Design with Nature
A proposed model for coastal settlements in Australia adapting to climate change and extreme weather events

Phillip B. Roös
Deakin University
phillip.roos@deakin.edu.au

The Australian coast is rich in history and is scattered with coastal settlements amongst a contrasting landscape with infinite visual and ecological diversity. These attributes provide the opportunity to create sustainable and resilient settlements, linking the wholeness of a place to the foundation of living in harmony with nature. On the contrary, the coastal regions of Australia are facing dynamic changes of population growth including the looming impact of a changing climate. Acknowledging these challenges, the Australian Government highlighted that one of the key requirements for a sustainable future is to establish sustainable settlements that are resilient against the impacts of climate change. Recent government studies and reports highlighted various possible impacts to the Australian coast and regional settlements due to sea level rise with associated coastal recession, extreme weather events, flooding, and prolonged heat waves. Various adaptation frameworks are proposed to deal with this issue, but very few consider the relationship between ecological systems and human built environments. The resilience planning of settlements must consider the co-evolution of human and nature under future climate effects. This paper is thus seeking answers to the question: How can the theoretical principles of Design with Nature (McHarg, 1967) and The Nature of Order (Alexander, 1980) provide for input to a adaptation model for settlements along the coast? Reflecting on a literature review of these two well established theories, the author select key principles from both as input to a ecological design based adaptation model for coastal settlements, which establishes a system of unfolding steps to create sustainable communities that connect with the landscape, and are resilient against future impacts of change.

Keywords: Resilient Communities, Coastal Settlements, Climate Change, Adaptation, Design, Generative, Pattern Language, Regenerative.
Introduction

Our human species’ affinity to water in the landscape, more specifically the attraction to the sea, and the resources it can offer, drew people to settle along the coastal areas of Australia more than 40,000 years ago (Flannery, 2005). Even now in the 21st century people flock to coastal areas in ever-increasing numbers, wanting a change in lifestyle from urban life, seeking the amenities and attributes that coastal settlements can offer. This phenomenon is known as ‘Sea Change”, the migration of people to smaller coastal towns within the regional areas of Australia. This fascination for the coast equates to an increased unsustainable development in the destination regional coastal settlements. The environmental changes associated with these land developments in the small coastal towns threaten the very qualities that make these places unique and attractive (Green, 2010).

Additional to population growth, the coastal settlements in Australia, especially those beyond the capital cities and in regional areas, are at the forefront of being impacted by climate change effects (DCC, 2009). These coastal communities are exposed to various levels of climatic hazards and direct impacts due to sea level rise, the recession of the coastline, short term flush flooding, long term inundation and storm surge events. These levels of physical exposure to impacts of climate change represent significant environmental and social risks to these coastal communities. The settlements along the coast are in peril. We know enough about how human actions are impacting the environment through the role we play. However, even with this knowledge, unsustainable behaviours of intense land development continue in the regional coastal areas.

The problem is clear; we have to change our behaviours, we need to acknowledge the vulnerability of our human species, and reconnect to nature. To connection with nature and the human relationship with the environment as well as dependency on the resources the environment offer for the survival of the human species, is paramount in the argument of this paper. For this reason the author propose that this paper considers the design theories of McHarg and Alexander, both supporting the co-evolution and the duality of man and nature. These theories have a common thread, the consideration of the whole. The wholeness of spatial configurations is present in many natural occurring events, phenomena, and aspects of complex systems behaviour (Alexander, 2003). In the context of the earth’s environment and climate, this wholeness is evident in the Gaia theory (Lovelock, 2009). Humans are part of this whole, and all their actions have a direct impact to the whole.

It is this connection to the ecological system that is evident in the teachings of Ian McHarg, where the solution for a sustainable future lies within the processes of design with nature. In his book with the title - Design with Nature, he provided a roadmap for applying ecological information to the way we interpret, plan and shape our surroundings (McHarg & Steiner, 2006). Similarly, arguments have been put forward by John Lyle and Christopher Alexander that climate and ecological systems are influenced by design (Lyle, 1991; Alexander, 2006). Every building project large or small, city making or settlement development contributes to climate moderation or extremity in some way or the other as part of a watershed, ecological system, floodplain or coastal environment (Lyle, 1991).

The conclusive arguments by both McHarg and Alexander state that humans and the environment are holistic connected, and that humans need to consider the protection and enhancement of
ecological systems to be resilient and adaptive. This paper thus explores options on how can the theoretical principles of Design with Nature (McHarg, 1967) and The Nature of Order (Alexander, 1980) provide for input to a adaptation model for coastal towns that are located in the coastal zones of Australia.

**Methodology**

To be able to link the supportive theories of McHarg and Alexander to the proposed design based adaptation model in this paper, the step by step process of pattern language (Alexander, 1977), requires that all aspects of a place and its history, heritage as well as ecological values to be considered. Further to consider the impacts of climate change, the structure of this paper follows a methodology of investigation of issues, and then a review of the application of the proposed model, concluding with outcomes and recommends further work. The research methodology used for this paper followed a systematic process as follows:

1. Literature review of the theories of Ian McHarg and Christopher Alexander, specifically identifying the design and planning methods for including the natural environment and the built environment as a whole;
2. Review the coastal history of Australia relating to the growth of human populations and its impacts on the coastal environment;
3. Identify the threats to the Australian coast, coastal communities as well as the impacts of potential climate change and sea level rise;
4. Identify and review climate change adaptation models, risk assessment tools and climate change approaches, considering the connection of humans and nature, and how these models approach this issue;
5. Establish the principles of a design based adaptation model through the importance of human and nature considerations;
6. Apply the principles of the design based adaptation model and align this model with the pattern language principles of Alexander as a potential combined methodology for adaptation; and
7. Summarise in conclusion the findings and recommendations, identifying future work.

**Coastal History**

Australia can be defined as a coastal society, with more than 83% of all Australians living within 50 kilometres from the coast (DEH, 2001). The coastal populations of Australia are distributed evenly along the coastline. A good example of this phenomenon is that in Victoria, the most densely populated state in Australia, 85% of its population lives on the coast, but human habitation still only occupies less than 10% of the physical coastline (DEH, 2001). However, Australia is a highly urbanised nation, and the settlement patterns of the population are characterised by high rates of urbanisation, and low-density cities, mostly within the 50km zone from the coast, as indicated in Figure 1.

There are also a large number of small remote settlements along the regional coastal areas, accounting for a very small proportion of the population (Newton, 2001). This geographical
distribution is due to the result of many years in history making from pre European settlement, as well as post European settlement due to the discovery and colonisation of Australia.

Figure 1: Population Distribution Australia (Source: Australian Bureau of Statistics). (3218.0).

Human settlement in Australia dates back at least 50,000 years, with coastal zones favoured by the Indigenous population engaged in hunting, fishing and gathering. With the arrival of Europeans a little over 200 years ago, the sighting of the Australian mainland by Captain James Cook in April 1770 was the first step in the establishment of European settlements along the Australian coast (PIRG, 1977). Throughout history and even today, the coast is favoured for habitation due to its amenities, attributes and pleasant environment that it offers. It is these attributes that are causing today a major population shift to coastal areas by city dwellers. Seeking a change in lifestyle and environment, this phenomenon is known in Australia as “Sea-change” (Burnley, 2004).

This trend is occurring on an international scale, where suburbanisation is occurring in smaller coastal towns in Europe, North America and Australia (Green, 2010). This form of migration is driven by the lifestyle values and the attraction of the coastal landscape, rather than other forms of migration that are typically driven by economical growth such as employment and industry (Roös, 2013). In essence what people are looking for are places that contrast with city life and provide beautiful scenery, which makes them, feel that they have escaped the pressures of a high pacing,
stressful day-to-day life. Unfortunately, this migration to the coast is adding to the elements that are putting the coastal areas under threat.

**Coast under Threat**

The migration from urban cities to the coast results in an unprecedented population growth in the coastal zones, with this shift of people from main metropolitan areas to coastal towns requiring more land development to provide housing and amenities (Green, 2010). The coastal townships in regional Australia, that are within two to three hours drive from major metropolitan areas, follow a distinctive growth pattern, sprawling along the coastline in a linear fashion, with properties and land development that demand ocean views (DSE, 2004). A good example of this coastal settlement ‘sprawl’ is the growth of new suburbs in the Bellarine Peninsula just outside Torquay, a coastal town two hours drive outside Melbourne in Victoria, Australia. This coastline sprawl has devastating effects on the natural coastal environment (VCC, 2008; VCC, 2013).

Additional to population growth, the coast is constantly under stress due to the dynamic forces of nature. It is the coast where the land interacts with the sea, experiences the forceful action of the wind, waves, tides, and currents that not only erode the shore, but also expand it with sedimentary deposits (Roös, 2013). Storm systems gather energy from the ocean and intensify natural coastal forces with wind, waves, and rain, powerful enough to severely damage natural and built assets with hastened erosive processes (GORCC, 2012). These dynamic forces of the coast make the coast in itself vulnerable, and the coast is constantly under threat.

**Coastal Impacts**

Changes in the climate and rising sea levels make the coast more vulnerable to these natural dynamic forces (IPCC, 2001: IPCC, 2012). Social and economic forces also bring stresses to coastal areas. Combining the impacts of climate effects and the pressures from peak tourism and increased coastal settlement growth makes the coast more vulnerable to drastic changes to the coastal landscape (VCC, 1998). Rising sea levels will bring significant change to Australia’s coastal zone in the future. Many coastal environments such as beaches, estuaries, coral reefs, wetlands and low-lying islands are closely linked to sea level. Additional to the natural assets, many built environment assets are under risk.

The Climate Change Risks to Australia Coast report (2009), indicated that up to $63 billion (replacement value) of existing residential buildings are potentially at risk of flooding, and inundation due to a 1.1 metre sea-level rise, with a lower and upper estimate of risk identified for between 157,000 and 247,600 individual buildings (CSIRO, 2009). Climate change also results in risks to people and organisations, impacting the day-to-day operations of our culture (DEEH, 2012). The level of impacts on these natural as well as built environments due to climate change and sea level rise, are influenced by the coastal stability of the regions, the geomorphological characteristics of the coastal zones.

These geomorphological coastal zones are classified in four coastal regions in Australia. As indicated in Figure 2, these regions are:
Region 1 – The Muddy North: highly tidal, cyclone influenced and muddy
Region 2 – The Limestone South and West: small tides, carbonate rocks, high wave and wind energy
Region 3 – Eastern Headlands and Bays: small tides, quartz sands, moderate wave energy, many bays
Region 4 – The Barrier Reef: northern Queensland, including low-lying rocky mainland coasts and the Great Barrier Reef and its islands.

Tasmania and the Bass Strait islands share many of the characteristics of regions 2 and 3 (Woodroffe, 2012).

The nature of the landforms in the different coastal regions means that while parts of the coast are highly resistant to erosion, the beaches and erodible sediments found in other regions are quite susceptible to coastal recession as sea levels rise. Due to the different landforms, the recent Surf Coastal Climate Change Vulnerability and Adaptation Project identified that significantly increased numbers of natural as well as built assets are located in areas that could be severely affected by coastal recession when allowing for 100m of recession for each metre of sea level rise, according to the Bruun rule (GORCC, 2012). It is evident that different methods of adaptation need to be considered, applicable to different scenarios and the type of coastal regions.
Adaptation and Risk Management

Theories, frameworks and models have been developed to provide possible solutions for adaptation for climate change impacts in Australian coastal areas. Key economic principles and risk management approaches are considered to provide frameworks for responding to the implications of climate change. A significant portion of climate change risk to coastal assets is in the future, but it is acknowledged that there is a need for early and immediate action for coastal adaptation for many coastal communities that will be affected by short-term climate impacts (DCC, 2009; IPCC, 2012). Mostly, it is the coastal communities that are located on sandy beaches and sandy and muddy shorelines, which are most susceptible to the effects of storms and can erode rapidly over a very short period of time (NSW Government, 1990; DSE, 2012).

Various coastal councils in Australia apply different coastal policy approaches to deal with climate change, both for short and long term. In coastal planning policy four classifications (do nothing, retreat, defend or adapt) have been widely used to examine response to climate change impacts (Norman, 2009). Although local adaptation actions differ from region to region, it is acknowledged that adapting to climate change could be costly in some areas, doing nothing is likely to be more expensive over the longer-term as substantial investments and assets are placed at risk (DCC, 2009).

Responding to these risks, a planned adaptation is proposed to proactively build communities’ capacity to minimise, adjust to or take advantage of the consequences of change, as indicated in Figure 3.

Figure 3: Framework for flexible adaptation options across times of change (GORCC, 2012)
The adaptation framework for planned adaptation provides for the development of flexible adaptation that is responsive to changes in sea levels, coastal recession and risk perception. It provides for the sequential deployment of adaptation options or tactics, each of which are suited to particular ‘windows’ of sea level rise or coastal recession. The deployment process begins before the risk threshold is reached to ensure there is sufficient time for planning, finance allocation and stakeholder engagement. Trigger points are risk-based and draw on experienced coastal hazard conditions. This process provides flexibility to adapt to more or less rapid sea level rise while remaining within acceptable risk levels (GORCC, 2012).

One of the key factors in adaptation planning is the consideration of risk. It is for this reason that coastal management and adaptation management plans are based on risk management principles. The risk assessment process is applied to adaptation planning by various local councils and governments, and is consistent with the broad approach to climate change adaptation promoted by the Australian Government. The risk framework is based on the Australian Standard for risk assessment and management AS/NZS ISO31000:2009 and comprises five core steps (Standards Australia/Standards New Zealand, 2009):

- Establish the context – determine the objectives for the risk assessment, its scope, stakeholders who need to participate or be aware of it and the climate and climate change scenarios being considered.
- Identify risk – describe how climate change affects key elements of the system, which is the subject of the risk assessment.
- Analyse risk – consequences and likelihood of each specific impact is assessed and from this the overall level of risk determined.
- Evaluate risk – the severity of risk is ranked and minor risks screened. High-risk impacts that require more detailed assessment and response are identified.
- Treat risk – options for treating priority risks are identified and evaluated. More effective and practically implementable measures are incorporated into action plans.

What is clearly lacking, in the above review of the adaptation planning and risk management processes, is the consideration of the impact of settlement sprawl on the natural environment and the relationship between ecological systems and the establishment of human built environments.

Decisions can be made for climate change adaptation actions based on risk assessments, economic assessments, coastal management and adaptation planning policies, but these decisions need to acknowledge that nature and human settlement goes hand in hand. It is the nature of order that is inherent in the qualities of the land and community structures, driven by generative patterns that will influence the future character as well as the adaptive capacity of these settlements in the future (Roös, 2013; Alexander, 2006). The author argues that adaptation planning of settlements must consider the co-evolution of human and nature under future climate effects. This proposal requires a good understanding of the relationship between our built environment and the ecosystem.

**Built Environment and the Ecosystem**

Lyle argued in his book *Design for Human Ecosystems - Landscape, Land Use, and Natural Resources* that ecologists choose to study ecosystems that exclude the human species, and humans think of
themselves as somehow separate from ecosystems. In contrary, humans are interacting and are integral components of ecosystems at many levels, and both contribute to the system of environmental balance (Lyle, 1991). A.G. Tansley has defined the concept of an ecosystem the first time in 1935 as: “Simply defined, an ecosystem is the interacting assemblage of living things and their non-living environment.” Among these living things are human beings, and both are coupled in an intrinsic complex system of nature and human built environments.

Our connection to nature and interaction with a global ecosystem are the foundation for the survival and adaptation to future changed climate environments. This consideration of how the ecosystems of planet earth are coupled to human environments is fundamental in an ecological design based adaptation model, considering the design of settlements with nature and acknowledging the patterns of order.

It is this connection to the ecological system that is evident in the teachings of Ian McHarg, where the solution for a sustainable future lies within the processes of design with nature. In his book with the title - Design with Nature, he provided a roadmap for applying ecological information to the way we interpret, plan and shape our surroundings (McHarg I. & Steiner, 2006). Ian McHarg, John Tillman Lyle and Christopher Alexander have put a similar argument forward that climate and the ecological system are influenced by design. Every building project large or small, city making or settlement development contributes to climate moderation or extremity in some way or the other as part of a watershed, ecological system, floodplain or coastal environment (Lyle, 1991).

This paper thus proposes that for human settlements on the coast to be resilient against changes of climate impacts, is to understand the patterns of natural systems, how we connect within these patterns, and how we can use these patterns for adaptability. Further, using regenerative design principles that seek to develop approaches to support co-evolution of human and natural systems is the only way to achieve true long lasting resilience.

**Design with Nature and Patterns**

Frederick Steiner summed up the influence of McHarg’s theory on contemporary design and planning as: “Nothing is as good as a good theory” (McHarg I. & Steiner, 2006). The dictum of “Design with Nature” not only changed design and planning disciplines, but also enormously influenced fields as diverse as engineering, geography, forestry, environmental ethics, ecology and even soil science (McHarg I. & Steiner, 2006). The theory not only deals with man’s relation to his environment as a whole, but also how ecology based design can shape and change the future for both. With input from the science of anthropology, McHarg developed his theory of ecological design. The principles tell us that culture is our most important instrument of adaptation. Furthermore, human’s ability to evolve their culture distinguishes them from other species (McHarg, 1992). Design and planning can then be viewed from a cultural perspective as adaptive mechanisms, and be used as tools for resilience. Design with nature in essence considers the regenerative capacities of both natural and human systems.

To shape our future, design with nature is key, a design that is regenerative. Regenerative design relates to people and nature, and seeks to develop approaches that support ‘the co-evolution of human and natural systems’ so that both natural and social capital is supported (Cole, 2012). To
achieve this balance requires the simultaneous consideration of cultural, social, economic and environmental aspirations. To do this, the uniqueness of ‘place’ needs to be understood and valued, and ideas about any changes in a locality need to be worked through with different people, representing different interests, over a period of time (Cole, 2012).

In its native form, the concept of regenerative design is based on a process oriented systems theory, including processes that restore, renew or revitalize their own sources of energy and materials, creating sustainable systems that integrate the needs of society with the integrity of nature. Regenerative design matches ecosystems in that biotic and abiotic material is not just metabolized but metamorphosed into viable materials. The process of morphogenesis applied to the design and planning of the built environment to achieve ‘deep sustainability’ was argued by Christopher Alexander in his Schumacher Lecture in Bristol, 2004, titled: “Sustainability and Morphogenesis: The Birth of a Living World”. The lecture explores the phenomenon of wholeness of a place, and proposes that the morphological growth of a place give it character and allows the settlement to adapt to changes (Alexander, 2003). Based on this natural process the coastal settlement achieves resilience (Roös, 2013). Alexander referenced most of his lecture content from his theories published in four books under an essay titled: “The Nature of Order: An Essay on the Art of Building and the Nature of the Universe, 2006”.

Alexander describes the formula that leads to a good liveable and sustainable built environment as a set of patterns, a system of explicit steps, for creating living structures within fabric. The generative codes are specific to the environment, and can be found in nature through the process of morphogenesis. The theory defines the word ‘generative’ as a process where there is always a sequence, an order, instructions that follow the rule of centres which appear within the larger whole as distinct and noticeable parts (Alexander, 2006). The generative codes are capable of driving the organic unfolding of a settlement in such a way that the people who live and work in the settlement have a good chance to be resilient and flourish personally, economically and ecologically (Alexander, 2005).

Using the principles of these theories, the possibility rise to develop a holistic integrated ecological design method that incorporates the regenerative patterns of nature, helping coastal communities to better appreciate how the landscape will change and therefore inform their adaptive responses.

**Adaptation Model**

The review of climate change impacts and methods of adaptation and risk management earlier in the paper reveals that there is a systematic process to be followed in the different scenarios of adaptation. This systematic process consists of clear patterns that follow specific sequences. The opportunity is thus there to combine the process of a risk based adaptation framework with a design scenario model, using the methods of design patterns and generative design. Reflecting on the theories of Ian McHarg and Christopher Alexander, including the systematic requirements of risk management and adaptation planning, key principles can be used as an input to a design based adaptation model that establishes a system of unfolding steps to create sustainable communities that connects with the landscape, and are resilient against future impacts of change. The combination of the two processes, and the relationship between the risk based adaptation and design based adaptation systems are demonstrated in Figure 4.
Combining the process of a risk based adaptation framework with a design model based on pattern language, using the methods of design patterns and generative design, the Design Based Adaptation Model (DBAM) can be used to chart the changes and consequences through design. Following an example on how the combinations of the processes are applied within the DBAM model by combining the identified design patterns with climate change risks and assets that are under threat.

To demonstrate this theory, the outputs of a workshop held for the Coastal Climate Change Vulnerability and Adaptation Project are used, where the potential effects of sea level rise and coastal recession on the key Surf Coast assets were identified (GORCC, 2012). A generic list was developed and used as appropriate, depending on the assets that were actually located within the relevant section of the coast and that were potentially exposed to the effects of climate change (i.e. due to temporary/ permanent inundation, long-term coastal recession and storm erosion) under the most extreme climate change scenario (GORCC, 2012). Indicated in Table 1, this list of assets has been allocated into a pattern language, and has been aligned with the patterns of the *Pattern Language* theory of Christopher Alexander.
<table>
<thead>
<tr>
<th>Asset at risk</th>
<th>Description of risk(s) as per risk assessment for climate change impacts</th>
<th>Relevance Pattern Language * Alexander, C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat ramps</td>
<td>Loss/reduced use of asset. Inundation and erosion.</td>
<td>30. Activity nodes</td>
</tr>
<tr>
<td>Car parks</td>
<td>Temporary/permanent inundation. Closure of car parks. Loss of amenity.</td>
<td>22. Nine per cent parking</td>
</tr>
<tr>
<td>Caravan parks</td>
<td>Erosion/recession/inundation leads to loss of use. Reduction in availability of sites, leading to reduced income and business viability.</td>
<td>91. Traveller’s inn</td>
</tr>
<tr>
<td>Commercial properties</td>
<td>Reduced turnover and/or loss of property value. Loss of access to commercial properties. Closure of business. Increased maintenance.</td>
<td>41. Work community</td>
</tr>
<tr>
<td>Creeks and estuaries</td>
<td>Loss of vegetation, destruction of fauna/flora habitat. Change in water quality and ecology. Loss of creeks.</td>
<td>64. Pools and streams</td>
</tr>
<tr>
<td>Cultural heritage features</td>
<td>Damage to heritage sites from erosion / recession / inundation. Loss of cultural values and tourism attraction.</td>
<td>13. Subculture boundaries</td>
</tr>
<tr>
<td>Drainage</td>
<td>Damage or reduced drainage capacity. Increased storm flood damage.</td>
<td>95. Building complex</td>
</tr>
<tr>
<td>Dune and cliff habitats and fauna</td>
<td>Loss of vegetation and destruction of habitat.</td>
<td>7. The countryside</td>
</tr>
<tr>
<td>Inter-tidal habitats</td>
<td>Loss of habitat and fauna</td>
<td>60. Accessible green</td>
</tr>
<tr>
<td>Pathways, walks</td>
<td>Loss of access. Tourism value reduced. Safety hazard.</td>
<td>100. Pedestrian street</td>
</tr>
<tr>
<td>Parks and facilities</td>
<td>Damage and loss of use due to erosion / recession / inundation. Increased maintenance. Reduced amenity.</td>
<td>67. Common land</td>
</tr>
<tr>
<td>Pier</td>
<td>Erosion damage. Temporary/permanent inundation. Loss of access, reduced amenity. Safety hazard.</td>
<td>25. Access to water</td>
</tr>
<tr>
<td>Residential property</td>
<td>Damage from erosion / recession / inundation. Loss of access. Reduced asset value. Increased maintenance. Loss of property.</td>
<td>48. Housing in between</td>
</tr>
<tr>
<td>Roads and bridges</td>
<td>Temporary or/and permanent inundation. Loss of use of roads/bridges. Increased maintenance. Loss of access. Damage to bridges and roads.</td>
<td>52. Networks of paths and cars</td>
</tr>
<tr>
<td>Sailing clubs</td>
<td>Damage from erosion / recession / inundation. Access to buildings diminished. Property damaged or destroyed. Increased maintenance.</td>
<td>72. Local sports</td>
</tr>
<tr>
<td>Surf breaks</td>
<td>Loss of beach or reef surf break. Reduced tourist/recreational usage. Loss of amenity.</td>
<td>25. Access to water</td>
</tr>
<tr>
<td>Surf Life Saving Clubs (SLSC)</td>
<td>Damage to SLSC results in diminished capacity to provide beach patrol services. Reduced user safety. Amenity loss.</td>
<td>72. Local sports</td>
</tr>
<tr>
<td>Water infrastructure</td>
<td>Accelerated deterioration. Increased maintenance. Damage to pipes and loss of land in easement. Loss of infrastructure.</td>
<td>95. Building complex</td>
</tr>
</tbody>
</table>

Table 1: Allocation of Assets / Climate Change Risks to Pattern Languages (Roös, P, 2013)

Application

Allocating numbers and group the same pattern together of uses, assets and similar climate change impacts, a pattern language is emerging for the coastal environment. For example “Assets at risk” that can be allocated the definition of the pattern number “25. Access to water” of Alexander’s pattern language; clearly emerges with the similar patterns of climate change impact risks for assets numbers 1, 13 and 17 such as:
- Loss of beach.
- Temporary/permanent inundation.
- Loss of amenity.
- Loss of access.
- Erosion damage.

Using a systematic process, or “chain of effects” can be developed, informing the Design Based Adaptation Model (DBAM) framework, combining the process of a risk based adaptation framework with a design model based on pattern language (Figure 4). In the framework this process will start with Identifying the Risks and the Design Patterns which are established in Phase 1, and then Evaluating the Generative Code in Phase 2, Synthesise & Appraisal of these will help with Design and Planning of a final Adaptation Framework in Phase 3 that can be implemented in a staged approach for the communities on the coast.

**Conclusion and Discussion**

In his theory of Design with Nature, Ian McHarg argued that the artefacts of man as a process are naturally deterministic, same as natural processes that are deterministic in an ecosystem, supporting morphology of man-nature relationship (McHarg, 1992). Similarly, John Tillman Lyle argued that human ecosystems are part of an order, and in the concepts of ecology there are three modes of order: structure, function and location (Lyle, 1991). In landscape design practice, Lyle refers to the principle of hierarchy of scale, and he developed a process for design what he called “The Chain of Effects”. The matrix developed by Lyle identifying the chains of environmental effects brought about by human actions in the environment is strikingly similarly in principle than the “Pattern Language” developed by Christopher Alexander (Alexander, 1977).

It is evident that according to these theorists that human’s connection to nature are deeply routed in a mathematical pattern and process, and this can be used as a roadmap for applying ecological information to the way we interpret, plan and shape our coastal settlements.

“To work our way toward a shared and living language once again, we must first learn how to discover patterns which are deep, and capable of generating life” (Alexander, C. 1977)

Facing unprecedented changes in our environment due to future climate effects, the way forward is to reconnect man with nature, and to discover the patterns for the co-evolution of both to establish resilience for the future.

This paper concludes that it is essential to combine the theories of McHarg, Lyle and Alexander, selecting key principles as an input to an ecological Design Based Adaptation Model for coastal settlements, which establishes a regenerative-adaptive system of unfolding steps to create sustainable communities that connect with the landscape, and are resilient against future impacts of change.

**Further Work**

The example above of the establishment of patterns and a language that is connected with coastal town development as well as climate change adaptation is the first step in putting the elements
together of the Design Based Adaptation Model. Important considerations are to map these patterns with natural environmental patterns, or processes. Using the example of the Surf Coast: Coastal Climate Change Vulnerability and Adaptation Project, the assets at risk need to be further investigated to identify the relationships between the built environment assets and ecological assets. Evident in this establishment of the patterns is a generative process that is expressive, which are morphologically determined.

References


DSE. (2004). *Great Ocean Road Region - Land use and transport strategy 2004*. Melbourne: Department of Sustainability and Environment DSE.


GORCC. (2012). *Coastal Climate Change Vulnerability and Adaptation*. Melbourne: Great Ocean Road Coast Committee - GORCC.


