LEARNINGS REPORT

Coastal Hazards Adaptation Strategy for Townsville [Pilot Project]

OCT 2012

GHD

Griffith UNIVERSITY

Queensland Government

City of Townsville

LGAQ

Australian Government

Department of Climate Change and Energy Efficiency

Scope and limitations

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1. Introduction

1.1 Background

GHD, assisted by Griffith University Centre for Coastal Management, was engaged to undertake a Coastal Hazard Adaption Strategy (CHAS) Study investigation for the City of Townsville. This landmark pilot project was the first of its kind in Queensland. The Townsville CHAS outlines how to minimise risks to new development and protect existing infrastructure and properties in areas projected to be at high risk from coastal hazards by the year 2100.

The pilot project was partnered by the Queensland Government, the Local Government Association of Queensland and Townsville City Council, funded by the Commonwealth Department of Climate Change and Energy Efficiency under the Coastal Adaptation Pathways Decision Program. This 'Learnings Report' is one of three key deliverables for the pilot project:

- The **Compendium of Coastal Hazard Adaptation Options for Queensland Coastal Councils** (the Compendium). The Compendium provides information on a range of adaptation options including regenerative, engineering, structural and planning options. The Compendium is intended to be used by coastal Councils to inform to CHAS development process;
- The **Coastal Hazard Adaption Strategy Study Report for Townsville** for consideration by Townsville City Council;
- The **Learnings Report** to inform any update of the Queensland Coastal Hazard Adaptation Strategy Planning Guideline.

1.2 Purpose

The purpose of the Learnings Report is to provide a database of all key learnings from the pilot project in order to:

- Identify key issues and lessons learnt;
- Where possible, identify the 'best practice' and 'acceptable' approaches required to undertake a CHAS study within other coastal Local Government jurisdictions; and
- Inform the planned update of the Queensland Coastal Hazard Adaption Strategy Guideline.

1.3 Methodology

The Learnings Report was composed on the basis of feedback from key project stakeholders, namely Townsville City Council (TCC), the Local Government Association of Queensland (LGAQ) and the Department of Environmental and Heritage Protection (DEHP), along with the authors, GHD and Griffith University, involved in the preparation of the CHAS.

A learning and feedback template was provided to 16 project stakeholders to provide information on:

- **Issues** encountered during the preparation of the Townsville CHAS
- The **outcome** of said issues, both in the case when the issue was addressed or when the issue was not able to be overcome due to lack of knowledge or resources
- **Learning** gained from discussion of the various issues, the adopted solution or the difficulties encountered

- **Recommendations** for Councils, State Government, consultants or other stakeholders undertaking the work in the future

Preliminary responses provided in the learning and feedback template provided the basis for a full day Learnings Workshop held on 26 July 2012 (at GHD, Brisbane) involving 11 participants from TCC, DEHP, GHD and Griffith University. The open-forum style workshop allowed participants to discuss various aspects of the CHAS pilot study from the methodology and management of the project, to technical difficulties with the benefit-cost analysis, community consultation and the impacts of the governance changes at the State and Local Government level. The initial draft set of learnings from the workshop was consolidated by Griffith University and then condensed and edited by GHD staff.

The project team, including the Board of Clients and GHD, experienced some significant changes from project inception through to completion. Unfortunately, this resulted in a loss of some learning input that may have been obtained throughout the project. Notwithstanding this, every effort has been made to capture learnings that had been documented throughout the life of the project, for example through meeting minutes, email trails and project team handovers.

Section 2 builds upon the learnings and feedback template to capture a synthesised version of learnings captured throughout the pilot project and recommendations to facilitate future the development of subsequent coastal hazard adaption strategies.

2. Learnings from the CHAS Pilot Study

The purpose of this section is to list the successes and limitations of the Pilot Study in order to inform the update of the Queensland Coastal Hazard Adaption Strategy Planning Guideline. The section has been broken down into the following project components:

- Compendium;
- Mapping process;
- Risk analysis;
- Adaptation strategy identification;
- Economic analysis (including multi-criteria analysis and cost benefits analysis);
- Communication plan;
- Funding mechanisms;
- Coastal hazard adaptation strategy document;
- Land use planning considerations; and
- Project management.

2.1 Compendium

The Compendium of Coastal Adaption Options for Queensland Coastal Councils was a key deliverable of the pilot project. The Compendium was generated to provide Councils with a range of adaptation options to consider during the preparation of CHAS. For each option, the Compendium provides:

- A technical description for each adaptation option, with examples of implementation from Australia and internationally
- A description of how each option can contribute to adapting to current and future coastal hazards, and potential synergies and conflicts with other adaptation options
- Legal and administrative considerations for implementation in Queensland
- An overview maintenance requirements, timeframe for review, risk of failure and costs
- A brief multi-criteria overview to assess each option against climate uncertainty, social, environmental and economic criteria

Griffith University Centre for Coastal Management, the principal sub-consultant to GHD, was the primary author of the Compendium, which was then reviewed by GHD. It is intended to be adopted by the State Government as a reference document to accompany the Queensland Coastal Hazard Adaption Strategy Planning Guideline. Learning and recommendations related to the Compendium are outlined in Table 1 below.

Table 1 Learnings related to the Compendium

Issue	Outcome	Learning	Recommendation
The Compendium may become out-dated over time as new adaptation ideas and experience grow.	The Compendium has been structured to allow the addition of new adaptation options following the same template. For example, Section 3.4 of the Compendium includes a list of potential options that are not currently included in the Queensland legal and administrative framework.	A number of additional adaptation options could be included in future assessments if they become mainstream. This may include: bounded approvals, community awareness, emergency planning, insurance, hazard full disclosure clause, and rolling easements	The Compendium should be considered as a 'live document' which is updated on a regular basis based on new research and emerging ideas.
The term multi-criteria has been used in both the Compendium and	Approach unchanged.	Users should consider the Compendium has been designed to	This distinction should be emphasised where appropriate.

Issue	Outcome	Learning	Recommendation
the CHAS economic assessment. This may cause confusion due to the different context within each document.		be a high level treatment of the Multi-Criteria approach.	
The existing structure of the Compendium does not delineate options on the basis of geomorphic character of the coast, e.g. high energy sandy coasts and low energy estuarine coasts.	This would require a re-structuring of the current document and whilst useful is not seen as essential given that it is expected that coastal professionals in the main will be facilitating any adaptation initiatives.	Local Councils may appreciate having the options grouped into regionally relevant classes relevant to their coast types.	Future revisions of the Compendium could consider this option.
While the Compendium does explore the compatibility of options it does not explicitly consider combinations or staging of options.	Not included in present version.	Considering combination or staging of options could be beneficial.	Considering combination or staging of options could be beneficial.

2.2 Mapping processes

The mapping processes relate to the method by which GIS layers for sea level rise and storm tide inundation extent were generated for use by the various CHAS analyses.

Learning and recommendations related to the mapping process are outlined in Table 2 below.

Table 2 Learnings related to the mapping process

Issue	Outcome	Learning	Recommendation
The Work Scope specified that a single hazard probability level was to be utilised for the vulnerability analysis and Benefit-Cost analysis (the 100 y Return Period) This had the potential to	GHD identified the essential need to include a range of hazard levels to ensure the validity and accuracy of the various analyses. Although there was no allowance in the pilot project budget for	Regardless of the planning period being considered, it is essential that the full range of hazards be considered in order to correctly assess potential future adaptation options.	Future CHAS studies must involve consideration of the full range of Return Periods and the relationship between the vulnerability and the hazard level (i.e. the topographic distribution of assets).

Issue	Outcome	Learning	Recommendation
underestimate the true hazard response and skew the subsequent analyses.	production of additional surfaces, GHD undertook this work to ensure that the results would be sufficiently robust.		Considering events rarer the nominal 100 y Return Period is also in accordance with the 2011 Qld Flood Commission of Inquiry recommendations.
Some of the DEHP supplied surfaces to be used in the vulnerability analysis contained errors ranging in magnitude from 0.2-0.3 m and up to 0.6 m in one area. There was no commonly agreed methodology for mapping storm tide inundation over land from the storm tide model reporting points on the coast. The complexity of inundation mapping was compounded by the need to include water level increases from wave setup and run-up which varied considerably along the coast.	Some of the water surfaces used in the vulnerability analysis contained errors typically related to consideration of dune over-topping and the consequent reduction of wave setup water levels. The number of urban localities considered for the proposed 1.1 m sea level rise sensitivity testing was necessarily reduced to Pallarenda and the Townsville Inner Suburbs.	Development of an agreed methodology for mapping inundation which incorporates wave setup and run-up is essential. Consistency and care in preparation of the hazard surfaces is essential in order to avoid further issues in the vulnerability and economic assessments.	Future studies should consider the benefits of a single service provider undertaking both the surface production and the CHAS analyses. A best practice methodology for mapping storm tide inundation over land, including wave setup and run-up, needs to be developed.
The rules for determination of erosion prone areas can lead to rapid changes (in the temporal climate context) in the extents along the coastline. i.e. the use of only 2 erosion or storm tide inundation extents at 2012 and 2100 would have been too coarse to fully understand the emerging impacts	The economic assessment is highly sensitive to the delineation of erosion prone areas.	Notwithstanding the small changes in sea level that occur over time, consideration needs to be given to the interaction between the physical topography and the distribution of assets that can lead to rapid changes in exposure.	Sea level rise and erosion surfaces should be produced for a number of different years during the planning period to provide a smoother transition.

Issue	Outcome	Learning	Recommendation
The rules used by DEHP for applying spatially variable but discrete changes in freeboard, wave setup and runup allowances caused water level stepping along the coast.	This sometimes created inconsistencies within the economic assessment for the regions affected. For example the estimated damage might not monotonically increase with water level and added unwanted noise to the economic analysis.	Inconsistencies in the hazard surfaces will degrade the value of the analyses and may produce misleading recommendations.	More physically-based approaches or more sophisticated GIS processes should be considered to reduce such inconsistencies.
The original scope included an assessment of the difference between hydrodynamic and 'bathtub' surfaces. However, only 'bathtub' surfaces were available for the combined cyclonic and non-cyclonic hazard that was needed for the analysis.	The sensitivity to this element was not able to be determined for Townsville. However it can be expected that present day inundation in some areas will be inaccurate due to non-consideration of hydrodynamics. The magnitude of the error will, inter alia, be dependent on the Return Period of the event and the extent of overland inundation.	Differences between 'bathtub' and hydrodynamic surfaces will be significant in some circumstances and may alter the adaptation strategy required. There remains uncertainty in the estimate of the shoreface evolution in response to projected sea level rise which should be considered when undertaking hydrodynamic modelling of future climate scenarios.	Where hydrodynamic results are available these should be used in preference to the so-called 'bathtub' approach, provided that wave run-up and setup water levels can be included. Shoreface evolution modelling of coastline response to future sea level rise should be undertaken as an essential part of any coastal hazard adaptation study to ensure inundation risk can be correctly depicted.
Only coastal hazards emanating from the ocean have been considered.	Some of the adaption options considered with the CHAS pilot may need to be refined when consideration of fluvial flooding impacts is included.	Fluvial floods are relevant processes that should be included in coastal hazard studies.	A comprehensive consideration of all hazards is desirable. Fluvial flooding in particular should be considered in the development of coastal adaptation options.
Lack of adherence to a standard methodology for modelling of storm tide hazards will result in additional	Possible issues in consistency across Council jurisdictions.	Consistency in and quality of the approach is important for obtaining robust outcomes.	Councils should require consistency and a minimum quality standard in approaches as already defined in

Issue	Outcome	Learning	Recommendation
variability in the production of hazard surfaces across regions.			State Government sponsored guidelines.

2.3 Vulnerability and risk analysis

The vulnerability and risk analysis was prepared to combine information on current settlements and infrastructure with the impacts of coastal hazards, informing the identification of suitable adaptation options for different urban localities

Learning and recommendations related to the vulnerability and risk analysis are outlined in Table 3 below.

Table 3 Learnings related to the risk analysis

Issue	Outcome	Learning	Recommendation
No comprehensive floor height database was available for the areas under investigation.	The Geoscience NEXIS database was considered however that dataset was found to be inadequate for the Townsville region. The JCU Cyclone Testing Station survey data was then applied where available.	Inadequate floor height data has direct implications for the accuracy of the vulnerability and economic assessment and as such may influence the choice of adaption option for a given area.	Council should develop and maintain comprehensive floor level and building use databases. If no floor height data is available then Council should as a minimum undertake sample surveys using rapid assessment methods (e.g.drive by sampling, Google Street View™).
The vulnerability assessment was completed using the existing landuse GIS data.	It does not consider future or proposed landuse planning.	The CHAS is designed to potentially influence future planning decisions and vice versa. The decision as to which planning base case is to be used remains a decision for Council.	Liaise with Council stakeholders upon CHAS project inception to determine individual Council requirements.
Building footprint data was not available.	Assumptions were required in regard to: • Likely coverage of buildings on large properties (i.e. large industrial lots); and • Determining the ground elevation of the building	Having building footprint data would lead to improved accuracy of analyses in the areas affected.	Include building footprint data in future studies where possible.

Issue	Outcome	Learning	Recommendation
	centroid.		
Vulnerability analysis thresholds (Acceptable, Tolerable, and Unacceptable) were developed subjectively.	Vulnerability assessment might vary dependant on the subjective assignment of risk levels.	As the main purpose of the risk assessment and mapping was to provide Council with a medium to communicate risk internally and with the community, Council should be allowed flexibility in the assignment of risk categories.	Adoption of the Pilot CHAS vulnerability analysis thresholds are recommended as a suitable reference.
Community was not involved in the development of vulnerability analysis thresholds.	Vulnerability assessment might vary dependant on the subjective assignment of risk levels.	There is potential to consider community views in the development of the risk levels.	Where possible, community consultation should be undertaken as part of the development of acceptable risk levels.
A number of asset classes were excluded from the analysis scope.	Not all asset classes have therefore been assessed (e.g. defence land, airports, ports, industry).	The decision to exclude some high value assets and associated stakeholders could significantly modify the recommended adaption options.	Future CHAS studies or reviews of existing strategies should consider collaboration with all land owners and tenures.

2.4 Development of Adaptation Options

Adaptation options were identified in consultation with TCC for coastal urban localities as identified in the *Townsville City Plan 2005* and *City of Thuringowa Planning Scheme* .

Learning and recommendations related to the identification of adaption options are outlined in Table 4 below.

Table 4 Learnings related to development of adaptation options

Issue	Outcome	Learning	Recommendation
The number of possible adaptation option combinations quickly grows as a result of a range of urban localities combined with a selection of possible solutions. i.e. initially there were in the order of 150 potential options for consideration Due to a.) the study schedule limitations and b.) the timing of the Local Government elections; there was reduced involvement by local stakeholders in the initial scoping of strategies for each urban locality..	There were a large number of strategies initially developed that were later discarded after further consultation with Council, which could have been avoided.	The identification of a comprehensive suite of adaptation options benefits from contributions from a wide range of relevant local stakeholders, e.g. Council technical staff, executives, Councillors, State and Federal agencies, and other entities.	Sufficient time is required to enable appropriate levels of engagement with the relevant stakeholders. In particular, consideration needs to be given to events likely to interfere in the CHAS project schedule. The development of adaption strategies is best undertaken in a workshop environment where coastal engineers and strategic planners are able to provide their professional advice on what is likely necessary and feasible.
External stakeholders were not involved in the initial development of adaptation options for the Council and community assets but were invited to an information and feedback workshop.	Only Council and community assets are included in the CHAS pilot but external stakeholder feedback did provide the basis for some modification of the options that were developed earlier.	Early engagement with external stakeholders at the local level may have resulted in the development of more holistic adaption measures for the some urban localities i.e. Port of Townsville/Airport.	Sufficient time is required to enable appropriate levels of engagement with the relevant external stakeholders. In particular, consideration needs to be given to events likely to interfere in the CHAS project schedule
The analysis covered areas that were subsequently identified by Council as regions where	A large amount of resources were allocated to regions where intensification of development was	Early development of options with Council stakeholders based on local knowledge coupled with output from	Sufficient time is required to enable appropriate levels of engagement with the relevant stakeholders.

Issue	Outcome	Learning	Recommendation
intensification of development was unlikely.	unlikely.	the risk assessment process may result in the early identification of areas that can be treated more simplistically in the adaptation strategy.	
There was some confusion amongst workshop participants over the definition of *Defend*, *Accommodate*, *Retreat* and *Maintain Status Quo* in the development of adaptation options.	A significant amount of time was spent discussing definitions of options both prior to and at the TCC workshops.	There is a need to clearly articulate the definition of adaptation strategies, acknowledging that adaptation options may consist of a mixture of traditional coastal protection, improving community resilience and planning approaches.	Use the options developed for Townsville as the example for future studies.
Limited information existed for the assessment of some strategies.	Some strategies will not be as rigorous as others in design and economic feasibility due to a lack of data.	There will exist data limitations during a high level CHAS investigation that will need to be re-considered in future detailed studies.	Utilise all available data when available and highlight gaps for further investigation.
Adaptation options have not been developed considering fluvial flooding issues.	Some defend options may result in creating long term flooding issues.	Need to consider local and regional flood studies.	CHAS studies should consider both fluvial and coastal inundation issues.
The Scope of Work only required options be considered that would provide protection against the 100 y Return Period event.	If *defend*/*accommodate* options that are limited to the 100 y Return Period event are implemented, then overtopping/failure of protective structures can occur due to events rarer than the 100 y Return Period. e.g. there is approximately a 5 % chance of experiencing a 1000 y Return Period or greater during a	Consideration of the cost/benefit of higher levels of hazard protection is required.	The impact of very rare events should always be considered as part of a comprehensive adaptation strategy due to the potential consequence of failure to life and property. Benefit –cost analyses should include a range of levels of

Issue	Outcome	Learning	Recommendation
	given 50 y period.		protection.

2.5 Economic analysis

The economic analysis combined:

- A Multi-Criteria Analysis (MCA) to preselect acceptable adaptation options based on a range of qualitative criteria and weightings, and
- A Benefit-Cost Analysis (BCA) to value costs and benefits of each option with quantitative data.

Learning and recommendations related to the economic analyses are outlined in below.

Table 5 Learnings related to the Multi-Criteria analysis

Issue	Outcome	Learning	Recommendation
Lack of familiarity with the MCA process by the stakeholders.	Difficulties in understanding the MCA criteria and related processes.	An understanding of the MCA process is essential to avoid confusion, save time and obtain consistency in ranking of options.	Ensure workshop participants are familiar with the MCA process and theory prior to the workshops being held, especially the concepts of longlisting, shortlisting, weighting and final ranking.
The MCA ranking framework varied slightly throughout the series of workshops. Although the initially developed and finally adopted MCA criteria were similar, the practicality of addressing a very large range of options during TCC Workshops 1 and 2 necessitated a simplified set of criteria be developed.	Very valuable data was collected during the series of TCC workshops. However, a lack of consistency in the scoring and ranking of options resulted in not all this data being able to be fully assimilated into the final MCA Workshop.	Consistency in scoring of the MCA throughout the project would have been beneficial notwithstanding that there was considerable time pressure to meet the deliverable schedule.	A comprehensive MCA process requires adequate time to address the many complex issues that will arise during a CHAS. Wherever possible, consistent scoring should be undertaken on a fixed set of criteria and a ranking process that is established early within the project.
Given the time and budgetary	The MCA process was used to filter	The MCA process comprising the	The approach used on Townsville

Issue	Outcome	Learning	Recommendation
constraints of the project, there were too many potential adaptation options to be practically assessed by a BCA process.	the very large number of potential options down to a manageable number for input to the BCA.	TCC Workshops and the final MCA Workshop provided a rational means of reducing a number of options to a more manageable number whist still allowing for essential stakeholder input.	CHAS could be adopted for future studies with refinement as necessary.
In hindsight not all of the MCA criteria developed at the initial Dec 2011 workshop were independent and/or physically consistent. For example, the *severity*, *frequency* and *duration* criteria interacted.	There was confusion by stakeholders as how to discriminate these criteria and this resulted in the subsequent decision to merge these into a single *severity* criterion. This also required merging of the initial weightings.	The MCA process can be significantly impacted by any source of confusion surrounding the criteria.	When developing criteria it is essential to consider whether there is adequate independence between criteria and also whether there is data available to provide a basis for participants to practically score options.
Outputs of the MCA can be highly sensitive to the weighting applied.	The resulting preferred adaptation option/s could be modified by relatively small changes to the weightings applied but sensitivity testing was conducted to determine whether more than a single option should proceed to the BCA because of uncertainty.	Weightings are judgements and need to be determined with appropriate levels of stakeholder engagement. Notwithstanding this, a robust process of sensitivity testing should identify where anomalies could occur.	Where possible, base weightings should be developed collaboratively with all stakeholder groups (e.g. Local community, environment groups, agencies etc). The MCA should also include a sensitivity analysis.
The “Complexity of implementation” criterion was found to be ambiguous depending on the stakeholder perspective. i.e. technical versus logistical.	On balance, it was collectively agreed that *Retreat* and *Maintain Status Quo* strategies would be more complex to implement than *Defend* strategies. This was due to the large engagement requirement involved in mobilisation of a community.	Clarity in the definition of the criteria is paramount to avoid confusion and allow an efficient MCA process.	When developing criteria it is essential to consider clarity of definitions.

Issue	Outcome	Learning	Recommendation
The requirement to consider capital, maintenance and operational costs within the MCA let to a large amount of potentially unnecessary effort given that there would be a BCA to consider these components in much more detail.	Preliminary costing was undertaken for a large number of options prior to the MCA with more detailed costing completed for the BCA. Costing required for the MCA required significant effort and led to potentially unnecessary delays in the project schedule.	It may have been better to exclude costing criteria from the MCA given that these factors could be investigated within the BCA with a much higher level of rigour.	Considerations of omitting cost criteria from the MCA can result in a more efficient economic assessment.

Table 6 Learnings related to the Benefit-Cost analysis.

Issue	Outcome	Learning	Recommendation
The large spatial areas and number of options that still proceeded to the BCA stage required significant resourcing within the limited time and budget.	This led inevitably to schedule delays and budget overruns.	The effort required is directly proportional to the number of options that need to be considered and their data requirements. This effort could have been reduced by improved option scoping and stakeholder engagement during early stages of the project.	Future CHAS studies should realistically consider the time and budget required to develop strategies for a large number of localities, taking account also of the uncertainty that naturally arises through stakeholder engagement.
The Storyboarding of the various adaptation options (i.e. implementation, sequencing and interaction with coastal hazards over time) required significant effort.	Significant effort was required to develop realistic adaptation scenarios. Simplifying assumptions were a necessity in the BCA process.	There is inherent complexity in estimating potential responses to climate change by industry, government and the community.	Specific research into the likely range of adaptation responses would greatly benefit future CHAS BCA studies.
The scope requirement to assess	Although outside the original work	The complexity of developing a	A sound BCA methodology is

only a single Return Period event occurring at the end of the planning period prevented development of a technically sound BCA methodology.	scope and without obtaining agreement for additional compensation, GHD undertook analyses sufficient to ensure that a technically sound BCA was achieved.	competent BCA analysis in the time available (i.e. one that necessarily includes a full range of events) was underestimated by both the client and GHD.	essential for a robust CHAS.ie the 100 y Return Period event only is not a sufficient basis for the analysis.
The outcomes of the BCA analysis might be altered by inclusion of the specifically excluded infrastructure items outside of Council jurisdiction.	The impact of the excluded items on the BCA has not been assessed.	A more comprehensive and inclusive CHAS would likely result in more robust BCA results for future consideration.	Where possible, future CHAS studies should aim to include all significant stakeholder infrastructure.
There was some discussion over the merits of different sequencing of the MCA and BCA.	MCA is being used to shortlist options and then BCA to assess that shortlist.	The strength of MCA is that it can compare various types of criteria. It is difficult to meaningfully include social and environmental issues in BCA.	MCA should continue to be used in early stages of the process to shortlist adaptation options, which are then assessed in detail using BCA.

2.6 Communication and stakeholder engagement plan

A Communications and Stakeholder Engagement Plan (CSEP) was prepared for the pilot project in December 2011 to guide consultation and communication activities both internally (between members of the Core Project Team and the Project Board) and externally for all consultation activities. Key aspects of the plan included a comprehensive stakeholder listing, identification of potential stakeholder issues, key messages, communication protocols (covering communication with both internal and external stakeholders), appropriate communication tools (including approval protocols and timings), a community and stakeholder engagement program, evaluation and reporting requirements.

Key learning from the Communication and Stakeholder Engagement Plan is outlined in Table 7 below.

Table 7 Learnings related to the communication plan

Issue	Outcome	Learning	Recommendation
Given the interdependencies between stakeholder groups, there was a lack of multiple rounds of consultation.	A limited range of information was collected from community stakeholders.	Stakeholder engagement is a complex process that should be undertaken systematically throughout the CHAS development process.	There is a need to create a recommended sequence of steps for stakeholder engagement for the CHAS process. The recommended stakeholder engagement sequence should be flexible enough to respond to local issues.
Generally there is a lack of awareness of coastal hazards within communities.	This reduced the effectiveness of the stakeholder engagement process.	Awareness of coastal hazards should be raised, based on solid science and technical foundations as a precursor to any community engagement regarding the CHAS.	A pre-CHAS workshop held at the local community scale to raise awareness on coastal hazards is recommended.
The timeframe of the CHAS was too short to allow adequate community engagement as well as obtain the necessary support from Council.	Planned community consultation was withdrawn for later consideration for Council.	Recommendations outlined in the CHAS have the potential to be politically sensitive and may require complex stakeholder engagement in order to both inform the community and capture stakeholder sentiment. As such, this requires extensive and long-term stakeholder engagement	The recommended stakeholder engagement process (refer above) should prescribe core engagement activities required throughout all phases of the CHAS process i.e. education preceding formal announcement, throughout the CHAS development and

Issue	Outcome	Learning	Recommendation
		both preceding formal announcement of the CHAS process, throughout the CHAS development and finally to facilitate implementation of potential options.	implementation phases.
There was a lack of direction regarding the exact purpose for and use of materials developed for community consultation (e.g. factsheet, Q&As, technical papers, discussion papers, letters, media statements, web page info).	Reduced effectiveness of the stakeholder engagement process.	Need for early involvement of the local jurisdiction regarding their preferred methods of community engagement.	Adopt the subject Council's best practice for community engagement to reflect locally specific responses to political and community issues.
Some strategies/options were not complete before consultation/engagement activities.	Confusion surrounding the potential range of adaptation strategies.	Strategies/options need to be well-defined and presented before any consultation/engagement The adoption of the Compendium (refer Section 2.1) will largely overcome this issue in the future as it provides detailed descriptions of adaptation strategies including case studies and examples.	Use the Compendium as a reference for the description of strategies. Sufficient time is needed to ensure that options analysis can be completed prior to stakeholder/community consultation.
Climate change issues are often met with scepticism by sections of the community.	This concern was expressed by Council with regard to the community accepting the need for action in responding to climate change issues.	Community recognition and acceptance could be improved by highlighting existing coastal hazards and the potential for intensification of hazards in association with climate change and sea level rise.	Clearly articulate the role of the CHAS in addressing coastal hazards that are a risk both now (e.g. king tides, cyclones, erosion) and likely to be increased in the future associated with climate change and sea level rise.

2.7 Funding mechanisms

A range of possible funding mechanisms were considered that would provide a means of paying for both the development and implementation of the CHAS in the short, medium and long term

Learning and recommendations related to adaptation funding mechanisms are outlined in Table 8 below.

Table 8 Learnings related to funding mechanisms

Issue	Outcome	Learning	Recommendation
Coastal adaptation for climate change is an emerging issue for which there is no traditional funding method.	The Compendium provides a series of currently available funding mechanisms that could be accessed for coastal hazard adaptation.	Until more guidance becomes available from a State or Federal level it difficult for Council to identify other viable funding mechanisms.	Council should continue to explore all options for funding of coastal adaptation strategies through all levels of Government.

2.8 Townsville coastal hazard adaption strategy study report

The Coastal Hazard Adaption Strategy for Townsville (the Townsville CHAS) is a key deliverable of the pilot project. The purpose of coastal hazard adaption strategies includes:

- The mitigation works or actions to be undertaken to mitigate the coastal hazard
- The cost of undertaking the works or actions
- Funding scheme or arrangements that will be establish to pay for the works or actions to be completed
- Timeline for the commencement and completion of the mitigation works or actions.

CHAS study reports are intended to be used to inform Local Government planning schemes, asset management plans, and other statutory and non-statutory organisational documents.

Table 8 provides an overview of learning and recommendations related to the coastal hazard adaption strategy study report.

Table 9 Learnings from the CHAS study report development

Issue	Outcome	Learning	Recommendation
The CHAS report deliverable, while termed a 'strategy' document, should perhaps more appropriately simply be termed the 'Study Report'.	The CHAS study document has been designed to assist Council in their decision-making processes that could lead to the development of a formal and concise strategy document.	There is a need to separate the role of a formal Council strategy document from that of a study that can be used to inform the strategy. Likewise one can envisage the need for planning documents that will describe how to implement the strategy.	Councils requiring CHAS-related services should consider whether they require a study inclusive of a formal draft strategy and a detailed investigation or investigation-only, such as has been done here.
For the pilot study the economic assessment (a large and essential component of the overall CHAS) was required to be an appendix to the study report.	This was completed as requested.	If the intent of a given future CHAS study is to act to inform a strategy rather than be the strategy then a combined report format would be preferable.	Consider developing a standard template for CHAS-related documents to support the CHAS guideline.

2.9 Land use planning considerations

This section summarises the issues and learnings associated with considering the current planning framework. This included:

- Establishing the planning framework through identifying and reviewing current planning documents;
- Locating and resolving information gaps; and
- Analysing local and future development potential.

Learning and recommendations related to the land use planning considerations are outlined in Table 10 below.

Table 10 Learnings related to land use planning considerations

Issue	Outcome	Learning	Recommendation
TCC indicated early in the project that they did not require or expect a detailed examination of Council's planning scheme as part of this investigation.	This was aligned with the overall decision by TCC to regard the CHAS deliverable as a 'study' rather than a 'strategy'. While a broad legislative review was still undertaken, this was less TCC-specific than had been initially indicated.	There is a need to separate the role of a formal Council strategy document from that of a study that can be used to inform the strategy. Likewise one can envisage the need for planning documents that will describe how to implement the strategy.	Councils requiring CHAS-related services should consider whether they require a study inclusive of a formal draft strategy and a detailed investigation or investigation only such as has been done here.
The present study focuses more on single long-term solutions for a given coastal area than a potential staging of short to medium-term solutions.	A mix of long-term and medium-term solutions has not been explicitly considered but the approaches presented can be readily reinterpreted in this context for future detailed studies.	Identification of interim measures prior to achieving an ultimate coastal hazard adaptation may provide opportunities to better align with planning horizons. Such interim strategies may be both more effective and less controversial for the community, whist maintaining the overall long-term goals of adaptation.	Councils should allow for a multi-staged approach to developing a long-term strategy. This should involve an initial high level, long-term assessment of options followed by more detailed studies that further investigate opportunities for interim staging. Importantly, Councils will likely need time to consider the outcomes of such initial studies to help frame their approaches to the more

Issue	Outcome	Learning	Recommendation
			detailed studies.
Local Government has expressed a desire to be protected from potential litigation.	Constraints imposed by the SPA regarding compensation and legal liability have been detailed in the Compendium. The assessment of individual adaption options in this study has not explicitly considered compensation and legal issues.	The subsequent formation of a strategy document should consider legal issues.	Engage with legal advisors early in the process to understand potential for compensation and legal liability associated with developing a formal strategy. While not dealt with directly by CHAS these issues should be acknowledged as potential barriers for climate adaptation.
Currently there is an absence of legislated design standards for flooding or storm surge.	The present study has recognised this by considering the full range of potential coastal hazards, although this is not specifically required by the current SPP. Notwithstanding this the study has adopted the 100 y Return Period storm tide level as the sole reference immunity level, noting this was a requirement of the project scope.	While there remains a need for more explicit guidance on design standards for flooding, storm surge and coastal adaptation it is imperative that decisions are based on the actual impact of potential events rather than fixed nominal levels of probability (e.g. a 100 y Return Period event).	Councils should adopt risk-based approaches to decision making in regards to coastal adaptation. This would include assessing the impacts that would lead to potential loss of life or damage to property/infrastructure, the environment and the economy. To achieve this, the full range of coastal hazards with varying likelihood needs to be considered. Such an impact assessment will determine what is an acceptable risk standard to be applied for a specific community.

2.10 Project management

This considers the types of issues and constraints related to the management of a CHAS project

Learning and recommendations related to the management of this pilot study are outlined in Table 11 below.

Table 11 Learnings related to the project management

Issue	Outcome	Learning	Recommendation
The project had pre-set time constraints imposed to meet Federal Government reporting schedules.	There was insufficient time available to adequately address the expansive scope of work, the scale and complexity of the TCC community, and to satisfy the pilot study governance arrangements.	If tight scheduling becomes the controlling factor in the delivery of a CHAS study it will significantly degrade the quality of the outcomes. The CHAS process is complex, involving a large component of stakeholder engagement and this requires suitably allocated timeframes to complete. This learning will be relevant to all CHAS studies but was particularly significant given the pilot nature of the present study.	Future CHAS studies should realistically consider the time required to develop strategies, especially for a large number of localities, taking account also of the uncertainty that naturally arises through stakeholder engagement. i.e. recommended minimum periods for consultation and response would be in the order of 2 y.
Complexity of the governance structure for the pilot study.	Specific resources were necessarily assigned to the extra reporting and communication requirements dictated by the pilot study's governance structure.	Complex governance arrangements do absorb resources that would be otherwise allocated directly to project deliverables.	Where It remains desirable to involve several project partners, it will be important to recognise the need for additional resourcing and extended timeframes to manage the governance.
The expansive and evolving scope of work required a level of effort inconsistent with the available budget, particularly in light of the	There was not sufficient budget to undertake the scope adequately without significant in-kind contributions by the consultant.	Clearly defined scopes of work and realistic timeframes are necessary in order for consultants to offer fixed price contracts. Projects involving	Councils should endeavour to stage the project or separate work packages into fixed and variable arrangements in recognition of the

Issue	Outcome	Learning	Recommendation
pilot study nature and the tight timeframe imposed.		significant uncertainty need to ensure that risks are jointly shared by all parties.	uncertainly associated with particular work items (e.g. community consultation versus vulnerability assessment).
CHAS studies are inherently complex undertakings that will provide critically important information needed for strategy development, planning and implementation by coastal Councils for generations to come.	The complexity of the investigation required a very significant level of effort and data in order to assemble the most basic yet essential set of information capable of addressing the study requirements.	The findings of the CHAS study represent the first step in providing coastal protection or adaptation plans for vulnerable coastal communities. This work will underpin a significant investment in the future viability of coastal communities and as such is deserving of a high priority in Government funding allocations.	Vulnerable coastal Councils should recognise that they have a responsibility to ensure that their community's future viability can be based reliably on the outcomes of their CHAS study and its future revisions.

3. Conclusion

This Learnings Report is a valuable component of the Townsville City CHAS Pilot Study initiative.

It illustrates the fact that CHAS studies are inherently complex undertakings that will provide critically important information needed for strategy development, planning and implementation by coastal Councils for generations to come. The complexity of this pilot investigation required a very significant level of effort and data in order to assemble the most basic yet essential set of information capable of addressing the study requirements.

The findings of any CHAS study represent the first step in providing coastal protection or adaptation plans for vulnerable coastal communities. This work will underpin a significant investment in the future viability of coastal communities and as such is deserving of a high priority in Government funding allocations. Vulnerable coastal Councils should recognise that they have a responsibility to ensure that their community's future viability can be based reliably on the outcomes of their CHAS study and its future revisions.

Coastal Councils are encouraged to consider the many recommendations contained herein when planning to undertake their own CHAS investigations. This advice should help frame schedule, budget, data, technical quality and consultation issues to assist in ensuring the success of such projects.

Appendices

Appendix A Suggested Changes to the Draft Queensland Coastal Hazard Adaptation Planning Guideline

DRAFT

Queensland Coastal Plan

Guideline for Preparing Coastal Hazard Adaptation Strategies

January 2012

Prepared by: Enviornmental Planning, Department of Environment and Resource Management

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Contents

Executive Summary

A high proportion of Queensland's urban development is located in the coastal zone, with some development located in areas vulnerable to coastal hazards. Coastal hazard areas are those that are potentially subject to permanent inundation (due to sea level rise or coastal erosion) or storm tide inundation. Coastal hazard risks are not new. However, climate change is projected to compound the vulnerability of Queensland's low-lying coastal areas to coastal hazard impacts.

The State Planning Policy 3/11: Coastal Protection (SPP), a component of the Queensland Coastal Plan (coastal plan), requires local government authorities to prepare adaptation strategies for urban areas projected to be within high risk coastal hazard areas. The SPP also requires adaptation strategies to be incorporated into local planning instruments for the relevant high coastal hazard area. This guideline is extrinsic material to the SPP. It provides operational guidance to assist councils in preparing and implementing coastal hazard adaptation strategies, and should be read in its entirety.

Adaptation strategies are intended to mitigate coastal hazard risk from communities identified to be at high risk over the long term, rather than addressing the risk on a development-by-development basis.

This guideline establishes a stepped and consistent approach (both statutory requirements under the SPP and best practice approaches) to mitigating high coastal hazard impacts in urban localities along the Queensland coast. The guideline recommends that coastal hazard adaptation strategies should be developed using the following stages.

1. Spatially identify areas at risk, preferably through local-scale hazard mapping.
2. Identify current and known future 'assets' at risk (residential, commercial, community) and assess their vulnerability to coastal hazards to the year 2100.
3. Identify potential adaptation options.
4. Consult the community about the potential adaptation options.
5. Undertake a cost-benefit analysis of adaptation options.
6. Select preferred adaptation option(s).
7. Develop an implementation program and financial plan.
8. Engage in community consultation on the draft adaptation strategy.
9. Develop a process for reviewing and updating the adaptation strategy.

Comment [gsd1]: The document refers to 'assets' but the focus on assets of interest varies throughout the document

In many cases there is general focus on residential, commercial, and community assets at risk.

In section 1.2 it is indicated that there is a need to maximise functionality of essential community service infrastructure[1] during and immediately following inundation events. And there is a footnote which defines 'essential community service infrastructure'.

It is of note that report does not indicate that the Townsville project assessed implications for most of the 'essential community service infrastructure' in the Townsville area.

This process aligns with the Australian and New Zealand Risk Management Standards (AS/NZS ISO 31000). These standards are tailored to provide a structured and consistent approach for use by councils in identifying the most appropriate and cost-effective adaptation measures.

To assist councils prepare coastal hazard adaptation strategies, the Local Government Association of Queensland, Townsville City Council and the Queensland Government have recently finalised ~~are jointly undertaking~~ a pilot coastal hazard adaptation strategy for Townsville (GHD 2012). ~~The Townsville pilot project, due to be completed late 2012, is a Coastal Adaptation Decisions Pathways Project funded by the Australian Government Department of Climate Change and Energy Efficiency~~The outcomes and lessons learned from the Townsville project are available at (www).

The challenge of dealing with the long-term impacts of coastal climate change is relatively new, and there is still much to learn about the best way to identify and implement economic and socially-acceptable adaptation options.

While councils can start preparing coastal hazard adaptation strategies at any time, the SPP requires adaption strategies to be finalised and incorporated into their planning schemes within five years after the commencement of the coastal plan. Development that results in intensification of use in a high coastal hazard area within five years of commencement of the coastal plan may only be approved if the risk is assessed and mitigated through siting, design and operational conditions.

This guideline provides sufficient information to complete the initial steps in the process of preparing an adaptation strategy—such as undertaking studies to develop local-scale hazard maps, undertaking a vulnerability ~~risk~~

assessment to assess the ~~vulnerability~~ risk ~~of assets to~~of coastal hazard impacts on identified assets, and commencement of community engagement. ~~However, it is recommended councils defer commencement of other requirements outlined in the guideline, including undertaking a cost-benefit analysis, until the outcomes of the Townsville pilot project are available to provide greater guidance.~~

~~The findings from the Townsville pilot project and additional guidance and support that can be provided to councils will be included in an update to Queensland's Climate Change Adaptation Strategy and this guideline in 2012.~~

Comment [r2]: This could be updated now.

1. Purpose of the guideline

The Guideline for Preparing Coastal Hazard Adaptation Strategies (the guideline) has been prepared to provide assistance to councils in preparing and implementing Coastal Hazard Adaptation Strategies (adaptation strategies). The guideline provides a consistent and structured approach to coastal hazard adaptation planning in urban localities taking into account the impacts of climate change. The guideline supports the Queensland Coastal Plan (coastal plan) and is extrinsic material to the State Planning Policy 3/11: Coastal Protection (SPP).

The scope of the guideline follows the statutory requirements of the SPP, which adaptation strategies must address. These requirements are identified through references to specific policies under the SPP. However, the guideline also outlines broader application of adaptation strategies and 'best practice' approaches that local councils should adopt. This will ensure that a comprehensive and integrated adaptation strategy is prepared that will mitigate coastal hazard impacts to both existing and future assets, and communities at risk.

Comment [m3]: Need to update

The guideline is not a complete technical guide for the assessment and management of coastal hazards. It does not prescribe particular methodologies or adaptation measures, nor does it provide detailed technical solutions to coastal hazard threats. These issues are best considered and costed locally, on a locality-by-locality basis.

1.1 Background

A high proportion of Queensland's urban development is located in the coastal zone, with some development located in areas vulnerable to coastal hazards. Climate change is projected to increase sea levels and storm intensity, and change rainfall patterns. This will compound the vulnerability of Queensland's low-lying coastal areas to coastal hazard impacts.

This increasing coastal hazard risk will occur over a long timeframe and significant changes are generally not projected to be experienced until 2030 or later. However, land-use planning decisions have long-term implications and new urban development cannot easily be relocated. Until now, conversion of land use from a lower to high intensity use has been considered permanent. Climate change impacts will challenge this precept. Adaptation strategies are planning for much longer timeframes than traditionally considered in land use planning. Climate change means we will have to consider land use decisions, and their social, economic and environmental implications, not in the typical 10 to 30 year context, but in the 50 to 100 or more year context.

Policy 1.6 of the SPP requires councils to prepare an adaptation strategy for urban localities projected to be within a high coastal hazard area to the year 2100. Policy 1.8 of the SPP also requires adaptation strategies to be appropriately reflected in local planning instruments for relevant high coastal hazard areas within five years of the SPP commencing.

Comment [m4]: Update

The Queensland Government has mapped coastal hazard areas along the Queensland coast. The maps indicate the extent of Queensland's coastal areas projected to be at risk from coastal hazards to the year 2100. Each map shows:

- areas to be permanently inundated – resulting from either coastal erosion or from sea level rise
- a default storm tide inundation area – medium hazard and high hazard inundation areas.

The coastal plan adopts the sea-level rise figure and planning period of 0.8 metres by the year 2100 (relative to 1990) based on the upper limit of the most recent projections released by the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (2007). This figure will be reviewed based on the outcomes of future IPCC realeases, the first one of which will be delivered by the end of 2014 (IPCC Fifth Assessment Report).

The Queensland coastal hazard area maps are available on the Department of Environment and Resource Management's (DERM) website <www.derm.qld.gov.au/coastalplan>.

Further information

Further information about the methodology used to determine coastal hazard areas under the coastal plan, and guidance about determining areas at risk from coastal hazards can be found in the Coastal Hazards Guideline, available on the DERM website <www.derm.qld.gov.au/coastalplan>.

'Queensland Coastal Processes and Climate Change' also provides information on coastal processes and the vulnerability of Queensland's five coastal regions. The publication is available at <www.climatechange.qld.gov.au/qld-coastal-processes-and-climate-change>.

The 'Planning for stronger, more resilient floodplains guideline' delivers a complementary toolkit for councils, which includes interim planning scheme measures to manage development outcomes in the floodplain so that risk to life, property, community and the environment during future flood events is minimised. The guideline is available at <www.qldreconstruction.org.au>.

1.2 What is a coastal hazard adaptation strategy?

Coastal hazard adaptation strategies document the results of an assessment of the risk urban localities face from high coastal hazard impacts over the medium to long term, propose adaptation measures to mitigate these impacts, and establishes an implementation program for the mitigation measures.[1]

Adaptation options considered in the adaptation strategy should:

- mitigate the adverse impacts of inundation
- improve the community's awareness and preparedness for actions required to mitigate future hazard risks
- maximise functionality of essential community service infrastructure[2] during and immediately following inundation events
- be incorporated into planning instruments, other council plans (e.g. community plan, corporate plan) and community programs.

Comment [MS5]: No option in the Compendium cover this item, whilst it was raised by the working group Griffith University/GHD early in the process

An adaptation strategy must address policies 1.6 to 1.8 of the SPP, which are reflected in the following stages 1 to 3 and 5 to 7. Adaptation strategies should also be prepared in accordance with the following 'best practice' stages 4, 8 and 9 (see Table 1 for further information on these development stages):

1. Spatially identify areas at risk, preferably through local scale hazard mapping.
2. Identify current and known future 'assets' at risk (residential, commercial, community) and assess their vulnerability to coastal hazards to the year 2100.
3. Identify potential adaptation options (e.g. avoid, defend or retreat).
4. Consult the community about the potential adaptation options.
5. Undertake a ~~cost-benefit analysis~~socio-economic appraisal of adaptation options.
6. Select preferred adaptation option(s).
7. Develop an implementation program and financial plan.
8. Engage in community consultation on the draft adaptation strategy.
9. Develop a process for reviewing and updating the adaptation strategy.

Comment [r6]: what about natural environment and character considerations as part of a MCA

Adaptation strategies will not be a 'silver bullet' for all coastal hazards issues. Policy 1.8 of the SPP outlines that adaptation strategies are to be incorporated into local planning instruments for relevant high coastal hazard areas. However, addressing the issue through a planning scheme and development assessment will only be effective in managing new development in urban localities projected to be at risk over the long term.

The purpose of this guideline aligns with the statutory intent of the SPP; however, assessing development under a planning scheme is only one part of the process for adaptation planning and management. Providing a comprehensive adaptation strategy should consider both existing and future development and communities at risk.

1 It is important to note erosion prone area policies in section 2 of the SPP apply regardless of whether an adaptation strategy has been prepared.
2 Essential community service infrastructure includes: emergency services infrastructure, emergency shelters, police facilities, hospitals, power stations and substations, communications facilities, sewage treatment plants and water treatment plants.

Although not a statutory requirement of the SPP, it is recommended that adaptation strategies should also be incorporated into emergency, community, financial, infrastructure and corporate plans, as appropriate.

1.3 When is an adaptation strategy required?

Policy 1.6 of the SPP requires local authorities to prepare a coastal hazard adaptation strategy for urban localities projected to be within a high coastal hazard area[3] up to the year 2100, whether or not intensification of development within the locality is proposed.

Policies 2.5.1 and 2.5.2 of the SPP outline that development proposals to intensify[4] land in high coastal hazard areas within five years of the coastal plan commencing can be considered. Prior to an adaptation strategy being finalised, individual development proposals require a risk assessment to be completed which demonstrates that projected coastal hazard impacts can be effectively mitigated[5]. After an adaptation strategy has been completed, intensification of development in a high coastal hazard area can only be approved where it is consistent with a coastal hazard adaptation strategy.[6]

Adaptation strategies are not mandatory for development in medium-risk coastal hazard areas; however, they may be useful for land-use planning in such areas.

The preparation of adaptation strategies need not delay completion of local council planning instruments. However, councils should not increase development rights (for example through changes to zoning or acceptable land uses) in high coastal hazard areas until an adaptation strategy has been prepared.[7]

Comment [m7]: Unless the increased development rights decrease the risk??

For the purpose of the guideline and the coastal plan, the initial adaptation strategy may include provisions in planning instruments to not provide for intensification in particular high coastal hazard areas. If this is the case, a cost-benefit analysis is not required to be undertaken for those areas. However, for an area where intensification is to occur then an adaptation strategy is to be incorporated in planning instruments.

As outlined in policy 2.5.2 of the SPP, an adaptation strategy is required where intensification is proposed in a high coastal hazard area within the statutory review period of a local planning instrument (every ten years). However, decisions on where intensification may occur in the medium to long term should be considered in order to minimise the frequency of undertaking a risk assessment and cost-benefit analysis. Local government could, therefore, prioritise timeframes for locations where intensification is proposed—for example in the next decade, and then the next. This should allow a more manageable approach to deciding where and when an adaptation strategy is required.

1.4 Who is responsible for developing adaptation strategies?

As outlined in policy 1.6 of the SPP, local government authorities are responsible for preparing coastal hazard adaptation strategies.

DERM can provide on-going technical assistance if required, including participating in any steering groups established by local councils (where invited) and providing councils with high resolution digital elevation data about their coastal areas to inform the preparation of adaptation strategies.

External expertise is likely to be required in undertaking certain steps in preparation of adaptation strategies—for example a detailed coastal hazard and risk assessment or a cost-benefit analysis of feasible adaptation options.

[3] The high coastal hazard area is defined in the SPP and includes the erosion prone area that is in the coastal management district; land that will be permanently inundated by a 0.8 metre sea level rise; and the storm tide inundation area that will be inundated by one metre or more during a defined storm tide event.

[4] Part C of the 'State Planning Policy 3/11 Guideline: Coastal Protection' outlines what constitutes 'intensification'.

[5] Refer to Annex 6 of the State Planning Policy 3/11 Guideline for guidance on undertaking a risk assessment.

[6] Section 2 of the SPP outlines the situations where this provision does not apply.

[7] Redevelopment can occur where there are existing approved protection works already in place that would address the risk of potential adverse coastal hazard impacts. Without such works in place, a development that results in an increase in the development footprint or an increase in the intensity of the existing approved use (such as additional residential dwellings) would be an increase in the exposure of the community to coastal hazard risks under the SPP. Replacing an existing single residential dwelling with a new single residential dwelling is not considered to be 'intensification' under the SPP. Redevelopment that maintains an existing intensity of use or scale of development (such as renovating a take-away shop and changing it into a corner store) is also not considered to be 'intensification' under the SPP.

1.5 Role of the state

The Queensland Government will assess adaptation strategies when planning schemes are submitted for State interest review required under the *Sustainable Planning Act 2009*.

The Queensland Government is also available to consult with councils during the preparation of adaptation strategies to ensure adaptation options are consistent with relevant regulatory requirements.[8]

~~1.6 Adaptation guideline review~~

~~The Local Government Association of Queensland, Townsville City Council and the Queensland Government are jointly undertaking a Coastal Hazard Adaptation Strategy Pilot Project for urban localities within Townsville City identified to be at risk from high coastal hazards to the year 2100 (Townsville pilot project). The Townsville pilot project is an Australian Government Coastal Adaptation Decisions Pathways project. The outcomes of the Townsville pilot project will provide practical guidance to councils on how to develop coastal hazard adaptation strategies.~~

~~This guideline will be reviewed and updated after completion of the Townsville pilot project (late 2012) to reflect the findings and recommendations. The guideline will also be reviewed should the climate change factors outlined in policy 2.1.1 of the SPP change or new information or processes warrant a review to ensure appropriate and up-to-date guidance is available to councils.~~

~~Queensland's climate change adaptation strategy, ClimateSmart Adaptation 2007–12, is currently being reviewed. An updated climate change adaptation strategy for Queensland is expected to be available in 2012. The updated strategy will consider the findings from the Townsville pilot project and any additional guidance and support for councils. Further information on the update is available at <www.climatechange.qld.gov.au>.~~

Comment [MS8]: Consider delete this section

8 Local authorities are requested to contact Coastal Planning, Department of Environment and Resource Management at <coastal.support@derm.qld.gov.au>.

2. Preparing an adaptation strategy

Effective risk management is fundamental to ensure that coastal hazard risks are identified, assessed and prioritised, then mitigated. The adaptation strategy development stages outlined in section 2.1 of the guideline are based on the steps outlined in the Australian and New Zealand Risk Management Standards (AS/NZS ISO 31000:2009).

Adaptation strategies should follow the development stages outlined in Table 1 and the following guiding principles:

- reflect locally-specific objectives (based on the broad objectives outlined in section 1.2 of the guideline)
- incorporate flexibility recognising that climate change benchmarks may change over time. In this regard, adaptation strategies should be considered a 'living' document to deal with changing risks, uncertainties and innovation
- integrate the range of coastal hazard risks across the inshore, foreshore and hindshore areas rather than treating coastal erosion, storm-tide inundation and sea level rise independently
- note that risks from coastal hazards are not uniform and will vary along the Queensland coastline affected by topography, sediment type and coastal processes, as well as local adaptive capacity. This makes adapting to coastal hazards a clear case for thinking regionally, but analysing and acting locally
- be based on the best available science and information
- be based on the precautionary principle[9] to mitigate coastal hazards to the year 2100, taking into account the long-term environmental, social and economic factors.

There is no set format that an adaptation strategy should adopt as there is not a 'one size fits all' approach. Further, it is acknowledged that some councils have already undertaken substantial amounts of work that can be used to progress adaptation strategies and councils may wish to use this material. To avoid duplication, adaptation strategies should reference work already conducted in accordance with the development stages outlined in section 2.1.

The minimum requirements and best practice approaches outlined in section 2.1 will ensure that all adaptation strategies address key elements and follow a structured, consistent approach.

Case studies on different adaptation options, both in Australia and internationally, are provided in Appendix A to provide further assistance and ideas if required. One of the by-products of the Townsville pilot project (GHD 2012) ~~will be a~~is the ~~compendium~~ Compendium of Coastal Hazard Adaptation Options relevant to the Queensland Coast.

[9] The application of the precautionary principle under the *Sustainable Planning Act 2009* requires that a lack of full scientific certainty is not used as a reason for postponing a measure which would respond to and prevent a threat of serious or irreversible environmental damage.

including ~~adaptation~~ examples and case studies. The compendium is available to Councils at (www) ~~that will expand on those provided in Appendix A.~~

2.1 Adaptation strategy development stages

The development stages in Table 1 outline the minimum requirements contained in the SPP that must be included in an adaptation strategy for relevant high coastal hazard areas. While not statutory requirements under the SPP, the 'best practice' approaches should be addressed to ensure that a comprehensive and integrated adaptation strategy is prepared that will mitigate coastal hazard impacts to both existing and future assets and communities at risk.

These requirements will be considered during State interest reviews of planning schemes under the *Sustainable Planning Act 2009*.

Table 1 Development stages and acceptable approaches for preparing coastal hazard adaptation strategies under the Queensland Coastal Plan

Development stages	Acceptable approach
2.1.1 Spatially identify areas at risk, preferably through local scale hazard mapping.	**Minimum requirement** ▪ Policy 1.6 of the SPP requires councils to identify urban localities that are projected to be within a high coastal hazard area between the commencement of the SPP and the year 2100 as a basis for preparing adaptation strategies. ▪ At a minimum, councils are to use the larger scale Queensland Government coastal hazard area mapping to identify areas at risk from coastal hazards to the year 2100. The coastal hazard area maps are available on the DERM website at <www.derm.qld.gov.au>.
	Best Practice ▪ Councils are encouraged to prepare local scale maps of coastal hazard areas in accordance with the Coastal Hazards Guideline. ▪ Local scale maps can be prepared at a finer scale and take into account local conditions, providing better accuracy (as opposed to using the default storm tide inundation area included in the Queensland Government coastal hazard area maps[10]). ▪ The Coastal Hazards Guideline outlines the mapping methodology used to develop the Queensland Government coastal hazard area maps and is available on the DERM website at <www.derm.qld.gov.au>. ▪ DERM can provide councils with high resolution digital elevation data for coastal areas to inform the preparation of local-scale coastal hazard mapping.
	Notes *Planning for future scenarios* ~~*Scenario planning*~~ The coastal plan adopts a sea level rise of 0.8 metres by 2100 (relative to 1990). However, it is likely that projections will change and possibly increase over time. In light of this, councils may use this opportunity to consider an additional higher sea level rise scenario when determining areas and assets at risk and when identifying adaptation options. The Townsville pilot project (GHD 2012) ~~will~~ has assessed the impacts of a 1.1 m sea level rise in addition to the 0.8 m required by the coastal plan. Where a council decides to consider a higher sea level rise scenario this approach will demonstrate how councils can best incorporate a second sea level rise factor when developing adaptation strategies. The Townsville pilot project ~~will~~has: ▪ identified~~:~~ areas subject to a 0.8 m sea level rise by 2100 as prescribed by the coastal plan

Comment [MS9]: Consider updating the Coastal Hazard Guideline based on the recommendations of the Learnings Report

Comment [MS10]: "Scenario planning" is a methodology to explore scenarios with stakeholders, the title is therefore misleading…we used scenario planning in SEQ CARI
Definition: http://en.wikipedia.org/wiki/Scenario_planning

[10] The Queensland Government coastal hazard area maps includes a default storm tide inundation area that is all land between high water mark and a defined storm tide event level of 1.5 metres above the level of highest astronomical tide in south-east Queensland or 2 metres above the highest astronomical tide in the rest of Queensland.

	▪ modeled the impacts of a 1.1 m sea level rise factor in recognition of possible future sea level rise projections ▪ undertake hydrodynamic and bathtub modelling to enable comparison between these two approaches. As the coastal plan mandates a projected sea level rise of 0.8 m for planning purposes, the 1.1 m sea level rise scenario would not be the basis for adaptation options to be included in council plans. It can, however, inform future planning, particularly should projections in sea level rise increase over time. Once completed, the Townsville Pilot Project will provide councils with advice on the range of modelling options that can be used when preparing local-scale coastal hazard maps.
2.1.2 Identify current and known future 'assets' at risk (residential, commercial, community) and assess their vulnerability to coastal hazard impacts to the year 2100.	**Minimum requirement** ▪ Policy 1.6 of the SPP requires adaptation strategies to be based on an assessment of the mitigation options that will mitigate the coastal hazard. As part of this assessment, councils are required to identify current and known future 'assets' at risk ~~and assess their vulnerability to~~from coastal hazards to the year 2100.
	Best Practice ▪ Council databases or other systems, such as the National Exposure Information System (NEXIS)[11] ~~may assist councils in identifying current assets located in high coastal hazard areas. Local planning~~ schemes, locally specific climate change infrastructure risk assessments, future strategies or regional plans may also assist in identifying future assets at risk. ▪ Councils may wish to involve the community during this stage to assist with identifying potential assets at risk. The community should be included early as awareness and education through this process will build capacity within the community to respond and bounce back from natural disasters, such as coastal inundation. Early community engagement will also inform and assist with the consultation stages outlined in steps 2.1.4 and 2.1.8. ▪ Once the assets in affected areas have been identified, a risk assessment should be undertaken to ~~determine vulnerability and help~~ identify and prioritise adaptation options for affected areas. ▪ The risk assessment ~~to determine assets vulnerable~~ to coastal hazard impacts is to be assessed and prioritised according to 'likelihood' and 'consequence' as outlined in the Australian and New Zealand Risk Management Standards (AS/NZS ISO 31000:2009).
	Notes The assets identified in high coastal hazard areas are projected to be at risk from coastal erosion, permanent inundation from sea level rise or ~~greater than one metre of~~ storm tide inundation greater than one metre. Therefore, the ▪ location (e.g. elevation, proximity to protection work) ▪ design (e.g. on stilts) ▪ construction (e.g. resilient materials) ▪ function (e.g. a nursing home) of these assets will determine how vulnerable they are to these coastal hazards and the adaptation response required to mitigate the impact.
2.1.3 Identify potential adaptation option(s)	**Minimum requirement** ▪ Policy 1.6 of the SPP requires adaptation strategies to be based on an assessment of the mitigation options that will mitigate the coastal hazard. ▪ Based on the areas and assets at risk, councils are to identify potential adaptation options to mitigate coastal hazard risks, including consideration of possible costs, impacts, future risks, trade-offs and benefits identified through the risk assessment process. ▪ Local long-term social, financial and environmental factors must be taken into account for each potential adaptation option or combination of options.
	Best Practice ▪ Adaptation options should consider soft and hard coastal protection works, ~~land use change~~, building and infrastructure standards and land use planning ~~retreat~~ options. Identified adaptation options should include sufficient details of the option to inform the cost benefit analysis in step 2.1.5. This may include, for example, the height, length and materials to be used for hard coastal

Comment [MS11]: The concepts of risk and vulnerability are quite different and should be possibly presented differently. I would suggest the following: Identify current and known future exposed 'assets' and assess their vulnerability to coastal hazards by 2100, including an assessment of risks.

In general:
Vulnerability=Exposure+Sensitivity+Adaptive Capacity
Risk: Probability of an exposed asset to be impacted.

Comment [MS12]: Not properly done in TCC pilot and reccomneded in the Learnings…

Comment [r13]: vulnerability assessment - consistent with new coastal state planning regulatory provision

11 NEXIS is being developed by Geoscience Australia to provide nationally consistent exposure information to support regional risk assessments of assets to various hazards. Further information on NEXIS is available on the Geoscience Australia website at <www.ga.gov.au>.

	protection works, the cost of fill or relocating infrastructure. ▪ Further information to assist councils in identifying appropriate adaptation options is included in the Compendium of Coastal Hazard Adaptation Options available at (www)~~at **Attachment 1**~~.
	Notes As part of the Townsville pilot projec (GHD 2012)t a compendium of examples of adaptation actions suitable for the Queensland coast ~~will be described~~has been prepared. ~~This~~ The compendiu~~mm will~~ identifie~~s~~ a comprehensive range of coastal hazard adaptation options including both hard and soft engineering options, building controls and planning options (for example, retreat or land use change). The compendium will further assist councils to identify potential adaptation options.
2.1.4 Consult the community about the potential adaptation options	**Minimum requirement** ▪ There is no specific statutory requirement under the SPP. ▪ Although public consultation is not a statutory requirement under the SPP, a coastal hazard adaptation strategy needs to be integrated into the planning scheme and consultation is required when planning schemes and planning scheme policies are prepared or amended under the *Sustainable Planning Act 2009* (SPA).
	Best Practice ▪ Keeping the general community and specific stakeholders informed early in the process is an important part of developing an adaptation strategy. The community should be informed of the overall project, areas at risk, and the findings to date. The community should also be offered the opportunity to provide their views on the adaptation options identified in 2.1.3 (including potential tradeoffs) and their long-term advantages or consequences. ▪ The guideline does not prescribe how community consultation should be undertaken; this is best identified at the local level, noting that councils already have consultation practices in place. The choice of which tools and techniques used depends on the complexity of the issues to be discussed and the purpose of the engagement—both, of which, should be determined in the initial steps of the process where a careful evaluation of the time and resources available should be performed.
	Notes The Townsville pilot project ~~will~~ has included the development of a best-practice community and stakeholder engagement process that may assist councils in undertaking public consultation when preparing adaptation strategies.
2.1.5 Undertake a ~~cost-benefit analysis~~socio-economic appraisal of adaptation options	**Minimum requirement** ▪ Policy 1.6 of the SPP requires councils to undertake a cost-benefit analysis (CBA)[12] of adaptation options to determine the most cost effective works or actions, taking into account long-term social, financial and environmental factors. ▪ ~~Councils are strongly encouraged to await the findings of the Townsville pilot project before proceeding with a CBA and subsequent steps in the process to help ensure that decisions are made consistently and are based on a supported and tested approach.~~ ▪
	Best Practice ▪ An effective approach is to combine two socio-economic appraisal techniques: multi-criteria analysis (MCA) and cost-benefit analysis (CBA). MCA can sets the stage for CBA, by assessing the identified options using a set of criteria selected and weighted using stakeholder input. CBA is performed on the short-listed of options with a higher degree of sophistication to quantify the scale of impacts and to understand the costs of adaptation versus status quo in the long term~~No best practice approaches are identified.~~ ▪ ~~The Townsville pilot project will investigate different CBA methodologies and circumstances (see notes below).~~ ▪ The Townsville CHAS Pilot study (GHD 2012) utilised an innovative benefit-cost methodology that correctly considered the possibility of extreme inundation events occuring at any time during the planning period and did not use a fixed level of hazard (e.g. such as the nominal 100 y Return Period). A Monte Carlo simulation approach was used to sample the full range of event probabilities and to also determine the optimum timing of adaptation initiatives.

Comment [MS14]: Consider amending the plan into Socio-Economic Appraisal

12 For the purpose of this guideline, a cost-benefit analysis may include other quantitative analyses that appropriately determine the costs and benefits of adaptation options.

	Notes There is not a single or pre-determined ~~CBA~~ socio-economic appraisal methodology that is applicable to this situation. The Townsville pilot project has~~will~~ investigated different CBA methodologies and circumstances in which they should be applied by councils. Consideration ~~will~~ was ~~be~~ given to: ▪ future costs of actions or inaction over the longer term including inter-generational discount rates over the 100 year period ▪ adaptation options analysis that keeps options open and enables optimal timing for decision making and investments (trigger points) ▪ cost effective approaches to protect community-valued assets that are difficult to quantify in monetary terms~~.~~ Even minor variations in the method and assumptions for a CBA can dramatically alter the results, so developing a standard approach is important.
2.1.6 Select preferred adaptation option(s)	**Minimum requirement** ▪ Policy 1.7 of the SPP requires adaptation strategies to describe the mitigation works or actions to be undertaken to mitigate the coastal hazard. ▪ Councils are to select adaptation option(s) to be included in an adaptation strategy to mitigate coastal hazard impacts.
	Best Practice ▪ Adaptation options selected need to include optimal timing for investment, trigger points and review processes for decisions taking into account risks and uncertainties (see step 2.1.7 below). ▪ Trigger points or indicators based on the ~~CBA~~ socio-economic appraisal findings should be set to identify the level of acceptable change before adaptation options must be implemented.
	Notes A triggered approach allows for actions to be implemented as the threat arises, while also allowing time to improve coastal hazard data and obtain necessary funding, resources and capacity. It also limits community burden, costs and inappropriate adaptation measures should coastal hazard impacts not eventuate as projected. The sea level rise adaptation trajectory at **Attachment 1**, which includes generic trigger points, may assist councils to further conceptualise what the adaptation pathway may look like for existing assets in a particular area.

2.1.7 Develop an implementation program and a financial plan	**Minimum requirement**
	▪ Policy 1.7 of the SPP requires adaptation strategies to describe the
	  • cost of undertaking the works or actions
	  • funding scheme or arrangements that will be established to pay for the works or actions to be completed
	  • timeline for the commencement and completion of the mitigation works or actions
	▪ In planning implementation, local councils will need to identify how the nominated adaptation measures will be funded to deliver effective implementation. This includes funding and resources required for monitoring and evaluation to determine whether new risks have arisen, the likelihood or consequence of risks have changed, and to identify when trigger points have been reached.
	▪ Policy 1.8 requires local planning instruments to appropriately reflect the adaptation strategy for the relevant high coastal hazard area within five years of the commencment of the SPP.

	Best Practice ▪ While policy 1.8 of the SPP only requires the adaptation strategy to be incorporated into local planning instruments, providing a comprehensive adaptation strategy should consider both existing and future development and communities at risk. It is, therefore, recommended that adaptation strategies should also be incorporated into emergency, community, financial, infrastructure and corporate plans. ▪ Other land-use decision makers (e.g. Commonwealth, State, Port Authorities and infrastructure entities) should be made aware of the proposed coastal hazard adaptation strategy and its planning implications, as appropriate.
	Notes

Comment [r15]: such as natural environmental values and local character and amenity - eg. sand nourishment over hard rock walling relates to maintaining character and recreational use.

	The Compendium of Coastal Hazard Adaptation Options includeds ~~Townsville pilot project will~~ out a preliminary identification~~y~~ of revenue-raising mechanisms available to councils for financing the adaptation options and identify measures to ensure the adaptation strategy can be integrated into local, state and national government planning and program areas. This guideline does not prescribe how adaptation options should be incorporated into local planning instruments; this is best considered at the local level. However, depending on the adaptation options selected, there are a number of ways in which objectives and options can be reflected in planning instruments. For example— ▪ The Queensland Government or local-scale coastal hazard area maps overlay could be incorporated into local planning scheme zonation maps. ▪ Assessment code requirements may be introduced to ensure design and standards (e.g. minimum floor heights, road levels) mitigate coastal hazard impacts, should intensification occur in an urban area. ▪ Planning instruments may identify areas where intensification is not permitted, until an adaptation strategy has been prepared, which outline how coastal hazard impacts will be mitigated.
2.1.8 Engage in community consultation on the draft adaptation strategy	**Minimum requirement** ▪ There is no specific statutory requirement under the SPP. ▪ Although public consultation is not a statutory requirement under the SPP, a coastal hazard adaptation strategy needs to be integrated into the planning scheme and consultation is required when planning schemes and planning scheme policies are prepared or amended under the SPA.[13] ▪ At a minimum, community consultation should be in line with the requirements under the SPA.
	Best Practice ▪ The community should be engaged early in the process, by providing opportunities for integrating their contribution in the identification of risks, adaptation options and criteria for appraisal. Once adaptation options have been selected and an implementation plan developed, the community should be consulted and given appropriate opportunity to comment on the draft adaptation strategy.
	Notes The Townsville pilot project ~~will include~~has developed~~ment of~~ a best-practice community and stakeholder engagement process that may assist councils in undertaking public consultation when preparing adaptation strategies.
2.1.9 Develop a process for reviewing and updating the adaptation strategy	**Minimum requirement** ▪ There is no specific statutory requirement under the SPP. ▪ Local councils are to review adaptation strategies if the climate change factors outlined in policy 2.1.1 of the SPP are changed. ▪ However, periods for review of adaptation strategies should, at a minimum, coincide with the review of planning schemes (every ten years).
	Best Practice ▪ Periods for review of adaptation strategies should coincide with the review of planning schemes. As outlined in the SPA, councils—in undertaking a review of a planning scheme—must include an assessment of the achievement of the strategic outcomes stated in the planning scheme. This will include measures adopted in adaptation strategies to ensure adaptation measures are effective and meeting locally-specific objectives.

Comment [MS16]: See section on vulnerability and risks: it states that community should be engaged!

[13] See Chapter 3, Part 5 of the *Sustainable Planning Act 2009* (SPA).

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Attachment 1

Identifying potential adaptation options

Comment [MS17]: I would delete this section as it will be replaced by the Compendium

The choice of potential adaptation options will vary greatly depending on the inherent impacts associated with coastal hazards, the vulnerability of the region, and the adaptive capacity of communities to respond. When identifying adaptation options, long-term environmental, social and economic considerations need to be considered through an integrated and precautionary management response.

Avoidance of future risk is the most cost-effective adaptation response in most cases and decisions on future development in coastal hazard areas should not increase the existing exposure of a community to coastal hazards risks. However, this option needs to be considered in the context that many urban localities within high hazard areas are already built up.

In considering the options available to address coastal hazard risks for existing development, the following generic adaptation measures have been identified (**Figure 1**):

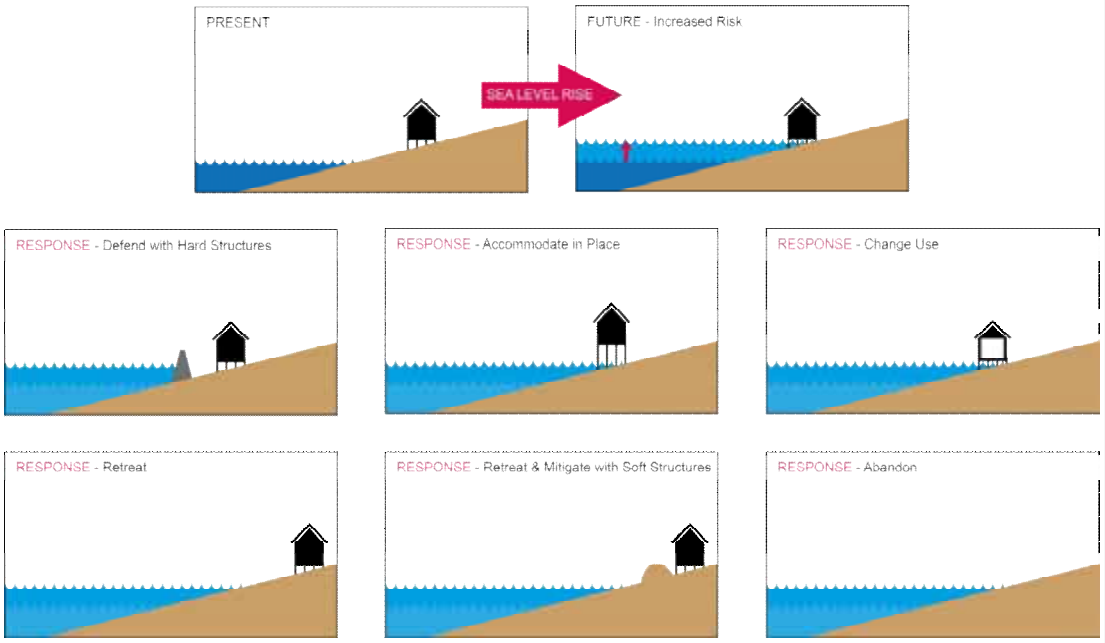

Figure 1: Different types of adaptation measures for existing development.

Sea-level rise projections and growing value of certain assets at risk may result in increasing reliance on defences, which may be appropriate for high value immovable assets where there is likely to be long-term commitment to a high level of development in the area to justify the rising long-term costs. In other cases, future assets could be designed to accommodate inundation (e.g. demountable buildings, building on stilts). The change use example in Figure 1 may include changing the use from a residential zone at risk to commercial or recreational purposes that

are less susceptible to coastal hazard impacts. Another option could be planned retreat behind natural defences such as dunes and wetlands, which play a protective role colonising land as the shoreline advances.

Natural ecosystems can provide valuable benefits, including buffering many of the risks associated with coastal hazards. Planning should consider maximising ecosystem resilience, allowing for ecosystem movement, and making explicit decisions about tradeoffs. For instance, while hard protection[14] can greatly reduce the impacts of sea level rise and inundation on socio-economic systems, this may be to the detriment of associated natural ecosystems due to 'coastal squeeze'.[15]

The sea-level rise adaptation trajectory in **Figure 2** may assist councils to further conceptualise what the adaptation pathway may look like for existing assets in a particular area. The trajectory highlights that at some point in the future (whether it is by the year 2100 or beyond) the costs of protection works and maintenance will eventually be greater than the value of the assets being protected. A cost-benefit analysis will indicate when this will occur. The trajectory also outlines that, generally, no single adaptation measure will result in permanent immunity against sea level rise and coastal hazards, meaning adaptation measures may need to change over time.

The trajectory includes adaptation options and generic trigger points, which may help planners and consultants decide when and what adaptation measures should be undertaken. For example, a trigger point for councils to review viable adaptation options would be when the cost of protecting an asset becomes greater than the value of the asset itself. At this point, councils may, for example, change the adaptation measure (e.g. from protection works to planned retreat) or change the land use to a type or design which is not vulnerable to sea level rise.

Planning for retreat would occur prior to the intolerable threshold being reached, at which point the retreat option may be implemented. The land-use change option is only shown at two points in the figure although it could occur at any time. However, the viability of the land-use change option may decrease as impacts approach an intolerable threshold and major investment has already occurred. The vulnerability 'envelope' shows that assets assessed as high vulnerability will reach impact thresholds earlier in time that those assets assessed as low vulnerability. 'Nuisance management' includes minor adaptation measures to address low-level temporary impacts, such as short-term flooding events during extreme weather conditions or wave over wash at periods of king tides. Examples of nuisance management may include tide flaps on drains, wave over wash walls or permeable wall finishes (such as limewash) which allow walls to dry out after inundation.

[14] Policy 2.4.2 of the SPP states that coastal protection work that involves beach nourishment to control coastal erosion is preferred over erosion control structures wherever feasible.

[15] The IPCC (Christensen et al, 2007) defines coastal squeeze as 'the squeeze of coastal ecosystems (e.g. salt marshes, mangroves and mud and sand flats) between rising sea levels and naturally or artificially fixed shorelines, including hard engineering defences'.

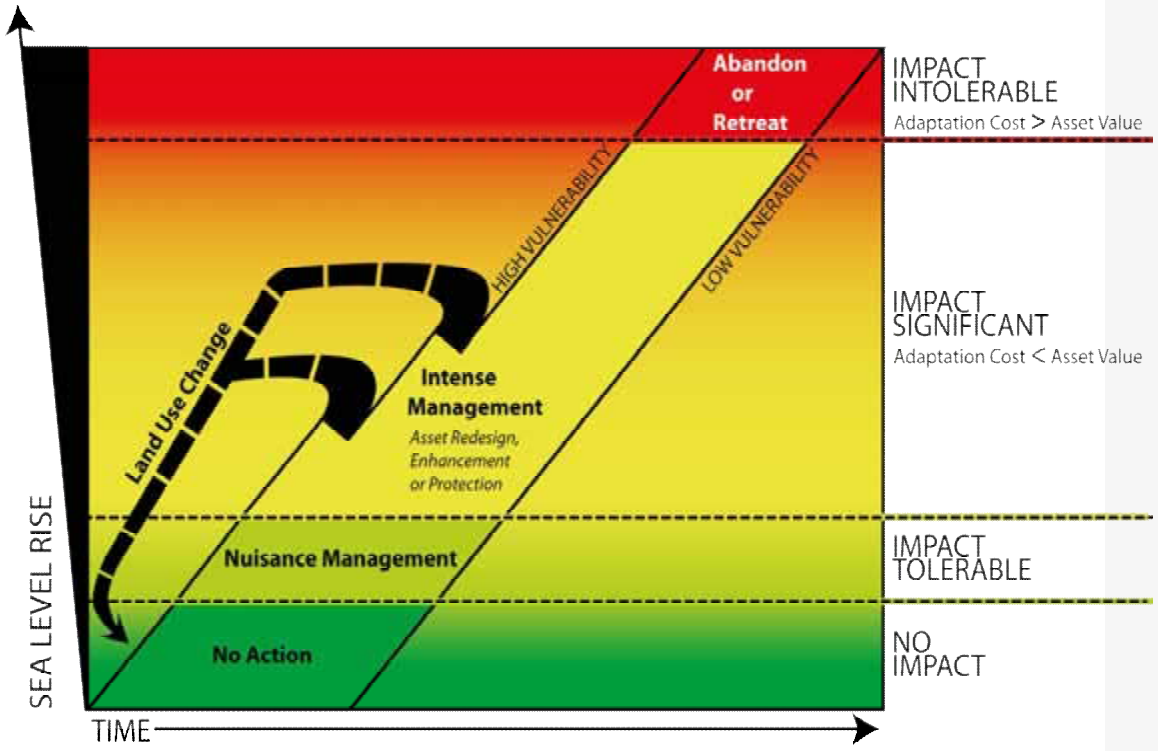

Figure 2: Sea-level rise adaptation trajectory for existing assets outlining adaptation options and trigger points to inform when and what adaptation measures should be undertaken.

The cost-benefit analysis method that will be prepared as part of the Townsville Pilot Project will consider a process for changing adaptation responses based on trigger points.

Further issues and questions that should be considered when identifying potential adaptation options are outlined in boxes 1 to 3 below.

A compendium of climate change adaptation options for coastal hazards is being prepared as part of the Townsville pilot project. This compendium will identify a comprehensive range of coastal hazard adaptation options including both hard and soft engineering options, building controls and planning options. The compendium will further assist councils to identify potential adaptation options.

Box 1: Considerations for defending assets

Would the defensive structure have adverse impacts on natural character, the local economy, scenic amenity and public access values?

What are the advantages or disadvantages of 'hard' verses 'soft' coastal protection works (i.e. sea walls verses beach nourishment)?

Would the public accept continually increasing the height and/or extent of coastal defence structures into the future?

Would there be an expectation that defences would be maintained 'forever', leading to ever increasing financial commitment to maintain and upgrade such defences? Who would bear the costs?

What are the implications once the cost of maintaining defence structures is greater than the assets being protected?

Is there allowance for coastal ecosystems to migrate landward as the sea level rises? What is the value of coastal ecosystems (e.g. for fishery resources or tourism)?

What lessons can be learned from examples where protection structures fail (e.g. the levees in New Orleans following Hurricane Katrina)?

What are the land tenure considerations and potential approval processes?

Would 'hard' defences cause erosion remote from their locations and, therefore, potentially generate the need for more hard defences on neighbouring beaches?

Box 2: Considerations for implementing planned retreat

What would the processes relating to transition mechanisms and timeframes for staging a strategic approach to managed retreat be?

What would be the anticipated public perception and timing for advising property owners of potential future retreat in relation to trigger points?

What provision and amount of land is available for a retreating coastal community?

What are the existing land-use rights?

What financial assistance is available for relocation (e.g. purchase of property, subsidies for relocation)?

What is the value of property at risk?

What other incentives (or disincentives) are available for property owners vacating land?

What mechanisms should be in place to inform existing or new property owners of future risk?

Is there opportunity to redistribute risks, uncertainties, benefits and costs among stakeholder groups (e.g. developers) to ensure they bear future costs from development?

Box 3: Considerations for implementing accommodation options

What would the design requirements be to accommodate coastal hazard impacts to the year 2100?

When would new development (and services) need, to follow design requirements?

Will the approach result in increased demand for emergency services? If so, is an alternative solution required? (Note: adaptation options should not depend on increased demand for emergency services.)

What types of (early) warning systems and preparedness could be accommodated to increase community awareness of, and preparation for, coastal hazard threats?

Consideration of other legislation

The coastal plan or adaptation strategies do not operate in isolation. Important aspects in considering the feasibility of adaptation measures include the application of other pieces of relevant legislation. For example, operational works (e.g. coastal protection works) on State coastal land, such as beach reserves, may conflict with land tenure considerations under the *Land Act 1994* (Qld). The type of operational works or development to assist in adaptation may not align with the purpose for which land has been allocated and, therefore, development may not be supported. While land tenure can be amended to accommodate adaptation works, local councils should be aware of potential approval processes.

Further, adaptation strategies may need to address issues of displaced environmental and cultural values that may be captured under other Queensland legislation (e.g. the *Marine Parks Act 2004*) or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act). Local councils should be aware that any adaptation measures that will have, or may have, a significant impact on a matter of national environmental significance under the EPBC Act will need to refer the proposal to the Australian Government.

While approval under the EPBC Act or other legislation may not be required for several years, in-principle support for the works from relevant decision makers should be sought prior to including the adaptation option in the adaptation strategy.

Appendix A
Case studies

Governments in Australia and internationally are planning for the impacts of climate change and coastal hazard impacts. The following case studies provide a range of examples of climate change adaptation planning processes and/or adaptation measures that may assist councils in identifying possible adaptation measures.

Note, a compendium of climate change adaptation examples for coastal hazards is being prepared through the Townsville pilot project. The compendium will provide councils with a range of options to consider for inclusion in their respective coastal hazard adaptation strategy. The project is being run under the Australian Government Coastal Adaptation Decision Pathways Program and will be completed late 2012.

Comment [BH18]: Replace by a section sumamrising the Townsville CHAS project as an example of best practice.

Australia

Western Port Region, Victoria – Coastal inundation and flooding

Coastal inundation and flooding have been identified as key longer term climate change risks as part of a major study for the Western Port Region in Victoria. Some 16,500 properties have been identified as vulnerable to flood events related to climate change.

A list of ten priority climate change issues was developed from over 200 risks identified, with most of these related to coastal inundation or flooding due to increased intensity of rainfall.

The issue of uncertainty over planning controls in areas affected by coastal inundation or flooding generated almost 30 adaptation measures, including capacity building to improve decision makers' understanding of climate change, and the amendment of local planning schemes to include specific provisions on the treatment of sea level rise and storm surge projections in relation to land protection, use and development.

On the issue of loss or degradation of beaches and foreshore areas, adaptation measures recommended in the study included the retention of coastal Crown lands in public ownership and that further modelling be undertaken to identify localities most vulnerable to sea level rise, storm surges and inundation now and in the future.

Source: Australian Government Department of Climate Change and Energy Efficiency 2010, *Climate Change Adaptation Actions for Local Government*, Report by SMEC Australia, pp. 22–23, <www. climatechange. gov.au/publications/local-govt/local-government.aspx>.

Clarence City Council, Tasmania – Coastal area risks

Consultation with community groups revealed that Clarence residents are aware of, and concerned about, climate change and sea level rise; but the extent to which they may be directly affected was not well understood. A significant theme was a desire to retain beaches in their current state.

A vulnerability assessment identified a number of localities and roads at risk now from storm surge, while other localities were considered risk areas in the medium term (25–75 years).

Recommended practical adaptive responses include:

- planning controls for new development
- physical works such as seawalls, groynes, dune management or sand nourishment, reconstruction of public infrastructure above flood level

- detailed emergency management and evacuation planning with hazard reduction requirements for affected properties
- community education and information to improve awareness and ability to cope
- ongoing monitoring, analysis and review of findings.

Council is undertaking a range of work including adding more sand to, and revegetation of, beaches and dune areas; the raising and reinforcement of some roads; the installation of effective sewerage systems; and the development of new standards and planning controls. The report can be downloaded from <http://www.ccc.tas.gov.au/site/page.cfm?u=1075>.

Source: Department of Climate Change and Energy Efficiency 2010, *Climate Change Adaptation Actions for Local Government*. Report by SMEC Australia, p. 24, <www.climatechange.gov.au/publications/ local-govt/ local-government.aspx>.

Darwin City Council – Climate change and environmental management

Darwin City Council has placed climate change and waste management at the forefront of its strategic directions document 'Evolving Darwin – Towards 2020 and beyond'. To support this commitment, council initiated an Environmental levy of one per cent in their 2009–10 Budget to provide additional support to respond to climate change and environmental programs.

A Climate Change and Environment Advisory Committee works with Darwin City Council to provide advice on priorities, with committee representation from community, environment, indigenous and science sectors, universities, the Northern Territory Local Government Association, and government agencies.

An Environmental Management Plan (EMP) for Darwin was developed in 2006 and the 'Climate Change and Environment Action Plan 2009–12' builds on the EMP 'City Atlas of Values' – which divides Darwin into separate environmental management units based on the city's 24 identified hydrological sub-catchment boundaries—thus enabling tasks to be undertaken at a local level.

A coastal erosion report undertaken for council provided a review of the physical, geological and environmental settings of the low-lying cliffs at two study sites and outlines the major sea and land-based processes which are causing enhanced erosion of the coastline.

Source: Australian Government Department of Climate Change and Energy Efficiency 2010, *Climate Change Adaptation Actions for Local Government.* Report by SMEC Australia, p.48, <www.climatechange.gov.au/ publications/local-govt/local-government.aspx>.

Coastal inundation at Narrabeen Lagoon, NSW – Optimising adaptation investment

AECOM was engaged by the Australian Government Department of Climate Change to undertake an economic analysis of climate change impacts on infrastructure through the development of a series of case studies. These studies analyse the benefits and costs of adaptation in response to risks of climate change.

Six possible measures are analysed in detail:

- Widening the entrance to the lagoon
- Lake Park Road levee
- Progress Park levee
- Nareen Creek floodwall and flood gates

- Early flood warning awareness
- Introduction of flood planning controls.

Opening the ocean entrance to Narrabeen Lagoon permanently by excavating a channel through the headland rock shelf would lower the water level by up to one metre. Modelling suggests that a 70-metre wide channel is economically viable now, but the benefits increase if deferred until 2035.

Construction today of a three metre high levee on Lake Park Road along the southern boundary of the Sydney Lakeside Holiday Park would generate net economic benefits of $0.9 million, and is therefore a viable proposition.

A floodwall and floodgates along Wakehurst Parkway would prevent rising floodwaters in the lagoon from backing up into Nareen Creek, which feeds into it. Although almost 300 houses would be protected, the study suggests that the cost involved outweighs the benefits.

A system to provide Pittwater residents with early warning of floods would be relatively inexpensive. With net benefits of $12 million in present value terms, it would be worthwhile implementing this strategy immediately.

Amending planning regulations to require an increase in floor height by at least one metre for all new buildings and renovations to existing buildings would reduce flood damage over time. Although an average house is renovated only every 40 years on average, the beneficial net present value from immediate adoption of this measure would be at least $13.8 million.

Source: Australian Government Department of Climate Change 2010, *Coastal Inundation at Narrabeen Lagoon: Optimising Adaptation Investment.* A report prepared by AECOM for the Department of Climate Change, <http://www.climatechange.gov.au/~/media/publications/adaptation/coastal-flooding-narrabeen-lagoon.pdf>

International

Northern Vietnam – Mangrove planting projects

In north-east Vietnam, thousands of hectares of mangroves have been planted and protected since 1994 to defend coastlines from the dangers of wind and storm surge. Previously, coastal storms would often breach dikes, wreaking havoc in both human and economic terms. However, thanks largely to the new mangroves, in the aftermath of typhoon Wukong, which pummelled the north-east coast of Vietnam in 2000, neither dike damage nor loss of human life was reported. Since then, the mangroves have successfully reduced dike maintenance costs by millions of dollars per year. The mangroves have also contributed to better livelihoods for inhabitants as a result of the wealth of crabs, shrimps, and molluscs provided by the mangroves.

Source: U.S. Agency for International Development (USAID) 2009, *Adapting to Coastal Climate Change: A Guidebook for Development Planners,* <www.usaid.gov/our_work/cross-cutting_programs/water/news_announcements/coastal_climate_change_report.html>.

Bangladesh – Mangrove afforestation

The coastal areas of Bangladesh have a high frequency of cyclones. It was realised that mangrove forests in the south-west of Bangladesh protected the local coasts from cyclone damage. Therefore, in 1966 a programme of mangrove planting was initiated on the seaward sides of protective embankments in the coastal districts.

The Bangladeshi mangrove planting programme mainly utilised two mangrove species, despite the occurrence of approximately 27 species in the country. These two species were selected because of their encouraging survival rates.

It was found that as well as providing protection against coastal erosion, mangrove planting also helped create large areas of land through accretion, provided large quantities of wood and other forest products, and provided employment for local villagers. Additionally, it was seen that although mangrove plantations were damaged during significant storms, full recovery was expected; the system is therefore self-repairing.

Source: Linham, M & Nicholls, R 2010. *Technologies for Climate Change Adaptation – Coastal Erosion and Flooding,* TNA Guidebook Series, University of Southhampton, <http://www.unep.org/pdf/TNAhandbook_CoastalErosionFlooding.pdf>.

Sarasota County, Florida – Transferable development rights

A voluntary program with increased potential for use in conservation and sea level rise adaptation is transferable development rights. The general concept is to give landholders the ability to transfer their development rights over ecologically valuable or sensitive lands to other areas that are suited for more intense forms of development. Since development rights are the focus, arrangements could be envisioned where the property owner kept title subject to a conservation easement, while gaining development rights to another property inland; alternatively, there could be a direct land swap. This concept has been available through zoning ordinances in most Florida counties since the 1980s, although it has rarely been used in this region.

Sarasota County's 2007 comprehensive plan explicitly recognizes the possible use of this mechanism to promote resettlement from high-risk coastal areas, like barrier islands, to inland areas that are less vulnerable to nature and natural disasters.

Source: Lausche, B 2009, *Synopsis of an Assessment: policy tools for local adaptation to sea level rise*, Marine Policy Institute at Mote Marine Laboratory, Technical Report #1419, October, <http://www.mote.org/>.

City of London Adaptation Strategy

The City of London developed a strategy for adapting to the impacts of climate change, *Rising to the Challenge – the City of London Corporation's Climate Adaptation Strategy. It* was developed using standard risk management tools in consultation with key stakeholders and service providers. The strategy devolves responsibility for implementation to individual departments and puts a monitoring system in place for delivery.

The principle practical adaptation options recommended in the strategy for managing flood risks are summarised below.

- The City of London Corporation should assign responsibility for coordination and liaison on flood risk management and identify, map, and manage risk in flash flood hotspots.
- The City of London Corporation should examine a range of incentives to encourage sustainable drainage systems and green roofs.*
- Developers should be encouraged to install sustainable drainage systems and green roofs in targeted flash flood 'hotspots' for new developments, redevelopments or major refurbishments.
- The City of London Corporation should ensure drainage systems can cope with heavy rainfall events by improving the monitoring and recording of gully overflows linked to heavy rainfall; assessing the capacity of the 72 km of sewers that it manages to cope with increasing rainfall; and should coordinate with the Thames Tideway Tunnel project.
- The City of London Corporation should encourage businesses to consider relocating flood-sensitive IT equipment and archives to areas at low risk of flooding.

* Green roof are considered a sustainable drainage systems technique. They are vegetated roofs, or roofs with vegetated spaces.

Source: *Rising to the Challenge – The City of London Climate Change Adaptation Strategy,* First Published May 2007. Revised and Updated January 2010, <http://www.cityoflondon.gov.uk/Corporation/LGNL_Services/Environment_and_planning/Sustainability/Climate_change/>.

East Riding of Yorkshire Council Coastline 'Rollback'

The East Riding of Yorkshire, UK, and its neighbors are particularly at risk from climate change due to an eroding coastline. East Riding of Yorkshire Council is implementing a coastal 'rollback' strategy to manage high rates of coastal erosion as part of its *Integrated Coastal Zone Management Plan*. 'Roll back' is a term used to describe the relocation of property and infrastructure further inland from the eroding coast. The council considers hard-engineered coastal defenses economically and environmentally unsustainable for protecting all development in the coastal zone.

The East Riding of Yorkshire Council website provides information on its *Integrated Coastal Zone Management Plan* as well as rollback programs for the caravan industry and residential and agricultural dwellings at risk from coastal erosion. With the need to have a sustainable approach to maintaining the viability of the caravan industry on this fast eroding coastline, the concept of 'rollback' was developed by the East Riding of Yorkshire Council in partnership with the Environment Agency and caravan park owners. Partners such as the Local Planning Authority have looked at the implications of re-locating the parks, and developed guidelines, standards and policies within which any moves can be made. The rollback strategy for the caravan industry has, to date, been highly successful. Whilst moving inland, the viability of the caravan industry is being maintained, sustaining communities dependent on caravan tourism.

Source: Western Australian Local Government Association (WALGA) website, <http://www.walgaclimatechange.com.au/ planning-case-studies.htm>.

Avalon, New Jersey: Artificial sand dunes and dune rehabilitation

The dune management programme in Avalon started with two activities: (1) building dunes along the entire seafront using sand fences and vegetation planting; and (2) raising money to buy undeveloped shorefront lots to create an undeveloped segment of coastline which provides space for landforms to evolve naturally, a source of sand for replenishing critically eroding areas, and a location for experimenting with environmentally compatible management strategies. It also prevented further development from taking place in the hazard zone. Another aspect of the management strategy authorised landholders to plant dune vegetation to initiate natural dune building processes.

Although the dune construction programme encountered early resistance because of the associated costs, restricted beach access and restricted views, this was overcome by raising awareness of the effectiveness of dunes as a means of coastal protection.

To date, the beach and dune management programme has had a number of beneficial consequences for residents. Flood insurance premiums have come down as a result of reduced flood risk; the beach has retained a natural image while accommodating human uses; and the flood hazard reduction properties of dunes have also qualified these structures for external funding to replace lost sediments.

The success of the scheme has been attributed to a number of factors. One essential feature of the programme is education and awareness raising among the public. A newsletter and flood hazard information are also regularly sent to property owners in order to maintain the collective memory of flood hazards.

Source: Linham, M & Nicholls, R 2010, *Technologies for Climate Change Adaptation – Coastal Erosion and Flooding*, TNA Guidebook Series, University of Southhampton,<http://www.unep.org/publications/contents/pub_details_search.asp?ID=6189>.

New Orleans: Preserving the wetlands to increase climate change resilience

Following the failure of structural flood defences during Hurricane Katrina in 2005, the State of Louisiana and the City of New Orleans have undertaken steps to increase the resilience of the city to sea level rise, hurricanes and river flooding. An approach utilising many lines of defence has been adopted, involving structural and non-structural defences.

One of the key protection measures is the conservation and restoration of wetlands as a buffer zone between the sea and the city. Detailed actions aimed at the promotion of wetlands are included in the New Orleans Masterplan under the headings of green infrastructure and city resilience. Inclusion of wetland conservation and restoration activities in the New Orleans Masterplan signals a significant change of flood-defence tactics in the region from an emphasis on levees and floodgates to the incorporation of more natural solutions.

Source: Kazmierczak, A & Carter, J 2010, *Adaptation to climate change using green and blue infrastructure: A database of case studies*, University of Manchester, <http://www.grabs-eu.org/casestudies.php>.

United Kingdom: Managing changes to our coastline – Hasketh Out Marsh West

As sea levels rise and the effects of climate change are experienced, the UK Environment Agency is starting to look at new ways of managing the coast, moving away from the solid flood defence structures that have previously protected the coast and estuaries.

Instead, a more natural way of dealing with coastal flooding is being explored, through what is called 'managed realignment' – using land as a place to store floodwater. In the past, this land might have been drained for farming. But allowing floodwater back onto the land returns it to salt marsh or mudflats. These can then absorb the impacts of higher sea levels and increased storm surges resulting from climate change.

The Royal Society for the Protection of Birds bought half of the land at Hesketh Out Marsh in 2006 to turn into a nature reserve. Since then, the Environment Agency has been working with them and other organisations to create salt marshes, creeks and lagoons.

Source: United Kingdom Environment Agency website, <http://www.environment-agency.gov.uk/ research/planning/109003.aspx>.

Adapting to sea level rise in Hayward, California

The Hayward shoreline, located along east San Francisco Bay, is susceptible to inundation from wave action and flooding. To assess the impacts of anticipated sea level rise along the Hayward shoreline, the Hayward Area Shoreline Planning Agency (HASPA) commissioned a study by an engineering consulting firm to evaluate vulnerable infrastructure and examine strategies to protect wetlands and shoreline development.

While projections show that sea level will rise in the future, the rate at which it rises varies, thus adaptation planning will need to be flexible. Adaptation strategies suggested included:

- hold the line – protect land and infrastructure from erosion, inundation and flooding through the use of levees and seawalls

- realignment – move the levee to a new location further inland to allow marshes and mudflats to naturally transgress landward
- gradual steepening – combines the virtues of 'hold the line' and 'realignment' to create a more sustainable shoreline that can accrete vertically and does not transgress landward too rapidly
- diffuse armoring – a modified 'hold the line' option where wave erosion buffers that emulate natural backshore wave-buffering processes are utilized.

Source: Climate Adaptation Knowledge Exchange website, <http://www.cakex.org/case-studies/2738>.

National Trust properties, Boscastle, United Kingdom

Following devastating floods at Boscastle in 2004, impermeable wall finishes on vulnerable buildings have been replaced with limewash. This allows walls to dry out after inundation. Internally, suspended floors have been converted to solid floors to reduce the impact of any future flooding, and electrical points have been raised off the ground. Floors in the Youth Hostel have been raised above the level of a 1 in 100-year flood.

The Engineering Historic Futures project provides better understanding of the wetting properties and drying processes in historic buildings.

Source: United Kingdom Environment Agency website, <www.grdp.org/static/documents/Research/_11__Adaptation_by_design.pdf>.

Managed retreat at Surfer's Point, California

Erosion has been a consistent problem at Surfer's Point in Ventura, California, for more than 20 years. The city's response to the erosion through the 1980s and 1990s was to use shoreline hardening, which ultimately resulted in more intense erosion at Surfer's Point and at other points further away; in some places, more than 60 feet of land was lost.

Multiple options were explored by city and nongovernmental groups, including the Surfrider Foundation. Surfrider Foundation played a critical role in the approval of a managed retreat strategy, which included relocation of a bike path and parking lot 60 feet inland; beach renourishment, habitat restoration, riprap removal; and petitioning for the removal of the nearby Matilija Dam to restore sand supply. The total construction estimate for this enterprise is about $3.8 million.

Source: Climate Adaptation Knowledge Exchange website, <http://www.cakex.org/node/1590>.

Malibu Land Use Implementation Plan – Setbacks and sea level rise

Sea level rise poses an enormous threat to the sandy beaches of Malibu as well as to the multi-million dollar homes lining the coast. To mitigate and prepare for the current and future hazards on coastal resources and development, the plan requires the following:

- all new development on the beach or oceanfront bluff be setback as far as possible and elevated above the base flood elevation
- all new development that would require shoreline armoring or hardening be prohibited

- all applicants for new development on beachfront or bluff-top property must include an impact report and analysis that addresses the effect of the development in relation to a number of things including future projections of sea level rise.

The land use policies outlined in the Land Use and Local Implementation Plans help prepare the city for the impacts of climate change by encouraging setbacks, low impact development along shorelines, and the removal of shoreline hardening where possible.

Source: Climate Adaptation Knowledge Exchange website, <http://www.cakex.org/node/2802>.

Preparing for storm surges in Annapolis Royal, Nova Scotia

A citizens-based group, the Clean Annapolis River Project (CARP), undertook a tidal surge project in 1998 to assess the town's vulnerability to storm surges.

CARP searched records from museums, newspapers and historical societies to discover the types of events that occurred in the past and to estimate changes in climatic and tidal factors. Using future climate change scenarios and resulting sea-level rise predictions, storm surge floods were mapped. With the information gathered, CARP was able to identify wide potential risk zones for tidal surge flooding and possible implications for people in the region.

The results of the project were presented to citizens in a series of public forums. These were followed by a mock disaster scenario that engaged local fire, medical and emergency response teams.

In response, various adaptive planning measures were taken. These include a renewed focus on the need to both raise and properly maintain dikes. The maps revealed that during a major flooding event, the fire hall—situated on a small rise—would become an island separated from the rest of the community. Subsequently, the Fire Department acquired a boat and modified its emergency response plans, including the relocation of much of the rescue equipment (previously stored solely at the station).

Source: Natural Resources Canada website, <http://adaptation.nrcan.gc.ca/case/index_e.php>.

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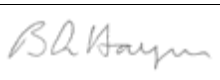
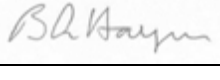
2	M. Smith B.Harper	B Harper		B Harper		12/10/2012
3	M.Smith B.Harper	S.Sultmann		B Harper		26/10/2012

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