 21st century? Although the exact timing of disasters can never be predicted, can collisions between urban development patterns and environmentally-driven processes such as earthquakes, hurricanes, flooding, tornados and fires, be anticipated and planned for? Researchers assert climate-change-related effects are already causing increased extremes of weather (e.g. flooding and heat waves), and predict events will intensify with further warming (IPCC 2014). Sea level rise will also impact urban development. With such potential for future disaster, the capacity of authorities and residents to transform to more adaptive living environments is critical.

One response might be to relocate to land less vulnerable to disruptions i.e. higher, less flood-prone land. However, substantial financial investments in infrastructure and housing make this difficult, not to mention the unmeasurable and untransferrable social ties and place attachments connected to these vulnerable landscapes. If people are to continue living 'in place' as greater extremes of climate events increase, how might they become more able to 'roll with the punches'; to adapt?

Infrastructure systems such as road networks, energy systems and stormwater management schemes, both influence urban form and direct social patterns and expectations (Edwards 2003; Hughes 2012; Sims 2007). Society and infrastructure have become integrated to such an extent that the infrastructure systems which support urban living are made invisible - a social right rather than a constructed and at times,

flawed system. However, infrastructure systems are often designed and constructed by engineers with little regard to social and ecological implications (Allen 1999; Bélanger 2009, 2012; Morrish 2008; Mossop 2006). When disasters occur, infrastructure systems can fail (flooding roads, power outages, downed communications etc) leading to increased confusion and anxiety (Kaika 2004). Rather than facilitating residents to adapt to the changing environment, current modes of infrastructure can actually hinder resilience through people's inabiltiy to take control and influence their environment (Bonanno et al. 2007).

Stemming from this troubling context, this research asks two core questions. The first is what role can the discipline of landscape architecture play in improving the resilience of communities so they become more able to adapt to change? The second is what concepts could be designed for alternative forms of residential development that better empower residents to understand and adapt the infrastructure that supports them?

Already in this brief introduction, many terms have been used which share multiple meanings. Clarification of definitions is therefore useful. The term resilience is perhaps the most fickle as many disciplines apply the term in different ways. The definition of resilience applied within this research follows the concept put forward firstly by ecologist, C. S. Holling (1973), and is thus defined as:

- *Resilience:* 'The amount of change a system can undergo (its capacity to absorb disturbance) and remain within the same regime – essentially retaining the same function, structure, and feedbacks' (Brian Walker and Salt 2006: 164).

This definition contrasts with the 'engineering definition', which defines resilience as the ability to return to normal conditions after a disturbance (Foster et al. 2010): resilience or 'adaptive capacity' in social-ecological systems is considered as a system's

ability to reorganise, learn and adapt. Subsequently, this thesis follows B. Walker et al. (2002) and uses the term *resilience* and *adaptive capacity* interchangeably. It is also important to define a number of other such terms, all of which have more straightforward definitions:

- *Social-ecological systems*: are defined as 'a linked system of people and nature in which people depend on nature and nature is influenced by people' (Graeme S. Cumming et al., 2013: 1140).
- *Infrastructure:* The Oxford dictionary (2014b) defines infrastructure as 'the basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of a society or enterprise'. However, as this is landscape architecture research, the infrastructure systems I refer to are land-based (networks of water, energy, transport, waste and communication). As Czerniak (2011: 16) states, '…the practice of landscape architecture is inseparable from the realm of transport and utility infrastructure'.
- *Community:* is defined following the description of Norris et al. (2008: 128) – 'Not always, but typically, a community is an entity that has geographic boundaries and shared fate. Communities are composed of built, natural, social and economic environments that influence one another in complex ways.'

The processes of design are integral to the research process and are undertaken and utilised as a method of inquiry – a tool which enables the researcher to explore and synthesise diverse ideas and contexts with the aim of creating 'imaginative breakthroughs' (Carter 2004: 13). Following Carter (2004), the approach of Abbott (2008) asserts the role of design research is not to determine final, refined outputs, but rather to *build possibility.* My research is positioned within this framework.

The research aims are to first explore through rapid investigative design responses, connections between landscape infrastructure theory and resilience theory, and what imaginative ideas can be designed through their synthesis. Second, a site-based design exploration of my findings and critique of the first design phase will aim to build the imaginative possibilities for ways adaptive capacity could be increased in communities experiencing amplified landscape change. Finally, analysis of the design process outcomes will aim to build the understanding of the role of landscape architecture in resilience strategies.

As stated in the preface, the experience and effects of the earthquakes in Christchurch influenced my chosen research subject matter, but also became the site for the design exploration. The former suburb of Avonside - now located within the residential red zone, a 630 hectare expanse of abandoned land in eastern Christchurch - was chosen as a site to explore the research questions due to its close proximity to central Christchurch and its relationship to flood risk. The earthquakes caused extreme social and environmental change with the residents of nearly 8000 properties having to leave the area due to severe land damage. Yet through this disruption, comes a significant opportunity to reimagine ways of living – to break apart previously held notions. As a result, Avonside provides a potent testing ground for experimental living and offered valuable insights into my research questions.

As a method for exploring the research questions, I reviewed and analysed the relationship between two theoretical frameworks: theoretical concepts aimed at building resilience in social-ecological systems and theoretical concepts for infrastructure design argued by landscape architecture theorists. In chapter four, I review and analyse the literature to build a design toolkit to apply and test through the site exploration design process. Several research findings were developed through this process and its critique.

The specific instrumentality of landscape architecture was located within six key benefits that are examined in chapter eight: the integration of ecological and social processes, possibilities for improving social capital, engaging with temporality, design-led innovation potential, increasing diversity and working at multiple scales. Additionally, to be explored in chapters seven and eight, a number of alternative concepts for urban development were imagined through applying a landscape and resilience theory synthesis toolkit to the Avonside site. These challenged conventional development through their emphasis on embracing change and temporality, and integrating people, infrastructure and landscapes.

Within this research, the need for greater theoretical knowledge in landscape architecture practice is asserted. The ability for landscape architects to become more instrumental in building the adaptive capacity of regions, cities or communities is heavily reliant on both their understanding of how increased resilience might be achieved and understanding landscape design methods for working towards these goals. As a result, the first three chapters of this thesis examine the connections between landscape architecture, infrastructure, transformation potential and resilience.

Chapter 2 Infrastructure: relationships and effects

Over time, changes in societal ideas and visions have greatly influenced the relationship between urban form and infrastructure. Early in the history of infrastructure development, systems were seen as saviours and associated with a better future. Yet today although infrastructure systems are essential to urban living, they have become invisible. Urban residents expect infrastructures to always function; a social expectation has been created and through this, people have lost sight of their dependence on infrastructure. As a result, when systems break, it is not only the network disruption that occurs, but disruptions in social expectations also.

2.1 Evolution of people-infrastructure relationships

Geographers Maria Kaika and Erik Swyngedouw (2000) provide a comprehensive overview of the relationship between infrastructure and society. In brief, they argue the industrial revolution and accompanying age of reason led to a belief that technology could advance society and improve living conditions. With urban living conditions deteriorating, technologies that could improve sanitation and reduce health problems were celebrated. Cables, dams, pipes and structures became urban landmarks and works of art themselves, celebrated not only for their physical appeal but for the promise they held for a better future.

During the first half of the 20th century, the 'decidedly destructive underbelly' (Kaika and Swyngedouw 2000: 132) of technology became apparent through the horrors of the two World Wars and the increasing mechanisation of workplaces. People became disillusioned with technology and its unfulfilled promises. As a response, after World

War II, infrastructure networks and structures were hidden, placed underground or away from cities to maintain a new pure, clean urban form.

A disconnection between nature and the city began which continues today. Technology and progress were no longer seen as saviours of society, but became instilled in the minds of people as essential aspects of their lives. Today we are in a position described by Robert Thayer in compelling terms: 'we find ourselves in a deeply fragmented situation where we love nature, but depend on technology. Ironically, as we recognise the harm technology has done to the land, we also depend on the illusion of *not* being dependent on technology' (Thayer 1994: 94).

Landscape architects are frequently charged with continuing this illusion by way of 'mitigating' the visual effects of infrastructure componentry. The disconnection between people and the infrastructure that supports them is highly problematic for a number of reasons. Current infrastructure systems are enabling an inequitable relationship between the environment and society, as well as decreasing people's resilience and ability to take control of their lives.

2.2 Environmental consequences

The water will always run from the tap, electricity will always flow to the light bulb, or so we assume. As urban residents we expect these outcomes as part of living in a developed society, yet most of us are unfamiliar with the processes and costs involved with using infrastructure products. Nature is commodified and the social or environmental costs associated with the transformation of nature into product are either ignored or unknown (Kaika 2004). The material needed to construct our roads comes from an unknown place and the energy we use is creating landscape impacts elsewhere.

Thayer (1994) discusses the separation between the familiar – the inside, and the unfamiliar – the outside. He suggests we are deluding ourselves into thinking the technology supporting us personally is somehow separate from the technology that is causing social or environmental degradation.

Although this is probably still true for many people, well-informed people today are likely to be increasingly aware of the associated costs of our infrastructure systems. Unfortunately the systems have become so engrained in our society and way of living that individual people, no matter how good their intentions, are generally unable to affect substantial positive change.

2.3 Social construction

Infrastructure and society are intimately connected. Infrastructure systems are socially constructed yet also have a considerable material influence on how society is shaped (Edwards 2003; Hughes 2012). For example, roads determine where we can travel and how long it will take, so much so that we often shape our behaviour around these parameters. We assume the infrastructure we rely on so completely will always function, and our social expectations with each other and organisations are constructed with this in mind. (Sims 2007).

The problem of having social relationships and expectations moulded so strongly by infrastructure is twofold. Infrastructure systems can be disrupted or completely fail, while the current modes of infrastructure design and management lead to a public that is unprepared to respond to system problems. If social organisation relies heavily on infrastructure, when it fails the outcome is not only a broken physical system but also a broken social system where social expectations and responsibilities are unable to be met. A disastrous example can be seen in the experience of the New Orleans police force after Hurricane Katrina. The city's electrical, telephone and internet systems

were all either destroyed or badly damaged and most roads became impassable due to flooding. The police force lost the ability to communicate and to move effectively around the city. The ability to connect to infrastructure networks frames ideas on what are suitable responses to problems, so while the police struggled to perform basic policing functions, social expectations were also violated (Sims 2007).

The social interconnectivity of infrastructure networks can also affect personal behaviour. A disruption or failure such as a power outage or a flooded road exposes the uneasy truth that we rely on systems beyond our personal control. The familiar feeling of home is challenged once evidence of problems in the 'outside' world infiltrate the bubble of domestic life, causing anxiety and discomfort (Kaika 2004).

Psychologist George A. Bonanno (2007) presents the trait of hardiness as a characteristic that could lead to improved personal resilience and suggests that hardiness to some extent could be achieved through people's belief that they are able to influence their surroundings and outcome of events. However, in a typical urban environment, people have an extremely limited ability to influence their surroundings. As a result, when an infrastructure system breaks or reduces functioning capacity, the meanings of physical and social urban living are challenged and most people are powerless to influence any significant adaptation. Therefore it can be supposed that the manner in which infrastructure systems are currently designed can not only be inconvenient when disrupted but also negatively impact social organisation and personal resilience. Additional problems of current infrastructure design characteristics are examined below.

2.4 System characteristics

Landscape architects routinely criticise the engineering profession's dominance over infrastructure design, owing to outmoded development patterns and principles that fail

to align with today's environmental and social context (Allen 1999; Bélanger 2009, 2012; Morrish 2008; Mossop 2006). Baseline principles of urban planning and civil engineering such as standardisation, mono-functionality and permanence have formed systems detached from nature and inflexible to change (Bélanger 2012). The human race is faced with increasing economic, social and environmental instability in coming years, and infrastructure systems that apply a one-size-fits all (and for all time) approach are less likely to encourage adaption to local conditions.

Another concern is that current infrastructures are built on the assumption of infinite resources (Hodson et al. 2012); a problem especially significant to residents of developed countries who have become accustomed to the overconsumption of resources (Kane 2012). How to realign the relationship between resource consumption and infrastructural needs is a hugely difficult yet essential question for society as a whole.

Additionally, infrastructure design methods have led to networks of great inter-connectivity, where a single disruption can lead to the cascading failures of multiple systems. New Orleans was particularly vulnerable to disaster owing to the city's complex and interdependent infrastructure (Leavitt and Kiefer 2006). The example of the police force demonstrates this interdependence. The dependence of the police functions on the transport network and the dependence of the transport network on the levee system to provide flood protection, resulted in multiple infrastructure failures. Although the authorities were aware of potential problems in infrastructure interdependencies, Hurricane Katrina hit before many issues could be addressed. One strategy to increase the resilience in infrastructure systems is to build redundancy into networks – 'loosely coupled systems are inherently less susceptible to catastrophic failure than those that are tightly coupled' (Leavitt and Kiefer 2006: 313). Could the

disastrous impacts of Hurricane Katrina have been reduced if the city's infrastructure systems were designed to expect failure?

2.5 Why change now?

From this examination of the interconnectivity of infrastructure and society and the disconnection it causes between people and the environment, it is apparent that many complex issues need addressing. But why is this question so critical right now?

My research focused on three key issues that infrastructure systems and people will have to respond to now, and into the future: climate change, resource depletion and ageing networks.

Climate change

The wide ranging effects of climate change have the potential for catastrophic outcomes if no action is taken. With over 50% of the world's population living in urban areas and forecast to increase to 70% by 2050 (World Health Organisation 2014), the capacity of infrastructure to continue to function in the face of climate uncertainty and disruptions is vital. Of the numerous associated issues of climate change, perhaps the most pertinent to landscape architects are sea level rise and increased incidences of extreme weather events. The 2014 Intergovernmental Panel on Climate Change (IPCC) summary for policy makers indicates a very high confidence that climate variability is already causing significant vulnerability and exposure for some ecosystems and many human systems. Furthermore, the report states that "for countries at all levels of development, these impacts are consistent with a significant lack of preparedness for current climate variability in some sectors" (IPCC 2014: 7). This highlights the urgent need to realign infrastructure to better adapt to the changing environment, for while the drivers of climate change maybe global, the effects will be local.

Resource depletion

Another catalyst for action is the increasing issue of resource depletion as many infrastructure systems are fuelled by or require natural resources to function. In conjunction, globalisation processes have enabled cities to rely on external resources. This disconnects people's understanding of the consequences of their consumption from actual landscape effects. This delays their knowledge and ability to act sustainably (Brian Walker and Salt 2006). As infrastructure systems facilitate resource consumption, it is of great importance that they enable citizens to better realise their environmental impacts.

Ageing networks

Furthermore, numerous infrastructure networks such as city wastewater or water supply systems have increasing service vulnerability due to their age, as many systems were constructed several decades ago. Technological advances also require system upgrades. Worryingly, while the vulnerability is acknowledged, there still exists a huge underinvestment in infrastructure to address this growing problem.

The Global Risks report delivered by the World Economic Forum (Global Risk Network 2010) indicates underinvestment in critical infrastructure to be one of the biggest threats facing humanity today. The report states The World Bank has calculated US$35 trillion is needed in global infrastructure investment, with both developing and developed countries at risk. For example, the American Society of Civil Engineers rated US critical infrastructure as a 'D', only just above failing and estimated US$2.2 trillion is necessary over the next five years to bring up the standard (Global Risk Network 2010). As society and infrastructure systems are so intertwined, the potential issues associated with increasing service disruptions need our attention now.

2.6 The role of landscape architecture

While a myriad of challenges confront the management of infrastructure, meeting these challenges opens up an important opportunity. In each system that repair or reconstruction occurs, exists the possibility this work will enable a transformation of networks or structures into facilitators of greater resilience, for people and landscapes alike (Yang 2010). Although infrastructure networks may seem too established to change, history shows that changes can be made, even radical ones (Balslev Nielsen 1999; Elle and Balslev Nielsen 2000).

Sociologist Chris Henke (2007) discusses two options in repairing infrastructure: repair as 'maintenance' or repair as 'transformation', however he also states that infrastructure is typically repaired as 'maintenance'. He suggests repair as 'transformation' is more difficult to achieve as transformation can often incur radical changes in the relationships between culture and the environment; changes people or developers may be unwilling to accept. Even so, considering the risks inherent in the current systems, it is vital that transformation occurs.

Discussions in the theory of large technical systems suggest that radical change to prevailing systems is unlikely to come from the *system builders* (Balslev Nielsen 1999). Historian Thomas P. Hughes' theory on understanding change in large technological systems identifies the influence of system builders (inventors, engineers, managers, financiers etc.) in infrastructure development. Describing this influence, Summerton (1994: 4) states 'system builders use a variety of tactics to promote and defend their systems. They can be expected to block attempts at reconfiguration that threaten their control'.

Consequently, an opportunity but also a responsibility for action is presented to neighbouring disciplines such as landscape architecture, which like infrastructure

engineers and managers, also work with landscapes and land use. Change to the degree that is necessary will require the exploration of alternative possibilities for living and engaging with the environment. In part, through the generation of new outside-the-box ideas that challenge current paradigms. Design professions therefore have an essential and challenging role to play in system transformations. Landscape architecture is also well-positioned to contribute to the repositioning of infrastructure through their awareness of ways to connect social and ecological aspects to the built environment. Further, landscape architecture has as a focus the ability to work across multiple scales and engage with many different disciplines.

The suitability and benefits associated with the discipline of landscape architecture engaging with infrastructure projects are well covered by landscape theorists, particularly in discussions of landscape urbanism. Within the discourse, theorists also put forward valuable design goals and concepts they consider could contribute to improving the issues facing infrastructure systems (Allen 1999; Bélanger 2012; Corner 2003, 2006; Czerniak 2011; Hung 2011; Morrish 2008; Mossop 2006; Poole 1998; Spirn 1989; Strang 1996). Many of these theories are related or very similar, but there appears to be an absence of an attempt at amalgamating them into a useful toolkit for application. In addition, although many of the principles discuss concepts that could improve social and system resilience, there seems to be a lack of cohesion within the literature and an absence of connection to strategies for developing resilience in social-ecological systems.

Increasing humanity's ability to adapt to future change could arguably be considered landscape architecture's most fundamental role and responsibility. Infrastructure systems such as transport networks, stormwater systems, energy networks, flood management schemes and the like are also central to maintaining the health and safety urban residents are accustomed to. Therefore the knowledge and theory base of

landscape architecture must be better aligned to facilitate the design of resilient landscapes and socio-technological systems.

Chapter 3 The Resilience Concept

Frequencies of extreme weather events will increase, the sea will continue to rise and as cultural disruptions such as terrorist attacks, civil war and food shortages persist, the concept of resilience is gaining more and more traction amongst researchers and policy makers alike (Foster et al. 2010). There are however, different disciplinary frameworks for discussing resilience, together with different determinants of what constitutes resilience in a system, person or structure. The multi-disciplinary aspect has both been discussed as having a potentially negative impact due to the 'fuzziness' in meaning (Foster et al. 2010), as well as a positive impact through the concept acting as a potential bridge that could foster increased interdisciplinary relationships (Allan and Bryant 2011).

3.1 Social-ecological system resilience

Foster et al. (2010) provide a helpful overview of the resilience concept, discussing both equilibrium analysis and complex adaptive systems analysis. The first framework, the 'engineering definition', considers resilience as the ability to return to normal conditions after a disruption, which presumes a single equilibrium of existence. The second framework considers social-ecological systems[1] as dynamic systems in a constant cycle of adaption, with resilience levels varying depending on which phase of the change cycle the system is located within (Foster et al. 2010).

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Figure 1 The four phases of the adaptive cycle
Source: Foster et al. (2010), adapted from Gunderson and Holling (2002)

[1] Social-ecological systems are defined as 'a linked system of people and nature in which people depend on nature and nature is influenced by people' (Graeme S. Cumming et al., 2013: 1140).

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Figure 2 Cross-scale interactions
Source: (Foster et al. 2010)

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Figure 3 Social-ecological systems change at multiple scales. Mapping of potential threshold change is part of managing for resilience.
This illustration represents the mapping of thresholds for a state change within the scale of the whole planet.
Source: (Constanza et al. 2009)

A danger in exclusively following the 'engineering definition' is that it supposes the variability of natural systems can be controlled - a demanding, if not impossible concept considering the unpredictability of the planet's systems (Gunderson and Holling 2002). In contrast, the non-equilibrium definition, refined by ecologists over the last 40 years (Allan and Bryant 2011), acknowledges the inherent complexity and uncertainty in ecosystems. Instead of trying to control natural systems, the framework focuses on living within systems, learning and adapting (Brian Walker and Salt 2006). Ecologists, Holling and Gunderson (2002) developed a four phase, 'figure 8' model that describes the different stages of change in the adaptive cycle of social-ecological systems (see Figure 1). A system such as a city or landscape is constantly moving through the cycle at multiple scales. Disturbances may occur within a very small aspect of the system and have limited impacts on the larger system, or a major disturbance might occur, affecting the whole system (see Figure 2 and Figure 3). The two key aims of resilience management is to prevent a system moving into undesirable configurations after a disturbance, and to foster qualities that enable improved adaptive capacity (B. Walker et al. 2002).

3.2 Landscape architecture and resilience

Such goals and concepts of resilience are also closely aligned with the IPCC's definition of resilience which is: "The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation." (IPCC 2014: 5). Therefore factors that increase the adaptive capacity of a system need to be incorporated into all aspects of living, including the built environment i.e. open space and infrastructure.

Researchers Brian Walker and David Salt (2006) developed nine attributes that could foster adaptive capacity in systems. Attributes that hold particular value for landscape architecture as many of the attributes have spatial implications and are already present in urban design theory in some form (Allan and Bryant 2011). Other disciplines such as psychology also put forward principles that could encourage a community's or a person's resilience (Bonanno et al. 2007; Norris et al. 2008).

Design disciplines have only recently begun to examine the possible connections between ecology, resilience and design potential (Allan and Bryant 2011). Guided by the resilience concept argued by Walker and Salt (2006), Landscape ecologist Jack Ahern presents five urban planning and design strategies for building urban resilience: multifunctionality, redundancy and modularisation, (bio and social) diversity, multi-scale networks and connectivity and adaptive planning and design (Ahern 2011). Ahern also argues that landscape ecology can make important contributions in transdisciplinary collaborations through capacities to connect ecological science with planning and design strategies (Ahern 2012). Planner and landscape architect, Nina-Marie Lister debates the role of design in building adaptive capacity in social-ecological systems, focusing on questions of strategy and adaption (Lister 2007). Ideas of indeterminacy and strategic thinking argued in landscape urbanism theory have strong ties to resilience thinking, however the direct connections are often left unspoken. Overall, foundations seem well laid for greater theoretical connections between landscape architecture and building social-ecological resilience, particularly through the writing of Lister (2007).

An area where knowledge could be increased however, is in the building of theoretical connections between strategies for infrastructure design argued by landscape architecture theorists and concepts of social-ecological resilience. Examining if and how a greater theoretical synthesis could increase the theory's potencies. Additionally,

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Figure 4 The Marina District of San Francisco after the Loma Prieta earthquake of 1989
Source: Wikimedia Commons

IMAGE REMOVED DUE TO COPYRIGHT

Figure 5 San Francisco Chronicle coverage of the disaster
Source: San Francisco library microfilm collection

as Ahern suggested for landscape ecology, landscape architecture's role in resilience-focused multidisciplinary collaborations could be probed, examining the benefits and instrumentality of landscape architecture and landscape approaches to planning and design in increasing the adaptive capacity of urban environments.

Possibilities for landscape design to engage with the 'creative destruction' (Gunderson and Holling 2002: 34) of disaster could also be explored further. Where design might be used as a tool for imagining new futures during the reorganisation phase experienced by urban areas after disaster strikes, a prospect further examined below.

3.3 Opportunities for system transformation

The social-ecological systems model further boosts the argument and possibility for infrastructure 'repair as transformation'. Immediately after a disruption, a system moves into the reorganisation phase (see Figure 1). This brings opportunities to reorganise, to reinvent and to break apart previously held notions; it is a time when resilience of a system is highest. The actions, processes and decisions occurring at this time have the power to affect great positive change, enabling the transformation of a system to better suit needs or desires. Likewise however, a system might return to much the same pre-disturbance existence, or it might convert into an undesirable state, one that no longer supports the same functions or grants the same benefits. It is therefore vital that the reorganisation phase is utilised by designers and planners to make significant changes to urban systems and landscapes that are too difficult once the systems move into the conservation phase. The relationship between a system disturbance and the opportunity for change can be illustrated further through an examination of the different experiences of San Francisco following the 1989 Loma Prieta earthquake and Christchurch following the recent 2010/11 earthquakes.

On October 17, 1989 a large earthquake (7.1 on the Richter scale) hit Northern California causing 63 fatalities, damage to more than 27,000 structures and a financial cost of $10 billion. The waterfront neighbourhood of the Marina District in San Francisco was hit particularly hard with the shaking causing several buildings to collapse (see Figure 4 and Figure 5) and extensive damage to infrastructure pipelines such as water supply and sewer systems (National Research Council 1994). Many infrastructure issues identified in the previous chapter as potential problems with current infrastructure systems surfaced. For example, the interdependence between power supply and wastewater pumps resulted in the dumping of raw sewerage into the San Francisco Bay, and failures in power supply and water networks would have contributed to emotional anxiety as well as water shortages for firefighters (National Research Council 1994).

The earthquake caused a disturbance in the social-ecological system but also increased the possibility for change. In viewing many photos of the Marina District and seeing the similarity between the images of the destruction caused by the Loma Prieta earthquake and the still fairly normal scenes that behold us in Christchurch, I was very interested to see for myself how San Francisco might have adapted their urban landscapes to foster a more resilient and connected relationship between people and infrastructure. However upon visiting the Marina District I saw no evidence of design interventions (that were apparent to a visitor) that would have increased a person's ability to adapt or influence their environment. Almost the opposite occurred. What I observed were numerous attempts at hiding infrastructure cables and pipes, camouflaging them as if they weren't really there, that they weren't critical foundations of urban living (see Figure 6 and Figure 7).

Although the Marina District could be said to be resilient in the 'engineering' definition as it has certainly bounced back from the disaster with no obvious visual signs of

Figure 6 Disguised infrastructure cables of the Marina District

Figure 7 Disguised infrastructure pipes of the Marina District

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Figure 8. A Greening the Rubble temporary garden
Source: http://www.christchurchdailyphoto.com

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Figure 9 A Gap Filler project of a temporary chess board on a vacant site
Source: http://www.christchurchdailyphoto.com

lingering effects, has it evolved from this experience with more adaptive capacity? In 2003 the U.S Geological Survey predicted a 62% likelihood of another major quake occurring in the area before 2032 (Eadie 2005). Did San Francisco do enough to capitalise on the potential for change a disruption brought?

In comparison, Christchurch very recently experienced a major disturbance and could be considered as still in the reorganisation phase or perhaps very slowly moving into the exploitation phase in some areas. The earthquakes triggered a rupture in the urban fabric and disrupted the lives of all Christchurch residents in different ways. Christchurch, particularly the central city and the areas to the east, is now in a position where radical change is very possible. What once seemed inflexibly fixed, like buildings and land use patterns, exist now only in memories, leading to a wide opening of possibilities. According to the social-ecological cycle, the reorganisation phase is characterised by aspects of innovation and experimentation, characteristics that come from having the flexibility to explore options without being bogged down with 'no, this is not how we do it' reactions.

Although there is much desperation from residents due in part to frequent flooding and the destruction of much loved heritage buildings, there is also a lot of excitement about what the future could bring. Organisations like Gap Filler, Life in Vacant Spaces and Greening the Rubble are engaging with temporary urban projects that adapt to different sites, arguably instigating a new aesthetic of urban design based on temporary and moveable materials like pallets and potted plants (see Figure 8 and Figure 9). The government response organisation, the Canterbury Earthquake Recovery Authority (CERA), released a rebuild 'blueprint' for the central city with many changes in land use proposed, a plan only possible after such a major disruption.

Designers have an opportunity, through the design of spaces, to transform the relationships between the environment, the city and its residents to become more adaptive and sustainable. However as designers, there is a need to be aware of the opportunity and engage with projects to encourage positive transformation, otherwise Christchurch could evolve to an unadaptive state similar to the city pre-earthquake or conceivably a degraded state. With climate change increasing the frequency of disturbances, how we respond now is critical to setting a pathway for an altered, hopefully more resilient city. Can Christchurch evolve from this event with more adaptive capacity and what is the role of landscape architecture in enabling this? And lying beneath this, what imaginative ways of living might be developed using design research as a tool for building possibility?

In the next chapter, landscape architecture theory is critiqued beside social-ecological resilience theory to explore the connections, gaps and to build a framework of synthesised theory with three overall research goals - to explore the theory's generative design potential, to build the imaginative possibilities for urban living and to examine landscape architecture's role in resilience design.

Chapter 4 Theoretical exchanges: landscape and resilience

Brian Walker and David Salt, in their book *Resilience Thinking,* describe nine characteristics a resilient world would value: diversity, ecological variability, modularity, acknowledging slow variables, tight feedbacks, social capital, innovation, overlap in governance and ecosystem services (Brian Walker and Salt 2006). See Table 1 on page 34 for a description of each characteristic. Although the authors clearly state that resilience cannot be prescriptive, the strategies can help build a system's adaptive capacity, encouraging a social-ecological system's ability to maintain functions when faced with gradual or sudden change.

A growing body of theoretical discourse within the landscape architecture discipline focuses on the role of landscape architects in guiding urban infrastructure design. The collective dialogue forms a blend of ideas associated with theories of landscape urbanism, ecology and more socially experiential theory on aesthetics and civic relationships. Although the ideas emerge from different perspectives, the theorists share common ground in that they all suggest strategies for the design of infrastructure. Several mutual strategies emerge that are argued by a range of theorists: Natural systems as structure, multifunctionality, multidisciplinary collaborations, community participation, placemaking, legibility and 'staging uncertainties'. See Table 2 on page 35 for a summary of the strategies.

Though a few of the strategies may seem isolated from each other - for example, the connections between community participation and natural systems as structure are not immediately apparent - they gain much holistic traction in the critique of their

relevance to resilience theory. All of the strategies suggested by landscape theorists support the notions of resilience presented by Walker and Salt (2006) to some degree.

The set of strategies for building adaptive capacity proposed by Walker and Salt (2006) were chosen for this theoretical analysis for two reasons. First, the strategies and concept of resilience they communicate have already been cited in theoretical discourse of landscape architecture exploring connections between design and resilience (Ahern 2011, 2012; Allan and Bryant 2011). In a study on the performance of urban design and open space in disaster recovery using case studies of the 1906 San Francisco and 2010 Concepción earthquakes, Allan and Bryant (2011) found urban design theory to be well connected to the resilience concepts put forward by Walker and Salt (2006). They state that 'because the attributes are general and already embedded in urban design discourse, they can be univesally applied, as an evaluative framework' (Allan and Bryant 2011: 42). While this work provides a solid foundation for the value of the resilience strategies, it does not focus on how the theory relates to landscape architecture discourse, instead focusing on urban design frameworks.

Second, Walker and Salt's content derives from the wider collaborative work of the leading-edge Resilience Alliance, 'a research organisation comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of social-ecological systems' (Resilience Alliance 2004).

This chapter examines the relationships between the two theory bases – landscape architecture theory and social-ecological resilience theory. Each strategy for infrastructure design put forward by landscape architecture theorists is firstly introduced, then critiqued against the resilience strategies to explore any connections or relationships between the two theoretical frameworks.

4.1 Connections and opportunities

Natural systems as structure

A recurrent theme in landscape architecture discourse is the call to realign infrastructure networks and urban living with underlying natural systems and ecologies (Bélanger 2012; Czerniak 2011; Morrish 2008; Mossop 2006; Strang 1996). As natural systems are inherently unpredictable, designers must embrace change and adaptability in their designs and plans, working 'with' nature rather than 'against' it (Lister 2007; Poole 1998).

In addition to providing a flexible, responsive armature for urban spaces, natural systems also have important performative roles in infrastructure. Both functionally and socio-culturally. For example, in stormwater management and canopy cover (Geuze and Skjonsberg 2011; Morrish 2008), and in the potential to better connect residents physically and emotionally to the natural resources that mutually support them (Poole 1998; Spirn 1989). These ideas relate well to concepts of building adaptive capacity, particularly ecological variability, which stresses the need to embrace variations in natural systems over attempts at control.

The ecosystem services concept however, although very related, is lacking in discussions. Walker and Salt (2006) suggest that all unpriced ecosystem services should be included in development proposals. Some discussion of the performative services of infrastructure exists (Geuze and Skjonsberg 2011; Morrish 2008), but the focus is mostly on how infrastructure should be utilised as an urban structuring tool. Could greater consideration of ecosystem services help landscape architects increase their design's influence in decision making circles when attempting to transform their 'natural systems as structure' ideas into reality?

Multifunctionality

The unrealised potential for infrastructure to perform multiple functions is another focus within the field of landscape architecture. In addition to utilitarian functions, infrastructure could also increase connections within ecological systems, build public amenity, stimulate economic growth, and strengthen neighbourhoods and civic cohesion (Czerniak 2011; Morrish 2008; Mossop 2006; Poole 1998; Strang 1996). The multifunctionality concept, arguably an overarching concept for the landscape architecture discipline, fits comfortably within the diversity strategy of Walker and Salt (2006). A diverse range of infrastructure functions could also help improve social capital and integrate ecological variability. Programmatic functions however, are only one aspect of diversity, as 'a resilient world would promote and sustain diversity in all forms' (Brian Walker and Salt 2006: 145).

Accordingly, designing for spatial and system diversity in infrastructure are also important to a system's capacity to respond to change, yet appear to be missing from the discourse on landscape architecture-led infrastructure design. Adaptive, flexible infrastructure is strongly advocated for (Allen 1999; Bélanger 2012; Czerniak 2011; Robinson 2011) and argued to be achievable through methods such as under-detailing designs (Bélanger 2012) and differentiating between fixed components and elements open to change (Allen 1999). However, although these ideas relate to concepts of building adaptive capacity, discussions of how spatial configurations could help achieve these concepts seem to be absent. Could the application of diversity become a spatial design method for landscape designers to increase a site's potential for future adaptation?

Multi-disciplinary

The diversity strategy (Brian Walker and Salt 2006) also supports the call for multi-disciplinary teams within landscape infrastructure practice, as argued by several

theorists (Allen 1999; Bélanger 2012; Corner 2003; Lister 2007; Poole 1998; Strang 1996). Engaging with concepts of sustainability and resilience through multifunctional design, requires landscape architects to become both educated in engineering techniques (Poole 1998), and willing to collaborate in diverse teams with people of varying expertise and values (Lister 2007).

Strong interdisciplinary collaboration is currently uncommon in everyday design practice where more top down planning and design approaches are favoured (Lister 2007), but as infrastructure networks often cross political boundaries as well as disciplinary boundaries, design must engage with this complexity (Bélanger 2012). Greater collaboration might also lead to the design of more innovative ways of managing the relationship between urban living and the environment, where possibilities emerge through experimentation, and through disciplines challenging each other's models and learning from each other. Could innovation, another strategy for building adaptive capacity (Brian Walker and Salt 2006), therefore also be increased through multidisciplinary teams and cross-collaborations?

Three out of the seven identified landscape strategies for infrastructure design: community participation, placemaking and legibility, could be considered to be subsets of the broader social capital concept. An emphasis that further highlights the social imperative of landscape architecture. Walker and Salt (2006) provide only a broad outline of social capital and given its importance to landscape architects, it is necessary to explore the concept in greater depth through community psychology theory.

Community participation

The need for community participation in urban environments is advocated for in theory on resilience (Lister 2007; Morrish 2008) and on social and civic interactions (Poole 1998; Spirn 1989). Lister (2007) argues that local people should be able to collectively

decide on their futures, to try out possibilities for changing their landscapes through trial and error and to learn by doing. In contrast, authority-led strategies for rebuilding or transforming infrastructure, created behind closed doors, denies opportunities for residents to manipulate their environment and can create insecurity that problems with current systems will resurface (Morrish 2008).

Infrastructure and natural systems are shared by all residents and the desire to establish more sustainable, resilient relationships between local ecology and supporting infrastructures holds great potential to unite residents through collective goals and shared purposes (Morrish 2008; Poole 1998). The link between these ideas and theories of social capital and community resilience is apparent, though not made explicit in previous disciplinary dialogues. In psychology research, social capital is identified as one of four key 'networked adaptive capacities' for building community resilience (Norris et al. 2008). Subsets of social capital include sense of community, citizen participation, social support, organisational linkages and cooperation (Norris et al. 2008); all aspects inherent in the ideas explored here in the context of landscape architecture and resilience. This further illustrates the applicability of landscape architecture theory in building resilience in social-ecological systems.

Placemaking

Infrastructure also holds potential for heightening or building a sense of place through incorporating locally contextual elements such as local ecologies and cultural meanings (Strang 1996). In the past, much pleasure and symbolic meaning was associated with infrastructure works (Spirn 1989) but today's emphasis on technology and engineering aesthetics have 'emptied common structures of their social and mythic connections' (Poole 1998: 131). The notion of building a sense of place through infrastructure relates well to another subset of social capital, 'place attachment' (Norris et al. 2008:

139), which refers to a person's emotional connection to the neighbourhood or city they live in.

Legibility

Closely related to placemaking, the idea of making infrastructure legible to the people it supports is another concept advocated for within the theoretical discourse (Morrish 2008; Poole 1998; Strang 1996). However as Kathy Poole (1998) argues, simply 'showing' infrastructure through techniques like daylighting storm drains, techniques that rely purely on visual means to gain legibility, can aestheticise natural systems to the point of becoming urban furniture devoid of meaning and connection to underlying ecologies. Rather, the functional relationship between ecology and culture, both in the physical and conceptual sense, should be engaged with by designers. This in part could help foster greater understanding and activity between residents and their environment (Poole 1998).

Greater understanding and experiential legibility of natural system processes can increase people's sense of belonging to a place and time (Spirn 1989), and could also affect their notion of cultural meanings and responsibilities to the environment (Meyer 2008). These concepts again connect with resilience theory. As discussed in chapter two, a person's hardiness is one pathway towards personal resilience. Hardiness consists of three aspects: a belief that someone has the ability to influence their environment, a commitment to finding meaningful purpose in life and the belief that you can learn and grow from life experience (Bonanno et al. 2007). It could be assumed that in order to influence your environment effectively, you must first understand it, and secondly be enabled to affect change through any number of means.

All three themes put forward by landscape architects, community participation, placemaking and legibility, could help increase personal resilience. Additionally, greater

legibility of the relationship between people, infrastructure and natural systems could also help increase a sense of place, enable and guide community participation, as well as strengthen community bonds through shared knowledge.

Exploring potential through design process becomes a powerful method to enable communities to explore many different possibilities for living in more sustaining and resilient ways, where the designer becomes less of a master planner and more of a facilitator (Lister 2007). This might require designers to let go of idealised stylistic goals to become more engaged with functionality (Allen 1999), as well as community involvement and enabling a landscape's ongoing transformation over time.

Staging uncertainties

The final conceptual theme examined is the theory of adaptive and flexible infrastructure, a concept similar to the resilience strategy of innovation which also aims to embrace change. Shifts in technologies, cultural needs, economics and environmental conditions require infrastructure to be successional, to be able to adapt to both predicted and unforeseen changes (Czerniak 2011). Design becomes a strategic 'staging' tool that, engaged with time and process, enables landscapes and infrastructures to shift and evolve in an undetermined manner, adapting and morphing with changing conditions (Allen 1999; Bélanger 2012; Corner 2004).

Although theories that argue for considerations of time, process and adaptation in design often don't explicitly connect the ideas to resilience concepts, the connections are evident. As discussed previously, one goal of resilience management is to build a system's adaptive capacity, a goal also sought by landscape and architectural theorists. However, debates of how to increase the adaptive capacity of infrastructural landscapes primarily focus on functional flexibility and performance, enlisted through '… subsurface programming, sectional thickening, and ecological engineering' (Bélanger

2012: 301). Although the need to facilitate social change is expressed, the potential for adapting infrastructure through social involvement is a dimension seemingly lacking in this theoretical dialogue. Designing through phasing or flexible management are given priority over culturally orientated adaptation measures – where 'staging uncertainty and harnessing contingency become the new urban imperatives…'(Bélanger 2012: 301).

4.2 Synthesising theory

Two key bodies of theory were important to enable a response to the research questions: theory of social-ecological systems and theory of landscape architecture. For the social-ecological theory, I identified the resilience concepts of Walker and Salt (2006). These were identified as having value through the literature review due to the researchers' ties to the research body the '*Resilience Alliance*', as well as being utilised by landscape architects in previous studies. Allan and Bryant (2011) used the concepts to explore the relationship between resilience theory and urban design theory in a study on the performance of urban design in the 1906 San Francisco and 2010 Concepción earthquakes. In this chapter, I have investigated and analysed the connections between social-ecological resilience theory and landscape architecture theory. A summary of the resilience strategies is shown in Table 1.

Strategies for building adaptive capacity and resilience developed by social-ecological systems theorists:
Diversity 'A resilient world would promote and sustain diversity in all forms (biological, landscape, social, and economic).'
Ecological Variability 'A resilient world would embrace and work with ecological variability (rather than attempting to control and reduce it).'
Modularity 'A resilient world would consist of modular components.'
Acknowledging Slow Variables 'A resilient world would have a policy focus on "slow," controlling variables associated with thresholds.'
Tight Feedbacks 'A resilient world would possess tight feedbacks (but not too tight).'
Social Capital 'A resilient world would promote trust, well-developed social networks, and leadership (adaptability).'
Innovation 'A resilient world would place an emphasis on learning, experimentation, locally developed rules and embracing change.'
Overlap in Governance 'A resilient world would have institutions that include "redundancy" in their governance structures and a mix of common and private property with overlapping access rights.'
Ecosystem Services 'A resilient world would include all the unpriced ecosystem services in development proposals and assessments.'

Table 1 Strategies for enhancing resilience in social-ecological systems quoted from the book Resilience Thinking
Source: (Brian Walker and Salt 2006)

Having identified a theoretical framework in which to explore social-ecological resilience, I also needed a framework for landscape architecture theory. In order to construct a theory toolkit for exploring the relationships between landscape and resilience theory and their generative potential, I reviewed and analysed infrastructure-focused theoretical writing of landscape theorists. I identified seven common conceptual threads within the body of theory. These seven strategies were distilled

into a toolkit for further analysis and design application. The result of this analysis is shown in Table two.

Strategies for guiding infrastructure design developed by landscape architecture theorists:
Natural systems as structure Urban systems such as infrastructure should be designed in relation to underlying natural systems such as hydrology and topography. (Bélanger 2012; Lister 2007; Morrish 2008; Mossop 2006; Poole 1998, 2004; Strang 1996)
Multifunctionality Infrastructure should perform multiple functions, i.e. ecological, social, economic etc. (Czerniak 2011; Morrish 2008; Mossop 2006; Strang 1996)
Multidisciplinary The design process of urban systems and infrastructure should be one of inter-disciplinary collaborations. (Allen 1999; Bélanger 2012; Corner 2003; Lister 2007; Poole 1998; Strang 1996)
Community participation Community participation should be enabled through every stage of development and subsequent operation. (Lister 2007; Morrish 2008; Poole 1998)
Placemaking Infrastructure should engage with people's sense of place and community (Meyer 2008; Morrish 2008; Spirn 1989; Strang 1996)
Legibility Infrastructure should be made legible to the people who are supported by it. (Morrish 2008; Poole 1998; Strang 1996)
Staging uncertainties Infrastructure should be designed to incorporate uncertainties and encourage adaptation. (Allen 1999; Bélanger 2012; Czerniak 2011)

Table 2 Strategies for landscape-focused infrastructure design identified through literature review

Through the analysis of the two theoretical frameworks, many concepts appear to be connected and nested in a number of ways. The landscape infrastructure strategies all have direct connection to the resilience strategies to some degree, though variations occur in whether landscape strategies form the guiding goals (as with natural systems

as structure) or whether they are in support of resilience goals (as with social capital). A synthesis and examination of these connections is shown in Table 3.

Strategies that provide overarching goals to be enhanced through supporting strategies	Strategies in support of dominant goal
Natural systems as structure (landscape-led)	Ecological variability
	Diversity
	Acknowledging slow variables (in nature)
	Ecosystem services
Staging uncertainties (landscape-led)	Innovation (the notion of embracing change)
Social capital (resilience-led)	Community participation
	Legibility
	Placemaking
Diversity (resilience-led)	Multifunctionality
	Multi-disciplinary
Modularity (resilience-led)	
Overlap in governance (resilience-led)	
Innovation (resilience-led)	
Tight feedbacks (resilience-led)	
Acknowledging slow variables (resilience-led)	

Table 3 Nested strategies identified through theory critique

Yet not all of the resilience strategies appear in the landscape dialogue. Although consideration of some of the missing resilience strategies are present in separate discussions (Ahern 2011, 2012; Lister 2007), landscape infrastructure-motivated theoretical debates do not focus on a number of resilience strategies: modularity, acknowledging slow variables, tight feedbacks, innovation and overlap in governance. Why might this be? Are they unhelpful as design generators? Or is it a result of the current lack of coordination between landscape and resilience theory?

This stage of the research process has set out to synthesise relevant theories to further explore the connections between landscape architecture and resilience. In applying

this theoretical synthesis to a design process, the following key questions for this thesis are identified. What opportunities might be imagined for designing more adaptive infrastructure and living spaces? What theoretical concepts might emerge as holding the most generative potential or relevance to landscape architecture-led resilience building?

The next chapter develops a design process methodology that will be used as a tool for inquiry to answer these questions.

Chapter 5 Design-directed inquiry: Questions and processes

This research was undertaken as part of a collaborative Designlab approach which utilises design as a tool for inquiry. Design is used to identify opportunities and develop 'imaginative breakthroughs' (Carter 2004: 13) and is defined as an 'iterative, associative and synthetic process that attempts to build possibility out of diverse elements' (Abbott 2008: 41). A key value of this approach is its contrast to more empiricist notions of research that tend to define research outcomes in advance, disallowing the process of invention and discovery of new concepts (Carter 2004). The issues facing society in regard to infrastructure systems and climate change require designers, engineers, leaders and residents to challenge numerous circumstances of current urban living patterns. If research only examines or reformats what is known, how will we be able to break away from current unsustainable, unadaptive models? New, imaginative approaches to urban living must be developed. As design is both generative and future-orientated (Jonas 2001), it can be instrumental in projecting and exploring different futures.

Most often, designers are charged with 'how to make it', once the decisions of 'what to make' have been undertaken. Designer and theoretician Charles Owen (2001) argues for a reconstitution of the traditional design process into two separate stages, where design is first used to explore 'what' should be made (see Figure 10). The 'what' over the 'how' is a position strongly resonating with Carter's concept of design research (Carter 2004). For how can alternative futures be explored if the structure and vision of

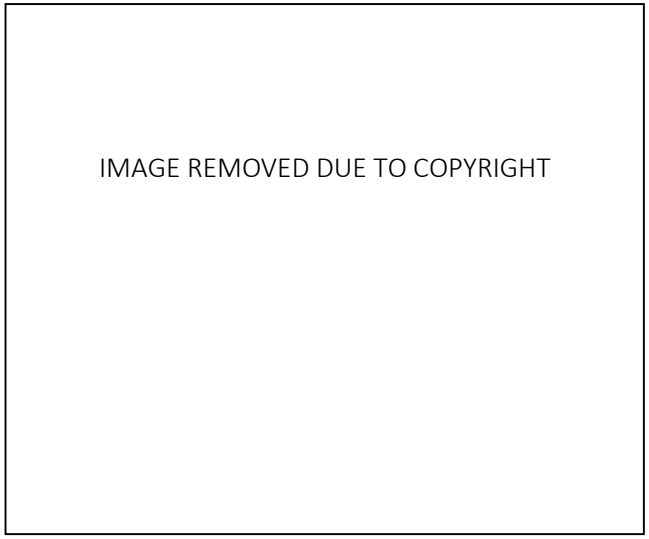


Figure 10 How to make vs What to make
Source: (Owen 2001)

the future are already determined? The process of probing, inquiring and designing the 'what to make' is thus an overriding position for this research.

In recognition of this framework, I purposely didn't attempt to apply any existing practical Christchurch-specific standards or guidelines through my design research process. The research purpose instead, was to build alternative possibilities - to add to the 'ideas library' of existing options. The design process was also undertaken with respect to the *wicked problems* framework developed by Rittel and Webber (1973), which asserts that most design problems have a fundamental indeterminacy stemming from their inherent complexity (Buchanan 1992). This results in wicked problems having no final stopping point where the solution becomes clear or no 'right' explanation - only multiple explanations depending on the intellectual perspective of the designer (Rittel and Webber 1973).

5.1 Research process

Detecting questions

Owen (2001) presents a model for design process which I found both useful as a tool for understanding the research process as well as describing the process through three distinct research stages. My research began with a broad question asking what landscape design could do to improve both the resilience of infrastructure and communities and whether any co-benefits could be created through design. Reading and questioning the literature around these ideas led to insights and a narrowing and slight shifting of this question (see Figure 11).

The research questions were subsequently developed as:

- What new projective possibilities for adaptive residential living in areas experiencing amplified landscape change could be imagined from a design

process synthesising theories of landscape architecture with social-ecological systems?

- Could a community's resilience be improved through their interactions with infrastructure?
- Could a community's resilience be improved through environmental management strategies?

- In multi-disciplinary collaborations focused on building the adaptive capacity of landscapes and communities, where might the discipline of landscape architecture be most instrumental?
- What theories, landscape-led or social-ecological systems-led, provide the greatest generative potential for design processes engaging with resilience in landscape-centric design?
- What opportunities for landscape design to increase urban adaptive capacity stem from the 'creative destruction' of disaster

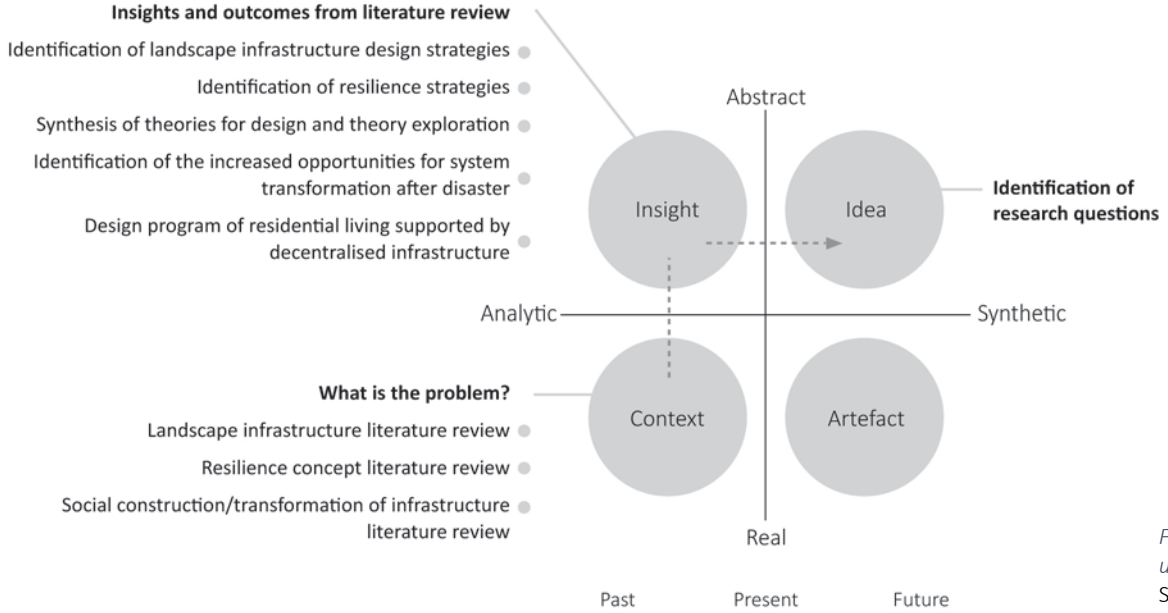


Figure 11 Stage one of the research process guided and analysed using Owen's model of design process
Source: (Owen 2001)

Probing theories and exploring concepts

The research questions were drawn from connections I made between existing ideas and theories, but to further investigate the scope and value of these questions, I undertook a matrix-driven design exploration of the theories, a tool advocated for by Jonas (2001) (see Figure 12 - Figure 15). Numerous ideas and diagrams were investigated through applying different theory/infrastructure combinations of the matrix. The different matrix combinations both acted as prompts for generating ideas and for increasing my understanding of the theories. The aims of the design probe process were to explore the links between theories and their generative potential, and to also create a multitude of design responses that could be used in the site synthesis research process. A first matrix was set up with categories of infrastructure, landscape infrastructure, positions of theorists James Corner and Elizabeth Meyer, and the resilience strategies as overall goals -shown in Figure 12. Through applying it to guide design explorations, the matrix was decided to be too complex, therefore a second more simplified matrix was designed (see Figure 14).

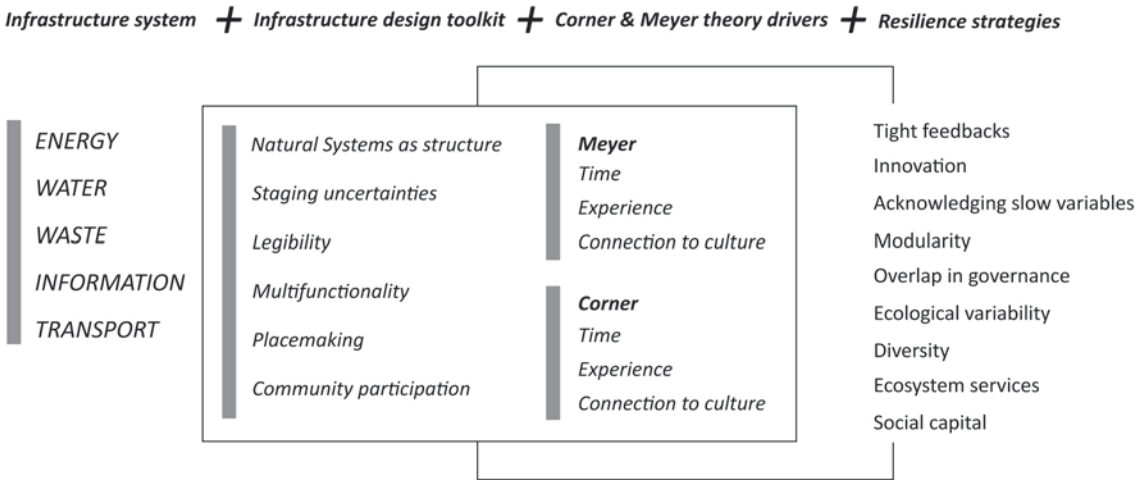


Figure 12 The first design probe model which proved too complex

The infrastructure system types for the matrices were selected by following the infrastructure categories put forward by Georgoulias and Allen (2012) in the book *Infrastructure Sustainability and Design.* They also defined landscape as a category of infrastructure (parks, public realm, ecosystem services), however in this research landscape is more than an infrastructure category. Landscape is positioned as the overall structuring element for urban systems (Mossop 2006), following the definition set out by Corner – '*Landscape* as noun (object or scene) is quieted in order to emphasise *landscape* as verb, as process or activity' (1999a: 4).

The generative prompts for the design investigations were identified through the literature review (see p.25) and formed two sets of strategies – strategies for landscape infrastructure design and strategies for increasing social-ecological system resilience.

Additionally, the theoretical works of landscape theorists James Corner (1990, 1991, 1992; 1996; 1997, 1999b, 1999c, 1999a, 2003, 2004, 2006) and Elizabeth Meyer (1996, 1997, 2000, 2005, 2007, 2008, 2009) were critiqued and applied to further prompt a landscape-oriented design exploration of the infrastructure types and strategies. Both Corner and Meyer argue for the instrumentality and performance of landscape to guide design decisions but argue for different landscape design approaches. The process of distilling Corner's and Meyer's theories into applicable and workable concepts for the matrices was intensive. Firstly, I reviewed all the peer-reviewed articles, essays and book chapters from each theorist available to me through the library or internet access. I then critiqued and compared their ideas by constructing tables representing what I saw as the key themes they both debate – site, aesthetics, time, representation, experience, insight generation and analysis, connection to culture, and infrastructure (see Appendix A.1). Through this process, I found Meyer to be consistent in the ideas she presented, however the ideas of Corner were much harder to pin down as they often changed tack between articles and periods of time. Further analysis of Corner's

work was undertaken using word images to identify key terms in each article (wordles) and through datascaping his use of terminologies over time(see Appendix A.2). From the results and insights of the analysis process, I selected Meyer and Corner's ideas surrounding time, experience and connection to culture to explore as generative prompts in the first design matrix; concepts I saw as their most compelling theories and the ideas which would offer the greatest difference in approaches.

In the first matrix, the complexity of attempting to combine all the ideas resulted in a lack of investigative rigour. The complexity is illustrated in Figure 13, where a probe was undertaken to explore the possibilities for placemaking in energy infrastructure design, using Corner's theories on time to guide one design investigation, and to use Meyer's theories on time to guide a second one. On top of this, the resilience strategies were to serve as overall goals.

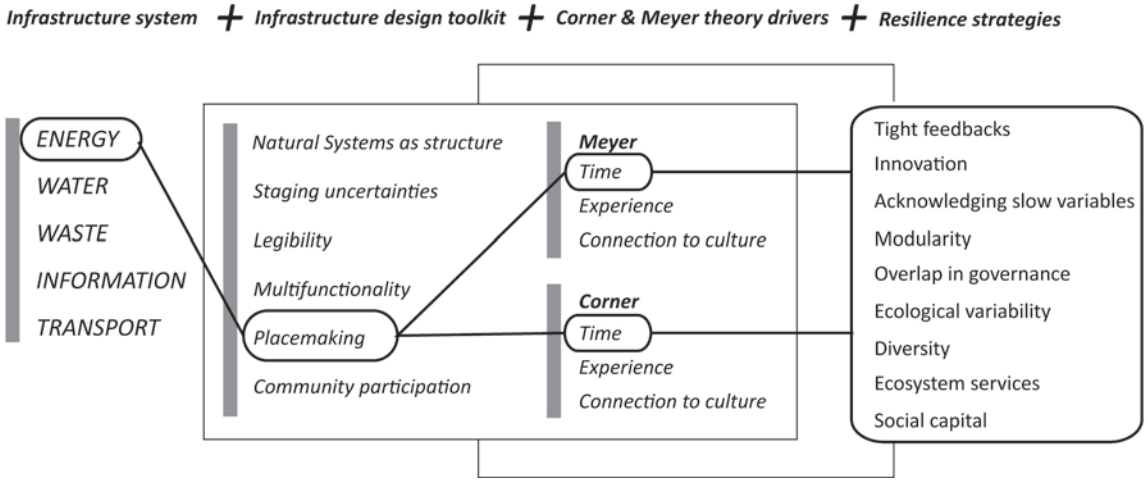


Figure 13 An example of one theory combination explored through using the first model

Having three different themes for Corner and Meyer made too many possible combinations of the matrix that I wouldn't have time to explore in full. Also, through using the model, I found the three themes to be very interrelated. Most of the resilience strategies were found to be strongly connected to the landscape strategies. For example, 'ecological variability' and 'ecosystem services' are concepts that both support and extend the 'natural systems as structure' theory. However, two resilience strategies – modularity and diversity – were found to be less integrated with landscape theory and also worked well as design generators.

As a result of the analysis, a second, less complex matrix was created (see Figure 14). The resilience strategies were simplified into a toolkit analysed to have the most generative potential during the test stage. Other resilience strategies (e.g. tight feedbacks, acknowledging slow variables) were still included as design generators but more as supporting concepts rather than the key drivers.

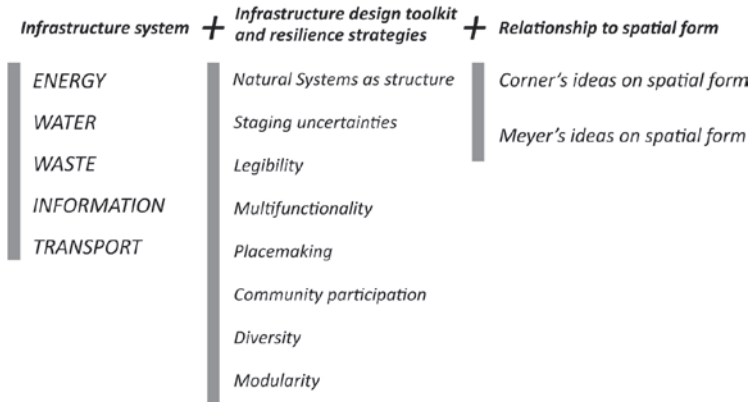


Figure 14 Refined simplified design probe methodology

The theories of Corner and Meyer were also condensed into what I analysed to be their fundamental difference – their contrasting ideas on what objectives should drive spatial form. Broadly speaking, their two positions can be summarised by comparing two quotes; Corner states:

> 'In design terms, landscapes and field organizations set up the conditions for life to evolve... Design strategy involves understanding that potentiality and shaping or deploying form in order to maximize effects' (Corner 2004: 34);

Whereas Meyer states:

> 'I believe that works of landscape architecture are more than designed ecosystems, more than strategies for open-ended processes. They are cultural products with distinct forms and experiences that evoke attitudes and feelings through space, sequence and form. Like literature and art, images and narratives, landscape architecture can play a role in building sustained public support for the environment' (Meyer 2008: 10).

For Corner, landscape forms (i.e. spaces, pathways, vegetation) should be designed with the objective of facilitating larger-scale processes (i.e. ecological succession, political and financial changes) to evolve and adapt the site. While Meyer suggests landscape forms should be designed to foster environmental consciousness between people and the land, created through increased aesthetic experience and knowledge of landscape processes. The matrix was therefore simplified to the infrastructure system, the landscape/resilience strategies, and applying Corner and Meyer's ideas on what goals should guide landscape form. An example of the second matrix applied is shown in Figure 15.

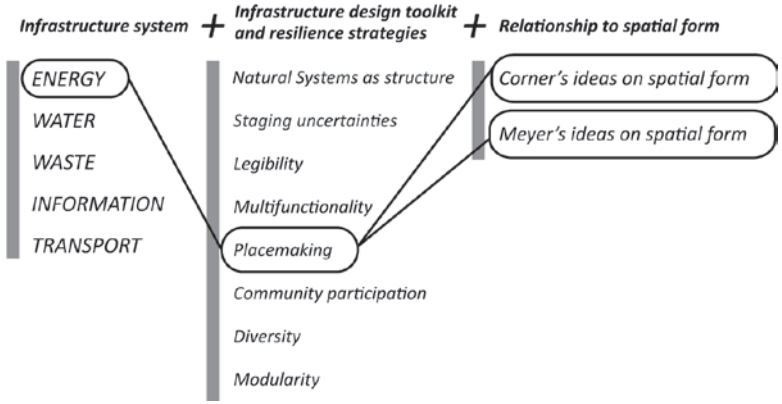


Figure 15 Example of a design probe using the second model

Through the design probe process, several key insights were developed (see Figure 16). First, the process resulted in the exploration of a wide range of site-scale and programmatic ideas that connected and synthesised infrastructure systems with theoretical ideas. These ideas provided a valuable 'library' of concepts for the site exploration. Second, the process contributed to the critique of theories of resilience and landscape architecture, helping connections to be made between theories and their potential bearings on site through the process of design. Third, analysis of the different infrastructure types and systems was undertaken through assessing the design process and outcomes.

The analysis examined connections between infrastructure systems, cultural needs and landscape implications and as a result, water and transport infrastructure and their interdependencies were determined to be the infrastructure systems most pertinent to my research questions (see page 56). Lastly, a design program was developed to guide a site-specific exploration of the questions – that of a residential development

connected by a central community area housing all the community's infrastructure needs.

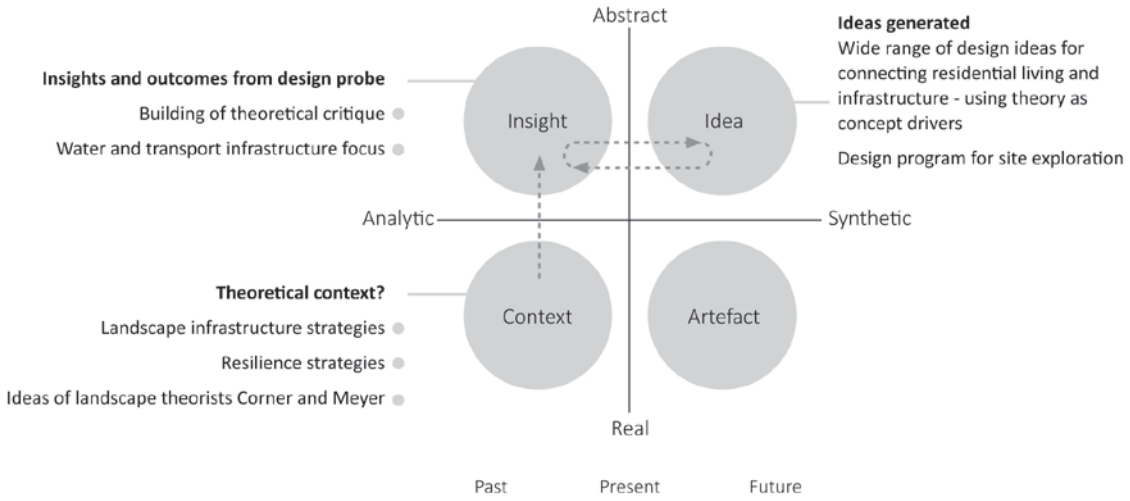


Figure 16 Stage two of the research process guided and analysed using Owen's model of design process

Site exploration

The design probe process was undertaken without considering how the designed ideas could be applied to a specific site. The contextual parameters of a site were seen as potential boundaries to exploring future possibility, where physical or social constraints might hinder the scope of generated ideas. However, as Corner states '…arguments for staging uncertainty, for indeterminacy and open-endedness, for endless scenario gaming and datascaping - in fact anything to do with the whole notion of free flexibility and adaptation – do not make sense in a world without specific material form and precise design organisations' (Corner 2004: 34). A site is therefore necessary to investigate the research questions further (see next chapter). The site exploration

stage of the research enabled a final testing and exploration of the research questions, leading to several key insights to be discussed in the final chapter (see Figure 17).

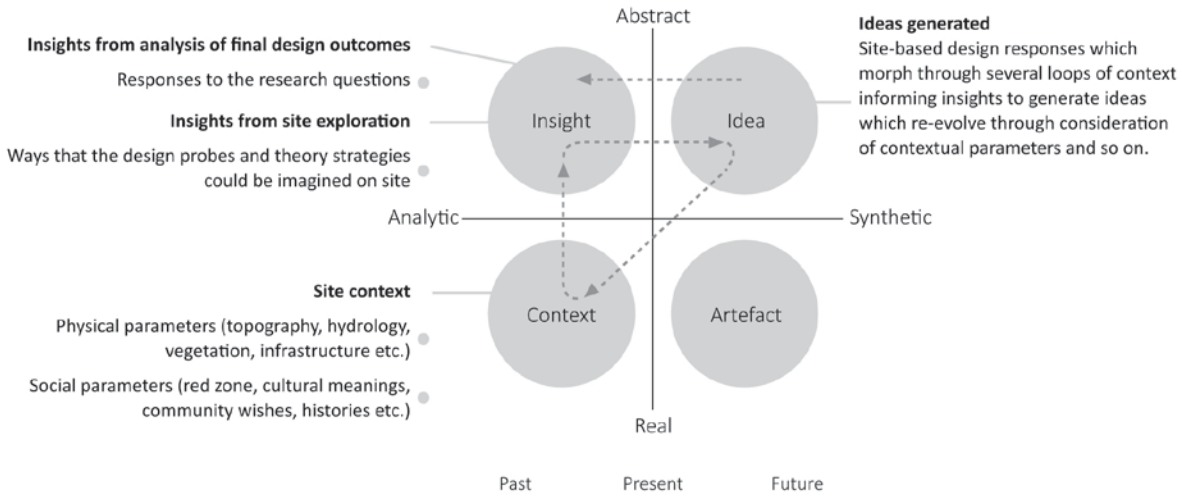


Figure 17 Stage three of the research process guided and analysed using Owen's model of design process

5.2 Design process methods

Throughout the research process, in both idea generation and graphic representation stages, drawing was the key method of inquiry, design and communication. Drawing engages the designer with the details of the landscape, as Catherine Dee states, the 'imperfect line of the hand in drawing (akin to walking) raises consciousness of the actual physical topographies and vulnerabilities of land, and its human habitation' (Dee 2008: 66). Furthermore, as the research questions focus on concepts of change and adaption, the fluidity of drawing was seen to be most suited to explore and convey these concepts. Other design process methods involved the use of diagrams, word images and mapping. Mapping was used not as a method of representation but as a

tool for inquiry, following the ideas of Corner, who states that 'mapping *unfolds* potential; it re-makes territory over and over again, each time with new and diverse consequences' (Corner 1999b: 213).

Building possibility and imaginative scope is critical to resilience thinking – innovation through experimentation and learning is one of the key strategies for building adaptive capacity (Brian Walker and Salt 2006). Design research therefore has an important role to play in imagining new futures for as Abbott (2008: 357) states, 'it is the optimistic and forward-looking orientation of design, that seeks opportunity and innovation in messy contexts'.

Chapter 6 Site exploration: context and selection

This research has identified many problems in the complex relationships between society, infrastructure and natural systems. The need to alter systems of urban living to become more sustainable, adaptive and resilient is critical everywhere across the planet and especially pertinent to areas experiencing impacts from landscape change such as sea level rise, hurricanes or other environmental impacts. The experience of the earthquakes and subsequent flooding in Christchurch has transformed the sometimes intangible ideas of climate change effects into actualities; into real problems that residents and authorities need to respond to now. This makes Christchurch a compelling location to explore the design potential of the strategies on site for two main reasons. First, by recognising the city's position in the social-ecological adaptive cycle, the extent and severity of the disaster's effects can be understood to be a powerful opportunity to change the makeup of deep-rooted systems and cultural paradigms. Second, the wide-ranging effects of the disaster will soon be common to thousands of other coastal urban areas due to the effects of sea level rise, creating significant opportunities for at-risk cities or towns to learn from Christchurch's experience and response.

6.1 The Christchurch experience

Figure 19 Lateral spreading beside a Christchurch river

Figure 18 Liquefaction in Christchurch

The Canterbury earthquake sequence, commencing with a magnitude 7.1 earthquake on the 4th September, 2010, caused wide-spread damage to structures and infrastructure systems. Damage was most highly concentrated in the central city and eastern suburbs, where strong shaking during the destructive quake on February 22nd, 2011 was on average one and a half to two times more powerful than shaking experienced in western parts of the city (Misko Cubrinovski et al. 2011). The intensity of shaking is well illustrated through comparisons to other understood forces: ground accelerations measured in parts of Christchurch were as much as four times higher than forces measured during the 2011 Japan earthquake, and up to twice the force of gravity (GNS Science 2011). The strong ground motions were in part caused by the 'trampoline effect' between underlying geological layers (GNS Science 2011), magnifying the intensity of shaking and causing wide spread soil failure. Liquefaction of soils, a process where soil transforms 'from its normal state into a heavy liquid mass'(Misko Cubrinovski and McCahon 2011: 4), occurred in much of eastern Christchurch causing large cracks, sinkholes, sand/silt/water ejection, lateral spreading and permanent vertical displacement (settlement). See Figure 19 and Figure 18. As a result, a general .1m - .5m subsidence or sinking has occurred across the city, with greatest impacts along the Avon river and the city's northeast (Tonkin & Taylor Ltd 2013).

In localised areas, the elevation drop exceeded 1m, the equivalent of a potential 100 year sea level rise recently set out in a Christchurch-based study (Tonkin & Taylor Ltd 2013). As Christchurch was built on a swamp, stormwater drainage issues and the potential for flooding have always held importance to the city's authorities. However the new earthquake-induced topography have exacerbated past stormwater management issues and propelled forward future issues around sea level rise. The

result can be described as a cascading disaster where worry of earthquake risk has been partly replaced by concerns and despair at the increased risk and experience of flooding. The extent and severity of damage to land and structures in parts of the city led to a large-scale government buy-out of properties located in areas that would be 'unlikely (to be) rebuilt on for a prolonged period'(Canterbury Earthquake Recovery Authority 2014). This process formed the residential red zone - an area covering over 630 hectares housing 7860 properties (see Figure 20). Land in close proximity to the Avon river forms the bulk of the residential red zone where damage to land was extensive. Clearances of properties by demolition crews continue today and are expected to be completed by the end of 2014.

6.2 Program for site exploration

Although the effects of climate change, resource depletion and ageing infrastructure networks will play out across all land use types, residential neighbourhoods, where people need to feel protected and safe are arguably the most socially vulnerable. Designers must engage with these issues and explore a range of possibilities to help communities build their adaptive capacity. One overall strategy for achieving a paradigm shift to resilient cities is a move to distributed cities – 'Cities will shift from large centralised power, water, and waste systems to small-scale and neighbourhood-based systems' (Newman et al. 2009: 56). In response, the design program and inquiry for my site exploration will be to question if and in what way a community's adaptive capacity could be increased through landscape systems of decentralised and adaptive infrastructure.

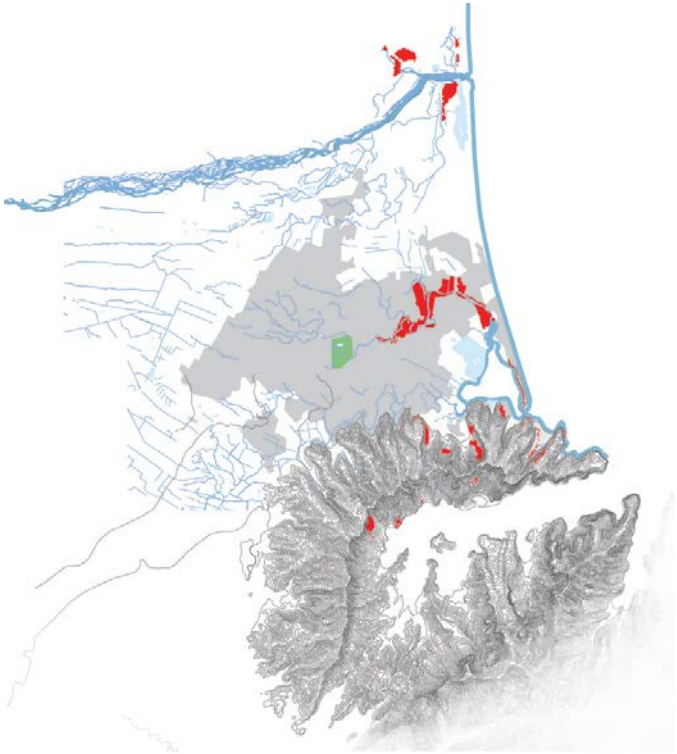


Figure 20 Christchurch city and the residential red zone
Map data sourced from Canterbury Earthquake Recovery Authority (CERA), Land Information New Zealand (LINZ) and Environment Canterbury (ECAN).

6.3 Site selection

All of Christchurch's residential areas have been affected to some extent by the earthquakes, though many parts of the city only experienced minor disruption and were able to return to normal functioning soon after each quake. In applying the social-ecological adaptive cycle to the residential red zone area however, the system can still be located in the re-organisation phase, making experimentation and innovation more possible than other areas within the city. The site for my design research exploration is accordingly located within the residential red zone land area.

In order to identify a community-scale area within the residential red zone, I identified two key criteria the site should meet.

1. **Close to CBD – within a 15 minute bike ride.** (see Figure 21)
   To decrease fuel dependency.
   To help promote life and activity at the rebuilding central city's edges.

2. **Some of the selected area's land should be currently located outside the Christchurch City Council's flood risk management area.** (see Figure 22 and Figure 24)
   To explore many different relationships between residents, land and water:

   - Land that will be at extremely low risk of flooding at least for 100 years.

   - Land that will move into the flood zone over time through sea level rise.

   - Land currently in the flood zone and experiences occasional floods.

   - Land that will become part of the river in the future through sea level rise.

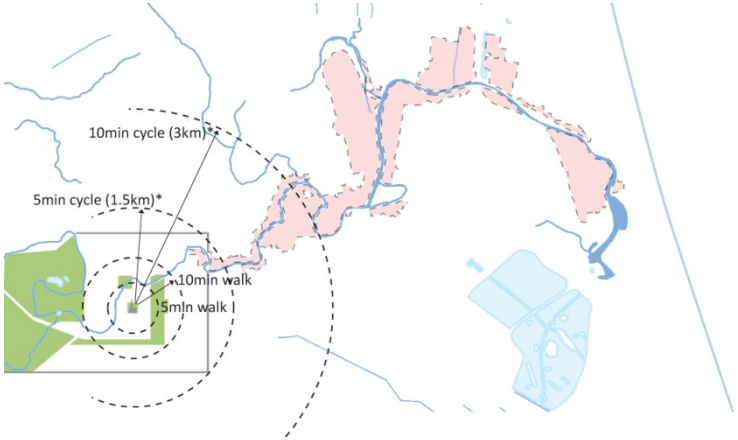
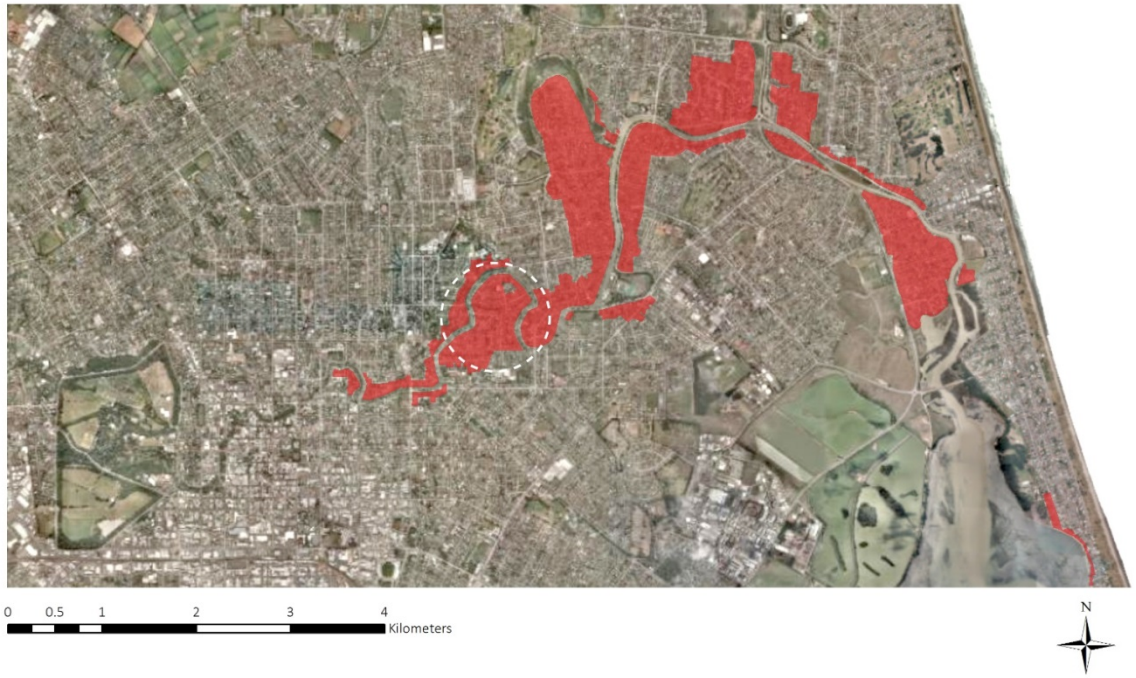
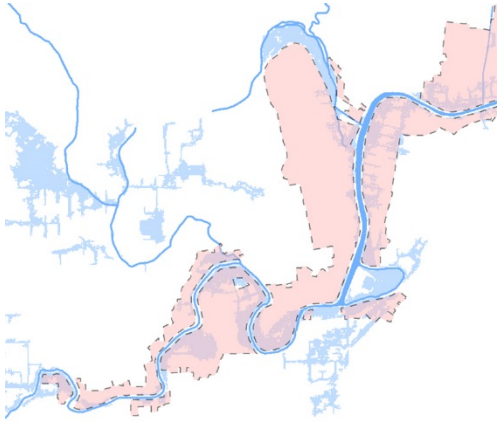


Figure 21 Pedestrian and cycle connectivity between Central Christchurch and the residential red zone
Map data sourced from CERA and ECAN.

Most of the residential red zone is located within the flood management area, and will be prone to increasing frequencies of floods due to sea level rise. The area of Avonside however, still has much of its land outside the flood zone. The area is also close to the central city. Although other areas nearby meet all the criteria also, Avonside is selected





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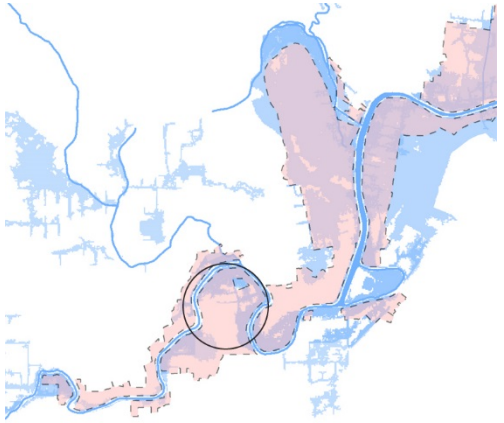

e Avonside site circled

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6.4 Infrastructure focus

The one year duration of this master's research project required a narrowing of the infrastructure focus to better achieve research depth and rigour. The design probe process led this narrowing. As discussed on page 42, the design probe process involved the exploration of design implications of the identified strategies on a range of infrastructure systems (water, energy, transport, communication and waste). Analysis of the design probes subsequently led to a focus on water and transport infrastructure for the Avonside site exploration.

Relationship of flows and cultural connections

'Natural systems as structure', an allied strategy of landscape infrastructure theorists and resilience theorists, works with ecological variability by using underlying natural systems as structures or frameworks for urban environments, making the role of natural systems in infrastructure networks important to identify and examine.

As interdependencies in infrastructure systems are a potential cause of vulnerabilities, I analysed the flow sources and interdependencies within systems to help determine an infrastructure focus. I analysed whether infrastructure flows (i.e. energy, water) were caused by people and therefore could more easily be managed or whether they were essentially uncontrollable (i.e. rain).

I identified water infrastructure, particularly stormwater and flood management as the systems whose flows were the most uncontrollable, therefore most directly connected to the strategy's goals of working with ecological variability. Shown in Figure 25, infrastructure networks of communication, energy or waste infrastructure are largely culturally constructed- people are responsible for creating the infrastructure flows. With solar energy infrastructure, solar panels are designed and installed by people and

although the generation of energy is affected by solar conditions, the flow and volume of energy required are determined and controlled by people.

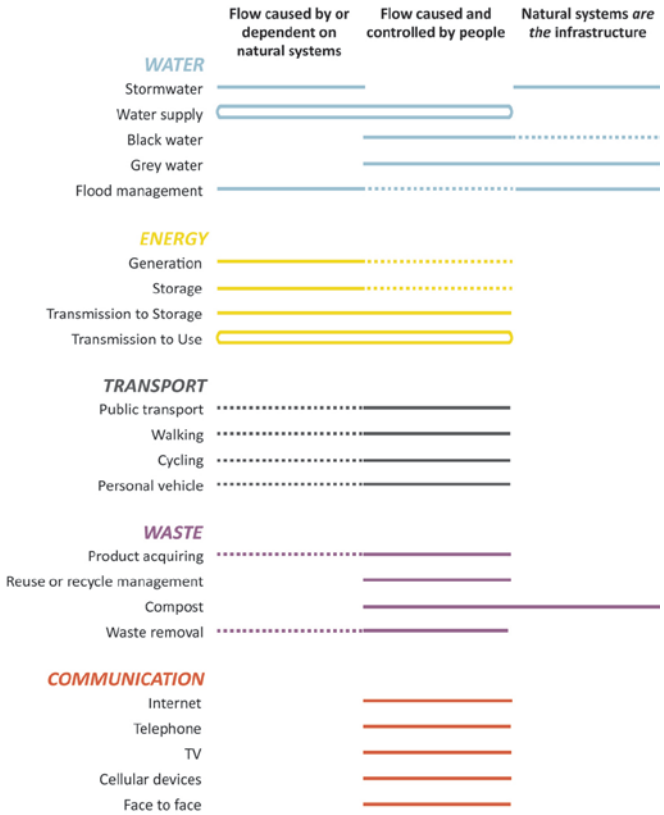

Figure 25 Analysis of the relationship of infrastructure systems to natural processes - analysis driven by design exploration of infrastructure types

In contrast, although the system flows of stormwater (rain) can be managed by people through engineered piping systems or more ecologically sensitive approaches (swales, infiltration), the volume, location, timing and intensity of rain cannot be controlled by

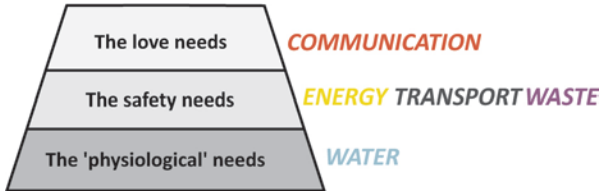

Figure 26 Comparison of infrastructure systems to Maslow's hierarchy of needs
Source: (Maslow 1943).

people. Stormwater systems can be designed to manage water volumes to a particular extent, but when water volumes exceed the system's capacity, the systems will fail and lead to flooding.

Furthermore, as I show in Figure 26 water is a basic physiological need - people cannot live without water to drink. Could this fundamental relationship be made clearer in urban environments? Anne Whiston Spirn writes,

> 'Water and its use for human purposes has great potential to forge emotional, functional, and cognitive links between people and nature in the city… Like a primordial magnet, water pulls at a primitive and deeply rooted part of human nature' (Spirn 1989: 119).

Interdependence and landscape space

I further analysed the interdependence between infrastructure systems, examining both the systems which are reliant on others to function, and systems which could be impacted by failures in other systems. Figure 27 shows this analysis. The infrastructure systems which do not rely on others to function are represented with a horizontal line, and the relationships between other infrastructure systems are indicated using arrows examining the needs and effects of systems on each other. Further analysis was undertaken to determine which infrastructure networks require the most consideration of landscape space.

The analysis found the most independent infrastructures to be energy generation, compost and stormwater management, and the systems of water and transport infrastructure to require the greatest consideration of landscape spaces. As investigated in Chapter two, infrastructure networks can be negatively impacted by problems in other systems – leading to the potential of cascading failure. The analysis demonstrates this potential: networks of communication infrastructure depend heavily

on energy infrastructure, waste infrastructure depend on road infrastructure. Stormwater systems, in comparison, are relatively independent of other systems, but can heavily impact the functioning of other systems if failures occur.

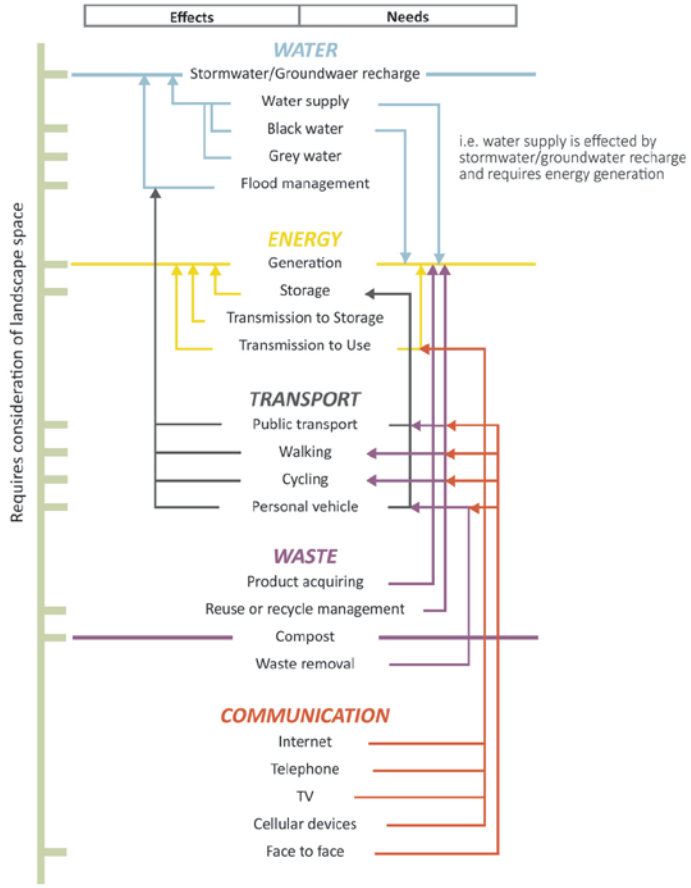

Figure 27 Analysis of the interconnectivity between infrastructure systems and their relationship to spatial requirements in the landscape

Transport and waste infrastructure are heavily reliant on stormwater systems and ensuing flood management operations to function correctly; a flooded road can greatly impact people's ability to move efficiently around an urban area. Water and transport also require the greatest consideration of landscape space. As examined in chapter two, the flooding of New Orleans's roads severely impacted the ability of the police force to move effectively throughout the city (Sims, 2007). Consequently, the vulnerable relationship between transport networks, and stormwater and flood management is to be the infrastructure focus of the site-based design investigation. The design response is to be the focus of the next chapter.

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Chapter 7 Site exploration: theories synthesised and applied

The Avonside context of the residential red zone (see Figure 28 and Figure 29) provides opportunities and parameters for a design-led testing and exploration of a synthesis of landscape infrastructure theory and resilience theory. Through the design process and analysis of outcomes, the role of landscape architecture in resilience design is explored and questioned, as well as new imaginative ways of living in urban environments.

In the following six strategies, I outline a number of design interventions that could be applied to Christchurch and other places experiencing landscape change. They attempt to challenge current conventions in the relationship between people and land use, and offer valuable starting points in the transformation to more adaptive urban environments. The first three strategies are new concepts developed through the design process, whereas the last three strategies discuss design interventions which could be described more as examples of how ideas within the theoretical frameworks could be played out on site.

Figure 28 Avonside: abandoned and environmentally degraded

Figure 29 The current landscape character of Avonside

7.1 Strategy one: Road corridor hierarchy: water first people second

Roads are frequently constructed at lower elevations than the land they service, enabling stormwater to run off properties onto roads. As water flows both across and along road surfaces, and below roads through pipes, roads can therefore be defined as a form of urban waterway. The culturally formed topographical relationships between road and property are perhaps expressed with most visual clarity in areas adjacent to rivers or coasts, where flooding sends water up the roads first, eventually creeping up into properties or houses as floods rise. But even in areas away from water bodies, roads can still flood when stormwater systems fail to cope with water volumes.

Roads are heavily relied upon in western cities, where dispersed urban patterns require people to often use vehicle travel to access even their most basic requirements e.g. social contact, food, health centres, schools or work. When roads flood, daily routines can become hugely disrupted and personal resilience is affected through people's inability to influence the situation (Bonanno et al. 2007). A lack of diversity (Brian Walker and Salt 2006) in movement modes and networks also lessens people's ability to adapt to changing conditions; flooded roads can trap residents who rely solely on the road network and vehicle travel to move around the city. Rising sea levels and increasing rainfall intensities will exacerbate flooding events, therefore roads need to be reframed and designed to accommodate and adapt to the changing conditions.

A potential strategy for future adaptation

In developing this strategy, I brought together landscape disciplinary theory and resilience theory with the contextual parameters of Avonside (see Figure 30 and Figure 31).

Figure 30 The Avon River - a picturesque aesthetic constructed by the early settlers

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Figure 31 Flood prone: the Avonside loop in a major flood
Source: www.nz.news.yahoo.com

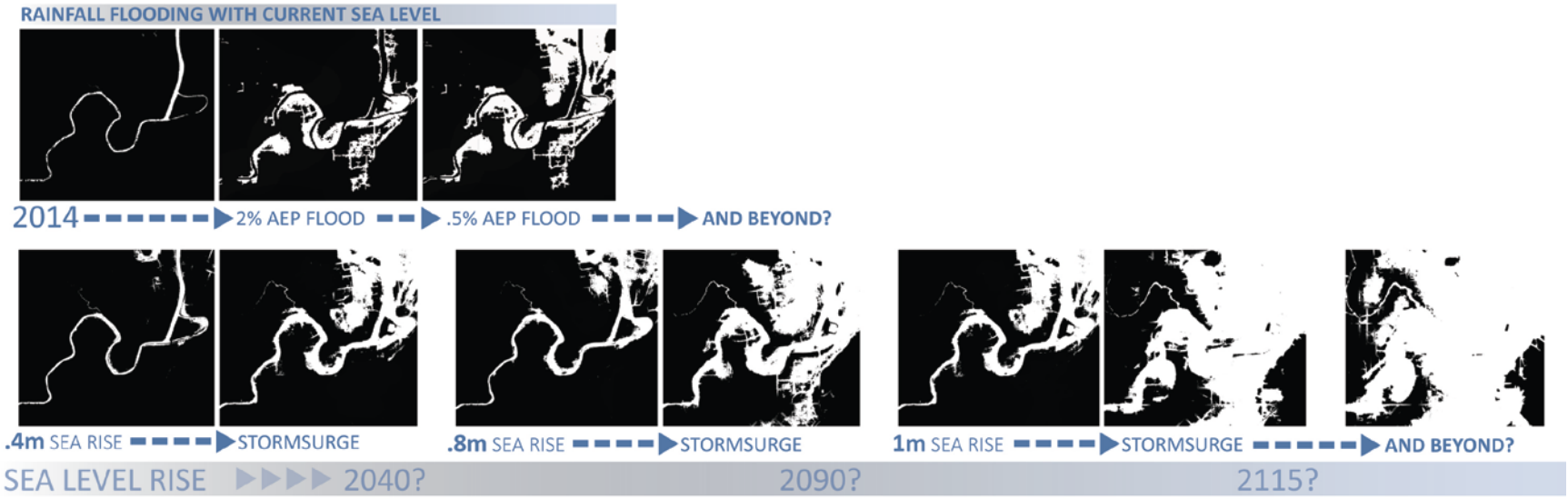


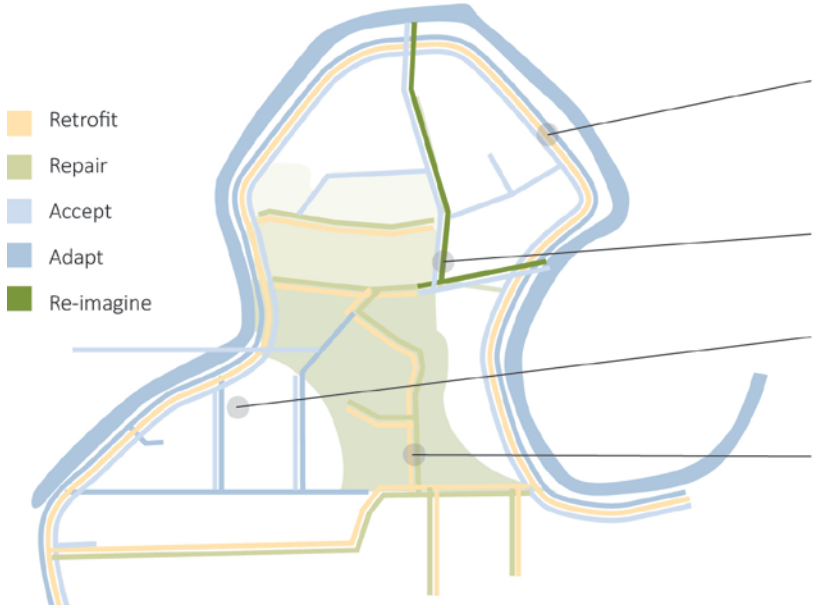
Figure 32 Analysis and graphic representation of the Avon River and future potential for flooding in Avonside
Data sourced and adapted from NIWA, Tonkin & Taylor Ltd (2013) and the 2011-03-08 Christchurch Lidar digital elevation model.

Topographical mapping of Avonside clearly illustrates the relationship between road, property and river, and can also be used to gain an understanding of the increasing effects of sea level rise on the road and land systems (see Figure 32).

Landscape theorists advocate for natural systems such as hydrology to guide urban form (Bélanger 2012; Lister 2007; Morrish 2008; Mossop 2006; Poole 1998, 2004; Strang 1996) and resilience thinkers argue for ecological variability and slow variables to be acknowledged and respected (Brian Walker and Salt 2006). Through mapping Avonside's predicted sea level rise and associated flooding, I became aware of the potential for many roads in Avonside to experience increasing frequencies of flooding. Current road systems are designed for people first, forcing the water to cooperate; yet we cannot make water simply disappear. Water must go somewhere and problems

quickly surface in the form of unwanted flooding when water can no longer be controlled. Embracing ecological variability and natural systems within Avonside means allowing flooding to occur, yet this challenges current road functions and design. However, if we embrace the waterway-like nature of roads and first design systems of water movement, and *then* work out ways for people to use them also, could both roads and people become more adaptive to changing hydrology conditions?

This strategy could be played out in many different ways (Figure 33). A road that doesn't currently flood could be retrofitted through using techniques of water sensitive urban design or low impact design - a combination of swales, rain gardens and infiltration areas designed to absorb water could lead the form of the road and subsequently guide the parameters of how people also use the road. Maybe the road becomes a bridge, or is narrowed or widened, or accommodates different modes of travel at varying heights; the spatial and system needs of water will determine a road's character and functioning parameters.



Avonside Drive is adapted to become part of a city to sea pedestrian and cycle pathway. It is retrofitted to allow water to infiltrate the ground under or adjacent to the road, and it is accepted the pathway will flood at times. Alternative routes will provide access in times of flood.

Morris St and Galbraith Ave are reimagined as canals and it is accepted that at times water will flow over some canal banks and flood adjacent areas.

Keller St, Bracken St and Retreat Rd are also adapted to new uses and accepted that they will flood. - Carparks, hard court sports, pedestrian and cycle pathways are all designed to accommodate and infiltrate water.

Silverdale Place is extended to become the main vehicle link to the area. It is repaired and retrofitted with water infiltration areas.

Figure 33 Multiple and varied design strategies could be designed in order to activate the water first road concept

Another response could be to fully embrace the strategy and reimagine what a road could be. In areas prone to flooding, protecting land and roads through structural measures such as stop banks or water pumps are in direct opposition to notions of social-ecological systems resilience. 'A resilient world would embrace and work with ecological variability' (Brian Walker and Salt 2006), thus embrace changing levels of water, both through flooding and overall increases in water levels due to sea level rise.

In an area such as Avonside where roads are increasingly inundated with water, road functionality needs to adapt to the changing landscapes. Roads that frequently flood could be reimagined as canals, where boat travel becomes the dominant mode of transport and fluctuating water levels are not a hindrance but part of the system and embraced.

The transformation from roads for people, to roads for water first people second, could offer many benefits and connect strongly to concepts of resilience identified by Walker and Salt (2006) (see page 33). Excavation of earth to form canals could be strategically applied to elevate areas inflexible to inundation or to implement overall topographic landscape frameworks (see Figure 34) (as discussed further on in the placemaking strategy).

Re-envisioning the character and function of roads could also contribute to a person's sense of place and belonging, thereby building social capital. For example, a canal could make legible the temporal movements of water,

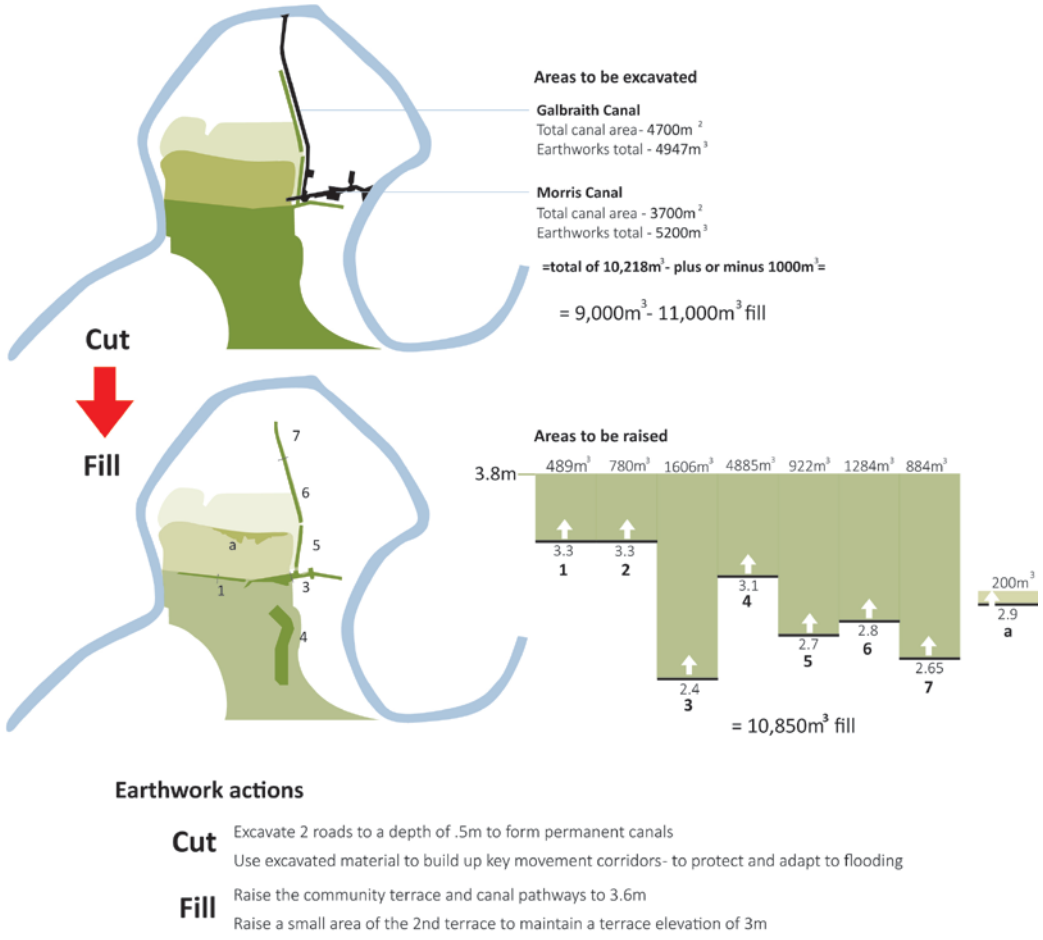


Figure 34 Canal excavation could provide earth material to raise strategic areas to meet the overall landscape strategy

heightening resident's experiences and feelings towards their environment (Spirn 1989). Tighter feedbacks could also be created, through impacts of falling rain experienced on site rather than downstream in a flooded neighbourhood. Although the strategy challenges current notions of water relationships in New Zealand, many communities around the world currently live with water in different ways as shown in Figure 35. Changing our notions of urban living to embrace changing landscapes is critical if we are to build adaptive capacity in communities.

7.2 Strategy two: Time-based land use

One of the overriding questions of this research is how urban landscapes and communities can embrace and adapt to change. However this leads to a further question: how can communities and authorities respond to change in an adaptive way if everything is too determined? A danger of the conservation phase in the social-ecological adaptive cycle is 'increased command and control' (Brian Walker and Salt 2006), where processes and rules are fixated upon and novelty is supressed. Current planning procedures of zoning land-use by activity is arguably an expression of this phase.

Designating an area as 'residential' or 'light industry' implies a degree of security and certainty for land owners and users that social, economic or ecological conditions will always provide suitable circumstances to support the indicated type of activity. Multiple experiences worldwide however, prove the falseness in this belief; cities shrink and decay as in Detroit, hurricanes and flooding challenge development patterns as in New Orleans and earthquakes disrupt lives in unpredictable ways in Christchurch. Current activity-based zoning can limit people's preparedness to expect and adapt to change and reduces flexibility in land-use. This can lead to high emotional and

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Figure 35 Canal imaginings. An image of Morris Street overlaid with images of canals from around the world – building the imaginative potential.

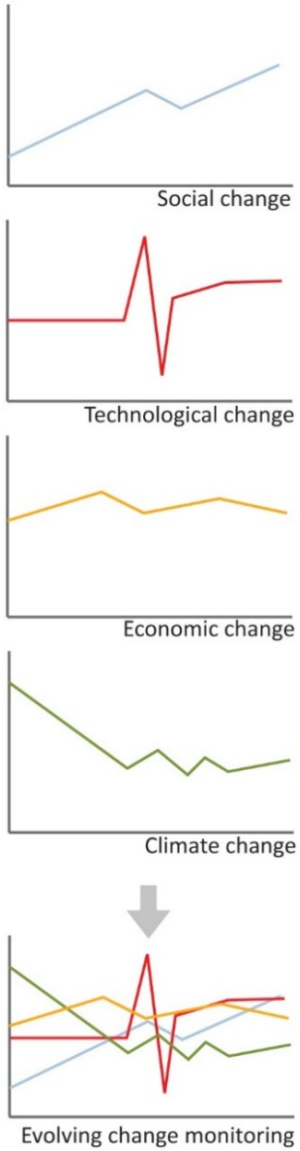


Figure 36 Acknowledging and monitoring slow variables could enable communities to understand the potential thresholds for change

economic investments in landscapes and structures which are difficult to walk away from.

A potential strategy for future adaptation

An essential requirement of resilience is to 'recognise that conditions are needed that occasionally foster novelty and experiment' (Gunderson and Holling 2002: 40). To design innovative methods for embracing change in the environment. But how can providing the possibility of experimentation be incorporated into land-use planning methodologies? One potential strategy is to manage land-use in cycles of *time* rather than *activities*. Through multidisciplinary collaborations, slow variables such as sea level rise and socio-economic shifts, as well the potential of more rapid change such as flooding or hurricanes, could be identified (Figure 36) and monitored. Acknowledging and monitoring these changes could inform land-use judgements based on designation of suitable time frames for land-use, as opposed to suitable activities. Individual ownership becomes less about owning a piece of land and more about owning a land lease for a certain time frame e.g. 5 or 10 years. Land-use activities would therefore be framed by the possibility that at the end of a lease, a different activity might be deemed more appropriate. For example, an area of land might be in a potentially strategic location for increasing residential density in the future, but as we can only forecast futures, the exact timing or actual need is too uncertain to be acted upon. However, the land could be zoned on a short time frame to allow for future flexibility. The same can be applied to areas expecting future water inundation through sea level rise. Limiting or excluding potentially innovative land use activity from using these areas in the short term reduces the capacity of a community to learn and adapt.

The 'safe to fail' concept (Lister 2007) could be enabled through capitalising on low time zones, providing both communities and developers low risk frameworks where temporary experiments in adaptive living, commercial activity and infrastructure can be

tested and learnt from. Economic and emotional investment can then be made in accordance to the level of change, i.e. high time frames could still result in high investment, but low time frames will result in more responsive and adaptive uses to changing conditions e.g. modular moveable houses, low investment agriculture. Activity-based zoning communicates an impression of the landscape as static, as if in fixed perpetuity, yet the social-ecological adaptive cycle describes a constant cycling and morphing of landscape systems. As well as increasing people's awareness of the temporal nature of the landscape, could a time-based zoning system also encourage an active and attentive attitude towards change?

In Avonside, landscape change is now chiefly in the form of flooding and impacts of rising sea levels, therefore in this designed scenario, land is zoned according to expected effects of future inundation (see for graphic illustration of zoning process - Figure 37). To incorporate additional adaptive capacity, time zones are also broken into smaller, modular units so variations within broad conditions can be accommodated. Development and changes can therefore occur in connection to surrounding areas or autonomously (Figure 38).

Figure 37 The process and methodology of zoning Avonside using topography and potential for flooding as slow variables

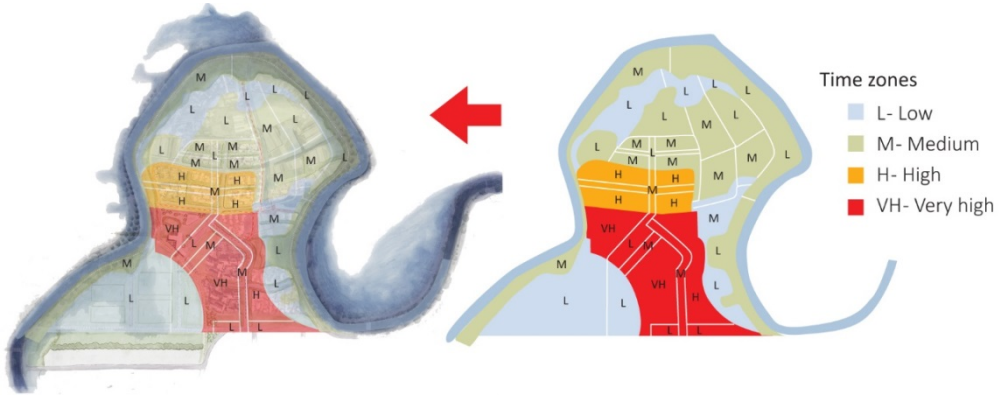


Figure 38 Larger areas of the same time zones are broken into modular, more autonomous sections and then applied to land use management in the Avonside Masterplan

Landscape architect Pierre Bélanger states 'staging uncertainty and harnessing contingency become the new urban imperatives, through the design of resilient and flexible edge, margins, and peripheries' (2012: 301). Yet can we really design with uncertainty and flexibility in complex urban areas? Do the complicated networks of property rights, social structures, economic investment and so on, limit possibility? A re-organising system like Avonside could be an ideal place to test out new relationships to change, for through the government buy up and compulsory abandonment of land, some of the complexities have been reduced. In this projective scenario, the land is used in a multitude of ways, with all land use decisions influenced by the interval of time the land is zoned for (Figure 39 and Figure 40).

Figure 39 Avonside within the context of Eastern Christchurch and the residential red zone.
Data sourced from CERA.

Low and medium time frame
Land is re-vegetated to form a native riparian zone

Low time frame
Land remains 'feral' until a lease is signed for a flexible activity

Low and medium time frames
Low intensity flexible horticulture uses that can handle flooding

Medium time frames
Low density housing- larger lease sections promoting more 'off the grid' living

High time frame
Medium density housing
Suburban-like urban pattern

Medium time frame
Transformed roads to canals- modular and removable residential housing

Very high time frame
Community infrastructure hub where shared amenities and decentralised infrastructure systems are located

Very high time frame
Higher density housing

Low time frame
Recreational playing fields

Within this designed scenario, the land use is fluid and constantly evolving - therefore this masterplan represents only a brief moment in time - not a structured visionary plan.

Key
Terrace corridor network
Vehicle access routes
Primarily pedestrian and cycle routes

Bridge to neighbouring community and shopping

City to sea pathway

Edge of residential red zone

0 50 100 200 300 400
Meters

N

Figure 40 Masterplan of Avonside showing different land uses guided by the opportunities and constraints of the time zones

7.3 Strategy three: Flexible space provision

Another strategy – flexible space provision, is also generated through exploring concepts of indeterminacy and adaptation, guided by the need to accommodate change in infrastructure networks. If distributed cities with neighbourhood-based systems of decentralised infrastructure systems are a possible step towards greater urban resilience (Newman et al. 2009), can designers imagine and project ways of enabling this transformation to occur?

Many decentralised technologies however are still in the development stage or not common enough to give authorities confidence in their application. Microgrids, for example are small-scale power systems that can operate autonomously or in connection to the central grid, offering numerous benefits associated with sustainability and resilience goals. Yet the concept still needs further research and testing (Ustun et al. 2011). Numerous alternative decentralised water systems are also in development, with many 'novel' technologies - such as urine separating toilets and living machines which treat wastewater through wetland ecological processes - finding real world applications, but have not yet become conventional mainstream technologies (Makropoulos and Butler 2010). The uncertainty of future decisions regarding system and spatial applications of such technologies requires a degree of flexibility in urban landscape projects.

A potential strategy for future adaptation

One strategy for providing future flexibility would be to simply set aside land in case it was needed in the future, however non-developed urban land is usually uncommon and large sections of undeveloped land could be seen by some as wasted space. An alternative multi-purpose strategy, closely linked to community participation theory, is to design community-managed flexible space throughout urban development. The site-

based design exploration of this concept in Avonside opens up possibilities for how this might be achieved spatially.

Pre-existing organisational networks that build cooperative capacity in relationships between community members and authorities are vital to achieving rapid responsive action if a catastrophe strikes (Norris et al. 2008; Vallance 2012). Synthesising this concept with diversity and modularity (Brian Walker and Salt 2006), led to an idea of forming a community programmatic pattern of small household clusters that could each influence and manage their immediate environment but also be connected to and able to collaborate with the wider community and the council (see Figure 42). Coupled with the need to provide flexible infrastructure space, an idea emerged of creating a network of flexible space, located in strategic areas such as along roads or pathways and in the community centre area, to be managed by the surrounding or adjacent housing cluster (see Figure 41 and Figure 43). Each housing cluster would determine the land's management structure (time frames, sectioning etc.) and use (crop farming, community garden, bee keeping etc.) and whether the land would be used for financial or household gain. However a clearly structured land use agreement with the wider community organisation or council would indicate the potential for the land's future appropriation if and when the need arose. Landscape designers could collaborate with community members to structure the networks of spaces and offer advice or build understandings of land use possibilities - using design to facilitate flexible use and change.

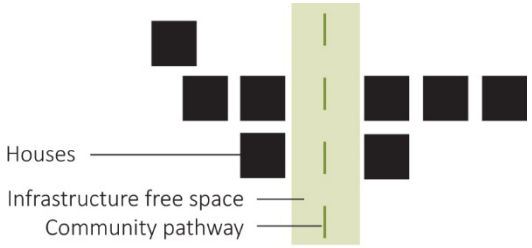


Figure 42 Example of possible housing cluster

Figure 41 Network of flexible spaces to be managed by housing cluster

network of terraces and flexible infrastructure space

7.4 Strategy four: Diversity in all forms

To manage the resilience of a system, it is necessary to consider *what* is a system resilient *to* (Carpenter 2001). However, change is often unexpected or cannot be predicted with certainty, leading to a need for building overall adaptive capacity to help infrastructure systems respond to a broad range of challenges (B. Walker et al. 2002). One strategy for building room to move is diversity -'a major source of future options and a system's capacity to respond to change and disturbance in different ways' (Brian

Walker and Salt 2006). As previously stated, multidisciplinary collaborations and multifunctional landscapes are advocated for by landscape theorists, yet diversity also holds great spatial and system potential. The design process, in both the design probe stage and the site investigation, generated a range of different applications of diversity. This included diversity in transport modes and connectivity, in infrastructure systems, in community management structures, in flood management relationships and in many compositional aspects. Diversity became such an underlying concept of the design work, that it is inherent in most of the design outcomes discussed. Below a sample of the numerous possible applications of diversity is discussed.

Potential strategies for future adaptation

The transformation from road into canal would substantially alter the character and functions of the chosen site. However, as the site within this research framework was zoned for a medium time frame use, speculated as 20 years, the activity of residential housing might be determined after 20 years to no longer be the most suitable land use. Could the houses and supporting infrastructure be designed and sited in a way that allowed for removal and re-establishment somewhere else if the need arose? Could diversity in the canal design help facilitate future adaptation to a different use? As part of the design process, potential future uses of the canal were forecasted, including tourism, fishing or farming, biodiversity support and recreation provision.

In identifying their possible spatial needs, many future uses were found to potentially benefit from similar aspects. For example, establishing habitat for fish could enable many futures uses, as well as keeping potential mosquitos at bay. The edges of the canal were subsequently designed and shaped in a crenulated way to encourage wildlife habitat for birds, fish and insects. The varying widths and diversity in water spaces - long and narrow, bays or peninsulas - might also encourage adaptation in the

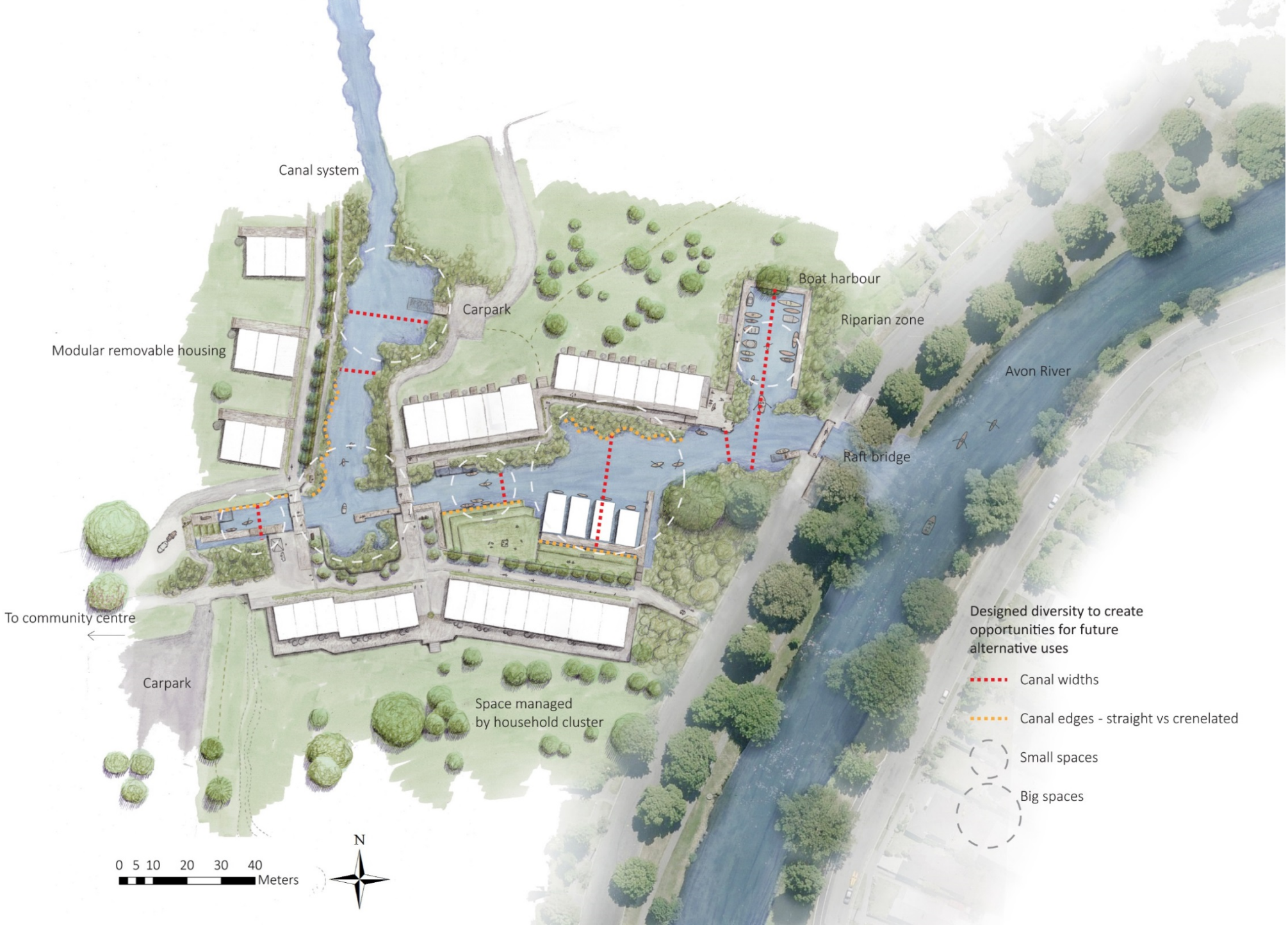


Figure 44 Diversity in canal shape - widths, edges, access

future (see Figure 44). Canal spaces might be used for example, for floating markets or houses, canoe polo, or wildlife tourism.

Diversity was also designed into the approaches to the water. Not only is there potential for future land use changes, but the area will experience changes in both fluctuating and gradual water level rise. Varying the location, fluidity, size and mode of entry might help increase resident's ability to adapt to changing water levels, as well as enable a wider variety of potential use (see Figure 45). For example, shown in the design study of the intersection of the two canals (see Figure 46), the open space east of the two bridges steps down to the water incrementally, enabling constant water access but at different levels.

At a wider scale, the potential for diversity in transport options and connectivity between the development and the city was investigated through design.

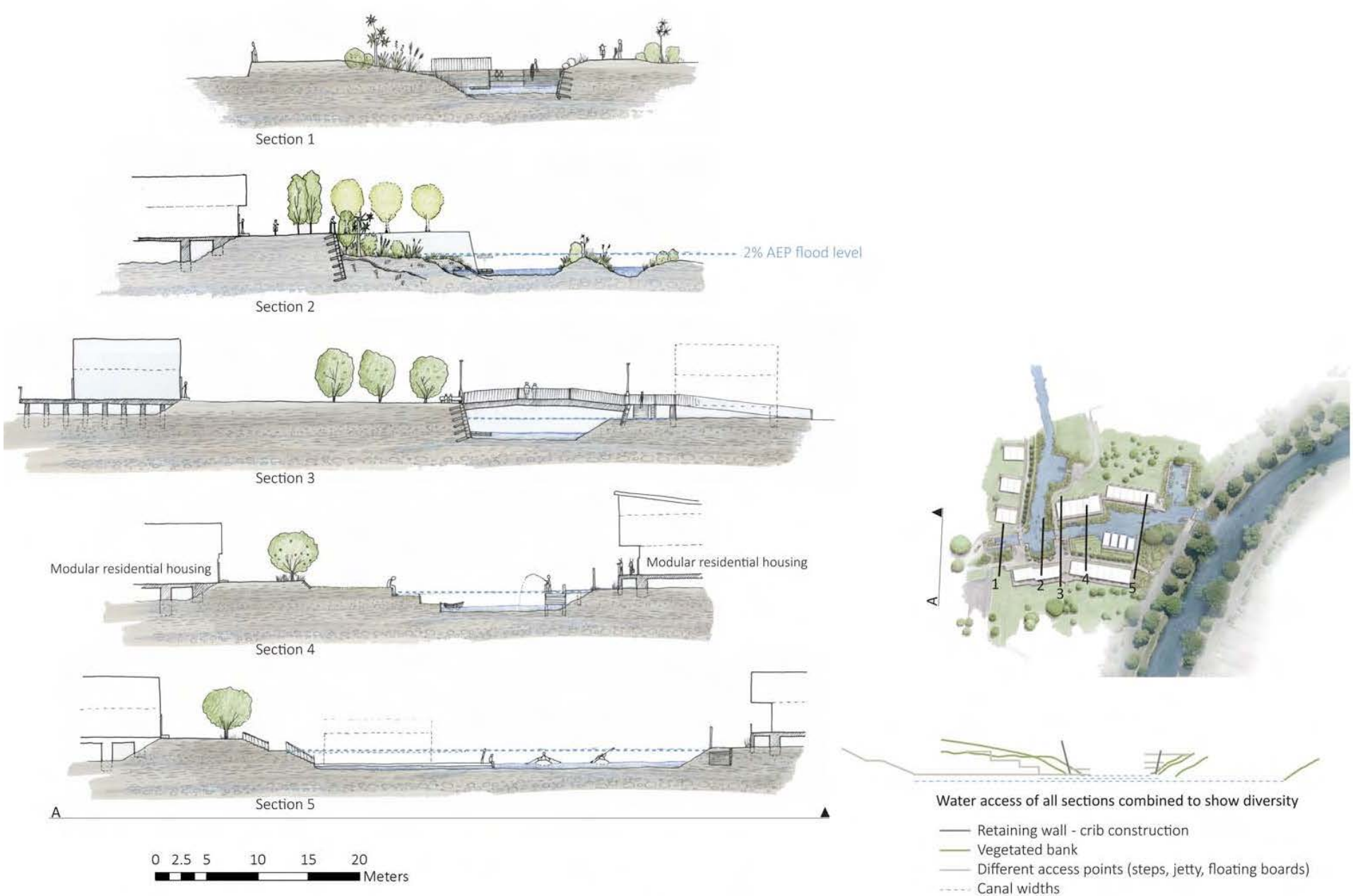


Figure 45 Diversity in the range of entry/exit points and types of entry – fixed, movable and step downs.

Entry points can be adapted according to the level of water

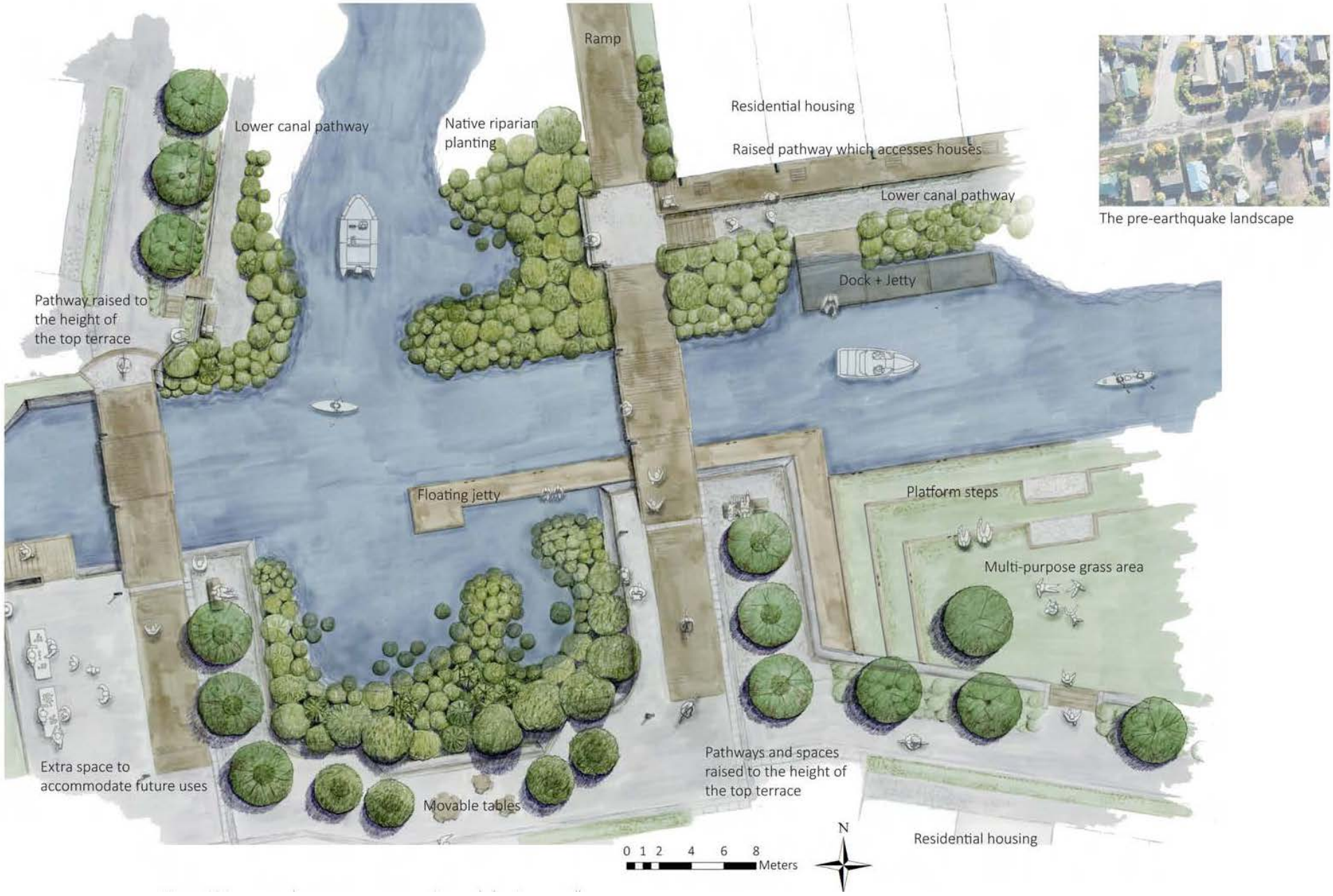


Figure 46 Spaces, pathways, water access points and plantings are all designed to increase diversity

7.5 Strategy five: Community as operators

The call for community participation is a concept resonating in both landscape and resilience theory and also connects to other understandings of social capital such as sense of community and social support (Norris et al. 2008). A landscape-centric design exploration of the Avonside site could potentially offer alternative, more land-based avenues for building relationships between residents and designing community-operated systems. The design program of a community supported by decentralised or locally-sensitive infrastructure systems gives the design process a conceptual starting point for exploring whether community resilience could be increased through landscape infrastructure-based concepts. However challenges arose in exploring the concept of community participation using a studio-based design process. As Norris et al. (2008) suggests,

> '…to access social capital, one of the primary resources of any community, local people must be engaged meaningfully in every step of the mitigation process. Enabled by professional practitioners, as necessary, community members must assess and address their own vulnerabilities to hazards, identify and invest in their own networks of assistance and information, and enhance their own capacities to solve problems created by known or unknown unknowns' (Norris et al. 2008: 143)

Communities should thus be engaged from the beginning of a project and even define the contextual and conceptual parameters, yet the scope of my research did not allow for such an approach. However, could community participation also be a barrier to innovation? A key aspect to building adaptive capacity is to embrace innovation, novelty and experimentation (Gunderson and Holling 2002; Brian Walker and Salt 2006). So too is building social capital, in part through community participation.

However, a potential friction emerges in a community-led process of designing experimental, innovative urban environments. If major system transformation is desired, i.e. changing land use paradigms or infrastructure patterns, will a community be able to challenge conventions of urban living to the degree that is needed?

Designers have the ability to create; to generate new models and to experiment and innovate. To enable paradigm-shifting experimentation, could design cultivate a range of opportunities and work in collaboration with communities to explore their potential? Possibilities for alternative living might emerge which communities never would have considered. However, 'because key information resides in the knowledge and mental models of stakeholders … without the inclusion that comes from participatory approaches, any proposed solution would face a legitimacy problem' (B. Walker et al. 2002).

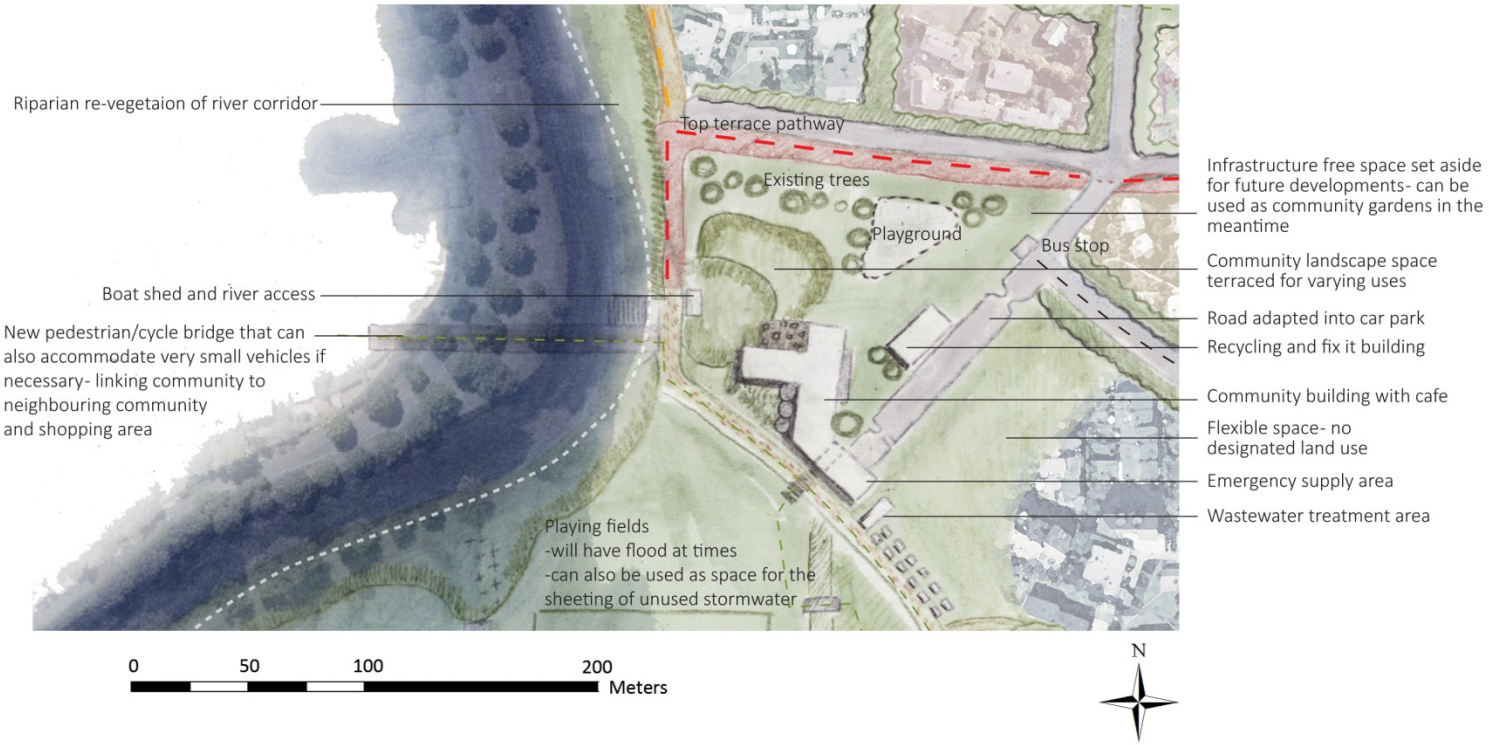
Allan and Bryant (2011) suggest a participation approach for disaster recovery with the designer playing a 'strategic role, negotiating between community and government to help find the best and most cost-effective way to achieve outcomes for the community, and assisting the community with design interventions that are tactical and responsive.' For this project, the above designer/community relationship was assumed where the designer leads and explores a range of possibilities but empowers the community to make decisions. Designed strategies to encourage community participation are described below.

Potential strategies for future adaptation

As discussed in strategy three, structuring the spatial and co-operative management systems of the community through a network of adaptive open space could provide physically for residents in any way they chose. This could also promote adaption, attachment to place, social support and organisation, communication networks, and

participation (Norris et al. 2008). In each cluster, a leader could be elected as manager and community representative to coordinate with the wider community and authorities. The emergence of leaders, particularly elected leaders, in disaster experiences from both Australia and New Zealand was a key predictor of community resilience (Paton et al. 2014). Additionally, experimentation in housing cluster size and patterning could increase opportunities to learn about the relationship between housing options and social interaction, building knowledge that could be applied to new or adapting residential developments.

Another design outcome was generated from exploring the potential of decentralised infrastructure systems through considering their spatial links to the wider area and emotional connection to residents. Ideas generated through the design probe process explored whether overall community participation and enablement could be increased through interaction with a wide variety of infrastructure systems. These ideas led to the idea of an infrastructure hub as a 'village centre' (see Figure 47). The centre could form the community's heart, where learning and experimentation are enabled, and decentralised infrastructure systems such as wastewater treatment and energy storage are integrated into social life. Rather than shut away from view, systems could be celebrated, innovatively designed and encourage community learning and participation. In addition, the centre would be guided by the landscape's topography. Located at the highest central point within Avonside the spatial organisation would increase topographic legibility and transform to a potential refuge site in times of need. The centre would also house an emergency supply building, stocked by the community and council with items such as water, sand bags, emergency food, radios etc.



through daily - connecting them with the workings of infrastructure and their community system

Community participation could also be designed into the infrastructure systems themselves. Could systems be owned or operated by community members? For example, each household might collect rainwater and manage tank volumes to accommodate high rainfall events, or the orientation or height of bridges could be designed to adapt depending on needs, requiring residents to engage and alter them. Residents could also be empowered through technology such as phone apps, where aspects like water levels or solar generation potential is shared and learnt from.

Numerous possibilities for integrating resident's daily lives with infrastructure could be explored. However a frequent issue arose through the design probe and site exploration process. Often participation requires extra effort from residents and a potential loss in convenience found in conventional systems.

Systems and designs must therefore become desirable to use - socially, emotionally and/or financially. Aesthetic experience[2] of landscapes and infrastructure systems, enabled through processes and outcomes of landscape design could play a significant role in building this desire.

7.6 Strategy six: Placemaking through functional legibility

In a study on the link between place attachment and community participatory planning, Manzo and Perkins (2006) argue that place attachments and place identity can help foster community action through stewardship and participation in planning processes. They define 'place identity' as consisting of 'those dimensions of the self that develop in relation to the physical environment by means of a pattern of beliefs, preferences, feelings, values, and goals' (Manzo and Perkins 2006: 337), evolved over time through engaging with the deep meaning of lived experiences. In this, a landscape architect's role in stimulating place identity and attachment is clear. As we design spaces for people, we 'must provide opportunities for people to have meaningful

[2] The concept of aesthetic experience is taken from theorist Elizabeth Meyer (2008), who believes the perception of beauty can be created through people's increased understanding and interaction with landscapes. She states 'The experience of designed landscapes can be a spatial practice of noticing, wandering and wondering in, and caring about the environment. The experience of landscape can be a mode of learning new, and inculcating values' (Meyer 2008: 21).

participation'(Clements and Dorminey 2011: 241). I originally identified two themes relating to ideas of place attachment and identity from the writings of landscape theorists – placemaking and legibility. However, upon further theoretical examination and applying the theories to the site design exploration, I established a merged concept of 'placemaking *through* functional legibility'.

Landscape Architect, Anne Whiston Spirn (1989) addresses the need for people to experience a sense of identity, unity and sense of place and to be able to participate in the shaping of their environment. She states,

> 'the perception of change is essential to developing a sense of who we are, where we have come from, and where we are going, as individuals, as societies, as a species. The perception of time depends upon regularly recurring events, without which, time would be an imperceptible, formless flow. The experience of repetitive and comprehensive change, as expressed by temporal cycles like the seasons, gains an even more powerful aesthetic potential in an age such as ours characterised by rapid change. Design that makes visible the operation of natural processes and their temporal cycles contributes to the experience of being connected to rather than separate from the past and the future' (Spirn 1989: 110).

Spirn (1989) compellingly describes the potency of landscape design and suggests design can help facilitate meaningful place experiences through increasing the awareness of landscape temporality and rhythms.

People's awareness of the interlocking natural and cultural systems of urban living, made legible through design, thus holds much potential in building place identity and attachment. However, as Kathy Poole (1998) states, legibility does not refer to simply 'showing' or 'exposing' infrastructure, instead it expresses a *functional* integration of

cultural and natural systems in the city. Supporting this argument, a community's ability to learn about their risks and share common understandings of reality and purpose can increase their ability to adapt to change (Norris et al. 2008), therefore could landscape design, through engaging with functionality and legibility in cultural and natural systems, help increase individual and community resilience? Could design outcomes facilitate both a person's sense of place and their ability to influence and adapt to their environment?

Potential strategies for future adaptation

This concept led to several different site interventions at multiple scales. First, as currently the main threat to urban living in the area is flooding, I explored through design, ways for flooding and changes in water level to become more legible - so residents had greater understanding of the relationship between the land's topography and varying water levels. Applying the theory requires an intermingling of social and ecological processes - for the functions of one system to affect the other and vice versa - so that as Elizabeth Meyer states 'nature is not out there but in here, interwoven in the human urban condition' (Meyer 2008: 16). Through exploring this concept I developed an idea for a terrace system, where the area's topography is structured and shaped into terraces that step down in elevation from the community centre at the highest to the river at the lowest; the terraces form the overall structure of the housing clusters, stormwater system and transport/movement system. Transforming this concept to a workable site intervention, I layered the digital elevation model, existing roads and existing vegetation to create a site-specific framework for the whole residential development, a process represented in diagram form in Figure 48.

Figure 48 The formation of the terraces were guided by the areas topography, existing roads and vegetation retention where possible

The development was thus structured by the creation of three terraces, each allowing for different levels of time-zoning and land-use character according to the associated relationship to flooding. For example, the highest terrace houses the community centre and decentralised infrastructure systems, higher density living and subsequently greater investment, while the lower terrace supports more 'off-grid' urban-rural living with lower densities and residents more willing to connect with temporal landscapes (see Figure 49 and Figure 50).

Figure 49 Masterplan and terrace system – see also time based land use strategy

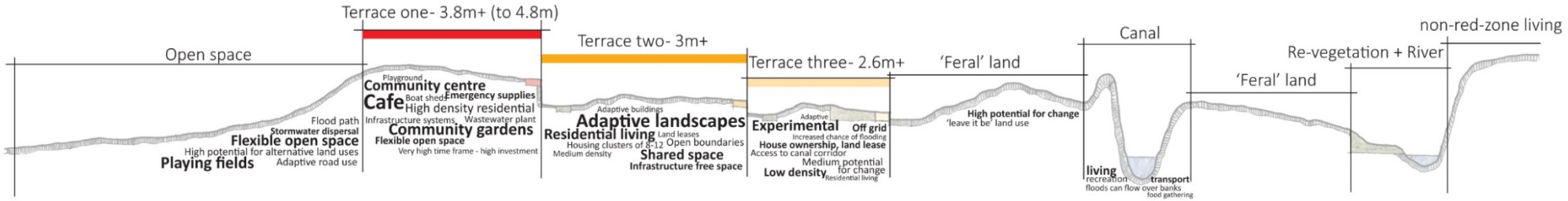


Figure 50 Exaggerated topographic difference to graphically represent the potential different responses to land uses in the terrace system

The potential for flooding doesn't limit development but encourages adaptive ways of living. As time progresses the lower terraces will become more increasingly inundated, but residents will be more prepared to respond through their understanding of the fluidity between land and water and the visual cues for different levels of inundation (see Figure 51).

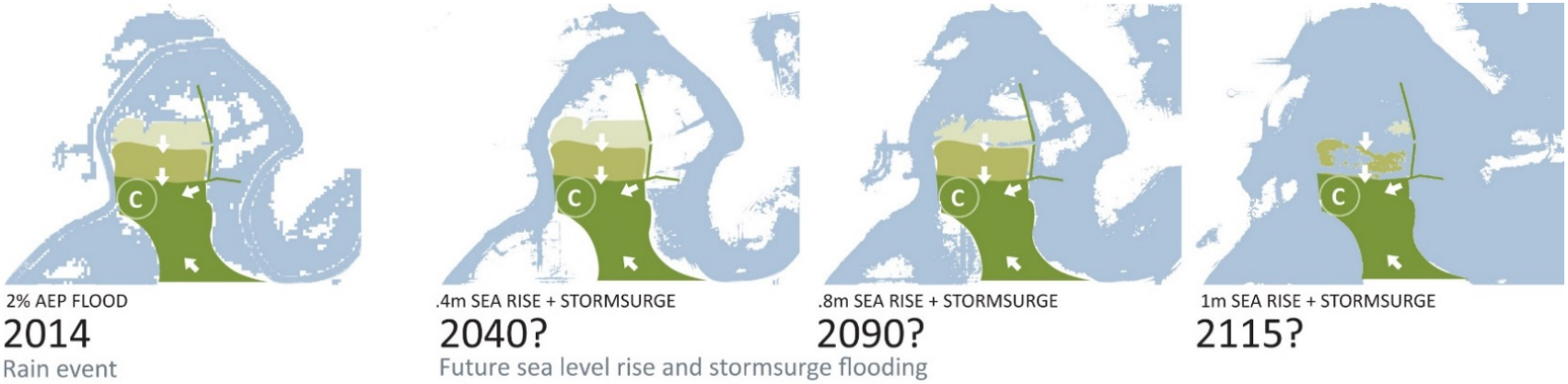


Figure 51 Current flooding and future sea level rise effects on the terrace system
Source: Data sourced and adapted from NIWA, Tonkin & Taylor Ltd (2013) and the 2011-03-08 Christchurch Lidar digital elevation model.

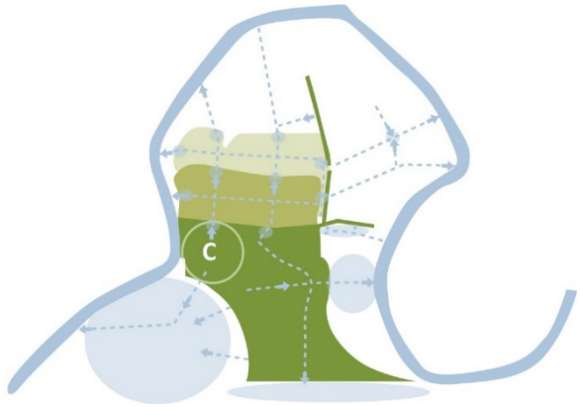


Figure 52 The stormwater management system is also designed to increase the legibility of the areas topography and terrace system

Infrastructure systems are also designed according to the terrace system. A pedestrian/cycle (and vehicle if required) pathway runs along each terrace circumference, providing both connectivity and a potential flood defence edge that could be lined with sand bags if required; the terraces can thus transform into retreat zones. The terrace system also provides the bones of the utility infrastructure systems and the stormwater management systems. Stormwater is filtered slowly down each terrace using swales and infiltration features. At the top of each terrace there is an informal small sump in the ground which collects and infiltrates water, overflowing in times of high volume, sending water down into the next terrace (see Figure 52).

At a more detailed scale, I explored functional legibility through design ideas that increase residents' awareness of the potential for some areas to flood while others stay dry, and for floods to affect social behaviour. Excavated earth from the canal construction is used to help form the terrace system and create a narrow terrace extension along one edge of the canal (see Figure 34) - constructing a pathway that is both above the canal and above the flood zone. The other canal edge follows the existing topography and will occasionally be submerged under water.

I explored design concepts that could help make these differences more legible to residents and affect how the area functioned for people. One idea was to create contrasts in materials, planting and patterns between each pathway. The higher pathway is structured, ordered-looking and repetitive – with boulevard plantings of fruit trees and hard surfaces like concrete and stone. The lower pathway is designed to appear more naturalistic and temporal, emphasising its potential for flooding – with a gravel pathway and 'messy' ecological planting. The two pathways promote different user experiences and functions. The higher pathway might be used for functional reasons, while the lower pathway might be used more for pleasure and recreation (see Figure 53 and Figure 54).

Figure 53 Photomontage of pathway height and character changes

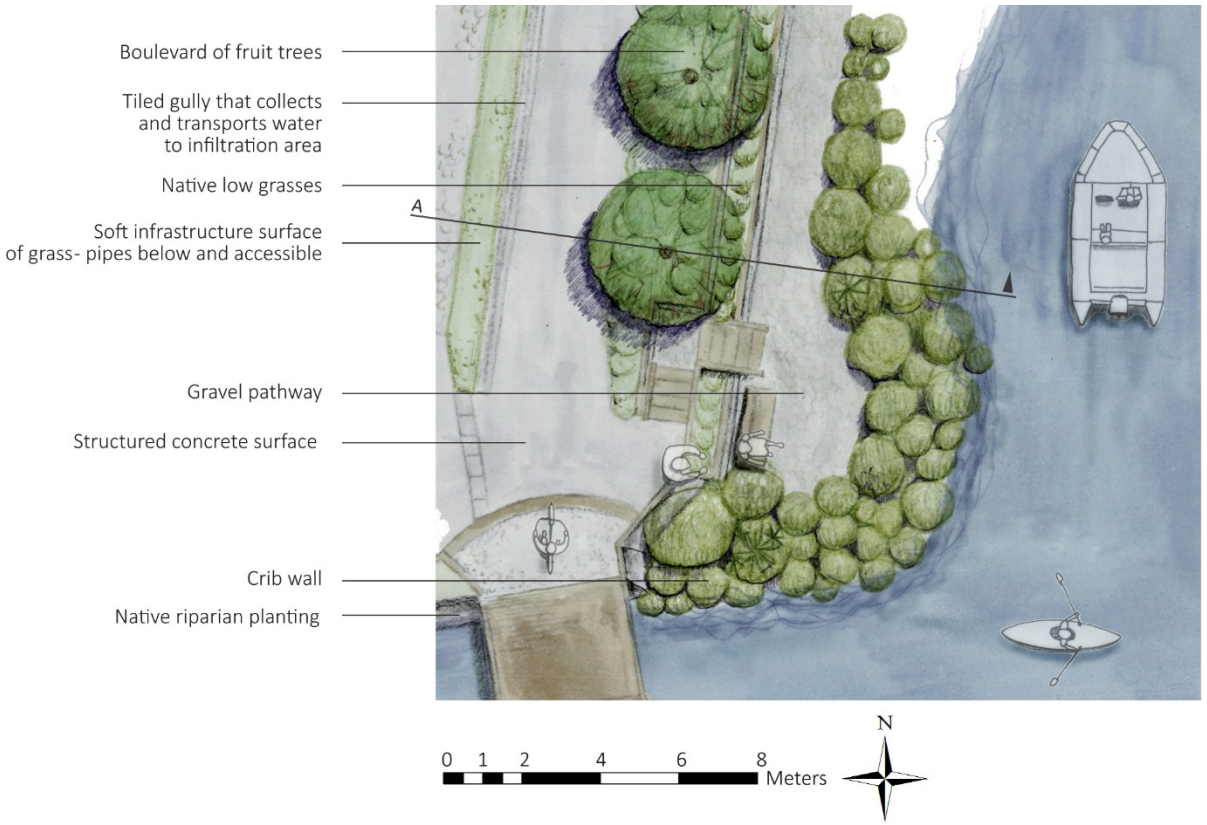


Figure 54 A play on structure vs non-structured to emphasise the temporality of the lower canal pathway

Another concept stemmed from consideration of the limitations of community activity in current infrastructure systems. Infrastructural pipes and cables are commonly buried beneath hard surfaces like asphalt, making them difficult to access without specialised equipment. In this conceptual reality, residents understand infrastructure; they know how to fix or adapt it and are enabled to do so. How can landscape design facilitate this reality through both increasing functionality and creating a sense of place

visually and experientially? One concept I developed through the design probe process, by combining theoretical ideas of community participation with flexibility, was to cover the submerged networks with surfaces of flexible planting or moveable tiles. Residents could then simply remove the tiles or dig up the planting to access the pipes and then replace or plant new covers at the work's completion. Different housing clusters could use different plants or tiles as a sign of identity and the process of removing, replacing or replanting would provide a functional legibility that both allowed residents to adapt and impact their environment while creating a sense of narration of the process.

This chapter has examined what I judged to be the most innovative concepts developed through the design process. Six strategies were formed by identifying and grouping key designed concepts. The six strategies are as follows: 'road corridor hierarchy: water first people second', 'time-based land use', 'flexible space provision', 'diversity in all forms', 'community as operators' and 'placemaking through functional legibility'. Each strategy has been described and analysed for its relevance and potential contribution to activating goals of resilience theory. The next chapter investigates what the design outcomes mean in response to the research questions. What new imaginative possibilities were created? How is landscape architecture placed to increase urban resilience and adaptability?

Chapter 8 Reflections and questions

This research was undertaken to explore two overall questions. What new projective possibilities for adaptive residential living in areas experiencing amplified landscape change could be imagined from a design process synthesising theories of landscape architecture with social-ecological systems? And what is the role of landscape architecture in building resilience or adaptive capacity in communities and urban landscapes?

Infrastructure systems are often described as the veins of urban environments, yet the literature review identified several potentially disastrous issues with current systems. The design-led inquiry into alternative concepts of residential development was a response to these issues. If current infrastructure systems are typically unsustainable and hinder community resilience; what might a residential development look like that synthesised concepts of landscape, community and infrastructure resilience? How might the adaptive capacity of a community be increased through their interactions with infrastructure and landscape?

Although multiple infrastructure systems were explored during the research's early stages, the connections between transport and stormwater/flood management infrastructure were analysed to be the systems requiring the discipline of landscape architecture's greatest attention. Debate on planning tactics for resilience building seem often to only present overarching strategies, similar to the set applied in through this research process (Brian Walker and Salt 2006). Although these strategies are invaluable as generative prompts, conceptual ideas are also needed that translate theories into potential site-based interventions. The following is a discussion into the

key insights and creative ideas advanced through the research process using a site-based design investigation.

8.1 Designed concepts: challenging conventions

Many ideas were developed throughout the design process. Five concepts however hold particular value to discussions on resilience as they attempt to challenge conventional urban development patterns and offer innovative approaches to infrastructure and landscape management. These concepts do not represent comprehensive solutions for building resilience in cities but more suggest potential starting points for increasing adaptive capacity; ideas that could be tested and experimented with through future interdisciplinary and community collaboration. I will present them only as an overview as their full explanation and theoretical reasoning can be found in the previous chapter.

1. Designing roads as urban waterways

Design roads for the movement of water first, and the movement of people second. As climate change effects will increase flooding volumes and frequencies, roads must be adaptive to these changes. If roads consistently flood, could they not be reimagined as canals? Embracing ecological variability is a key tenet of resilience thinking (Brian Walker and Salt 2006), so how might landscape architects design road systems that embrace and welcome the flows of water?

2. Land zoning through intervals of time rather than activity

Social-ecological systems are constantly moving through cycles of change; evolving, disrupting, and transforming. Yet how can static land use controls allow landscapes and people to adapt to changing environments? Could land use be reorganised into time-

demarcated land leases of flexible activities rather than permanent activity-based ownership?

3. Community-managed flexible landscape space

Unforeseen and unpredictable spatial needs can arise in urban areas - extra space might be needed for stormwater management, for community solar generation, for temporary settlements, for urban agriculture. Could urban configurations be designed or retrofitted to include networks of interconnected, undesignated free space?

4. Infrastructure pipes and cables buried under flexible and removable surfaces

Infrastructure networks are frequently buried under asphalt or concrete - limiting quick and easy access for repair or transformation work. Could community members become empowered to fix and adapt their own infrastructures? Would flexible and removable coverings of infrastructure pipes better facilitate their adaptive capacity?

5. Increased topographic definition

Many urban environments appear flat when they are not. Rain falls, rivers rise, and unexpected flooding can occur when residents are unaware of the landscape's topography. Could topographic legibility be heightened in flood prone areas to form the overall urban structure? If residents are more aware of flood risk through simply living in the built environment, might they be more prepared to adapt and respond to the changing social-ecological systems?

Each concept may find value in real-world applications, however testing the potential value is beyond the scope and purpose of this research. The aim of the research was to instead increase the imaginative scope of what is being considered; the what if..., to prompt discussion of the imaginative possibilities for alternative forms of residential development and what they might look like. Subsequently, a significant outcome

stemming from this process was identification of the generative potential of landscape design. Though this might seem obvious, the power of design to imagine alternative futures seems to be lacking in many debates on resilience building. Analysis of the design outcomes in relation to resilience theory identified a number of key strengths of landscape architecture in improving resilience in urban environments.

8.2 The role of landscape architecture in improving urban resilience

Management of resilience in social-ecological systems is learned through collaborations of diverse voices and perspectives (Gunderson and Holling 2002; Lister 2007). For a community threatened by flooding, adaptive responses might emerge from a collaboration between residents, civil engineers, climate scientists, planners, ecologists, designers, artists and so on. This research found the discipline of landscape architecture to have significant value in multi-disciplinary collaborations and therefore the involvement of landscape architects can bring much to urban projects aiming at building urban resilience.

Every profession has its strengths, for example civil engineering excels in resource efficiency and optimisation. This research asserts that in resilience building, the strengths of landscape architecture lie in its instrumentality in integrating social and ecological processes, improving social capital, engaging with temporality, design-led innovation potential, increasing diversity and the working across multiple scales. These judgements were made through an analysis of the design outcomes against the resilience strategies identified by Brian Walker and Salt (2006). Each design strategy e.g. time-based zoning, was indicatively ranked in order to analyse the value or benefits provided to each resilience goal. For example, the community as operators strategy provided little value to goals of ecological variability but provided many benefits to enhancing social capital. A table of the combined results is shown in Table 4.

Strategies for building adaptive capacity and resilience:	Benefits established through landscape design
Social Capital	♦♦♦♦♦♦♦♦♦♦♦♦♦♦♦
Innovation	♦♦♦♦♦♦♦♦♦♦♦♦♦
Diversity	♦♦♦♦♦♦♦♦♦♦♦♦
Ecological Variability	♦♦♦♦♦♦♦♦♦
Ecosystem Services	♦♦♦♦♦♦♦♦♦
Acknowledging Slow Variables	♦♦♦♦♦♦♦♦
Tight Feedbacks	♦♦♦♦♦♦♦♦
Modularity	♦♦♦♦♦♦
Overlap in Governance	♦♦♦♦♦

Table 4 Ranking of design outcomes to analyse the potential value of landscape architecture in increasing resilience in landscapes and communities

The ranking associated with each resilience goal represents the combined total from the analysis of each individual design strategy ranking. The influence or potential effectiveness of each design strategy in increasing the resilience goals was ranked low – high (0 diamonds - 3 diamonds). See Appendix B for the individual strategy tables.

The results indicate social capital, innovation, diversity, ecological variability and ecosystem services to be the strategies that landscape design in this contextual instance, was most valuable in building resilience. The following is a discussion examining the strengths of landscape architecture with regard to these goals.

Integration of ecological and social processes

The value of ecological and social integration is discussed first as it is perhaps the most intrinsic goal of landscape architecture. Although the ranking analysis indicates less benefit to ecological aims compared to other strategies, the table is misrepresentational in this respect. Many of the resilience strategies, particularly social capital, were achieved through placing emphasis on natural systems and processes.

Embracing ecological variability is a major imperative of resilience thinking – 'many of the biggest environmental problems we now face are a result of past efforts to dampen

and control ecological variability' (Brian Walker and Salt 2006: 146). As a compelling illustration of this statement, throughout Christchurch's developmental history many natural springs and streams were converted to drainage channels - buried beneath urban development. Swamps were drained in an attempt to control the water, but such measures have now come back to haunt residents and authorities in the form of severe land damage and subsequent abandonment. Draining the wet areas of Christchurch and forcing the water to conform to the wishes of development instilled a false understanding of the physical and temporal character of the land. When the earthquakes hit, the underlying soils and hydrology increased the intensity of shaking and subsequent damage, prompting many angry residents to question why development should have been allowed in the first place.

If a new urban mantra of integrating ecological variability into living patterns is to gain traction, won't an increase in society's awareness and involvement with ecological processes and implications be essential? Multiple ideas surrounding community and personal resilience tell us the answer is yes (Bonanno et al. 2007; Norris et al. 2008; B. Walker et al. 2002).

Civil engineering can design infrastructure systems with greater adaptability, but what about the social dimension? How can infrastructure be designed both *with* communities and to enable communities to understand, to embrace, to operate and even to love the systems they live amongst? In this respect, landscape architecture offers valuable inputs. The need to acknowledge the performance of landscape, that landscapes perform functions and facilitate processes, is argued widely by landscape theorists. Through utilising this potential, designed landscapes could reconnect people with integrated urban living and ecological processes. Landscape architect Elizabeth Mossop describes this potential, she states 'landscape design can be instrumental in working with natural processes to make new hybrid ecological systems. It is clearly not

about making approximations of pristine natural environments, but rather making functioning ecologically based systems that deal with human activity and natural processes in the urban environment' (Mossop 2006: 170). Landscape design as a tool, could encourage greater awareness of the interface between social life and ecological variability, where temporal changes in natural or human design systems become part of daily life and a welcomed sensory experience (Meyer 2008).

'Natural systems as structure' is a strategy for infrastructure design argued for by multiple landscape theorists, who indicated infrastructure and urban form as a whole should be structured by underlying natural geomorphology and processes (Bélanger 2012; Lister 2007; Morrish 2008; Mossop 2006; Poole 1998, 2004; Strang 1996). This position could be considered as an umbrella concept for many resilience strategies: ecological variability, tight feedbacks, acknowledging slow variables and ecosystem services. Though these resilience strategies are inherent in many projects or debates of landscape design, could landscape architects do more to identify or utilise these strategies to further extend the instrumentality and potential economic uptake of the natural systems as structure concept? Many design ideas were generated through synthesising these ideas within the Avonside site (Figure 55). These might provide future tool kits or idea prompts for designers engaging with adaptive capacity in urban environments, but they also demonstrate the generative value of the theory; theories landscape designers could engage with in future urban projects.

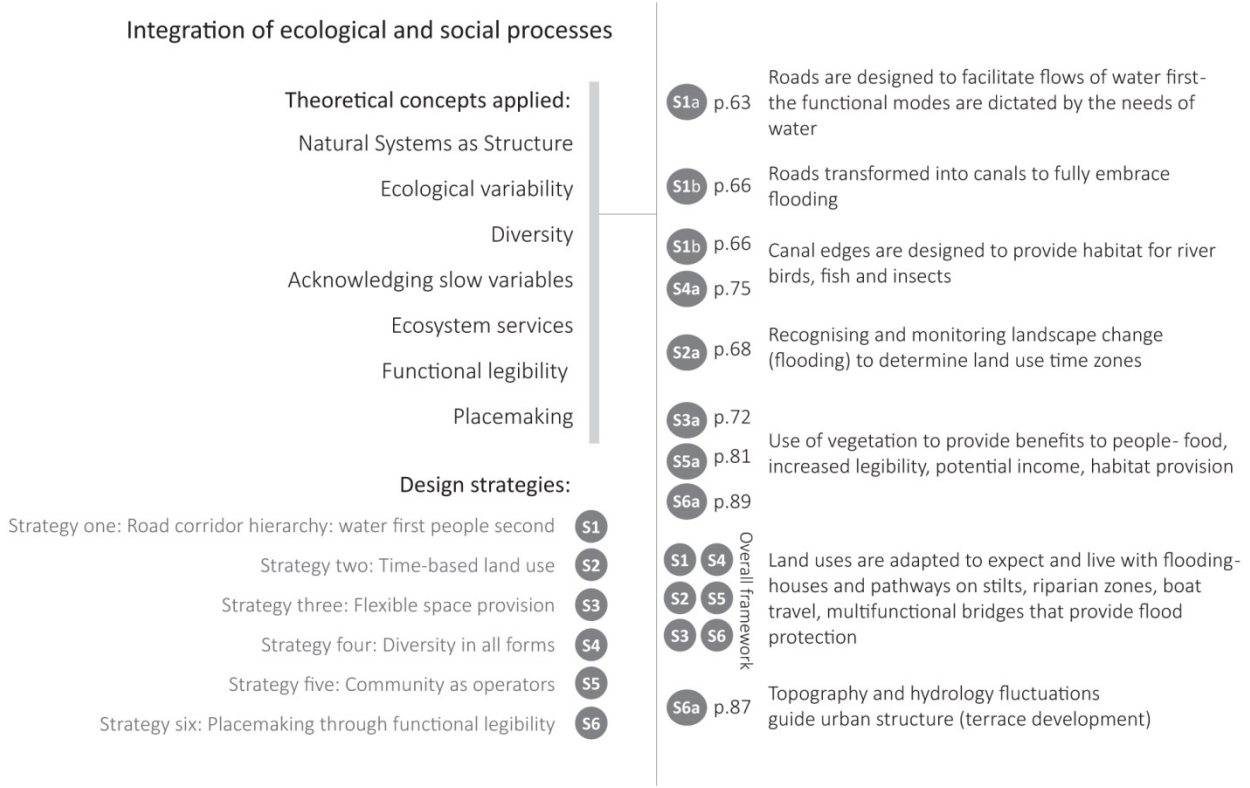


Figure 55 Design ideas generated that facilitate greater integration between ecological and social processes

Improving social capital

The concept of social capital presented by Brian Walker and Salt (2006) calls for well-developed social networks that enhance people's ability to learn and adapt. However an extended literature review of the social capital concept found concepts of place attachment, sense of community, citizen participation and community competence (understanding of risk/options) also contribute to a community's adaptive capacity

(Norris et al. 2008). In the design outcome analysis, social capital was the resilience strategy most enhanced by landscape architecture. The value of landscape architecture in increasing social capital is further illustrated through landscape theory: three out of seven principle strategies for infrastructure design put forward by landscape theorists were related to building social capital (community participation, legibility and placemaking).

At all scales - detailed spatial design to wider strategic design - landscape design can do much to improve enhance social capital (as illustrated in Figure 56). Design goals of functional legibility and placemaking could increase a community's resilience, but design decisions must be made for the right reasons. A constructed stream might build an appreciation of visual aesthetics, but if it is only a superficial treatment can it increase the awareness and knowledge of how a community could respond to change? How might landscape design be utilised to build place attachment and community relationships through increased understanding and awareness of infrastructure systems and natural processes? The theoretical writings of Spirn (1989), Howett (1987); Meyer (2008) provide rich descriptions and ideas for building these connections. They argue for landscape design to emphasise the experience of temporal and natural processes to enable people to better understand and interact with their environment. Suggesting the perception of beauty could be enhanced through the increased awareness of landscape phenomena and social ecological integration.

Another disciplinary strength is the existing knowledge and practice of landscape architects' in working with communities or resident groups. More attention however needs to be given to adaptive learning. Rather than designers collaborating with communities to create a final resolved spatial interventions, designers could instead operate as tools that communities utilise for imagining their futures and learning how to experiment and adapt their own environments (Folke et al. 2005). Lister (2007),

Ahern (2011) and Allan and Bryant (2011) provide a significant starting point for cultivating landscape architecture's role in this respect. They emphasise the need for adaptive planning and design, where the role of the designer is a strategic facilitator rather than a visionary masterplanner.

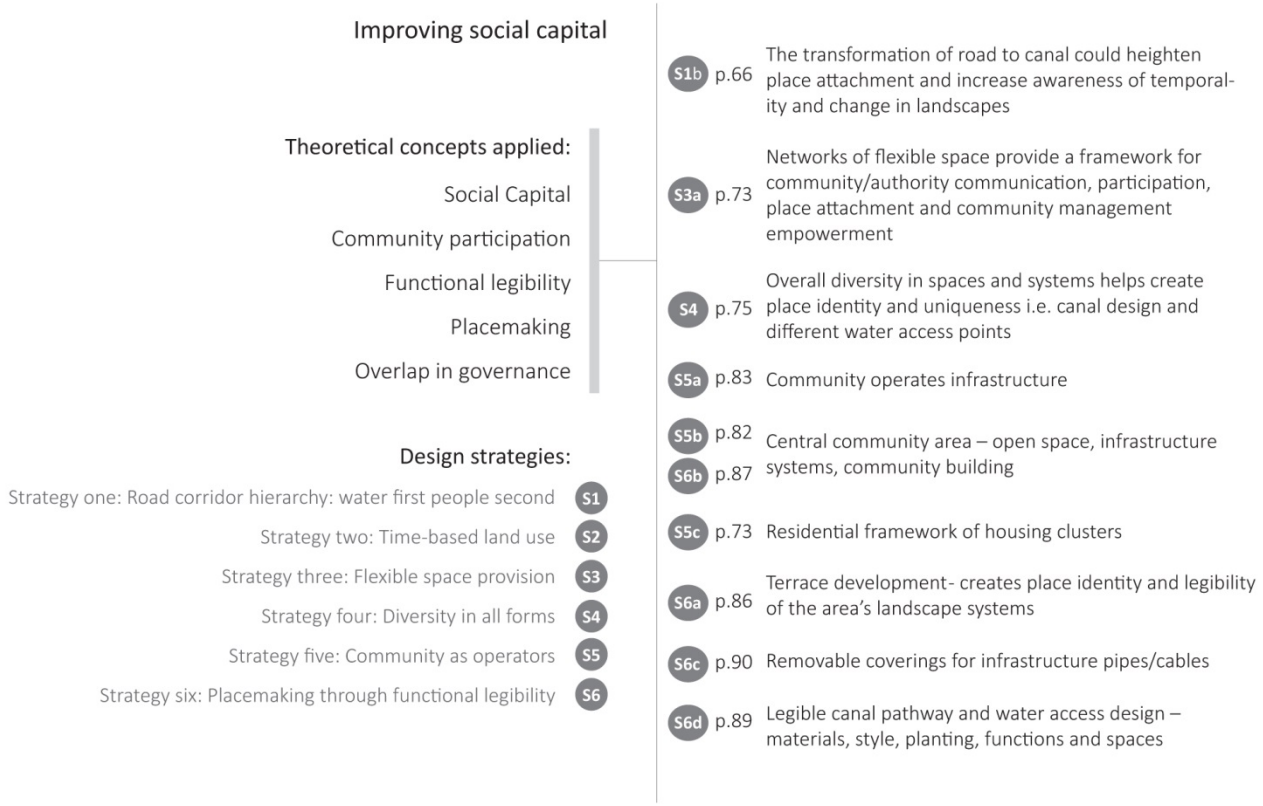


Figure 56 Ideas generated that might enhance social capital

Engaging with temporality

Notions of embracing change and variability are at the forefront of the resilience concept. Within the identified resilience strategies, embracing change is represented as part of fostering innovation. The temporal focus of landscape architecture, driven by the ever-changing medium of landscape, results in significant potential for the discipline to collaborate in resilience building projects. The value is summarised powerfully by James Corner who suggests 'landscape and ecology understand projects as dynamic, grounded temporalities, as context-specific unfoldings – becomings, durational emergences, themselves seeding potentials that go on to engender further sets of effect and novelty' (Corner 2004: 32). I suggest the more defined values lie in the ability of landscape architects to create time-based design responses and to graphically communicate concepts of temporality and staging uncertainty. That said, although many landscape discipline theorists compellingly address concepts of indeterminacy and adaption (Bélanger 2012; Corner 2004, 2006), suggestions for design tools or strategies to facilitate the 'staging' could be made more apparent.

The synthesis of landscape and resilience theories was influential in transforming the temporal theories of landscape architecture to more workable strategies (see Figure 57). For example, the concept of acknowledging slow variables (Brian Walker and Salt 2006), although potentially inherent to some projects, provides a strategic connection between time-based design responses and improving adaptive capacity through formally identifying how a landscape or system could change and managing for that change. Diversity and modularity also suggest ways that landscapes could be designed to facilitate adaption by creating more options – more room to move.

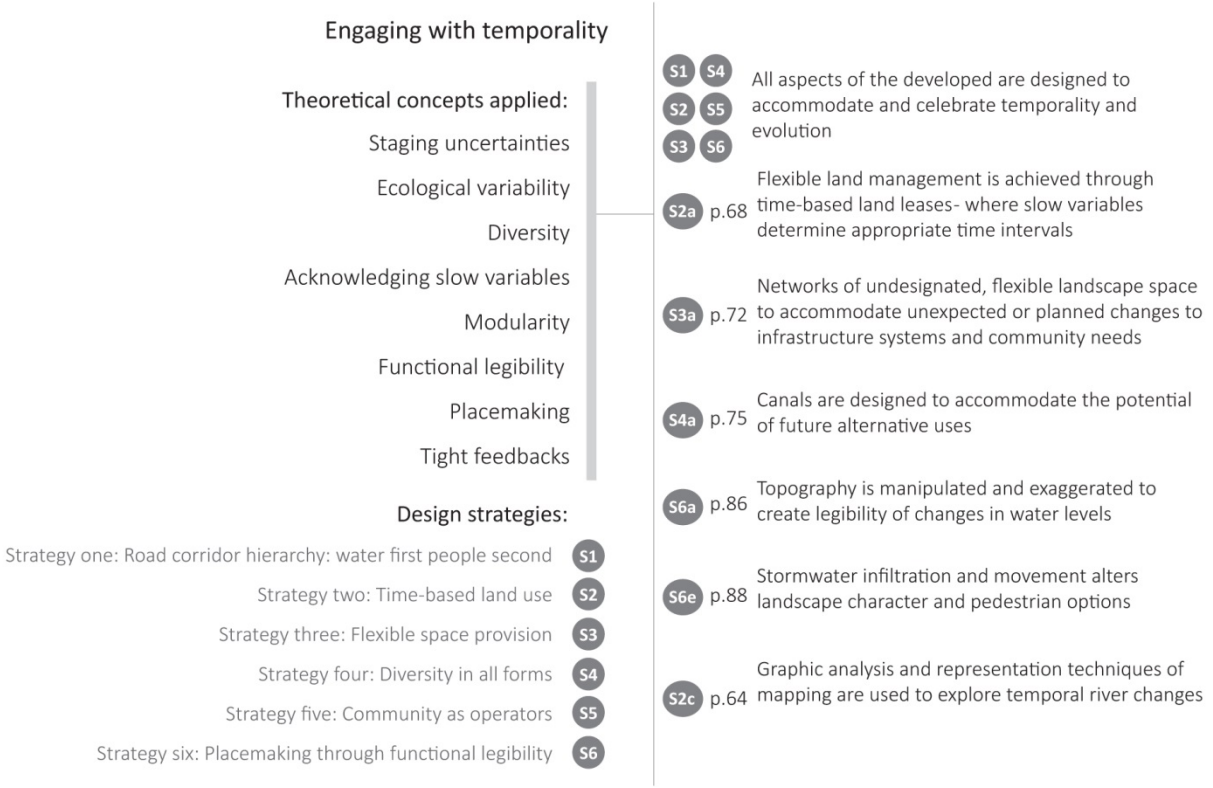


Figure 57 Ideas generated which engage with temporality and could foster greater adaption to change

Design-led innovation potential

As mentioned already, the design-focused nature of landscape architecture could be of major significance for increasing resilience, for 'a resilient approach fosters and encourages novelty and innovation' (Brian Walker and Salt 2006: 149). The Oxford Dictionary defines novelty as the quality of being new, original or unusual and innovation as a new method or idea (Oxford Dictionaries 2014a). As design can be described as 'the human capacity to shape and make our environment in ways without

precedent' (Heskett 2002), the apparent lack of emphasis on the benefits of design professions in resilience debates is perplexing. Perhaps it is due to the prominence given to adaptive learning or maybe a misunderstanding of the potential role of design to reimagine and project futures. In the book *Resilience Practice* for example, the authors state '*Robustness*… has more of a design connotation. For example, how do you design a bridge, or a management policy, that will continue to function under a range of conditions?' (Brian Walker and Salt 2012: 92). Is the concept of design associated only with absolutes and precision? In an article exploring the value of design in planning processes, van Dijk (2011) compellingly summarises the untapped opportunities of design:

> 'Unique to the design, as opposed to the decisions, is that the former is not about operationalising choices made, but rather about helping to choose, because designs are foremost explorative; they help to imagine in what ways our ambitions can be satisfied and what the consequences of those possible ways are. Designs visualise possible futures, often without saying what future we should choose' (van Dijk 2011: 129).

Though he emphasises design as a product, I would emphasise design as a process, a process that enables multiple voices to explore and probe new ideas and visions for living.

In the article Resilience management in social-ecological systems: a working hypothesis for a participatory approach (B. Walker et al. 2002), the authors suggest the identification of potential future scenarios as a tool to create discussion about the threats or possible change trajectories groups might face. This research shows that landscape design is also valuable in generating concepts for scenario based futures (see

Figure 58). Planning for adaption could then involve identifying potential futures and working through possible responses, as well as also projecting creative, alternative, maybe slightly 'out there' ideas that challenge conventions –ideas that expand the range of possibilities considered.

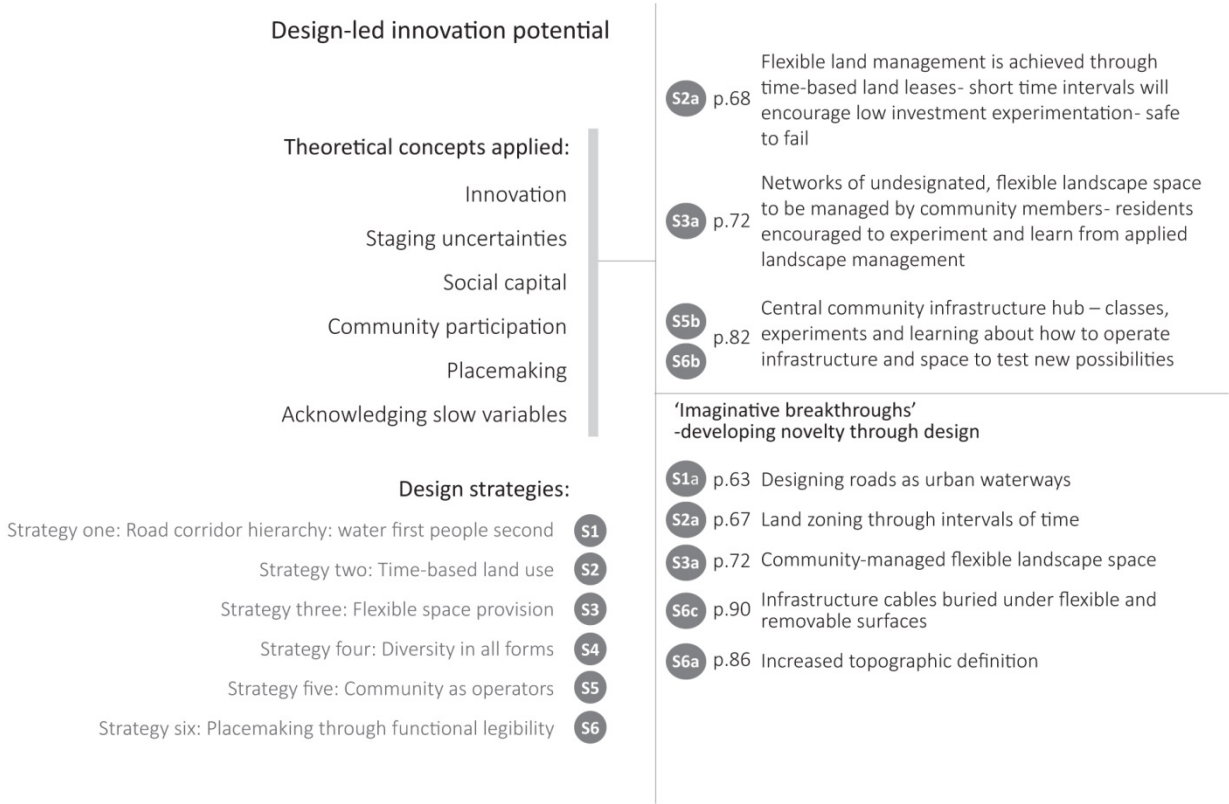


Figure 58 ideas generated which both encourage innovation and learning in community members, and attempt to challenge typical urban patterns

Increasing diversity

Diversity is both a strategy of resilience and a potent design tool for landscape architecture to use in building the adaptive capacity of landscapes. Although

multifunctionality is widely accepted as being a positive and sustainable facet of landscape planning and design, the potential for spatial diversity as a design tool is under-recognised. Corner states 'the *interrelationships* amongst things in space, as well as the *effects* that are produced through such dynamic interactions, are becoming of greater significance for intervening in urban landscapes than the solely compositional arrangement of objects and surfaces' (Corner 1999b: 227). Yet the compositional arrangement of spaces – the actual physical forms – can do much to increase adaption. Increasing the diversity and modularity of landscape systems and spaces offer two ways that spatial composition facilitates potential effects of greater resilience, as illustrated in Figure 59, but more spatial design tools are needed as well as greater awareness and application.

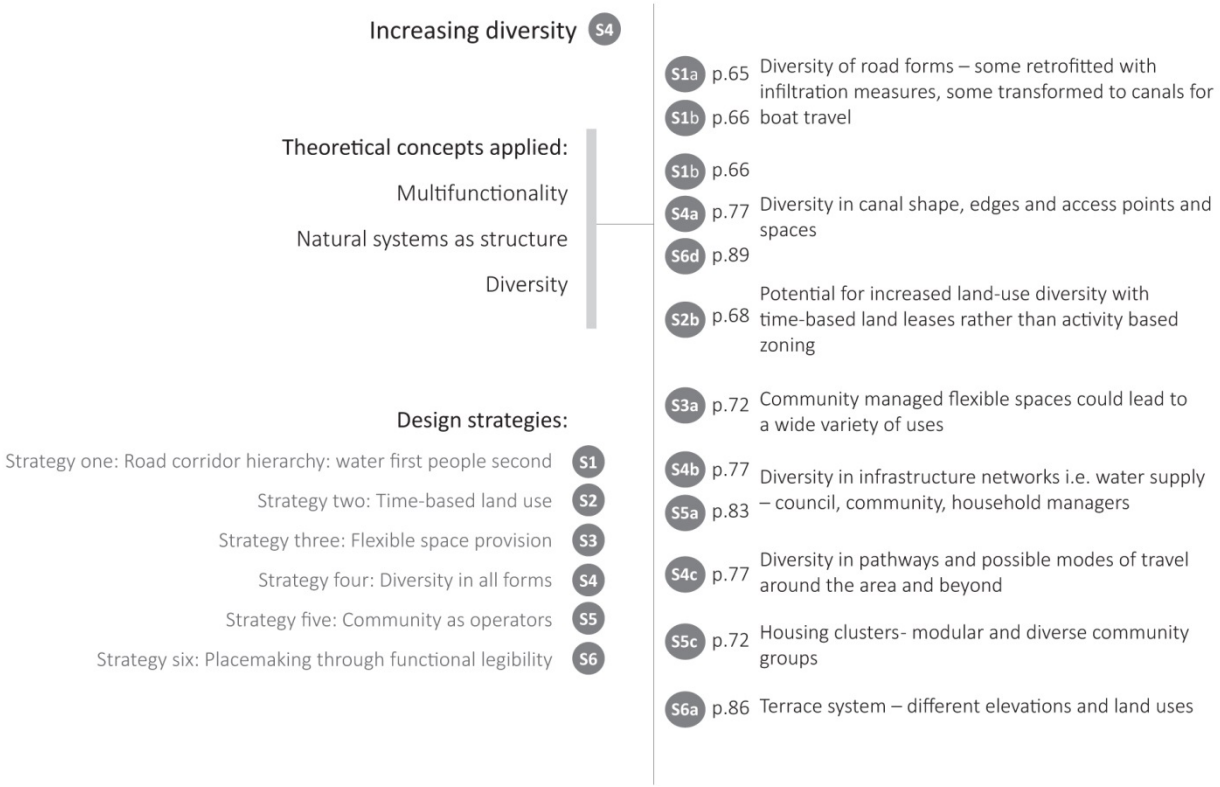


Figure 59 Ideas generated through applying the diversity strategy

Multiple scales

The adaptive capacity of social-ecological systems is linked across multiples scales. A property, neighbourhood, city and region will all be working through the adaptive cycle at different stages and the level of resilience at a particular scale can be affected by the scales above or below (Brian Walker and Salt 2006). For example in Christchurch, many properties in the residential red zone experienced only minor damage, yet their location in the broader scale of the residential red zone resulted in them being red-zoned. Unlike architects, engineers or planners, who might be more oriented towards a particular scale, landscape architecture works across multiple scales – from regional connections right down to construction materials. Could the multi-scale approach of landscape architecture result in practitioners acting as mediators in multi-disciplinary collaborations – the link between a multitude of voices, values and scales of focus?

This research presents particular resilience goals as having more relevance to landscape architecture, but this does not discount the importance for landscape architecture to engage with all the resilience strategies. For example, overlap in governance is perhaps an approach requiring the attention of social planners and sociologists, yet landscape architects collaborating with other disciplines could help explore innovative ideas for alternative governance systems through design thinking and process.

Modularity was another strategy the analysis didn't represent well. Modularity was an invaluable design prompt for the design exploration and even guided the overall site program of decentralised *modular* residential development. The dominant value of modularity found within this design research lay its potential as a spatial organiser – transport connectivity, land use management and system design of infrastructure; aspects fundamental to design and planning but discussed only broadly in this research.

Tight feedbacks was the strategy least used as a generative prompt and also low on the ranking list. Tighter feedbacks in landscape design might mean limits to global materials used or increased monitoring of finished projects to determine their consequences. As the resilience strategies are presented as having equal weight, what could landscape architecture do to tighten feedbacks in their projects? Lastly, acknowledging slow variables had significant value as a generative prompt but require greater inter-disciplinary teamwork; landscape architects will need to collaborate to determine the full range of variables potentially acting on a landscape.

Through a critique of the value of landscape architecture in increasing adaptive capacity in urban environments, this research found the discipline particularly instrumental in six aspects: integrating social and ecological processes, improving social capital, engaging with temporality, design-led innovation potential, increasing diversity and the working across multiple scales. Furthermore, several imaginative concepts were developed that expand the range of possibilities for adaptive residential living. These are: designing roads as urban waterways, land zoning through intervals of time rather than activity, community-managed flexible landscape space, infrastructure pipes and cables buried under flexible and removable surfaces and increased topographic definition.

The next chapter draws conclusions and further openings out of these insights. With the aim of exploring possible limitations to the involvement of landscape architecture in disciplinary collaboration and suggesting possible steps forward to engage in debates of resilience planning.

Chapter 9 Final thoughts

The research process revealed ways in which landscape design could reimagine and potentially transform urban landscapes after disaster. The conclusions of this research are not so much answers to specific questions as are a series of openings being created. Many further questions appear through considering the potential of my research findings to increase the instrumentality of landscape architecture in urban design.

This research found the discipline of landscape architecture to have instrumental significance to resilience strategies and the potential to have a valued role in multi-disciplinary collaborations. The efficacy of the discipline in augmenting the resilience strategies is found to be strongly connected to landscape disciplinary theory. For example, the possible resilience benefits found through landscape architecture engaging with temporality and staging uncertainties finds greater potency through applying the theoretical ideas of landscape urbanism (Bélanger 2012; Corner 2004, 2006). The potential for designed landscapes to enable greater awareness of the interconnectivity of ecology and society in urban environments - thereby increasing social capital - is made more conceivable through applying concepts of aesthetic experience and civic meaning (Howett 1987; Meyer 2008; Poole 1998; Spirn 1989). Furthermore, this research found the resilience strategies presented by Brian Walker and Salt (2006) to be not only helpful as overall goals, but also helpful as idea generators.

Theory application in developing more adaptive landscapes and communities is therefore vital. The role of theory is compellingly described by Corner (1990: 62) who states:

> '…there is a distinction between craft and motivation, between the skill of making and the purpose that motivates the skill… A built landscape may well survive blemishes of craft, but will rarely survive a creative stillbirth. This relation between craft and motivation, the how and the why, is the forgotten role of theory'.

If theory is thus critical to motivate both *how* a project might be realised, but also *what* sort project might be appropriate; how can the application and knowledge of resilience theory become more integrated in the practice of landscape architecture in the real world? As the effects of climate change has potential to bring catastrophic changes to social-ecological systems at all scales, increasing the adaptive capacity of communities and their landscapes should be an overarching imperative of landscape architecture. This research has shown that as a discipline there is much value in resilience thinking, but how can we better assert that value?

Through the 'creative destruction' of disaster, opportunities to reimagine living patterns and challenge conventional paradigms emerge (Gunderson and Holling 2002). The transformation potential of Christchurch's residential red zone is exceptional in this regard, owing to overarching land management decisions of large-scale property buyout and demolition. Allan and Bryant (2011) debate the creative possibilities for designers after disasters but suggest large scale transformations are rare, in part due to people wanting to return to normal life as soon as possible, and the reluctance of residents relocate and give up their properties. In Christchurch, a dictatorial decision making process resulted in residents being forced to sell and move. Although hugely socially disruptive, this process significantly opens the potential for transformation. In comparison, in New Orleans after Hurricane Katrina, each individual home owner was given a choice to rebuild or leave the city. Although this allows for more individual freedom of choice and the chance to hold on to place attachments and emotional

connections with the land and people, it has left the city in a challenging situation of extreme urban fragmentation. This process has arguably left these communities with insufficient critical mass for creating a vibrant community, and made large-scale planning and transformation more difficult to achieve (Bowring 2014).

An additional value I found of the extreme change experienced in eastern Christchurch was that it unlocked many design ideas for alternative living possibilities during the design process. No houses, no people, no property ownership issues, no un-transformable infrastructure systems, no differing community views. Although these conditions do not usually exist in urban environments, they allowed me as a designer to extend the range of possibility to the extreme. Transforming a road to a canal in an established neighbourhood might seem implausible, as might changing land management systems from permanent ownership to time-based leases. But as current living patterns are typically both unsustainable *and* unresilient, affected communities need some different ideas.

As a methodology for extending the range of possibility, I suggest as part of the scenario process where practitioners work *with* communities to identify multiple possible change trajectories (B. Walker et al. 2002), designers also encourage the consideration of the range of responses - including the extreme. Design theorist Jonas (2001) describes scenario building as a central concept in design and advocates using the 'Quattro stagioni' (see Figure 60) diagram in design process, where two sets of extreme variables are placed at each indices. The combination the extreme of each variable frames four different scenarios. This methodology could be used to great effect by landscape designers in working with communities to create alternative visions for the future. In Figure 61, I present a range of potential alternative site conditions that could form a starting point to scenario building, gathered both through insights in

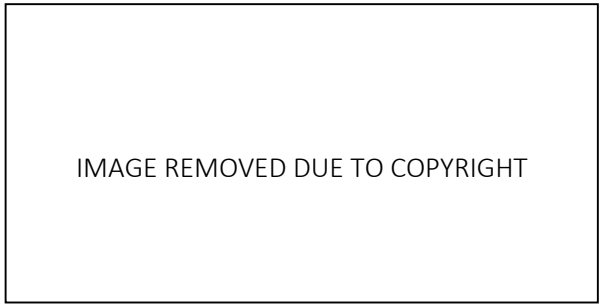


Figure 60 'Quattro stagioni' - Four scenarios are imagined through combining two variables
Source: (Jonas 2001)

this research project and through learning about different responses around the world to disasters and more adaptive living.

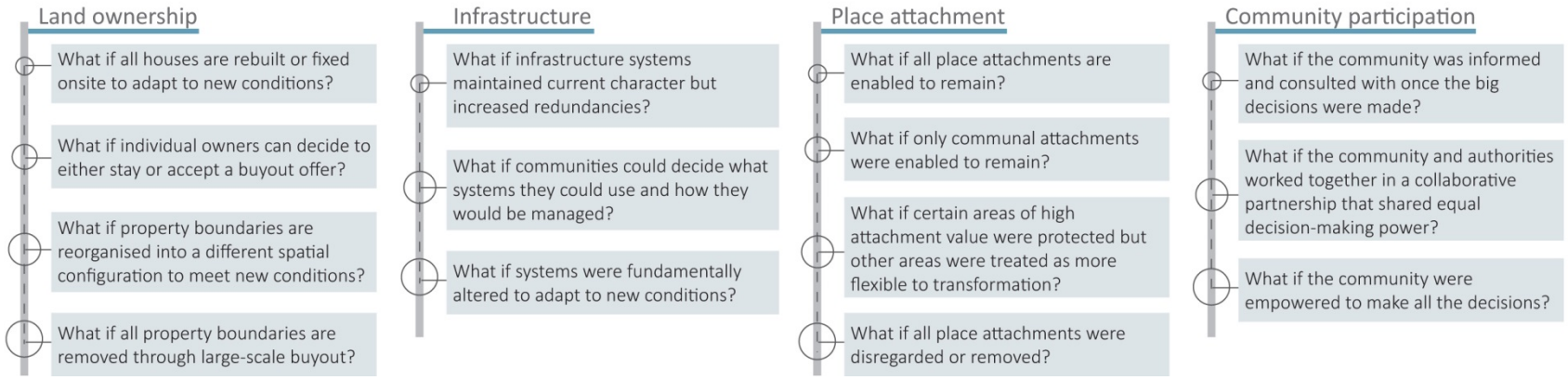


Figure 61 Scenario building - what alternatives might be imagined when the 'givens' are removed?

However, even with such transformation opportunity, how can decision-making environments conducive to design exploration and investigation be set up in reality? First, assuming landscape architects were well equipped with theoretical knowledge and understandings of how they might use design processes to increase community's adaptive capacity; how can they assume an integral role in decision-making collaborations, or do they wait to be invited to participate once the decisions are made? Stepping back, perhaps one of the most significant roles for landscape architecture in city planning debates could be to enforce the need for environmental and social adaptive capacity – to increase resilience in social-ecological systems. As a discipline connecting ecology with society in the built environment, perhaps landscape architects need to become advocates for increasing adaptive capacity in general.

Opportunities for future research include further investigation of a spatial design tool kit for encouraging resilience in landscape design. This research found landscape architecture theory overall to be already well connected to concepts of social-ecological resilience but the links between this theory and the potential instrumentality of landscape architecture in this respect could be better documented and acknowledged. Additionally, gaps were found where existing landscape theory failed to noticeably align with the resilience strategies. Resilience is not prescriptive or definite. The resilience of a social-ecological system is relational to what phase of the adaptive cycle the particular system is in. However there are visions, as Brian Walker and Salt (2006) put it, as to what a resilient world might look like. A mission of landscape design should be to facilitate movement towards aligning urban environments with these visions. Though more work is needed on a landscape design tool kit for increasing adaptive capacity in landscapes and communities, I suggest a start – created through the synthesis of resilience strategies with landscape theory, and with insights taken from the design research process (see Table 5).

Natural systems as structure

- Facilitate urban systems such as infrastructure and residential developments to be designed in relation to underlying natural systems such as hydrology and topography.

- Embrace ecological variability (e.g. flooding, forest fires) as part of living in the world – design to facilitate these temporal or gradual changes rather than constrict them.

- Design for ecosystem services and include them in development proposals.

- Engage with mapping tools to understand the natural systems of the site: topography, hydrology, geomorphology etc. – how can design transform urban landscapes to welcome flooding?

Staging uncertainties - Embrace temporality and change in landscapes. Designers need to explore creative strategies for facilitating adaption e.g. staging, phasing, scenario building etc. - Where possible or beneficial, create land management systems framed by the expectation of change e.g. time-based or event-based zoning - Identify and monitor the slow variables at a range of scales working on a site (e.g. sea level rise, vegetation succession, demographic change). How might landscape design facilitate a positive adaption to these changes?
Increase awareness of interconnectivity of social and ecological processes - Engage with concepts of aesthetic experience and meaning to increase resident's knowledge of how their places work, how infrastructure systems support them, where water will flow when floods occur, how they might respond to operational challenges when they arise, and how, through their own actions, they could influence their environments.
Community participation – adaptive learning - Encourage community participation throughout all community-based projects, working *with* communities as a facilitator rather than a 'masterplanner'. Encourage projects that empower communities to experiment and learn from their success and failures. The building of imaginative possibilities through design becomes more about helping communities realise processes for adaption than final resolved concepts. - Also, explore ways where communities could have increased operating responsibilities.
Modularity -Design modular systems (i.e. transport connectivity, stormwater systems). Modularity and redundancy provides room for failure and adaption. City transport grids for example, are well documented to increase resilience through their modularity. - Design using modularity but maintain interconnectivity to increase the flexibility of systems. A decentralised, modular neighbourhood could operate autonomously to wider city networks (i.e. energy grids), and keeping a connection to the larger grid allows the neighbourhood to connect to the outside systems if their own systems fail.
Diversity -Design using spatial, system and programmatic diversity. Diversity helps create opportunities for adaption. A suburban park with many different types of spaces (size, character, shape, open or closed), uses (sports, hard courts, community gardens) and entry/exit points for

example, could provide residents more opportunities to adapt different elements to suit their needs.
Overlap in governance -Work with other disciplines to explore ideas for alternative governance systems – the management of landscapes might provide an instrumental framework for connecting multiple agencies and actors.
Innovation through design and by encouraging systems of change and experimentation -Use design as a tool to expand notions of what's possible. Work with communities to explore innovative ways they might encourage adaption in their environments. Explore through design, scenarios where seemingly unchangeable elements of urbanity (like roads or land ownership) are removed. Design landscapes integrated with frameworks of experimentation and learning.
Tight feedbacks -Consider how landscape design could tighten feed backs – for example, so stormwater is infiltrated on site or materials used in construction are sourced locally. How could design also increase awareness of the environmental problems associated with loose feedback systems of globalisation, and encourage residents to act more sustainably?
Design for flexibility -Consider the potential future use of a space. Is it likely to stay the same land use or will it change? Might it change significantly or only slightly? What will potential uses in the future require? Could spaces be designed to accommodate unknowns? Perhaps an urban courtyard near the beach might in the future be returned to dunes or wetlands, therefore how could design enhance the ease of this transformation? Use of more flexible or removable materials like durable timber might be more appropriate than concrete. - Design spaces to create opportunities for evolving uses – for example, in the future more cities might integrate e-bike networks. Provide flexible spaces for these evolutions to occur.

Table 5 Strategies for landscape design to increase the adaptive capacity of landscapes and communities

A possible limitation to the instrumentality of landscape architecture being a significant force in urban organisation is found in the current lack of use of the word 'resilience' by many theorists. Allan and Bryant (2011) describe the resilience concept as acting as a potential disciplinary bridge. Many different professions use the term, including engineers, psychologists and ecologists, and although different definitions or focuses might cause misunderstandings, there is potential for the concept to unite diverse professions. The ecology-based strategies of landscape urbanism are strongly related to concepts of social-ecological systems: ideas of indeterminacy, staging uncertainties and adapting to changing conditions are inherent to resilience thinking.

Why do the theorists advocating for these ideas not describe them in terms of resilience? An example of this word exclusion is illustrated through analysing the book *The landscape urbanism reader* (Waldheim 2006). The term resilience was used in only one chapter and that was to describe the resilience of human trafficking systems. The term resilient appeared fleetingly in two other chapters but was used in the descriptive rather than strategic sense.

Landscape urbanism advocates for the 'acceptance that ecological and social processes in an urban environment cannot be determined' (Czerniak 2011: 15), an underlying concept of the social-ecological cycle. If landscape urbanism already affords a solid foundation for resilience thinking, might an increased use of the term 'resilience' increase the validity and relevance of landscape architecture in resilience debates in the eyes of city decision-makers? Interestingly, many high profile landscape designers also refrain from using the term 'sustainability'. Elizabeth Meyer humorously suggests their possible mantra - 'Sustainability is not to be spoken; it is a form of reductive ecological functionalism' (Meyer 2008: 14). Why might this avoidance of potentially disciplinary-bridging terms occur? Could more use of wide-ranging terms like resilience

do more to foster the inclusion of landscape architecture in prominent decision-making circles?

The potential for processes and outcomes of landscape design to build imaginative possibilities for alternative living systems was a key finding of the value of landscape architecture in building adaptive capacity. Enabling innovation, learning and experimentation is essential to resilience thinking (Brian Walker and Salt 2006). However, in practice, is there enough emphasis on exploratory design? How could landscape architecture better align its practice to collaborate with communities and empower them to experiment and learn from their experiences? Who defines the goals or programme for commissioned projects? How can landscape designers position themselves to explore the possibilities of 'what if' rather than simply working out 'how'? If practitioners of landscape architecture are unable to become involved with more exploratory design processes, could universities and design practice-based research instead be utilised to generate new potential? Could communities and universities form increased partnerships where they collaborate to explore possible futures and opportunities for communities to increase their adaptive potential?

The challenges confronting humanity in the 21st century, although likely to be disastrous and catastrophic at times (see Figure 62), also create huge opportunity for the discipline of landscape architecture to become instrumental in strategic city planning. Designing processes *as well as* forms to encourage future adaption is critical. Strategies are needed for how we might frame land use and activities to evolve with changes. Further, the experience of landscape forms and systems is equally important to increasing personal and community resilience. Christchurch is just one city among thousands experiencing the collisions of mismatched social and ecological systems, but through the extensive damage and disruption caused by the earthquakes, we have an exceptional opportunity for large-scale transformation. How we respond now will set

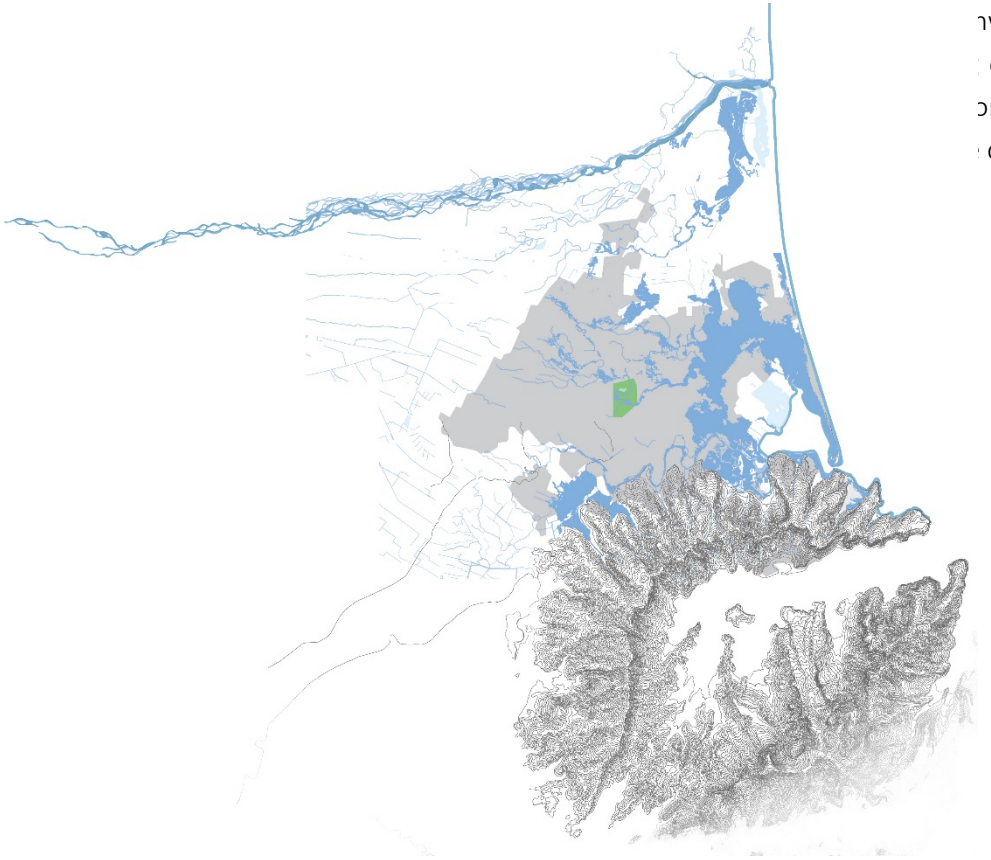


Figure 62 Christchurch during a storm surge with a 1m sea level rise - estimated to occur in just a century
Map data adapted from Tonkin & Taylor Ltd (2013), LINZ and ECAN.

ıway for the future. This research has explored a possible future framed by opportunities to adapt and change. As Christchurch and other coastal cities ɔme increasingly watery in the future, how can landscape architecture respond challenges?

Postscript

This research was undertaken in response to the experience and effects of the Canterbury earthquake sequence - particularly in reaction to the unique context of the residential red zone. In exploring research questions focused on generating site-based possibilities for urban adaption and transformation of the residential red zone, it was necessary to identify future effects for why adaption might be important. The research and analysis quickly found flooding, both from rain events and storm surges, to be a significant cause of severe landscape change in the area, now and into the future. I spent many hours mapping the area of Avonside - the topography, flood risk, and analysing and mapping the effects of sea level rise and storm surge flooding. This physical setting and predicted future effects gave my research questions a contextual base. As a result, my research evolved to explore how urban living might adapt to flooding and sea level rise in the future. Visualising the potential for land and roads to flood, strongly influenced many of the design responses - including transforming roads into canals, the terrace system development and time-based land management.

At the commencement of this thesis in July, 2013, flooding was a well-known issue for Christchurch, both historically and more recently – the earthquakes caused severe flooding and some surface flooding had occurred since. However, on March 5th, 2014, while I was in the final phase of the design exploration, an intense rainstorm caused a 'one in a hundred' year flood across several communities within the greater Christchurch area (see Figure 63 and Figure 64). Less than two months later, another major rain event again caused flooding and wide spread disruption and damage. In an extreme case, one man's home has flooded nine times since the earthquakes

IMAGE REMOVED DUE TO COPYRIGHT

Figure 63 Community spokesperson Jo Byrne outside her Flockton home in March
Source: www.3news.co.nz

IMAGE REMOVED DUE TO COPYRIGHT

Figure 64 Flooding in the suburb of St Albans
Source: www.nznewsuk.co.uk

(Mathewson 2014). The graphic representations of flooding shown in the maps I had studied became a disastrous reality for hundreds of residents. One of the hardest hit areas is a neighbourhood of streets known as the Flockton Cluster. Although the potential for flooding was present before the earthquakes, the earthquakes substantially increased the severity (see Figure 65); a situation explained by the city council flooding task force – 'In general land across the area has dropped, the stream channels have narrowed, and river beds risen due to the silt and sediment build up and heave. These changes mean that the waterways are no longer able to discharge flood flows'(Land Drainage team 2014). The number of affected properties in the Flockton area alone, is in the hundreds (see Figure 66).

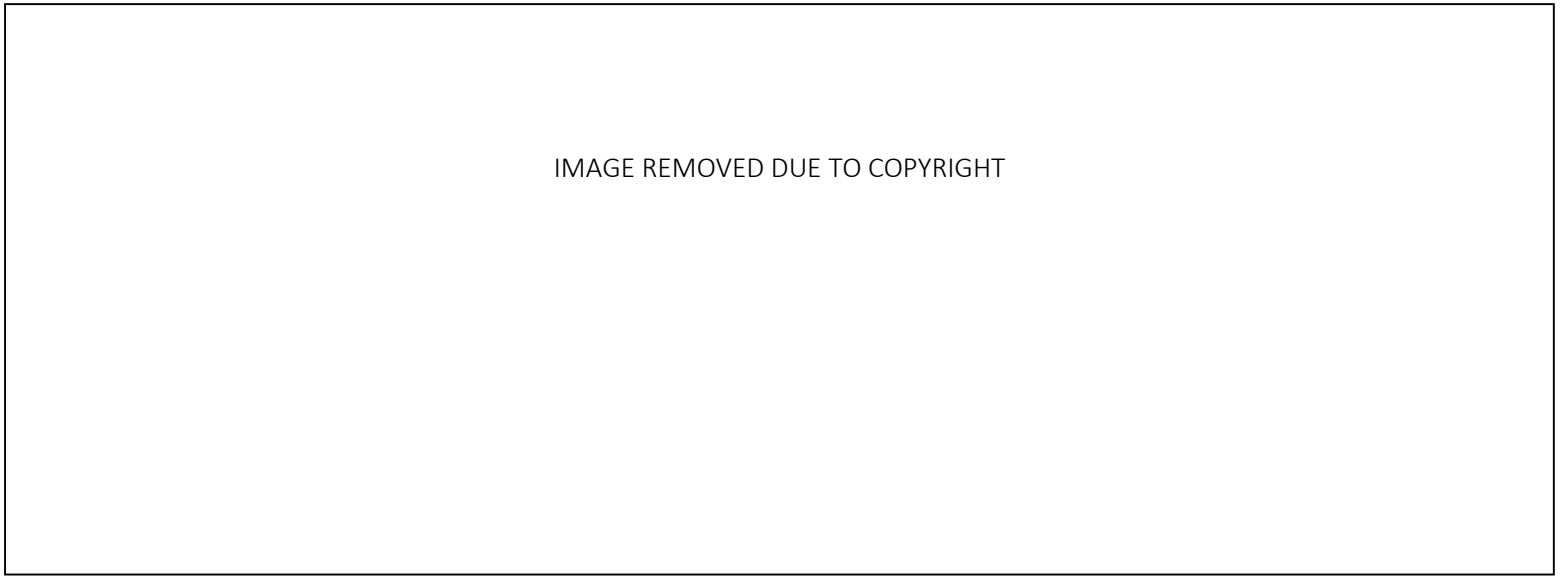


Figure 65 The increased flood risk caused by the earthquake
Source: (Christchurch City Council and Jacobs SKM 2014)

The theoretical and projective future I explored in Avonside where flooding becomes a frequent and expected part of living in a low lying riverside area is now a soul-destroying reality for hundreds of residents who live in houses and land management frameworks not designed to adapt to these changes.

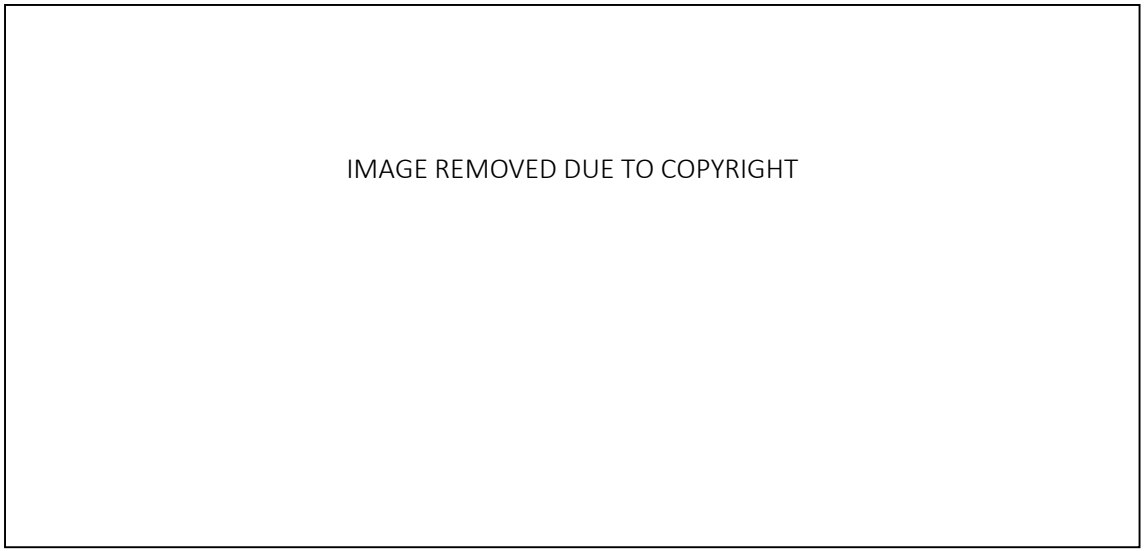


Figure 66 Flooding in the Flockton area - numbers of properties affected
Source: Image showing exaggerated topography from Land Drainage team (2014), estimated property data from Rebuild Christchurch (2014)

Within the residential red zone context, many complex layers that could restrict adaption possibilities were removed – property boundaries, emotional and financial investments in land, community will and sentiment – yet these all exist in the Flockton area and in numerous other areas around the city affected by flooding. The situation is neither financially or emotionally sustainable, yet the inherent complexities mean no

quick fix or 'right' solution. Nevertheless, the issues facing both residents and authorities attempting to respond will unfortunately become more and more common as neighbourhoods face the effects of climate change. The Flockton area 'solution', has the potential to become an instrumental learning exercise for all of New Zealand in how to adapt to landscape change, but are the conversations really heading in this direction? Are concepts of social-ecological resilience being explored?

A key tenet of social-ecological resilience is to embrace change, adapting to change can reduce the build-up of impacts (Brian Walker and Salt 2006). In Christchurch for example, attempting to constrict flooding might result in a false belief that infrastructure and property can be designed and rebuilt without considering flood risk, increasing the potential economic and emotional fallout when flooding overwhelms systems. Another strategy for increasing resilience is improving social capital, involving community participation and competency. Many residents in the Flockton area have lived there for several years, or even decades; their insights into how the landscape works and changes, are invaluable. Theory on community resilience states people need learn about their options and risks, and work creatively together to solve their problems. Although the Council advocates strongly for community participation, it appears to involve activities of informing and consultation rather than community empowerment; as illustrated in the Dudley Creek Upgrade Options Feasibility Assessment Report – "It is important to note that no consultation with land owners has yet occurred and that the designs will be further refined once a preferred option has been selected..".

The problems facing the Flockton area will become more and more prevalent to low-lying communities over the next century. Is it enough to widen streams and install flow bypasses and pumps? Might we actually need to question our fundamental relationship to landscapes and change? Perhaps we need to start experimenting with

alternative options - different land use frameworks and housing types for example. For an area like Flockton, short term flood relief is necessary, yet longer term questioning of how changing landscapes might be most appropriately used is essential. For an area like Avonside, the lack of complexity makes it an ideal place to test alternative patterns that could be applied to areas like Flockton in the future. Change however, is often not wanted – change might bring unwelcome economic or political consequences for some – yet embracing change, learning, experimenting and adapting to create more resilient urban environments is vital for all.

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Appendix A

A.1. A comparison of ideas from the writings of James Corner and Elizabeth Meyer: ideas grouped into themes for examination

As part of the process of analysing the theoretical frameworks in order to create a useful toolkit for applying to the design investigations, I reviewed and analysed the theoretical concepts of James Corner and Elizabeth Meyer. See page 43 for a full explanation.

Through the analysis process I critiqued and compared their ideas by constructing tables representing what I saw as the key themes they both debate – aesthetics, time, experience, insight generation and analysis, connection to culture, site, infrastructure and representation. As a result of applying the theories to the first design probe methodology, I further condensed the theoretical concepts into what I analysed to be Corner and Meyer's fundamental difference – their contrasting ideas on what objectives should drive spatial form. I also developed a table analysing this difference.

The following tables were developed as part of the research process – to enable me to understand their ideas and apply them to explore potentials. As a result, the tables do not contain references as they do not have a 'report' function. Some tables are followed with a discussion and some are not.

AESTHETICS

CORNER	MEYER
Landscape ought to be valued less as a scenic spatial phenomenon, and more as an active & temporal medium.	Appearance differs from aesthetics. Somatic aesthetic experiences over generic scenery. Aesthetics are multisensory, celebrates motion & change. Systems aesthetics over object aesthetics.
Detaching the landscape from culture as an object of aesthetic contemplation is to distance people from the various relationships, reciprocities & indifferences between them and the land.	Beauty in nature has the power to spur action and shift selfish attitudes to collective concerns for our shared environment and to encourage different responses to risk. Beauty is also restorative
Wants a landscape architecture less preoccupied with ameliorative, stylistic or pictorial concerns, and more engaged with imaginative enabling & diversifying practices.	Beauty is not generic, it is site specific. We should be challenged by new forms of beauty specific to particular environments & contexts.
Beauty as a charade, an illusion that hides the ills of contemporary life.	Aesthetic experiences can overcome the blindness of everyday life to make a connection between landscape and people.
Scenic and semantically encoded landscape design denies deeper relationships between people and the earth.	Awareness of natural systems & processes and knowledge of our interdependence to them, can alter aesthetic preferences/values.
	Aesthetic values are malleable and can be influenced by changing approaches to nature.
	Beauty should be based on current reality as opposed to romantic ideals of the past.
	The regular experience of the landscape transforming over time can allow new forms of familiar beauty to emerge.
	Beauty (a process between the senses & reason) includes agency. Beauty can evoke social and ecological desire.
	A concern for beauty is necessary for sustainable design to have a significant cultural impact.
	Beauty will be discovered through the way a designed landscape artfully expresses & celebrates responsiveness to a whole range of interactive systems. i.e. vegetation, climate, soils, community
	New forms of beauty will be discovered as new approaches for reclaiming, remaking and reforming a site's natural processes are invented. New forms of strange beauty.
	Aesthetic experience as a tool of sustainable landscape design.

	Provoking a sublime experience of landscape can help change collective environmental consciousness. Sublime – the knowledge of the violent relationship between beauty and destruction. Awe and terror. Can achieve a sense of post-modern sublime only though the knowledge of a place's history
	Avoid aestheticizing natural processes or reducing to spectacle. Beauty in understanding and experience.
	Experience of post-modern sublime is not scale specific, not vast scales. It's about interactions, relationships and knowledge, not scale.

Thoughts on aesthetics:

Meyer

For Meyer, aesthetics **is** experience - she hardly every writes about aesthetics without writing the *aesthetic experience, the aesthetic landscape experience.* To her, landscape aesthetics and beauty is not something separate from herself, she has to experience them to know them. Aesthetics are somatic, site specific and systems based. Aesthetics can be transformative, regenerative and change people's attitudes and behaviour towards the environment.

Corner

Corner sees aesthetics contemplation as objectifying the landscape – separating himself from the landscape. He becomes a person outside of landscape experience. As a result, he seems to see aesthetics as only visual & scenic, ameliorate & pictorial. Separating oneself from the landscape removes haptic, somatic and experiential qualities – only visual is left. He sees beauty as a setting, not inherently part of the landscape.

He argues against the scenic, visual and pictorial approach to landscape architecture - how visually focused landscape architecture projects are reducing the practice and separating culture from the environment. He is less focused on ways to remedy this situation – more focused on identifying the issue. He does however argue for a landscape architecture that better engages people in the environment, and calls for designs based on strategies and processes over formal stylistic concerns.

Discussion

They seem to view aesthetics in two completely different ways. Meyer as part of landscape experience. Corner as separate to experience, thus objectifying landscape. 'Landscape as object' is something both Corner and Meyer strongly advocate against.

TIME

CORNER	MEYER
In order to reflect the pulsing flow of life, landscapes must resist closure & representation – be caught in the processes of indeterminacy , diversification and dynamics – the processes of ecology. View the whole metropolis as "a living arena of processes."	Processes flow across site lines. Boundaries are blurred, there are no edges.
Rather than a description of what the finished product will look like, Corner argues for program. Program over description. – "processes, stragegies, agencies, scaffoldings." A catalytic framework that sets up conditions for processes and strategies to play out in diverse relationships. This needs a highly specified physical base from which more undetermined practices/processes can take place. This framework needs to be flexible but strong enough to accommodate change while not losing identity and legibility.	To change collective identity & environmental values, large park design must employ multiple, temporal strategies.
Plans lead to an end. Maps provide generative points and are not overly determined. Though he also says 'a good strategy is a highly organised plan that is at the same time flexible.'	An increase in understanding of the relationship between appearance and function over time increases the pleasure experienced in the landscape. Spiritual, symbolic and physiological needs that are achieved over time – no instant gratification.
Political, cultural, environmental etc processes are more significant in shaping urban relationships than spatial forms of urbanism. Emphasis on how these processes shape spatial form over object qualities of space (formal & scenic).	New forms & arrangements of landscape design can be revealed through a close study of a sites's natural processes. Resulting in an experience of landscape based on temporal & spatial sequences over conventions of the scenic & visual. Spaces based on rhythms & flows. E.g. wind direction, river movements, floods
Proponents who argue for strategy over form are misguided. Use strategic thinking to find greater efficacy and potential for the physical reshaping of our world. Form, geometry and material are the bones that a strategy plays itself out. Site specific forms.	Sites are full of histories and meanings. "it is a living place" one that changes over time but doesn't change at all.
Landscape ought to be valued less as a scenic and spatial phenomenon, more as active, temporal medium.	"the intrinsic beauty of landscape resides in its change over time" dynamic processes over static, multiple visions. Beauty that recognises the flow of time as well as single moments in time.
	It is important for the designed landscape experience to tap into the citizen's concrete understanding of place – not be an uncomprehendable interpretation of place by the designer.

Thoughts on experience:

Meyer

Focuses more on the experiential aspect of time – the meanings, understandings and pleasure that can be attained through the experience of a landscape over time. Dynamic landscapes as beautiful and mentally restorative. She discusses the depth of history to a site, sites are not empty canvases waiting for a designer to come along. They have histories, stories and processes layered within, through and beyond. A landscape experience can be guided by these temporal structures - this challenges the dominant conventions of the visual and scenic to facilitate pleasure and beauty. She also briefly mentions employing 'temporal strategies' in design and relates this to how we could change collective identity & environmental values.

Corner

Focuses on the idea that large scale processes and strategies should guide design decisions more than spatial, formal concerns – seemingly focusing mainly on large scale urban design, rather than a more intimate experiential scale. He argues for program over description, function & agency over appearances and meanings. However, he states that a strong material structure (influenced by a site conditions) is essential for program and strategy to play out - setting out the conditions for life to evolve. He strongly advocates for maps over plans but seems indecisive as he also states that a highly organized yet flexible plan is ideal also.

Discussion

Both Corner and Meyer advocate the use of time and experience to overcome conventions of visual and scenic landscape architecture, however they discuss this in very different approaches. Meyer is focused on a more human experiential scale concerned with beauty, experience and changing values and notions of land ethics. She doesn't seem to sway much from these core goals. Corner writes about time as strategy and process – a more panoptic approach where the designer is setting up conditions for these large scale processes to play out across a site. He wants to move away from meanings and appearances but still says form is crucial. So how is this form experienced if appearances and meanings are not as important as function? He seems to expand so far out, so high above the landscape medium that how his ideas can actually be translated into a site becomes a little fuzzy. He talks of poetry, symbols and 'being' a lot so perhaps when I look at that closer it will become clearer what he wants this form to be.

EXPERIENCE

CORNER	MEYER
Landscape experience is never only aesthetic – more deeply experienced as a network of relationships and associations.	The experience of pleasure in the landscape can be gained not only by somatic & aesthetic experiences, but also through the knowledge of people's relationship to the land (ie. Land management ethics). This experience can also be restorative – reconnecting us to the biophysical world.
Experience of landscape takes time, a culmination of events, encounters & associations	Landscapes are 'full spaces', full of meaning, histories, rituals & nature – imbued with experiences. Form is not separate from this. An axis can be more than a line.
Experience belongs to all senses, visual is only one part of experience – negatives of scenographic design	A sensory landscape experience is a more powerful educator that reading about a landscape issue. Somatic, haptic & aesthetic experience transforms abstract knowledge to embodied knowledge.
The landscape is not an object separate from the world	Landscape experience should intermingle cyclical natural processes with collective social life.
Scenic landscapes are shallow, hold no meaning, are aestheticized experiences that are escapist – they displace the viewer & the landscape	The experience of beauty as a way to increase attentiveness and care for the environment.
Design to guide experiences of engagement, participation and use over time.	Beautiful sustainable landscape design involves the design of experiences as much as the design of form and ecosystems – noticing, wandering, wondering, and caring about the environment.
Landscapes should be defined by activities & experiences over appearances. i.e a garden by the activity of gardening rather than the formal appearance. Experiences of space cannot be separated from the events that happen in it. Space is remade every time it is encountered by different people & different situations.	It is important for the designed landscape experience to tap into the citizen's concrete understanding of place – not be an uncomprehendable interpretation of place by the designer.
Experience with the primary realm – rocks, rivers, solar cycles, seasonal change, has given different cultures understanding to the ideal. (the invisible)	
The most inspired landscape architecture has made the ideal explicit, providing humankind with a sense of meaningful belonging and orientation while transcending earthly limitations.	

Thoughts on experience:

Meyer

Aesthetics and experience are extremely related, almost the same thing. Beauty *is experienced* as opposed to viewed. An aesthetic is created through experience and these experiences are multisensory, somatic, dynamic and informative. The experience of a place can alter how someone feels or acts towards the environment. The design of landscape experiences can tap into citizens consciousness and effect their behaviour, and can increase the understanding of the inter-relationship between humans and cultural systems and the natural world.

Corner

Experience is never only aesthetic but is based also on relationships and associations. Experiences in the landscape take time – through cumulative events and happenings. He also discusses the power of landscape architecture to tap into the ideal, the invisible world of phenomena. Though he doesn't clearly state what he means by this.

Discussion

Meyer would consider the relationships and associations as part of the aesthetic whereas Corner sees them separately. Experience in landscape takes time – both agree on this point, Meyer expands this further to discuss what the result of this experience can be – pleasure and shifting attitudes. Corner is very focused on the anti-visual and scenographic argument and presents a compelling argument against experiencing the landscape as purely visual. He doesn't progress this much further rather than talking of process and function which relates to the time discussion. Meyer goes way beyond this and treats the visual argument as a given, an understood notion of landscape. Might this be a time of publication thing?

CREATIVE INSIGHT GATHERING AND DESIGN STRATEGIES

CORNER	MEYER
Tactics of collage, abstraction, appropriation, and imaginative projection, reveal and mesh new ideas and relationships. *"These do not represent the reality of the idea but rather inaugurate its possibility." (p.163)* However motives for these techniques need to be critically motivated. The function of abstraction is simply to gain new insights, not to justify a project	There is a move from site analysis drawn from rational mappings to site readings and interpretations, which drawn from first hand experiences provide strong foundations for design response. These are 'memorable drawings' that convey a site's properties, operations and sensual impressions.
Speculative and demonstrative drawing can act as vehicles for creativity	Study the surface form as well as the processes that form it.
Mapping can '*unfold* potential' – uncover realities previously unseen. The use of mapping to explore social and natural process relationships gives designers great 'efficacy in intervening in spatial and social process.' – mapping is never neutral	Interpretations of built works should be based on primary experience that is informed and extended by historical records (maps, journals, photographs, etc.)
Mapping is perhaps the most formative and creative activity of any design process. New techniques of mapping may generate new practices of creativity	Use site description that avoids binaries and the reducing qualities of nature - culture, landscape – architecture
'Tradition' in human culture is a constantly evolving practice that we are part of. It is not a relic that we are separate from. Thus we should find ways to reconcile previous accomplishments with ones of our own time. Blending the past and present - layering to build fuller landscapes with each pass	Challenge normative ways of interacting with the landscape. Explore past relationships with the land as well as current. Times change and alter how a site is read.
Hybridised and composite diagramming techniques allow multiple issues and relationships to be considered. (datascapes, imagetexts, pictographs etc)	Use design strategies of scaling, intersection, overlay and superimposition rather than strategies of composition to create patterns of urban form.

Thoughts on creative insight gathering:

Meyer

Meyer seems to focus on alternative methods of insight gathering, rather than relying on objective and rational analysis techniques. She advocates for site readings and interpretations based on primary experience as well as interpretation of past events and processes. She also urges us to challenge conventional ways of reading the site, and breaking down binaries and boundaries, allowing unrealised relationships to emerge. However, elsewhere she does state that it is critical that the designed landscape must enable users to relate to and engage with it, rather than a confusing exploration of a designer's individual insights. With regard to design strategies, she advocates for the use of scaling, intersections, overlay and superimposition over composition strategies.

Corner

Corner has a strong focus on discussing various creative techniques that can open up new ideas and relationships. These include collage, drawing, creative mapping and various diagramming techniques. He emphasizes that it is not solely about the end product of these techniques (i.e. the final diagram or map) but also in the activity of finding, selecting and manipulating the material that critical insights emerge. He states that the use of these techniques must be founded on critical theory and purpose, and should not be used simply to represent and sell the final end product. On a different path of thinking, he discusses the idea that tradition should be seen as constant cultural evolution rather than as a practice separated from the present. That designing should build upon this evolution to create richer, fuller landscapes.

Discussion

Corner and Meyer are quite similar in this regard. They both argue for alternative interpretation techniques – for us to explore and invent new techniques and to challenge conventional notions of creative practice. Meyer focuses more on site-level interpretations, and although Corner appears to agree with Meyer, he is more focused on exploring higher level relationships, e.g. social, political, cultural, environmental processes and events.

CULTURAL CONNECTIONS

CORNER	MEYER
A physical connection with the natural world – rocks, rivers, solar cycles, seasonal changes etc. can provide people a sense of meaningful, spiritual and ontological belonging.	Sites have a capacity to tell stories – about production, consumption, histories etc.
Landscape design should relink today's practice to our cultural heritage traditions. We need to "devise new meanings (futures)" from critical reinterpretations of past traditions – where landscapes evolve and become richer, as opposed to being wiped clean every time a new intervention is designed.	We need design strategies that connect people and their behaviour to individual and collective identity, and ecological and industrial processes. How can such approaches engage people to become aware of their impact on our environment, and reframe environmental problems as social, economic and political issues?
Landscapes are the setting for human situations (birth, death, love, friendships, discussions etc..).	Designers should design landscapes that engage people in the truths of the environmental impact of our industrialised way of life, but without overly determining meaning.
Uniting artistic creativity with ecology might "inform more meaningful and imaginative cultural practices", where cultural and biological life is enriched, liberated, diversified and revealed – where a sense of wonder is achieved.	Design can alter an individual's consciousness and restructure their values and priorities.
Landscapes of mystery, poetry and existential experience and emotion have been forgotten. Our culture's tendency to view phenomena as scientific occurrences to be pragmatically measured has led to a spiritual and ecological crisis.	Sustainable landscape design should not only perform ecologically, but also should be interwoven with society and culture.
"As the great mediator between nature and culture, landscape architecture has a profound role to play in the reconstitution of meaning and value in our relations with the Earth." 1991	.Designed landscapes as constructed human experiences need to move citizens to action. Designed landscapes are visited by people whose environmental impact spread much further than the designed landscapes they visit.
"A move away from ameliorative and scenographic *designs* toward more productive, engendering *strategies* necessitates a parallel shift from appearances and meanings to more prosaic concerns for how things work, what they do, how they interact, and what agency or effects they might exercise over time." 1999	Landscapes can do more than reveal natural processes; they can illuminate the interdependencies between people and the land – fragilities, vulnerabilities and connectedness.
Phenomenal experience may still be embraced but landscapes full value is strategic connections – aligning diverse and competing forces.	Designed landscapes must engage in the stories and contexts of a place – these stories must be able to be sensed and interpreted by the community.
Design with the idea of landschaft – working towards building a cognitive and collective sense of place through the activity of *work*.	

"The significance of the landscape content for the architectural and environmental arts lies not only in the deeply sensuous and experiential dimensions of the land but also its semiotic, ecological, and political content." 1999	
Landscape architecture should be concerned with reconnected people with participatory landscapes – emphasizing 'experiential intimacies' of engagement, use over time, participation.	
"A good designer must be able to weave the diagram and the strategy in relationships of the tactile and the poetic." 2006	

SITE

Corner	Meyer
A strategy plays itself out through the physical media, the substrate – form, geometry and material of a site. No 'general strategy of battle, only a specific unfolding of battle as dictated or afforded by the specific contours and local conditions of a particular terrain."	Site analysis has given way to site readings and interpretations – first hand experience and understanding of histories. Site readings form strong conceptual base for design response and might consist of memorable drawings & mappings that convey a site's physical properties, operations and sensual impressions. Move away from *formal informal* site analysis to more experiential site reading. From landscape as object to landscape as subject.
Landscape is not an object. Landscape cannot be separated from the complexities of reality. Sites are part of a large active milieu; they are more than a geometrically defined parcel of land.	"Site as framework, site as figure and site as fragment." – physical characteristics of site. Temporal moments, episodic contrasts, haeceities are all site specific too.
Landscape may embrace phenomenogical and naturalistic experience but its biggest value is that of a strategic art form that creates new relationships between diverse forces. (i.e. political desires with ecological processes)	The landscape is not empty before a designer arrives, it contains many histories and stories.
Rocks, rivers, material - existence of the ideal....	The pre-existing form, structure and histories should be in conversation with any new markings/interventions on a site. " landscape design is not about monologues"
	Landscape as foreground, not background. A system of intersections (ands & both) – the terrain, the particular,
	"Structure and phenomena as well as perception and conception are vital to the activity of making landscapes." Landscape architects should study the processes that shaped the landscape form as well as the surface form.

Corner
Corner doesn't really focus on 'site' very much. He seems to be much more focused on the larger scale social or ecological processes that influence a site as opposed to specific site conditions of topography or phenomenology. He considers a site to be edgeless, part of the social milieu - maybe there is no such thing as 'site'. That said, he still appears to place value on working with the particulars of terrain and local conditions.

Meyer
Meyer's ideas on site connect strongly with her ideas on time, experience and aesthetics. Sites should be read and interpreted experientially, sensuously. A site has histories that cannot be erased – a designed landscape should be a conversation between past and present histories.
Site histories consist of natural and cultural processes and forms. The terrain and site conditions should be foregrounded as guiding urban form, as opposed to backgrounded in the language of formal and informal.

Discussion
Both see sites as having blurred boundaries, places where processes flow across and beyond. Corner sees the landscape as having more value as a synthesizer of cultural processes, than as a place that is experienced phenomenonology and naturalistically. Whereas in opposition, Meyer places emphasis on phenomenological aspects of site, interpreting a site and conversing with the natural and cultural histories of a site.

INFRASTRUCTURE

CORNER	MEYER
What appears to be prosaic and banal measures in landscape (roads, lines, etc.) actually provide a "hyper-reality" of exhilaration and emancipating opportunity.	Best management practices in sustainable management are good, but if our contributions are invisible infrastructures, with no legible designers touch, then it is not sustainable enough! We are not civil engineers.
Due to the dynamic relationships of processes, cities and infrastructure are just as 'ecological' as forests and rivers.	Discusses Olmsted's Fens as a child of civil engineering and landscape architecture – an entity that harnessed and structured natural systems into a new typology of urban infrastructure and aesthetics.
Surface understood as urban infrastructure. "Urban infrastructure sows the seeds of future possibility, staging the ground for both uncertainty and promise." – Rem Koolhaas – "irrigation of territories with potential"	Legibility .
Infrastructure as providing tactical choreography of elements and materials in time that extends new networks, new linkages, and new opportunities. Eg. the grid – provides structure but allows flexibility and change over time.	

REPRESENTATION

Corner	Meyer
The static nature of a photograph is unable to convey the temporal experience of landscape	Digital landscape images that show generic fit happy faced people skating and cycling through 'disturbed sites' limit the potential collective and individual experience of large parks – the environmental consciousness
The aerial image conditions how we see and act towards the built environment.	"To imagine the encounters and spaces that might be possible, new ways of drawing and modeling are necessary." - help surface the temporal unfolding of program – best example is the works of Anu Mathur and Dilip da Cunha
Representations are neither reflections nor objective inventories of reality. Instead, they are projections, interpreted renderings of reality. Representations are susceptible to ideologies, abuses of power and can highly influence how projects and opinions are shaped.	Need designers to use "notational systems for imagining the complex temporal and spatial choreography of ecological process, cultural rituals, industrial production, and political agency."
Maps make the invisible visible. They can re-shape the world we live in, mapping "*unfolds* potential"	Conceptualizing sustainable landscapes requires new languages as well as new techniques – "design flourishes when fixed categories are transgressed and their limits and overlaps explored." We need to avoid binaries that limit landscape to formal - informal, natural – cultural
More imaginative practices of measure & geometry are needed to construct a landscape of a more social & ecological life.	Avoid feminine language that contrasts to hard masculine forms – soft, wild, irregular. Instead rediscover descriptions that derive from ecological processes, plant growth, cyclicality, emergence, decline. – "reconstruct unheard languages of the modern landscape"
The medium of landscape is the physical world – plants, water, stone, light. Yet our creative access to this world is 'masked by a 2-dimensional' screen. Drawing is a translatory medium.	If height is a critical dimension in a design then the section not the plan is key in describing a lands structure and a designs response to it
Landscape is experienced equally if not more through the body than the eye. Drawing is however only experienced optically and no matter how accurate or skilful of a representation, it cannot reproduce the spatial, temporal and somatic experience of landscape.	Descriptive diagrams and drawings (section & axonometric) make the terrain conspicuous and prominent. The terrain becomes the guiding structure much more than with a plan, and becomes impossible to ignore.
Projective drawing has degenerated into a prescriptive recipe for harmless but thoughtless, trivial production.	

Notational systems of representation are useful for building layers of experience, movement and time. There is a lack of exploration in notational devices in landscape architecture. This would be a promising area of research.	
The danger of pictorial representation is that designers make pictures instead of 'landscapes'. They make scenes based on the illusions of picture planes rather than experiences of temporal, spatial and material qualities. To continue to project landscapes as pictorial objects severely reduces the scope of the landscape idea.	
Representations that articulate greater experiential aspects focus less on the optical image of things and more on the underpinning ideas.	
Drawing precedes built projects. Therefore drawing has the possibility to transform societies visions about landscape – "perhaps playing less on the picture and more on the phenomenological enigmas inherent in the landscape itself."	
2 issues with drawing – 1. the seductive qualities of drawing as a prized art form. 2. The potential richness of drawing is suppressed through reductive practices that advocate for purely instrumental and technical representation.	
2 potentials in landscape architecture drawing: 1. it's directness in application to landscape. 2. it's disengaged, abstract qualities. Abstraction in drawing should be used to gain insight, not to obfuscate or justify a project.	
Drawing should be understood as the '*locus* of reconciliation between construal and construction, or between the symbolic and instrumental representations.' Drawing as a vehicle for creativity as well as realization.	
Graphic and collage fields allow new possibilities to emerge through the wealth of images. Tactics of appropriation, collage, abstraction, imaginative projection "prompt free association, providing liberatory mechanisms of construal." – However this needs to be theoretically and critically motivated by the maker.	
Fundamental imaging techniques include mapping, planning, diagramming and sectioning – concentrating how things work, how they go	

REPRESENTATION CONTINUED

together as opposed to the formalization of scenic landscapes. Hybridized and composite diagramming techniques of layering and separation enable multiple issues to be incorporated.	
Maps by necessity must be abstract to retain meaning and utility. Through the selection and abstraction of reality, maps become depictions rather than representations	
Maps effect ideas, rather than represent geographies. They are mental constructs, ideas that enable and effect change.	
In todays world of rapidly changing urban and communication processes, mapping and spatial design techniques appear outmoded and struggle to engage with the "dynamic and promiscuous character of space and time today"	

Corner

Corners writings focus largely upon aspects of representation. He discusses the nature of landscape representation – the ability of a representation to influence or construct ideas, as well as the power and failure of landscape drawing. As opposed to other aspects of his writing where he states that something isn't right but doesn't offer alternative modes of practice, Corner when discussing representation is full of ideas of how to remedy the issues he identifies. It seems his main motivation for different techniques of representation is to capture the more experiential and phenomenological aspects of landscape that are forgotten in pictorial representations. This is interesting as it seems that elsewhere he doesn't really talk about phenomenology very much. This could connect to the sense of 'being', ideal and poetry that I need to delve deeper into.

Meyer

Meyer doesn't spend much time debating issues of representation. She writes briefly of the shallow nature of generic landscape representations and advocates for notational devices as a way of developing layers in representations. Instead of describing what these could be, she gives her opinion of the best - the diagrams of Anu Mathur and Dilip da Cunha. Another aspect she writes about more than once is the use of techniques that make the terrain more prominent – sections, diagrams, descriptive drawings. She also discusses language as representation - the need to move away from binaries and explore new forms of landscape description.

Discussion

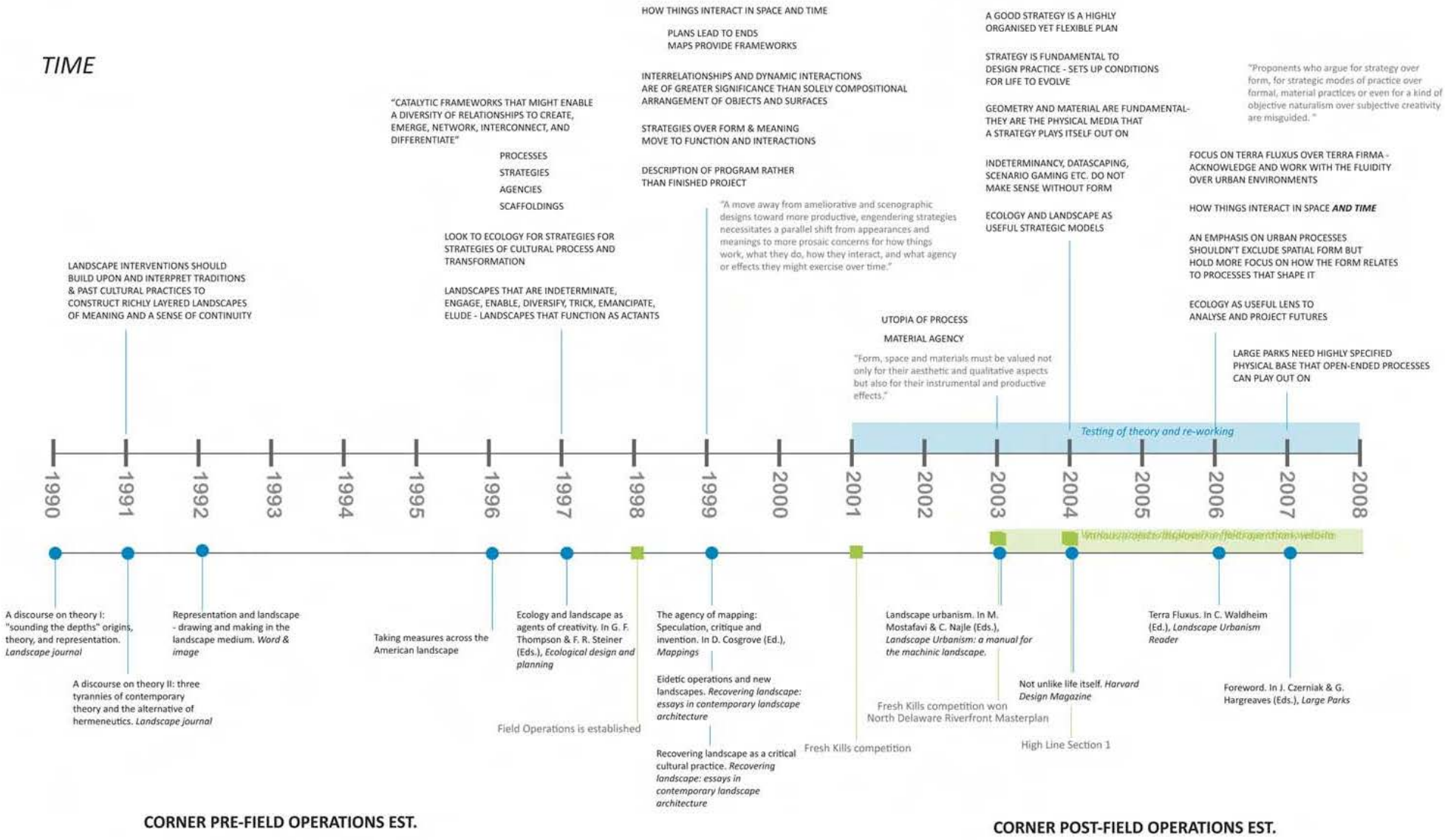
Corner and Meyer have very similar ideas with respect to representation. They both advocate for the use of notational devices as a way to convey the more experiential and invisible layers of landscape. They also both advocate for the use of diagramming and sections. Meyer doesn't go into such depth as Corner on the character of landscape representation, and Corner expands his ideas to a much greater extent. He presents ideas on representation that are pratical and could be translated into practice. Meyer discusses an aspect of representation that Corner does not – that of language, how a project is described.

APPROACHES TO SPATIAL FORM

CORNER	MEYER
Move from formal composition of appearance and meaning to more prosaic concerns. How things work, what agency they hold over time.	Designed landscape forms should artfully express a responsiveness to interactive systems – in this experience, beauty will be discovered.
Strategy is fundamental to design as projects are **Formal** (material) **Durational** (time and process) **Complex** (subject to multiple forces and relations)	Landscapes should be 'form-full' and draw the attention of people often distracted. Design techniques of exaggeration, amplification, distillation, condensation, juxtaposition or transposition can be used.
Apply strategy to gain greater efficacy in the reshaping of our world and in the complex design of landscape form	Forms that facilitate aesthetic experience – sensory, haptic, somatic, time sensitive experiences. An awareness of natural rhythms and cycles. This can increase people's awareness of the environment around them. Beauty in nature can spur action and be restorative
Form as the stage, the scaffolding that facilitates program and innovation to evolve. Prepare the surface for future appropriation – operational logic over compositional design.	Designed form to facilitate a sublime experience where the "interdependence of human life and natural processes – become palpable"
Focus on the processes that flow through, manifest and sustain urban form. These are more significant shapers of society than form itself. Focus on systems over object qualities of space – "tactical choreography" – e.g. the grid system – provides strong legibility while allowing individuality of each part.	Design translates "cultural values into memorable landscape forms and spaces that often challenge, expand, and alter our conceptions of beauty"
Deploy form to maximise future potential. Form is necessary - strategy does not make sense without physical form, but form needs to be flexible and accommodating. Form as a facilitator of process rather than form for forms sake.	
Program over description	

A.2. Further analysis of the evolution of Corner's ideas through time

As part of the analysis of James Corner and Elizabeth Meyer, I further mapped and analysed the evolution of Corner's ideas over the years. This was performed to enable me to better understand in particular, his changing theoretical views on the importance of experience/aesthetics and his ideas on time and strategy.


TIME
HOW THINGS INTERACT IN SPACE AND TIME
PLANS LEAD TO ENDS
MAPS PROVIDE FRAMEWORKS
A GOOD STRATEGY IS A HIGHLY ORGANISED YET FLEXIBLE PLAN
STRATEGY IS FUNDAMENTAL TO DESIGN PRACTICE - SETS UP CONDITIONS FOR LIFE TO EVOLVE
"Proponents who argue for strategy over form, for strategic modes of practice over formal, material practices or even for a kind of objective naturalism over subjective creativity are misguided. "
"CATALYTIC FRAMEWORKS THAT MIGHT ENABLE A DIVERSITY OF RELATIONSHIPS TO CREATE, EMERGE, NETWORK, INTERCONNECT, AND DIFFERENTIATE"
PROCESSES
STRATEGIES
AGENCIES
SCAFFOLDINGS
INTERRELATIONSHIPS AND DYNAMIC INTERACTIONS ARE OF GREATER SIGNIFICANCE THAN SOLELY COMPOSITIONAL ARRANGEMENT OF OBJECTS AND SURFACES
STRATEGIES OVER FORM & MEANING MOVE TO FUNCTION AND INTERACTIONS
DESCRIPTION OF PROGRAM RATHER THAN FINISHED PROJECT
GEOMETRY AND MATERIAL ARE FUNDAMENTAL- THEY ARE THE PHYSICAL MEDIA THAT A STRATEGY PLAYS ITSELF OUT ON
INDETERMINANCY, DATASCAPING, SCENARIO GAMING ETC. DO NOT MAKE SENSE WITHOUT FORM
FOCUS ON TERRA FLUXUS OVER TERRA FIRMA - ACKNOWLEDGE AND WORK WITH THE FLUIDITY OVER URBAN ENVIRONMENTS
"A move away from ameliorative and scenographic designs toward more productive, engendering strategies necessitates a parallel shift from appearances and meanings to more prosaic concerns for how things work, what they do, how they interact, and what agency or effects they might exercise over time."
LOOK TO ECOLOGY FOR STRATEGIES FOR STRATEGIES OF CULTURAL PROCESS AND TRANSFORMATION
ECOLOGY AND LANDSCAPE AS USEFUL STRATEGIC MODELS
HOW THINGS INTERACT IN SPACE AND TIME
AN EMPHASIS ON URBAN PROCESSES SHOULDN'T EXCLUDE SPATIAL FORM BUT HOLD MORE FOCUS ON HOW THE FORM RELATES TO PROCESSES THAT SHAPE IT
LANDSCAPE INTERVENTIONS SHOULD BUILD UPON AND INTERPRET TRADITIONS & PAST CULTURAL PRACTICES TO CONSTRUCT RICHLY LAYERED LANDSCAPES OF MEANING AND A SENSE OF CONTINUITY
LANDSCAPES THAT ARE INDETERMINATE, ENGAGE, ENABLE, DIVERSIFY, TRICK, EMANCIPATE, ELUDE - LANDSCAPES THAT FUNCTION AS ACTANTS
UTOPIA OF PROCESS
MATERIAL AGENCY
"Form, space and materials must be valued not only for their aesthetic and qualitative aspects but also for their instrumental and productive effects."
ECOLOGY AS USEFUL LENS TO ANALYSE AND PROJECT FUTURES
LARGE PARKS NEED HIGHLY SPECIFIED PHYSICAL BASE THAT OPEN-ENDED PROCESSES CAN PLAY OUT ON
Testing of theory and re-working
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A discourse on theory I: "sounding the depths" origins, theory, and representation. Landscape journal
A discourse on theory II: three tyrannies of contemporary theory and the alternative of hermeneutics. Landscape journal
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Taking measures across the American landscape
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Not unlike life itself. Harvard Design Magazine
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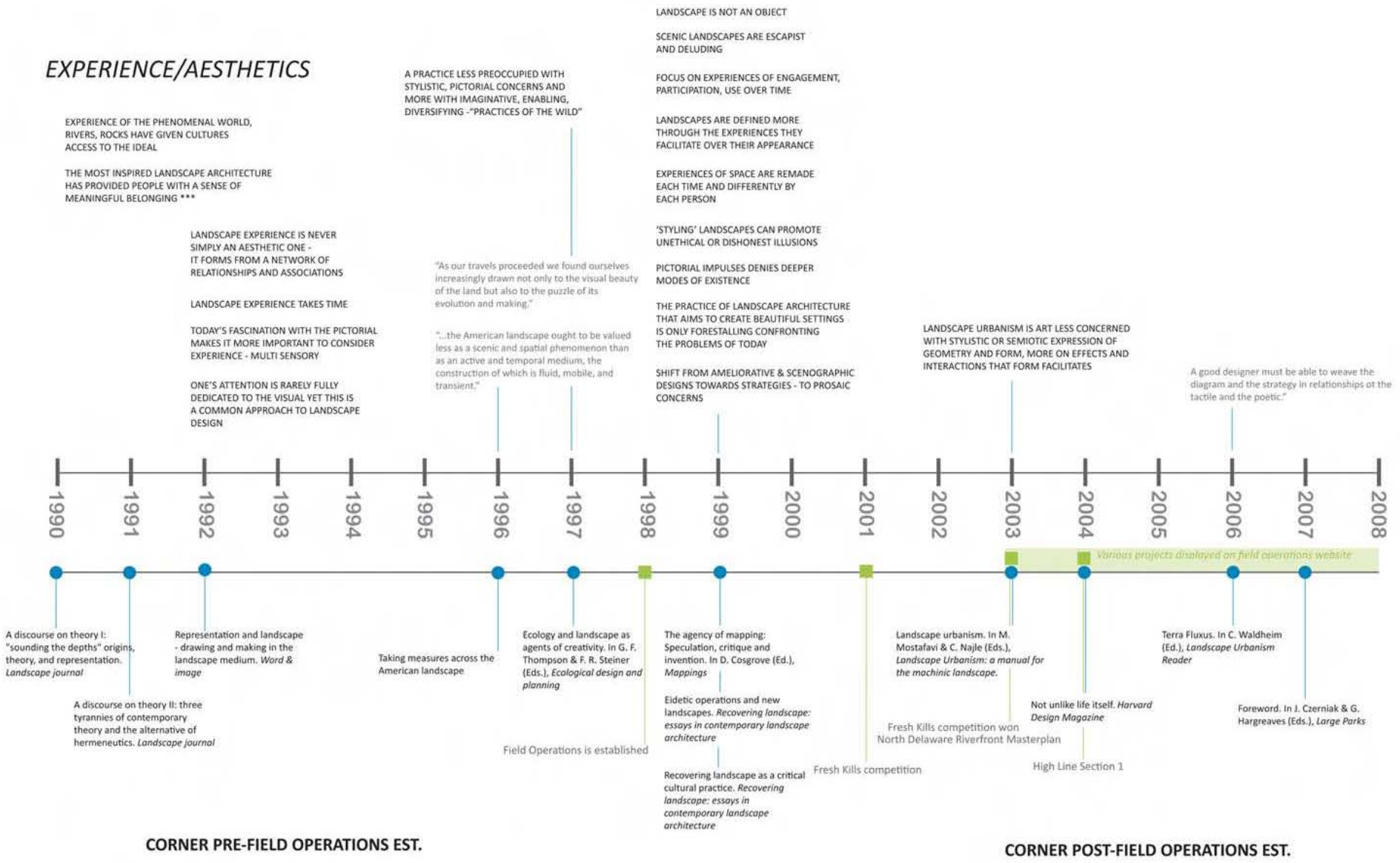
CORNER PRE-FIELD OPERATIONS EST.
CORNER POST-FIELD OPERATIONS EST.


EXPERIENCE/AESTHETICS
EXPERIENCE OF THE PHENOMENAL WORLD, RIVERS, ROCKS HAVE GIVEN CULTURES ACCESS TO THE IDEAL
THE MOST INSPIRED LANDSCAPE ARCHITECTURE HAS PROVIDED PEOPLE WITH A SENSE OF MEANINGFUL BELONGING ***
LANDSCAPE EXPERIENCE IS NEVER SIMPLY AN AESTHETIC ONE - IT FORMS FROM A NETWORK OF RELATIONSHIPS AND ASSOCIATIONS
LANDSCAPE EXPERIENCE TAKES TIME
TODAY'S FASCINATION WITH THE PICTORIAL MAKES IT MORE IMPORTANT TO CONSIDER EXPERIENCE - MULTI SENSORY
ONE'S ATTENTION IS RARELY FULLY DEDICATED TO THE VISUAL YET THIS IS A COMMON APPROACH TO LANDSCAPE DESIGN
A PRACTICE LESS PREOCCUPIED WITH STYLISTIC, PICTORIAL CONCERNS AND MORE WITH IMAGINATIVE, ENABLING, DIVERSIFYING -"PRACTICES OF THE WILD"
"As our travels proceeded we found ourselves increasingly drawn not only to the visual beauty of the land but also to the puzzle of its evolution and making."
"...the American landscape ought to be valued less as a scenic and spatial phenomenon than as an active and temporal medium, the construction of which is fluid, mobile, and transient."
LANDSCAPE IS NOT AN OBJECT
SCENIC LANDSCAPES ARE ESCAPIST AND DELUDING
FOCUS ON EXPERIENCES OF ENGAGEMENT, PARTICIPATION, USE OVER TIME
LANDSCAPES ARE DEFINED MORE THROUGH THE EXPERIENCES THEY FACILITATE OVER THEIR APPEARANCE
EXPERIENCES OF SPACE ARE REMADE EACH TIME AND DIFFERENTLY BY EACH PERSON
'STYLING' LANDSCAPES CAN PROMOTE UNETHICAL OR DISHONEST ILLUSIONS
PICTORIAL IMPULSES DENIES DEEPER MODES OF EXISTENCE
THE PRACTICE OF LANDSCAPE ARCHITECTURE THAT AIMS TO CREATE BEAUTIFUL SETTINGS IS ONLY FORESTALLING CONFRONTING THE PROBLEMS OF TODAY
SHIFT FROM AMELIORATIVE & SCENOGRAPHIC DESIGNS TOWARDS STRATEGIES - TO PROSAIC CONCERNS
LANDSCAPE URBANISM IS ART LESS CONCERNED WITH STYLISTIC OR SEMIOTIC EXPRESSION OF GEOMETRY AND FORM, MORE ON EFFECTS AND INTERACTIONS THAT FORM FACILITATES
A good designer must be able to weave the diagram and the strategy in relationships ot the tactile and the poetic."
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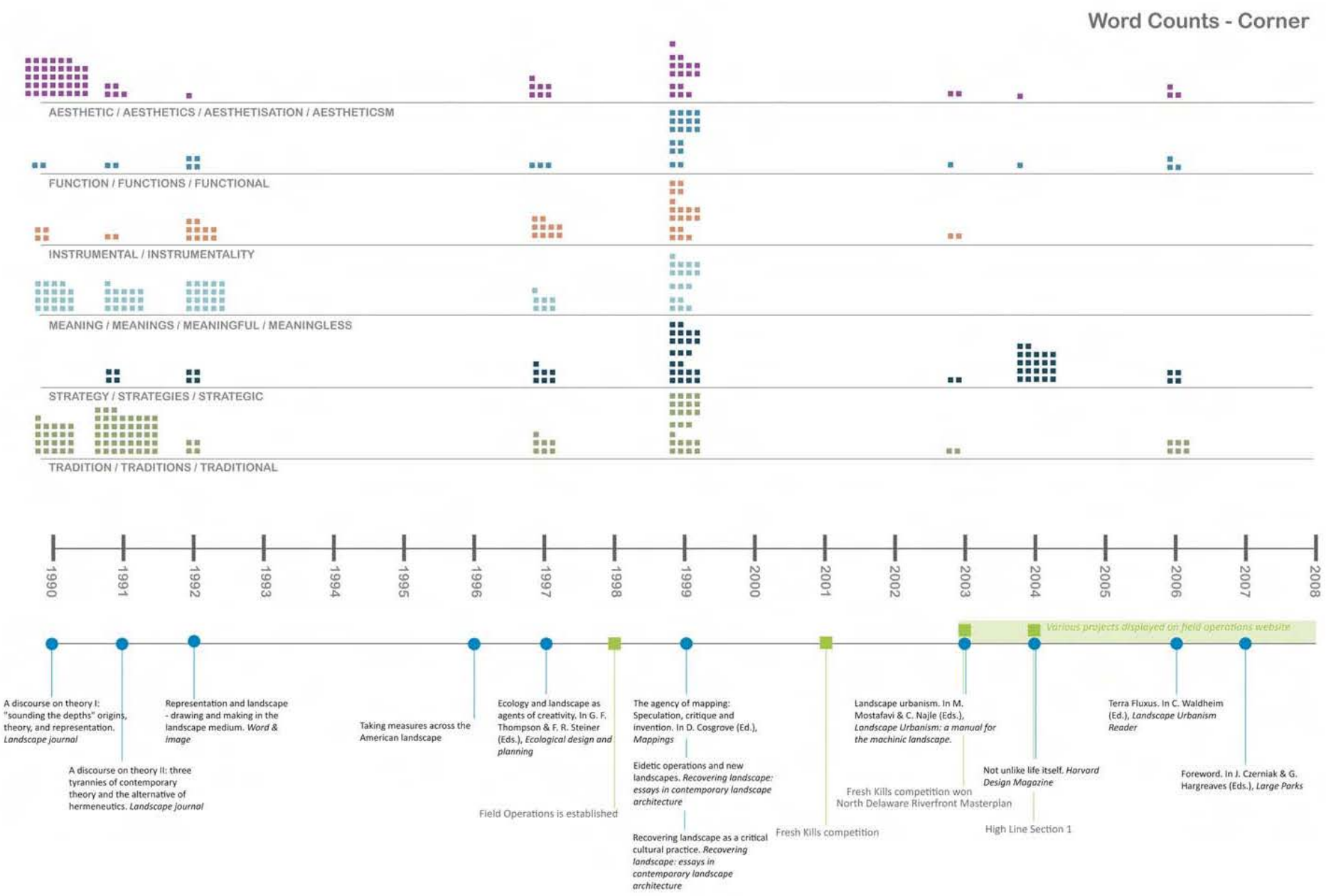
Word Counts - Corner
AESTHETIC / AESTHETICS / AESTHETISATION / AESTHETICSM
FUNCTION / FUNCTIONS / FUNCTIONAL
INSTRUMENTAL / INSTRUMENTALITY
MEANING / MEANINGS / MEANINGFUL / MEANINGLESS
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Appendix B

B.1. Analysis of the potential resilience benefits realised from a landscape approach to adaptive residential design

Strategy one: Road corridor hierarchy	
Strategies for building adaptive capacity and resilience:	**Benefits established through landscape design**
Diversity	♦
Ecological Variability	♦♦♦
Modularity	
Acknowledging Slow Variables	♦♦
Tight Feedbacks	♦♦
Social Capital	♦♦♦
Innovation	♦♦♦
Overlap in Governance	
Ecosystem Services	♦♦♦

Strategy three: Flexible space provision	
Strategies for building adaptive capacity and resilience:	**Benefits established through landscape design**
Diversity	♦♦
Ecological Variability	
Modularity	♦♦
Acknowledging Slow Variables	♦♦
Tight Feedbacks	♦
Social Capital	♦♦♦
Innovation	♦♦♦
Overlap in Governance	♦
Ecosystem Services	♦♦

Strategy five: Community as operators	
Strategies for building adaptive capacity and resilience:	**Benefits established through landscape design**
Diversity	♦
Ecological Variability	
Modularity	♦♦
Acknowledging Slow Variables	
Tight Feedbacks	♦
Social Capital	♦♦♦
Innovation	♦♦♦
Overlap in Governance	♦♦
Ecosystem Services	♦

Strategy two: Time based land use	
Strategies for building adaptive capacity and resilience:	**Benefits established through landscape design**
Diversity	♦♦♦
Ecological Variability	♦♦♦
Modularity	♦♦
Acknowledging Slow Variables	♦♦♦
Tight Feedbacks	♦♦♦
Social Capital	♦
Innovation	♦♦
Overlap in Governance	♦♦
Ecosystem Services	

Strategy four: Diversity in all forms	
Strategies for building adaptive capacity and resilience:	**Benefits established through landscape design**
Diversity	♦♦♦
Ecological Variability	
Modularity	
Acknowledging Slow Variables	
Tight Feedbacks	
Social Capital	♦♦
Innovation	
Overlap in Governance	
Ecosystem Services	♦♦

Strategy six: Placemaking through functional legibility	
Strategies for building adaptive capacity and resilience:	**Benefits established through landscape design**
Diversity	♦♦
Ecological Variability	♦♦♦
Modularity	
Acknowledging Slow Variables	♦
Tight Feedbacks	♦
Social Capital	♦♦♦
Innovation	♦♦
Overlap in Governance	
Ecosystem Services	♦

For each design strategy, the potential benefits to the nine resilience goals set out by Walker and Salt (2006) are indicatively ranked to analyse the value each strategy could bring to increasing resilience in social-ecological systems. Low to high value. (0 – 3 diamonds)

See The role of landscape architecture in improving urban resilience on page 96 for the summary table and conclusions.