# TOWARDS THE DEVELOPMENT OF A CLIMATE CHANGE RISK INDEX FOR LOCAL GOVERNMENT: SOME EVIDENCE FROM COASTAL COUNCILS IN AUSTRALIA

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**Abstract**

The objective of this investigation is to assess the views of coastal council managers regarding which infrastructure assets are vulnerable to climate change to develop a Climate Change Risk Index. There are several implications emanating from this study including that local council managers will require more reporting guidance from federal and state governments. Adequate and consistent reporting across local councils can be used as a means of protecting infrastructure at risk to climate change. This paper contributes to the topical area of the risk climate change could pose for local council infrastructure assets. There are important implications for the safeguarding and maintenance of infrastructure in the face of increasing climatic events.

**Keywords:** Local Government, Climate Change Adaptation, Infrastructure Assets

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## 1. Introduction

Although there appeared to be a general sombre assessment regarding the outcomes achieved at the Climate Change Conference held in Copenhagen, Denmark in 2009, it is significant that the Australian Government is continuing to push forward with reviews and policies to address the risks of climate change domestically. This is particularly so for Australia's coastal region given that these areas are most vulnerable to the effects of climate change. The coastline can experience inundation and/or erosion risk, both of which can impact on the performance of infrastructure. For example, Garnaut (2008 p.128) predicts significant risk to coastal buildings from storm events and sea level rise including flash flooding and extreme wind damage. Nicholls et.al (2007) reports that annually, about 120 million people are exposed to tropical cyclone hazards, which killed 250,000 people from 1980 to 2000. This report also draws attention to the prediction that there will be a *strong* (emphasis added) impact on infrastructure in the coastal zone from floods, extreme events such as storms and wave surges, salt water intrusion and erosion. In support of these findings, Hennessy et.al (2007 p.520) states that:

Sea-level rise is virtually certain to cause greater coastal inundation, erosion, loss of wetlands and salt-water intrusion into freshwater sources with impacts on infrastructure, coastal resources and existing coastal management programmes.

Research investigating climate change and infrastructure is important because as at June 2006 there were 6.26 million people living in Australia's non-metropolitan coastal areas (ABS 2009a). In addition, a large amount of Australia's infrastructure is located in the coastal zone such as ports, power stations, treatment plants, hospitals, universities and schools.

A study by Hennessy et al. (2007) has suggested that by 2030 extreme weather events will overwhelm some existing infrastructure in the coastal zone. There is no one universal definition of the coastal zone, however, for the purposes of the current study, infrastructure within 500 metres of the coastline is considered within the coastal zone. Hence, how councils who control much of this infrastructure intend to respond to this threat falls under the topic of *climate change adaptation* (CCA).

Two major studies released recently have, in part, instigated this current investigation. The first of these reports, *Managing our Coastal Zone in a Changing Climate* (known as *The George Report*) was produced by the House of Representatives Standing Committee (HRSC) on Climate Change, Water, Environment and the Arts (HRSC 2009). Two issues raised from this report are the subject of investigation in this current study. The first is the acknowledgment that climate change will have a significant impact on coastal infrastructure by increasing the likelihood of damage, repair, replacement and accelerated wear to such structures.

Accordingly, the committee developed *Recommendation 16:*

Given that much of Australia's infrastructure is in the coastal zone and the particular threats facing the coastal zone from climate change, involving significant socioeconomic costs, the committee recommends that the Australian Government ensure there is a comprehensive national assessment of coastal infrastructure vulnerability due to inundation from sea level rise and extreme sea level events (HRSC 2009 p.105).

The second issue is in reference to how the disclosure of the risks of and responses to climate change are reported by councils. At the very crux of this problem is that without adequate and consistent data regarding potential risks to the coastal zone, private purchasers and other public sector agencies will continue to make decisions that may have serious consequences in the longer term. Stakeholders may require disclosure of assumptions made regarding, for example, sea level rise and other climatic risks so that they can make informed decisions. Whether that information is made available in the annual report is not investigated in the current project, but certainly is something that should be entertained in future research. What needs to be considered at this point is the role of the accounting information system for CCA. This is a theme explored by Adams and Frost (2008) who suggest that with respect to environmental issues, accounting information is not being used in the decision making process. Presently, the debate regarding climate change, its effects and its causes has been dominated by the hard sciences. This is demonstrated by the volume of research being reviewed within the auspices of the Intergovernmental Panel on Climate Change (IPCC)[1].

This research has a more applied focus and has implications for practice (Adams and Larrinaga-Gonzalez 2007). That is, it is intended to inform local government managers regarding the identification of assets at risk to climate change. The focus of this report is on coastal infrastructure controlled by local councils. In this respect examples of the types of assets which would fall under this category include buildings, water and telecommunication structures, roads and drainage (see Table 3 for a full list of assets). With reference to climate change it is important to note that risks to infrastructure are not limited to sea level rise but also includes other climatic events such as wave surges, extreme storms, bushfires, coastal and inland flooding, droughts and heatwaves and earthquakes.

[1] The Intergovernmental Panel on Climate Change is the leading body for the assessment of climate change, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences.

## 2. Literature Review and motivation for the project

In order to provide a frame of reference for this investigation, a review of literature on social and environmental accounting and sustainability accounting is undertaken. Further, a discussion of climate change adaptation is provided as it is a major component of the federal government's strategy in mitigating the effects of climate change.

The sustainability discourse is relevant for this investigation because sustainability implies benefits accrued over the long-term. Infrastructure assets are also acquired for long-term use and communities rely on their operational functionality regardless of the type and frequency of climatic events. In fact, there is a case to suggest that ensuring the operational integrity of infrastructure during and after climatic events is even more important as without that, rescue and recovery efforts can be severely hampered. The recent floods in Queensland and Victoria and the earthquake and subsequent tsunami in Japan are examples of this premise. How infrastructure coped under climatic events would provide stakeholders with an understanding of which assets are predominantly at risk. In addition, it may well be appreciated that additional costs may need to be incurred before, during and after acquisition of such assets in order to add credence to the sustainable proposition.

In the accounting domain, terms such as social and environmental accounting (SEA), triple bottom line (TBL) and the balance score card (BSC) appear recently to have been surpassed by the phrase sustainability accounting and reporting (SAR). There is now a substantial body of literature in this field and is being further encouraged by special issues on this topic (Bebbington and Gray 2001; Gray 2006; Daub 2007; Frame and Cavanagh 2009; Lehman 2001; Thomson, 2007).[2]

What sustainability accounting and reporting (SAR) means has been subject to critical analysis (Schaltegger and Burritt 2006). For example Gray (2010 p.50) provides a thorough analysis of the use of the sustainability phrase intimating that the more often it is used, the less often it is scrutinised thus:

> *This has the effect of presenting a suite of increasingly pervasive narratives/accounts of sustainability comprising some relatively benign, win-win cocktail of economic achievement, managerial excellence, environmental probity and social responsibility. This tantalising recipe shows every sign of populating business and management discourse – and probably political discourse – largely unchallenged.*

The Global Reporting Initiative (GRI) also uses the phrase sustainability reporting in its documentation and has developed a specific *Public*

*Agency Sector Supplement* (GRI 2005). A recent report by the GRI found that city councils were more likely to disclose information regarding the *State of the Environment*, but overall found a low level of use of the sector supplement (GRI 2010).

Several theoretical frameworks have been adopted to help explain sustainability accounting. Ball and Craig (2010) use institutional theory to help explain operational changes regarding the waste disposal services at one English county council and a Canadian city council. They found that greater scrutiny of the interests, beliefs and activities of managers would provide deeper insights into change at the institutional level. Bebbington, Higgins and Frame (2009) also used institutional theory to help explain why organisations initiated sustainable development reporting. In analysing the narratives of six organisations, the authors found that institutionalisation influenced the sustainable development activity rather than the content of sustainable development reporting.

In the context of sustainability research in the public sector it would appear that theories of accountability and stakeholder theory may be more relevant. In the study by Marcuccio and Steccolini (2005), twelve local authorities in Italy were investigated to ascertain the reasons for the adoption of social and environmental reporting and assess whether this form of reporting reduced the accountability gap within local authorities. They found that the overwhelming reason for the introduction of social and environmental reporting (SER) was not to legitimise its activities but because of a search for improved efficiency, effectiveness and accountability in the context of public sector reforms.

Alternatively, there is no reason why more than one theory cannot be used to help explain organisational behaviour. Larrinaga-Gonzalez and Perez-Chamorro (2008) in their investigation of nine public water companies in Spain suggested that improvements to accountability did not necessarily have to be through formal sustainability reports, but that informal reporting such as web-site information, flyers and advertising could be just as effective. Moreover, practical achievements in terms of increasing availability and decreasing per capital consumption of water were adequate to maintain legitimacy rather than publishing sustainability reports.

The justification for SER has also been informed by legitimacy theory which features considerably in the accounting literature (Deegan 2002; Cho and Patten 2007; Kuruppu and Milne 2010). Deegan (2007, p.123) defines legitimacy as theory:

> *that proposes that organisations always seek to ensure that they operate within the bounds and norms of their societies; that is they attempt to ensure that their activities are perceived by outside parties to be legitimate.*

This is closely aligned with stakeholder and accountability theory as well in that external organisations and the community in general have a vested interest in the activities of the organisation. How local councils intend to report on CCA and which infrastructure is at risk to climate change can be reasonably contended as being information that would be desired by the wider community. Accountability implies that managers are able to justify their decisions. In the context of the public sector, it can be argued that this accountability notion is even stronger because unlike in the private sector where there is a choice by the individual on whether or not to invest in a particular company, no such choice exists in the public sector. That is, we are all taxed.

### *Coastal climate change adaptation*

Adaptation refers to the ability of the community to put in place structures, procedures and policies in order to continue to function after a climatic event (Mirfenderesk & Corkill, 2009). Hence, this would imply that the public has greater resilience due to the increased adaptive capacity. In order to facilitate coastal climate change adaptation, an organisation would also need to have in place adaptive policy making, planning, management and governance. This suggests that successful climate change adaptation practices cannot be implemented in isolation from all other facets of the organisation.

A comprehensive study investigating the adaptation practices across numerous types of organisations (public, private, NGO's and local authorities) in the UK, identified more than 300 types of adaptation (Tompkins et.al. 2010). Important drivers of adaptation to climate change included regulation, perceived and real climate change impacts as well as corporate social responsibility obligations. Tompkins et.al. (2010) also found that adaptation initiatives have been dominated by government initiatives which suggests that market forces alone are unlikely to be effective in building adaptive capacity.

In Australia, there are three generally accepted methods of adaptation although more detailed and specific adaption measures are also available (DCC 2009b). *Protection* refers to constructing fixed defences against storm surge and sea level rise. These could include sea walls and dykes. *Accommodation* allows continued use of the asset but may include elevated floor requirements, increased setback guidelines and emergency management plans. *Planned* or *managed retreat* involves relocating or abandoning assets based on a cost-benefit scenario due to their being located in a high risk location.

The review of the literature suggests several knowledge gaps in accounting for climate change. It demonstrates calls being made for additional research in this domain because it is a relatively new area of investigation ripe for exploring some very

fundamental issues at the local government level. These include, but is not limited to, exactly which types of infrastructure is vulnerable to climate change, what kinds of problems are councils concerned about with regards to CCA and how should CCA be reported. This investigation seeks to fill part of this void. Hence, the objective of this project is to:

- identify which infrastructure assets are at risk to climate change and develop an index to quantify that risk through the development of a *Climate Change Infrastructure Risk Index* (CCIRI).

## 3. Research method

The investigation is exploratory in nature. It is designed to ascertain the current 'state-of-play' regarding what assets are at risk to climate change. This is a 'first-order' raw data requirement in that these findings are crucial in gaining an understanding of the current landscape that the coastal councils now find themselves in. Importantly, the research question drove the research design (Zikmund et al 2010).

The database used for the distribution of the survey instrument to the coastal councils was provided with the assistance of the National Sea Change Taskforce (NSCT). This organisation was established in 2004 and represents the interests of coastal councils in Australia. In particular, the taskforce was established as a representative group to voice concerns regarding the 'sea change' phenomenon. This has included rapid population growth in many coastal communities and identification of a lack of infrastructure and support services to meet the expectations of growing communities. Collectively, the member councils on this taskforce represent approximately four million residents.

The survey instrument was provided to the NSCT directorate, who, in-turn, e-mailed the survey to the Chief Executive Officer (CEO) of all of its coastal council members. As of May 2010, there are fifty-five local council members spanning across the six states of Australia. It was considered that a more favourable response rate would be achieved if the Director of the NSCT sent out the survey with a covering note encouraging participation in the project. After approximately four weeks twelve responses were received representing a response rate of 21.8%. After an additional e-mail from the NSCT Directorate to the coastal councils, a further nine completed surveys were received. Thus, in total twenty-one responses from a total database of fifty-five were received representing a 38.2% response rate.

### *3.1 Data analysis*

Respondents to the survey were asked to identify which three (3) assets (from a list provided) they thought were most at risk to climate change, where one (1) equated to *most at risk* . Thus, a ranking of one to three was documented. The development of the CCIRI index was undertaken by attaching a numerical value to each of the three assets selected as detailed below in Table 1:

**Table 1.** Development of CCIRI

| **Respondent ranking of risk to asset (1, 2 or 3 *where 1= most at risk)*** | **Points assigned** |
|---|---|
| 1 | 3 |
| 2 | 2 |
| 3 | 1 |

Each of the raw score rankings one to three were manually recorded for each respondent in an excel spread sheet. Then these rankings were converted to the *points assigned* classification. The total of these points were calculated with the rule being that the higher the points assigned to the asset class, the higher the risk that asset poses from climate change.

## 4. Findings

### *4.1 The Climate Change Infrastructure Risk Index (CCIRI)*

Respondents were asked to identify and rank the potential risk to infrastructure due to climate change. Table 2 indicates that roads, drainage, recreational parks and wharves and jetties are assets significantly more at risk to climate change than other assets. It is noteworthy also that other infrastructure such as arterial roads, water supply, sewerage and public transport may be managed and maintained by other government departments and agencies within their respective states. These types of infrastructure were not included in the current study as they fall outside the responsibility of the local councils.

**Table 2.** Climate Change Risk to Infrastructure

| Asset | Risk index (CCIRI) |
|---|---|
| **Roads** | 35 |
| **Drainage** | 31 |
| **Recreational parks** | 16 |
| **Wharves and jetties** | 11 |
| **Sewers** | 5 |
| **Boat ramps** | 4 |
| **Footpaths** | 4 |
| **Foreshore areas** | 3 |
| **Sea walls** | 3 |
| **Bridges** | 2 |
| **Caravan parks** | 2 |
| **Natural assets** | 2 |
| **Council buildings** | 1 |
| **Water assets** | 1 |
| **Energy assets** | 0 |
| **Communication assets** | 0 |
| **Ovals** | 0 |

There are significant risks when roads are severely damaged especially during climatic events. Medical and rescue operations may be compromised and this is particularly concerning where there is only one major road to enter and exit the coastal town. This limited road access is a feature of many small coastal towns. Major floods which is a characteristic of the low level landscape of Australia appears to be linked to the drainage index being rated the second highest risk index. Most council guidelines refer to a 1 in 100 year event or Average Recurrence Interval (ARI). Therefore, a flood the size of a 100 year ARI flood is likely to occur once in 100 years on average, but it has a one per cent chance of occurring in any one year. Many factors are considered when designing new roads, including potential regional flooding. Roads may be designed to allow floodwaters to continue to flow out of the river system into the ocean rather than temporarily holding them back. In many instances residential roads may be designed to a height above the one in 100 ARI flood event, others to one in 50 ARI or one in 20 ARI, to ensure evacuation routes remain passable during a regional flood event.

In addition, prolonged drought and heatwaves also have the potential to unduly physically expand and contract infrastructure to the point of irreversible damage or repair. Physical measures such as dams, detention basins, widening and deepening channels and levees can reduce peak flood levels and potential damage.

## 5. Conclusions

CCA is a major component of climate change policy. Data from the scientific community suggests sea level rise of between 110-120 centimetres by 2100 (IPCC 2007). There are also predictions regarding the severity and frequency of other climatic events such as severe storms and heatwaves. How councils can adapt their infrastructure to withstand such events is an important question that needs to be addressed. This report has highlighted a number of important issues that could be used by public sector managers and policy makers in continuing the discourse of the appropriate way forward for CCA.

With respect to the identification of infrastructure assets at risk to climate change there are implications for accounting practice. Discussion within and between councils and external organisations needs to be commenced on whether there is a need for separate reporting of these assets. If not separate reporting, then the question of whether the assets most at risk to climate change need to be flagged some way is warranted. Stakeholders need to be made aware of these *at risk* assets, not only for future repair, replacement and funding decisions but also for adaptation purposes. Stakeholders need to be aware of these risks but importantly, they need to be involved in developing a response. Adams and Larrinaga-Gonzalez (2007 p.346) refer to this as 'meaningful stakeholder engagement'. As discussed in the literature section, adaptation may be a resource intensive exercise which could include protection, accommodation measures or a planned retreat decision. Identification of assets at risk to climate change will have to rely on the latest scientific evidence. This scientific evidence is not static and therefore, assets previously not deemed to be at risk, may subsequently be identified as at risk depending on the latest scientific projections. Councils will need to be conversant with the latest predictions in order to justify their CCA strategies and progress. Therefore, there is scope for further analysis of the *basis* from which specific infrastructure have been identified at risk. That is, managers will be accountable for ensuring that infrastructure is protected through adaptation processes.

The development of the CCIRI could be a useful tool for council managers in helping to identify which assets need to be considered for CCA. The evidence from this investigation suggests that roads and drainage are the two highest at risk assets. A potential barrier to adapting infrastructure to climate change is a lack of resources to implement adaptation strategies. Although this is not a new challenge in that whenever a new issue or requirement is asked of local government, the question of who is to fund the new initiative is inevitably posed. Whether a separate climate change charge should be considered would be a very politically sensitive topic that would involve great courage to sell to the public; a portion of which, still need to be convinced that climate change is real and can have serious consequences. Currently, in Australia, the on-going debate regarding the imposition of a proposed new carbon-tax highlights the sensitivity of the issue.

### *Further research*

The findings of this report have opened up other new and interesting opportunities for further research. For example, selecting a number of councils (via a case study method) that have implemented a CCA project would serve a useful purpose to other councils to gain an understanding of what worked (and how do they know), what did not, and why. For example the Federal Government provides funding to local councils for its *Local Adaptation Pathways Programme*. The aim is to help councils develop a CCA action plan. Identifying councils who are part of this program and investigating the process and data collection activities that the councils are pursuing would provide a valuable induction for exploring the challenges confronting CCA.

There are also potential financial reporting implications for assets at risk to climate change. For example, accounting standards relating to the depreciation, impairment and re-valuation of assets may have to be re-visited in light of the impacts of climate change. What this suggests is that further information requirements regarding the asset management of coastal councils is required. Investigating how councils are or intend to report on the effects of climate change would also provide a valuable insight.

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