Prioritising Coastal Adaptation Development Options for Local Government

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Project Summary Report

SYDNEY COASTAL COUNCILS GROUP

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

University of the Sunshine Coast
Sustainability Research Centre

Coastal Adaptation Decision Pathways Project **(CAP)**

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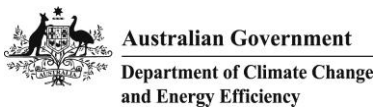
The Sydney Coastal Councils Group (SCCG) is a voluntary Regional Organisation of Councils representing fifteen coastal and estuarine Councils in the Sydney region. The Group promotes cooperation and coordination between Members to achieve the sustainable management of the urban coastal environment.

ACKNOWLEDGEMENT



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Coastal Adaptation Decisions Pathways Projects (CAP) - an Australian Government initiative.

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Glossary

Adaptation	Action taken to avoid actual or anticipated impacts from climate change, or to attain potential benefits arising from climate change [IPCC, 2007a].
Adaptive Capacity	The emergent property of a system to adjust its characteristics or behaviour to better cope with existing climate variability or future climate conditions. Adaptive capacity also refers to the set of resources available for adaptation, and the ability of a system to deploy resources effectively in pursuit of adaption (UNDP 2005).
CBD	Central business district.
Climate	Average weather (or, more specifically, the mean and variability of variables such as temperature, precipitation and winds) over a time period ranging from months to thousands of years to millions of years.
Climate Change	A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.
Flexible Adaptation Pathway (FAP)	An adaptation plan which identifies a range of potential adaptation options which may be implemented depending on when or if certain climate thresholds are reached. The Flexible Adaptation Pathway is dynamic and can incorporate new science as it emerges and supports iterative decisions in context of long-term view of change.
Interconnected water infrastructure	Stormwater, wastewater and water supply infrastructure, where management is shared between agencies or different tiers of government, or where there is physical interconnectedness or shared financial or asset management due to overlapping governance.
Low regrets	An adaptation option which is highly likely to increase resilience to climate change, no matter what the extent of climate change that occurs, and if it does not increase resilience, results in very little loss of resources or capital.
Maladaptation	Any changes in natural or human systems that inadvertently increase vulnerability to climate variables; an adaptation that does not succeed in reducing vulnerability but increases it instead.
No regrets	An adaptation option which increases resilience to climate change no matter what the extent of climate change that occurs.
Real options	Real options are adaptation options that include flexibility over time to avoid inefficient maladaptation. Real options are 'fitted with' flexibility to adapt to future changes, rather than be fitted for the projected change.
Risk appetite	The level of risk that an individual or organisation is willing to accept and tolerate before they require action to take place to mitigate the risk.
Scenarios	Scientifically based projection of one plausible future climate and likely biophysical impacts for a region based on knowledge of human impact on climate.
SLR	Sea Level Rise.
Threshold	Point expressed in terms of a climate variable beyond which risks become unacceptable.
Trigger point	Point (expressed either in terms of climate parameters or as a point in time) at which action must occur to avoid unacceptable impacts.
Vulnerability	The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.
Water infrastructure managers	Persons who has a responsibility for the design or ongoing maintenance and performance of water infrastructure assets such as but not limited to pumping stations, pipes, channels.
Weather	Atmospheric conditions at a particular time, such as hours or days, as defined by variables such as temperature, precipitation and winds.

Prioritising Coastal Adaptation Development Options for Local Government

Managing the risks posed by climate change to coastal communities is an international challenge, particularly in Australia where 85% of the population lives within 50 km of the coast. While much of the literature relevant to coastal adaptation has focused on assessing the vulnerability of coastal communities, our focus is to develop tools for the appraisal of specific adaptation options. To explore this decision challenge, we undertook a participatory, multi-criteria analysis (MCA) of coastal adaptation options for Local Government, for three case study regions along Australia's east coast.

Local Government staff participated in a series of workshops to capture the normative judgments of the performance of different exemplary adaptation options against multiple governance, financial, social, and environmental criteria. Results indicated the clear time preferences of Australian Local Government staff for different adaptation options. They are also averse to adaptation options that create long-term lock-in to investments, generate environmental externalities, create moral hazard, and/or position Local Governments as the insurers of last resort. These general attitudes toward adaptation, spatially disaggregated to the property level by using Bayesian Belief Networks, used a series of decision rules to integrate staff perceptions with spatially explicit information regarding coastal hazards and assets. Outputs from the BBN, exported to a GIS environment, enabled information on hazards, assets, and the utility of different adaptation options to be readily visualised for any property in each study region. In so doing, the project represents a first-generation adaptation information system that could be the basis for future development of practical decision support tools.

1. EXECUTIVE SUMMARY

The Coastal Adaptation Pathways (CAP) project *Prioritising Coastal Adaptation and Development Options for Local Government* developed an integrated methodology and allied suite of tools both for evaluating plausible coastal adaptation options for Local Government, and for monitoring and reporting on implemented options to facilitate learning regarding best practice. Sydney Coastal Councils Group led the project, assisted by researchers at Oak Ridge National Laboratory (USA) and the University of the Sunshine Coast. In addition, Sunshine Coast Council and Bega Shire Council also joined the project as partners to expand the scope of the study to include three case study regions.

The project used a series of workshops with Local Government staff in each of the three study regions, as well as an on-line survey, to elicit both specific and general information regarding how Local Government incorporates different values into decision-making, preferences regarding different adaptation options, and the challenges and opportunities for monitoring and reporting on coastal adaptation efforts. This participatory approach enhanced learning for Local Government and ensured relevant knowledge and attitudes were incorporated into the various analyses and tools.

For the evaluation of different coastal adaptation options, the project applied two different stakeholder-driven multi-criteria analysis (MCA) methods. The first focused on developing 'performance matrices' that benchmarked current thinking among Local Government staff with respect to the performance of different plausible adaptation options against 16 different criteria, spanning the dimensions of governance, finance, social, and environmental considerations. This analysis revealed the potential trade-offs associated with specific adaptation options as well as the aggregate performance of different options over different time-scales. A second method

disaggregated these general results spatially to specific properties vulnerable to coastal hazards in the three case study regions. A Bayesian belief network integrated information on hazards, assets, and the performance of different adaptation options as well as different decision criteria relevant to those options. Data sources, provided by local, state and federal organisations, were used to characterize individual properties and, ultimately, assign utility scores to different adaptation options for every property at risk. This information was imported into a GIS environment for visualisation.

In addition to the use of such MCA methods for prioritising adaptation options, the project also developed a monitoring and evaluation framework to assist Local Government in tracking progress toward adaptation goals and learning about best practice for coastal adaptation. This framework included multiple practical templates that to be deployed as is or modified to better suit the needs of Local Government. Those templates address the adequacy of adaptation plans, the capacity of Local Government to implement those plans, and the performance of specific adaptation measures. The report provides demonstrations of how the templates can be applied to specific adaptation challenges.

Collectively, the project delivered a number of novel assessments and tools unavailable until now for Local Government, and suggests multiple pathways forward for enhancing adaptation planning, and in making this information available to decision-makers. Their novelty suggests the benefits of the project will transcend Australia to be of international interest.

2. INTRODUCTION AND AIMS

Significant investments have been made by Australia's Federal, State and Territory, and Local Governments in recent years to characterise the potential consequences of climate variability and change in Australian coastal communities. As a largely coastal nation, the impacts of climate change, and therefore the deployment of adaptation solutions, will affect coastal communities at a rate disproportionate to other regions of Australia. Significant work has also occurred in identifying potential adaptation options to manage the risks posed by climate change, and Local Government, in particular, has literally identified thousands of discrete adaptation options that could be implemented for climate risk management. Nevertheless, barriers to adaptation persist, in part because adaptation implementation is challenged not so much by a lack of understanding of the option, but rather a lack of understanding regarding the costs and benefits of those options and their appropriateness for different contexts.

Under the auspices of the Coastal Adaptation Pathways program funded by the Department of Climate Change and Energy Efficiency, the '*Prioritising Coastal Adaptation and Development Options for Local Government*' sought to explore a range of analyses and tool development activities to contribute learning regarding how to progress more focused evaluation of coastal adaptation and the design of flexible adaptation pathways. The project was designed with two key considerations in mind. First, decision-making regarding adaptation in the coastal zone fundamentally hinges upon the reconciliation of multiple societal values that influence perceptions regarding the costs and benefits (market and non-market) of different options. Second, achieving success over the long-term is contingent upon the ability to monitor progress toward management goals, evaluate the extent to which specific policies and measures are contributing to that progress, and revisit past decisions to address challenges that are standing in the way of success.

While policy appraisal is dominated by the application of cost/benefit analysis methods, a number of researchers have argued that such methods are inappropriate for climate change policy development. Deep uncertainty, long time-scales, and system complexity pose substantive challenges to the utility of cost/benefit analysis. In addition, cost/benefit analysis assumes that decisions will be guided by objective evaluation of the results, when in truth there are a broad range of normative factors that guide decision-making. One alternative to cost/benefit analysis is multi-criteria analysis (MCA), which represents a structured approach to incorporating the range of values and normative criteria that determine a decision environment into policy appraisal. In so doing, it enables one to explicitly examine the potential trade-offs in values associated with particular decision alternatives. Such methods have seen limited applications to coastal adaptation problems, and thus the current project sought to explore the utility of such methods for Local Government decision-making. In so doing, it is important to assess Local Government perspectives on different approaches to adaptation generally, but also, in providing decision support capability, to enable the appraisal of different options at a scale appropriate to the decisions.

Meanwhile, once one or more adaptation options are prioritised for implementation, both the implementation and the subsequent outcomes must be monitored to ensure those options are achieving the intended outcomes. Such monitoring and evaluation (M&E) is critical for judging the successes and failures of potential adaptation options, identifying opportunities to enhance efficiencies and avoid redundancies, not to mention ensuring that appropriate knowledge and resources are available for implementation. There is a range of existing M&E activities for Local Government, many of which are voluntary. None of these were developed specifically with climate change adaptation in mind. In fact, such M&E for adaptation is a nascent area of practice in public policy, and thus little guidance exists for Local Government with respect to how to approach M&E. Yet, should councils move forward with pursuing adaptation in the absence of such tools for tracking progress, opportunities are likely to be missed and maladaptation may occur, yet go unrecognised.

Prioritising Coastal Adaptation and Development Options for Local Government therefore developed an approach to MCA for coastal adaptation in Local Government that incorporated Local Government knowledge and preferences for adaptation options. This participatory approach enabled normative perspectives of Local Government staff to drive the MCA (rather than investigator assumptions) while also providing opportunities for shared learning among staff. This MCA was undertaken both generally within each of three case study regions (Sydney, NSW; Sunshine Coast, QLD, and Bega, NSW), as well as specifically for thousands of properties within these regions potentially vulnerable to coastal hazards in a changing climate. This MCA was accompanied by the development of a monitoring and evaluation framework, consisting of templates that can be readily applied within a Local Government setting to track progress on adaptation objectives.

3. METHODS

Task 1: Co-development of detailed project plan, partner agreements, associated contracts, and budget.

Task 2: Project launch The project launch introduced participants to the objectives and methods, including the project team and project roles, engagement processes, and expected outcomes. This step was important to get buy-in for future stages, especially from management.

Task 3: Literature review The literature review informed adaptation options and strategies, and supported the development of MCA, and M&E tools.

Task 4: GIS database development SCCG and ORNL staff elicited various data resources from councils, state government agencies (particularly in New South Wales), as well as federal agencies. ORNL staff compiled these data into a spatial database for use in the project.

Task 5: Online survey An online survey conducted between 15 November and 14 December 2011 that investigated the relative importance of different values in council decision-making, the factors triggering changes to coastal risk management , limits to council decision making and monitoring evaluation processes. One hundred and twenty (120) responses from the participating 17 councils (Sunshine Coast Council, Bega Council and the 15 member councils of the Sydney Coastal Councils' Group) provided data, supporting the development of MCA and M&E frameworks. The analysis of the data from the survey is included in '*A Multi-Criteria Analysis of Coastal Adaptation Options for Local Government'* (Attachment 1)

Task 6: Stakeholder workshops Three workshops (one each at the Sunshine Coast, Bega Valley, and Sydney) engaged participants from the three case study areas, focusing on:

1. Reviewing results from prior project activities with a particular emphasis on the on-line survey of Local Government stakeholders (Task 5);
2. Facilitating an evaluation of a suite of coastal adaptation options against multiple governance, financial, social and environmental criteria; and
3. Exploring the issue of evaluation and monitoring of adaptation toward the design of a useful framework for Local Government.

The outcomes of the workshops fed into the Stage 1 multi-criteria analysis (MCA) to inform to understand council preferences regarding different adaptation options over different time scales. The Bayesian model for adaptation evaluation incorporated that information to undertake the spatial evaluation of adaptation options. The analysis of the data from the workshops is included in '*A Multi-Criteria Analysis of Coastal Adaptation Options for Local Government*'.

Task 7: **Development of Bayesian Belief Networks (BBN)** – The BBN was constructed as a transparent network that represented the flow of information in the analysis among independent and dependent variables, each represented by a node in the network. The foundation for the BBN was a range of 'decision' nodes that represent the key independent variables upon which information could be stratified:

- adaptation options,
- study region,

- time horizon (short, medium, and long),
- public vs. private land,
- land subject to erosion, and
- room available on property in increase coastal setback

The sixteen evaluation criteria associated with the four value dimensions (governance, financial, social, environmental) were represented as 'nature' nodes in the network, and responses from the workshops regarding performance of adaptation options against each criterion were entered into each of these criteria nodes. Again, information input into each criterion node was stratified by study region and time horizon. Each of these 'nature' nodes were then weighted based upon either:

- information emerging from the stakeholder survey regarding the importance of the values represented by that criterion, or
- a spatial weight representing the risk to financial, social, or environmental assets.

These risk characterizations were developed by integrating information on inundation and erosion hazards over different time scales for each of the three study regions with available data indicative of asset densities.

Using the BBN it was possible, therefore, to undertake a range of analyses of adaptation options including the following:

- Generation of a quantitative metric of the relative performance of different adaptation options based upon individual criteria and/or value dimensions
- Calculation of overall utility of individual adaptation options based upon underlying uncertainty in option performance against specified criteria and their associated weights
- Stratification of adaptation options utilities based upon case study region and time horizon
- Testing of the sensitivity of utility scores to underlying performance scores for individual criteria and/or weights:
    - Evaluation of the appropriateness of different adaptation options for individual properties
    - Identification of robust adaptation options that appear to be favourable across a wide range of values preferences

This information emerging from the Bayesian model was visualized in a GIS environment to enhance accessibility of the information to stakeholders.

Task 8: Development of a Monitoring and Evaluation Framework –The Framework includes a simple, reporting oriented format, and a more comprehensive format for practitioners to work through the process of designing and implementing appropriate M&E investigations.

In particular, the framework constitutes three components to assess:

1. adaptation processes
2. organisational adaptive capacity, and
3. adaptation outcomes.

4. OUTPUTS

The project produced the following products:

4.1 A survey of Local Government staff perspectives on:

- the values used in Local Government to guide decision-making,
- perceptions of the risk associated with different coastal hazards, and
- information on the factors that trigger decision-making specifically on coastal adaptation within Local Government (including tools, sources of knowledge).

The survey revealed a strong emphasis in Local Government regarding the need to take all values within a community into consideration as councils develop plans and policies. However, in workshops where stakeholders were asked to reflect back upon the survey results, it became apparent that decision-making in Local Governments does not necessarily reflect the values of staff. In other words, politics often imposes itself into the decision-making process.

The survey also indicated that coastal erosion and future inundation are a particular concern for local councils, with the concerns about the risks of inundation anticipated to grow into the future with continued climate change. The survey also aided in clarifying the key factors influencing Local Government decision making regarding coastal management, with information about coastal hazards, state policy, and legal liability topping the list of factors. With respect to the tools councils use to manage such risks, survey respondents indicated that financial analysis tools, risk management practices, and learning from other councils were the most important mechanisms at their disposal.

4.2 A literature review of approaches to coastal adaptation that synthesised current understanding regarding:

- the principles of adaptation
- the classic typology of coastal adaptation options (i.e., protect, accommodate, retreat), and discussion of the conditions under which each would be pursued and/or considered appropriate
- coastal adaptation planning and action currently occurring within Local Governments in the case study regions.

The coastal adaptation literature review provided some information for the other project deliverables, particularly with respect to summarising relevant adaptation options and the conditions under which they would be implemented. This information was particularly relevant to structuring the MCA analysis.

4.3 A Monitoring and evaluation framework to track:

- best practice adaptation;
- adaptation capacity; and
- adaptation outcomes.

The framework benefits Local Governments intending to plan for adaptation, already involved in adaptation planning and implementing adaptation measures. The framework provides three templates.

- **Template 1** provides a checklist of key adaptation processes and performance criteria for each process. Councils use this template to assess their performance against provided criteria, which seek to establish the existence of a process or lack of it. Council provides staff with statements seeking to establish adherence to a specified guiding principle. Staff will either agree or disagree to the statements on a scale of "strongly agree" to "strongly disagree" and "don't know" (in the case of being unaware of the subject). Responses are compared to establish issues that need action.
- **Template 2** seeks to track organisational adaptation capacity. Different statements that can be agreed on or not are provided against each capacity identifier (e.g. human, social, natural).
- **Template 3** guides the tracking of adaptation outcomes over time. This template demonstrates the need to advance monitoring and evaluation of adaptation outcomes within social, economic, governance and environmental sustainability contexts.

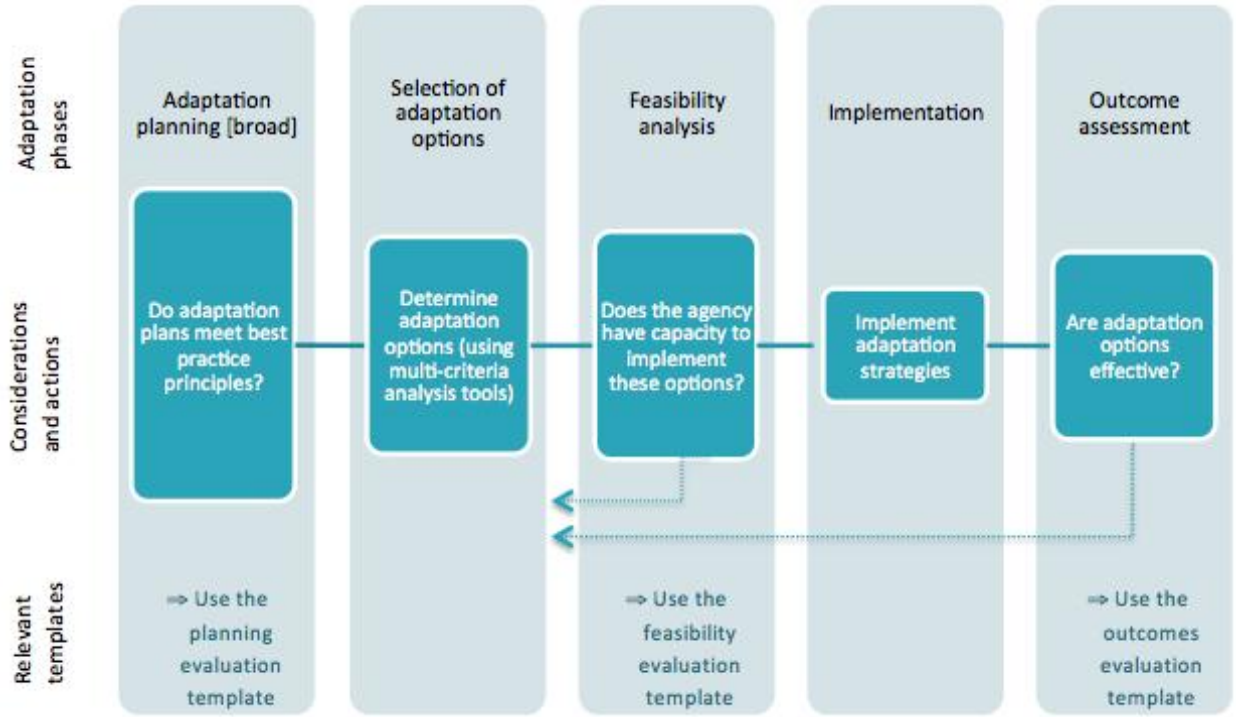


Figure 1 Schema outlining use of Templates for Adaptation Monitoring

4.4 Two different types of MCA analyses for:

- regional evaluation of the utility of coastal adaptation options based upon information elicited from stakeholders regarding the performance of different options against multiple, quadruple-bottom line decision criteria, and
- property-scale evaluation of coastal adaptation options based upon spatial information regarding hazards, assets, and the appropriateness of different adaptation options for addressing risk in different geographic contexts.

The MCA analyses provide a means of benchmarking current opinion within Local Government with respect to the types of adaptation options that are in the best interest of councils, both now and over the long-term. Such information generally reveals a preference for commencing a long-terms

shift in coastal management toward practices that can enable the coastline to adapt naturally to the effects of sea-level rise.

The analyses also enabled the research team to screen a large number of coastal properties to identify hazards and sets of adaptation options most likely to be effective for a specific property and its characteristics. Such a capability is novel in the context of coastal adaptation and suggests some promising future pathways for both research and practice.

4.5 A visualisation framework to manage and visualise, on the landscape, the large quantity of model outputs.

By linking output from the Bayesian model to GIS software, it was possible to visualise all properties potentially exposed to coastal hazards in each study region, their relative complement of assets (financial, social, or environmental), risk to those assets, and the utility of different adaptation options at that location.

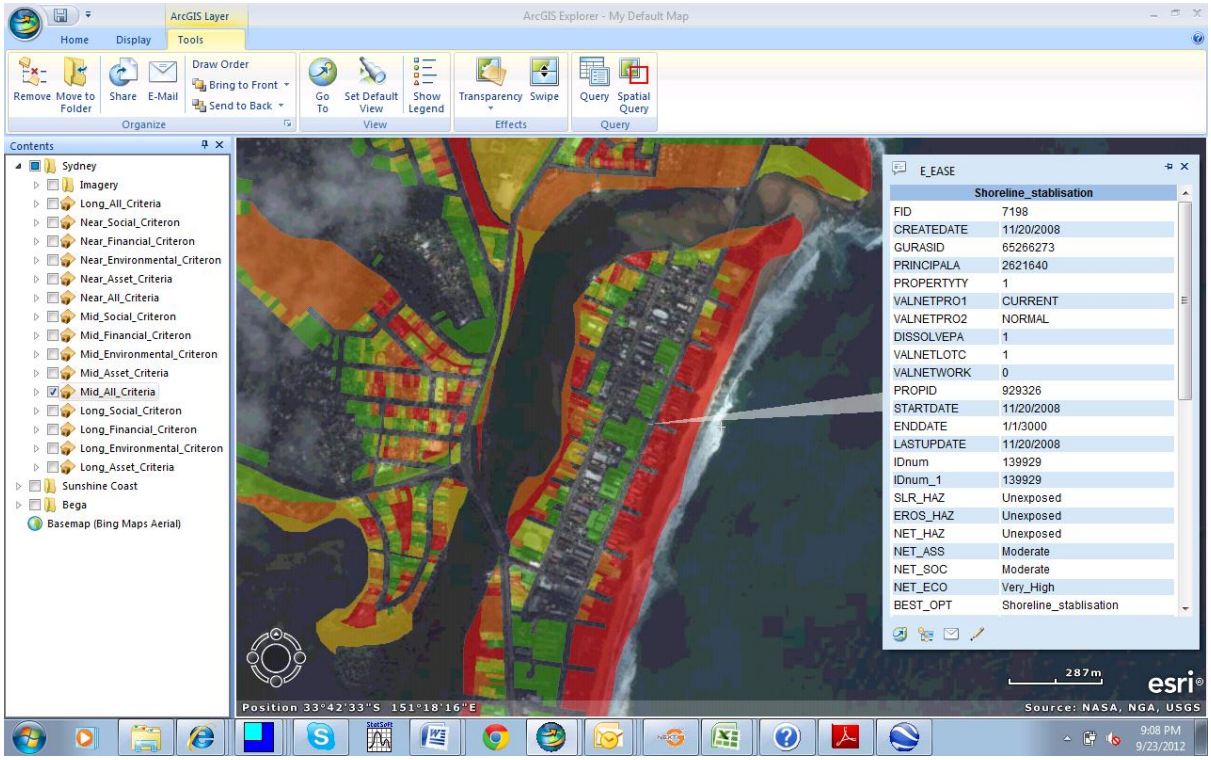


Figure 2. Illustration of the visualisation of results from the spatial MCA

Results for North Narrabean Beach, Sydney. The visualisation is based on map layers displayed in the ESRI ArcExplorer (free for public use) software application. The map identifies all of the properties potentially susceptible to coastal hazards in the coming decades, with different colour shading to reflect different levels of exposure (green for low levels of exposure; red for high). The pop-up table adjacent to the map provides a list of metrics for the specific property indicated by the arrow. These including hazard and asset classifications for the property, identification of the single best adaptation option for the location, as well as quantitative and qualitative utltiy scores for 12 different adaptation options.

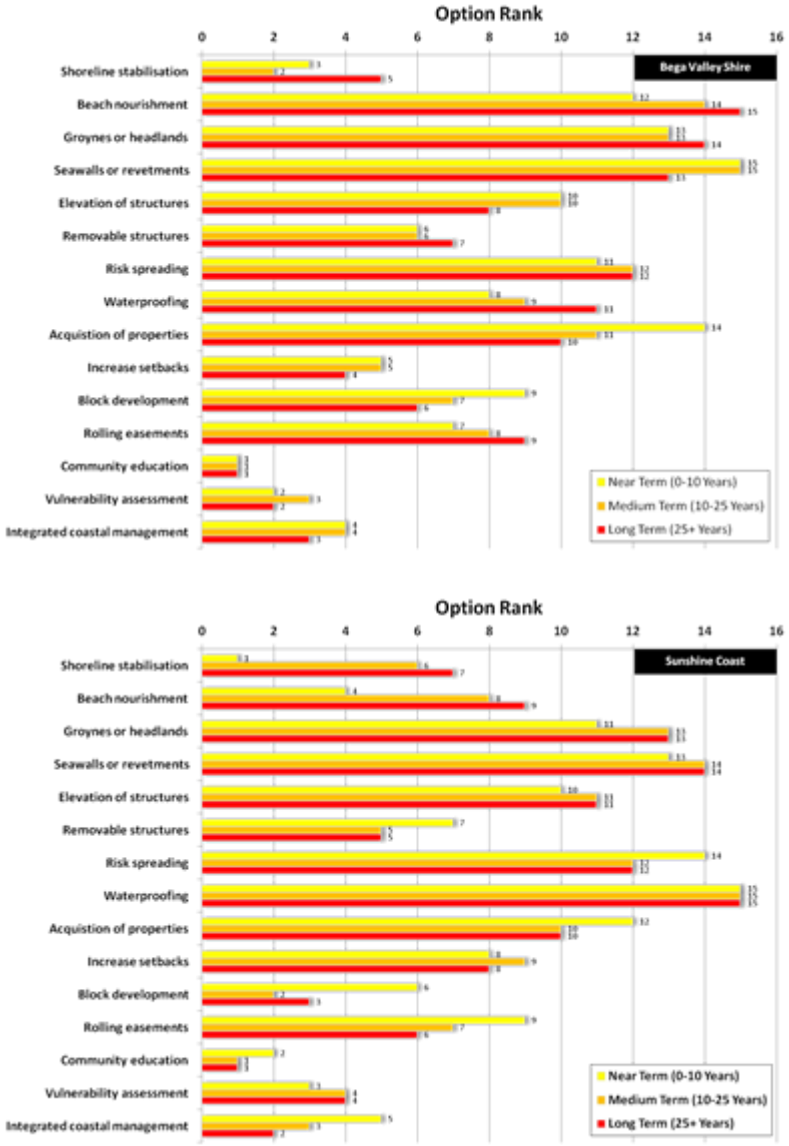
5. DISCUSSION

5.1 Multi-Criteria Analysis

The project applies two different MCA approaches to evaluate 15 coastal adaptation options for Local Governments on the Australian East Coast from which a number of key conclusions emerge:

1) Staffs in Local Governments balance multiple societal values in developing policy recommendations for coastal risk management. While attempting to give equal weighting to different values, the political process and/or interactions with other levels of government may force trade-offs in decision-making resulting in certain values taking precedent

2) The perceived utility of different coastal adaptation options varies only slightly among the different regions and communities included in the study (Figure 3), which suggests there are substantial commonalities among different Local Governments (regardless of size, scale, or jurisdiction) with respect to what constitutes effective coastal adaptation for climate change



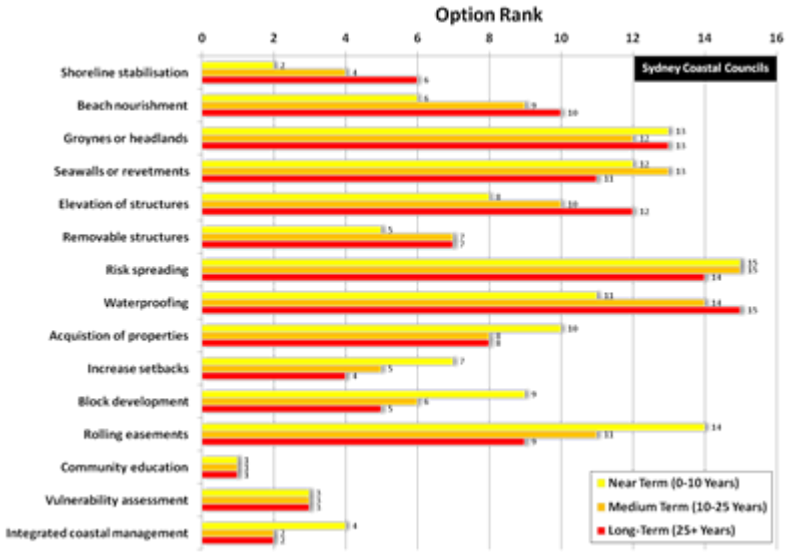


Figure 3 Comparison of the rank utility of different coastal adaptation options for the different case study regions (arranged from top to bottom). Results are based upon results from the BBN integrating performance scores with weights.

3) When viewed by Local Government, the most unfavourable coastal adaptation options are those that create long-term investment obligations for councils, incentivise risk-seeking behaviour, and/or create 'moral hazard' by positioning Local Government as the insurer of last resort (Figure 4).

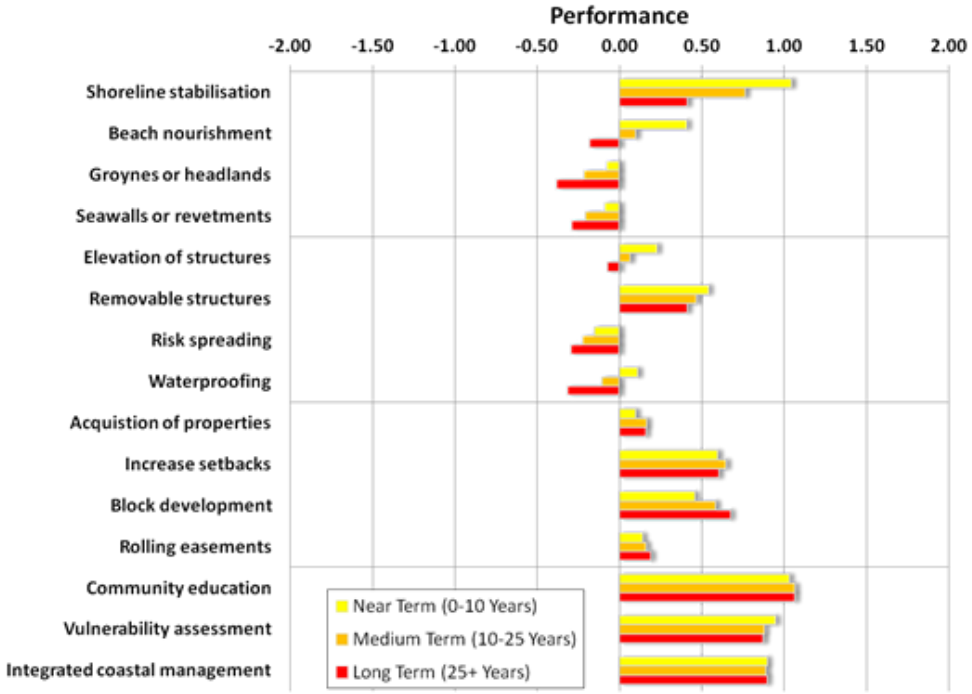


Figure 4. Comparison of average raw performance of different coastal adaptation options for different time horizons. Results are based upon the weighted average of performance scores for all case study regions. Positive values represent a favorable assessment of performance. Negative values indicate an unfavorable assessment of performance.

4) The utility of almost all adaptation options designed to reduce vulnerability directly declines over time (Figure 5) due to:

- Increasing risk associated with climate change
- Increasing costs associated with managing that risk, and/or
- Increasing uncertainty about the future social, economic, environmental, and political landscape.

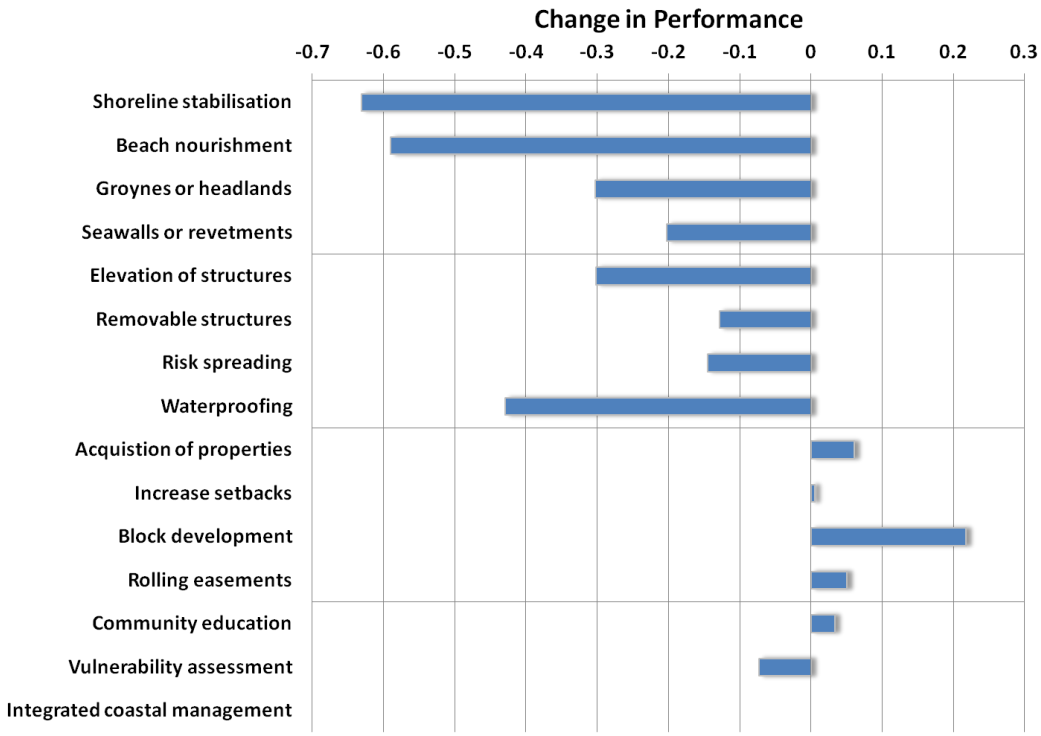


Figure 5. Changes in performance of different adaptation options over time, based upon stakeholder performance assessment.

The exceptions to this phenomenon were the 'cross-cutting' options, which respondents viewed as equally valuable across most of the criteria even over different time horizons.

5) Adaptation actions that represent broader capacity building measures, which create the necessary bottom up community support and evidence base for more substantive actions, are viewed as robust, low-cost measures that can be readily pursued by Local Government

6) While the issues of governance and the limited autonomy of Local Government was identified as a common constraint on the majority of coastal adaptation options, criteria associated with the financial and/or environmental implications of options had the greatest influence on their ultimate utility.

7) Although economic and environmental values often appear at odds in decision-making regarding coastal management, this study generally finds that those actions that performed best against various financial criteria also performed well on environmental grounds. This conclusion may not hold up if one considered adaptation options from the perspective of private property owners, or the broader regional economy.

8) The capacity to visualise hazards, assets, and the utility of different adaptation options on the landscape suggests the project has opened the door on a new suite of valuable capabilities described more broadly as "Adaptation Information Systems". Workshops revealed that Local Government often struggles to enable their staffs to examine spatial information and, particularly, to integrate different sources of information relevant for decision-making. This project therefore provided a 'proof-of-concept' of such tools, which could have broader applications.

Evaluation of the Multi-Criteria Analysis Approach

A common concern for any form of Multi-criteria Analysis is the extent of subjectivity built into the process. This has two components (at least):

- the extent to which researchers have simply validated their own beliefs, and
- the extent to which new insights are generated.

With respect to the former, the work largely represents stakeholders' judgments. Obviously, researcher influence cannot be excluded. The researchers influenced the selection of criteria for inclusion, and the different time horizons considered by stakeholders (although both were informed quite significantly by the stakeholder survey). The time horizons incorporate strategic planning cycles reported by stakeholders, as well as stakeholders' arguments that the time scales relevant for decision-making are much more compressed compared to those typically used by researchers in climate change studies. These issues largely influence the structure of the MCA more so than the outcomes.

Whether or not these findings are "new" in the context of Local Government is difficult to say. Getting new information is not the challenge. Taking what we already know, and to examine that information in ways that educates and assists stakeholders is key. Undoubtedly, these findings are consistent with the existing subjective attitudes of some elements of civil society, but inconsistent with others. The point of this project is about making subjective preferences more explicit and to identify how Local Government stakeholders trade-off different values. The software used allows users to vary inputs to undertake sensitivity testing to explore elasticity in values in influencing the outcomes.

Given stakeholders were apparently unwilling to express any strong preferences for values (e.g., environmental concerns were reported as being equal to social concerns which were reports as being equal to financial concerns, etc.), the basic MCA model based upon performance matrices and the and BBN yield quite similar results, at least at the aggregate regional level. Stakeholders viewed this because of their position in Councils as attempting to represent the "Community" rather than their own views. One comment was that until they are required to make a choice they keep all options open. As such, given the basic approach is more transparent, one could argue it is perhaps more relevant for a Local Government context, and the software will allow the update of values to resolve choices, something a standard MCA cannot do.

The use of economic information enters into the analysis through the four financial criteria within the MCA and the spatial information on financial and physical assets at risk on coastal properties. This allows the potential to look at distinctions between developed vs. undeveloped lands with respect to preferred adaptation options. This has suffered a bit as so far only one of our case study regions (Bega) has supplied property value information for the project, which means we were forced to use

proxy ABS data at coarser resolution proxies such as rents to supplement what we know about the spatial distribution of critical infrastructure and buildings. Formal CBA is often the wrong tool (or at least applied to the wrong question) and the approach here allows users to incorporate preferences about what outcomes are important to maintain or pursue, and the timing of actions to meet these preferences, in ways that fit into budget constraints over time.

A clear weakness in much adaptation to climate change is the lack of true Flexible Adaptation Pathways, and the MCA-GIS output allows the potential to map such pathways based on the time preference of options generated by the BBN input. While this was explored to some extent over the course of the project through an intern at ORNL and some discussion is included in the MCA report, full mapping of adaptation pathways based upon MCA results was not able to be completed within the scope of the grant.

5.2 Monitoring and Evaluation

In light of lack of monitoring and evaluation of adaptation, the project provides a monitoring and evaluation framework to track processes, resources needs and outcomes associated with coastal adaptation. The identification, development and evaluation of adaptation processes, resource needs and outcomes is instrumental as adaptation involves the interaction of diverse stakeholders, implementation of diverse measures with varying impacts on different sectors of the economy and society, and the need to prioritise adaptation activities. The framework is relevant for Local Governments at the initial stages of adaptation planning to help define the scope of adaptation outcomes, resource needs and processes involved. The framework further provides insights into post-implementation evaluation of adaptation to guide the tracking of progress towards achieving adaptation outcomes. Interventions are mostly locally specific and are a result of a process that considers social, economic, and environmental issues for effective adaptation. The framework therefore guides the development of more local specific frameworks sensitive to social, economic and environmental sustainability issues.

A key lesson emerging from adaptation efforts in the participating councils is the limited consideration of the dynamic nature of adaptation. Adaptation planning often lists measures based on static assumptions such as a certain level of sea level rise in a defined period. In this regard, the project highlighted the need to accommodate the dynamic nature of adaptation options by establishing review periods and triggers points (linked to climate change impacts drivers) that alert the need to transition from one set of adaptation measures to another.

6. CONCLUSIONS

Although a number of outputs from the project were developed, the two principle tools generated by the project were the monitoring and evaluation framework and the spatial visualization framework for coastal adaptation options at the property-scale. These tools, developed specifically to target staff in Local Government, can either be readily implemented in projects or, through ‘proof of concept’ demonstrations, provide guidance for future planning. The MCA integrates various forms of knowledge and information for a particular location, yielding insights useful for distinguishing adaptation options likely to be of benefit.

The key benefits associated with these tools include;

- Advancing the consideration of adaptation in the coastal zone from general discussions of potential adaptation options to the analysis of the appropriateness of those options in specific locations. In so doing, the project also enables one to understand explicitly the various trade-offs associated with the pursuit of one option versus another.
- Establishing a formal framework for the structured monitoring, evaluation, and reporting of adaptation processes in Local Government to facilitate learning and guide continual improvement in coastal management systems. This represents the first guide in Australia that specifically focuses on M&E for coastal adaptation.

The project revealed that there are limited examples of implementation of adaptation in Local Government, even though there is a wide acceptance of the need for adaptation, and significant investments in adaptation planning. However, current adaptation planning processes are not well integrated with other council activities. To this extent, the project recommended a more integrated approach to implementing, monitoring and evaluation of adaptation. The project identified opportunities to embed adaptation in existing planning frameworks such as the "Integrated Planning and Reporting Framework" and "Local Environmental Planning" processes and across sectors by engaging all stakeholders in planning, implementation, monitoring and evaluation of adaptation. Such integration helps identify trade-offs between and amongst adaptation options to avoid maladaptation. The need for this integration informed the development of monitoring and evaluation framework and the multi-criteria analysis of adaptation options.

Drawing insights from workshops and literature review the project showed that adopting the quadruple bottom line (QBL) approach provides a mechanism for integrating adaptation into existing monitoring and evaluation frameworks and across council divisions. The QBL approach provides common themes to evaluate adaptation effectiveness. The project also showed the need to identify processes that ensure good practice adaptation to ensure:

- the interaction of diverse stakeholders,
- implementation of diverse measures with varying impacts on different sectors of the economy and society, and
- transparent prioritisation of adaptation activities.

The project developed a process and outcome based monitoring and evaluation framework. The framework used both simple checklists and more outcome specific indicators. Checklist type indicators track progress towards attaining the necessary adaptation capacity and the implementation of processes that ensure best practice adaptation. Outcome based indicators were based on various adaptation objectives. This approach enables simple and summarised narrative reporting of both positive and negative outcomes, alongside quantitative indicators and therefore accounting for diverse information sets.

Prioritising Coastal Adaptation and Development Options for Local Government developed an approach to MCA for coastal adaptation in Local Government that incorporated Local Government knowledge and preferences for adaptation options. This participatory approach enabled normative perspectives of Local Government staff to drive the MCA (rather than investigator assumptions) while also providing opportunities for shared learning among staff. This MCA was undertaken both generally within each of three case study regions (Sydney, NSW; Sunshine Coast, QLD, and Bega, NSW), as well as specifically for thousands of properties within these regions potentially vulnerable

to coastal hazards in a changing climate. The monitoring and evaluation framework complemented the MCA, allowing users to track progress on adaptation objectives.

7. WHAT NEXT?

As part of an ongoing communications strategy for all the CAPs projects, the SCCG will explore opportunities to enlist stakeholders for participation in both future workshops and in applications for these tools and the Framework to real situations.

This work represents an innovation in prioritising coastal adaptation development options, providing information at a property scale. The SCCG will pursue opportunities to extend the capability and usability of this approach to strengthen the role of Local Government in planning in the coastal zone.

The SCCG will pursue opportunities to present this information to relevant conferences and professional meetings.

Notes

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