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Societal Responses to Significant Change:

An Historical Analysis of Adaptive Capacity

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This report, **Societal Responses to Significant Change: An Historical Analysis of Adaptive Capacity,** is part of the South East Queensland Climate Adaptation Research Initiative, a partnership between the Queensland and Australian Governments, the CSIRO Climate Adaptation National Research Flagship, Griffith University, the University of the Sunshine Coast and the University of Queensland.

South East Queensland is particularly vulnerable to climate change because of its growing population and coastal location. Human settlement, infrastructure, unique ecosystems, and primary industries all face threats from more extreme weather events, increased temperatures and altered rainfall patterns because of increased greenhouse gas emissions. Despite these risks and challenges, climate change may also bring some economic and social opportunities.

SEQ-CARI aims to provide research knowledge to enable the region to adapt and prepare for the impacts of climate change. It will develop practical and cost-effective adaptation strategies to assist decision-makers in government, industry and the community. The Initiative is the first comprehensive regional study on climate change adaptation undertaken in Australia and one of only a few worldwide. It is exploring both vulnerabilities and adaptation options in response to climate change so that our prosperous regional economy, environment and lifestyles can be maintained into the future.

For more information about this and other projects in the South East Queensland Climate Adaptation Research Initiative visit: www.csiro.au/partnerships/seqcari.html

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Executive summary

South East Queensland, Australia, will face significant challenges over the coming decades because of climate change. Preparation to respond to these challenges requires a prospective vision that develops the region's adaptive capacity. The foresight needed to step confidently into an unpredictable future is enhanced by historical reflection. Such reflection fosters the anticipatory social learning that strengthens adaptive capacity. Consequently, this report seeks to examine the historical record to identify how societies in the distant and recent past have responded to changes in both the natural and social environment.

This report's exploration of societal responses to significant change thus turns to history and asks: *What lessons from the past can inform current approaches to adaptive capacity for South East Queensland stakeholders today?* It is understood that social resilience hinges on practical answers that are translatable to other contexts. Furthermore, the role of stakeholders in managing their contexts is also appreciated. Therefore, case studies have been gathered with relevance to the four sector groupings participating in the South East Queensland Climate Adaptation Research Initiative (SEQCARI), namely: Human Settlement and Health; Agriculture; Ecosystems and Biodiversity; and Energy.

Thirty-three case studies are presented in this report (Table A). They cover local micro contexts, regional and national meso contexts, and global and civilisational macro contexts. Diversity was sought in case study selection with case studies profiling a range of contrasting issues that date from fifteen thousand years ago to the present. Some case studies span several sectors.

Table A: Historical case study distribution

Sector	
Human Settlement and Health	16
Agriculture, Forestry and Fisheries	10
Ecosystems and Biodiversity	9
Energy	10

To enable easy access to the insights generated by the case studies each has been scaffolded to make explicit the adaptive learning possibilities inherent to the case. The focus is on demonstrated adaptive capacity, social learning, primary and secondary drivers, barriers and successes, and the implications for climate change adaptation.

To facilitate reflection on the case studies, key determinants have been summarized and broader connections are made between them. The determinants identified refer to either external drivers that frame context, or internal drivers that frame responses. Factors shaping context include: the degree of social complexity, how isolated the context was, available resources, how authoritarian the governance structures are, the technologies that impact on human choices, and the scale and nature of growth experienced in the context. Factors shaping adaptive responses include: the nature of leadership, institutions and their ability to learn, a capacity for risk taking, the richness of the social imagination, what social addictions may drive contexts to undermine their own long-term interests, and the quality and extent of information available to inform those in each context.

These case studies present an overview of social change and adaptive capacity that point to the unique nature of each context while identifying generic features about human social

organisation. The historical insights indicate that all social fields are dynamic and changing (Figure A).

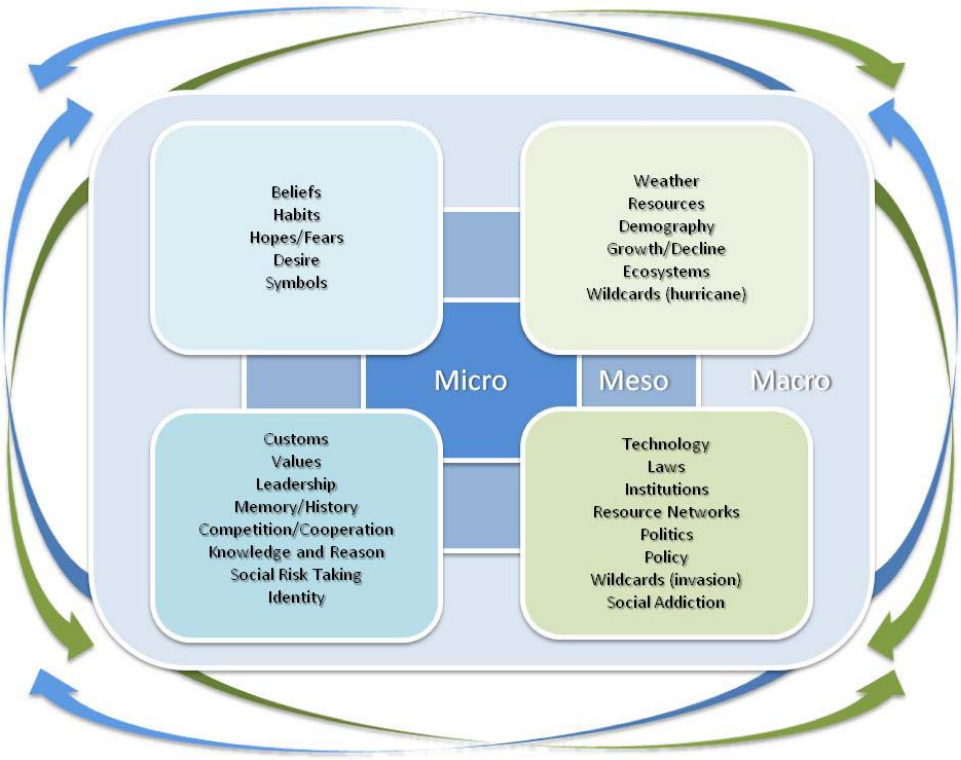

Figure A: Folding field of adaptive capacity mapping determinants

The human tendency is to try to minimize change while maximizing the energy yield of context. This struggle for order and abundance is a key feature of culture. The case studies profiled indicate that culture, and its adaptive capacity, is responsive to the following contexts.

Complexity and leadership

Central to defining any adaptive response is the degree of social complexity. Highly complex societies are vulnerable to stress, they tend to have a deep commitment to infrastructure that maintains their complexity and a resistance to forces that would challenge the dominant order (eg: Sydney 2000 and New Orleans 2006 case studies). Complex systems are highly energy dependent and reluctant to redeploy resources to enhance adaptive capacity (eg: Phuket 2009 case study). The importance of leadership and governance structures is also critical. Authoritarian leadership may work for a short period but tends to inhibit social learning (eg: Azerbaijan 2005 case study). Adaptive leadership on the other hand broadens the base for creative and innovative action and includes collectives in thinking through implementing adaptive responses to change (eg: Sweden 2006 case study).

Institutions and values

Institutions and the values that shape them are also critical. Institutions supply meaningful structure for action. They shape the dominant logic of a context and are instrumental in implementing responses to change (eg: Britain 1800 case study). Values inform institutions and are instrumental in determining the actions institutions perform. Values are not always inclined to support adaptive responses and can work against the best interests of the collective (eg: Easter Island 1500 case study). Such values are understood

as social addictions. To challenge such addiction can appear to be risky to those working the 'coal face' as it challenges habits and identity that is invested in current social and institutional practice (eg: Rome 1CE case study). Risk involves moving from the 'tried and true' into the unknown. Risk taking is therefore a part of adaptive capacity.

Technology and imagination

Technology is also a determinant in thinking about responses to change. Its impact on human experience is profound as it shapes both the physical contexts in which humans live and work and our ways of understanding the world. Social identity and social choices are also often linked to technology (eg: The Mobile Phone 1990s case study), with the result that alternatives to dominant constructions of the present can be sidelined or overlooked (eg: Sydney 2000 case study). Social imagination can challenge such omissions by drawing on the diversity that constitutes complex societies (eg: The Novel 1850 case study).

Information and knowledge

Complex systems and their institutions rely on information and knowledge to manage context. Information and knowledge are important in challenging dominant value structures (eg: Donora 1948 and Curitiba 1990s case studies). They inform adaptive leadership and the attention to context necessary for timely responses to climate change. How information is generated, who gets to see it and how it is deployed in responding to change is determined by knowledge systems that reflect the dominant values of the system (eg: NSW Parks 2009 case study). Knowledge systems filter data and information (eg: Indigenous Australians 2009 case study). Adaptive responses are heightened when knowledge systems become more flexible and multidisciplinary and hence open to challenge and redefinition (eg: Chesapeake 2009 case study).

Scale

How such social forces play out is determined by context and scale. The more complex a system the easier it is to hide dysfunction for longer (eg: New Orleans 2006 case study). Small systems tend to show stress rapidly and can be considered the canary in the mineshaft for larger systems (eg: Byron Bay 2009 case study). System priorities often change across scale and cause turbulence when there is interaction across scales (eg: Maroochy 2009 case study). This working across scales is in fact a question of adaptive capacity and is worthy of further study.

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Preamble

This report seeks to deepen the relevance of the selected case studies to an understanding of climate change adaptation by also treating them as scenarios. Historical scenarios suggest four possible trajectories for South East Queensland over the coming decades: Continuation, Collapse, Disciplined Society and Transformation. Scenarios stimulate the imagination to engage with the possibilities of context. Stakeholder groups will be able to see how social forces that shaped past choices and social adaptations have relevance for thinking about and engaging with the adaptive capacity inherent to their context.

An historical appraisal of past human adaptive actions allows some degree of insight into current practices and possibilities. This insight, it must be acknowledged, is only partial. Contexts are always unique. Yet human activity also has a generic nature and historical patterns emerge when a range of cases are examined. The case studies gathered in this report form a kernel of information that can inform the practical reckoning of those in context. Ultimately however, the onus is on those in context to think beyond history to the future.

Introduction

The focus of this report is the historical precedents for human adaptive capacity. Responses to major sudden change and incremental change are considered. No particular priority is given to climate change because the capacity to adapt to environmental, social, political and economic change is an integral part of the human condition, although implications for climate change adaptation are discussed. What is considered in this report are the nature of adjustments and their timeliness and appropriateness as responses to altered and threatening changes to the stability of societies.

For the purposes of this report, adaptive capacity is taken to mean “The ability of a system to adjust to climate change … to moderate potential damages, to take advantage of opportunities, or to cope with the consequences” (IPCC, 2001, p. 881). A society’s ability to do these things is determined by a range of general and unique factors relating to; 1) its capacity to convert human, social, financial, built and natural capitals into new forms; and 2) its capacity to overcome the inertia that present practices and their historical momentum impose on context.

Adaptive capacity is also about defining vulnerability to likely impacts and consciously reducing vulnerability through:

- reducing exposure (mitigation and physical, institutional and individual change),
- reducing sensitivity (removal of threat, increasing resistance and resilience).

Fundamental to adaptive capacity is the ability to learn, especially at the societal level through its institutions, and mobilise capitals in response to threats.

The historical record is replete with examples of human societies and communities responding to a variety of stressors that include climatic change, threats of war, economic and agricultural decline, competition for resources, disease and extreme natural events. Responses have ranged from denial leading to collapse, as in the case of the Western Roman Empire, to the total reordering of the economic and political systems of the state as in the case of both Britain during the early years of the Industrial Revolution and of the United States, which endured a civil war that established the social and economic conditions for rapid industrialisation.

Such examples provide insights into how societies and communities have responded in the past to stress and threat to the status quo. They also provide insights into the conditions that strengthened or diminished adaptive capacity. As Adger notes:

> Given that the world is increasingly faced with risks of climate change that are at the boundaries of human experience, there is an urgent need to learn from past and present adaptation strategies to understand both the processes by which adaptation takes place and the limitations of the various agents of change – states, markets, and civil society – in these processes. (2003, pp. 387-388)

This report aims to offer a selection of historical case studies relevant to the stakeholders being consulted in the South East Queensland Climate Adaptation Research Initiative (SEQCARI). The objective is to inform the need to address climate change with historical depth and with an appreciation of the social and cultural processes that frame action and shape decision making. The report identifies a range of drivers that have either increased or decreased social resilience. The case studies illustrate how such drivers represent opportunities or barriers to adaptive capacity. Each case study can be considered as an historical scenario that profiles features of collective action to be found in human engagement with contextual stress. As such, they offer lessons for the present and guide-posts to a range of possible futures for South East Queensland and beyond.

Rationale

Social learning, and therefore adaptive capacity, does not occur without context. The historical profiling of responses to significant change illustrates how a variety of factors contributes to a society's success or failure. These factors traverse a range of scales that can be civilizational, involving a mix of world views and cultural processes designed to facilitate these; institutional processes that coordinate human activity in context and across time; and individual processes that indicate, at times, the important role played by individuals working in context. There is also the emergent global context to be considered in which a complex array of natural, cultural, social and economic forces are increasingly impacting on civilizational, institutional and individual contexts. Case studies are classified according to their relationship with these scales. Three categories are used:

- Macro: which includes both global and civilizational contexts and indicates that the human, social, financial, built and natural capitals available to those working at this level are broad and complex;
- Meso: which indicates that the context is largely regional (national and sub-national) in nature. It focuses on geographic, national and institutional settings and suggests that the human, social, financial, built and natural capitals are defined and constrained by the historical, institutional and social structures of the setting; and
- Micro: which are cases that also focus on local contexts. Such case studies offer insight into adaptive capacity at the grassroots level where the human, social, financial, built and natural capitals emerge directly from interactions in situ.

It is also important to challenge a single contextual frame of reference because scales are not singular in nature but impact across scales, often with significant and unexpected

results. Each scale consists of a set of processes that determine operational priorities within the scale. An adaptive response at one scale may be maladaptive at another.

The historical analysis is intended to clarify the interplay of these factors of scale. The work is built around a series of historical case studies designed to facilitate reflection on the present and the drivers that maintain global, civilizational, institutional and personal trajectories. Analysis is intended to create the opportunity for stakeholders, communities and individuals to engage with processes more effectively to increase the adaptive capacity of key stakeholders and institutions.

To consider the case studies as historical scenarios increases their potency as *lessons for the future*. As historian Ronald Wright notes: 'whenever history repeats itself, the price goes up' (Wright, 2006, p. 149). Thus, he calculates when Mesopotamia collapsed 500000 people suffered, when Rome collapsed some tens of millions suffered. If contemporary society were to collapse, more than 6 billion people will suffer. Historical scenarios take examples from the distant and recent past and present them in such a way that lessons can be extracted from them for the future.

This report therefore seeks to identify the possibilities for action within context. This concern is practical in nature and intended to enlarge the range of practical choices facing stakeholders in their lived and working contexts. Consciousness of the drivers of change and an understanding of obstacles to change gained from historical study increase the "sphere of practical reckoning" (Smith, 2009, p. 4) and enlarges the frame of reference and the critical, imaginative and psychological resources available to decision makers.

Core concepts

This report draws on a number of core concepts. These will be described in the following sections. A glossary of terms is also provided in the Appendices.

Social learning

Social leaning is shaped by historical and contextual processes. It is practical in that it has effects that are to be seen within society (Wenger, 2000). It involves collective processes such as policy and infrastructure in reworking how reality is configured and experienced. It also has a personal dimension in that it involves individuals enacting collective goals and negotiating social space.

This is a complex and iterative process. Perhaps the most effective social learning can be termed anticipatory action learning (Inayatullah, 2007). Such learning invokes the future, a specific desired future or a dysfunctional future, and engages iterative cycles of reflexive and goal driven action in generating effective processes for either achieving or avoiding the anticipated future. All of this revolves around what Slaughter (1995) calls 'strategic foresight'. One way of engaging with the future is via scenarios. The historical case studies in this report can be used as scenarios as they represent examples of human actions in the distant or recent past that point to possible ways contemporary society might respond to issues such as climate change.

Tabara and Pahl-Wostl (2007) describe how social learning informs decision making. They argue that it determines opportunities for critical (or uncritical) reflection upon and engagement with context. They see it as a dynamic process of empowerment that works across scales, harnesses democratic and communal engagement encourages decentralisation of decision-making and fosters a sense of interconnectedness.

Social capital

Social learning reflects the degree of social capital available to any decision making group when faced with contextual stress. The importance of social capital in adaptive responses

is clearly articulated by Ahn and Orstrom who define it as: “a set of values and relationships created by individuals in the past that can be drawn on in the present and future to facilitate overcoming social dilemmas” (2002, p. 2). Adger further notes that “social capital describes relations of trust, reciprocity, and exchange; the evolution of common rules; and the role of networks” (2003, p. 389).

Thus social capital refers to the extensiveness and thickness of webs of social interaction available within and between social groups (Hooghe 2003). Such ‘webs’ are important in historical analysis and also in any assessment of the adaptive capacity of a community or group. The historians McNeill and McNeill (2003) argue for the centrality of such webs in human history because the tendency in cultural evolution, over all, has been to move from simplicity of social organisation to complexity in which the use of energy – both physical and cultural – has grown exponentially.

Such webs lie at the heart of social learning. They represent the learning potential of a community. Thus the more webs a community has the greater is the potential for learning (Wenger, 2000). The stakeholder groupings of Human Settlement and Health, Agriculture, Ecosystems and Biodiversity, and Energy in the SEQCARI represent communities of practice built around specific sets of concerns and contexts. Historical profiling for each stakeholder group deepens these webs by including the past in understanding the learning potential in context.

Climate change specific concepts

Adaptive capacity

The Intergovernmental Panel on Climate Change Third Assessment Report (IPCC 2001, p. 881) defines adaptive capacity as “The ability of a system to adjust to climate change … to moderate potential damages, to take advantage of opportunities, or to cope with the consequences”. This generates a simple checklist that can be used to assess adaptive capacity within context:

- ☑ Adjust to climate change
- ☑ Moderate potential damages
- ☑ Take advantage of opportunities
- ☑ Cope with Consequences

This simplicity is somewhat beguiling and misses much that is inherent to an understanding of adaptive capacity as a systemic property of context. Thus Jakku and Lynam (2010) emphasise the process of adaptive capacity. They define it as follows:

> Adaptive capacity comprises the properties of a system that enable it to modify itself in order to maintain or achieve a desired state in the face of perceived or actual stress.

This definition suggests a dynamic approach to contextual factors that generate stress within a system. Jakku and Lynam suggest that such an approach must take into account the resources available to the system, the specific (unique) nature of context, and the play across scales of influence. They also suggest that adaptive capacity is a potentiality within any system and that it goes beyond being a coping strategy as the IPCC defines it.

Vulnerability

Adaptive capacity is closely linked to questions of vulnerability. Vulnerability is a function of a system’s exposure and sensitivity to hazardous conditions. It can be expressed as the degree of exposure of a population and its environs to a hazard and the degree to which it is prepared and able to respond to the hazard (USIOTWSP, 2007). Jakku and Lynam

suggest that context is a key factor in thinking about vulnerability and offer a nested hierarchy of contextual to better understanding the ways in which vulnerability questions play out (2010, p. 7). Generally, vulnerability is represented as a simple flow chart with exposure and sensitivity defining potential impact that can be moderated by adaptive capacity to define a level of vulnerability (Figure 1).

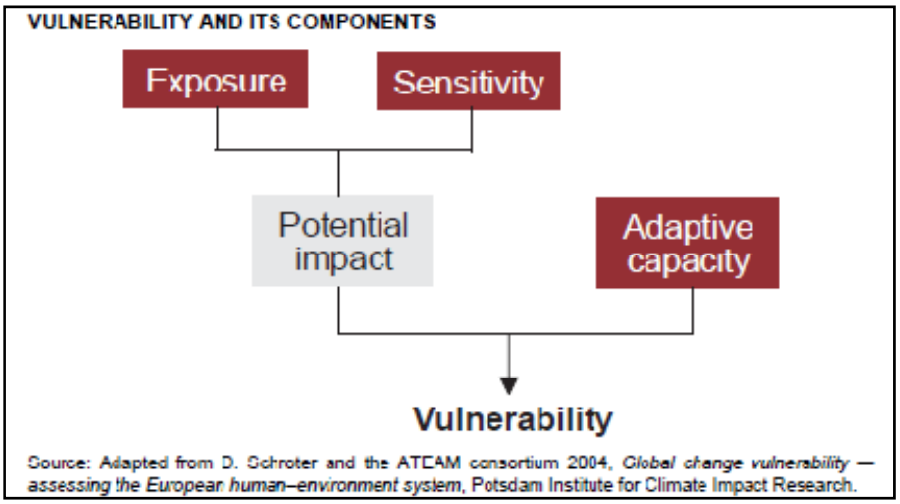

Figure 1: Elements of vulnerability (Schroter 2004)

The dynamic definition of adaptive capacity brings flexibility to this arrangement by suggesting shifting scales, open-ended causal relationships and the unique nature of context as generic variables in thinking about vulnerability. Furthermore, Adger (2003) points out that in social systems there is a power differential between decision-making processes and those considered vulnerable. Systems priorities and decision-making processes tend to favour those at the centre, while the most marginalised and vulnerable tend to be at the periphery. Any assessment of vulnerability needs to be able to challenge such a differential via democratic and inclusive decision-making process built around nested relationships. Thus, he concludes:

> ...adaptation processes involve the interdependence of agents through their relationships with each other, with the institutions in which they reside, and with the resource base on which they depend (2003, p. 388).

Resilience

Resilience relates to the ability of a system to cope with change (Walker, 2006). It implies social learning and the ability to develop new ways of acting. A resilient system is a learning system. As Folke, et al. (2002) acknowledge, when a system is resilient it is able to 'absorb shock while maintaining function'. They also note that when a system is resilient it is able to find opportunity in change while a system that is low in resilience will only be vulnerable.

Much of this report can be understood as an historical examination of resilience in action. Resilience is linked to the scale of the context and is interactive. This interactivity is built around a sense of relationship between a range of drivers. Thus another recent report defines community resilience as: "the capacity of a community to adapt to and influence the course of environmental, social, and economic change" (USIOTWSP, 2007, p. 31). Relationships across scale are also significant, often involving shifts in the dominant logic between scale (e.g., local community group attempting to interact with a State government).

Resilient systems are open ended, able to cope with uncertainty, engaged in cycles of adaptive learning, flexible, innovative, historically aware and diverse. They also

demonstrate the ability to conserve elements of the past while re-ordering essential systems to meet new challenges. Thus, they are also open to the future and its possibilities. Folke et al (2002) suggest that resilience can be fostered using structured scenarios. These, they note, can be used to "envision alternative futures and the pathways by which they might be reached" (2002, p. 9).

Historical scenarios

Scenarios are a key tool for fostering social learning. They do this by suggesting alternatives, challenging dominant constructions of the present and allowing people to develop visions of the future that are aligned to their own aspirations as individuals and communities. Furthermore, they challenge linear constructions of social process and affirm human agency – our ability to act on the present – by highlighting our centrality as social actors (Inayatullah, Molitor, et al, 2009).

Generally, scenarios are set in the future. This report uses historical case studies to suggest possible trajectories for the future based on past responses to contextual stress. So, though history does not repeat itself, there are patterns within it from which societies can learn from (Galtung, 1997). These patterns suggest possible ways our society might respond to the current challenge of climate change. Futurist Jim Dator (2002) has argued that scenarios can be extended when linked to what he calls 'historical archetypes'. Such archetypes represent deep patterns that recur over time (Bezold, 2009; Inayatullah, 2008).

By studying the historical record, he identifies four clear social responses to stress:

- continuation – this is the hopeful model of business as usual;
- collapse – less hopeful, but useful in reminding people in contexts that *contexts do fail;*
- disciplined society – in many respects this is a return to a past 'ideal' environment in which society is organised around an overarching set of values: "usually considered to be ancient, traditional, natural, ideologically correct, or God-given" (Dator, p. 10); and
- transformational society – in which the current form gives way to a qualitatively different social dynamic. Some see it as 'high-tech' or 'high spirit'; it tends to be built around a different relationship to energy and social organisation.

These categories he calls archetypes as they represent deep patterns that are found across history and its geographical/cultural settings.

This report seeks to present a series of historical sketches that reflect Dator's analysis. The scenarios will highlight the barriers to social learning, the opportunities available within contexts for social learning and the determinants that shape the nature of the choices societies face and the decisions societies make. They will chart a range of possible and preferable futures available to stakeholders in South East Queensland.

Report development and structure

This report seeks to provide relevant stimulus material for the four sectors being addressed by the SEQ Climate Adaptation Research Initiative. It is designed to further understanding of the range of determinants that shape adaptive capacity in any context. Core concepts are summarised to orient readers to the key issues being explored in the case studies.

Researchers have contributed case studies designed to illustrate an aspect of social adaptive capacity pertinent to the interests of each stakeholder group. The Sector Based Case Studies sections are designed to stand alone for each stakeholder group. As such,

they can be read discretely as a stimulus to reflection and action. When read collectively, a more nuanced picture emerges of adaptive capacity at work across society.

The synthesis section integrates findings from the four Sector Based Case Studies sections and is relevant to all stakeholder groups. Similarly, the historical scenario sections are firstly presented within each stakeholder section and then a broad set, relevant to all sectors, is provided as a platform for discussion, reflection and adaptive action.

The report can be read in its entirety, or sampled selectively from the perspective of a specific stakeholder. All case studies are included in Appendix 3 and preceded by Appendix 1: an Overview of the Case Studies, Historical Scenarios and Sectors, and Appendix 2: a summary of Historical scenarios by Sector.

Figure 2 summarises this outline and gives a 'bird's eye view' of the report.

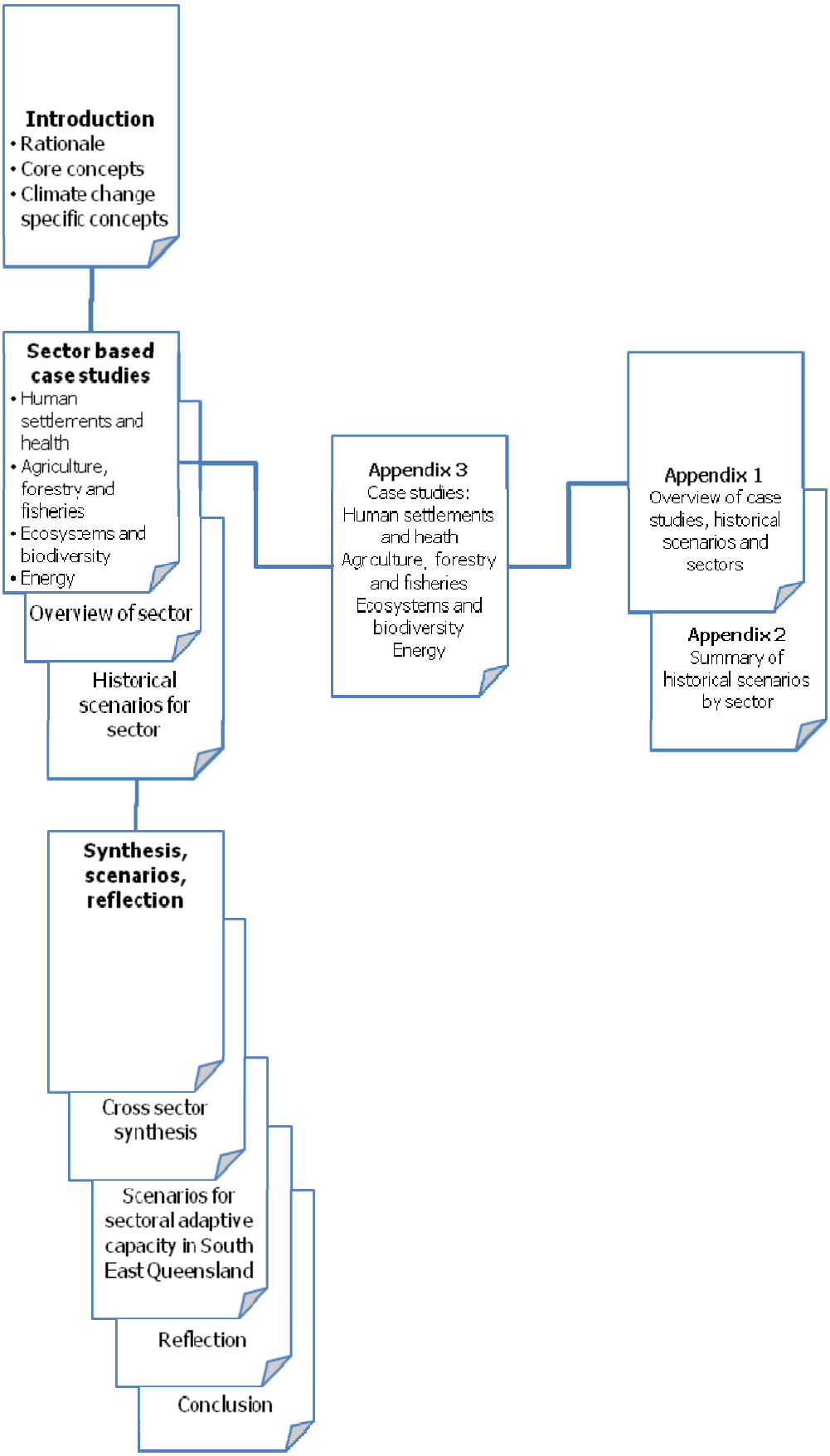

Figure 2: Report Development and structure

Sector based case studies

In all, 33 case studies (Table 1) were collected to stimulate reflection by representatives of the four sectors that are the focus of the SEQ CARI project: Human Settlement and Health, Agriculture, Ecosystems and Biodiversity, and Energy. The case studies range from 15 kya (thousand years ago) to the present with 20 falling within the past twenty years. Sixteen case studies focus on issues relating to Human Settlement, ten relate to Agriculture, nine to Ecosystems and Biodiversity and ten to Energy. Ten case studies relate equally to two sectors.

Table 1: Historical case study distribution

Sector	
Human Settlement and Health	16
Agriculture, Forestry and Fisheries	10
Ecosystems and Biodiversity	9
Energy	10

There are case studies representative of each of the scenario archetypes offered by Dator (2002). Seventeen case studies reflect an expectation that the future will be in some way much like the past, six look at cases of near or total collapse, seven profile cases in which an ideal model of social process is drawn on as an organising model for human activity and thirteen present cases in which some form of social transformation has occurred in response to contextual stress. There are ten instances where case studies reflect the contested nature of social process. In these contexts, two scenario types can be seen working in parallel.

Human settlements & health

Overview

There are sixteen case studies of relevance to Human Settlement and Health. This is the largest number of case studies in the report. The large number reflects the diversity and richness of issues relating to this stakeholder category. The case studies demonstrate the role of values in determining choice and generating alternatives. They also bear witness to the importance of webs of interaction and to the significance of leadership in enabling adaptive capacity and spear heading social learning.

- Palaeolithic 15kya
- The Natufians 12kya
- Athens 590BCE
- Rome 1CE
- Angkor Wat 1200
- Britain 1800
- The Novel 1850
- Donora 1948
- Netherlands 1953
- Mobile Phones 1990s
- Curitiba 1990s
- Sydney 2000
- New Orleans 2006
- Byron Bay 2009
- Netherlands 2009
- Eco-communities 2009

Adaptive capacity and social learning

The further back in time the researcher goes the simpler was the response to contextual stress. This suggests that the human system in operation was itself simpler than more modern human systems. Civilisation is characterised by increasing complexity over time. Therefore, the Palaeolithic and Natufian examples show people moving to adjust to changes in their environment. This is largely the extent of their adaptive capacity. In the case of the Natufians, they moved from a semi-settled life way to a hunter gathering one. Their adaptive response was to reduce complexity.

Millennia later there are the Greeks of Athens rethinking their political and legal system. In this case, both strong leadership and collective desire for a more inclusive form of governance were essential to a success adaptation. The Romans actually chose to move away from democratic political processes (they kept the form but not the substance) to a more centralised imperial arrangement that revitalised the operations of the Empire. While guaranteeing stability in times when there was a strong leader it was also prone to long periods of instability when rivals for the Imperial 'throne' struggled for dominance.

Facing a different set of problems, the people of Angkor Wat would modify their hydraulic technology and built in a modular system of agriculture that allowed a degree of resilience to support the system. The British combined the solutions of the Greeks and Romans to their problem of emerging empire and industrialisation. They also reconfigured the political and legal system and widened the system of parliament constructing a constitutional monarchy and an increasingly representative democracy. Thus, they maintained a centralised Empire while building a degree of ownership into it for its citizenry.

The cases of Donora 1948, the Netherlands' floods of 1953, Sydney 2000 and New Orleans 2006 were more specific in nature and involve technological and scientific engagement with the problem and, particularly in the case of Donora, legal action to

protect people from polluting industries. The case studies of Curitiba 1990s, Byron Bay 2009 and the Netherlands 2009 illustrate at different levels of scale how more holistic solutions to systemic challenges are being engaged. These cases demonstrate a willingness to think creatively and to challenge dominant mindsets when looking for a solution. Teamwork, multidisciplinary thinking and (political) risk taking are evident.

The Novel 1850 and the Mobile Phone 1990s exemplify how technologies change the way people do business and demonstrate how identity, values and desires are affected by new technologies. Such changes must have occurred also many times in the past when new social forms such as agriculture and urbanisation emerged. The adaptation takes the form of rapid uptake and acclimatisation to a new setting, which becomes a necessary ingredient to social and personal processes. The social learning in such cases is often unexpected and innovative. These cases point to the emergence of a deeper sense of self, a commitment to human rights, increased personal and social mobility and new forms of political power.

Such imaginative resources represent new cultural processes at work. The role of the imagination in these is demonstrated in the last case study for Human Settlements: the Eco-communities 2009. This case study shows how anticipatory action learning leads to experimentation with a new social form that seeks to pre-empt an anticipated disruption of energy. This is an imaginative and creative act that draws on a mix of romantic desire for simpler and more aesthetic forms of human community, an eco-centric value system that looks at alternatives to human domination of the natural capital of the planet while not denying the utility of technological and scientific advances in achieving a win-win for humanity and the biosphere.

Implications for human settlement, health and climate change

The five premodern case studies illustrate a wide range of adaptive measures with implications for climate change. The Palaeolithic and Natufian examples demonstrate how vulnerable societies are to climate change and how the level of complexity determines the degree to which societies can and do respond. When looking at the Natufians and the Angkor Wat case studies it is evident that abandonment of more complex social forms is a viable option for human survival. Memory seems to work across time scales and demonstrates that abandonment does not preclude a return to complex structures in the future.

Angkor Wat also illustrates that pathway dependency in the form of investment in infrastructure can make a society vulnerable and reduce alternatives when an adaptation ceases to be advantageous to its context and in effect becomes a maladaptation over a longer time scale. So the hydraulic work of the Khmer in Angkor can be better understood as mitigative rather than adaptive. The centralisation of authority in the person of the Roman Emperor Augustus Caesar can be understood in the same way.

In the case of Athens, under the leadership of Solon and later Cleisthenes, there is a values ferment where strong leadership is linked to changing values in the collective. As this happens at a meso level of a local municipality, it remains vulnerable to wider threats – in this case, the military might of neighbours. A similar lesson is to be learnt from the case of Curitiba where reforms have been compromised by a municipal, as opposed to regional, vision. However, it is important to recognise that values can and do change. In all but the Palaeolithic example cited here, this fact is evident. Numerous other case studies in this set also demonstrate this.

Values are also found shifting, in fact being engineered, in Britain 1800 and the Netherlands 2009. Both case studies demonstrate the power of legislative measures in reframing values. Furthermore, the British commitment to education in the 19th C and the

Dutch to public information and pedagogy and multilevel engagement in the 20th and 21st Cs illustrate that other social tools can be utilised to shift values towards desired ends. The Dutch also demonstrate a willingness to network social capitals in creative ways. The example of Byron Bay 2005 also demonstrates this while highlighting the contested nature of values shifting.

Adaptive learning sometimes is rather minimal as in the cases of Sydney 2000, New Orleans 2006 and the Netherland 1953, where structural thinking links with technological confidence in managing the present and preparing for the future. The case of New Orleans is particularly interesting as there is a considerable degree of 'amnesia' at work as this city has been destroyed numerous times and yet there has been little creativity in looking for solutions to its ongoing vulnerability. Furthermore, the case of Sydney profiles the playing out of political imperatives that have short rather than long-term time frames and considerations. The same techno-scientific confidence can be seen in the case of Donora 1948 but this is linked with a focused application of scientific research and legislative change to ensure high levels of environmental security for a vulnerable population. All of these case studies demonstrate the importance of the State in framing and leading responses to systems stress.

The cases of the Novel 1850 and the Mobile Phone 1990s profile the impact of a technology on social values and activity. These studies demonstrate the power of the intersection of a technology with its context. There are often unforeseen consequences to an adaptation and technology always has a social dimension. It is certain that Guttenberg could not have anticipated the impact of printing on the world; similarly, Alexander Graham Bell could not have anticipated the use of the mobile phone in the terrorist attacks on Mumbai in 2008 or the protest movements in Iran in 2009. Social learning is neither linear nor simple. It involves risk taking and a degree of surprise at the unexpected turns it can lead to.

Finally, the case study of the Eco-communities 2009 is suggestive of the role of experiment and imagination in social learning and adaptive capacity. This case study profiles small groups of people experimenting with different social configurations. The experiment is premised on the need to anticipate new learnings. In it is found a range of social capitals being networked in innovative ways to foster and test run new social forms that may provide adaptive advantages to communities.

Human settlement and health, cultural values, social addictions and imaginative resources

The case studies for Human Settlement span fifteen thousand years. They begin when society was relatively simple and had a largely passive relationship with the environment. The primary drivers were the weather and the migratory patterns of a community's primary source of energy (food). The social values of this period were largely egalitarian and the imaginative horizon was stable: *the past is the future*. For the bulk of human history, this has been the case. Today however, life is much more complex and change is the common condition for our civilisation. Premodern hunters and gatherers were largely free of social addictions as social, in contrast to familial, stability was guaranteed by a continuation of a social process that had existed for millennia. Tradition was the major element here and memory exerted a deep influence on all people.

The same can be said also of the Neolithic Natufians at 12kya. They had however moved some distance away from the Palaeolithic order and were now experimenting with a semi sedentary life way. Climate change challenged this order and they retreated into a fully mobile hunter-gatherer life way for roughly 1500 years. As for the people of the Palaeolithic, memory was the primary source of imaginative capital. However, the imaginative memory now carried the possibilities of stable sedentary abundance. When

the climate changed again (roughly 11.5kya) to the milder and more fertile weather patterns that characterised the early Natufian period they were able to respond and reclaim the semi sedentary ways and make another major innovation by cultivating grain. Context had to support this innovation yet the people collectively had to embrace a way of life as different from their past as the industrial system is from the agricultural.

It is important to consider in this context the role of risk taking, the lure of abundance and stability and the impact of a new system of social organisation on future values and the imagination. Perhaps the desire for abundance can be seen as a social addiction. From the perspective of this report, such addictions constrain future choices, lead to unsustainable patterns of behaviour, create distinctions between what is considered rational and what is not and blur the distinction between adaptation and mitigation.

As case studies become more complex, there is also an increase in the complexity of the values and imaginative resources at work. Social addictions too are more varied. In Athens, Rome and Angkor Wat strong leadership was essential in overseeing the building of a new social order that was able to cope with increasing complexity and the demands complexity places on social institutions. However, for Athens strong leadership was motivated by a democratic vision while for both Rome and Angkor it was characterised by authoritarianism. All three case studies had imperial aspirations (the Athenians were only interested in democracy for themselves). Ultimately, for all three these aspirations contributed to their collapse. The drive to expand is therefore perhaps a social addiction. Authoritarianism is a quality of empire and it suggests an imbalance between the centre and the periphery. Such imbalances weaken both, as the centre becomes dependent on resources it does not directly produce while the periphery is weakened through the loss of resources.

The case of Britain 1800 tells a similar story. This case study profiles a dynamic and expansive society experimenting with an early form of capitalism. British elites at this time valued enterprise and novelty and were heavily dependent for resources on Britain's colonies. This resource dependency made Britain vulnerable to the decline of empire in the 20th century. It also expresses an absolute commitment to profit and the expansion of individual over collective needs that released a huge amount of social energy in the form of creativity, innovation and growth. Yet it can paradoxically also be seen as a social addiction in that it has harmed the longer-term aspirations of the British people.

The commitment to the individual is reflected in the emergence of the Novel 1850 as an important artistic and social form. Through it, the values of the subjective realm and of human rights emerged. The mobile phone is another form that has tapped into the dynamism of the individual as a creative social unit. Of course both can be seen to reflect aspects of a culture that when unbalanced lead to high levels of alienation and a culture of self-centeredness.

Two other themes that characterise the case studies collected for this report are a set of values ordered around technology and scientific confidence. Both convey a sense of control and agency to modern culture. Both are also intimately related to our institutional society and demand of it high levels of authority and submission. The case studies of Sydney 2000, Donora 1948, the Netherlands 1953 and New Orleans 2006 illustrate these values in operation. They both compliment and contrast with the values of multidisciplinary and collectivity to which the case studies of Curitiba 1990s, Byron Bay 2009, the Netherlands 2009 and Eco-communities 2009 all point to. These case studies all demonstrate creative ways adaptive learning has been practiced. Inherent to each is a valuation of risk and a willingness to consider and work with alternatives to the mainstream.

These studies profile human ingenuity being put to the test. The range of learnings outlined here suggests societies are on a learning continuum in which collective action is as important as individual insight. Technology has profound implications for culture while changes often have unforeseen consequences. Similarly, adaptations to context should be read across a range of temporal scales as an adaptation in the short term can be a maladaptation in the longer term. Finally, it is clear that values have and continue to change. This can only be good news.

Human settlement, health and leadership

As the case studies move across scales of complexity a range of leadership possibilities emerge. The early studies from the Palaeolithic and the Neolithic are characterise by collective leadership. This style of leadership is described by anthropologists as *acephalous,* which is derived from the Greek meaning 'headless'. Historians generally agree that once agrarian societies emerged there was a move towards both authoritarian and urbanised social orders. It seems that centralised leadership was an adaptive response to the need to order the collective and to guard against attack from other groups. Similarly, laws, law enforcement, writing and a range of facilitative technologies relating to architecture, sanitation, water and transport can also be seen as adaptive responses to increased complexity.

In the remaining case studies only the Novel 1850, the Mobile Phone 1990s and Eco-communities 2009 have a diffused unspecified leadership though of course specific authors such as Charles Dickens, Jane Austin and Victor Hugo are examples of leaders for the early novel; Nokia and Apple are currently market leaders driving mobile technology while specific communities such as Crystal Waters (Queensland Australia), Findhorn in Scotland and Auroville in India can claim to be leaders in the Eco-community movement.

There is a clear divide in the case studies between examples that demonstrate authoritarian and top down leadership styles that are either driven by strong individuals (Athens, Rome, Angkor), or a mix of bureaucratic/systemic imperatives and discipline based expertise (Britain 1800, Donora 1948, Netherlands 1953, Sydney 2000, New Orleans 2006) and more inclusive egalitarian approach to leadership (Curitiba 1990s, Byron Bay 2009, The Netherlands 2009). The latter tend to explore alternatives to the dominant authoritarian model of leadership that has characterised society for many years.

Determinants for human settlement and health

Determinants in these case studies may appear to reflect the uniqueness of each individual context. Yet they are essentially of two types: 1. external drivers, such as weather, resource availability, and demographic pressures; and 2. internal drivers relating to values, worldviews and knowledge systems. These two sets mutually reinforce one another. How a context responds to an external event such as an extreme weather phenomenon reflects its values. Similarly, a society's worldviews determine how it deals with continuity and change. Athenians for example were socially resilient enough to tolerate a period of transition between authoritarian and democratic rule.

External drivers are often unique. New Orleans for instance is the only case study vulnerable to Hurricanes; Donora had a unique mix of ethnic workers, unfavourable geography and unregulated toxic industries; Sydney had both the Olympics on the horizon and vocal local pressure groups; while Curitiba had a long period of stable local government and also nothing to lose in trying innovative solutions to structural problems. Yet all external drivers demand that collectives demonstrate adaptive capacity and resilience. They also hinge on perennial issues of sustainable human activity in the presence of limitations such as the weather, political demands, and infrastructure issues pertaining to growth or decline and changes in resources flows.

The internal drivers demonstrate the role of values and worldviews in determining how cultures respond. Worldviews form the backdrop to choices and decision-making and are often unconscious drivers. Their power lies in their ability to shape identity and to frame how people perceive problems. For example, the state of Philadelphia saw the accident at Donora as a management issue. The aim was to protect both citizens and maintain the productivity of industry. These are not mutually supportive goals. In Byron Bay, values have led to development taking a back seat to sustainable town planning.

At times worldviews offer stability over time while at other times they are contested and demand allegiance of their adherents. When this is the case, debates can be passionate and social learning often reflects the contested nature of the cultural terrain. This is evident for instance in all issues pertaining to sustainability and climate change. The 'elephant in the room' is not the rightness or wrongness of the arguments but the dominant values and assumptions that drive the various positions. Work to make these explicit often allows for greater adaptive capacity. The case of the Netherlands 2009 illustrates how consultation and dialogue that modulates value sets have been used in such a manner. Similarly, the study of the Novel 1850 has enabled social thinking about subjective aspects of culture to come to the fore.

Historical scenarios for human settlement and health

These case studies are suggestive of possible routes stakeholders in the Human Settlement and Health grouping can explore. As historical scenarios, they can inform decision-making and clarify confusions around choices that might be mitigative as opposed to adaptive in nature. It is often the case that both are required to deal with immediate and long term adaptive demands. They suggest the importance of thinking about time frames and about societal compulsions to solve problems according to a restricted set of logical assumptions premised on limited and limiting worldviews.

This section sketches implications for human settlement. It is organised around Dator's four scenario archetypes:

- continuation
- collapse
- disciplined society
- transformational society

Each archetype represents a deep pattern found in history. As an archetype, it is a distillation of countless human experiences. The case studies collected in this report can be organised into these sections. When worldviews are being contested, multiple readings are suggested for case studies. Thus, some case studies can fall into two possible scenario categories as they suggest alternative interpretations to researchers.

The case studies presented for the Human Settlement and Health stakeholders are spread across these categories with most falling in the Continuation or Transformational Society categories. As noted above, case studies can sometimes appear twice as they are suggestive of two possible trajectories. The case study distribution is presented in Table 2.

Table 2: Scenario summaries for human settlement and health

Categories	Human health and settlement case studies
Continuation	HS 1.1 Palaeolithic 15kya
	HS 1.2 Donora 1948
	HS 1.3 Netherlands 1953
	HS 1.4 Sydney 2000
	HS 1.5 New Orleans 2006
	HS 1.6 Netherlands 2009
Collapse	HS 2.1 Angkor Wat 1200
	HS 2.2 New Orleans 2006
Disciplined society	HS 3.1 Eco-communities 2009
	HS 3.2 Palaeolithic 15kya
Transformational society	HS 4.1 The Natufians 12kya
	HS 4.2 Athens 590BCE
	HS 4.3 Rome 1CE
	HS 4.4 Britain 1800
	HS 4.5 The Novel 1850
	HS 4.6 Mobile Phones 1990s
	HS 4.7 Curitiba 1990s
	HS 4.8 Byron Bay 2009
	HS 4.9 Eco-communities 2009

Historical scenarios for human settlement and health

Continuation

Societies rarely consider their own impermanence. Life is too busy and the day-to-day struggle to keep everything running prevents such reflection. In fact, there is resistance to reflection and this is expressed as pathway dependency, institutional inertia and landscape amnesia. This mix underlies the case studies presented as being representative of the continuation scenario.

Scenario HS 1.1 the Palaeolithic 15kya is a reminder that this condition is not simply a product of the modern world. The natural rhythms of ancient life are as much an inducement to habit and complacency as the frenetic activity of modern life. In HS 1.2 Donora 1948 and HS1.3 Netherlands 1953, adaptive learning occurs in response to serious loss of life and property. New legal and institutional changes occur to preserve and extend the present. In the cases of HS 1.4 Sydney 2000 and HS 1.5 New Orleans 2006, the system responds to issues of health and water quality (Sydney) and complete system failure (New Orleans) with technological and top down solutions that fail to address the longer-term issues of sustainability and collective well being. The case HS 1.6 Netherlands 2009 flags a shift in attitudes in which technological solutions are linked to social processes and a degree of inclusivity and consultation. There is a tension here as the goal is to keep things going as usual but there is a greater willingness to transform structures and processes to do so.

Collapse

The case study HS 2.1 Angkor Wat 1200 is set towards the end of this civilisation's productive period. From the perspective of this report, it can be a classic case of over extension and the failure of the infrastructure of society to maintain the energy flows (both water and commercial) required to sustain it into the future. Collapse was rapid and virtually total. The key driver was the physical context of the case study. It was situated in a tropical monsoonal region and the system of canals and ponds based on heavy land clearing resulted in huge loses of top soil and in the erosion of canals and locks used for transport and irrigation. Infrastructure dependency is apparent in this context.

By contrast, HS 2.2 New Orleans 2006 demonstrates the human capacity for stoicism in the face of an ongoing threat. The city is destroyed and then it is rebuilt. There are economic and subjective (i.e. sentimental) reasons for this. Yet how it is rebuilt is at issue. Despite an abundance of imaginative solutions being at hand (Costanza, 2006) it appears that it is again being rebuilt in conventional fashion. Dominant visions for the future and top down leadership are driving this work yet there is little social imagination demonstrated.

Disciplined society

The utopian nature of HS 3.1 Eco-communities 2009 points to the disciplined nature of this scenario. Eco-centric movements are a mixture of a desire for a simpler past and a willingness to embrace aspects of the new – especially technology – in the realisation of this dream. Human drives need to be disciplined for this to happen. Thus, consumerism and hyper-individualism must both be restrained for this vision to be fully realised. Such communities can be either secular in nature as in Crystal Waters which is motivated by the philosophy of permaculture or built on a spiritual vision that draws on ancient religious visions such as Auroville or New Age aspirations and sensitivities such as Findhorn. Yet all are motivated and 'disciplined' by an ideological understanding of human potentiality and the social structures that best facilitate this potential.

HS 3.2 Palaeolithic 15kya is an example of a naturally disciplined social group. The hunter-gatherers of this period work collectively and social order was clearly based on custom. Memory was the primary means of assessing a context. Innovation and freedom were not considered and if they emerged, would have been regarded as threats to the dominant order and security of the group. Much so called 'crime' in hunter-gatherer context stems from the conflict between individual desires to challenge custom.

The contrast between HS 3.1 and HS 3.2 is marked. For Dator (2002) the archetype refers to modernist movements that seek to rekindle the order and security demonstrated in HS 3.2. He would include religious communities, fundamentalist sects, ideologically correct political parties and groups that have formed around a charismatic individual in this archetype (see also Thompson, 1967). In the case of Eco-Communities, the discipline comes from an ideological commitment that is clearly modernist in orientation whereas for the Palaeolithic people of HS 3.3 Palaeolithic 15KYA, it was an organic and largely unconscious state of being.

Transformational society

As this report is focused on adaptive capacity, it is not surprising that a large number of the case studies for Human Settlement and Health look at various expressions of social learning that point to some degree of transformation. In HS 4.1, the Natufians 12kya ultimately moved from a nomadic life way to a settled one. Hunter gathering was replaced by agriculture and new possibilities were introduced as increasingly complex social forms emerged as a result. In the case of HS 4.2 Athens 590BCE, a group of people aspire for greater political self-expression. Leadership here was important in facilitating democracy but the language developed to articulate and legislate this radical shift was a collective expression of the desire for the rule of law, freedom from authoritarian and arbitrary power and democratic engagement in the process of governance.

The Romans 1AD (HS 4.3) had a different problem which they shared with HS 4.4 Britain 1800. Both were expanding and dynamic social enterprises that need considerable social engineering to guarantee their ongoing viability. This required transforming the social order through legislation and at times the studied application of violence. Both contexts had experienced civil war and both had come to solutions that placed power in capable hands. The Romans turned to executive authoritarian leadership while the British developed a unique brand of parliamentary monarchy. Furthermore, the British totally transformed the system of production creating private property, a working class and large industrial hubs, and the Empire to mobilise the resources needed to feed the constantly expanding industrial machine.

Imagination is always mobilised for any transformative project and HS 4.5 the Novel 1850 and HS 4.6 Mobile Phones 1990s, both point to the role technology plays in generating transformative possibility. Similarly, municipalities such as HS 4.7 Curitiba 1990s and HS 4.8 Byron Bay 2009 need to engage their citizens and explore real alternatives for deep change to occur. Yet they are limited by scale as their actions often occur in regional contexts that do not fully support them. In such cases, work across scales can bolster adaptive capacity. Finally, HS 4.9 Eco-communities 2009 provides an alternative model for approaching change. This is based on clearly articulated sets of principles that contest the dominant worldview of context. Such contexts can be understood as laboratories for transformation as they vary widely in their organisation. High in creativity and energy they offer alternatives to the present, yet they are contested spaces in which personalities and the gap between ideals and reality often erode the vision and energy needed to maintain them.

Agriculture, forestry and fisheries

Overview

There are ten case studies with high relevance to agriculture, forestry and fisheries. The studies span 12 thousand years of human history, represent macro, meso and micro scales and illustrate the constant tension between human ingenuity and the debilitating power of custom and pathway dependency.

- The Natufians 12kya
- Angkor Wat 1200
- Amazon 1400
- Hawaii 1700
- Sale 1870
- Cuba 1990s
- Chesapeake Bay 2001
- Azerbaijan 2005
- Bolivia 2009
- Adelbert Mountains 2009

Adaptive capacity and social learning

Human agricultural practice can be understood as a litmus test for adaptive capacity because of its centrality to any civilisation. The core values of a society are revealed in how they respond to agricultural stress. The long-term viability of an agricultural system thus tells researchers much about the long-term viability of a society's adaptive capacity. When contexts become stressed, actions tend to be either mitigative or adaptive. Mitigative actions eventually lead to collapse as they are only responding incrementally to an issue that is much more deeply challenging to the sustainability of the system. In such contexts, the system ramps up its effort to keep ahead of the problem further exacerbating the condition. Adaptive actions reframe the issue and demonstrate higher degrees of creativity and a preparedness to take risks.

Angkor Wat 1200 is an example of mitigative actions. It demonstrates that tinkering with the system forestalls but does not avert severe disruptions in agricultural practice. There are plenty of historical examples not in this report to bear this out. One example is that of the Mesopotamians. These people gradually salinated their agricultural areas. This took a number of centuries over which time they gradually moved away from salt sensitive wheat production to the hardier barley until that too could not withstand the levels of salt and the agricultural basis for this civilisation collapsed (Ponting 2007). Even today, the heart of ancient Mesopotamia in Iraq is arid and the soil is heavily salinated.

Such behaviour contrasts with the adaptive action of the Natufians 12kya. These people had established a semi-sedentary society that depended on stable natural crops of wheat and barley. With the onset of the Younger Dryas 12.8 kya this stability was lost and the Natufians responded by returning to earlier foraging patterns. They abandoned villages and became nomads again. Obviously, their infrastructural dependency was not as great as the Khmer of Angkor Wat or Mesopotamians and the populations they supported were markedly lower so this gave them a greater degree of flexibility in the face of rapid change. Yet they also demonstrate social learning in that memory must have remained alive across a span of some 1500 years. When the climate changed, they returned to their semi-sedentary ways and very soon appear to have begun the intentional cultivation of their favourite grains.

The case studies of the Amazon 1400 and Hawaii 1700 profiles the balance between customary practice and social learning. Both peoples developed flexible and sustainable

agricultural systems capable of sustaining relatively large populations. These practices depended on the broader cultures in place and declined rapidly with the disruptive encounter with Europeans. They had internal adaptive capacity but lacked sufficient resilience in the short term to cope with civilisational instability. However, such practices are inspiring a rethinking of agriculture and the case study of Bolivia 2009 illustrates a possible way forward where indigenous memory is being linked to agricultural and scientific systems.

The case of the Adelbert Mountains 2009 also indicates another possible pathway for such adaptive learning. In this case, sustainable practices are being linked with a broad based cooperative culture that reflects collective aspirations and a shared entrepreneurial spirit. The connection between agriculture and human culture is being leveraged in an attempt to develop a commitment to sustainable agricultural practice that reflects local knowledge and builds local identity in this grass roots enterprise.

Two authoritarian contexts (Azerbaijan 2005 and Cuba 1990s) illustrate how different such context can be. Azerbaijan relies heavily on modern agro chemistry while Cuba, in the absence of such, has followed the Natufian example and returned to traditional practices. This return has not been a simple reversal however, as they have embraced permacultural and organic practices, linked agricultural to their broader cultural revolutionary aspirations and allowed considerable scope for individual enterprise. This creative and flexible solution contrasts with the much less flexible context of Azerbaijan.

The ability to embrace multiple practices is interpreted as a strength. The case of Chesapeake Bay 2001 illustrates how this is being applied in a Western developed context. In this context a holistic approach is emerging which combines a range of stakeholders working together using a variety of integrated approaches to restore oyster numbers to the bay. Finally, the case study of Sale 1870 has been included as it illustrates how the scientific temper emerged as an integral feature of modern agricultural and social practice. In this case, a perceived vulnerability to flooding leads to the determination to chart rainfall in the hope that extremes can be anticipated and responded to pro-actively.

These examples demonstrate the contextual nature of adaptive capacity and social learning. They highlight the role creativity and multidisciplinarity play in adaptation and social learning.

Implications for agriculture, forestry and fisheries and climate change

The most notable lesson from these studies is that human systems such as with agriculture production, can respond rapidly to environmental change. The success or otherwise of these changes depends on the degree of creativity involved and on the ability to shift between scales in order to generate holistic responses. Generally, linear responses tend to be mitigative rather than adaptive in nature.

Rapid changes challenge the context for the Natufians 12kya, the Angkorians 1200 and the Cubans 1990s. In each context, the change was dramatic and the response of the first two was to revert to less complex systems. The Cubans, with a substantial population of 11 million, did not have the same option. Instead, they turned to traditional agricultural systems and incorporated a range of permacultural and organic practices into their response to generate high yields. Furthermore, they still rely heavily on scientific research to help better understand this system and to leverage its potential. In their case, it can be said they had nothing to lose; so risk taking became part of the solution with varying degrees of social and economic experimentation taking place.

It is hard to see such freedom being expressed in the Chesapeake 2001 or Bolivian 2009 contexts where there is still a dominant logic for how to proceed in place. Generally, the issue of scale has relevance to how a system responds. Smaller localised systems such as

Sale 1870 and Adelbert Mountains 2009 can have greater freedom to move whereas a nation such as Bolivia or Azerbaijan 2005 is often constrained by economic conditions and the demands of funding bodies.

Closed systems such as the Amazon 1400 and Hawaii 1700 examples tend to be internally resilient but vulnerable to unforeseen external disruptions. The colonisation by Europeans disrupted the internal balance of these societies and led to rapid decline. Traditional authority was replaced by an external authority driven by a different instrumental logic. The authority of different systems of knowledge generation is also an issue. Agriculture has always based its success on the experience of the farmers on the ground yet in Western cultures some of the expertise of farmers has been syphoned off to institutional bodies. These bodies are driven by scientific and bureaucratic rationality. Solutions are now tending to seek to balance local with meso scales and Bolivia 2009 and the Adelbert Mountains 2009 are examples of this cross scale development.

Agriculture, forestry and fisheries, cultural values, social addictions and imaginative resources

The pre-modern case studies of the Natufians 12kya, the Amazon 1400 and Hawaii 1700 profile traditional values at work in harmony with creative enterprise. It is easy to overstate this balance as systems are always alive to change and modern culture has a tendency to romanticise the past. As the case of Mesopotamia above and that of Easter Island 1500, discussed in the section on Energy, illustrate, pre-modern systems were as vulnerable to change and could be just as damaging to ecological balance as any modern system.

The values covered in these case studies all demonstrate a human system that seeks to control and manipulate the environment to the advantage of human populations. All forms of agriculture seek to increase the amount of energy available to a social system. This increase can be driven purely by technologies of domination (e.g. agrochemistry and monocropping, as in the case of Azerbaijan 2005 and Sale 1870) or by a synthesis of traditional, sustainable and modern methods (Adelbert Mountains 2009, Bolivia 2009). When a system pits itself against the natural processes, it increases the likelihood of system failure over time, because such a relationship is energy demanding and often results in a degradation of the agricultural context as in the cases of Angkor Wat 1200, Sale 1870 and Chesapeake Bay 2001. Systems, such as the Amazon 1400, Hawaii 1700, Cuba 1990s and the Adelbert Mountains 2009, which to work with the natural context tend to be more resilient and more energy efficient.

Social addictions spring from core values that have unintended consequences for a society. Energy intensive demanding agriculture is an example. This is seen clearly at work in the case of Angkor Wat 1200 where huge amounts of human energy were used to clear forest and construct canals. This work was unending and largely done by a slave class. Over time, the system could not keep up with the pressure of monsoonal rains, erosion and the need for intensive human labour. This condition was further exacerbated by the predatory nature of the Angkorian regime itself, which was engaged in regional conflicts and often collected slaves from this process. Ultimately, it began to lose in such encounters, which further destabilised the system. Other addictions identified in these case studies include the drive to exploit, short-term thinking, and failure to respond to a negative trend (social and institutional inertia), a naive reliance on science and technology, infrastructure dependency and an inability to think holistically.

These addictions frame the imaginative resources available to those in context. For the premodern context, these consisted of oral memory and custom but did not preclude creative social ordering as in the cases of the Natufians 12kya and the Hawaiians 1700 who had both carefully reframed their contexts. The example of the indigenous peoples in

Amazon 1400 developing the *terra preta*, or black earth, is illustrative of a people who worked both with custom but also must have challenged it substantially to leverage the agricultural potential of the otherwise poor soils of the Amazon basin. What is significant in this case is that the practice did not compromise either the human or the natural system.

In the case of Sale 1870, the imagination was tied to the emerging belief in science as the way to manage uncertainty. Heavy land clearing by pastoralists was resulting in massive flooding and land degradation. Their answer was to turn to the science of meteorology and measure the natural weather cycles in the hope of gaining a degree of control and understanding. Imagination here was stimulated by a new development, which in many contexts was revolutionising the human relationship with energy production. For the people of Sale in 1870 science and progress were linked in the collective imagination.

Some contexts have rich reserves of cultural capital to draw on. Cuba 1990s for example drew on a collective culture that valued resourcefulness, optimism and the power of education. In this case, Bolivia 2009 has some parallels. There indigenous memory is being linked to science in the development of *callones* to protect seed stocks and canals based on ancient systems for irrigation during drought periods. Yet this is not simply a return to the past as genetically modified seed is also being explored to help farmers cope with changing environmental conditions.

Agriculture, forestry and fisheries and leadership

The case studies for agriculture all point to leadership at the meso level of institutions, local political contexts and industry. There is a tendency in many contexts to share knowledge in the search for answers to perceived threats and environmental limits. Thus, leadership is diffuse and often decentralised. Innovation seems to be less likely to occur in centralised contexts such as Azerbaijan 2005.

In the premodern examples, leadership was traditional in nature. In developing contexts, it tends to be driven by a combination of NGOs and governmental institutions. The cases of Adelbert Mountains 2009 and Bolivia 2009 illustrate this configuration. When a problem is specific in nature such as the flooding in Sale 1870 then the leadership response is simple with an individual taking responsibility for the context. The case of Chesapeake Bay oyster farming however challenges this simplicity as in this context the leadership is multisectoral and open-ended. Cuba in the 1990s is a case where leadership leads by handing over authority to decentralised and empowered units. In this way, creativity and dynamism are leveraged to increase human commitment to productivity.

Determinants for agriculture, forestry and fisheries

There are two sets of determinants at work for agriculture. One relates to external drivers such as climate, political events, institutional policy and technology. The second relates to internal drivers that hinge on values, leadership, multidisciplinary and holistic thinking, and risk taking. These two domains mutually reinforce and reflect the divide between physical and social structures and personal and cultural processes. Agriculture tells much about the environment of a society; it also tells much about its values.

Case studies point to a number of external drivers for agriculture. The first relates to the variations in the weather. Climate change affects all agriculture and some degree of flexibility is required to ensure resilience. The simple example of Sale 1870 demonstrates that such adaptation can be the adoption of a new technology. Bolivia 2009 illustrates how systems also need to respond more holistically and take risks in seeking out solutions to climate-oriented problems. Political changes also affect agriculture. A slave culture such as that of Angkor Wat 1200 is vulnerable to loss of human energy (i.e. slaves) to maintain their high-energy system, but also attack from outside can precipitate rapid decline or

collapse and both were factors in the collapse of Angkor. Cuba 1990s also suffered with the collapse of its primary sponsor, the Soviet Union. Technology also affects agriculture and can have a dramatic effect on agricultural systems by leveraging yields in the short term. In the long term, such practices can usher in collapse when soil fertility declines, pests increase and erosion undermines irrigation and quality land.

The second set of determinants related to the values of those in context. Traditional values in the cases of the Natufians, the Hawaiians and the Amazonians helped maintain balance. Yet they were vulnerable to external factors such as climate change and regional conflict. Multidisciplinary values and a holistic mindset generate creativity and flexibility in responses to change where the system under stress has room to move. Many traditional societies had focussed on balance within a system and lacked resilience when faced with external surprises such as the arrival of a colonial power. Holistic and traditional values contrast markedly with growth at all costs values that undermined Chesapeake's oyster fishery and are still driving Azerbaijan's approach to agriculture.

The value of consistent leadership is also important. Cuba's enforced isolation and the single party system might be deemed impediments but these conditions have accelerated social learning. How leaders chose to lead is an essential part of how social systems cope with change. Preparedness to take risk on the part of Cuba's leadership has opened agriculture to experiments in collective entrepreneurship and horticultural innovation. That such work has been presented as a social project in which a people have a sense of ownership is also significant as this broad-spectrum approach increases creativity.

Historical scenarios for agriculture, forestry and fisheries

Aligning the Agricultural case studies with Dator's for scenario archetypes of Continuation, Collapse, Disciplined Society and Transformational Society generates some interesting insights into the possibilities of context (Table 3). Five of the case studies (Bolivia 2009, Chesapeake 2001, Hawaii 1700, Cuba 1990s and Adelbert Mountains 2009) are suggestive of two possible scenarios. Such bifurcation is a reminder that contexts are never stable. It is a human tendency to assume that the present is stable and that change occurs in the future. Scenarios help challenge this misconception. The case studies are grouped in the following table:

Table 3: Scenario Summaries for Agriculture

Categories	Agriculture case studies
Continuation	Ag 1.1 Sale 1870
	Ag 1.2 Azerbaijan 2005
	Ag 1.3 Bolivia 2009
	Ag 1.4 Chesapeake 2001
Collapse	Ag 2.1 Angkor Wat 1200
	Ag 2.2, Hawaii 1700
	Ag 2.3 Chesapeake 2001
Disciplined society	Ag 3.1 Amazon 1400
	Ag 3.2 Hawaii 1700
	Ag 3.3 Cuba 1990s
	Ag 3.4 Adelbert Mountains 2009
Transformational society	Ag 4.1 Natufians 12kya
	Ag 4.2 Cuba 1990s
	Ag 4.3 Bolivia 2009
	Ag 4.4 Adelbert Mountains 2009

Continuation

It is common for people to assume that the future will be a seamless extension of the present. Studying the past is a reminder that this is not the case. Ag 1.1 Sale 1870 shows people working on the premise that the future is an extension of the present. They are committed to the ideals of scientific, economic and civilisational progress that characterised this period in Colonial Australian history.

The lure of progress also underpins the commitment of both Ag 1.2 Azerbaijan and Ag 1.3 Bolivia 2009. These two case studies are markedly different readings of these possibilities. The deep historical roots of Azerbaijan offer an authoritarian future while Bolivia's cultural ferment is exploring indigenous and modernist synergies. In the context of Ag 1.4 Chesapeake 2001, the focus is on a community trying to grapple with the destruction of their oyster fishery, which is a consequence of the progress pathway. They are being forced into the paradoxical situation of exploring holistic solutions to this problem in order to ensure that their tomorrow is more like yesterday.

Collapse

The complete disappearance of Ag 2.1 Angkor Wat 1200 beneath the tropical jungles of Cambodia is a reminder of how complete collapse can be. This society disappeared within a generation and was soon even lost to memory. This pattern recurs and it seems unlikely that it will cease now. All complex societies have collapsed to be replaced, often after centuries, by new iterations. The failure of agriculture usually implicated in this cycle.

Social failure is also evident with the loss of agricultural diversity in the case of Ag 2.2 Hawaii 1700. The loss of resilience and political independence of the Hawaiians is reflected in the disappearance of their agricultural system, the Ahuapua'a. In the case of Ag 2.3 Chesapeake Bay 2001, the collapse is partial and has been locally sustained because the economy of the area is diversified and decentralised. This contrasts with the fisheries in Valdez, Alaska that were decimated in 1989 by the Exxon Valdez oil spill. Resilience for communities there depends on how diversified their economies are.

Disciplined society

Traditional societies are examples of disciplined societies in that they are bound by tradition and custom. Ag 3.1 Amazon 1400 and Ag 3.2 Hawaii 1700 are representative of the delicate balance between custom and social learning. In the modern context, such societies hold lessons for the future and some social experiments seek to return to earlier forms to reclaim lost practices that historically are understood to be sustainable. Both Ag 3.3 Cuba 1990s and Ag 3.4 Adelbert Mountains 2009 are working on reducing complexity and the energy demands that this requires. Such are the conditions that frame this work that conventional solutions to scarcity are not available or practical. These societies are learning to incorporate aspects of traditional agriculture with a range of scientific and social experiments. In this, they recognise that social process is reflected in agricultural practice and visa-versa.

Transformational society

Arguably the greatest transition in human history was that from hunter gathering to agriculture (Watson, 2006; Wright, 2006). This switch had a profound effect on how human beings related to one another, generated meaning and organised themselves in groups. Ag 4.1 the Natufians 12kya were front-runners in this transition. They demonstrate high levels of creativity and innovation in the arts and social practices. These ingredients are essential in all moments of transformation. Societies reach a point where business as usual ceases to provide meaning or security and change comes either because it is driven by environmental and historical momentum or because it is invited.

To be proactive does not mean to foresee all outcomes. It simply means, as in the case of the Natufians, to be willing to explore possibility. Such creativity and risk taking can be seen in the cases of Ag 4.2 Cuba 1990s, Ag 4.3 Bolivia 2009 and Ag 4.4 Adelbert Mountains 2009. In the cases of Cuba and Bolivia, change is driven by need and comes as a blend of science, tradition and imagination. The same is true also of the Adelbert Mountains cooperative yet this is a self-sustaining grass roots unit and exists as an expression of utopian desire to realise a better world through collective action. Enterprise is an essential ingredient in this context. It is also a high priority in the Cuban solution to scarcity. Such work is collective in nature but does acknowledge individual contribution. It suggests different ways of managing high yield agricultural projects.

Ecosystems and biodiversity

Overview

Nine studies profile adaptive responses in the area of ecosystems and biodiversity. All are current and reflect the recent turn to considerations of the environment in public consciousness, institutional policy and planning, and the sciences. The case studies are:

- Maroochy 1990s
- Garcia River Forest 2000
- Indigenous Australians 2009
- Phuket 2009
- NSW Park 2009
- DMZ/Chernobyl 2009
- Gray Whale 2000
- Adelbert Mountains 2009
- Eco-Communities 2009

All except for the Eco-Communities 2009 relate to local or regional activities. All have a central concern with the natural capital and resilience of an area that they express in various ways. The Garcia River Forest offers some historical background to environmental awareness in the United States and then focuses on economic incentives to maintain remnant old growth forest. This concern with economic activities that complement environmental goals is shared by those involved in the cooperative project in the Adelbert Mountains of New Guinea. The cases of Maroochy 1990s, Indigenous Australians 2009 and the NSW Parks 2009 all deal with the nature of institutional work for the environment. They point to both its potential and its weaknesses.

The cases of Phuket 2009 and the Gray Whale 2000 examine the environment under stress and look at obstacles to effectively dealing with these issues. The case of the DMZ/Chernobyl 2009 illustrates what happens when humans are removed from a context. This surprising turn of events occurs only under extreme situations. Finally, the Eco-Communities 2009 study explores the global quest for ecologically aware communities. This global vision is also shared by the co-operative movement that the Adelbert Mountains profiles. Such case studies illustrate the creative work being done by groups and individuals engaged in anticipatory learning simultaneously at the grassroots and global levels.

Adaptive capacity and social learning

Adaptive capacity and social learning *for* the environment is a recent phenomenon. Social learning around natural capital has nearly always been focussed on; 1.) how to maximise the human intake of energy flows from the environment, 2.) how to sustain these flows when there were problems with the natural system, and 3). how to reconfigure our relationships with the natural world when a system no longer provides what it once did.

To learn to see the environment as something other than a resource is a challenge for modern humans. Yet it is an emergent issue that evokes considerable emotional power. The case studies in this report all involve institutions. Human institutions can function as learning contexts and always express and operationalise human values. Thus, it was the State government of New South Wales that created the world's second National Park in 1879. The first was the Yellowstone National Park in the United States established in 1872.

Of the nine case studies presented, five involve state and regional institutions: Maroochy 1990s, The Garcia River Forest 2000, Indigenous Australians 2009, Phuket 2009, NSW Parks 2009. Two others, The Gray Whale 2000 and the Adelbert Mountains 2009, involve

NGOs often working with the state. The case study of DMZ/Chernobyl 2009, illustrates what happens when institutions become deadlocked or fail. Rather than being a story of collapse, this offers insights into possibilities for renewal while pointing to how fragile such possibilities are. The study on Eco-Communities 2009 looks at a creative initiative that is global in nature though local in expression. The common feature is a determination to live in harmony with nature. The philosophical nature of this social experiment suggests there is a utopian dimension to these communities. Yet the sources of inspiration vary greatly from permaculture to ancient Indian metaphysics. All seek to offer practical insights into what an eco-centric culture might look like.

Adaptive capacity is frequently demonstrated by citizens and communities. They are often the first to witness a problem in the environment. The Maroochy 1990s case profiles two community responses to water quality on Queensland's Sunshine Coast. In this context, adaptation was complex and the social learning uneven. As small groups, they needed to adapt to the institutional environment of council and state funding regimes. Their effectiveness on the ground was considerable but the institutional journeys have been markedly different. The solution has been to balance group identity and core values with the broader institutional culture of governance that frames the contexts of these groups. From an environmental perspective the long-term viability of a group is perhaps less important than its short-term impact. In this case, both groups, the Maroochy Mooloolah Catchment Coordinating Association (MMCCA) and Maroochy Waterwatch, were both locally significant in improving water quality and raising awareness.

The situation of the Garcia River Forest is different. This remnant stretch of forest is now part of an experiment involving the Californian government and private capital. The social learning context is that state legislation on its own will not always contain environmental degradation. Human self-interest can be harnessed to this end. Adaptive capacity is embedded in all systems. Creativity and lateral thinking can release its potential if the conditions are right and there is the political and social will to do so.

This will faces obstacles such as cultural blindness, resource limitations, and imbalances between stakeholders as in the case of Indigenous Australians 2009 and institutional inertia, lack of information and the inability to enforce required correctives as in the case of Phuket 2009. Institutions can and do learn as the case of the NSW Parks 2009 demonstrates. Even though there was the fear of political failure, this case study demonstrates that adaptive management can become part of corporate culture. This involves a values shift, the preparedness to share information and work collaboratively, to evaluate work within a corporate framework, to develop more effective accountability measures and to reflect on adaptive management strategies over time.

The case of the Gray Whale 2000 is open ended. Through the lobbying of NGOs and general public pressure, this species is now protected and numbers were on the increase. The changing ice sheet coverage of the Arctic is now compromising this comeback. The study illustrates the importance of information and the role that can be played by both NGOs and institutions in contributing to the ongoing viability of this species. By contrast, the case of the Adelbert Mountains 2009 is more encouraging. This study illustrates the effectiveness of local interventions by NGOs.

Essentially cooperative enterprise encourages a collective such as the Adelbert Mountains Cocoa Cooperative to take responsibility for local natural resources and develop commercial enterprises that are less destructive in terms of both their human and environmental impact. Those involved, community members, NGO workers and state government officials, are looking for win-win possibilities that see profits shared and community infrastructure developed. The Eco-Communities 2009 illustrates how such cooperative work is aligning with intentional communities based on an eco-centric

philosophy or commitment. Such communities usually embrace the co-operative ethic and inclusive enterprise structures found in the Adelbert Mountains Cocoa Co-operative.

Eco-Communities tend to be cultural experiments involving individuals and families who usually have no original connection with the community's location. Members can come from anywhere and are drawn by a sense of intellectual and emotional commitment to the project. Their strength lies in their commitment, their vulnerability lies in the social dislocation they imply (i.e. members are not local/indigenous to their area). In this way, eco-communities differ from contexts like the Adelbert Mountain Co-operative where members are local to the area and are seeking to increase the area's profitability without compromising the environmental and social capital of the site.

Implications for ecosystems, biodiversity and climate change

Human systems have a direct effect on how ecosystems and biodiversity can respond to climate change. At one level, this is a question of management responses. At another level, it relates to what human beings do as social and cultural units. The side effects of human actions are often unintended and unanticipated. The case studies illustrate both the barriers and opportunities that must be considered when assessing the potential for adaptive capacity and social learning for the non-human world.

The Maroochy 1990s case study demonstrates that across scale interactions can compromise the original values of grass roots movements. How this is understood depends on one's perspective. To some it undoubtedly is seen as institutional growing, and all growth comes at a cost. In this case, the reorientation of values is to enhance legitimacy and therefore leverage within a system. To grass roots advocates, this reorientation is not growth decline. It is symptomatic of the power differential at play when communities engage with their institutional contexts.

In this sense, there is a parallel with the case study Indigenous Australians 2009 exploring the relationship between indigenous communities and government. In such interactions, the institution imposes a dominant logic on a setting. That logic is often insensitive to local perspectives. This mismatch does a disservice to both interests because learning is marginalised and issues of resilience, agency and creativity are lost in a scramble for authority and control.

The case study of Phuket 2009 is another example in which local and state priorities are out of step with the environmental problems of this region. This case study illustrates the interplay of tensions across local and regional scales. Self-interest at all levels hampers adaptive capacity. This is compounded by a lack of knowledge about the problems faced by the reef and coastal environment of Phuket. Institutional ignorance of local issues combined with an unwillingness to address issues of environmental decline is further exacerbated by a lack of resources, particularly financial, in dealing with the issue.

The case study NSW 2009 illustrates an effective management approach for parks across an Australian state. What is identified is the importance of leadership at multiple levels in an institution for change to become effective. A culture of institutional learning needs to be fostered and in leading this, the importance of early adopters cannot be under estimated. The importance also of information as a driver for informed action and as the medium of shared meaning and purpose is demonstrated. Finally, this study illustrates that information needs to be context specific for it to have relevance for those expected to adapt management.

The case study of both the Garcia River Forest 2000 and the Gray Whale 2000 is a reminder that in some contexts information is not enough. The interplay between self-interest, rational action and contextual framing suggests that institutional adaptive capacity is also determined by the values of those at its heart. In the case of the logging

of the North American redwoods, even a US President is unable to change the determination of a minority to capitalise on a natural resource. It the case of the Gray Whale, although whaling itself has been stopped the broader issues of anthropogenic climate change demonstrate that there is still a long way to go before a whole of government, or even a whole of planet, consensus can be arrived at. The lessons of NSW Parks 2009 are still highly pertinent to this issue and suggest that for planetary action to be effective leadership and information in the context of a values commitment to informed action are a precondition for success.

The case study of the Garcia Forest also points to the role of innovation and creative institutional learning in addressing current dilemmas in management, adaptive capacity building and social learning. The case study of the Adelbert Mountains Cocoa Cooperative further demonstrates the place for creative learning in thinking about human activity that supports ecosystems and biodiversity. This study is supported by the case study of Eco-Communities 2009. Both profile attempts to rethink social processes of enterprise and subsistence that enhance the adaptive capacity of ecosystems and biodiversity while also enriching human potential. Both are reminders that social practices are not unchangeable. Both also illustrate the centrality of values in defining meaningful adaptive responses to contextual stress. While the Adelbert Mountains study illustrates the importance of traditional networks in enriching thinking about social and economic alternatives, the study of Eco-Communities point to the role of philosophy, particularly ecophilosophies, in enriching our thinking about social practice and its relationship with the natural world.

Finally, the case study of the DMZ/Chernobyl exclusion zones is a reminder that human activity often has unexpected consequences. In the absence of humans, these sites are rebounding as ecological refugia. Though they are compromised and their futures are unclear they provide contexts for thinking about policy, planning and management of places in the absence of human presence.

Ecosystems and biodiversity, cultural values, social addictions and imaginative resources

Jared Diamond (2005) points out that all civilisations decline when they adversely affect their environments. There is therefore a degree of self-interest in human environmental management. This self-interest however is not simply the result of a rational calculation of plus and minus. Human relationships with the environment are deeply shaped by the values of individuals and their communities. The case studies all demonstrate that values are key to determining a group's adaptive capacity.

The case studies of Maroochy 1990s, Indigenous Australians 2009, Phuket 2009 and NSW Parks 2009 all illustrate how values are embedded in institutions. They also demonstrate that values and the institutions that embody them can and do change. The NSW example points to the fact that work needs to be done to align values across scales as the other three examples profile what happens when this does not happen. Resilience and adaptive capacity are diminished when values are overlooked. When values are clearly framed, as in the cases of the Garcia River Forest 2000, the Adelbert Mountains 2009 and Eco-Communities 2009, both agency and creativity are increased.

Social addictions are both cultural frames of mind and the social processes these engender that negatively impact upon a context. Such addictions are also values. Some case studies can be seen to be challenging these addictions: the Garcia River Forest is challenging the assumption that nature is a resource and that the human world is separate from the natural. A similar challenge is mounted by both the Adelbert Mountains 2009 and Eco-Communities 2009 studies. They however also challenge the individualism that generates excessive competition. The case of NSW Parks 2009 challenges the performative demands of institutions. It argues that high expectations of performance with no consideration of

context are actually counterproductive. The Indigenous Australians 2009 confirms this by pointing to the mismatch between institutional goals and local knowledge. It suggests that the need to control and the tendency to see communities as homogenous are both addictive drives that need to be challenged to release local human and natural potential.

The imaginative resources available to a group are critical to its adaptive capacity. This is clearly illustrated in the case study of the two Maroochy groups presented in Maroochy 2009. One adapts to the institutional climate fostered by local and state funding arrangements while one does not. The profile of the two groups' management teams suggests that the professional backgrounds of the former gave it an edge in this regard. Case studies such as Garcia River Forest 2009, Eco-Communities 2009 and the Adelbert Mountains 2009 indicate that creativity and imagination drive social and economic experimentation. Such developments do not occur in a vacuum but draw on many years of innovation in thinking in economics, environmental lobbying, and cooperative association. This confirms the point well made by the NSW Parks 2009 case study that information is essential in facilitating adaptive capacity. Information can inform thinking and stimulate imaginative responses. Other case studies in this section point to the problems that occur when imaginative resources are limited to business as usual assumptions and the goals these promote.

Ecosystems, biodiversity and leadership

Leadership is central to effective adaptive capacity. These case studies illustrate its contested and fragmentary nature. It is clear that where there are successful examples of adaptive capacity that leadership has been clear, open and working at various scales. Such leadership can be described as adaptive (Heifetz, 2009). However, where this is not the case adaptive learning has been partial at best.

The Maroochy 2009 example illustrates this. Both the Maroochy Mooloolah Catchment Coordinating Association (MMCCA) and Maroochy Waterwatch had strong local leaders. Yet the way these worked and the basis on which they were constituted varied. The MMCCA was a composite group with a rigid structure and no clear vision. Leaders came from a range of sectors and often had competing agendas that ultimately undermined the groups' effectiveness. By contrast, the Maroochy Waterwatch was streamlined, flexible and innovative in structure. Leaders tended to be professional, expert and specialized. Their vision was more cohesive and the spirit was entrepreneurial. These were all factors in the groups' ongoing success. Leadership that was innovative and not risk averse is also demonstrated in the case of the NSW Parks 2009. Leadership in the context was across levels of management. It was committed to effectively resourcing innovations and seeing the information was available and relevant. Such flexible leadership was able to cope with the restructuring demands of the integrated programme adopted by NSW Parks administration.

Adaptive leadership is also shown in the cases of the Garcia River Forest 2009 and the Eco-Communities 2009. In such cases, leadership is imaginative and able to work across levels and across sectoral boundaries. Innovation and vision are important qualities and in the case of the Garcia River Forest effectively combined with entrepreneurial knowhow.

Piecemeal and authoritarian leadership has less effectiveness in areas relating to ecosystems and biodiversity where a degree of moral authority is also needed to drive change that reaches beyond immediate utilitarian concerns. The case of Phuket 2009 demonstrates this while that focusing on Indigenous Australians 2009 illustrates the problems that arise when leadership styles are mismatched and where systems of authoritative knowledge fail to dialogue with context. Grassroots work requires that grassroots leadership has a degree of congruence with external leadership. In such contexts, contested leadership leads to loss of traction and legitimacy.

Determinants for ecosystems and biodiversity

Context is always unique yet when looking for determinants they are of two kinds. The generic level that is common to the human condition: 1.) External drivers such as weather, national politics, wild-cards and institutional flexibility; 2.) Internal drivers relating to values and knowledge systems.

Each context has its own unique set of external drivers. The role of external drivers in the shaping of context varies according to how close a context is to the natural systems with which it is engaging. Determinants in these settings are external but set within the larger framework of global human activity that is affecting polar ice and creating exclusion zones that become refugia for a range of species and ecosystems.

Unforeseen determinants are called 'surprises' or 'wild cards' in the literature (Barber, 2006). They are what systems theorist Nassim Taleb (2007) calls 'black swans', highly improbable events that impact on a context, shaping both its barriers and also presenting new possibilities. Thus, the role of national politics in the creation of DMZ is a surprise. National politics also hampers coordinated attempts to address climate change.

In the cases of Maroochy 2009, Indigenous Australians 2009, Phuket 2009 and the NSW Parks 2009 the external determinants include 1. local and national histories that frame issues and define groups; 2. institutional patterns that generate a dominant logic; 3. resource availability and dominant economic process; and 4. leadership styles. Such determinants are at play in the remaining case studies Adelbert Mountains 2009, Garcia River Forest 2000, and Eco-Communities 2009. Yet they are tempered by greater flexibility and innovation. The ability to take risks is also significant in these later studies.

Risk taking points to the second set of determinants that involve internal drivers such as values and knowledge systems. Values underpin how groups and individuals respond to risk. Risk averse settings tend to be centralist, authoritarian contexts in which conformity is put before innovation. Institutional culture tends to replicate such settings; Phuket 2009 and Maroochy 2000 both illustrate the barriers posed to effective social learning when institutional inertia blunts effective adaptive capacity. NSW Parks 2009, faced with similar constraints however manages to challenge structure because of a value set that valued human capital inputs, promoted institutional change and generated meaningful knowledge that met the needs of those in grass-root management positions.

Worldviews that are holistic and committed to changing the dominant narrative of business as usual are presented in the case studies of Garcia River Forest 2000, the Adelbert Mountains Cocoa Cooperative 2009 and the Eco-Communities 2009. All demonstrate the role of values and worldviews in the generation of new social forms. These case studies represent emergent trends that are starting to have an impact on how the broader public and private sectors are beginning to operate.

Historical scenarios for ecosystems and biodiversity

The scenarios generated by the case studies collected for the Ecosystems and Biodiversity sector cover all of Dator's (2002) scenario archetypes: Continuation, Collapse, Disciplined Society, and Transformational Society (Table 4). As with the case studies for Human Settlement and Health and for Agriculture scenario 1 Continuation is well represented. It is clear that much of the world works on the assumption that tomorrow will be very much like today. This is understandable as change, even rapid change, is incremental and therefore hard to perceive for those being swept along by it. The complex nature of context also leads to two possible scenarios being applied to a single case study. Three appear in different scenario descriptions below (Table 4).

Table 4: Scenario Summaries for Ecosystems and Biodiversity

Categories	Ecosystems and biodiversity case studies
Continuation	EB 1.1 Gray Whale 2000
	EB 1.2 NSW Parks 2009
	EB 1.3 Garcia River Forest 2000
	EB 1.4 Maroochy 2009
	EB 1.5 Indigenous Australians 2009
	EB 1.6 Phuket 2009
Collapse	EB 2.1 Gray Whale 2000
Disciplined society	EB 3.1 Adelbert Mountains 2009
	EB 3.2 Indigenous Australians 2009
	EB 3.3 DMZ & Chernobyl 2009
Transformational society	EB 4.1 Adelbert Mountains 2009
	EB 4.2 Eco-Communities 2009

Continuation

In complex societies, there is a wide range of settings in which business as usual can be carried out. The plight of species such as the gray whale excites the hearts and emotions of citizens but has limited scope on the international scene where a host of interests play out. EB 1.1 Gray Whale 2000 is a reminder that species decline is a central concern for this sector and that business as usual is clearly not the optimal response. EB 1.2 NSW Parks 2009 profiles a coordinated and effective response within a continuation model in which system is able to act with foresight and a degree of flexibility. EB 1.3 the Garcia River Forest 2000 illustrates how the system itself can be taught to respond differently to a context such as loss of old growth forest.

The abundance of structural alternatives inherent to complex systems cannot be under estimated (Bussey, 2009). The use of financial incentives to protect areas such as the Garcia River Forest demonstrates possibilities for adaptive capacity within the continuation scenario model. The development of a new economic and policy language for legitimising such pro-environment work illustrates this – thus the literature is growing rapidly in the area of sequestering of CO_2, carbon trading and the utility of 'carbon sinks'.

The case studies of EB 1.4, EB 1.5 and EB 1.6 all profile contexts where institutional priorities seek to maintain current practice and normalise behaviours and values that compromise adaptive capacity. This is played out in different ways but points to elements

of institutional inertia and societal resistance. The EB 1.4 Maroochy 1990s study illustrates what is at stake when community groups seek institutional recognition. EB 1.5 demonstrates the barriers to effective cross-cultural cooperation while EB 1.6 links institutional inertia, and weak leadership with the self-interest and ignorance of those at both the local and regional levels. Essentially continuation models all hold to the status quo and frame information and knowledge within dominant value sets that constrain adaptive capacity and social learning.

Collapse

Complex systems have a tendency to collapse (Tainter, 1988). This holds true for both the natural and the social world. The case study EB 2.1 (The Gray Whale 2000) illustrates the paradoxes inherent to context. This species is threatened by habitat loss and despite number recovery after the cessation of whaling it is under pressure from the rapid breaking up of the Arctic ice shelf. There is both a dearth of information about the exact circumstance of this whale and of social will to address the underlying problems it faces and will face in the future.

Although EB 2.1 does not refer directly to human social collapse, it illustrates the paradoxes involved in looking at social and ecological collapse. The case study EB 1.6 could have been included in this scenario section as it has many symptoms associated with collapse: Degraded and declining environmental condition, weak and contested leadership, short-termism and self interest, and what Jared Diamond calls “landscape amnesia” (2005). Landscape amnesia indicates that social memory is locked in the present and that how an environment was in the past is not used as a benchmark for assessing the quality of the present.

Diamond uses Easter Island (E 4.1) as a case in which ecosystem and biodiversity decline lead to collapse. The people of Easter Island destroyed ecological integrity of their island severely compromising its biodiversity and as a result destroyed their own future. Collapse was inevitable and came swiftly.

Disciplined society

All cultures are disciplinary in nature. The discipline comes from the following of cultural rules that regulate behaviours, shape values and determine choices. These rules are usually dictated by custom as in the case of EB 3.1 the Adelbert Mountains 2009 and EB 3.2 Indigenous Australians 2009. In both these contexts, the social organisation is informed by custom. Yet both are exploring synthesis with possibilities available in the present: in the case of the Adelbert Mountains, it is work with an NGO, in the case of Indigenous Australians; it is work with a Federal government department. Such work involves a degree of imagination and innovation in which tradition and innovation work to find new models of social process that incorporate traditional valuing of the environment with knowledge drawn from science and economics. The Adelbert Mountains is clearly more successful at this than the case of indigenous communities working with Australian government institutions where the mismatch between white authority and indigenous aspiration is stark.

The study EB 3.3 DMS/Chernobyl 2009 points to a different understanding of this scenario type. The exclusion of human beings from an area suggests a different order of discipline in which natural processes reassert a degree of control over a context. It suggests that perhaps another dimension to *discipline* is that of human withdrawal.

Transformational society

This scenario archetype illustrates the power of people in context to redraw the rules and values that generate social meaning and order. The case of EB 4.1 Adelbert Mountains Cocoa Cooperative takes the ideal of cooperatives and ties it to a traditional social context

and long term sustainable environmental goals. The overall aim of such eco-cooperatives is to empower local peoples while protecting the natural capital of a site. For this to occur a qualitatively different approach to production and organisation needs to be enacted.

Ideals also underpin the study EB 4.2 Eco-Communities 2009. This study profiles possibilities for human organisation that do not compromise the environment. These communities seek to harness the ability for human beings to consciously work with the environments they inhabit to increase the potential of both. Eco-centric philosophies can vary greatly in nature from secular practises such as permaculture (Crystal Waters) to spiritual visions of humanity in harmony with nature and themselves (Auroville). Such visions do not exclude the importance of science nor seek to lock people in cultural traditions from a past age.

Both studies can be considered social experiments that are participatory in nature and transformative in intent. They seek to trial futures oriented sustainable learning methods in anticipation of environmental disruptions that current practices are making increasingly likely.

Energy

Overview

Complex societies are heavily energy dependent (Christian, 2003). This section profiles ten case studies that illustrate this dependency and its effects on social organisation and the common citizen. The case studies span two millennia and look at a range of approaches to energy by social groups. All societies generate order to harness and manage energy – the examples presented here illustrate how this order might be authoritarian, egalitarian, legal, scientific, agricultural or social.

Energy is generally accepted as an implicit precondition for culture, which at its broadest can be understood as a complex human response to energy requirements. The ten case studies presented in this section are:

- Rome 1CE
- Easter Island 1500
- Hawaii 1700
- Britain 1800
- Donora 1948
- Cuba 1990s
- Curitiba 1990s
- Azerbaijan 2005
- Sweden 2006
- Eco-Communities 2009

Adaptive capacity and social learning

In agricultural societies, energy is derived from a population's working the land. It is measured by the degree of surplus. Innovation is required of a context when this surplus falls and places stress on the population (Tainter, 1988). Adaptive capacity can be measured by the degree to which a group can respond to a decline in energy. Thus in the case of Rome 1CE the civil structure of the republic had to be replaced with a streamlined imperial structure. This required institutional and legislative change and was driven by the strong leadership of Augustus Caesar. A similar reordering was required of Britain around 1800. Arguably, this was a more sweeping innovation than that executed by Augustus. The whole relationship of labour with the land was reconfigured and a new class, the urban industrial worker, was created (Thompson, 1967).

The difference between these two contexts is that Britain no longer relied purely on agricultural surplus for energy. The Industrial Age heralded the emergence of the modern world's dependency on fossil fuels. To harness fossil fuels and a range of technologies designed to do this required the rethinking of social process (Bauman, 2000). Technology, politics and commerce were all reordered and enshrined within the nation state (Hetherington, 1997). International relations became a process of exchanging sources of energy.

The cases of Rome 1CE and Britain 1800 illustrate that adaptive capacity is expressed institutionally when sources of energy are being rethought. Rome chose a centralist authority in the form of a tributary state that drew energy from extensive territories. In the case of Britain, it chose a parliamentary monarchy, industrial production and extensive empire to draw energy from the periphery to the centre. In Rome's case, the social learning was essentially managerial. For Britain, it was more complex and involved the rethinking of management, technology and political process.

The longevity of both the Roman and British empires relied on extensive webs of interaction. Such webs were not available to the Easter Islanders whose spectacular

development was followed by an equally spectacular collapse (Ponting, 2007). The case study Easter Island 1500 presents the case of a society with limited access to energy. This society was primarily agrarian and relied heavily on human physical energy and the use of tree logs. The 'energy race' between clans meant that trees were felled until there was a total and irreversible collapse of the 'tree economy'. Such was the nature of this society that not to fell trees was unthinkable – and an early example of what is currently known as the 'growth at all costs' model of development.

The case study of Hawaii 1700 tells a different story. This was an internally resilient society with considerable sophistication in management of its agricultural resources. Energy from the land supplied all their needs. The appearance of Europeans challenged the balance of this system. One tactic of empire is to make other cultures dependent on energy systems controlled by the colonial power. Energy for the British was linked to the power of production. Accordingly, the collapse of Hawaiian agriculture can be understood in terms of a reordering of the energy requirements of Hawaiians. This case study demonstrates internal adaptive capacity but points to the effect of an unforeseen external event that destabilised and then replaced traditional agricultural practices. The control of energy was taken from the Hawaiians and was replaced by a two-tiered colonial system.

These premodern and early industrial examples indicate that energy is not to be valued simply for what it can achieve in a context. It also has political value. The power of a state, early or modern, can be measured by the amount of energy it both consumes and deploys. The next case studies point to a range of adaptive responses on the part of the state when facing different energy challenges.

In the case study of Donora 1948, a number of state institutions are seen responding to an industrial disaster. Following the Donora incident scientific research was focussed on pollutants to generate information for policy. There were also legislative changes to protect citizens and to try to control polluting industries. Industry too begins to be more mindful of its actions. The issue of air quality also moved into the social domain and became an issue of growing concern.

The two studies of Cuba 1990s and Curitiba 1990s offer interesting parallels. In 1989 with the collapse of the Soviet Union Cuba experienced its own energy crisis, which President Castro dubbed somewhat wryly the 'special period'. Many aspects of civil society ground to a halt as oil ran out and agriculture collapsed. The crisis stimulated innovation as the Cuban's had nothing to lose. The authoritarian government did an about face on many centralist policies and released land to citizens who were prepared to cultivate it. Control of profits was also put in the hands of a range of citizen groups. All this allowed for high levels of cultural freedom and social innovation. These actions can be read in various ways – a scramble for political survival on the part of the government or a return to home bread socialism that had be squashed by Cuba's forced dependence on the Soviet Union in the face of US hostility.

Curitiba on the other had its own homegrown crisis of population growth, poverty, pollution and infrastructure failure. The response was to become socially innovative and challenge the dominant logic of urban development. As with Cuba, Curitiba has had a long period of consistent leadership that invested in and oversaw the implementation of a master plan focused on public transportation, environmentally sensitive design, and low or contextually-appropriate technologies. The goal was to reduce energy wastage across the city, move citizens away from cars and other forms of conspicuous energy consumption. Education played an important role in this shift. In this Curitiba paralleled Cuba where education was also a significant social force.

Both Cuba and Curitiba worked hard to effect a values shift in their populations to support the necessary changes relating to energy consumption. Both leaderships understood the importance of citizen ownership of change. Both have also struggled with larger systems that are not sympathetic to these changes. Energy consumption when constrained by environmental failures must be rethought and new social practices devised. The adaptive capacity of contexts such as Cuba and Curitiba are limited by broader issues such as the ongoing US embargo on Cuba and regional difficulties for Curitiba. Yet adaptive learning has grown rapidly in the face of complete or partial system failure.

In contrast, the study of Azerbaijan pollution is high and little systemic work is being down to address this. The centralist government is committed to growth at all costs and ignores environmental decline and the threats posed to its citizens. This study illustrates that leadership can also pose barriers to adaptive capacity and social learning.

The studies of Sweden 2006 and Eco-Communities 2009, illustrate two contrasting ways energy use and production can be rethought. In the Swedish case, a Nation State engages in participative forms of governance to address the growing need for energy. Swedes largely see the state as a mediator of change. The social learning in this context is two-way, with the state facilitating public awareness through the media and seeking to engage citizens and stakeholders via consultancy with constituent groups. In this way, the nuclear plans were dropped by popular consent and the state began exploring alternative energy sources. Sizeable investment has been made in wind and biomass sources of energy. The state and its citizens are committed to balancing growth with a deeper commitment to social equity. This commitment is informed by the expectation that the state maintain a standard of living that keeps all from poverty. The turn to renewable energy reflects a culture that is willing to take social chances.

The example of Eco-Communities 2009 approaches the question of energy from a different angle. Such communities are experimenting with a range of energy alternatives in contexts of conscious social learning. Motivated by eco-centric philosophies and with a strong vision of alternative futures such communities try to limit energy consumption without losing the standard of living that the energy rich world promises. Adaptive capacity in such settings hinges on the degree of resilience built into a community's infrastructure. It is also impacted on by belief systems that can impede responses to stress. Community members also see themselves as advocates for alternatives and use public consultancy and various media outlets such as YouTube to promote sustainable action and a questioning of dominant assumptions about energy[1].

Implications for energy and climate change

The energy case studies suggest a strong relationship between energy usage and political and economic power. The social learning that occurs is mediated by power blocks and reflects deep-seated values held by these groups. The Romans and the British were seeking to consolidate and extend power. In the case of Azerbaijan, central authorities seek to maintain current production levels regardless of costs to citizens and environment.

The Easter Island example illustrates how resource scarcity exacerbated by social values drive communities to collapse. Hawaii on the other hand demonstrates that the power of custom can maintain an energy balance but this balance is vulnerable to external factors such as colonialism. Contact with the British destroyed the balance and instituted a formally imposed agricultural system of production that swept aside traditional methods.

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[1] See ***Seeds International*** (www.seedsinternational.com.au) a small company working out of Crystal Waters, Australia. http://www.youtube.com/watch?v=Md5iOBJiZBI

Strong and proactive leadership can bring innovation and adaptive learning to the fore. This is demonstrated in the cases of Cuba 1990s and Curitiba 1990s. Both cases profile how value shifts on the part of both ruling elites and the public can occur rapidly when previous energy flows are severely disrupted. A modified case for the same finding is presented by Sweden who rethought its energy dependency and initiated sweeping social changes to protect social capital into the future.

In the case of Cuba and Curitiba, the changes were driven by necessity. The hardships faced on the ground turned the attention of leaders towards preparing for the future. Sweden in contrast, experienced only minor difficulties but leveraged a strong social sentiment on the part of its citizens to develop a proactive anticipatory foresight approach to energy production. Whereas the suffering of the people of Donora in 1948 lead to interventions by the state in industry. It did however bring the issue of air quality into the public arena and initiated legislative responses that ensure higher levels of security for citizens.

The question of anthropogenic climate change is contested because of the symbiotic relationship between energy and political and industrial power. The Eco-Communities movement seeks to challenge this relationship by experimenting with alternative social systems. These systems are not free from external constraints but they are anticipatory action learning sites in which values are tested and clarified over time. The relationship between these communities and energy is a significant context for such experiments.

Energy, cultural values, social addictions and imaginative resources

These case studies expand the general understanding of energy, as in fossil fuel or its alternatives, to the dominant resource that maintains a level of complexity. For much of human history this has been agriculture and trade in commodities. Industrial societies have added to this the demand for higher order energy sources such as fossil fuels, nuclear fuels and alternative energy. Both preindustrial and industrial societies have frequently needed to extend their supply of energy when local and regional sources have diminished. In the past, this was usually achieved by conquest. More recently, societies use economics and cultural imperialism to achieve these ends.

The linkage of energy to political power brings into question the research and development that surround current energy regimes within the nation state. Tainter points out that “human societies are problem solving organizations” (1988, p. 194) Problem solving does not occur in a vacuum. Values frame what is researched and how resources are deployed. Social and natural costs are also overlooked, as energy is considered essential for maintaining a socio-political unit. Yet as complexity increases, so too does the energy cost per capita of population. Investment in complexity as a problem solving response to declining returns bears fruit at a certain point in a society’s evolution. Thus for Augustus Caesar in Rome and for the British of 1800 such investment paid off. The central value of growth in any context reaches a point where it ceases to fulfil its function of system maintenance and becomes instead a liability.

Growth propelled both Rome and Britain into empire. A compulsion to grow drove the Easter Islanders to collapse. The ability to control growth maintained Hawaiian society until the British arrived. Growth is driving the Azerbaijan state towards an environmental and social precipice. Both Cuba and Curitiba have channelled growth into new forms. This has involved reducing complexity in the hope that once a new energy equation emerges, social capital will stabilise and a new approach to prosperity for all will materialise. Sweden also has contained growth in seeking to affirm broader social and environmental aspirations while Eco-Communities experiment with alternative models for growth and sustainability. The range of responses to energy profiled here suggests a diversity of values that foster innovation, creativity and future possibilities.

The concept of social addiction points to cultural orientations that are counter-productive to the overall goal of culture to provide stability and security for its members. Culture builds identity around forms of expression. Over time, these forms can cease to be productive. Time frames are important guides to the question of adaptation and maladaptation. A commitment to growth can become addictive when the energy form that is required to fulfil that need puts more stress on the system than it relieves.

Values and addictions frame what is rational in any circumstance. Contexts are largely framed by their history, which provides the imaginative template for what is possible. Thus, Azerbaijan's commitment to authoritarian governance is historically predetermined. However, other case studies illustrate that probable futures are not inevitable. Britain's own transformation is one example of this as is the example of Cuba's post-Soviet transformation. Such cases also illustrate that such transformation is always painful and linked to strong leadership and a future vision of human possibility beyond the present set of limitations.

That some contexts can break free from a historical trajectory that there are imaginative resources present in contexts that are overlooked when a system is functional but emerge when a system experiences stress. The likelihood of this happening is determined by context. The cases of Easter Island and Azerbaijan indicate that such a break with the past is not always possible; at least, without significant external intervention.

Energy and leadership

Case studies profile a range of leadership possibilities. Eco-Communities are generally built around charismatic individuals who are in turn led by a received value set such as permaculture (Crystal Waters, Australia) or a religious philosophy such as Vedanta (Auroville, India). The British ruling class in 1800 were motivated by a mix of greed and inspiration. They truly believed in the possibilities of the new industrial order to generate abundance and spread order across Britain.

The state can also be a leader. In the case of Donora 1948 both the federal and state legislature were involved in thinking through the implications of environmental degradation and human industrial activity for the citizen. Their task was to balance growth with social security – both health and jobs. Authoritarianism does not necessarily have to affect the social order adversely. Augustus Caesar is remembered more for his spectacular success and reforms than for being a vicious and calculating autocrat. The Castro government's response to a mini-peak oil experience showed considerable restraint and social commonsense. Free from Soviet demands ideology gave way to pragmatism. The creative and innovative measures of the 'special period' indicate that the considerable trust Castro regime's part was repaid with the worst of the decline in energy now behind Cuba. The case of Azerbaijan 2005 contrasts with such approaches and is a reminder that authoritarianism can often be reactionary and greatly compromise a society's resilience and adaptive capacity.

The readiness of leadership to engage constituencies is borne out in case studies such as Sweden 2006 and Curitiba 1990s. Such work is adaptive in nature and tends to be multilevel, consultative and flexible. Leadership of this kind involved dialogue and genuine engagement. Such work fostered social learning on the part of state institutions and the citizenry, who developed a sense of ownership for issues relating to energy innovation and social reordering.

These are examples of adaptive leadership. Adaptive leadership is flexible and resilient in nature. Such leaders, when in politics, can come from authoritarian and democratic contexts and can drive social change and innovation. They have the potential to rethink social relationships and seed alternatives for the future.

Determinants for energy

As with the other sectoral analyses, determinants for the Energy sector fall into sets of external or internal drivers. The more complex a system is, the more vulnerable it is to disruptions in energy availability. Premodern societies drew energy largely from agriculture. Modern societies draw energy from a range of technologically mediated sources such as fossil fuels, nuclear fission and alternatives such as solar, wind and biomass. Complexity mediates adaptive learning and generates a sense of distance from vulnerability. Thus, modern societies can underestimate a threat to their viability over the long term.

External drivers for energy include resource networks, competition, institutional constraints and wildcard events while internal drivers relate to the subjective field of cultural values and temporal consciousness. These drivers are not separate areas but inform each other in both direct and subtle ways. The premodern case studies of Rome 1CE and Easter Island 1500 both demonstrate this interplay. Both adopted short-term mitigative responses to systemically weak long-term needs. Ability to think of the future and plan are significant contributors to longer-term viability of a complex system. In the cases of Rome and Easter Island growth and complexity, failure in leadership, short term fixes to deeper systemic problems and weakening of agricultural and environmental bases were all determinants in final collapse.

Two wildcard events worth noting are the arrival of the British in Hawaii and the collapse of the Soviet Union. Both events sent the status quo respectively in Hawaii and Cuba into a spiral. Determinants at work in these contexts were isolation and resource dependency. Sweden 2006 is another example of a small country that engages in rethinking its relationship with energy. Recognising itself to be energy dependent, it has begun a process leading towards greater energy self-sufficiency. The determinants in this case are its rich forestry resources, its size and its flexible and open leadership.

Of note is the special case of Eco-Communities. These sites respond to a different set of external determinants. What drives such contexts is a philosophical position and though this is a value position, it can be understood as externally imposed on context. As ‘artificial experiments’ in cultural adaptation these communities emerge not from context but from people’s hearts and minds. The context then generates a secondary set of determinants that shape the physical expression of these communities.

Internal determinants can be seen at work in the external contexts described above. How leadership is thought of and enacted has significant implications for a society’s long-term viability. Similarly, how the human relationship with nature is thought of has immediate implications for society. If nature is values as a resource or seen as of intrinsic value for instance determine how human beings treat it. Intrinsic value does not mean that society values nature in a disinterested way but that it is seen as having deeper implications for cultural stability and social growth. Some case studies such as those on Sweden 2006, Cuba 1990s and Curitiba 1990s illustrate that valuing social capital and trusting citizens are also instrumental in fostering adaptive capacity and social learning. Such values diminish the drive to control which a central function of government as illustrated in the case of Azerbaijan 2005. This suggests a possible tension for those engaged in Eco-Communities where the tendency to put philosophy first might lead to issues of control and trust that stifle innovation. The discipline of philosophy and tradition can be balanced against human needs as in the case of Hawaii 1700 where energy flows were sustainably managed over time.

Historical scenarios for energy

The historical scenarios for energy fall across all four scenario archetypes suggested by Dator (2002) (Table 5). Interestingly the case of Cuba 1990s suggests three possible scenarios. By force of circumstances (Soviet collapse and US sanctions), Cuba has been unable to assume that continuation scenario will work for them any time soon. They have been forced to endure collapse, a return to traditional rural disciplines and to work for transformational synergies across a range of sectors.

The continuation scenario is well represented with four case studies. The Collapse and Disciplined Society scenarios both have two studies each and the Transformational Society scenario has four studies (Table 5).

Table 5 Scenario Summaries Energy

Categories	Case studies for Energy
Continuation	E 1.1 Rome 1CE
	E 1.2 Donora 1948
	E 1.3 Azerbaijan 2005
	E 1.4 Sweden 2006
Collapse	E 2.1 Easter Island 1500
	E 2.2 Cuba 1990s
Disciplined society	E 3.1 Cuba 1990s
	E 3.2 Hawaii 1700
Transformational society	E 4.1 Britain 1800
	E 4.2 Cuba 1990s
	E 4.3 Curitiba 1990s
	E 4.4 Eco-Communities 2009

Continuation

The hold of Rome on the Western imagination is great. Yet Rome is usually thought of in connection with collapse not continuation. This civilisation lasted for over eight hundred years with the empire established by Augustus lasting well into the fifth century. For most Romans, the future was no doubt going to be the same as the past and the present. Rome's collapse was unthinkable. The power of the present to impose a sense of permanence on a moment is demonstrated in this case study. Rome was reconfigured by Augustus so that the future was guaranteed to be Roman.

The case of Donora offers a different scale to consider. This town and its people felt secure and yet the unthinkable happened. The response of the government was to ensure that lessons were learnt and measures taken to mitigate against the worst effects of environmental degradation. Continuation was the core business of the state whose purpose was to balance the interests of business with the well-being of its citizens.

Azerbaijan 2005 illustrates that core business can be 'lean and mean' with little regard for the future. The system will continue until it fails with the country's elite quarantined from failure by wealth. Sweden 2006 on the other hand looks to balance growth with citizen welfare. In this scenario continuation hinges on the maintenance of high-energy consumption, provided by less damaging 'greener and cleaner' technologies.

Collapse

Easter Island is the classic collapse scenario exemplar. Historians and geographers such as Clive Ponting (2007), Jared Diamond (2005) and Ronald Wright (2006) all compare it to planet Earth. They deploy the story as a moral tale in which an isolated island demonstrating a dynamic and vital society is caught in an endgame scenario from which rational action and choice is banished. They see Earth and its planetary civilisation as caught in a similar dynamic. Humanity is dependent on a finite energy source, yet considers growth the only option. Isolated in this conviction we are all heading for collapse.

The case of Cuba 1990s illustrates that collapse is a relative concept. Much can be lost but people often somehow manage to keep on going. In such cases, collapse clears the head and allows for innovation and new learning to occur. Collapse scenarios are useful in reminding people in context what is at stake and suggesting that foresight can allow a degree of anticipatory action learning to occur before it is too late.

Disciplined society

Cuba 1990s also demonstrates that when complexity is reduced earlier patterns of social process may re-emerge. Older traditions suppressed by modern answers come to the fore with family and community reclaiming responsibilities long held by the state. Cuban leadership actively fostered this process. They combined the dual disciplines of traditional life with a Communist philosophy of hope. Both act as disciplinary measures in time of distress.

They contrast markedly however with the traditional disciplinary society of Hawaii. Such a society arose not in response to decline but to leverage energy from the environment in a sustainable way. The discipline of Cuba is very different from that of Hawaii. The latter is steady state while Cuba is a volatile and unpredictable context.

Transformational society

This volatility in Cuban culture suggests that it is also transforming rapidly. As a scenario for transformation, Cuba offers an authentic demonstration of what might be expected if modern energy supplies collapsed. It avoids the mock heroics of dystopian movies but points directly to the human suffering engendered by collapse and to the role of ingenuity, creativity, freedom and strong leadership in seeking to find sustainable ways forward for the majority of people affected.

Britain's transformation was also radical and glosses the immense suffering of the majority of the British populace at this time. Cuba's transformation is very hands on while British transformation was distanced from the suffering of the new working class because much of it was legislative and institutional. This work set the context for factories and empire.

Curitiba's transformation like Cuba's, was hands on and involved imagination and persistence. Strong leadership and consultative processes spread the social learning amongst the cities people. Attitudes and values had to shift for this to happen. Thus, communication and the fostering of a shared vision were essential.

The Eco-Community case provides a different insight into transformation. In this context, idealism is essential. Cuba shares this in that it is ostensibly a Communist society. Idealism provides sustenance for leaders and followers. It also challenges dominant assumptions and offers alternatives that need to be tested on the ground. Such communities are sites where social learning is occurring that is inspired by transformational visions of humanity and its relationship with energy. The testing of ideals is not easy when contexts rarely support the broader aspirations and where resources are in short supply. Problems shared by both Cuba and Curitiba.

Synthesis, scenarios, reflection

Cross sector synthesis

The case studies underline a set of common determinants at work across all sectors. What stand out are not the differences but the similarities across both time and scale. This section will summarise these determinants and offer a map for understanding them as complex and dynamic relational fields that determine adaptive responses to changes in the physical and social environment.

As repeatedly noted, the determinants at play across the sectors and across all instances of human responses to change fall into two domains, external drivers and internal drivers. Essentially these drivers account for the processes at work in any specific environment. All historical contexts are unique in the details of what is occurring, however historical patterns are clearly identifiable. Negotiating these patterns is an exercise in historical thinking and demands historical judgement. This judgment is informed by the question asked. This report is motivated by the need to better understand adaptive capacity across the ages and how to consciously engage adaptive capacity in the present. It is an exercise in 'practical reckoning' (Smith 2009). In this case, the question asked is *What lessons from the past can inform current approaches to adaptive capacity for South East Queensland stakeholders today?*

Adaptive capacity is largely determined by context. Context in turn can be understood as the experience of the present informed by external and internal factors. This report has described these factors as determinants. The determinants common to all sectors are summarised in Figure 3.

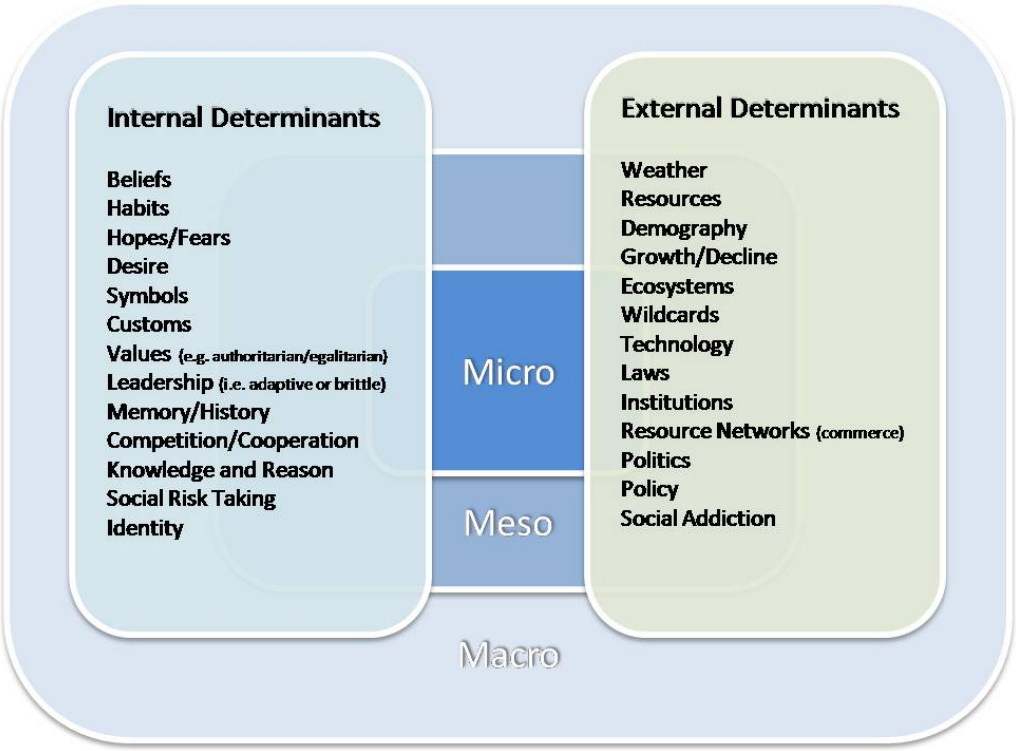

Figure 3: Internal and external determinants across scale

These determinants work across scale and form unique configurations in time that shape a moment in history, informing a choice or decision, excluding possible alternatives while suggesting others to those in context. This does not suggest a simple historical

determinism. Such is the vitality of these two fields that possibility always exists for imagination, courage, inspiration and plain defiance to challenge the momentum of history.

There is always room for an individual such as Solon of Athens, Augustus of Rome or Jane Austin of Britain to challenge custom and tradition by suggesting alternatives to business as usual. There is equally the opportunity for anonymous individuals and collectives to do the same. The importance of the individual suggests a further of (Figure 4) table above that breaks it into four quadrants. This break down allows for a deeper more informative synthesis of historical determinants to occur in which the individual and unique features of context are recognised while also accounting for the collective experience of institutions and culture.

A four-quadrant model of historical determinants

Figure 4 below is based on the work of Ken Wilber (2001) who divides a square, representing the entirety of human experience, into four quandrants by internal (personal) and external (impersonal) (the X axis); and collective and unique contexts (Y axis). These quadrants distinguish between domains of experience and action.

The Y-axis indicates that historical determinants can be uniquely personal for the individuals involved while also made up of discrete occurrences in the purely physical environment (the upper two quadrants). This acknowledges that there is a collective dimension that all unique occurrences inform. This shared level of reality is either cultural (Personal Collective) or structural (Impersonal Collective). This level of human experience in turn informs the unique and personal.

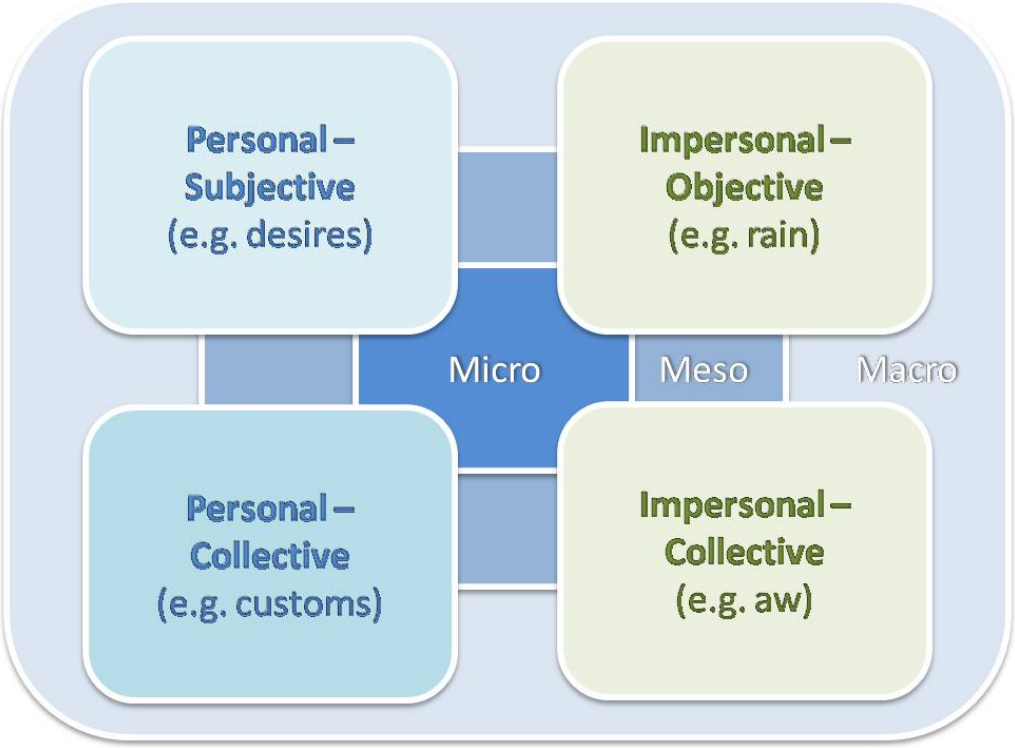

Figure 4: Level two – Folding field of adaptive capacity, mapping determinants

This four-quadrant model allows the determinants listed above in Figure 4 to be ordered so that the specific orientation of the determinant is better understood. Figure 5 captures this more specific information thus:

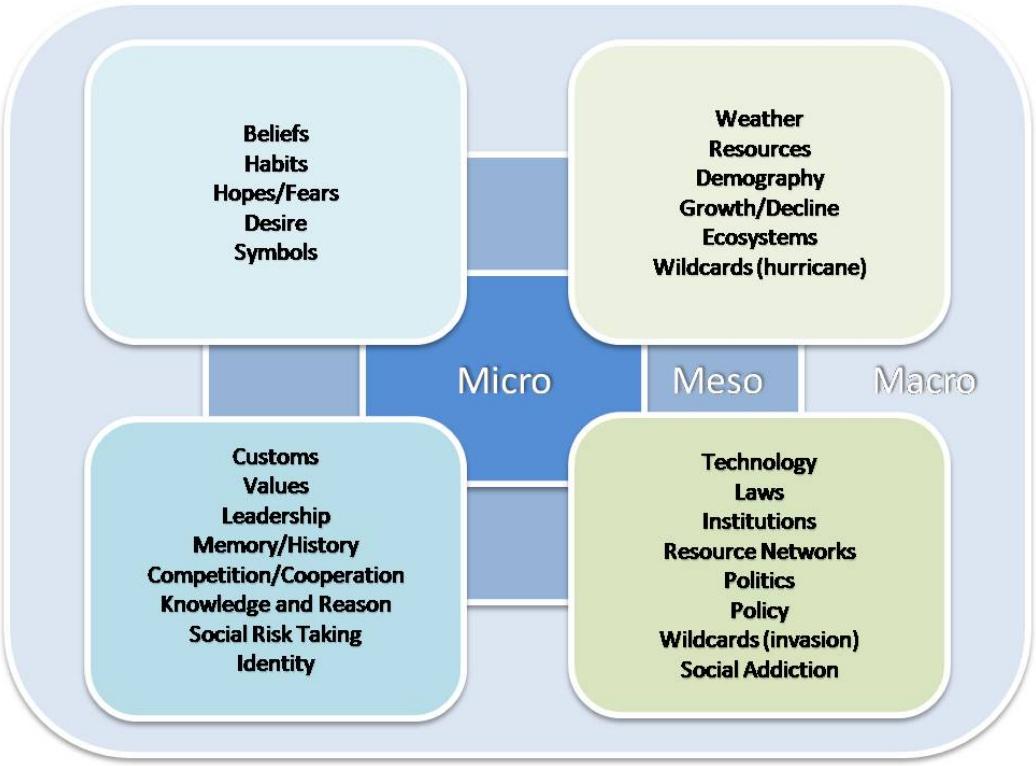

Figure 5: Level three – Folding field of adaptive capacity, mapping determinants

The utility of this analysis is that it allows further development to illustrate the dynamic relationships that exist between each determinant. Historical contexts are alive with the interplay of historical determinants. Such is the diversity of possibility that no two contexts are ever duplicated. Yet the pattern of interactions reveals processes at work that are intelligible in all sectors and across all scales. Thus, the parallels between the context of Rome 1CE and Britain 1800 are as striking as are their differences.

These determinants form unique fields of meaning and action according to context. These fields fold in and out of one another and across scale. This process is captured in the (Figure 6) which illustrates the interactive nature of the folding fields that determine adaptive capacity in any context. It captures both the uniqueness of context and the generic nature of human historical and social processes.

Figure 6: Level four – Folding field of adaptive capacity, mapping determinants

Understanding adaptive capacity as the dynamic potential inherent to context can stimulate thinking about context that is free from habit and conditioning. The four-quadrant model presented demonstrates that adaptive capacity exists in a dynamic field of folding relationships. No longer can the 'system' be thought of as a discrete agent in a social question. The system is now clearly connected to values and assumptions about knowledge and identity. These assumptions in turn are carried forward by individuals who hold to a set of beliefs that time, culture and identity have imprinted on them. Not only this, but biophysical events such as the weather and processes such as ecosystems are no longer separated from the cultural and institutional domains they impact. How human beings make sense of and respond to such 'natural' occurrences is now folded into their adaptive capacity at any one moment, selecting and promoting valid responses from a range of alternatives embedded in context.

Tying it all together

The four quadrant model and the folding fields illustrates how dynamic and complex all social settings are. It also illustrates that thinking about adaptive capacity needs to address internal issues relating to the cultural and subjective conditions that frame meaningful action while working with external issues of vulnerability which involve both institutional readiness and flexibility and infrastructural capacity. Resilience can be understood as the adaptive potential that emerges when we consider both inner and outer determinants.

It is tempting to tackle climate change as a set of physical challenges to human security. This historical survey indicates that successful adaptive responses have included both technical and cultural solutions. Both are necessary conditions for resilience and act as measures of adaptive capacity. Technical solutions on their own tend to be mitigative in nature while cultural solutions that are not grounded in technical innovation tend to be

cosmetic in nature. This observation suggests that technology is a subset of culture while culture always generates technologies that reflect and sustain dominant value sets. Lasting cultural change therefore can always be linked to technological developments. The techno-fix mindset, for example Sydney 2000 and New Orleans 2006, never challenges dominant cultural values while cultural change is ephemeral without sound technological underpinnings.

The following is a summary of insights for thinking about adaptive capacity generated by this historical survey. The insights are presented in two sets that correlate with the social and the cultural domains.

Social processes

- Social learning increases exponentially the more collaboration, networking and information sharing occurs
- Social learning is diminished when information is siloed in disciplinary or administrative units
- Effective adaptive management includes ongoing effective evaluation of corporate frameworks and transparent accountability
- Pathway dependency compromises social imagination
- To postpone pain is to diminish adaptive capacity
- Short term security can compromise long term sustainability
- Political and institutional short termism create institutional inertia
- Political and institutional short termism create institutional amnesia
- Institutional amnesia sees the past as the future, is committed to business as usual
- Social addictions constrain choices
- Grassroots leadership needs to have a degree of congruence with external leadership
- Grassroot structures need to have a degree of congruence with external structures
- Resources availability determines adaptive capacity
- Institutions frame the logic and values of a situation, therefore adaptive capacity requires a continual engagement with institutional logic
- Technology has a social dimension
- Adaptive capacity has political, legal, economic and technological dimensions
- Leadership needs to be clearly aligned across scales with adaptive learning

Cultural processes

- Values and institutions do change
- When values are clearly framed both agency and creativity are increased
- Adaptive capacity is directly related to a collective desire for learning
- Creativity and risk taking are significant elements in social learning
- Collective desire and institutional capacity are both inhibited by the need to control and by the need for security/stability
- Imagination is a cultural resource, it can be passive or engaged and self aware
- Holistic and multidisciplinary activity increases resilience
- Risk taking facilitates resilience
- Multiple time frames generate deeper reflection on adaptive strategies
- Imaginative resources determine adaptive capacity
- Local and national histories define groups, generate identity and thus frame possible solutions to a problem while marginalizing other solutions

These insights highlight the social and cultural processes at work when engaging adaptive capacity. Social processes are structural in nature and relate to institutions and

their political, economic and educational activities. Cultural processes are value laden and relate to the production of collective meaning, knowledge and reasoning. Adaptive capacity works across the socio-cultural domain and is most effective when it does so knowingly.

Historical memory deepens adaptive capacity by extending the range of experiences and data available to those in the present. It can inform decision making and increase the level of practical reckoning of decision makers, leaders and communities who are proactively engaging with the emergent context of climate change.

Scenarios for sectoral adaptive capacity in South East Queensland

Scenarios leverage reality. They enable those in context to think about alternatives to the dominant paradigm that defines their choices and informs their decisions. Essentially scenarios are internally consistent images of the future that reflect the trajectory of a dominant logic within a context.

This report has used the scenario template developed by Dator (2002) to inform scenario work based on the historical case studies presented. Dator suggests four scenario archetypes:

- Continuation: this is business as usual with the future being very much like the present.
- Collapse: this is the fear that haunts all societies, the termination of all infrastructural processes and ensuing death and disorder on a massive scale
- Disciplined Society: this suggests either a return to the past, as in simpler social forms where authority is clear and life was good; or, the embracing of a Utopian vision of order and balance were life is good
- Transformational Society: this points to a fundamental shift in values and organisation for a context

When thinking about scenarios for South East Queensland the case studies indicate that issues of personal and cultural values are significant drivers as is leadership and historical momentum. Similarly, there are also contextual drivers such as climate variability, resources and the institutional processes in place at the time. Various combinations of such determinants suggest four possible scenario profiles, based on Dator's work, for South East Queensland.

Continuation

South East Queensland (SEQ) is a complex and diverse setting with a range of systems in place to meet climate change possibilities. The use of strategic foresight planning enhances the adaptive capacity of existing infrastructure while generating the required flexibility and vision to address new contingencies when they emerge. The underlying attitude is that Queenslanders are tough and resilient and that they will adapt. Mateship and stoicism are important themes that reinforce pre-existing Aussie myths. Adaptation will thus take place at the personal level where life style shifts will occur, social infrastructure will respond proactively by having systems in place (e.g. energy, transport, health infrastructure) in advance of the worst possible impacts of climate change. At the heart of this scenario lies a faith in human adaptability and resilience and a trust in the institutional and social processes that have built the state.

Collapse

Complex systems are vulnerable systems. SEQ underestimates the impact of climate change on essential systems. Increased average annual temperature of up to 4^{o}C, irregular and extreme rainfalls, tidal surges, and the influx of tropical diseases overwhelm

essential systems. There is a southward migration of people both into and out of SEQ. Areas north of SEQ suffer from drought and flooding, increase in tropical disease, and a break down in infrastructure and people come to SEQ as a refuge. In turn, people in SEQ are also looking south for increased security in essential services. There is a loss in confidence in government and public institutions with the old and the poor suffering the brunt of infrastructure failure. Popular mistrust of politicians is high with old cultural themes of "Can't trust Government" resurfacing. Population declines, the economy contracts, prices for essential items soar and growth areas on marginal lands are depopulated. There is a high level of community anger and confusion over a lack of leadership in meeting climate change with community groups taking the lead in managing and protecting local resources.

Disciplined society

Federal, state and regional leaders rally South East Queenslanders around old myths of Aussie stamina in adversity. Infrastructure failures and resultant stresses all fuel a sense of being at war with nature. Social complexity is scaled back and a paternalistic central authority swings into action to keep up the public's morale. The SEQ economy contracts and models itself on War-time processes with food and fuel rationing, high levels of unemployment, high levels of volunteerism and jobs in essential services being frozen while the unemployed are directed to service in areas that have been affected by loss of infrastructure. There is a move out of heavily urbanised areas and society is remodelled around a centralist approach to social order in times of severe stress. Church and community groups, such as the Lions, RSL, St Vincent de Pauls and Apex, become essential support networks for families in distress. The traditional work ethic is extolled, and the image of Aussie resilience and stoicism is promoted through print and visual media. Such stereotypes appear in popular culture and the government establishes self-sufficiency centres across SEQ to reskill people in line with a new ethic of local productivity for local people.

Transformational society

The impact of climate change on SEQ is much greater than most leaders expected. It is complicated by a crisis in oil supplies. Public confidence in conventional leadership and their parties is dashed with a resultant electoral backlash that ushers in a new set of leaders inspired by an ethic of social resilience and environmentalism. Regional leaders and their communities work with State and Federal bodies to reconfigure their communities into more locally sustainable units that combine industries of scale (e.g., local farms and food processing plants, local trader and transport networks) with broader socio-economic networks. Think-tanks are established around the region where the expertise of people from movements such a Transition Town, Permaculture and Biodynamics are brought together to help reframe dominant assumptions about economics, energy and agriculture. These centres become educational outlets for disseminating a new approach to social health and productivity. The myth of Aussie toughness and ingenuity becomes more focused on Aussie innovation and cultural creativity. This heralds a "Community Renaissance" in SEQ culture. Such is the shock felt by mainstream society that these moves are welcomed and a genuine engagement with the new ethic shapes a sense of possibility within limits.

Reflections on the historical scenarios

Scenarios establish a set of coordinates for thinking about the future and how to prepare for it. Accordingly, SEQ faces a series of interlinked choices about what kind of future appears viable and desirable. Thinkers about society's future possibilities regularly divide them into three categories: 1. probable futures built around the continuation scenario; 2. possible futures built around a combination of the continuation, disciplined and transformational scenarios; and 3. preferable futures which combine continuation with transformation to provide a sense of win-win for society (Bell, 2007). The collapse scenario is held up as a wildcard possibility to remind everyone that security and stability are not guaranteed (Barber, 2006). Stable societies have been regularly up-ended much to the surprise and discomfort of those who lived during such periods.

The historical scenarios gathered in this report are invitations to SEQ stakeholders to think about the present in different ways. The internal determinants point to the role of values, leadership and knowledge in framing how a context is understood. The external determinants highlight the significance of institutions, technology and resources in shaping how much room to move a context has when faced with severe stress. The whole point of the exercise is to loosen the bonds of habit and what Jared Diamond so eloquently calls 'landscape amnesia' (2005).

Habit constrains adaptive capacity, locking it into a series of diminished possibilities. As the case studies illustrate for this inquiry into adaptive capacity are invitations to SEQ stakeholders to think about the present in different ways. They foster anticipatory action learning by looking not at events but at the processes that underpin them. Processes are action based and when framed as scenario archetypes they become guides to possible anticipatory actions today. This becomes anticipatory learning when the future is thought of strategically in the present and values are linked to actions. This reframes the present and stimulates human agency to cast off the habits of context. As the case studies illustrate, a resilient sector is one that demonstrates creativity, flexible leadership, engagement, rich social imagination, requisite knowledge and a preparedness to take risks. Such qualities are all present in context: how they are expressed is usually determined by external factors relating to institutional arrangements, the technologies in place and the availability of resources.

Conclusion

This report is intended to provoke thought and debate around issues of social change. It draws on historical case studies to profile human responses to stress and perceived vulnerability. The case studies have highlighted how resilience is manifest at different times and in different geographical and cultural contexts. Some case studies have also pointed to what happens when resilience fails and societies spiral into chaos and decline. Resilience is linked to social learning and adaptive leadership and is dependent on information, resources and flexibility. Foresight and anticipatory thinking, and the social imagination these rest upon, are essential in charting directions beyond current practices that are dominated by conventions designed to maintain a system rather than transform it.

Historical thinking can inform adaptive capacity and stimulate an appreciation of social processes. Such thinking helps people in context understand that all social arrangements are designed to solve problems. Some problems however are easier to solve than others. Both scale and complexity significantly challenge social systems when they begin to

engage with global climate change. South East Queensland has only limited capacity in this regard, yet as many case studies demonstrate scale should be no obstacle to success.

This report has sought to answer a single question: *What lessons from the past can inform current approaches to adaptive capacity for South East Queensland stakeholders today?* The answer turns out to be complex and partial. Historical examples remind the researcher that each case is uniquely configured and yet also rich in alternatives. Ultimately, adaptive capacity can be measured by the balance between the values and structures that shape any given moment. Often those in context are only dimly aware of these. When such awareness becomes clearer, there is evidence to suggest the ability to adapt more effectively is increased. As historical thinking and the historical scenarios this research has generated both promote such awareness perhaps the utility value of this work lies in fostering a more informed public debate.

Appendix 1: Overview of case studies, historical scenarios and sectors

Case studies	Human settlement	Agriculture	Ecosystems	Energy	Scenario type
1953 Netherlands	■		◘		1
Adelbert Mountains 2009	◘	▣	▣		3, 4
Amazon 1400		■	◘		3
Angkor Wat 1200	▣	▣	◘	◘	2
Athens 590BCE	■				4
Azerbaijan 2005		▣		▣	1
Bolivia 2009		■	◘		1, 4
Britain 1800	▣	◘		▣	4
Byron Bay 2009	■		◘		4
Chesapeake Bay 2001		■	◘		1, 2
Cuba 1990s	◘	▣	◘	▣	2, 3, 4
Curitiba 1990s	▣			▣	4
DMZ/Chernobyl 2009	◘		■		3
Donora 1948	▣			▣	1
Easter Island 1500	◘		◘	■	2
Eastern North Pacific Gray Whale 2000			■		1, 2
Eco-Communities 2009	▣		▣	▣	3, 4
Garcia River Forest 2000			■	◘	1
Hawaii 1700		▣	◘	▣	2, 3
Indigenous Australians 2009	◘		■		1, 3
Maroochy 2009	◘	◘	■		1
Mobile Phones 1990s	■				4
Natufians 12kya	▣	▣	◘	◘	4
Netherlands 2009	■	◘	◘		1
New Orleans 2006	■		◘		1, 2
NSWs Parks 2009	◘	◘	■		1
Palaeolithic 15KYA	■			◘	1
Phuket, Thailand, 2009	◘		■		1
Rome 1 AD	▣	◘		▣	4
Sale, 1870		■	◘		1
Sweden 2006	◘			■	1, 4
Sydney 2000	■		◘		1
The Novel 1850	■				4

Legend	
High Correlation	■
Moderate Correlation	◘
Little Correlation	Blank
High correlation case studies relating to more than one sector	▣

Appendix 2: Summary of historical scenarios by sector

Categories	Human Settlement and Health case studies
Continuation	HS 1.1 Palaeolithic 15kya
	HS 1.2 Donora 1948
	HS 1.3 Netherlands Floods 1953
	HS 1.4 Sydney 2000
	HS 1.5 New Orleans 2006
	HS 1.6 Netherlands 2009
Collapse	HS 2.1 Angkor Wat 1200
	HS 2.2 New Orleans 2006
Disciplined society	HS 3.1 Eco-communities 2009
	HS 3.2 Palaeolithic 15kya
Transformational society	HS 4.1 The Natufians 12kya
	HS 4.2 Athens 590BCE
	HS 4.3 Roman Empire 1CE
	HS 4.4 Britain 1800
	HS 4.5 The Novel 1850
	HS 4.6 Mobile Phones 1990s
	HS 4.7 Curitiba, Brazil 1990s
	HS 4.8 Byron Bay 2009
	HS 4.9 Eco-communities 2009

Categories	Agriculture case studies
Continuation	Ag 1.1 Sale 1870
	Ag 1.2 Azerbaijan 2005
	Ag 1.3 Bolivia 2009
	Ag 1.4 Chesapeake 2001
Collapse	Ag 2.1 Angkor Wat 1200
	Ag 2.2, Hawaii 1700
	Ag 2.3 Chesapeake 2001
Disciplined society	Ag 3.1 Amazon 1400
	Ag 3.2 Hawaii 1700
	Ag 3.3 Cuba 1990s
	Ag 3.4 Adelbert Mountains 2009
Transformational society	Ag 4.1 Natufians 12kya
	Ag 4.2 Cuba 1990s
	Ag 4.3 Bolivia 2009
	Ag 4.4 Adelbert Mountains 2009

Categories	Ecosystems and Biodiversity case studies
Continuation	EB 1.1 Eastern Pacific Gray Whale 2000
	EB 1.2 NSW Parks 2009
	EB 1.3 Garcia River Forest 2000
	EB 1.4 Maroochy 2009
	EB 1.5 Indigenous Australians 2009
	EB 1.6 Phuket 2009
Collapse	EB 2.1 Eastern Pacific Gray Whale 2000
Disciplined society	EB 3.1 Adelbert Mountains 2009
	EB 3.2 Indigenous Australians 2009
	EB 3.3 DMZ & Chernobyl 2009
Transformational society	EB 4.1 Adelbert Mountains 2009
	EB 4.2 Eco-Communities 2009

Categories	Energy case studies
Continuation	E 1.1 Roman Empire 1CE
	E 1.2 Donora 1948
	E 1.3 Azerbaijan 2005
	E 1.4 Sweden 2006
Collapse	E 2.1 Easter Island 1500
	E 2.2 Cuba 1990s
Disciplined society	E 3.1 Cuba 1990s
	E 3.2 Hawaii 1700
Transformational society	E 4.1 Britain 1800
	E 4.2 Cuba 1990s
	E 4.3 Curitiba 1990s
	E 4.4 Eco-Communities 2009

Appendix 3: Case studies

The following case studies are both numerically and colour coded. The numerical coding situates the study's position in the historical scenarios sections of the report. The colour coding relates each case study to the first sector in which it appears. When a case study relates to multiple sectors, the coding is in the heading of the first table of each case study description.

Coding:

Human Settlement and Health = HS
Agriculture = AG
Ecosystems and Biodiversity = EB
Energy = E

Angkor Wat 1200 CE

HS 2.1, Ag. 2.1	
Sector focus	Human Settlement and Health
Adaptation to	Heavy erosion
Adaptive capacity	Modify existing patterns to maximise resource accessibility
Social learning involved	Adjusting existing social organisation and ramping up technological 'solutions'
Primary and secondary drivers	Population growth, stratified social organisation
Success and /or barriers to adaptation	Successes: established extensive urban systems, trade, military domination, artistic and cultural expression Barriers: Hard to retreat from population growth without loss of life
Implications for climate change adaptation	Implications of investment in infrastructure, pathway dependency, only applies in moderate contexts – villages and social organisation abandoned when no longer functional

Research into the Angkor Wat temple complex and its urban surrounds has been uneven, broken by a range of social disturbances the most notable of which was the Khmer Republic of 1970 to 1975. However a fascinating picture of the culture of the Khmer is emerging as the result of a radio tomography survey performed by NASA in 2000 which scanned the entire site of approximately 3000 km^2 to reveal what some authors describe as a 'hydraulic city' (Evans, et al., 2007). The picture coming into focus is one of an urban civilization characterized as:

> ...a vast, low-density settlement landscape integrated by an elaborate water management network covering >1,000 km^2 , the most extensive urban complex of the preindustrial world (ibid, p. 14277).

The urban space was constructed in a modular fashion in a wide forested plain that was subject to monsoonal rains. Each module consisted of a temple complex surrounded by an irrigation pond and vegetable gardens and paddy fields. Larger canals linked modules and from the 9th Century CE radiated out from the central Angkor temple complex. Over time, as the Khmer civilization expanded, they spread their influence over a wide area including parts of Thailand, Laos, Vietnam, and Myanmar.

The extensive land clearing that underwrote this expansion allowed monsoonal rains to destabilize the soil and lead to massive topsoil loss. Thus Evans et al observe:

> *It is now clear that anthropogenic changes to the landscape were both extensive and substantial enough to have created grave challenges to the long-term viability of the settlement (ibid p. 14277).*

The Khmer civilization was active for nearly a millennium emerging in the 6th Century of the current era and disappearing by the 16th Century (Penny, Pottier, Fletcher, & Barbetti, 2006). Over this time they adapted to the demands of water, agriculture and demography by developing an intricate canal system (Figure 1), a water management system built around ponds and reservoirs, and by moving administrative centres every few centuries. Trade with neighbours was an important cultural driver and increased their social learning (Higham, 2003; Ponting, 2001). The initial success of Khmer agriculture, primarily rice, led to large surpluses the Khmer could trade. They had a successful port city at Phnom Krom that attracted trade with Malaya, Sri Lanka, India and China.

Socially Angkor was a stratified slave society in which a small elite controlled the majority of resources (Ponting, 2001, p. 393). The Angkorian landscape, which can be understood as a 'materialised history', with its centralized temples and wide spreading agricultural areas reflects this social ordering (Stark, 2006, p. 408). Initially a Hindu society a succession of Buddhist rulers changed the religion yet religion remained an issue as there was increased competition between the elites, some of whom held on to Hinduism. At its peak, Angkor's population was perhaps 300000. It consisted of about 13000 villages associated with the temples and ponds, yet pressure on the land lead to areas being abandoned and returned to after lengthy periods. The dependence on slave labour was also a weakness reducing innovation and resilience. Ponting points out the scale of this dependency when he describes a typical temple complex.

> In the late 12th Century, the Ta Prohm had 12640 people living within the walls of the temple, including 18 high priests, 2740 officiants and 2632 assistants (of whom 615 were dancers, 439 were hermits and 970 were students). It was supported by its own estates worked by slaves and temple serfs who provided over 2500 tons of rice a year (2001, p. 394).

Slaves and serfs however, were restless and after the Mongols attacked Angkor in the 13th Century there was a revolt and the collapse of Angkorian civilization followed (Ponting, 2001, p. 394).

The civilization was maintained by extensive management of water (Higham, 2003). The pressure was always how to balance the demands of irrigation with monsoonal rains. Erosion was always a problem that required adjustments to the system of social organization. The low-density settlement can be one response to this, as can the reworking of canals and the relocating of administrative centres. Ultimately, the technology could not keep up with a degraded environment and the social order, which

was hierarchical and inflexible, lacked the resilience to respond through any means other than violence.

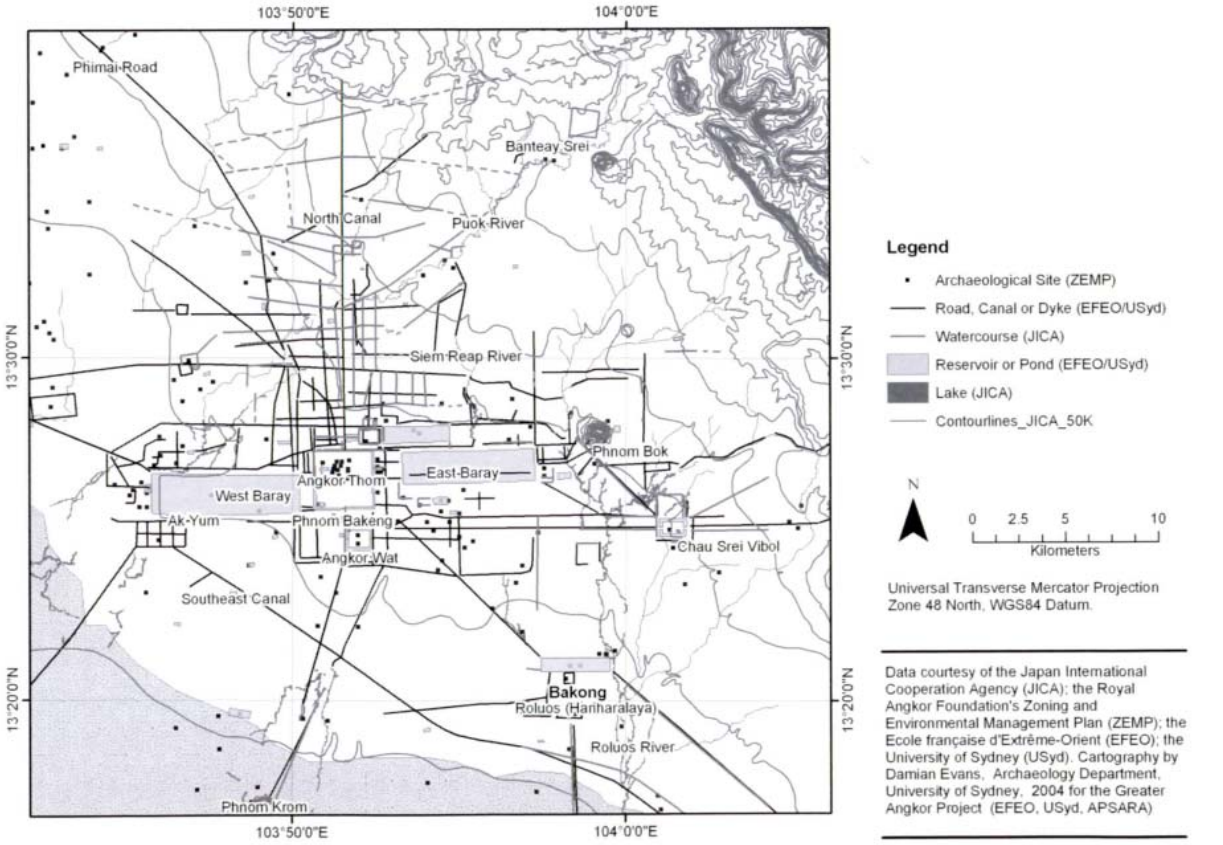

Figure 1. Map of Greater Angkor, central Cambodia, showing the location of Roluos (Hariharalaya) relative to the later capital of Yasodharapura, centred on Phnom Bakeng and Angkor Thom.

Figure 1: Greater Angkor (Penny, et al., 2006, p. 600)

Level: macro, meso or micro	Meso: regional response to monsoonal conditions
Physical context	Lowland plains cleared of tropical vegetation; canal system and low density urban complex
Rapid or incremental change	Incremental but sustained mitigation to a chronic situation of deforestation, erosion and social stratification
Cultural values	Authoritarian and Theocratic
Societal addictions	Land clearing and authoritarianism
Imaginative resources	Agrarian village life intensified not via centralisation but by modular replication
Leadership	Hierarchical social order
Related case studies	Rome 1 AD, New Orleans 2006, Netherlands Flood 1953
Summary	The Khmer civilisation of Angkor succeeded by extensive management of water. The modular nature of its society allowed it to mitigate against environmental decline by shifting the centre of authority. The environmental impact of their hydrology was great but decline is also to be linked with a limited political order in which a few elites dominated the many and in which military conflict with neighbours also played its part.

Analytical framework for comparative analysis

Determinants	Deforestation, erosion and population growth
	Social stratification
	Large social investment in modular village building
	Regional conflict

Athens 590BCE

HS 4.2	
Sector focus	Human Settlement and Health
Adaptation to	Unstable and violent political and social environment
Adaptive capacity	Modification of laws and validation of a new value set that privileged collective engagement
Social learning involved	Laws need to be guarded against individual and collective tyranny
Primary and secondary drivers	Rivalry between aristocratic families; economic instability; threats from other Greek city states
Success and /or barriers to adaptation	Successes: Initiated a value shift in public consciousness After initial failure these values come to dominate Athenian society Barriers: Individual ambition; social desire for security; social infatuation with charismatic individuals
Implications for climate change adaptation	Values can and do change, they involve strong leadership, legal (i.e. structural) changes to support the shift, collective ownership of the change and time

At the opening of the 6th Century BCE the city-state of Athens was struggling with social unrest, economic decline and the violent rivalry of its wealthier citizens. The Athenians faced three related problems: 1. Contested authority – the city had been controlled by authoritarian rulers known as kings, or *tyrants*, these had been cast out but that left a power vacuum in which noble and wealthy families vied for control; 2. A weak system of governance that was unable to resolve tensions between the nobility and common Athenians, this was often played out as clan competition based on regions within the Athenian country side; 3. Related to this, was the regional rivalry between city states. There was an increasingly authoritarian turn led by Sparta that foreshadowed ill for common Athenians who saw their equals in other city-states being reduced to slave status (*helots*).

A solution was needed to avoid this fate. The Athenians turned to a trusted member of the aristocracy, Solon. He was elected chief magistrate (*archon eponymous*) of Athens in 594BCE. In this position Solon instituted a number of sweeping reforms (Rhodes, 2006). At first, these reforms were not that effective and Athens again had to endure a period of tyranny under Solon's cousin Peisistratos. However, they laid the foundations for the emergence of Athenian democracy later in the century. Nevertheless, the tyranny of Peisistratos was not a painful period for Athens as he was an able and respected ruler. However, his son Hippias was weaker, lost the confidence of the people, and was ousted by a Spartan coup in 508BCE. The Athenian Cleisthenes revived Solon's reforms and developed them in such a way that he is credited with being the father of Athenian democracy (Lévêque & Vidal-Naquet, 1996).

What is unique about this series of events is that Solon's reforms went against the better interests of himself and his own class. For example, he cancelled debts owing to the aristocracy and some scholars argue that he granted sweeping franchise rights to even low born (*thetes*) Athenian males. To guard against tyranny Solon set terms for office and

also divided power between magistrates to ensure no consolidation of authority in the hands of one man (Harris, 2006). Upon the end of his term of office, Solon withdrew into effective exile for a period of ten years. It can be argued that he did so to distance himself from the city and allow his reforms to work without any chance of him being accused of self-interest. However, the fact that Athens had to feel its way towards a new way of social process is important, as a society needs to be ready for change and feel the pressure of circumstance for change to be willingly embraced. The retreat of Athens into tyranny and then back to a stable form of democratic process reminds us that social learning is a slow and complex process.

Solon's case demonstrates that legal safeguards are not enough and that character and a value set that places justice and freedom before personal needs and authority is essential. The Athenians were neither the first nor the last people to allow liberty and social health to be compromised in the face of a charismatic tyrant. The German people voted away their freedoms in 1933. A more banal example is the way democracies around the world compromised their freedoms following the attack on the Twin Towers. In this case ideologues manipulated the public mood of anxiety to compromise long held rights (Butler, 2004).

This archaic period of Greek history is difficult to fully chart due to lack of historical material (Harris, 2006, see Ch 1.), but it is clear that the effective choice of a leader on the part of the Athenians at a time of crisis enabled them to negotiate a difficult transition period in their history. It is easy to overstate the case of Solon's reforms and his leadership style. Yet it is clear his reforms did save Athens from slipping into tyranny in the way that many of the neighbouring city-states did for periods at that time.

Level: macro, meso or micro	Meso: change at the collective and institutional level of the state
Physical context	City-state in Archaic Greece, surrounded by rural areas. Most of the population where peasants. There were some merchants and powerful families vied for control of the government.
Rapid or incremental change	Incremental change over a century
Cultural values	Contested: strong dislike of authoritarian rule (tyranny) but preparedness to support this when the individual is charismatic, fair and strong. An emergent democratic temper.
Societal addictions	Partisan followings
Imaginative resources	Growing language and examples of democratic and just process – much embodied in the person of Solon
Leadership	Solon was charismatic, balanced, fair and just but also visionary and refused to be partisan or put self-interest before community needs. He knew how to take chances and model respect for people not from his own class. Cleisthenes was a similar leader.
Related case studies	Cuba 1990s, Sale 1870, Britain 1800, The Novel 1850, Byron Bay 2009, Sweden 2006, Rome 1CE
Summary	Athenian journey towards democracy was slow and painful. The value shift did not occur over night but took a number of generations and needed the moral authority of leaders like Solon and Cleisthenes to bring clarity and legitimacy to this new form of social process.

Analytical framework for comparative analysis

Determinants	Social instability
	Laws in place to facilitate change
	A new moral vision
	Failure of alternatives

Britain 1800

HS 4.4 & E 4.1	
Sector focus	Human Settlement and Health
Adaptation to	Emergent possibilities relating to production
Adaptive capacity	Social engineering – economic and political reconstruction
Social learning involved	New opportunities require new social systems
Primary and secondary drivers	Resource boom Population growth New technologies New ideas
Success and /or barriers to adaptation	Successes: designed a new economic and political order Barriers: popular resistance to change
Implications for climate change adaptation	New value sets can reshape the entire course of a society Self interest of a few can drive social change Values are essential in reshaping a society and its core processes

Britain in 1800 was at the beginning of the industrial revolution. Many factors played a part in this new social experiment: the discovery of coal, a revolution in agricultural productivity and a related population explosion, new technologies relating to weaving, pottery manufacture, the development of the factory, a system of monarchy that included the parliamentary process, a growing landless population that supplied the labour needed for manufacture and the intellectual ferment of the Enlightenment period that promoted a belief in rational human action (such as the factory) and a commitment to bettering this world through human endeavour, science and knowledge (Hetherington, 1997; Watson, 2006).

This commitment to reason was expressed in economics as free trade. The importance of property gained a moral dimension and the sovereignty of individual activity, even at the expense of the collective, was established again and again through Acts of Parliament which had been working since the early 18th century and continued to work well into the 19th Century to establish the legal frame work of Capitalism and the new morality of competition. A centre piece of this legislative enterprise was the Enclosure Acts which effectively privatised the lands of Great Britain and created a landless working class (Ponting, 2001, p. 641). Despite this development agricultural production rose rapidly as new techniques were developed and a scientific temper reshaped traditional agricultural practice. The result is that by 1840 the average agricultural worker in Britain was producing 17.5 million calories compared to his French counterpart who produced 11.5 million. Agricultural production rose 3.5 times between 1700 and 1850 while the percentage of the British workforce engaged in agriculture went from 61% to 29% (Christian, 2004, p. 416ff).

All these developments were harnessed by a new system of political integration known today as the Nation State (Sanderson & Alderson, 2005, p. 101ff). The British state led the way in fusing economics and politics. This development can be seen emerging from the

stresses of the 17th century with its civil war, with the diminished authority of the monarchy from the 18th century was constitutional rather than absolute, in the growth in private property and the economic and political systems designed to protect and enlarge it. Mercantilism became Industrialism and was enshrined as the force to shape the future in 1851 by The Great Exhibition organised by Queen Victoria's husband Crown Prince Albert (Leapman, 2001). This Exhibition was a publicity coup in which all the suffering and struggle of the British working class was eclipsed, and perhaps validated, in the celebration of new technology and innovation.

Level: macro, meso or micro	Macro: a nation state reordering legal and economic systems
Physical context	Small island with extensive imperial reach and buoyant growth at home
Rapid or incremental change	Rapid change over three generations
Cultural values	Enterprise, competition and thrift
Societal addictions	Profit at all costs
Imaginative resources	Ordered utopia based on reason, ordered labour and technical innovation
Leadership	Constitutional monarchy in which a limited franchised shaped the economic and political order
Related case studies	The Novel 1990s, Mobile Phone 1990s, Rome 1CE
Summary	Great Britain was reorganised around a simple set of ideas to maximise the profits of a few. Self-interest is a powerful vehicle for social change. Populations can be dragged into new modes of social process.

Analytical framework for comparative analysis

Determinants	Constitutional democracy
	Change in values and social ordering
	Creation of a new form of reasoning and tools for measuring success
	Harnessing media and prestige to legitimate a new form of social process

Byron Bay 2009

HS 4.8	
Sector focus	Human settlement and health
Adaptation to	Anticipated beach erosion as the result of Climate Change
Adaptive capacity	Working with a context rather than seeking to control it Long term thinking
Social learning involved	Working with nature Adjusting time frames Breaking out of election cycle thinking Seeing the bigger picture
Primary and secondary drivers	Environmental values Commitment to maintenance of a public resource (the beaches) instead of private demands (wealthy property owners on coastal strip)
Success and /or barriers to adaptation	Successes: Planned withdrawal in place since 1988, 2004 election of Green Mayor, resistance to pressure from wealthy lobby groups Barriers: Broader social expectations, property values and pressure to develop
Implications for climate change adaptation	Social processes can be changed when a new set of values are embraced and made the driver for legal, institutional and cultural priorities

Byron Shire's coastline extends from the Tweed-Byron Shire border in the Billinudgel Nature Reserve in the north, to Byron-Ballina Shire border in the south. The coastline includes sandy beaches, rocky shores and headlands, rivers and creek entrances. Cape Byron is a dominant feature of the coastline and is the eastern most point of mainland Australia with sweeping views to the north and south.

Byron Bay Shire has been a pioneer in tackling coastal erosion issues under the principles of sustainability, allowing nature to drive coastal changes and developing a planned retreat policy to accommodate shoreline retreat. Planned retreat is an approach that aims to allow natural processes to take place without building large engineering structures to attempt to counteract those processes. On an eroding coastline this will require the retreat of development and infrastructure as the erosion escarpment (most landward limit of erosion) moves landward (Byron Shire Council, 2009a).

The Byron Shire coastline has endured a long history of large coastal storms and coastal erosion and has been identified historically as an area that is undergoing long-term coastal recession. The history of storms and coastal damage in the Byron Shire between 1888 and 2009 (Byron Shire Council, 2009b) demonstrates that this coastal stretch has been under constant change since the first records. Due to the nature of this coastal stretch, consisting of lowlands and sandy beaches in most of its parts, it is likely that coastal change will continue in the future, exacerbated by climate change. The Byron Shire Council has lately adopted the NSW Government sea level rise policy which considers 40 cm slr in 2050 and 90 cm slr in 2100. The adoption of these guidelines has no effect on

the current existing planning instruments (WRL, 2009), which provide developing standards in areas at risk (Byron Shire Council, 2002).

The community of the Byron Shire is sensitive regarding the sustainable development of their community and this is reflected in the election in 2004 of the first Green Party major of an Australian town and in the consequent environmental and social policies adopted. Coastal erosion is a sensitive issue as Belongil Beach, one of the areas most prone to erosion processes, is backed by a number of expensive properties. A legal battle between the owners and the council is currently being held, as the defence of properties from coastal erosion using hard structures is not allowed under the current coastal policy.

The development of coastal planning instruments is based on a strong participatory approach, as reflected in the Draft Byron Shire Coastal Zone Management Plan (Byron Shire Council, 2002). The results of the analysis of the contribution of stakeholders to the preparation of the plan reflect a specific set of environmental values. The values of the Byron community are closely tied to the maintenance of a pristine environment and a low impact development in the shire. The quality of the beach and the landscape is a major value as people consider it important not to have buildings readily visible from the beach. Other important values relate to the peacefulness, isolation and tranquillity of the beach landscape, high accessibility to the beaches and their surrounds, including beach-walking opportunities along the entire coastline.

At the same time people recognise that the planned retreat policy, initiated in 1988, is a major issue for the community so that alternatives should be further investigated (ABC, 2010). The number of tourists and the tourism industry is generally considered by some as a threat to the local community and capping bed numbers and reducing the number of holiday rental properties is openly canvassed.

Level: macro, meso or micro	Micro
Physical context	Coastal town with major beach erosion problems
Rapid or incremental change	Major storms which cause a rapid damage to the beach, threatening beachfront properties
Cultural values	Environmental and social sustainability of the community, public engagement, development of environmentally friendly policies
Societal addictions	No
Imaginative resources	The planned retreat policy is based on a do-nothing scenario. No imaginative resources are used to address the problem from a technical perspective.
Leadership	A strong leadership from the local council, governed by the Green Party and supported by an environmentally friendly community
Related case studies	New Orleans 2006, Ecocommunities 1990s, Sale 1871, Palaeolithic 15kya, The Natufians 10kya
Summary	The Byron bay coastal area is subject to a continuous change, exacerbated by the damages to storms events. The local community and the leaders are adopting a planned retreat policy based on the lack of environmental friendly options to tackle the problem.

Analytical framework for comparative analysis

Determinants	Coastal erosion
	Land use
	Value of the beachfront properties
	Sustainability values
	Environmental policies

Curitiba, Brazil 1990s

HS 4.7 & E 4.3	
Sector focus	Human Settlement and Health
Adaptation to	Rapid population growth
Adaptive capacity	Effective political and education systems Significant imaginative resources
Social learning involved	Small scale changes effect larger scales Values underpin social action
Primary and secondary drivers	Central location (trade and transit), economic investment (various sectors), population growth, intensified urbanisation, flooding and pollution, impacts on human health
Success and /or barriers to adaptation	Successes: Adaptation through strong and consistent leadership Significant imaginative resources (resulting from limited financial and physical resources) Effective education systems. Barriers: Continued success limited by negative impacts from the wider regional and national system (e.g. continued population pressure, unplanned development on city fringes)
Implications for climate change adaptation	Working across scales would increase Curitiba's success Ongoing commitment to a vision enables success

Curitiba is the capital city of the state of Paraná, in southern Brazil. With approximately 1.7 million inhabitants, Curitiba is spread over an area of 430 sq km and is located on a 945m plateau separated from the Atlantic Ocean by the Serra do Mar mountain range. With origins as an agricultural area followed by rapid urbanization and population growth, Curitiba gained international notoriety in the 1990s as a model of best practice for city planning and liveable cities (Macedo, 2004).

Curitiba was originally favoured as a settlement due to its central location and proximity to the main regional port on the Atlantic coastline (Campbell, 2009). Significant economic development began in the 1940s through investments related to coffee production (Macedo, 2004). Rapid population growth in Curitiba continues through migration from within the state (particularly from rural areas), and migration from other states and nations. Historical analysis demonstrates that various drivers are responsible for such sustained population growth (Campbell, 2009; Macedo, 2004). Initial rural-to-urban migration was driven by several *push factors* whereby technological advances in agricultural mechanisation in the 1960s and the failure of coffee plantations in the 1970s, forced many rural residents off the land. By way of contrast, the effective marketing of Curitiba as a 'model' or 'well-planned' city with the 'best quality of life in Brazil' encouraged increased investment and industrial growth in the city, representing *pull factors* that enhanced immigration from outside of the state. Though the rate of population growth has now slowed, the combination of these factors saw Curitiba's population double every ten years over the thirty years from the 1950s to the 1980s (Macedo, 2004)

Initial periods of rapid population growth had a number of adverse impacts on Curitiba including pollution and a shortage of infrastructure and services (Campbell, 2009). In particular, the City was prone to flooding as the main urban area was developed in the Upper Iguaçu River Basin. Consequently, the processes of urbanisation and unapproved public occupation and development of the floodplain increased the severity and damage from flooding events (Tucci, 2002). However, implementation of a master plan focused on public transportation, environmentally sensitive design, and low or contextually-appropriate technologies, distinguished Curitiba from most developing cities at that time (Campbell, 2009; Rabinovitch & Leitman, 1996). The plan was developed by a small group of highly-qualified staff (including planners, engineers, architects, sociologists etc) that utilised ideas sourced internationally, nationally and locally (Campbell, 2009). One of these original staff, Jamie Lerner, was later appointed by the military government as mayor of Curitiba and was able to ensure the implementation and development of the master plan. Lerner and politicians from his group have continued to serve in this role from 1971, except for the period between 1983 and 1988 where mayors representing a more decentralised approach were elected. Macedo (2004) argues that this centralised approach to leadership by the same political group for almost forty years is unique and demonstrates that 'planning is a function of political will' (p. 541). Similarly, Campbell (2009) cites political continuity and public entrepreneurship as key factors in Curitiba's success.

In implementing the plan, Curitiba officials opted for low-tech solutions that were supported through education. For example, the 'surface metro' system of public transit utilises standard and articulated buses, designated bus lanes, and low-cost boarding tubes to provide commuters with a rapid and affordable transit system that has resulted in Curitiba having the lowest levels of air pollution in Brazil (Campbell, 2009). Rabinovitch and Leitman (1996) further highlight the material conservation of this innovation, noting that older buses are re-used as mobile offices and classrooms. Similarly, instead of expensive engineering solutions to address flooding issues, a system of public parks was created in floodplain areas to limit development in these areas and avoid costly damages to infrastructure (Tucci, 2002). Other innovative features within the city include: waste recycling with the sorting completed largely at the household level (negating the need for expensive mechanical sorting); the garbage exchange program (providing a means to access food and educational materials for poorer residents); and the 24-hour street (the juxtaposition of various business types and residences to ensure the improved safety and utility of areas) (Rabinovitch & Leitman, 1996).

Recently, the success of the city in terms of liveability has attracted even more immigration and adverse impacts upon the sustainability status of Curitiba have again been cited. Of particular note are the limited options for low-cost housing within the city, and the increasing number of unplanned settlements on the city fringe and within neighbouring areas. These neighbouring areas have no, or limited, supporting infrastructure (e.g. sewerage systems) and are now growing at a faster rate than Curitiba itself, resulting in significant environmental degradation to the point where some have concluded that processes and events external to Curitiba have overwhelmed the positive initiatives within the city (Macedo, 2004). Consequently, analysis of the city planning demonstrates that these features could have been avoided or lessened with greater attention to considerations within and beyond the city bounds and a more comprehensive approach to planning that addressed regional issues.

Level: macro, meso or micro	Meso – structural innovation through municipal planning and education.

Physical context	Large capital city located centrally (with regard to the State) and strategically for trade and commerce (with regard to the nation). Historically prone to flooding and surrounded by poorer agricultural areas.
Rapid or incremental change	Rapid city growth and urban intensification through accelerated population growth driven by increases in industrial and commercial investment in the city.
Cultural values	Politically driven development and an entrenched culture of centralized decision-making with minimal citizen participation. However, education and social learning are valued at all levels. Relatively affluent city within the nation, but significant differences in income between inhabitants remain.
Societal addictions	Urbanisation and growth.
Imaginative resources	Committed to learning from international examples as well as local and national innovators.
Leadership	A relatively strong and consistent approach to leadership through the key developmental phases of the city's growth driven by the same mayor that was variously appointed by the military dictatorship and elected by the people throughout this time.
Related case studies	Ecocommunities 2009, Cuba 1990s, Adelbert Mountains 2009, New Orleans 2006
Summary	A consistent approach to leadership and a commitment to learning at all levels enables rapid and effective social transition. This is further enhanced through the use or adaptation of existing resources and infrastructure rather than the use of expensive imports or new technologies. However, initial successes can exacerbate future problems if planning is limited in focus and does not adequately address the broader regional context.

Analytical framework for comparative analysis

Determinants	Consistent leadership and vision.
	A 'low-tech' and resource-efficient approach to innovation (retro-fitting of existing infrastructure combined with behavioural change through school and community education).
	A commitment to learning at all levels.
	Overly focussed on the local context without adequate consideration of broader influences.

Donora, Pennsylvania 1948

HS 1.2	
Sector focus	Human Settlement and Health
Adaptation to	Factory Pollution (smog)
Adaptive capacity	Legislation of air emission standards Research into pollution and human population
Social learning involved	State takes more responsibility for environmental effects of industry Industry takes more responsibility for its impact on location
Primary and secondary drivers	Human death Research and statistics into impact of pollutants on human populations Media coverage
Success and /or barriers to adaptation	Successes: lead to first Clean Air Act in the US Factories closed down Barriers: Lessons slow to transfer to other sites
Implications for climate change adaptation	There is a role for state and Industry in responding to environmental issues. This is most effective when coordinated and informed by research

A 1948 environmental disaster in the company town of Donora bolstered public support for the first air pollution legislation in the United States. This small town of 14,000 residents, 30 miles (48 km) south of Pittsburgh, PA was home to the Union Steele Company, the Carnegie Steele Company, the Matthew Woven Wire Fence Company, Donora Zinc Works, a rod mill and the Pennsylvania Railroad. The industrial town was situated along the Monongahela River Valley in Pennsylvania, with hills rising up to 400 feet (122m). The geology created a natural bowl, “which can- and in this instance – led up to bottling up of the air on the valley floor for lengthy spells.”(Townsend, 1949)The majority of the residents were recent immigrants of Russian, German and Polish decent (Musser, 2009) who migrated to the vicinity seeking jobs. These residents were more than familiar with the sulphur dioxide odour, poor visibility created from the belching smoke and fumes emitted from the factories and up until 1948 had not even considered these emissions more than a daily nuisance (Templeton, 1998). Incremental signs of the pollution impact were visible, as the vegetation around the homes would not grow where the plumes of smoke would fall and farmers saw more disease and low crop growth when the winds blew in the direction from the factories.

A temperature inversion befell the town on October 26, 1948 trapping the emissions from the factory smokestacks in concentrated form in the valley. The thickened smog laden with sulphur dioxide was not new to the residents and many went on with their life as usual, without concern about the magnitude of what lay ahead.

The town held a staunch work ethic and despite developing sore throats, coughs and difficulty breathing, they continued the around the clock work shifts as the mills operated 24 hours a day. Shutting down some of the mill furnaces was not an option, as due to their construction they would have started up again. The smog became so thick that the

players at a high school football game were not visible; cars were driving mid-day with their lights on and eventually it became unsafe to drive at all. This prevented evacuation measures when the severity of the incident became apparent. Later in the investigation, it was discovered that some residents who chose to stay in their homes and not leave during the five days of extreme pollution retrained a higher level of health. The first death occurred about 2 AM on Saturday morning on the 29 October, followed by 17 more deaths by nightfall. Twenty people were asphyxiated by the time the cleansing rains fell on Sunday 30th October with over 7,000 hospitalized or severely ill. (Hess, 1995)

Up until this event public health officials, health providers, and manufacturers did not consider industrial emissions and air pollution a vital issue. A year-long investigation of the Donora Smog disaster commenced that was "the most intensive and exhaustive study the country has ever made on air pollution, and possibly the most intensive effort undertaken by the Division of Industrial Hygiene of the US Public Health Service." (Townsend, 1949, p. 183) It was the first study ever conducted on air pollution in the United States and marked a turning point in the complacency of the industrial pollution. The Public Health Service's recommendation after the investigation was to provide a weather station, establish a warning system tied to weather forecasts, and air sampling. In 1955, with additional influence from the similar 1952 London Smog incident, Pennsylvania passed the first State Clean Air Act, followed by the 1970 U.S. Clean Air Act.

Eventually in 1957, the Donora Zinc Works shut down followed by U.S. Steele Company in 1968. Ironically, the research and statistics for that area for the following years revealed significant and elevated chronic heart and respiratory disease than average. The Donora study confirmed that contaminants in the air could have direct links to the health and well-being of our lives and environment. It was a key point in time that has led to enforcement of air emission standards, continuing research and a quest for drastic improvements in air quality in the industrialized world.

Level: macro, meso or micro	Meso – innovation, policy changes and continued research into air pollution.
Physical context	Small industrial town: built in a geographical area exacerbating industrial pollution.
Rapid or incremental change	Incremental in effecting agricultural and natural vegetation dye-off, reduction in human health quality with rapid change due to extreme weather event.
Cultural values	Multi lingual and cultural, majority immigrants; work ethic; no community awareness of connections between industrial pollutants and health
Societal addictions	Work ethic, materialism and industrialism
Imaginative resources	limited understanding of links between pollution and health; technology drives life; self esteem linked to toughing out work conditions
Leadership	U.S Public Health Service conducted investigation, and influenced policy making to establish the first Clean Air Acts at local, state and federal levels. Law in place to reduce emissions nation wide, influenced other countries.
Related case studies	Azerbaijan 2005, Britain 1800, Chesapeake Bay 1990s, Sale 1871
Summary	First time in history that an epidemiological study was conducted for air pollution due to the 1948 Smog Disaster. Set new anti-pollution policies and brought various sectors together in cooperative efforts. (US Weather Bureau, US Public Health Service, public health professionals, sanitation, housing inspectors, engineers, industrial manufacturers, chemists, agronomists, many other related specialists)

Analytical framework for comparative analysis

Determinants	Immigrant families from highly polluted areas in USSR with no understanding of health effects of pollution; Strong work ethic
	Industrial emissions from Zinc, Steele and other factories linked to deaths, poor health and environmental degradation; availability of scientific measures and broad research.

Eco-communities 2009

EB 4.2 & E 4.4	
Sector focus	Human Settlement and Health, Infrastructure/Agriculture/Energy/Ecosystems and Biodiversity The world, the eco-universe and all that is, and may still be possible
Adaptation to	Social and environmental changes due to peak oil shortages
Adaptive capacity	Shortage of human and financial capital
Social learning	Capitalism and neo-liberal modernity
Primary and secondary drivers	Western consumerism, moral values, urbanization, social isolation, community breakdown, environmental degradation
Success and/or barriers to adaptation	Successes: establishment of alternative human settlement, new community design, environmental renewal, alternative economy, technological innovation, community and environmental responsibility, education and outreach Barriers: finding participants, financial independence
Implications for climate change adaptation	Responses beyond the technical and economic allow for creative explorations in social organization Trialling new technologies in local settings has a wide range of benefits

Since the 1990s, the term ecovillage has come to refer to a particular form of intentional community. Historically intentional communities such as communes, kibbutz, ashrams and housing cooperatives were established to pursue alternative religious, political economic and personal values. What distinguishes ecovillages today is a concern with ecology (Kaper 2008). Ecovillages have been defined as: 'a human scale full-featured settlement in which human activities are harmlessly integrated into the natural world in a way that is supportive of healthy human development and can be successfully continued into the indefinite future' (Dawson, 2006). There are approximately 906 ecovillages worldwide (Global Ecovillage Network (GEN), 2009). In many cases, they combine local and traditional knowledge with modern science and engage in experimental and innovative forms of sustainable settlement, education and business development.

An important aspect of ecovillages is the way their interest in technological development and innovation enables them to pioneer new models of sustainable practice (Dawson 2006). Ecovillages can be regarded as representing a productive response to the negative social, political and economic effects of contemporary neo-liberal modernity and capitalism (Kirby, 2003). However, they are a response to change that is not entirely driven by structural social and environmental changes. Ecovillages are also fuelled by new ideal-moral values and cognitive understandings about the negative impact of human activity on the environment. As such, they represent a new mode of social learning that is seeking to road test possible responses to climate change and general environmental stress that seek deeper social and cultural responses to issues that are generally described in mechanistic and economic terms. Recognition of the innovations and directions pursued by ecovillages

in these terms may well provide insight into adaptive capacity and adaptive responses to unsustainablility.

The kinds of innovations fostered by ecovillages are described in detail below:

- **Human settlement, community design and environmental renewal**: the majority of ecovillages build and create new sustainable eco-housing structures and new forms of community design. In 2008, the Ecovillage at Currumbin in Australia received international acclaim for urban design and development. Their vision is to inspire the development industry to take up the challenge of sustainability (The Ecovillage at Currumbin, 2009). In the outskirts of New York, the Ecovillage at Ithaca (EVI) has recorded that their households use one third of average energy consumption (Kirby 2003). Additionally, Auroville in India has undertaken land reclamation, ecosystem restoration

- **Sustainable economies**: most ecovillages have on site "home occupation zoning" and promote co-creation of sustainable "green" businesses developing products from sustainably produced materials. Many contain ecotourism options, on site sustainable and wellness educational experiences. Some communities have created their own monetary systems (Dawson 2006)

- **Technological innovation:** Ecovillages are a testing ground for new green technology. Many communities have undertaken pioneering work in renewable energy, appropriate building technology and wastewater treatment biomass, solar and wind technologies, sophisticated wastewater and reclamation systems (Dawson, 2006). Communities such as Auroville work with local communities and form partnerships with agencies. Auroville has developed and exported home-lighting kits and solar water pumps that have been exported across the Asian sub-continent and Europe (Beder, 1991; Dawson, 2006).

- **Community and environmental responsibility:** The majority of the ecovillages have a passionate and deep commitment to social and environmental justice, ecological restoration, community and service (Walker, 2005): 'what distinguishes the ecovillage paradigm is an expanded notion of 'community' one that includes not only people, but countless other species as well' (Van Schyndel Kasper, 2008). Ecovillages inspire a sense of community and environmental connectedness. Because they administer jointly shared resources residents gain a sense of self-determination. The spirit of community and cooperation sits in the heart of the ecovillages and is often spiritually based and/or embodied in shared values and principles.

- **Education and outreach**: Ecovillages promote understanding of alternative ways of living and synthesise the knowledge, action, theory and practice of those alternatives. They commonly organise classes, workshops, apprenticeships, internships and conferences as well as support disaster relief, building projects and political advocacy (Van Schyndel Kasper, 2008). They are places where education honours the teaching environment as a key element and is just as important as the teaching itself (Findhorn Foundation, 2009) and many have initiated environmental education in local schools.

Internal and external challenges

Internal challenges include shortage of resources and time to engage with surrounding communities. Frequently ecovillage services are more valued by those living elsewhere than those in the immediate community (Dawson, 2006). This is because members often work as travelling consultants and neighbouring communities may be unaware of location of expertise (Crystal Waters Ecovillage Co-operative, 2010). The achievement of long-term commitment and collective cooperative living is also a challenge. Disparities of income amongst members and differential access to housing are also a source of tension.

The major external challenges faced by ecovillages are shortage of human and financial capital. They often find it difficult to attract new members to the community particularly those from ethnically diverse backgrounds. Most ecovillages also find it difficult to develop a viable economy and many ecovillage enterprises still rely on external work and on offsite income. The majority are dependent upon private donations, fundraising and benefactors. Although ecovillages provide important contributions to understanding sustainable living, many innovative projects never come to fruition. Unless an ecovillage is large enough to become a valued research, demonstration and teaching centre it is difficult to sustain innovation, in addition the regulatory framework for citizen-led research and development (e.g. in the development of wind-farms, wastewater systems and shared living space) mean that often more funds are spent getting approvals than on the innovation (Dawson, 2006).

Well-known and successful Ecovillages are:

- **Auroville**, India, founded in 1968, 2 000 residents on 25Km2. Led by a spiritual vision to build a universal township dedicated to unity, peace and harmony. Pursuing the development of sustainable technologies, eco- businesses, a cashless economic system, emission-free transport and energy supplies based solely on sun, wind and biomass, education reform, research and ecological agriculture and reforestation (Auroville, 2009).
- **The Farm**, America, founded in 1971, 180 residents on 1,750 acres. A rural ecovillage combing training and outreach on transition from high consumption to low impact lifestyle. Educating in solar energy, bio fuels, eco-construction technology, renewable energy, midwifery, eco-business, public policy development (The Farm, 2009)
- **Crystal Waters**, Australia, founded in 1987, with 200 residents on 85 acres. Based on mixed land ownership, new design in human settlement. Developing innovative wastewater technology and eco-building materials and techniques. International outreach and consultancy on these and restoring ecology through permaculture practices (Crystal Waters Ecovillage Co-operative, 2010).
- **The Findhorn Foundations**, Scotland, founded 1962, 400 residents in a 50 mile radius of the community centre. Based on spiritual, cooperative and sustainable values. Designed as an 'experiment in conscious living' the village determined by the Sustainable Development Research Center to have the lowest ever ecological footprint for any community in the industrialized world (Tinsley & George, 2006) Findhorn has consultation status in the UN as an NGO. It serves as an international education and training centre for the ecovillage movement and has pioneered the development of the 'living machine' biological sewage treatment plant operated by the foundation (Dawson, 2006).
- **EcoVillage at Ithaca (EVI)**, founded in 1991 by Cornell University's Center for Religion, Ethics, and Social Policy. The settlement serves as an international model of sustainable development and plays a large role in educating people on sustainable living through its connections to local universities and schools. EVI is acknowledged internationally as a model of sustainable development and it showcases co-housing neighbourhoods, small-scale organic farming, land preservation, green building, energy alternatives and hands-on education (Ecovillage at Ithica, 2009).

Level: macro, meso or micro	Macro – Worldwide initiatives on Micro scales
Physical context	Seven continents with various sizes of ecovillage communities
Rapid or incremental change	Rapid emergence of response to world issues in the 1970-80's which incremental changes since then
Cultural values	Ecological, spiritual, holistic and gaia-centric
Societal addictions	Tensions between idealism and practice; elitism; unwillingness to engage with mainstream systems
Imaginative resources	Draws on Utopian traditions, integrative sciences, enthusiasms of the 'hippy' period, a wide range of spiritual traditions
Leadership	Generally consensual, though often driven by strong charismatic leaders
Related case studies	Cuba, Curitaba, The Novel, the Natufians
Summary	Social innovations usually start at the periphery – ecovillages though widely spread are still an unusual (and minority) response to social and environmental pressures. Hot houses of innovation both technically and culturally, they are also places where people struggle to realize social possibilities beyond current practice

Analytical framework for comparative analysis

Determinants	Ecocentric and spiritual values
	Utopianism
	Social alienation and Environmental degradation

Mobile phones 1990s

HS 4.6	
Sector focus	Human settlements and health
Adaptation to	(1) technological advances; (2) the desire for persistent mobility and continuous communication (at a distance) simultaneously; (3) social re-organisation from communities to networks.
Adaptive capacity	Significant imaginative resources (technological development and marketing)
Social learning involved	Mobile etiquette, texting, multitasking
Primary and secondary drivers	Persistent mobility and communication needs → technological advancement and economic imperatives → social status → social inclusion →social ability
Success and /or barriers to adaptation	Successful adaptation by appealing to significant human desires (e.g. nomadism, inclusion, status) and providing key social and everyday functions (e.g. communication) in a rapid and convenient form. Mobile phones are also distinguished from other technologies in that users report feelings of emotional attachment to their phones. Barriers: Possible health risk, social exhaustion, the 24/7 society
Implications for climate change adaptation	Technology has a social dimension Rapid uptake of a new technology occurs when linked to social imagination and values

The mobile phone is the most widespread and rapidly adopted information communication technology ever with over 4 billion mobile phone subscribers representing 61% of the global population (International Telecommunication Union(ITU), 2009). The number of mobile subscribers first exceeded fixed-line subscribers in 2002 and the number continues to rise as developing nations rapidly adopt this technology (International Telecommunication Union(ITU), 2009; Srivastava, 2002).

Contemporary mobile phone technology developed from early beginnings with two-way radio systems used in vehicles and, more recently, 'walkie talkies'. By the 1940s telecommunication companies had the technology to deliver the first mobile telephone service through the public telephone system (Kumar & Zahn, 2003). At this time, the primary drivers underpinning the development of mobile phones stemmed from the need for certain vocations to be mobile and in contact with others across significant distances (e.g. taxi drivers and army personnel). Subsequent drivers underpinning the rapid and widespread adoption of mobile phone technologies are an evolving mix of technological, economic and social forces (Kumar & Zahn, 2003).

The widespread adoption of mobile phone technologies and utilisation for an increasing range of everyday functions has allowed the mobile phone to become 'a key social object' Srivastava (2002). Following initial use by certain vocations, the subsequent uptake of mobile phones by more affluent sectors of society appears to have been a response to the increasing availability and development of the technology and the social status afforded through ownership of such exclusive and expensive technology–no doubt also driven by the economic imperative of the mobile service providers. Srivastava (2002) notes that the mobile phone remains a status symbol (albeit the latest model), and has now become a fashion accessory rather than a simple communication device. Moreover, with increasing technological development and an ever-increasing range of functions (e.g. financial, identification, and entertainment), mobile phones are set to become increasingly indispensible aspects of modern life (Srivastava, 2002).

Kumar and Zahn (2003) highlight that the initial development of more recent variants of mobile communication technologies, such as 'personal digital assistants' enabled with a range of handheld computing abilities, was driven by the rising extent of virtual networks and an increasingly mobile and geographically dispersed workforce. However, the uptake of such technology is no longer limited to particular vocations or particularly affluent societal sectors. For example, the increasingly rapid adoption of mobile technology in developing nations now provides an efficient means for the provision of communication and economic networks in areas with limited existing technological infrastructure. By reaching a critical mass of subscribers on a global scale, use of mobile communication technology now represents a means of social inclusion rather than exclusivity. The transition of mobile phone technology from exclusivity to social inclusivity ensures that the technology retains, and even enhances, its perceived value to users and potential users.

The widespread adoption of mobile phones has also enabled the expansion of social networks and even new identities for groups of people based on communication networks rather than place or physical location (Srivastava, 2002). However, several authors have voiced concerns over the limitations of the rapid and decontextualised communication afforded by mobile phone technologies, not least the deterioration in the quantity and quality of face-to-face interactions. (Geser, 2002) argues that the extensive use of mobile phone communication tends to weaken communities of place (including families and local groupings) and to strengthen decentralised and dynamic networks. As Srivastava notes, 'it is clear that we have not had sufficient time, as a society, to adapt to this new technology, with its overwhelmingly pervasive nature' (2002, p. 123).

Certainly, there is potential for problems to arise from the rapid adoption of any new technology where the pace of the technological development is greater than the development of any appropriate social norms. However, mobile communication technology is distinct in fostering a form of social reorganisation no longer dependent on 'physical proximity' or 'stable dwelling places', for interaction or the development of more complex forms of communication (Geser, 2002). Indeed, the word 'mobile' is derived from the Latin 'mobilis' meaning flexible, agile, rapid or able to change expression or status (Srivastava, 2002:111). The implications for communication, learning and relationships seem profound and beyond the scope of this paper. Mobile communication technologies may offer significant opportunities for rapid and widespread adaptation or response to life-threatening scenarios; it has also been instrumental in terrorist behaviour such as in Mumbai in 2008, while paradoxically it is also playing a part in resistance to authoritarian regimes and centralist political structures such as in the Iranian protests in 2009.

Level: macro, meso or micro	Macro – a technology that is global in extent and adoption.
Physical context	Global roaming – the technosphere
Rapid or incremental change	Rapid change – the fastest uptake of all communication technologies.
Cultural values	These are diverse given the widespread nature of the technology. They include: • Instant communication • Convenience • Freedom • Individualism • Technophilia
Societal addictions	Individual social status and constant mobility
Imaginative resources	Imaginative resources are integral to the initial and continued development and marketing of the technology. Imaginative resources also play a significant role in the dynamic application of the technology by users across particular contexts. The use of Twitter in the Iran election is a recent example of such social reflexivity.
Leadership	Market leadership (e.g. Apple, Nokia etc) and Social leadership are both important in the diffusion and adoption of this technology – the latter represents a popular democratic urge that is both conformist and sometimes transformational.
Related case studies	The Novel 1850, Britain 1800
Summary	An innovative technology that builds on persistent human desires for continuous communication and mobility, status and social inclusion. Recent developments that also incorporate mobile computing will ensure that such technology becomes an increasingly indispensable aspect of modern living.

Analytical framework for comparative analysis

Determinants	Fulfils a range of universal human desires and contemporary functions.
	Is unique among ICTs in creating an emotional attachment between the technology and the user.
	Virtually unlimited by physical constraints.
	Potential to be overly focussed on social networks at the expense of local social and ecological connections.

Netherlands Flood 1953

HS 1.3	
Sector focus	Human Settlement and Health
Adaptation to	River floods, storm surges and periods of extreme precipitation
Adaptive capacity	Increasing technological sophistication
Social learning involved	Progression from simple solutions (raised mounds for buildings) to complex engineering
Primary and secondary drivers	Past history of extreme weather events Changing landscapes and increasing risks, institutional support mechanisms
Success and barriers to adaptation	Success: Imaginative resources triggered by the need of a safer water environment Barriers: Landscape commitment to technological intervention limits choice
Implications for climate change adaptation	Human choices have unforeseen consequences. Pathway dependency leads to intensification of existing solutions

In February 1953 the Netherlands was hit by the combination of a north westerly storm and high springtides that killed over 1800 people, caused emergency evacuations of ten thousand people, swamped almost 200000 hectares of land, destroyed 26000 homes and hundreds of farms and thousands of animals through drowning (Gerritsen, 2005; Orr, Stodghill, & Candu, 2007). Flooding caused by storm surges was a common occurrence throughout coastal provinces (e.g. all Saints flood of 1570 killed thousands and caused huge damage to property).

The earliest coastal inhabitants of the Netherlands had adapted to flood disasters by building mounds on which to build their houses. As the population grew and there was more demand for arable land, people began to build dikes between these mounds. Dikes grew higher and higher weakening their structures and resulting in more frequent floods events (Tol & Langena, 2000). Secondary protection was required which prompted the use of sideway diversions, seepage quays, cross dikes and windmills to pump away water. Around 1800, there were thousands of windmills in the Netherlands, which later saw the boom in wind-powered lake reclamation schemes creating large polder areas. Later in the 17th century, an idea was introduced to dam the channels between the islands to further protect from floods, an idea later implemented in 1927 following the 1916 floods.

The Ministry of Water Management commissioned the sealing Zuyder Zee from the North Sea by constructing a 32km long barrier dam. However, the use of further protective measures did not stop the traditional use of dikes in the control of floods in Netherlands. Following the 1953 floods' breaching of over 150 dikes, dike heightening continued (Gerritsen, 2005).

An immediate response to the 1953 disaster was the birth of the "Delta Project" or Delta works. This project involved the reinforcement and heightening of dikes, construction of a moveable storm surge barrier and huge sluices to regulate discharge of water from dams

and major rivers (Disco & van der Vleuten, 2001). The project also recommended the closure of the last open estuary, the Eastern Scheldt, resulting in great resistance by oyster farmers and environmentalists. A partially open storm surge barrier with huge moveable gates subject to closure when a storm is imminent was ultimately built (Disco & van der Vleuten, 2001). This would allow for the preservation of the ecological value of the Eastern Scheldt whilst keeping the vulnerable populations safe. The 1953 floods also prompted legislative changes that included the incorporation of higher standards for the design of flood defence structures (Wesselink, 2007).

Flood management strategies were not without limitations. It was evident in the 1990s that the dike reinforcement programme had caused significant unintended damage to the landscape. Sandbanks had formed in the river due to continual deposition of river flooding materials between the dikes. This had slowly raised the river beds resulting in reduction in water quantity and flow (Jan Oosthoek, 2006). In other cases, increased water quantity accumulating in between the heightened dykes had the effect of increasing the hydrostatic pressure further increasing the risks of future floods. The increased dyke height did not only increase the threat of future flooding but also presented a challenge regarding the trade off between safety of human beings and, ecosystems and landscape protection values.

"We have the best system of flood protection in the world today, but we have to start preparing for the future," says Cees Veerman

1953 North Sea Flood (http://one-blue-marble.com/blog/2009/03/18/fingers-in-the-dykes/)

Level: macro, meso or micro	Meso – structural innovation – Dikes and storm surge barriers and huge sluices to regulate discharge of water from dams and major rivers to control flooding.
Physical context	Rural and urban communities of Netherlands
Rapid or incremental change	Population growth resulting in high demand of land for human settlement and agriculture.
Cultural values	Agricultural communities traditionally responding to flooding with the erection of dikes that became a cultural response.
Societal addictions	Technology to fix a problem (pathway dependency)
Imaginative resources	Technology as the major instrument of change
Leadership	National and local government
Related case studies	Netherlands 2009, New Orleans 2006, Sydney Northside Storage Tunnel 2000
Summary	This case provides evolution of flood control in Netherlands through adaptive learning. The move from raised mounds to the use of dikes to the more sophisticated moveable storm surge barrier and huge sluices to regulate discharge of water from dams and major rivers reflect the progression of flood control in the Netherlands adapting to lessons from flood control over the years. Also of note is the need for sustainable response strategies to risks, including the unforeseen impacts of human activity, that not only enhance human system's ability to adapt but that also take into account the likely environmental challenges.

Analytical framework for comparative analysis

Determinants	Water management practices and dike heightening culture (pathway dependency)
	Population growth
	Economic drivers
	Environmental concerns

Netherlands 2009

HS 1.6	
Sector focus	Human Settlement and Health
Adaptation to	River floods, storm surges and periods of extreme precipitation
Adaptive capacity	Flexible and multi- disciplinary structure that enables adaptation to changing physical landscapes.
Social learning involved	Balancing social engagement with institutional responses to water and coastal management
Primary and secondary drivers	Past history of extreme weather events (see 1953 example) Changing landscapes and increasing risks, institutional support mechanisms
Success and barriers to adaptation	Imaginative resources triggered by the need of a safer water environment
Implications for climate change adaptation	Flexible solutions lie in multidisciplinary approaches to a problem Working across scales increases adaptive capacity

The Netherlands is a small and densely populated country. The area of the Netherlands (some 40,000 Km2) consisting of a series of deltas and flood plains from the rivers Scheldt, Meuse, Rhine and Ems, hosts a population of around 16 M, with a density of about 400 Inhab/km2. At present, almost one-third of the country is located below average sea level and a further third has to be protected against flooding by rivers in periods of high discharges. Water, consisting in rivers, lakes and canals, covers around the 18 % of the whole country. A Low-lying country such as the Netherlands is highly vulnerable to the consequences of extreme climatic events such as river floods, storm surges and periods of extreme precipitation. Consequently, water levels have been a dominant boundary condition for the existing land and its users for thousands of years.

The Dutch population faced an incremental change in the last thousand years, characterized by an increasing population and economic growth threatened by an extremely dynamic water environment (Van Koningsveld, Mulder, Stive, & Van Der Weck, 2008). The current extension of the country is the result of a history of land reclamation and adaptation strategies. The initial occupation of the lowland can be dated from the 1st to the 9th centuries. Repeated storm surges between the 9th and the 13th century, causing thousands of deaths and major economic damage (Carpenter & Bishop, 2009) were the triggering factors to set up a water management system which was institutionalized from the 13th to the 17th century. Large-scale reclamation projects took place in the 18th and 19th centuries, culminating with the Delta Works, which followed the 1953 flood, aiming at the protection of the coast of the Netherlands from the floods through the estuaries of the rivers Rhine, Meuse and Scheldt. After the threats of flooding in 1993 and 1995, when more than 100,000 people had to be evacuated from areas along the rivers Rhine and Meuse, government policy focused on alternatives to maintaining existing flood protection and safety levels (e.g., land use changes and floodplain restoration).

Public participation and stakeholder involvement in water management is deeply rooted in the Dutch culture, and the contribution of stakeholder groups to decision-making is

considered an important value for the efficiency of the Dutch system. The ancient water boards, still active, are considered the basis for the Dutch consensus culture, also known as the “polder model”. These bodies strongly favour the reaching of agreements and aim for the prevention of conflicts rather than the application of authoritative solutions and hierarchical decision-making. Such a decentralized approach to decision making suggests promising conditions for the wider implementation of public participation.

No specific societal addictions have been identified as constraints that have affected the efficiency of the water management process. However, the consensus culture can be considered sometimes as a societal addiction which can delay the decision making process in developing critical infrastructure to keep the population safe from floods. Politician have sometimes heavily criticised this consensus culture in favour of a more formal representative decision making mechanism to allow more firm and timely decisions to be taken (Enserink, Patel, Kranz, & Maestu, 2007).

Imaginative resources of the Dutch society can be found in the multidisciplinary approach used to develop new ideas to transform and adapt the country to new challenges. Space limits, population density and the high concentration of economic assets make such an approach necessary to find new ways to cope with different issues. Artists and architects often challenge engineers and environmental specialists in the creation of new concepts for land use. For example, the Netherlands Architecture Institute is a hub for new ideas developed by technology universities (e.g. TU Delft), architects and planners. Events such as the International Architecture Biennale Rotterdam, with the theme ‘Flood’ represent important bases to develop new ideas on the relationship between urban development and water engineering (Hooimeijer, Meyer, & Nienhuis, 2005). At the same time, new public-private partnerships, such as Ecoshape, aim at a new approach in building hydraulic infrastructures while working with nature and the society (de Vriend & Wesselink, 2009).

A well defined Leadership and water management structure characterize the Netherlands. Under the Ministry of Public Works and Infrastructures, the Rijkwaterstaat (Directorate-General for Water Management) is committed to protect the Netherlands against flooding, with a long-term perspective. At the same time, it manages the main waterway network and traffic flows and ensures an adequate supply of good quality water for all users.

The second level of water management is represented by the Water Board (Watershcap) in charge of one of 27 regions of the country. This body is in charge of management and maintenance of water barriers, dunes and dikes; management and maintenance of waterways; maintenance of a proper water level in polders and waterways; maintenance of surface water quality through water treatment.

Finally, the third layer of water management is represented by the Waterbedrijf.

These are private companies in charge of supplying water-related services in different parts of the country, including drinking water and nature conservancy of the dune area. Dunes water is used as the raw material for the production of drinking water. The water content of the dunes is recharged by supplying purified river water from rivers. In this sense, dunes play a major role in the production of drinking water and nature conservancy is a core business for the water sector.

Another example of strong leadership in water management in the Netherlands is represented by the involvement of the Royal Family in water management issues: Prince Willem Alexander is considered a champion of water management for being the Chair of United Nations' Secretary General Advisory Board on Water and Sanitation.

The Netherlands has a long history of change and adaptation to the challenges posed by water, as the most developed areas of the Netherlands lie in flood prone areas from the sea and from rivers. Hydraulic engineering and water management evolution and

improvement were triggered by the need to defend and develop the country from water threats. The country has adapted itself to incremental changes in the landscape and in the availability of space based on water engineering and management. This can be considered as an increasing adaptation towards safer conditions for dwellings and economic assets that, in turn, generate a base of knowledge and good practices which have been exported worldwide.

Public participation in water management is a fundamental cultural value of Dutch society that can at times be considered as a societal addiction. This contributes to a more democratic decision making process but at the same time slows down important decisions on some occasions. A multidisciplinary approach from different fields of knowledge (planning, architecture, engineering, social and environmental sciences), with a strong link with arts represent imaginary resources which are finally translated in specific land use and water management strategies and development projects. The implementation of such initiatives is supported by a strong government leadership, represented by the Rijkswaterstaat, and by a well-structured distribution of competencies in water management between the different levels of the administration.

Level: macro, meso or micro	Meso: regional and national level
Physical context	Water and coastal changing environment, delta areas
Rapid or incremental change	Adaptive change along the centuries, faster adaptation in the last 50 years
Cultural values	Participatory approach in the decision making process
Societal addictions	Consensus decision making
Imaginative resources	Multi-disciplinary approach to water solutions
Leadership	Institutional support at the national, regional and local level
Related case studies	Netherlands Flood 1953, Sydney Northside Storage Tunnel 2000, New Orleans 2006
Summary	The Netherlands has adapted itself to a challenging changing water environment based on the integration of imaginative resources, technical solutions and a strong sense of community It is following a long term plan not looking for short term fixes

Analytical framework for comparative analysis

Determinants	Water-related risks
	Multidisciplinary approach
	Multilevel institutional capacity – effective leadership across scales
	Participatory approach

New Orleans 2006

HS 1.5	
Sector focus	Human settlement and health
Adaptation to	Extreme weather events
Adaptive capacity	Builds on engineering approaches used to develop levees in the past
Social learning involved	Structural engineering and technological advances in storm forecasting and warning Regeneration of New Orleans' wet lands to act as storm barrier
Primary and secondary drivers	Past history of extreme weather events Increased urbanisation over the past 50 years
Success and /or barriers to adaptation	Successes: building of ever bigger levees; increased community exploration of alternatives Barriers: No active institutional memory of past events; inability to innovate
Implications for climate change adaptation	Social Learning is impacted on by value orientations of key players Implications of investment in infrastructure – pathway dependency

Situated in the Mississippi delta much of New Orleans is 0.6m to 5m below sea level. In 2005, it was hit and largely destroyed by Hurricane Katrina. This hurricane is considered the worst natural disaster in U.S history (Costanza, 2006) and is the third deadliest hurricane to strike the United States (Blake, 2007). It was not the first natural disaster to devastate New Orleans. The city was first rebuilt in 1722 following a hurricane. Since then it has been flooded and storm ravaged 27 times (Johns, 2007). New Orleans performs important economic role to in the global economy as it services the Mississippi delta and port from which huge amounts of oil and natural gas is shipped. A side effect of Hurricane Katrina was that global oil prices increased (Huppert, 2006, p. 1876). So the question is not whether the city will be rebuilt but how will it be rebuilt?

Constanza et al. (2006) argue that New Orleans has one of two choices: 1. to rebuild according to conventional wisdom or 2. create something different and better (Costanza, 2006, p. 465). The first approach is the result of imaginative limitations and infrastructural logic that generate pathway dependency. Bigger levees able to withstand a Category 5 hurricane are now being planned. The imaginative resources available to the army engineers are limited by the logic of defence in a battle with the environment. Constanza et al. (2006) argue for a systems approach that would provide a qualitatively different response to environmental threat. This approach sees the importance of linking environmental-human systems and working within natural constraints.

New Orleans is currently contested territory. Old patterns for problem solving still attract the big dollars from federal authorities. The local perspective is looking however beyond these solutions. Creative and flexible social learning, spear headed by the Bring New Orleans Back commission, is seeking to create a city this is:

> "... a sustainable, environmentally safe, socially equitable community with a vibrant economy. Its neighborhoods will be planned with its citizens and connect to jobs and the region. Each will preserve and celebrate its heritage, culture, landscape, and architecture" (cited in Costanza, 2006, p. 469).

New Orleans is a fine example of how societies follow past patterns, often laid down as infrastructural investments (i.e. levee building), when seeking to repair damage and/or prepare for future foreseeable natural disasters. The history of disaster suggests a high level of institutional resistance to creative thought, a commitment to technocentric problem solving and a high level of institutional amnesia. The emergence of viable alternative solutions suggests that local learning is becoming more assertive, reflexive and creative. The authority of the technological mind set is hard to challenge.

In a recent National Weather Services report (Blake, 2007) the following observations serves as a grim reminder of the frailty of personal and institutional learning:

> "Sociologists estimate, however, that people only remember the worst effects of a hurricane for about seven years (B. Murrow, personal communication). One of the greatest concerns of the National Weather Service's (NWS) hurricane preparedness officials is that people will think that no more large loss of life will occur in a hurricane because of our advanced technology and improved hurricane forecasts" (emphasis in the original Blake, 2007, p. 7)

Level: macro, meso or micro	Micro – a one-off technological solution to storm surge.
Physical context	New Orleans in the Mississippi delta Close to oil and gas fields Degraded delta environment and rising water levels
Rapid or incremental change	Rapid increase in numbers of extreme weather events however long history of these dating back to 1722
Cultural values	Technocentricism and centralist planning
Societal addictions	Engineering solutions
Imaginative resources	Little, apart from structural engineering and technological innovations Calls for a holistic eco-engineering perspective
Leadership	Top-down government-driven initiative challenged by citizen and council level groups
Related case studies	Netherlands Flood 1953, Netherlands 2009
Summary	New Orleans is an example of the dominance of technological and centralist planning solutions. It also illustrates how local contexts can challenge a dominant logic.

Little change is found in tools from this period. Hunter-gatherers followed the prime source of energy – food and material resources for a culture (appropriate stone, hide, bone, etc). In this case, the response was not really adaptive but shaped by external factors of weather and animal availability. As Wright notes, 99.5% of human existence has taken place in the Palaeolithic period. “During most of that time, the pace of change was so slow that entire cultural traditions (revealed mainly by their stone tool kits) replicated themselves, generation after generation, almost identically over staggering periods of time,(2006, p. 18). Mobility of early human groups meant that the adaptation frequently took the form of movement rather than change in social organization.

Palaeolithic 15 KYA

HS 3.3	
Sector focus	Human settlement and health
Adaptation to	Change in climate and resource availability
Adaptive capacity	Movement
Social learning involved	
Primary and secondary drivers	Availability of suitable material for tools Seasonal movements of ibex and chamois
Success and /or barriers to adaptation	Success: 7 Millennia of human habitation Barriers: No adaptive capacity beyond movement
Implications for climate change adaptation	Human settlement has always been dependent on climatic conditions Movement away from inhospitable places is still a human response – e.g. climate refugees

The Voidomatis River rises on the western flank of the Pindus Mountains, draining a catchment of 384 km^2 upstream of its confluence with the Aoos River in Epirus, northwest Greece (Woodward, Lewin, & Macklin, 1992). This high-relief catchment has undergone major changes in its morphology since the last ice age (~ 10 kya) driven by processes such as glacial and peri-glacial weathering, solutional decay of limestone and fluvial and alluvial sedimentation (Woodward, et al., 1992).

Rock shelters located in the lower reaches indicate Palaeolithic human habitation 17,000 and 10,000 years ago but absence or rarity of occupation before and after this interval. (Bailey, et al., 1990). Archaeological material at two of these rock shelters indicates more-frequent hunting incursions up the lower gorge for this period of inhabitation (Lewin, Macklin, & Woodward, 1991) with evidence of seasonal specialization in the exploitation and processing of the goat species ibex and chamois (Bailey, et al., 1990). Furthermore, the geology of the catchment indicates that during this period, raw material for their stone artefacts would have been more abundantly available than in the present-day river gravels (Bailey, et al., 1990). Subsequently, it appears that the concentration of occupation at this particular reach of the Voidomatis Basin between about 17,000 and 10,000 years ago was "related to environmental changes associated with local glaciation which created a 'window' of ideal conditions for the use of the gorge as a seasonal base for ibex and chamois exploitation during the Late Glacial period" (Bailey, et al., 1990, p148-149).

Cultural change over this time was almost non-existent. Little change is found in tools from this period. Hunter-gatherers followed the prime source of energy – food and material resources for a culture (e.g. appropriate stone, hide and bone). In this case, the response was not really adaptive but shaped by external factors of weather and animal availability. As Wright notes, 99.5% of human existence has taken place in the Palaeolithic period. "During most of that time, the pace of change was so slow that entire cultural traditions (revealed mainly by their stone tool kits) replicated themselves, generation after generation, almost identically over staggering periods of time, (2006, p. 18). Mobility of early human groups meant that the adaptation frequently took the form of movement

rather than change in social organization.

Level: macro, meso or micro	Micro - Palaeolithic human settlement in Voidomatis Gorge, Greece
Sector focus	Human Settlement
Physical context	Small catchment in NW Greece under glacial and peri-glacial conditions during last ice maxima. Occupation of rock shelters within the gorge during warmer periods of the last “ice age”.
Rapid or incremental change	Incremental change - interglacial period 17000 - 10000 years ago.
Cultural values	Hunter Gatherer
Societal addictions	Nil
Imaginative resources	The past is the future
Leadership	Acephalous society – i.e. in theory all are leaders
Related case studies	The Natufians 10kya
Summary	Mobility of early human groups meant that the adaptation to climate change and resource availability frequently took the form of movement rather than change in social organization.

Analytical framework for comparative analysis

Determinants	Climate change
	Resource availability
	Forager life-way responds to external stimuli

The Roman Empire: 1CE

HS 4.3	
Sector focus	Human Settlement and health
Adaptation to	Increasing complexity at all levels: political, economic, environmental, cultural and social
Adaptive capacity	Political and economic reconfiguration
Social learning involved	Innovation in many areas of human organisation: political, economic, environmental, cultural and social
Primary and secondary drivers	Growing size and complexity
Success and /or barriers to adaptation	Successes: continued maintenance of extensive empire over 4 centuries Barriers: Decline in commitment to a shared vision; corruption and greed; weakened leadership, increased authoritarianism, loss of agency for the common citizen. Degradation of the environment
Implications for climate change adaptation	Social Learning is impacted on by value orientations of key players Imaginative resources central to the maintenance of a system over time Social addiction to centralist authority

The Roman Empire represents a pinnacle in Western history and its collapse is looked to as a cautionary tale for all moments in time when a dominant system seems so entrenched as to be unassailable. As Tainter points out, the twilight years and final collapse of the Western Roman Empire has fascinated generations who see it as having parallels with our own unruly and shabby global civilisation (1988, p. 2).

No one reason can be given for this collapse. It involves a cocktail of drivers that include economic decline, political instability leading to loss of faith in institutions and also inefficiencies in the chain of command, repeated waves of disease beginning in the 2nd Century AD, collapse of trade routes with the Eastern Roman Empire which had supplemented the West's grain reserves for centuries and declining yields at home due to environmental degradation (Diamond, 2005, pp. 13-14; Ponting, 2007, p. 77; Wright, 2006, p. 122ff).

That the Roman Empire reached its height when it did is a reflection of the intensification of human trading and cultural webs (J. R. McNeill, and McNeill, William, 2003, p. 76ff). As the Roman Republic grew, it organised and channelized increasing amounts of resources around and later beyond the Mediterranean region. This led it into conflict with the Carthaginians who were attempting to do the same. After two wars, the Roman Republic emerged the victor and continued to consolidate power.

Ultimately the institutions of republic could not handle the increased complexity of the Roman state (Wright, 2006, p. 120) and a series of civil wars occurred which ended with the victory of Julius Caesar's great-nephew Octavian in 27 BC who was declared "Augustus", not emperor, and consequently initiated reforms to the taxation system, the

roads and other institutions to better maintain and service Rome's imperial rule. He also established Rome's extensive borders and developed a system of Imperial patronage which maintained order for much of the following two centuries (Gruen, 2005).

The period of Republic was characterised by a commitment to disciplined values and civic duty. These values became increasingly outdated in Imperial Rome in which power was concentrated in the hands of a few families and Roman citizens where increasingly disempowered. The city of Rome kept growing well into the 4th century AD at which time the Emperor had at his disposal an standing army of half a million men (Wright, 2006, p. 123). After the Emperor Constantine split the Roman Empire into Eastern and Western parts, the west struggled to maintain a dynamic economy and politics increasingly descended into civil strife. The decline of the agricultural land of the Mediterranean and North African regions increased and power fragmented (Ponting, 2007). Inflation became rampant and Barbarian incursions increased.

The lessons of the Roman Empire include the import link between environmental sustainability and higher order civilizational processes, the link between future oriented values and institutional resilience, the role of quality leadership and institutional innovation in rekindling a civilizational vision, and the link between decline and cultural fatigue in which imaginative resources dwindle and hope evaporates.

Level: macro, meso or micro	Macro: Cosmopolitan Civilisation built around a shared vision of Roman security – the *Pax Romana*
Physical context	Varied physical contexts all linked to a central need for resources – both physical and cultural
Rapid or incremental change	Incremental decline
Cultural values	Authoritarian Centralism versus Civic duty
Societal addictions	Hierarchy and Centralism
Imaginative resources	Hierarchy, Roman traditions, technical answers (engineering mind)
Leadership	Top-down
Related case studies	Angkor Wat 1200, Easter Island 1500
Summary	Rome represents a complex system that declined over generations – loss of integrity, loss of memory, loss of imagination, loss of vitality and a belief in the future. At its peak also illustrates how a system can be redesigned to effectively address new levels of complexity

Analytical framework for comparative analysis

Determinants	Top-down decision-making
	Large cultural investment in a centralist vision of order and prosperity
	Increased corruption and apathy eating away at civic values
	Military power ultimately depends on resource availability – failure of the food chain lead to a collapse of the army

Sydney 2000

HS 1.4	
Sector focus	Human settlement and health
Adaptation to	Runoff from extreme rainfall events entering existing sewage systems and causing sewage overflows
Adaptive capacity	Builds on engineering approaches used to develop sewerage systems
Social learning involved	Structural engineering and technological advances among Sydney Water staff, other government departments, and consultants
Primary and secondary drivers	Health concerns over sewage overflows in urban areas → increasing number and volume of overflows (increased intensity and frequency of storm events combined with population growth) Immanent Olympic Games
Success and /or barriers to adaptation	Successes: the number of sewage overflows was reduced Barriers: Significant differences in perspectives (worldviews) regarding the preferred solution to sewage overflows resulted in a number of barriers to adaptation (e.g. lack of support among several communities of place for the adaptation).
Implications for climate change adaptation	Social Learning is impacted on by value orientations of key players Implications of investment in infrastructure – pathway dependency

Sydney has relied on ocean disposal of sewage for more than a century. However, as population of the city grew, the adequacy of the near shore primary sewage treatment plants (North Head, Bondi, and Malabar) diminished. At Manly (adjacent to the North Head sewage treatment plant) there were numerous public rallies in the 1980s regarding the deterioration of water quality at popular ocean beaches. The NSW State government's response to deteriorating water quality on the Sydney beaches was to extend the outfalls further into the ocean (details of the 5-year environmental monitoring program of the deepwater outfall can be accessed via a special volume of the journal *Marine Pollution Bulletin*, 1996(Leadbitter, 1996)). The decision to extend the outfalls was unpopular with many communities of place as demonstrated by the election of Cr Dr Peter MacDonald, who ran for both local and state political representation on the platform of anti-ocean outfalls (served 8 years as a state member in NSW, and 4 terms as a councillor for Manly, including being Mayor from 2004 to 2008). Ocean outfalls as a means to dispose of sewage has also attracted criticism within the engineering profession (Beder, 1991).

While the Sydney seaward beaches experienced improved water quality as a result of the greater dispersal of sewage in deeper water further offshore, there remained significant health concerns relating to sewage overflows during extreme rainfall events—whereby, runoff such as stormwater enters sewerage systems (due to aging sewerage infrastructure that has cracked in numerous places) and floods the systems, causing raw sewage to

release through overflow manholes and other escape points such as cracks. The contamination from overflows on the northside of Sydney resulted in water quality deterioration of Sydney Harbour. The imperative for action was made more urgent after the decision for Sydney to host the 2000 Olympics that included water-based events to be held on the harbour. As a result, the NSW Government initiated a scheme to construct a sewage containment structure to manage peak flows (the Northside Storage Tunnel).

The aim of the Northside Storage Tunnel was to improve water quality in Sydney Harbour through improved capture of sewage from four major overflow sites (Lane Cove River West, Scotts Creek, Tunks Park, and Quakers Hat Bay) during periods of heavy rainfall (it remains empty for 300-330 days per year) (Sydney Water, no date). The tunnel acts as a large containment structure that is 16km long (from the Lane Cove river to North Head), with a diameter ranging from 3.8m to 6.6 m, and a total storage volume of almost 500 million litres (Sydney Water, no date).

Sydney Water (no date) details the extent of resources for the community relations activities during the 600 days of construction, including:

- 25,000 staff hours;
- over 7,100 recorded contacts;
- 8,000 emails circulated to Community Liaison Committees (one for each major construction sites), facilitators and project staff;
- 9,000 calls received and made;
- 330 formal meetings;
- 68,400 pages of meeting notes circulated to the Community Liaison Committees and staff; and
- 500 questions tabled by Community Liaison Committees members.

However, despite the extensive expenditure on 'community relations', there was minimal change from the original project design and the Minister for Urban Affairs and Planning approved the Northside Storage Tunnel on 22 December 1997.

(Leadbitter, 1996) proposes, the community awareness of sewage disposal has resulted in "… demands for the greater recycling of water and mechanisms for reducing water use". However, the entrenched infrastructure and capital investment in the existing and extended sewerage system provides little incentive for the additional investment in recycling on the part of the custodians of large centralised infrastructure (i.e. State governments). Community opinion continues on the topic and on 7 November 2009, in *Viewpoint* (http://cumberland-courier.whereilive.com.au/your-news/story/viewpoint-november-7/), the Managing Director of Sydney Water, Kerry Schott, responded to a letter in the *Manly Daily* newspaper published the day before, defending the Northside Storage Tunnel by stating that the "Northside Storage Tunnel has decreased Harbour pollution significantly as it was designed to do. Since 2001 the tunnel has prevented more than 38 billion litres of diluted sewage from reaching the harbour during wet weather" but goes on to state (despite the extensive investment in the construction of all the existing sewage infrastructure of Sydney combined with the upgrades such as the storage tunnel—alone worth $650m) that "Small scale recycled water supply is prohibitively expensive at present, though new technologies are being developed. Wide scale implementation of these is not likely in the near future due to the cost".

Level: macro, meso or micro	Micro – a one-off technological solution to sewage overflows on the northside of Sydney. However, entrenchment of existing infrastructure has relevance across scales
Physical context	Sydney – Large coastal capital city with a population of about 5 million persons
Rapid or incremental change	Rapid but incremental change – project inception to completion occurring over a few years but builds on infrastructure decisions over several decades
Cultural values	Technocentricism
Societal addictions	Engineering solutions
Imaginative resources	Little, apart from structural engineering and technological innovations
Leadership	Top-down government-driven initiative
Related case studies	Curitiba 1990s, New Orleans 2006, Sale 1871, Maroochy 2009
Summary	The Sydney Northside Storage Tunnel case demonstrates the *default preference* for extension of existing infrastructure to accommodate (cope with) additional (extreme) loads on systems (in this case, increased frequency and intensity of storm events coupled with population growth). It also highlights the future problems that are likely to be encountered if an alternative adaptation is needed (e.g. potential redundancy of significant capital investment and resources)

Analytical framework for comparative analysis

Determinants	Top-down decision-making
	Large capital investment for management of extreme events
	Entrenchment of existing infrastructure limiting future adaptations – *pathway dependency*
	Overly focused on engineering solutions to engineering problems

The Natufians (10KYA)

HS 4.1	
Sector focus	Human Settlements and Health
Adaptation to	Climate Change
Adaptive capacity	Modify existing patterns to maximise resource accessibility
Social learning involved	Moving into and out of complex social relationships – i.e. village life (even secondary forager life) is more ordered than hunter gatherer existence
Primary and secondary drivers	Climate change, population growth, social organisation
Success and /or barriers to adaptation	Successes: established extensive village systems, food storage, artistic and cultural expression Barriers: Hard to retreat from population growth without loss of life
Implications for climate change adaptation	Social Learning is accelerated when rapid environmental change occurs Implications of investment in infrastructure, pathway dependency, only applies in moderate contexts – villages and social organisation abandoned when no longer functional

The Levant is the site of the mesolithic Natufian culture that flourished between 12.5 thousand and 9.5 thousand years ago (kya). This area is about 1100 kms long and between 250 and 350 kms wide, with its northern reaches in the southern Taurus Mountains of Turkey and its south in the Sinai Peninsula (Bar-Yosef, 1998). Today this is arid terrain, but twelve thousand years ago, it was a rich and diverse woodland landscape. The Natufians are credited with some of the earliest sedentary (or semi-sedentary) communities (Belfer-Cohen, 1991). These hamlets offered a base from which Natufian hunter-gatherers could emerge to make maximal use of the rich surroundings. These people are credited with the regular use and storage of some of the first grains domesticated by humans. Yet the archaeological record is unclear.

It is suggested that the Natufians favoured a semi-sedentary base in order to store grains collected from the wild but there is scant evidence for this (Bar-Yosef, 1998, p. 163; Munro, 2003, p. 59). Bar-Yosef describes them as 'secondary foragers' to distinguish them from primary, constantly mobile, foragers (Bar-Yosef, 1998). This transitional life-way allows for return to simpler subsistence methods but also lays the foundation for a full shift to agriculture. As secondary foragers, they did not cultivate grain in the first instance. With the onset of the Younger Dryas (11.8kya), an interglacial period of dry cold conditions that did not favour the wild grasses the Natufians collected, the settlements tended to disperse and older patterns of survival re-emerged (Munro, 2003). In this case, social learning, when the climate was warm and moist, responded to the abundance of a natural resource – wild grains and game – and then responded again to their desiccation during a 13-century long cold dry period.

It has also been suggested that with the ending of the Younger Dryas and a return to moister warmer conditions that the late Natufians returned to the earlier settlement model

and laid the foundation for what archaeologists call the Pre-Pottery Neolithic A period in which mud bricks were used as a housing material. It was during this period that the first examples of Neolithic agriculture are to be found in this area (Munro, 2003). Social learning leading to cultural evolution has three main drivers in such contexts: environmental change, population growth and social organisation (Byrd, 2005, p. 234). It is likely that in the Natufians' case all three play their part and that we need to develop holistic interpretational schemas to make sense of key cultural shifts (Verhoeven, 2004).

Level: macro, meso or micro	Meso: regional response to bounty and scarcity
Physical context	Rich woodlands with open grain heavy savannah, plentiful game (primarily gazelle) and wild fruits and nuts
Rapid or incremental change	Rapid change occurred with the onset of the Younger Dryas – within a decade
Cultural values	Forger ethos with a willingness to innovate to increase the potential for leveraging environmental resources
Societal addictions	Importance of tradition?
Imaginative resources	Deep memory
Leadership	Acephalic social order
Summary	The Natufians demonstrate that even deeply held patterns of social organisation can be challenged if the conditions for doing so are ripe. Social learning responds to contextual drivers

Analytical framework for comparative analysis

Determinants	Climate change and population growth
	Resource availability
	Large social investment in village building
	Forager life-way retained so memory not lost – and returned to during Younger Dryas

The Novel 1850

HS 4.5	
Sector focus	Human Settlement and Health
Adaptation to	Technology change, growing importance of national languages and growing literacy levels
Adaptive capacity	Rapid adoption of a new technology
Social learning involved	Changed how humans collectively and personally negotiate social space
Primary and secondary drivers	Invention of paper and moveable type Emergence of local languages to challenge the dominance of Latin
Success and /or barriers to adaptation	Successes: rapid diffusion of the technology, rapid acceptance of the novel as a core cultural artefact of the modern world Barriers: literacy levels were low in working class
Implications for climate change adaptation	Social Learning is accelerated when rapid technological change occurs Implications of new technologies that challenge the way people view themselves and their world

There is an important link between technology and culture. The European invention of the printing press (variants had existed in China and Korea for centuries[2]) by Johannes Gutenberg in 1452 allowed Bibles to become a widespread household item in Europe and the free thinking this generated was a significant contribution to the breakdown of the Roman Catholic Church's monopoly on 'truth' that triggered the Protestant Reformation. Historian of ideas, Peter Watson observes:

> "Printing thus began the destruction of the unified Latin culture of Europe, the culture that had helped propel Europe ahead of India, China and the Arab world, and it also marked the origins of a culture belonging to the masses. It was a change of seismic proportions" (2006, p. 387).

The full import of this change took time. In the 19th Century printing became industrialized and a further massification occurred which gave rise to new forms of writing. An important form to emerge at this time was the novel. The novel set the stage for greater internalization of human experience. For the first time inner worlds became available to people. These were both deeply personal but also shared as cultural experiences (Tarnas, 1991). This step gave rise to a number of events that include the birth of mass media, the context for psychology and the groundbreaking work of Freud and Jung, the rise of the concept of culture as a collective inner experience and the birth of empathy as a social force which led to the development of the human rights movement (Hunt, 2007).

[2] See Peter Watson (2006, p. 299-304).

The novel allowed readers to discover an inner 'feeling' that was physically experienced by the brain as 'real'. Lynne Hunt links such feelings to the recent work of neuroscience on the biology of the brain and feeling[3]. She argues that

> "What might be termed 'imagined empathy' serves as the foundations of human rights…It is imagined, not in the sense of being made up, but in the sense that empathy requires a leap of faith, of imagining that someone else is like you" (Hunt, 2007, p. 32)

She concludes:

> "My argument depends on the notion that reading accounts of torture or epistolary novels had physical effects that translated into brain changes and came back out as new concepts about the organization of social and political life. New kinds of reading (and viewing and listening) created new individual experiences (empathy) , which in turn made possible new social and political concepts (human rights)" (Hunt, 2007, p. 33-34).

If Hunt is correct, there is a biophysical link between technologies such as printing, human brain function and our social organization. The discovery of an inner world via the novel and the whole psycho-drama that underpins the novel's narrative can be seen to have made a powerful contribution to social learning. Thomas Jefferson for instance was deeply affected by the struggles of Laurence Sterne's *Tristram Shandy* (1759-67) while Elizabeth Gaskell's industrial novel *Mary Barton* (1848), which pre-empted Charles Dickens' own influential industrial critique *Hard Times* (1853), was the first to lay bare the plight of industrial families in the Midlands of England. Along with Dickens' novel his story initiated a wave of popular middle class protest which led to improvements both physically and legally for urban factory workers – child labour for instance was ultimately banned (Ponting, 2001, p. 664).

[3] There is much on this coming out at the moment see:
http://www.physorg.com/news186687539.html and also
http://www.npr.org/templates/story/story.php?storyId=110997741

Level: macro, meso or micro	Macro: a society changes its view of the human condition
Physical context	Dynamic social and political environment – through scientific, political and industrial revolutions
Rapid or incremental change	Rapid change occurred over a matter of decades in which core values relating to individuality, free will and human rights became both enshrined and promoted by the novel
Cultural values	Individuality, 'the Rights of Man'
Societal addictions	Learning confined to middle and upper class
Imaginative resources	The social drama of change, the class system, competition
Leadership	Great authors
Related case studies	Ecovillages 1990s, Mobile Phones 1990s, Britain 1800
Summary	The novel and novelists along with the industrial print era came together to shape core values of an era

Analytical framework for comparative analysis

Determinants	Technology – paper and the printing press
	Philosophical development – the age of Reason and then the Enlightenment both with a deep commitment to human reason and social development
	The Media age makes money from a new artistic form – the novel
	A range of injustices from gender inequity, class prejudice and industrial hardships provided rich contexts for engaging and volatile writing

Amazon 1400

Ag. 3.1	
Sector focus	Agriculture
Adaptation to	Poor soils
Social learning involved	Manipulating soil fertility
Primary and secondary drivers	Growing population
Success and barriers to adaptation	Success: ability to support a population of between 1 and 11 million
Implications for climate change adaptation	Preindustrial techniques have a place in rethinking current industrial practices

In 1400, extensive Indian settlements stretched along the Amazon River. It was estimated that the population was between one and eleven million people at the time of European arrival (Bush & Silman, 2007). The main livelihood activity was agriculture. Fish, manioc and maize were the main sources of food for the Amazonians. This context suggests the question: How could the Amazon basin feed millions of people from mainly agriculture with its characteristic low nutrient soils. The dominant yellow or orange Amazonian soils, largely characterised by iron oxide and aluminium oxide, did not contain sufficient nutrients to support agriculture. Most Amazon soils would be exhausted of their essential nutrients after five tills of maize production with fallow periods of between 20-30 years (Bush & Silman, 2007).

Recent archaeological excavations revealed sites averaging 20 hectares and in some isolated cases 350 hectares of unusually dark soils of up to 2m deep spread over thousands of kilometres across the Amazon basin (Bush & Silman, 2007). These fertile dark earth soils (also known as *terra preta*), coupled with potsherds, pieces of bones and organic residues provided some indication of human use of biochar in agriculture for many hundreds of years. The dark soils, in contrast to the usually yellow or orange soils of the Amazon, contained a fine grained, carbon rich material that was believed to come from charred organic materials such as manure, crop residue and bones. These soils provided strong evidence that the Amazonians must have known how to manipulate the soil and grow crops to feed the millions of people.

The lack of sophisticated kilns and ovens often used in the production of modern biochar and the characteristic poor nutrient soils implied that the Amazonian communities used other methods involving burning organic materials. It has been suggested that the Amazonian communities could have practised slash and burn agriculture. However high populations could not support the nomadic nature of slash and burn agriculture. The discovery of pottery vessels, too big for people constantly moving from one place to another, suggested that the Amazonian people could have lived in near permanent settlements. There was therefore need for nutrient elevated soils to support intensive agriculture to feed the high population density.

Slash and char method of farming was the most likely adopted farming method (Bush & Silman, 2007). This method involved clearing of land, piling up all the resultant biomass and other organic materials such as manure, bones, and fish for smouldering (rather than burning). It is believed that dirt was used to cover the smouldering materials to eliminate oxygen whilst allowing heat to bake the organic matter to eventually form *terra preta*. Unlike modern soil fertilisation techniques, *terra preta* retained soil fertility for hundreds if not thousands of years (Michalovic, 2009). This is also a case of ancient chemistry being applied to adapt to adverse conditions for survival.

Level: macro, meso or micro	Meso: structural innovation. Biochar was ancient technology used to improve soil productivity to support millions of people's livelihood through agriculture in the Amazon basin.
Physical context	Rural agricultural communities improving crop productivity by improving soil nutrient content.
Rapid or incremental change	Rapid increase in populations and the consequent demand for food.
Cultural values	Agricultural communities
Societal addictions	Nil
Imaginative resources	The cultural isolation meant limited cross-cultural interaction to stimulate social learning.
Leadership	Local Chiefs, deeply traditional leadership style
Related case studies	Hawaii 1700, Indigenous Australians 2009., Bolivia 2009
Summary	Core learning is recognising the importance of the need for sustainable agricultural practices to support human populations. Amazonian communities used biochar to enhance soil productivity and hence crop yield per unit area of production to feed millions of people.

Analytical framework for comparative analysis

Determinants	Cultural values intertwined with natural land management practices, cultural isolation, livelihood support systems
	Intensive use of land, maximising productivity per unit area

Azerbaijan 2005

Ag. 1.2 & E1.3	
Sector focus	Agriculture/Energy
Adaptation to	Environmental Degradation and Authoritarian rule
Adaptive capacity	Nil
Social learning involved	Based on replicating the past
Primary and secondary drivers	Resource rich Totalitarian rule Environmental degradation High levels of illness and death due to uncontrolled pollution
Success and /or barriers to adaptation	Successes: none Barriers: Authoritarian Governance, Historical conditioning
Implications for climate change adaptation	Social Learning is inhibited when historical conditioning, governance and economic systems actively discourage it

Post-Soviet Azerbaijan has the unfortunate status of being one the most polluted countries in the world (Huseynova 2007). Sumgayit, about 30 km from the Caspian coast, for example, is listed in the top 10 most polluted cities by the Blacksmith Institute. Air and water pollution is causing poor health among its inhabitants, as authorities are unable or unwilling to cope with growing volumes of toxic waste generated by new factories that accompany the nation's new dependence on oil. Azerbaijan can lay claim to:

- having one of the world's highest infant death rates;
- suffering high a incidence of cancer;
- being subject to outbreaks of tuberculosis in its prisons, and;
- being traditionally deprived of democratic and human rights.
- Solutions to these problems, however, will also have to address the impacts of climate change.

Historically, the population of Azerbaijan has had little opportunity for a genuine contribution to information, wealth, health or well being. While claims were made of improved environmental management, progress appears to have been mythical or extremely slow (Shelton 2003). Moreover, the capacity for real change and effective social learning is constrained by a history of centralist totalitarianism, a culture of corruption and now the currently exploitative character of western imperialism. Despite the transition from the controlled economy of the Soviet regime to the new age of free market global economy, there seems to be few avenues for the voice of the public to be heard, unless it throws off its oppressive historic shackles.

Under Soviet rule, rights to cultural identity and environmental quality were undermined by the 'production at all cost' regime. The Soviet era was replaced by a new dictatorship that values 'profits at all cost'. The burgeoning oil industry combined with a culture of corruption has created new constraints to democracy and thus the capacity for public protest or policy participation. According to Heradvstveit (2001, p. 261), even some of the

privileged elites claim that 'Western businesses shut their eyes to the violence the regime commits against its own citizens'.

So what does the future hold for Azebaijan? The only way to break the corruption cycle according to Heradstveit (2001) is through a strong civil society. Since 2001, however, pollution has worsened as more factories release new contaminants into the atmosphere and the waterways and public health continues to deteriorate (Huseynova 2007). The voice of the people does not seem to be heard and the road to democracy may be a long one. As Shelton (2003) states, 'the weight of the past still hangs heavy'. The future, on the other hand, will also be burdened by demands imposed by climate change.

Level: macro, meso or micro	Meso
Physical context	Resource rich central Asian state Post Soviet regime High levels of pollution
Rapid or incremental change	Incremental poisoning of the population
Cultural values	Authoritarian, corrupt, short term thinking
Societal addictions	Exploitation of natural resources and populace – 'profits at all costs'
Imaginative resources	Historically bound
Leadership	Authoritarian and Corrupt
Related case studies	Garcia River 2000, Donora 1948, Curitiba 1990s, Easter Island 1500, Sale 1870
Summary	Azerbaijan illustrates how effective social learning and adaptive capacity is conditional on factors relating to governance, economics and a sense of agency at both community and personal levels

Analytical framework for comparative study

Determinants	Authoritarian and centralist government
	Weight of the past
	Unbridled industrial growth
	Absence of a core ethic of social and environmental responsibility in leadership

Bolivia 2009

Ag 1.3	
Sector focus	Agriculture
Adaptation to	Poverty and impacts of climate change
Adaptive capacity	Local and indigenous memory Scientific and technological interventions
Social learning involved	Need for flexibility and multi-scale solutions
Primary and secondary drivers	Deterioration of environment Failure of conventional methods Indigenous memory Government and NGO intervention
Success and /or barriers to adaptation	Success: Unclear Barriers: scepticism and social inertia
Implications for climate change adaptation	Solutions may lie across scales Solutions may involve both scientific resources and Indigenous Australians

Bolivia is a poor country even by South American standards with a GNP per capita of approximately $950 (Navajas, Schreiner, Meyer, Gonzalez, & Rodriguez-Meza, 2000). The division of wealth is acute with a particular concentration of poverty in rural areas (Navajas, et al., 2000). Poverty is attributed significantly to its relatively undeveloped status on the global stage. In addition, political unrest and climate change are now adding to the numerous challenges facing the Bolivian poor population.

As an undeveloped country, Bolivia's contribution to global warming is negligible, producing under 0.1 % of the world's carbon emission. Paradoxically, however, the impacts of climate change are proving to be disastrous for Bolivia as droughts and floods increasingly threaten the county's most vulnerable citizens. The 'Uru Chiaya' people, for example, who survived the Spanish invasion and outlasted the Inca Empire, now face extinction (Carrol & Schipani, 2009). Droughts are threatening the sustainable production of quinoa, a staple cereal, while the Brazil nut industry, its chief export commodity, is also under threat. Devastating floods during the last two years have also threatened crops, livestock and human lives. Proposed actions to meet these challenges include historical, global and indigenous solutions.

Climate change adviser (Nordgren, 2009) in his primary role to help indigenous farmers "improve their yields and adapt to climate change" proposes that development is the only way out of poverty for Bolivia. For example, it is proposed to apply modern genetic technology to develop drought resistant Brazil nuts. Another proposal is the introduction of 'micro-credit' schemes for the poorest households (Navajas, et al., 2000).

At the other end of the spectrum, impoverished indigenous farmers in the Amazon basin are looking to indigenous memory for adaptation to the new threats. This search is based largely on oral history and old recorded methods. Their objective is to develop a

sustainable approach to crop production employed by their ancestors dating back to some 1000 years. This method encompasses the construction of raised platforms or 'callones' that prevent loss of seeds during the floods, surrounded by canals that provide irrigation during the droughts. The program is sponsored by the Kenneth Lee foundation and Oxfam (Gibson, 2009).

No method is a proven solution, and each approach has its sceptics among the local populations. Nonetheless, the threats facing one of the world's poorest nations provide several lessons about adaptation to an unequal global economy and climate change. They emphasise the point that there is no single solution and the problems and solutions are fundamentally global, national and local in scale. Further, solutions require economic, political, cultural and historic dimensions. Solutions may therefore be found in the convergence of the past, present and future and in the confluence of history, culture and technology. More importantly, Indigenous Australians has a prominent role in the quest for adaptive capacity.

Level: macro, meso or micro	Meso-Micro: nation state and local peoples
Physical context	Rural agricultural; considerable clearing; increased flooding or drought
Rapid or incremental change	Rapid increase in climate related events
Cultural values	Development and Indigenous practice
Societal addictions	Nil
Imaginative resources	Ranges from scientific tool box, to tapping into social capital and NGO resources to reassessing indigenous practice
Leadership	Multiscale – Global NGOs, National advisors and Local
Related case studies	Cuba 1990s, Indigenous Australians 2009, Amazon 1400, Hawaii 1700, Adelbert Mountains 2009
Summary	Bolivia is adopting creative mixes of solutions in an attempt to secure the livelihoods of its majority poor and vulnerable. Flexibility and sensitivity to local practices and needs are central to long-term success.

Analytical framework for comparative analysis

Determinants	Rapid impact of climate change
	Creativity & Flexibility
	Indigenous memory
	NGO resources
	Multi-scale approach

Chesapeake Bay 2001

Ag. 1.4	
Sector focus	Agriculture
Adaptation to	Decline in oyster fishery (Chesapeake Bay, USA) caused by overfishing and exacerbated by decline in water quality
Adaptive capacity	Modify existing management patterns to restore oyster stocks in Chesapeake Bay
Social learning involved	Increased understanding of the problem and consequences of previous actions.
Primary and secondary drivers	Resource extraction (oyster harvesting) Reduced resilience of the system
Success and /or barriers to adaptation	Successes: holistic view of problem; integrated approach to adaptation adopted Barriers: Water quality may be too poor to re-establish oysters; entrenched resource management mores; competing interests (ecological v socioeconomic); historical alteration of catchment
Implications for climate change adaptation	Holistic and integrated management vision possible.

Oysters are an important commodity in the Chesapeake Bay area of USA, serving as an important economic source (NOCB, 2004), food source (Chesapeake Bay Program, 2009), fill for road construction during early settlement (NOCB, 2004), environmental sentinel (Reinfelder, Wang, Luoma, & Fisher, 1997) and water quality purifier (Jackson, et al., 2001). The oysters were initially so plentiful, that they were a navigational hazard to shipping (NOCB, 2004).

The oyster fishery in Chesapeake Bay is an important regional fishery, accounting for some $29.3 million in 1980 (NOCB, 2004) and providing income for lease-holders and subsidiary activities such as shuckers, packers, shippers and so on (NOCB, 2004). However, this oyster fishery has declined significantly, with the 'total dockside value' in 2001 worth $4.3 million (NOCB, 2004), considerably less than the $29.3 million for 1980 (ca. $60 million if adjusted to account for inflation over these years to 2001 level).

The decline of the oyster fishery in Chesapeake Bay began with European settlement, after which the quantity of oysters within the Bay was dramatically depleted with a negative flow-on effect on the local water quality.

Prior to European settlement, the oyster population was large enough to theoretically filter or cleanse the entire water volume of the Bay every three days (Jackson, et al., 2001) - whereas the current oyster population, which is about 2% of its pre-settlement abundance, would take about 1 year to achieve this (Chesapeake Bay Program, 2009). While this important fishery sustained indigenous harvesting, and even early European harvesting, the introduction of mechanical harvesters using dredgers in the late 19th century saw the oyster population rapidly decline (Newell, 1988). Within 60 years, episodes of eutrophication (algal blooms, high nutrient levels) are recorded (Cooper &

Brush, 1993) with the associated deleterious effects of decreased dissolved oxygen (hypoxia and anoxia), fish kills and general ecosystem decline. Furthermore, these effects coupled with continued dredging, land clearing, air pollution (air pollution provides ca. one third of nitrogen load into Chesapeake Bay [Chesapeake Bay Program 2009]), farmland (ca. 3.6 million hectares [Chesapeake Bay Program 2009]) and other catchment activities interact to provide a feedback loop that prevents the recovery of the oysters and associated communities to pre-settlement numbers (Jackson, et al., 2001).

Bay states, federal government, academia, environmental organizations and the oyster industry have worked together to develop regional fishery management plans in response to the declining population of the oyster fishery. Most notable is the Oyster Management Plan, which combines the past fishery management efforts into one document and has the primary goals of rebuilding native oyster populations and improving oyster management (OMP, 2004):

> "The purpose of the OMP is to provide both a general framework and specific guidance for implementing a strategic, coordinated, multipartner management effort"

The relatively recent development of the OMP coupled with the general long-term approach to management entails that its success (or otherwise) is still yet to be determined although the first quantitative objective is soon: "*a tenfold increase in oyster biomass by 2010 relative to a 1994 baseline*". However, it is acknowledged in the OMP that even this tenfold increase, which still represents a small fraction of the historical numbers, might not be attainable in this timeframe because the system is too 'impacted' and the oyster numbers too low. This latter point has led to the consideration of introducing a non-native oyster (*Crassostrea ariakensis*) to supplement the native population (NOCB, 2004). Finally, the dramatic changes of the Bay's catchment that have occurred since European settlement entail that it might not be possible to fully restore the oyster population levels to pre-European settlement numbers (OMP, 2004).

Level: macro, meso or micro	Meso – regional scale management of oyster fishery
Physical context	Oyster fishery in Chesapeake Bay, USA. Bay also important for navigation, recreation and sink of diffuse (catchment runoff) and point source (e.g. wastewater treatment plants) loading of nutrients and other contaminants.
Rapid or incremental change	Rapid decline in oyster population and general ecosystem health since late 19th century
Cultural values	Dominate and exploit nature for financial gain. Nostalgic view of the way the Bay use to be.
Societal addictions	Capitalism, Exploitation of resource
Imaginative resources	Historical memory, coordinated mulitpartnering, technofixing, and ecosystem manipulation by introduction of non-native oysters to supplement [replace?] native species.
Leadership	Bay states, federal government, academia, environmental organizations and the oyster industry
Related case studies	Sydney 2000, Eastern Pacific Gray Whale, Garcia River Forest 2000, Easter Island 1500, Hawaii 1700
Summary	The collapse of the oyster fishery has alerted authorities and business to the cross system impact of human activity and on the need to develop sustainable practices. This is not the first case in which bounty has been reduced to scarcity by unbridled human activity (see Garcia River Forest 2000; also see the extinction of the North American Passenger Pigeon).

Analytical framework for comparative analysis

Determinants	Resource availability / exploitation
	Lost ecological services provided by (abundant) oysters – filtering water column, regulation of algal blooms
	Holistic action for managing restoration of oysters

Cuba 1990s

Ag. 3.3, 4.2 & E 2.2, 3.1	
Sector focus	Agriculture/Energy
Adaptation to	Sudden loss of oil and other imports previously relied upon (e.g. medical and food supplies)
Adaptive capacity	Significant imaginative resources and resourceful citizens
Social learning involved	Various agricultural techniques (e.g. permaculture and organic farming)
Primary and secondary drivers	Politically imposed trade embargos (USA) Collapse of other nations previously relied upon for trade (USSR)
Success and /or barriers to adaptation	Successful adaptation through a socialistic response and strong centralised leadership that re-oriented the model of agriculture towards a decentralised approach that encouraged sustainable practices.
Implications for climate change adaptation	Rapid change demands rapid and original responses. The collapse of a major energy source challenges the basic assumption upon which a society works and creates new pathway possibilities.

Cuba is a sub-tropical island nation in the Caribbean with over 11 million inhabitants. Throughout its long history, Cuba has been the site of many conflicts with controlling interests and trade reliance on nations including Spain, the United States of America and the Soviet Union. This summary will provide a brief historical context before focusing on the so-called "*special period"* (1990-present), involving several economic, institutional and agricultural reforms in response to the rapid loss of oil supplies, export markets, and externally imposed trade embargos.

From 1492 to 1898, Cuba was a Spanish colony whose 'brutal' rule severely depleted the native Taino people Zepeda (2003). Uprisings against Spanish rule were successful in 1898 when the U.S. became involved and defeated Spain, beginning a period of U.S. military rule of Cuba from 1898 to 1902. (Zepeda, 2003) notes that in the following decades, U.S. businesses and individuals gained some of the best land and focussed on sugar production at the expense of other food crops. These processes ensured a greater reliance on food imports, concentrated the financial wealth of the nation in the hands of a few individuals, and meant that most Cubans were extremely poor without land or sufficient incomes. In response, Fidel Castro and his allies led a revolution and overthrew the reigning U.S.-supported Batista government in 1959.

Fidel Castro formed a new socialist government and expropriated much of the U.S. property leading to a policy of isolation from the U.S. Zepeda (2003, p. 1) states that the isolationist policies of the U.S. led President Castro to become 'an accidental communist' and reliant on the Soviet Union for trade. Heavily influenced and subsidised by the Soviet Union, Cuban agriculture involved large monocultures, intensive mechanisation and substantial amounts of fertiliser and pesticides (Zepeda, 2003). However, with the collapse of Soviet block in 1989 and the simultaneous increase in the U.S. trade embargo, Cuba

experienced a sudden decrease in its oil supply and export market. In particular, imports decreased by 50%, GDP reduced by 25%, the availability of fertilizers and pesticides fell by 70%, and food and other imports declined by 50%, leading to a decline in calorie intake by 30% (Zepeda, 2003). In addition, the "Cuban Democracy Act" passed by the U.S. in 1992, prohibited food and medical assistance to Cuba (Frye, 2009).

In response to these sudden and severe constraints, the Cuban government began a series of social, institutional and agricultural reforms. Fidel Castro is said to have stated that such reforms were 'designed to save the revolution and not to transform it' (Colantonio & Potter, 2006). Similarly, Frye (2009) noted that the leadership realised that the crisis was as much an opportunity as a constraint. Programs encouraged increased bicycle use, using oxen instead of tractors, instigating urban agriculture, using natural and organic fertilisers and pesticides, and ensuring support for essential medical services (Grant, 2007). Renewable energy options, including solar power generation have also been instigated.

Of particular note, are the five reforms underpinning the transition towards greater agricultural production and food security including: a focus on agroecological technology supported through research, education and extension institutions; land ownership reform from centralised state to cooperatives; fair economic returns to farmers; emphasis on local production to reduce energy costs; and the development of farmer-to-farmer training (Zepeda, 2003). These reforms have seen the government re-allocate a significant proportion of the previously state-controlled agricultural land back to farmers as perpetual leases in exchange for contributing to the sustenance of the community by fulfilling production quotas. Since 1994, farmers have been allowed to sell the surplus at farmers' markets encouraging the quality and sustainability of practices (Frye, 2009; Zepeda, 2003). In this way, the practices of permaculture and organic farming are of increasingly value in Cuba.

Recently, the socialist government has again sought to be reconnected to the global economy through the development of international tourism focussed predominantly on the 'sun and beach' experience (Colantonio & Potter, 2006). This has resulted in intensive development of the coastal strip, particularly in the capital city, Havana. Colantonio and Potter (2006) highlight the beginnings of a re-emergence of a bifurcated societal structure, similar to pre-revolution structures, as external desires (e.g. accommodation infrastructure for tourists) are provided at the expense of local needs.

In addition to the broader social and institutional reforms led by the ruling socialist party, many authors refer to the adaptive and entrepreneurial nature of the Cuban people themselves. The following quotation from Gutierrez clearly illustrates this point:

> "This is a nation held together with baling wire, duct tape and backyard welders, and a people as adaptive as Darwin's finches" (Gutierrez, 2009).

Similarly, Megan Quinn refers to the resolve of the Cuban people for autonomy and the will to resist various dominating forces, or 'resistir', which she views as both a value and an ideal in Cuban culture (McBay, 2005). This is not to say that all inhabitants have appreciated the socialist reforms and economic hardships. Nevertheless, Cuba is an effective example of what can be achieved through the primacy of the nation over the individual, and strong, albeit communist-style, leadership in ensuring rapid behavioural change.

Level: macro, meso or micro	Meso – an entire nation (~11million inhabitants).
Physical context	Sub-tropical island nation in the Caribbean.
Rapid or incremental change	Rapid loss of external resources due to trade embargos and the collapse of significant trading partners.
Cultural values	• Resourcefulness • Creativity • Socialism • Optimism • Education • 'Resistir' – the determination to overcome any obstacle
Societal addictions	Nil
Imaginative resources	Imaginative resources related to agricultural and recycling innovations have been important in adapting to food, oil and medical shortages posed by a sudden loss of trade with other nations. Reportedly, Cuban's have the highest literacy rate in world at 98%.
Leadership	Since the 1959 revolution, leadership remained consistent with Fidel Castro in power until resigning in 2008. His brother, Raúl Castro has been subsequently elected as president.
Related case studies	Curitiba 1990s, Adelbert Mountains 2009, Bolivia 2005, Hawaii 1700
Summary	Cuba has been the site of many conflicts. Over its long history, it has had various controlling or dominant interests ranging from Spain, the USA, and the USSR before the 1959 revolution and the rule of the Castro regime until present. The focus of this summary has been on the so-called *special period,* characterised by organisational and production reforms in order to sustain the local population in the context of the loss of external trade. This was possible through a resourceful and educated population and strong socialist leadership.

Analytical framework for comparative analysis

Determinants	Strong and consistent leadership (socialist).
	Effective research and educational systems.
	Arable land and benign, sub-tropical climate.
	Resourceful and adaptive citizenry.

Hawaii 1700

Ag. 2.2, 3.2 & E 3.2	
Sector focus	Agriculture/Energy
Adaptation to	Diverse ecosystems Growing population
Adaptive capacity	Local and indigenous memory
Social learning involved	Need for flexibility
Primary and secondary drivers	Need to maintain a sustainable and diverse ecosystem that supports human habitation
Success and /or barriers to adaptation	Success: Large population at the time of European contact Barriers:
Implications for climate change adaptation	Culture and environment can develop symbiotically to support a large population without negatively impacting on the ecosystem

The *Ahupua'a* was an ancient Hawaiian land management and sustainable living system that divided land into five biological resource zones supporting all life including plants, animals, marine and humans. The traditional land use was based on the vertical arrangement of an island's natural ecosystems from the mountains to the sea, or mauka to makai maximised the use of biodiversity over short distances (Mueller-Dombois, 2007). Five biological resource zones have been defined by Mueller-Dombios (Table 1). These zones represent the typical land division in an *Ahupua'a*.

Table 1 Five biological resource zones representative of Ahupua land division

Hawaiian name	Zone description	Resources
wao nahele (inland forest region)	Upland/inland forest zone	Forest products, firewood, timber, birds and plants
wao kanaka (inland area where people work)	Agricultural zone	Alluvial areas, taro patches (Hawaiian staple), irrigation ditches, tree crop plantations (bananas, breadfruit, coconut), temples, burial sites.
kahakai (beach or seashore region)	Coastal zone	Habitation sites, coastal trails, temples, burial sites, fishponds, fishing, seaweed and salt ponds
muliwai	Estuaries on the windward side of the island	Vertical through ahupua'a, modified by man-made ditches for irrigation, and fish ponds.
kahawai	Freshwater ecosystems and streams	

In pre-contact Hawaii, each *Ahupua'a* was assigned a lower chief who in turn appointed a headman who administered the traditional natural resource and food production systems. The five zones and their related ecology guided these management systems and stewardship practices. The agricultural engineering talents of the early Hawaiians that facilitated this sophisticated system were noted by Muller and Dombois et al. in the form of the irrigated terraces (lo'i) and fishponds. This enabled them to make full use of the productive capacity (Mueller-Dombois & Honolulu, 2005) .

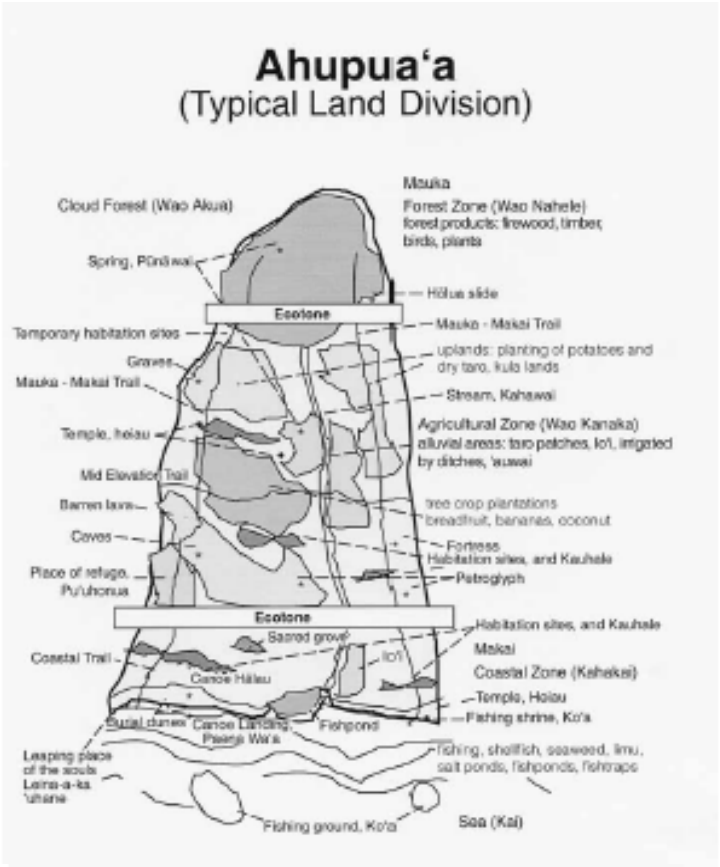

Figure 3. *Ahupua'a* model after Luciano Minerbi 1999, slightly modified. Note the five biological resource and production zones from *mauka* to *makai*: *wao nahele*, *wao kanaka*, *kahakai*, *kai*, and the *kahawai* (stream ecosystem).

Upon first significant contact with Europeans in the late 1700's the *Ahupua'a* system supported a large population of approximately 400,000 Hawaiians (Kaneshiro, 2005). The density of the population was the result of these sophisticated management practices that integrated land and sea bioregions. Such practices were embedded into the culture and based on a deep sense of place.

Major factors for the decline of the *Ahupua'a* system came along with changes in land tenure, European and missionary influence, the shift to a monetary economy and the spread of introduced disease (Kaneshiro, 2005). The Hawaiian Islands have been transformed from a diversified, integrated aquaculture and agriculture system able to sustain itself to a Western monocultural model with a substantially reduced resilience. This Western model allowed for intense resource extraction based on the dominant mono-crop plantation system. Currently this model is part of the characteristically modern landscape we know today that offers "mixed rural-urban-industrial land use ... with a largely tourism and defence-based economy" (Kaneshiro, 2005, p.352).

Level: macro, meso or micro	Meso – structural innovation – The *Ahupua'a* was an ancient Hawaiian land management system to support all life and protect natural resources.
Physical context	Rural agricultural communities mitigating shifting cultivation practices that were threatening the environment.
Rapid or incremental change	Incremental emergence of a sustainable agro-ecology
Cultural values	Ancestral worship, stewardship and agricultural communities
Societal addictions	
Imaginative resources	Indigenous memory and movement between islands that sustained learning webs
Leadership	Local Chiefs and Priests. Authoritarian and deeply traditional leadership style
Related case studies	Easter Island 1500, Bolivia 2009, Angkor Wat 1200
Summary	Core learning is recognising the importance of ecosystems as supporting units for all life. The land division into different resource zones was of great Hawaiian cultural importance and provided integrated landscape units that could be cooperatively managed as life supporting units.

Analytical framework for comparative analysis

Determinants	Cultural values intertwined with natural land management practices, cultural isolation
	Rapid loss of land and population due to contact with Western European influences and adoption of monetary systems
	Sense of place and honouring the wisdom, values of the ancestors as foundation for today's sustainability strategies.

Adelbert Mountains, Papua New Guinea 2009

Ag. 3.4, 4.4 & EB 3.1, 4.1	
Sector focus	Agriculture/Ecosystems
Adaptation to	Loss of traditional life-ways Pressure on natural resources
Adaptive Capacity	Rethinking of social enterprise and entrepreneurship
Social learning involved	Movement towards decentralized economy and co-operative principle
Primary and secondary drivers	Isolation, environmental degradation, maintaining cultural characteristics and traditional social organization in fast developing countries. Need for local people to work together to support themselves without developing agribusiness etc
Success and/or barriers to adaptation	Successes: alternative to more exploitative industries can continue cultural traditions i.e. social structure and traits such as sharing, environmental stewardship Barriers: equitable sharing mechanism crucial, functional structure and governance, financial independence, initial set up requirements. Vulnerability to specialization in trade partners or product type.
Implications for climate change adaptation	Social practices are not unchangeable. Traditional communal and natural capital can be drawn upon to create alternatives to unsustainable market economy.

Adelbert Mountains Cocoa Co-operative, Papua New Guinea.

The Adelbert Mountains Cocoa Co-operative in Papua New Guinea is an example of the worldwide co-operative movement that promises to reshape the lives of many of the world's disadvantaged peoples. The Nature Conservancy[4] (TNC) has been working with 23 communities since 1993 and all levels of government. In the late 1990s, it targeted the Adelbert Mountains as an area to develop sustainable conservancy practices.

One such practice is based on the conservancy co-operative. The cocoa co-operative has 54 financial members from 15 participating communities (TNC, 2008). Income will be used to build schools, aid posts and set up eco tourism facilities as well as cover conservation management costs. Increasing financial members and productivity of crops is the primary focus as is establishing an access route to transport stock to market (Weber, 2009).

Overview of co-operatives

The International Co-operative Alliance (ICA) was founded in London in 1895, ICA is the largest non-governmental organization headquartered in Geneva. ICA has representation in over 94 countries; serving more than 235 member organizations and involving well over 760 million individual members around the world. The United Nations reported in 1994 that the livelihood of nearly 3 billion people, half of the world's population, was made

[4] See for details: http://www.nature.org/wherewework/asiapacific/papuanewguinea/work/art6725.html

secure by co-operative enterprises. Co-operatives significantly contribute to economic and social development on a global scale (ICA 2010).

A co-operative is defined by The International Co-operative Alliance as an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise. The fundamental principles include: voluntary and open membership; democratic member control; economic participation; autonomy and independence; training, education and information; co-operation and a concern for the community (Grossman, 2008; ICA, 2010).

There are different official co-operative focus types such as agriculture, women's involvement, poverty alleviation etc., however co-operatives, such as the Adelbert Mountains Cocoa Co-operative, formed through an environmentally aware conscience are of particular focus here for the relevance to climate change adaptation (ICA, 2010). Conservation or agro-ecological co-operatives are less common but are emerging as a strong model from which much can be learned for climate change adaptive strategies and behaviour (Faber, & McCarthy, 2001). They have formed where sustainable land management practices are being encouraged and business enterprises are in accordance with social and environmental needs. In many circumstances, the formation of conservation co-operatives is facilitated by a Non Government Organisation (for example The Nature Conservancy) and often occurs in developing countries where much of the earth's biodiversity and sustainable culture reside (TNC, 2008).

Agro-ecological or conservation co-operatives

The Adelbert Mountains Cocoa Co-operative is an example of an agro-ecological or conservation focused co-op. Such co-ops are groups of people with a common purpose that learn to communicate and work together to achieve sustainability and equity, managing their natural capital while earning income from producing organic fair-trade products. It is a shared concern for the community and environment that distinguishes these co-operatives and sustains them whilst introducing modern tools that aid capability of adaptation to the changing social, economic and environmental context (TNC, 2008). Often they combine local and traditional ecological knowledge with the biological sciences and partake in the challenging process of implementing this integrated approach to sustainable business development and natural resource management by adopting the most environmentally and culturally sensitive approach (Menzies, 2006).

NGO involvement with agro ecological co-ops can facilitate access to networks and services and aid the challenging set up process for local people. NGOs, such as TNC, also incorporate payments for Reduced Emissions from Deforestation Destruction (REDD) and eco tourism in conservation planning as promising sustainable income sources. TNC collaboratively establishes binding conservation agreements that are sensitive to indigenous land management and in doing so improve property rights with legal reinforcement by liaison with all levels of government. This also introduces external monitoring to access the set up process and aid strengthening the initiative by work-shopping to reduce potential weaknesses to their success and can bring secure and measurable success (Weber, 2009).

This mode of interaction and social organisation develops adaptive learning cycles that foster capacity building and problem solving. Such learning processes are highly advantageous as climate change issues arise. The strong bonds and motivation to help each other in the co-op will ensure human capital is effective during crises when other facilities services may not be available.

Internal and external challenges

Co-ops have a strong emphasis on building economic function and adhering to shared social and ecological principles reinforced with bylaws. The main external challenges faced by co-ops are lack of human and financial capital. Recruiting sufficient financial members and saving sufficient funds to get fair trade and organic certification can also be extremely difficult for peoples in developing countries. Internal challenges include shortage of facilities to produce quality and quantity of product, gaining necessary skills base to manage finances, co-operative function and develop professional trade relationships (Weber, 2009).

Equitable sharing of tangible benefits is of particular importance in a co-operative as is good governance structure and function. Often conflict can arise within a group or between groups due to unequal access to resources, infrastructure or services, thus equal enabling conditions must be considered (Weber, 2009). Lasting conservation and successful economic enterprises is a function of the ongoing management of social relations, constructive planning and judicious adherence to principles and bylaws.

Other common challenges are listed below (Weber, 2009):

- Market price fluctuations
- Management & planning that is fair and effective
- Developing financial management skills and equitable sharing mechanism
- Prioritizing expenditure to establish health and education services
- Maintaining ecologically sensitive practices and producing enough yield
- Initial set up cost and sufficient financial members
- High compliance requirements (fair trade and organic certification)
- Lack of effective communication/awareness
- Insufficient representation of disadvantaged groups
- Producing enough stock to meet trade quota without over expenditure
- Dependency on external assistance.
- Specialisation i.e. having only one major trade market or producing only one product.

Common factors associated with successful co-ops include (Weber, 2009):

- Good land management
- Good governance and planning
- Equitable benefit sharing
- Access to decision making process
- Social, economic and environmental tolerance & resilience
- Effective training & monitoring
- Technical support
- Diverse crops and markets
- Communal resource use

Level: macro, meso or macro	Macro vision working at the micro level
Physical context	94 countries
Rapid or incremental change	Conservation co-ops have been on the scene since the 1980s but it is only recently that the context (legal, cultural and economic) has been in their favour.
Cultural values	Stewardship, communal sharing, ecologically and spiritual respect, lore guided.
Societal addictions	Greed; jealously; rebellion, individualism, competition. Lack of cohesion. The idea that structure can be transposed (i.e., a social process can only be successful if it is work-shopped from within).
Imaginative resources	United vision and commitment for common good, integrative sciences, intent to maintain biodiversity, range of spiritual traditions, social adaptation whilst being culturally and environmentally sensitive.
Leadership	The co-op structure has elected board members and directors; however, this is often encouraged to be considerate of cultural organization or relations.
Related case studies	Curitiba 1990s, Ecovillages 2009
Summary	The Adelbert Mountains Cocoa Co-operative in Papua New Guinea is an example of a new approach to co-operative economics that links conservation, entrepreneurship and social capital to increase the wellbeing of local communities. The conservation co-op structure and function can be adopted to assist governance and promote social and environmental resilience.

Analytical framework for comparative analysis

Determinants	Lack of opportunity to participate fully in economic initiatives.
	Detrimental effect of exploitative industries on environment and livelihoods.
	Linkage between global social movements and local resources
	Lack of access to markets and income, lack of infrastructure and services.

Sale in 1870[5]

Ag. 1.1	
Sector focus	Agriculture
Adaptation to	Intense rain period – 17 floods in 1870
Adaptive capacity	Application of new instrumental (scientific) understanding of the world
Social learning involved	Measurement provides a level of control
Primary and secondary drivers	Dependency on weather patterns for agricultural work Public demand (pushed by local media) for authoritative solution
Success and/or barriers to adaptation	Success: Establishment of local weather monitoring Barriers: Alignment of local power with commercial setting (Publican as mayor and weather monitor)
Implications for climate change adaptation	Social groups look for authoritative solutions and their choices are based on current assumptions about knowledge/control

The rural Victorian town of Sale, situated in the Gippsland region experienced seventeen floods in 1870. Rainfall across Victoria had been highly variable that year and resulted in a public call for regular monitoring by an authority. Prior to this, the only public 'record' had been local memory.

Thus, we find the *Gippsland Times* noting on Saturday October 23 1869.

> The cattle about Rosedale, in fact throughout the district are looking fat, sleek and impudent. It is quite gratifying to behold their polished sides and the air of satisfaction with which they swing their tufted tails...We have been informed by a gentleman residing near Rosedale that he does not remember a season equal to the present for seven years past. Nor has he seen anything like the present rapid growth of grass during the last fortnight. Should the season prove a dry one, the bush fires will be most extensive.[6]

In the following year after seventeen floods the same paper noted on 19 July 1870:

> 'The rainfall in the neighbourhood of Melbourne, according to the Argus, has only been 12.80 inches since the beginning of the year. The rains thus far during 1870 have varied much in different parts of the colony; but it is questionable if any place has been more severely visited in this respect than Gippsland. It would be well if a rain gauge were established at one of the Government offices, either here or at Bairnsdale, as records, besides being interesting, would be likely to prove useful in a country so liable to periodical inundation by disastrous floods.'

[5] Information provided by Kylie Carman-Brown in her paper "Hydrology and History: A Match Made in Heaven or Hell?" as part of her doctoral research in the History Program, Research School of Social Sciences, Australian National University.
[6] Gippsland Times, 23 October 1869

The public authority to do the measuring was the mayor. As a result of extreme weather variability and the threat to livestock and human habitation, Sale became the first rural site to host a 'weather station'. This was thirty-one years after the area was first colonised.

Level: macro, meso or micro	Meso – structural innovation – the measuring and recording of rain, temperature and air pressure
Physical context	Rural agricultural; considerable clearing; increased flooding
Rapid or incremental change	Rapid increase in number of extreme hydrological events
Cultural values	Anecdotal memory, measure relates to productivity, science increases control
Societal addictions	Heavy land clearing
Imaginative resources	Science and progress linked
Leadership	Mayor, due to public and media pressure initiates a public record; Mayor has resources to fulfil immediate demand – i.e., he has a thermometer barometer and hygrometer
Related case studies	New Orleans 2006, Sydney 2000,
Summary	Core learning is measurement to aid control of a variable phenomenon. Structural adjustment linked to emergent science of hydrology. Sale becomes the first regional weather recording station in colony of Victoria – 31 years after colonisation of the area.

Analytical framework for comparative analysis

Generic determinants	Emergent scientific culture of measurement; emergent science of statistics
Context specific determinants	Flash flooding linked to land clearance; availability of measuring instruments

Exclusion Zones - DMZ and Chernobyl – 2009

EB 3.3	
Sector focus	Ecosystems and Biodiversity
Adaption to	Consequences of human action – exclusion zones where human activity is minimal
Adaptive capacity	Involuntary parks form in these exclusion zones providing sanctuary for flora and fauna including rare and endangered species.
Social learning involved	Improved understanding of how 'impacted' (heavily populated and cultivated, war, nuclear fall-out) areas may react in the absence of human settlement and associated activities.
Primary and secondary drivers	Derivation of exclusion zones devoid of human activities/settlement due to conflict (Korea) or disaster (Chernobyl) has provided uncontested environment for flora and fauna.
Success and/or barriers to adaptation	Success: Ongoing exclusion of people from these zones National and international recognition of the environmental amenity provided by the restoration of flora/fauna in these areas. National and international scientific recognition of these areas. Barriers: Economic pressures to re-populate these areas as population increases. Residual radioactivity (Chernobyl) has adverse impacts on physiology of flora and fauna.
Implications for climate change adaptation	Social learning and adaptive capacity arise in unexpected places. Human action has unforeseen effects from which unanticipated learning may arise.

Exclusion zones, which are areas devoid of human settlements and associated activities, can be the consequence of conflict and disaster. They provide an 'involuntary' refuge for local flora and fauna. Two of the best-known exclusion zones are the demilitarized zone (DMZ) that demarcates the boundary between the Democratic People's Republic of Korea and the Republic of Korea, and the 30 km radius exclusion zone around the site of the 1986 Chernobyl disaster. The primary objective of these exclusion zones was to keep people out, however a beneficial and unanticipated side-effect has been to provide sanctuaries where local flora and fauna can forage and re-establish their populations in the absence of competition with humans.

The DMZ between the Democratic People's Republic of Korea (North Korea) and the Republic of Korea (South Korea) was established by the United Nations Military Armistice Commission in 1953 (John, Youn, & Shin, 2003) and created a sparsely human-populated 1000 km^2 corridor spanning the Korean peninsula. Contiguous to the DMZ is the Civilian Control Zone (CCZ), which is a 5-20km wide zone running along the southern border of the DMZ and incorporates farm and forest lands with a few inhabited residential and commercial areas that provides a buffer zone for the DMZ (John, et al., 2003). The effects of isolating this war-scarred area includes restoring the habitat and providing a sanctuary where endangered, threatened or even locally extinct biota such as the Asiatic black bear, leopard, Eurasian lynx, Goral sheep and red-crowned and white-napped cranes have re-established their populations, at least at a local scale (DMZ Forum, 2005; John, et al., 2003; Kim, 1997).

The context for biodiversity within the exclusion zone around the site of the Chernobyl nuclear disaster is complicated by the confounding effects of radioactive fallout and the absence of human settlements. On April 1986, the Chernobyl Atomic Power Plant released between 100 and 200 million Curies of radiation into the environment (Baker & Chesser, 2000). The human health impacts associated with this disaster has been devastating and continuous, as characterized by the ongoing increase in incidence of thyroid carcinoma (Thyroid cancer) in those people exposed to the radioactive fallout (Williams, 2008). However, the creation of a 30 km radius exclusion zone has reportedly been beneficial for biodiversity and species richness of local flora and fauna (Baker & Chesser, 2000) although these are not as clear-cut as for the Korean DMZ and there is some debate as to whether in the long-term, there will be a benefit. There is agreement that the initial impact of the explosion and fall-out was adverse, especially on the aboreous layer (flora) which initially trapped 60-90% of the radionuclide fallout and saw the death of ca. 400 hectares of pine forests (Sokolov, et al., 1993). Møller & Mousseau (2007), contest the claims that the ecosystem promoted for the Chernobyl exclusion zone is thriving arguing that residual radiation played a prominent role in reducing the species richness, abundance and population of local forest birds. However, the change from a densely-populated area that was intensively farmed to an area devoid of humans and their domesticated animals (cattle, dogs etc) improved the local foraging conditions (Sokolov et al. 1993) as highlighted by the observations of (Baker & Chesser, 2000), who sighted moose, roe deer, Russian wild boar, foxes and river otters within the exclusion zone but not outside of it. Baker & Chesser (2000) did acknowledge that there are adverse impacts of radiation for local flora and fauna but that "*the benefit of excluding humans from this highly contaminated ecosystem appears to outweigh significantly any negative cost associated with Chernobyl radiation*."

Both exclusion zones face management challenges in the future. While the DMZ is controlled by the Military Armistice Commission (Kim, 1997), both North and South Korean Governments hold that this is only a temporary administrative line, not a permanent border (www.globalsecurity.org/military/facility/ dmz.htm). What we find in these situations is a resurgence of species previously compromised by human activity. The collective learning associated with this unexpected result is mixed. People are excited by the rapid resurgence in biodiversity but torn over the precarious and compromised nature of these areas.

Level: macro, meso or micro	Micro
Physical context	Exclusion zones with resurgent ecosystems
Rapid or incremental change	Rapid depopulation of an area
Cultural values	Nil
Societal addictions	National security and Risky forms of power generation
Imaginative resources	New possibilities open up as the result of military and health concerns
Leadership	National
Related case studies	Cuba 1990s, Mobile Phone1990s, Ecovillages 2009
Summary	Both the DMZ and the Chernobyl exclusion zone present opportunities for thinking about unintended consequence of human activity.

Analytical framework for comparative analysis

Determinants	Military and health risks
	Human exclusion
	Environmental resilience

Eastern Pacific Gray Whale 2000

EB 2.1	
Sector focus	Ecosystems and Biodiversity
Adaptation to	Cessation of commercial exploitation. Ongoing decrease in the Arctic ice-sheet extent
Adaptive capacity	Gray whales moving to new foraging grounds.
Social learning involved	
Primary and secondary drivers	Drivers - Decrease in ice-sheet extent from global warming (food availability). Cessation of commercial hunting.
Success and/or barriers to adaptation	Success: Gray whale numbers appear stable Barriers: Sparseness of data may hide adaptive capacity/resilience of the whales to this environmental change Competing species for existing and new whale foraging grounds
Implications for climate change adaptation	A single cause (whaling) is easier to address than broad spectrum socio ecological decline

The Eastern North Pacific (ENP) gray whale (*Eschrichtius robustus*) is a large baleen whale that forages mainly on benthic amphipods in the Bering-Chuckchi Seas (Coyle, Bluhm, Konar, Blanchard, & Highsmith, 2007; Highsmith & Coyle, 1992) during the boreal summer and migrates each year to winter breeding grounds in Baja California (Reilly, 1992). This species was previously commercially hunted to near-extinction in the early 20th century but have re-established their population since the cessation of commercial exploitation. However, a recent decline in whale numbers has, amongst other factors, been linked to a shrinking Arctic ice sheet (Rugh, et al., 2008). Indigenous Arctic peoples may still hunt the gray whale yet but this activity is not linked to numbers of gray whales.

The extent of the Arctic ice-sheet has been generally decreasing since 1979 although the ecological consequences of this trend on ENP gray whale dynamics are not clear. It has been postulated that the ENP gray whale benefits from a reduced ice-sheet because it allows longer and earlier access to traditional and new feeding grounds (Perryman, Donahue, Perkins, & Reilly, 2002; Tynan & DeMaster, 1997) with a longer and more productive feeding season leading to higher calf recruitment. However, within the Bering-Chuckchi shelf, which has been described as a prodigiously productive area (Springer, McRoy, & Flint, 1996), the ampeliscid amphipod community declined by more than 50% between 1972/1973 and 2002/2003 (Coyle, et al., 2007). The decline of benthic productivity in this region has been linked with recent high mortalities of gray whales observed in 1999 and 2000 (LeBeouf, Perez-Cortes, Urban, Mate, & Ollervides, 2000).

Ice-sheet extent in both the Arctic and Antarctic oceans has been noted as an important driver of regional ecological dynamics (Atkinson, Siegel, Pakhomov, & Rothery, 2004; Loeb, et al., 1997; Mueter & Litzow, 2008) with many Arctic species, including ENP gray whales, appearing to be strongly dependent on this coupling of carbon between the water column and the sediment (Budge, et al., 2008; Tynan & DeMaster, 1997). This carbon flux

is instigated by a combination of ice-algae and phytoplankton blooms in Spring (Budge et al. 2008) and the nutrient-rich water imported by the Anadyr Stream (Springer, et al., 1996). Potentially, a reduction in the Arctic ice-sheet could result in increased and earlier phytoplankton production in the Chirikov Basin and the greater Arctic region, aided by warmer water temperatures and reduced light limitation from the ice-sheet itself (Coyle et al. 2007). However, it has been observed that a decreasing ice extent in the Arctic Peninsula has resulted in declining krill and increasing salps indicating a change from a high-productivity to low-productivity area (Atkinson, et al., 2004; Loeb, et al., 1997). Furthermore, increased thermal stratification resulting from warmer temperatures may restrict nutrient resupply through the water column and therefore limit phytoplankton growth (Tynan and DeMaster 1997).

Human responses to declining numbers of this species are confused. There is a general sense that the charismatic Arctic mega fauna such as the gray whale are the indicators of ecosystem health and integrity. However, it is unclear what is to be done. Whaling has stopped and numbers revived but now the problem is less specific and constitutes a system level that is compromised. It is unclear if there is the political will or social imagination to engage fully with the issue.

Level: macro, meso or micro	Meta - global population of Gray whales
Physical context	Arctic ocean
Rapid or incremental change	Rapid and incremental change - blurred somewhat by sporadic population counts
Cultural values	Indigenous cultural values - harvesting of whales for food; romantic attachment to mega-fauna
Societal addictions	Whaling
Imaginative resources	Compromised ability to think globally/holistically about a problem
Leadership	Government, research institutions and interest groups
Related case studies	DMZ/Chernobyl 2009,
Summary	Example of how shrinkage of ice-sheet extent may be affecting the population dynamics of a whale population that has previously recovered from commercial hunting. However, dynamics of population dynamics are unclear, which has implications for ongoing management/protection

Analytical framework for comparative analysis

Determinants	Whaling
	Shrinking Ice Sheet
	Inability to think globally
	Climate change

The Garcia River Forest 2000

EB 1.3	
Sector focus	Ecosystems
Adaptation to	Diminishing Old Growth Forest
Adaptive capacity	Utilise market forces for the environment
Social learning involved	Self Interest can be turned to innovation Rethinking economics, value and long term thinking
Primary and secondary drivers	Loss of old growth forest Climate Change New thinking on Natural Capitalism
Success and /or barriers to adaptation	Successes: establishment of carbon traps Barriers: Institutional inertia Pressure of big business A resource ethic rather than a custodial ethic
Implications for climate change adaptation	Social Learning is accelerated when linked to a dominant value set

This small Californian tract of redwood forest is relatively young and is the site of a new economic and environmental experiment being marketed as “living carbon traps or ‘sinks’” (Henderson, 2009). Ninety Five per cent of old growth redwood forest on the East Coast of North America has been cleared. Deforestation globally accounts for 20% of Greenhouse Gas emissions (Henderson, 2009).

Famed ecologist Michael J Fay recently conducted a mega transect of the redwoods: 1800 miles in all, taking 333 days. His conversation with the timber ‘folks’ he met makes grim readings:

> “Timber folks know the history – most I met in redwood country used words like nuked, hammered, blitzed, wasted and raped to describe the logging of the past” (2009, p. 60).

Originally seen quite simply as a resource the redwoods were systematically felled for over a century, a fact to which Fay attests:

> “I spent too many days on the transect pushing past gigantic stumps, through weedy stands of small trees amid crumbling road systems, over eroded hill sides, and across rivers choked with gravel and silt, whose fisheries had collapsed. It was a landscape shaped by greed and waste.” (2009, p. 60).

The process of forest destruction was the subject of a 1908 conference organised by US President Theodor Roosevelt who noted that it was necessary to:

> “...consider the question of the conservation and use of the great fundamental sources of wealth of the nation... [this] is the chief material question that confronts us” (2009, p.60)

The action of congress could not save the redwoods but did turn the story for the white tailed deer that was endangered at the time but now number more than 30 million. Fay notes however that no such conference has been organised since by a US President.

The redwoods are depleted but places like the Garcia River Forest can still be saved via innovations like carbon sequestration. The selling of carbon credits can induce for-profit forest owners to move away from logging and into other forms of profitable forestry management. With 90% of its wood already removed Garcia River Forest is a shadow of its former self yet it still is a stunning stand of trees.

Thinking is beginning to emerge that questions the narrow view of nature as a resource. The natural system (Hawken, et.al., 2000) argue is a complex set of energy flows. Natural capital is a new form of social learning that fosters adaptive capacity within the economic frame. The Garcia River project is an example of this thinking at work.

Long-term vision is also required to bring it back to health. How long? About 1000 years.

> "'These projects take time. It's not the kind of thing that you can turn a switch and you've got millions of acres of forests sequestering CO_2,' said Eron Bloomgarden, president of environmental markets at Equator LLC, a for-profit venture creating forest carbon projects" (Henderson, 2009).

Following the logic of those who felled the forests, groups are today using self-interest to generate environmental change. In the case of the Garcia River Forest, this is a work involving both the Californian government and private capital. This is where Roosevelt went wrong – he failed to engage with capital.

> California forest projects fetch $5 to $12 a CO_2 ton, more than in other parts of the world and other types of sequestration, because they meet California's developing rules, the closest thing yet to regulations for an official forest market, said Lenny Hochschild, a managing director at environmental brokerage Evolution Markets.
>
> For-profit forest owners increasingly are being tempted to sell carbon, joining non-profits pioneers, he said.
>
> "If you incentivize folks to clean up the environment, they'll clean up the environment," he said.

Level: macro, meso or micro	Meso/Micro: The Garcia River Forest is a micro example of a meso shift towards linking market forces with environmental learning.
Physical context	Dramatically depleted forestry area along 2900kms of North America's east coast.
Rapid or incremental change	Rapid: Intensive logging for over 150 years has virtually eliminated all old growth forest.
Cultural values	Nature is a resource; human needs are separate from natural energy flows.
Societal addictions	Profit at all costs; nature is there for us to use and enjoy.
Imaginative resources	Anthropocentric – human building with hands, over coming obstacles, enduring privation to build a great modern civilization; contrast with the nature romanticism of Thoreau which motivated the generation of Teddy Roosevelt
Leadership	No coherent leadership on behalf of conservation; leadership of the market
Related case studies	Azerbaijan 2005, Easter Island 1500
Summary	The Garcia River Forest represents a new initiative that seeks to combine market interest with environmental goals. It occurs in a context of intensive destruction of a natural resource/habitat. Little adaptive capacity has been shown until recently where a range of initiatives are flagging belated concern for a natural wonder. Tension is between a past pattern of extensive destruction and its legacy and the present attempts to recalibrate human patterns of relating to the environment.

Analytic framework for comparative study

Determinants	Climate change combined with changes in market orientation
	New Leadership
	Hybrid forms of activism that combine market strategies with environmental interventions

Indigenous Australians 2009

EB 1.5	
Sector focus	Ecosystems and Biodiversity
Adaptation to	(1) the imposition of different types of environmental management on Indigenous people brought about by colonisation and globalisation; and the (2) desire to bridge the gap between indigenous and non-Indigenous people, and in particular, in cross-cultural environmental understandings
Adaptive capacity	Limited: Only when significant financial resources are redirected to Indigenous peoples; and there is personal investment in the collaborative process by individuals and institutions.
Social learning involved	There is need for dominant stakeholders to reflect critically on their own practice in social learning processes. These approaches primarily require appropriately trained social scientists of the environment who can transcend the nature culture divide. Better practice requires the definition of problems as shared goals that can be solved through differing perspectives.
Primary and secondary drivers	Cultural and biological interdependencies → attempts to integrate these components of sustainability → often done badly or by people experienced in only environmental/natural sciences → often reported as successful from the point of view of the dominant stakeholder or weaknesses in the process or community are exploited for the aims of the dominant stakeholder and no linking of social-ecological systems occurs.
Success and /or barriers to adaptation	Success: Limited Barriers: The lack of valuing of alternative perspectives, usually through a powerful stakeholder, stimulates competition and mistrust. Representative arrangements are poorly thought through and usually lack cross-scale coordination to bridge the local regional tensions of communities and authorities respectively.
Implications for climate change adaptation	Drawing on alternative knowledges sounds good in theory but faces entrenched systemic barriers to become effective

Long standing, local knowledge, practices and traditions held by small-scale communities who have maintained some degree of connection with their natural environments are often manifest in rules and norms that community members establish and enforce with each other. Community-based environmental management is championed as a decentralised form of social and ecological sustainability that works with people and their environmental management systems to bring about better outcomes for the natural and social spheres.

Community-based approaches are often promoted in settler societies by the dominant culture and indigenous peoples in an attempt to foster greater collaboration with indigenous people and garner improved environmental management, and reduce financial and resource costs for central governments through decentralised activity. Yet, these approaches are largely applied uncritically and with little evaluation as to their outcomes (Carter, 2008).

Partly these approaches seek to embed some form of knowledge exchange between participants using joint social learning mechanisms (Bradshaw, 2003; Pahl-Wostl & Hare, 2004). Ideally, they require dominant agencies to value alternative ways of managing environmental systems and to support community aspirations to do so; and conversely, but problematically, that community understands agency objectives and systemic procedures (Wenger, McDermott, & Snyder, 2002) Yet competition, mistrust, privileging of some individuals over others, the presumption of an 'imagined' community and the performative aspects of the participatory process in exchange for benefits often thwart such attempts (Few, 2002; Quaghebeur, Masschelein, & Nguyen, 2004).

Mostly the barriers to successful interaction are related to bureaucratic cultures and ingrained ways of perpetuating the dominant perspectives through institutional racism (Carter & Hill, 2007a). Institutional incapacity to engage equitably and to devolve 'real' power (Carter and Hill 2007a) and lack of legitimized and validated acknowledgement for, and respect of, the community-based system (Carter & Hill, 2007b, p. 872) are further barriers to successful long-term implementation of these approaches. While there are some successful examples of cross-cultural collaboration, resolution of these issues will require more than internal attention to community-based engagement strategies – it will necessitate significant political and cultural shifts in the relative power of Indigenous people and other environmental managers at regional and national scales.

Level: macro, meso or micro	Micro – seeks to work with local communities; but Meso – attempts to generalise or co-opt any successes into the dominant paradigm
Physical context	Small-scale, rural communities
Rapid or incremental change	Minimal change, often through limited political commitment to long-term equitable outcomes
Cultural values	Varies within and between communities but there is usually a mistaken assumption by institutions that communities are homogeneous Institutions often mistakenly assume there is equality in the process, decision making or even level of interest/participatory desires held by community members
Societal addictions	Institutional need to control
Imaginative resources	Bureaucratic and linear; attempting to integrate systems thinking and multi scale processes; indigenous cultural practice
Leadership	Often leaders are chosen for a particular instance but institutions continue to work with their contact or with any person they can find without reflection or further guidance by community members. Leadership is a contested field and issues of governance and representation are a complicated field.
Related case studies	Hawaii 1700, Curitiba 1990s, EB 3.1
Summary	An approach that is usually championed in theory and limited in practice, or at least, from the perspectives of many Indigenous peoples.

Analytical framework for comparative analysis

Determinants	Successes are sometimes hijacked by institutions or communities and reworked to serve dominant agendas.
	Overly focussed on environmental technicalities at the expense of local social and ecological connections.

Maroochy 1990s

EB 1.4	
Sector focus	Ecosystems and Biodiversity
Adaptation to adaptive capacity	Self- determined, reflective, flexible and multi- disciplinary structure and constituency that enables adaptation to changing physical, economic and political landscapes.
Social learning to adaptive capacity	Balancing group identity and core values with institutional responses to environmental management.
Primary and secondary drivers	Group dynamics, expertise and values; Institutional support mechanisms
Success and barriers to adaptation	Innovative, entrepreneurial, co-operative, interactive, collaborative and participative approaches to catchment management can both enhance and constrain adaptation when engaging institutional structures
Implications for climate change adaptation	Interactions across scale can compromise the original values of grass root movements

Since the mid 1990s, community groups and collectives have featured prominently in Natural Resource Management (NRM) in South East Queensland as various stakeholders demanded more efficient and equitable management strategies to address threats to the region's catchments. Effective management of change needs to incorporate strategies that enhance the resilience and adaptive capacity of a catchment as a social ecological system in the event of rapid change

Community involvement in decision-making processes has become increasingly institutionalised as recognition that individual citizens expected fair and equitable participation in decision-making processes increased. Provision for such participation was instituted through the State Government's Integrated Planning Act applied through Integrated Catchment Management (ICM) principles, which advocated coordinated, participatory and collaborative approaches to direct the energies, knowledge and expertise of the grass roots. They advocated 'best practice' and sustainable methods for stakeholders to tackle rapid economic, demographic and cultural changes.

The Maroochy Mooloolah catchments with their physical, social, cultural, and economic diversity provide a particularly heterogenic population whereby stakeholders of contrasting values, knowledge and interests compete for access to land and water. The catchments are geographically and ecologically diverse, consisting of coastal and estuarine areas, mud plains and hinterland terrain. They support a broad range of activities within a relatively small boundary where citizens compete for water, land, recreational space, infrastructure, and aesthetic position. Although a consensus exists that sustainable strategies for the catchment are desirable, several ICM committees, Landcare, Waterwatch and Catchment Care Groups emerged in direct response to specific demands imposed by perceived ecological, industrial and developmental threats to the area's ecological, social and cultural wellbeing. Table 1 illustrates the demands and responses generated by the Maroochy Mooloolah Catchment Coordinating Association (MMCCA) and Maroochy Waterwatch.

Table 1: Group demand and response

Organisation	Demand / Threat	Response
Maroochy Waterwatch	Deteriorating health of Waterways, especially tributaries and streams	Water testing, Education, Networking, Revegetation
MMCCA	Government demand for Integrated Catchment Management Strategies	Development of Catchment Strategy by 22 community sectors. Devolution of funds to community groups

Source: (Nash, 2005)

These groups contribute to the decision-making process by providing knowledge and information pathways between grass roots and the strategic level participants. Such grass roots' activists have their 'fingers on the pulse' of community responses and concerns, thus identifying emerging ecological and cultural adaptation demands (Smit & Wandel, 2006).

Cultural values: structure, constituency and orientations

Maroochy Waterwatch and the MMCCA members were largely motivated by concerns for environmental quality, 'sand and sun' lifestyle, regional identity and rights to self-determination (Nash, 2005). Both groups were committed to protecting the economic, ecological, cultural and social identity of the Sunshine Coast. The underlying values that drove both groups were clearly linked to these concerns. Despite preponderance for substantive or non-material values, there was an overwhelming desire for institutional acceptance, acknowledgment and support, and an absolute reliance on science and technology, but tempered by the desire for autonomy and freedom from interference. This tension emerged as a determining factor in framing each groups' resilience and adaptive capacity.

The organisational structures, constituencies and orientations of both groups illustrate this point as indicated in Table 2. Whereas Maroochy Waterwatch was able to integrate the instrumental character of the system and science with their intrinsic values, the MMCCA demonstrated a limited capacity to do so.

Table 2: Group Comparison

	Maroochy Waterwatch	MMCCA
Public access	Open shopfront office	Closed location in a government department building
Origin	'Bottom up' organisation	Government initiated incentive
Community structure	Networks extensively with other 'grass roots' organisations, schools, sporting clubs and local businesses	Community sector representation
Inter-group relations	Collaboration with industry groups, local government and larger non-government organisations (NGO)	Representation by industry groups, local governments and NGOs.
Strategic role	Engagement in regional strategic level processes as a community based group	Responsible for strategy development
Group orientations	Intrinsic, cultural and spiritual value orientations	Instrumental, goal orientation
Group structure	Autonomous, self-determined clear group identity.	Competing sectoral interests and needs
Organisational structure	adaptable, entrepreneurial, flexible and re-inventive	Rigid bureaucratic profile and structure
Constituency	Skilled, expert, specialised members.	Sectoral representation
Vision	Shared, consensual, dynamic	Fragmented, pre-determined

Source: Nash 2005-Social Harmony in Catchment Management.

Trajectories: Response to change

Despite fundamental differences, both groups contributed significantly to the ecological, aesthetic and cultural well-being of the Sunshine Coast. Both groups have played central roles in the development and implementation of the regional strategy management plan while also successfully participating in, or overseeing, numerous community environmental projects. However, the different trajectories of the groups indicate that their resilience in the face of change varied considerably. In the early 1990s, a number of changes occurred that tested the resilience of both groups. These were:

- ICM organisational arrangements were disrupted by the withdrawal of administrative support from a government agency.
- The collapse of the sugar cane industry on the Sunshine Coast resulted in the withdrawal of cane farmers from the catchment management processes.
- South East Queensland Catchments was created as a single body to manage the catchments' natural resources.
- The Maroochy Shire Council began developing its own strategy.

The MMCCA was a composite group formed specifically to coordinate the catchments' NRM activities and to develop a catchment strategy. It successfully implemented a 'Grants Devolution' scheme to distribute funding to several local projects, while its formulated strategy contributed to the current SEQ Catchments framework. However, it was found failing when faced by the above abrupt changes. It had been too rigidly 'locked in' to its pre-determined agenda (Allison & Hobbs, 2004). With the loss of direction and leadership, the MMCCA lost support of its members and consequently disbanded in 2006.

Maroochy Waterwatch, on the other hand, exploited the changes to its advantage. It began as a small group of concerned citizens who united to monitor the health of the rivers and raise awareness of the growing threat to the waterways. Since its inception, it has progressively expanded and intensified its role and status in the community to meet changing demands and institutional arrangements. It responded by adopting a pivotal role in the catchment by entering into partnership arrangements with the Maroochy Shire Council, and serving as a hub for new organisations such as SEQ Catchments and Qld Environmental Sustainable Schools Initiative (QUESSI). However, success may come at a cost to its core values and identity.

In its quest for institutional recognition, Maroochy Waterwatch has inadvertently elevated its status towards the meso organisation level. In many ways, this emanates from a conflict of leadership culture. It is committed, on the one hand, to its core values and objectives, while pandering to its institutional cravings on the other. The traditional charismatic style of leadership and the modernistic hierarchical mechanisms are at odds here (Pakulski, 1991). This may well be what (Touraine, 2000) refers to the "subject struggling against the triumph of the market and technologies, on the one hand, and communitarian authoritarian power on the other". Maroochy Waterwatch's strong links to local government and SEQ Catchments, for example, may weaken its autonomous and self-determining character as its members struggle to balance its intrinsic orientation with the instrumental needs of the meta and meso levels.

Consequently, its flexible, substantive mode has been compromised to a considerable degree by the formal and bureaucratic rationale in its quest for autonomy. Practices and procedures are increasingly expected to conform to funding requirements and support mechanisms, or what is commonly referred to as 'capacity building' (Curran, 2006). As a move to maintain its autonomy, it has embarked on a commercial venture in which its 'catchment services' tenders for revegetation projects. Maroochy Waterwatch, by entering the open market, is now competing with former allies. As the potential impacts of climate change and population-growth becomes clearer, the values, identity and orientation of Maroochy Waterwatch may become increasingly compromised as its executives attempt to integrate its autonomous grass roots' character with institutional objectives.

Level: macro, meso or micro	Micro: Grass roots/ community based integration into management strategy development at meso level.
Physical context	Catchments under pressure from social, demographic, ecological and economic change.
Rapid or incremental change	Rapid institutional and administrative change.
Cultural values	Lifestyle, environmental non-material values versus economic development and progress.
Societal addictions	Desire for recognition and institutional integration
Imaginative resources	Creative, cultural, inter-disciplinary, visionary.
Leadership	Charismatic consensual versus hierarchical order.
Related case studies	Curitiba 1990s, Sydney 2000
Summary	Community groups are vulnerable to institutional demands and their need for system recognition can compromise core communitarian values

Analytical framework for comparative analysis

Determinants	Group values, orientations, constituencies and trajectories used as indicators for group representation of community.
	Rapid institutional changes growing pollution, health issues and demand for democracy.

NSWs Parks and Wildlife 2009

EB 1.2	
Sector focus	Ecosystems and biodiversity
Adaptation to	Monitoring information and performance assessment
Adaptive capacity	Institutional change in response to information
Social learning involved	Management effectiveness evaluation data and a desire to entrench adaptive management in corporate culture resulted in a change in the park management framework, as well as differential use of the information generated, depending on level in the corporate structure, and how information was presented.
Primary and secondary drivers	A critical government audit report and requirement for transparent reporting of performance. International priorities associated with the Convention on Biological Diversity. Top and mid-level leadership and engagement of operational levels. Requirement for numerous governmental reports.
Success and /or barriers to adaptation	Successful adaptation through: • embedding management effectiveness evaluations within the corporate framework for protected area management; • improving efficiencies in corporate reporting; • fostering reflection on the process of management. Barriers relate to: • fear of political consequences of reporting 'failure'; • providing information at the right time, in the right form to the right level for use.
Implications for climate change adaptation	External drivers are important in stimulating change. Leadership at multiple levels in an institution and facilitation of an institutional change process are vital. Early adopters are important to provide a benchmark to influence others. Institutional structures must permit and foster learning and risk taking to facilitate change. Pathways for integrating new information must exist between and through institutional structures. Clearly identifying what is acceptable will define the level of adaptation for the context. Information must be context relevant to those expected to adapt management.

Stimulated by a government requirement to report on the 'State of the Parks' (SoP), Audit Office criticism of the capacity to report on performance, criticisms of previous reports that

were largely inventories with some quantitative measures for a few parks, and a desire for collect data to better inform management, the New South Wales Parks and Wildlife Group of the Department of Environment, Climate Change and Water (NSW DECCW) embarked on a system-wide evaluation of management effectiveness (see Hockings, Cook, Carter, & James, 2009). This paralleled world-wide emphasis on protected area management effectiveness evaluation driven by work of the IUCN-WCPA (World Commission for Protected Areas) (see Leverington, Hockings, & Lemos-Costa, 2008) and the Program of Works on Protected Areas adopted as part of the Convention on Biological Diversity (SCBD, 2004) as well as work in all states of Australia (see Jacobson, Carter, & Hockings, 2008).

By 2009, after three assessment iterations, almost 800 parks and reserves covering an area of 6.7 million hectares or 8.4 per cent of the state had been assessed (Growcock, Sutherland, & Stathis, 2009) and reported (NSW DEC, 2005). A wide variety of information was collected, with the issues for assessment identified during extensive consultation with staff and experts early in program development.

The questions on management effectiveness were linked to management themes, such as weeds, pest animals, fire, threatened taxa, cultural heritage, visitors and asset management. The result is a massive database of information on management effectiveness (at least 30000 bits of information per iteration) with the potential to track progress and provide insight to what management approaches are effective, or otherwise. Of relevance to this analysis is what facilitated the comprehensive collection of the data with the potential to inform adaptation of management and to what extent has the information and analyses actually influenced adaptation of management.

Facilitation of data collection

Growcock, et al. (2009) propose four key challenges in collecting information to inform adaptive management at a system-wide scale:

1. Engendering a sense of ownership of the program throughout the institution was essential, along with ongoing leadership from senior managers (see Schultz & Fazey, 2009), which instilled confidence that participation was worthwhile and that assessments were being used to guide strategic programs. Repeated training was important for data consistency, but also to reinforce the intended uses and potentials of the data.
2. Reliable and defendable data were achieved by basing the program on an internationally recognised approach (see Hockings, Stolton, & Dudley, 2000), repeated training and extensive guiding notes, and data checking through and on-line review system moderated by senior managers.
3. Developing a system for information sharing (products and tools that facilitate the access and use of assessment results) has been fundamental to the uptake of the State of the Parks program (c.f. Stathis & Jacobson, 2009). Sharing of evaluation information supports standardised reporting of management issues and effectiveness, while improved knowledge of management strengths and weaknesses within the park system allows for the development of targeted work programs. However, specialised skills are required to analyse and interpret large or multi-layered datasets and results need to be in a format that can meaningfully inform planning and operational decisions.
4. Acknowledging negative assessments challenges all institutions, public and private, especially where reporting is necessary to stakeholders and shareholders. In the park situation, less than desirable outcomes may be related to management failure, but also to contextual situations such as landscape scale threats (over which

management cannot apply) or simply temporal issues related to allowing time for management interventions to take effect. Identifying the cause of lack of success is essential to adaptive management.

The largely qualitative and expert-based assessments (staff experience, specialist and community opinion, planning documents) of the SoP program are underpinned by integrating science (corporate databases, research and monitoring studies) with management to inform and triangulate the assessments. In areas of management characterised by incomplete knowledge, use and recording of the best available knowledge is essential.

The influence of knowledge on adaptive management

While long-term assessment of the use of the SoP assessments to adapt management remains unclear, early studies of uptake are positive (see Jacobson, et al., in prep; Jacobson, Cater, Hockings, & Kelman, in revision). Issues that emerge are:

- presenting data in a form readily usable by managers and which matches their decision-making frame;
- having a system that provides clear pathways for integration of new information; and
- providing opportunities for managers to manipulate the data to suit their spatial and time-bound decision-making requirements.

Because of high levels of uncertainty within park agencies, management is conducted within two guiding frames: the precautionary principle and adaptive management.

Adaptive management, however, is interpreted in many ways. Its roots are in ensuring managers learn from their actions in robust ways. This has resulted in the practice of large-scale experiments on management; for example, the Fox adaptive management program in Victoria (Parkes, Robley, Forsyth, & Choquenot, 2006). Other interpretations focus on the participation of community, Indigenous people and government in the management of natural resources (e.g. Allan & Curtis, 2003). Underpinning both of these forms of adaptive management is a simple tenet*: when outcomes are uncertain, a wise manager learns from their experience*.

In reality, the practice of adaptive management lies not in adherence to strict experimental guidelines, but in accepting that a range of approaches to management exist, the appropriateness of which depends on the context, question and capacity of an agency (Jacobson, Hughey, Allen, Rixecker, & Carter, 2009).

Level: macro, meso or micro	Macro – system wide assessment of performance to inform management.
Physical context	Protected area management across multiple tenure forms, biogeography, and different levels of resourcing.
Rapid or incremental change	Incremental change to values being managed based on historical land use and increasing threats to the protection or realisation of these heritage resource values.
Cultural values	Entrenched management traditions towards use and sources of information.
Societal addictions	High expectations of performance without understanding of context and acceptability of performance in context.
Imaginative resources	Restructuring of institutional arrangements to integrate new knowledge.
Leadership	Significant at multiple levels within the institution, especially in terms of providing resources and supporting integration of new information into the management framework.
Related case studies	Britain 1800, Garcia River Forest 2005, Donora 1948, Sydney 2000, Maroochy 1990s.
Summary	Use of management effectiveness evaluation information for decision making to support adaptive management can be constrained by the absence of a learning culture within organisations, systems to proactively support use and learning, and presentation of information in ways that are of immediate use to decision-makers at various levels. While presenting summary analyses is part of the needed process, assisting managers to interact with data sets to address issues of relevance to their decision making frame will improve uptake and management that is more reflective.

Analytical framework for comparative analysis

Determinants	External stimulus to change; internal desire for greater confidence in management actions; community demand for greater accountability
	Adapted institutional structures to respond to new information
	Economic and human capital inputs to facilitate change.
	Information presentation in a form that matches the decision-making context.

Phuket, Thailand 2009

EB 1.6	
Sector focus	Energy, Infrastructure and human settlements. Ecosystems and biodiversity.
Adaptation to	Water quality and reef condition decline.
Adaptive capacity	Nil Adaptive capacity constrained by incompatible social goals.
Social learning involved	Based on replicating the past Failure to acknowledge change, cause and probable implications.
Primary and secondary drivers	Resource rich Totalitarian rule Environmental degradation High levels of illness and death due to uncontrolled pollution Immediate social and economic objectives dominate decision-making. Unwillingness to take responsibility for remedial action.
Success and /or barriers to adaptation	Successes: none Barriers: Authoritarian Governance, Historical conditioning Absence of information that links undesirable change and cause. Lack of capacity to enforce social and infrastructure adjustment. Lack of financial capacity to implement remedial actions.
Implications for climate change adaptation	Social Learning is inhibited when historical conditioning, governance and economic systems actively discourage it Personal, community and institutional self-interest (especially relating to income) can thwart effective adaptive response to a threat. Institutional ignorance and unwillingness to acknowledge responsibilities for environmental decline thwart effective adaptive responses. Institutional ignorance stems from a lack of knowledge and a short-term economic focus of interest. Governance approaches to ameliorate environmental degradation can be constrained by community expectations. Financial capacity to address historically based degrading activity is needed with a whole of government and community approach to reverse trends in degradation.

Runoff and sewage discharge from land developments can cause significant changes in water quality of coastal waters, resulting in coral degradation. Coastal waters around Phuket, Thailand are influenced by numerous sewage outfalls associated with rapid tourism development. Water quality and biological monitoring around the Phuket region reveals strong gradients in water quality and biotic characteristics associated with tourism concentration levels as well as seasonal variability (Reopanichkul et al. In press, available

on-line 3.12.2009). Water and reef quality decrease with increasing tourist intensity, but improve with increasing distance from sewage discharge. In addition, the effect of wastewater discharge is not localised around the source of pollution, but elevated nutrients and turbidity appear to be transported to non-developed sites by currents, and exacerbated in the wet season. Wastewater disposal has been shown to significantly increase inorganic nutrients and turbidity levels, and this degradation in water quality results in substantial ecological shifts in the form of i) increased macroalgal density and species richness, ii) lower cover of hard corals, and iii) significant declines in fish abundance. Thus, the effects of nutrient pollution and turbidity can cascade across several levels of ecological organisation to change key properties of the benthos and fish on coral reefs. Maintenance or restoration of ecological reef health requires improved wastewater management and run-off control in order for reefs to deliver their valuable ecosystems services (Reopanichkul et al., 2009).

Such environmental decline threatens the sustainability of the (marine) tourism sector in a major tourism region of Thailand. Of interest to this analysis is the absence of an adaptive response to a widely acknowledged shift in environmental quality and its implications for the tourist sector.

Stakeholder awareness and response

Reopanichkul (2009) explored tourist, operator and government response to declining water quality around the Phuket area to find that international tourists, especially those who focused on marine based activities, indicated that they were largely unaware of any decline in reef and water quality, but would holiday elsewhere if water and reef quality declined significantly. In contrast, domestic tourists indicated that they were well aware of the decline and identified that they would contribute to conservation measures and programs to restore water quality. However, they expressed concern that no community program existed to which they could contribute. Domestic tourists also identified the likely link between water and reef quality decline and the level of tourism, especially the effect of untreated sewage effluent. Tourist operators were also aware of environmental degradation, and their economic dependence on quality environmental conditions, but did not acknowledge the influence of sewage effluent from accommodation centres; rather, they attributed the cause of environmental decline to residential growth. When asked what could be done to remedy the situation, there were few solutions proposed and a lack of knowledge expressed about wastewater management approaches and technologies.

Government officers at the national and regional level expressed considerable concern for the situation, especially for its implications for tourism and fisheries. They identified the existence of legislation requiring impact assessment and sewage treatment plants for developments over 80 rooms. However, developers bypass these requirements by dividing projects into smaller entities. This has led Thai authorities to implement additional regulations that require resorts or hotels with less than 40 rooms (ONEP 2006; Wong 1998) to comply with water quality protection measures. Although legislation is present, government has been slow in responding to the rapid development, with little or no enforcement of regulations (Wong 1998), so the impact of unplanned tourism development continues.

The lack of budget for routine maintenance and monitoring of wastewater treatment systems and qualified technicians to undertake this work are partly the reason for poor water quality management in Thailand. Usually, the construction of public wastewater treatment facilities is funded by the central government with operation and maintenance of the systems transferred to local government. Local governments, especially in rapidly growing regional areas, tend to be constrained, budget-wise, so operation and maintenance of these plants is often neglected. Budget constraints also affect the capacity to undertake regional water quality monitoring as well as analysis of effluent from

treatment plants before release to the sea or underground. The result is that local and regional management of tourism and urban growth occurs in informational ignorance.

Wastewater treatment fees exist in the two main tourist areas of Thailand (Pattaya and Phuket) and are intended to be applied to ensure effective operation of sewage treatment plants. However, the economic crisis in Thailand, since 1997, has meant that collection of fees has not been pursued. Moreover, collection of wastewater fees is difficult because most of the local people, especially in cities, strongly resist payment of the fee. Exacerbating the shortfall in funds to pay for system maintenance, the mayors and staff on most municipal administrations hold their positions through democratic elections. The widespread public resistance to payment of the wastewater treatment fee means that elected public officers are sensitive to public backlash at the ballot box. Accordingly, the wastewater treatment fees policy is all but moribund (Simachaya 2000).

Level: macro, meso or micro	Meso – regional decline in marine water quality and biota and associated threat to tourism.
Physical context	Marine waters associated with significant coastal tourism activity.
Rapid or incremental change	Incremental but accelerating in response to increasing development and as the biophysical environment exceeds its assimilative capacity for pollutants. For the tourism sector, a tipping point may be reached (physical or perceptual) and rapid decline in tourist numbers will result.
Cultural values	Business sector economic imperative predominates and influences acknowledgement of the need to adapt.
Societal addictions	Commitment to economic growth creates unwillingness in government and business to enforce or apply necessary adaptive measures.
Imaginative resources	The social and financial capital to apply needed whole of community response to the pollution threat to livelihoods does not exist.
Leadership	Government, business and community leadership does not exist. Where community awareness is high, capacity to influence local decision-making is low.
Related case studies	Maroochy 1990s, Garcia River Forest 2000, Gray Whale 2009, NSW Parks 2009
Summary	Strong evidence exists that rapid tourism development in the Phuket, Thailand tourism destination region is degrading water and reef quality. This has long-term implications for the sustainability of marine based tourism. While awareness to the threat to livelihoods of declining reef condition exists, business and community short-term self-interest and government inaction in response to political risk mean that change in pollution management is not being considered. Stakeholders that do not benefit financially from the services quality water and reefs provide are disempowered in taking adaptive action to remedy water quality decline.

Analytical framework for comparative analysis

Determinants	Short-term business self-interest and the economic imperative.
	Lack of government leadership due to political risk of a community and business backlash to enforcing legislation and a user-pays policy.
	Lack of community and business awareness and taking of responsibility to apply adaptive measures.
	Disempowerment of the community sector with greatest awareness of the need for adaptation and a willingness to act.

Energy

Easter Island 1500

E4.1	
Sector focus	Human Settlement/Energy
Adaptation to	Environmental Degradation and Authoritarian rule Emergent possibilities relating to production
Adaptive capacity	Social engineering – economic and political reconstruction
Social learning involved	New opportunities require new social systems
Primary and secondary drivers	Resource boom Population growth New technologies New ideas
Success and /or barriers to adaptation	Successes: complex and vital civilisation Barriers: Assumptions about the future based on the past Competition Pathway dependency
Implications for climate change adaptation	Social Learning is inhibited when historical conditioning, governance actively discourage it Isolation inhibits learning

Easter Island was caught in a civilizational end game. The hierarchical structure of Easter Island culture combined with the intricate and prescriptive ceremonial nature through which status was displayed severely limited the cultural resources available to the population when faced with imminent collapse. This combined with weak middle level social infrastructure due to political authoritarianism and the high degree to which local practices were prescribed by tradition and custom, effectively denied the populace any mitigating or recuperative courses of action in the face of rapid environmental decline and high level competition for limited resources (Morrison, 2006).

Isolated Polynesian Island in the South East Pacific. Accounted one of the most isolated inhabited islands on the planet, Easter Island lies 3510 km west of Chile and 2075 km east of Pitcairn. It is a volcanic island formed around an ancient caldera. First settled around 500CE the island grew in population until it reach about 7000 individuals (Ponting, 2001, p. 136). Island resources were limited as the traditional plants and stock brought by colonists were not suited to the temperate climate. Diet as a result was simple and restricted to poultry and sweet potatoes.

> "Easter's isolation makes it the clearest example of a society that destroyed itself by over exploiting its own resources" Diamond, 2005, p. 118.

According to both Ponting (2007) and Diamond (2005) social collapse came rapidly after 1550 following environmental collapse brought about by unremitting tree felling. Land was cleared to support the growing population and to maintain a social commitment to ancestor worship.

As Polynesian ancestor worship was of high priority, local kinship patterns were also very important and resulted in competition for resources to build the famed moai. These figures represented the ancestral deities of the clan and stood looking over traditional lands. The carving of these statues is considered a remarkable feat of intellectual, physical and artistic merit. Ponting speculates that it was the relatively simple needs of the inhabitants – eating mainly chicken and sweet potato – that allowed for much free time for the development of an elaborate religious and ceremonial life that found expression in these monolithic carvings. Cannibalism, a legitimate practice in Polynesian culture, was seen to increase after the collapse of social order, a fact that Diamond speculates as being an increased quest for food.

Commitment to ancestor worship and the clan warfare that underpinned Easter Island society can be seen as significant contributors to social decline. All trees were cleared from the island by the mid 16th century with no hope of replanting or replenishing the forests. Ponting has argued that trees were needed for the transportation of the moai to their final destination and that competition was fierce in this regard. Trees were also cleared for agriculture and housing. By the time Europeans arrived in the 18th century there were no houses of wood, no boats able to sustain long ocean travel and the population was less than half it had been only one hundred and fifty years earlier. Clan warfare continued into the mid-nineteenth century and saw the toppling of the majority of standing moai. However, half the moai ever carved were set in place. Over three hundred remain in the quarry in various states of being finished, indicating how rapid the decline was from societal vigour to collapse.

> "...at the very time when the limitations of the island must have become starkly apparent the competition between the clans for the available timber seems to have intensified as more and more statues were carved and moved across the island in an attempt to secure prestige and status" Clive Ponting (2007, p. 7).

Easter Island's isolation meant that for over a millennia the islanders had no outside communication. (McNeill and McNeill, 2003) point to the need for cross-cultural interaction to stimulate social learning and effective problem solving in the face of new contexts. They also indicate that isolation – literally nowhere to go – also creates 'endgame' contexts that, in the face of failure to adapt, leads to social chaos and the break down in traditional codes and wisdom. The cultural resources of the people were therefore limited to adding details to an existing cultural script. Such was the intensity of competition and the intellectual attraction/completeness of the Easter Island belief system that no significant changes in direction occurred until late in its development (post-collapse) when a new, still untranslated, script called rongorongo appeared. The decisions to fell the last trees were therefore made within a logic driven by clan competition and ancestor worship.

Leadership was clan based and define by competitive responses to violence. The reliance on transmission of learning from elders to the young weakened in the face of ongoing violence and a highly stratified social system in which only a small number of the elite had mastery over the intricacies of social order and the belief system that underpinned it. As the island's social structure collapsed, the cult of the ancestor (moai) was replaced by the cult of makemake or the birdman. This however was also a violent cult and continued the instability of the previous generations.

Easter Island society collapsed rapidly. It demonstrated little or now adaptive capacity. Instead, it intensified known systems of organisation and practice. Thus, tree felling, violence and competition for limited resources all increased that ceased only when the social and physical resources of the culture were irreversibly depleted. Yet the violence and competition continued until the island's population was finally depleted by the incursions of slavers in the 1860s. Disease followed and by 1871 there were only 111 original inhabitants left and of these only 36 had any offspring.

Level: macro, meso or micro	Macro/Meso
Physical context	Isolated island, limited ecological base
Rapid or incremental change	Incremental environmental degradation followed by rapid tipping point
Cultural values	Authoritarian, short term thinking, competition for status
Societal addictions	Authoritarian and competitive clan structure
Imaginative resources	Historically bound
Leadership	Authoritarian
Related case studies	Curitiba 1990s, Azerbaijan 1990s
Summary	Easter Island is the classic Collapse case. It illustrates how core cultural values and deep isolation can shut down imaginative resources and the ability to see and work with alternatives.

Analytical framework for comparative study

Determinants	Hierarchical cosmology
	Competitive ethos
	Future same as past
	Polynesian Warrior Culture
	Limited resources
	Lots of free time

Sweden 2006

E 1.4	
Sector focus	Agriculture/Energy
Primary and secondary drivers	Need to maintain a sustainable and diverse ecosystem that supports human habitation
Social learning to adaptive capacity	Balancing group identity and core values with institutional responses to environmental management.
Primary and secondary drivers	Group dynamics, expertise and values; Institutional support mechanisms
Success and barriers to adaptation	Innovative, entrepreneurial, co-operative, interactive, collaborative and participative approaches to catchment management can both enhance and constrain adaptation when engaging institutional structures
Implications for climate change adaptation	Crisis can initiate change and adaptive learning. Social preparedness to take risks is also essential when thinking about long-term structural change.

In 2006, 27% of the Swedish energy was derived from renewable resources and 15% from bioenergy. Sweden turned to the development of alternative energy following the 1970's oil shock. This commitment was furthered by the need for economic development particularly in the rural areas (Hillringt, 2002). Sweden's extensive forests are key to the ongoing success of its bioenergy program. In addition to energy conservation awareness campaigns, research and development funds were made available by the Swedish Government in 1973 for nuclear, hydropower and bioenergy production (Björheden, 2006). Through programmes such as the "Whole Tree Utilisation" in 1974 and the 1976 "Energy Forest Program" bioenergy production from forestry resources and the cultivation of Salix where explored as sources of alternative energy for heat production (Björheden, 2006).

Environmental sceptics did not approve of nuclear power. In 1980 a referendum was held that resulted in nuclear energy being voted out of the Swedish alternative energy mix and the ultimate phasing out of the early nuclear reactors in 1999 (Haegermark, 2001). Biomass based energy sources remained a priority and support for its development accelerated. In the period 1980 - 1983, the Swedish government made available 170 million Swedish Kroner under the Oil Replacement Fund to make oil burners compatible with alternative fuels and 1.4 billion Swedish Kroner was dedicated to energy research (Björheden, 2006). Another 1.7 billion Swedish Kroner were allocated for the same purpose for the period 1984 – 1987. In 1991, Sweden introduced a carbon tax targeting fossil fuels (Hillring 2002).

The huge dependency of the bioenergy sector on forestry resources raised questions about the sustainability of Swedish forestry systems. This is a contentious issue and the outcome is yet unclear.

Bioenergy projects were largely located in the rural areas, in particular forestry communities in Sweden. The country's climate and land is influenced by its northerly position and the recession of glaciers over 10,000 years ago resulting in wetland areas and shallow and nutrient deficient soils (Barklund, 2009). For this reason, the vegetation is dominated by coniferous forest and relatively slow vegetation growth. Forest cover and

related wooded land constituted 75% of the total land area according to the Swedish national forest inventory 2004-2008 (productive forests - 56%, non productive forest land-14% and other wooded land-5%) (Barklund, 2009).

Sweden grew rapidly in the 20th century. Its economic growth was driven mainly by the forest, agriculture and iron and steel industry between 1913 and 1973. Sweden averaged an annual GDP per capita growth rate of 2.3 between 1913 and 1950, the highest growth rate in this period compared to other industrialised countries (Krantz, 2004). The production and use of durable goods such as cars and other electrical goods grew in the 1930's contributing to the fast growth. This growth came with a high demand for oil and coal that were relatively cheap and could be conveniently used compared to other energy sources such as wood. Sweden increased its energy use by a factor of five or an annual growth rate of 7% between 1945 and 1970 world (Aleklett, 2006).

This commitment to growth is tempered by a deeper commitment to social equity and the expectation that the state maintain a standard of living that keeps all from poverty. The turn to renewable energy reflects a culture that is willing to take social chances. Swedes largely see the state as a mediator of change (i.e. Government is not 'the problem' as Reagan and other conservatives argued).

The structural changes required for this shift came from national and regional governing bodies. Social attitudes and values were bolstered by public education programmes and social debate. Leadership for implementation was largely provided by local governments who collaborated with private companies, research institutions (dominated by local universities) and forestry organisations. This model was intended to pool resources and experiences together in transitioning from a fossil fuel society to a renewable energy society. In some cases local governments created private companies (reporting to local government) that were solely tasked to drive bioenergy development.

Level: macro meso or micro	Meso – structural innovation – the introduction of complementary energy system driven by the need to replace fossil fuels whose supply was uncertain following 1970's oil crisis and later the need to mitigate climate change.
Physical context	Rural Forestry and agriculture; considerable harvesting and replanting of trees and Salix. The bioenergy sector was largely supported by the countries forestry resources. In 2008, productive forests covered 56% of the total Sweden land area.
Rapid or incremental change	Rapid increase in the demand of energy to support improving lifestyles largely dependent on durables such as cars and electrical goods.
Cultural values	Modernity is good; affluence is not equal to happiness; basic needs of all need to be guaranteed by social structures and institutions; individual endeavour and state process are not mutually exclusive
Societal addictions	Demand for energy intensive products
Imaginative resources	Science and progress linked; high degree of risk taking
Leadership	Local governments funded by the national government through research and technology development grants
Related case studies	Cuba 1990s, Curitiba 1990s, Maroochy 2009
Summary	Rethinking a nation's relationship with energy requires a deep commitment to the social learning that this implies. Swedish culture is not risk averse; they work on shared goals at various levels of government and develop programmes that inform the public of what is at stake and the purposes of state initiatives.

Analytical framework for comparative analysis

Determinants	1973 oil crisis
	Social commitment to alternative energy
	Need to safe guard growth economy from a perceived vulnerability
	Resource rich - forestry
	High degree of public involvement

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