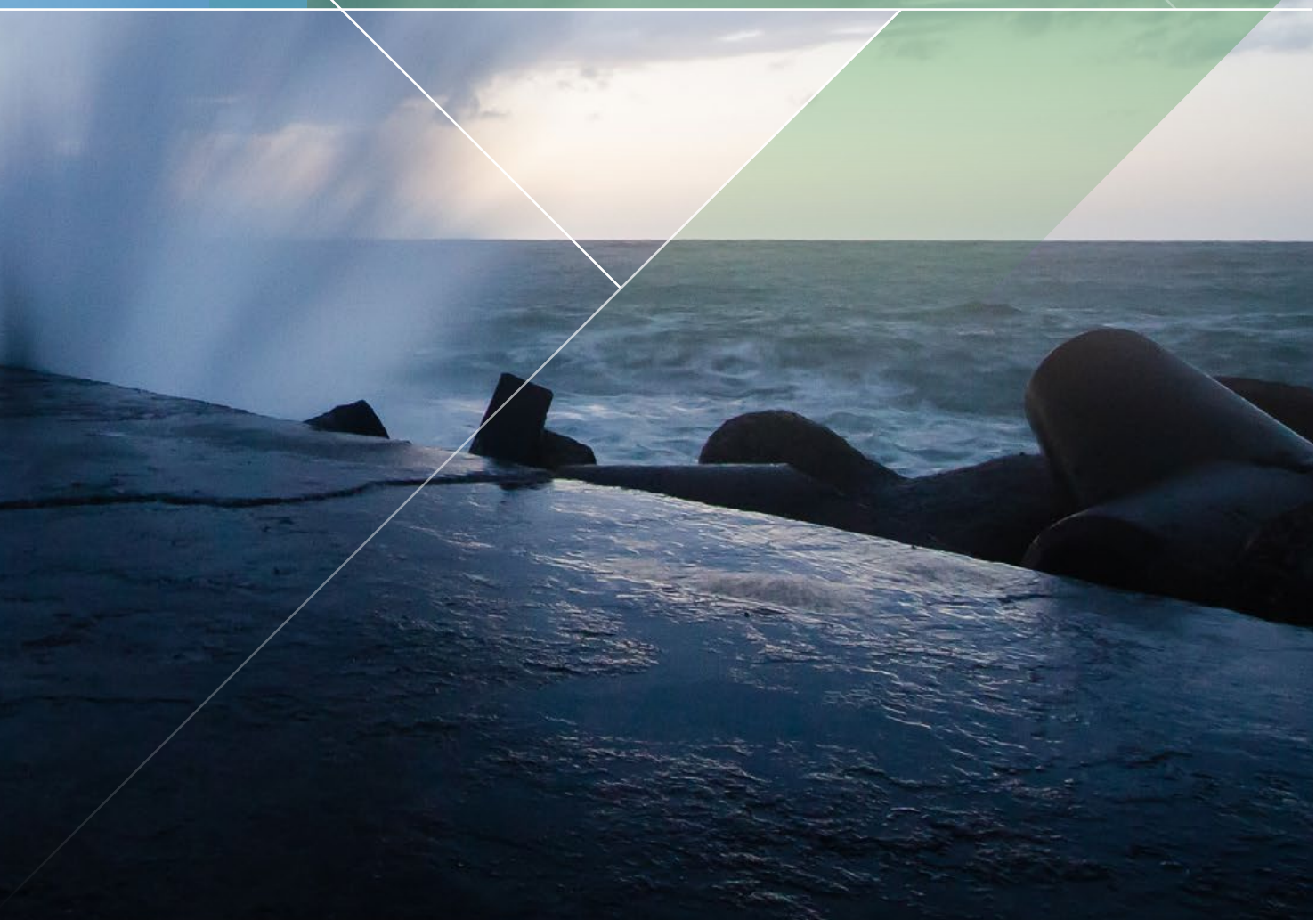
Climate Change Adaptation
Good Practice - Case Study

Sydney Coastal Councils Group: Mapping and Responding to Coastal Inundation



About Adaptation Good Practice

Adapting to climate change is a relatively new concept to many. It is important to learn from practitioners who are undertaking adaptation activities that are beginning to have tangible outcomes. Documenting examples of good practice and identifying the criteria that makes them work, enables those interested in adaptation to learn about how to take action.

There are expectations that Adaptation Good Practice (AGP) includes a definite start and finish to a project. However climate change practitioners' experiences show that adaptation projects are often steps in longer learning journeys. There are no golden rules on how to adapt and often practitioners across Australia are inventing the wheel that drives future AGP. This case study of Sydney Coastal Councils Group's (SCCG) three-phase 'Mapping and Responding to Coastal Inundation' is part of a series of 16 case studies that recognise exemplars for AGP in Australia. Through the development of these stories of successful adaptation it was refreshing to see an emergence of similar experiences and challenges regardless of the project or location. A synthesis of these stories can be seen in the Synthesis Report 'Climate Change Adaptation Good Practice: Key lessons from practitioners experiences', which will help practitioners to understand that they are not alone in their challenges and to see some of the clear lessons learned about what drives good practice in adaptation.

Following the Snapshot there is a more in depth narrative of the experiences, learnings and network links to stimulate further engagements and knowledge sharing among the growing community of adaptation practitioners.

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For further information contact:

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education
Email: stakeholderrelations@climatechange.gov.au

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D. Rissik and N. Reis from the National Climate Change Adaptation Research Facility.

Acknowledgements : Dr Philip Booth Australian Climate Change Research Network for Settlements and Infrastructure (ACCARNSI). UNSW. Assistance from Geoff Withycombe, Executive Officer Sydney Coastal Councils Group, as a key informant was greatly appreciated.

References: **1.** Leitch, A., Harman, B., & Lane, M.B. 2010, 'From blueprint to footprint: climate change and the challenge for planning'. In T. Bonyhady, A. Macintosh, J. McDonald, (Eds.), *Adaptation to climate change: law and policy* (pp.63-79). Sydney, The Federation Press. **2.** Preston BL, *et al*. 2008, *Mapping Climate Change Vulnerability in the Sydney Coastal Councils Group*. **3.** Smith, T.F., *et al*. 2008, Case Studies of Adaptive Capacity: Systems Approach to Regional Climate Change Adaptation Strategies prepared for the Sydney Coastal Councils Group, Sydney Australia. **4.** Smith, T,. 2011, *The Nature and Utility of Adaptive Capacity Research*. Keynote address by Tim Smith Director, Sustainability Research Centre, University of the Sunshine Coast to ACCARNSI 6th National Forum and Workshop, 21 November 2011.

Case study snapshot

Sydney Coastal Councils Group: Mapping and Responding to Coastal Inundation

The Sydney coastal region extends from Port Hacking in the south to the Hawkesbury River in the north, encompassing approximately 590 km of ocean and estuarine shorelines. In 2009 the SCCG undertook a major study, 'Mapping and Responding to Coastal Inundation' in partnership with the CSIRO. which made an investment co-contribution to the project. The SCCG was also awarded co-funding to undertake this 3-phase project under the Natural Disaster Mitigation Program.

The project journey

In response to sea level rise predictions in the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (AR4), the Sydney Coastal Councils Group initiated a regional coastal vulnerability study in 2007 (Preston *et al.* 2008; Smith *et al.* 2008). It provided a foundation for a suite of related climate research projects.

SCCG Member Councils requested a follow-on regional assessment project to show hazard lines including sea level rise (SLR) predictions on coastal inundation maps, which would become a call to action to cope with future impacts of increased coastal inundation and erosion events on existing, redeveloped and new developments within coastal landscape areas.

This ambitious and challenging project to map and respond to coastal inundation in all 15 Member Councils commenced in 2009 and culminated in 2012. The mapping and modelling phase proved to be more technically complex than first envisaged by the SCCG team and Member Councils.

→ Lesson learnt:

In retrospect, they would approach this project differently by making a better estimation of the time required to obtain, collate and integrate all existing biophysical baseline data.

And contingent on the availability of more resources, they would also include wave run up in the modelling. These key learnings will be a future focus of improving the data set.

Other consistent and strong observations to take forward from this project include:

- Firmer understanding of the complexities of managing coastal inundation in terms of technical, social and political aspects
- Involvement of communities in the Member Councils is the next logical step in responding to coastal inundation.

→ Lessons learnt:

- Projects such as this highlight the need to include the diversity of research, technical and practical expertise
- Maintain constant attention to ensuring good project management structures, procedures and accountability

Drivers for adaptation action

In 2009, requests from SCCG Member Councils for a regional inundation assessment project that would show **hazard lines** and **benchmark numbers** on inundation maps, and become a call to action.

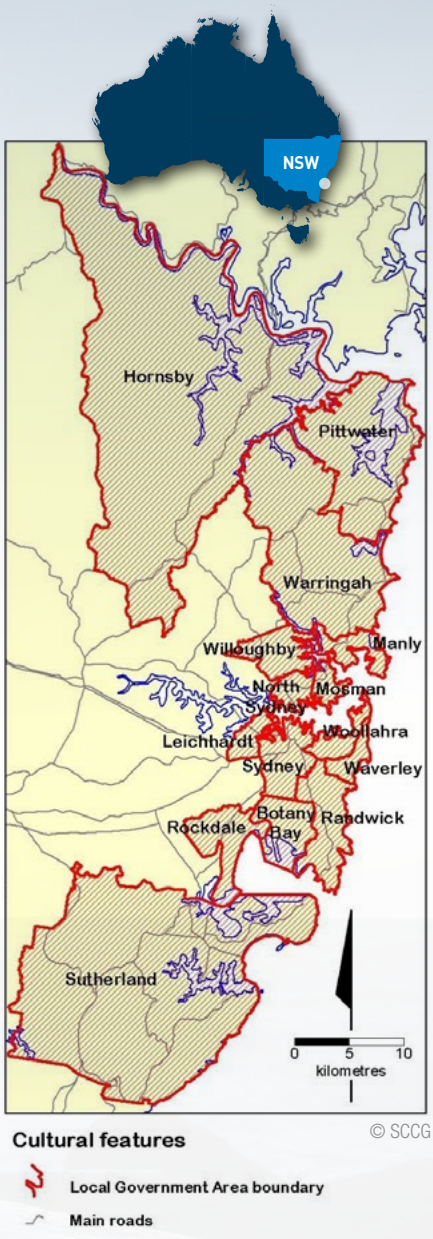

Figure 1: Map of SCCG showing 15 Member Councils of the Sydney coastal region SCCG's coastal region extends from Port Hacking in the south to the Hawkesbury River in the north, approximately 660 km of ocean and estuarine shoreline, and four coastal lagoons.

The key success factors included the dedication of the people who came together with a shared vision to deliver this project, including members of the Expert Panel.

→ Adaptation Action

To effectively incorporate sea level rise and extreme sea level modelling into the Sydney Coastal Councils' planning and management systems.

Risks and impacts addressed

Anticipated sea level rise (SLR) and increased frequency and intensity of extreme weather events, resulting in higher coastal inundation events and coastal erosion.

Project aims

The focus and key aims for each phase of the project were:

Phase 1 – 'Inundation Modelling and Mapping': map areas of Sydney at risk of sea level rise, utilising sophisticated modelling to determine hazards and assist the development of consistent model planning and management responses. Produce a set of high resolution hydrodynamic model simulations, to obtain current climate, storm tide return level estimates, and SLR considerations

Phase 2 – 'Regional Planning Responses': conduct a national and international review of legislative frameworks to clarify consistent planning principles and model planning provisions that underpin appropriate regional planning responses that address coastal inundation.

Phase 3 – 'Communicating Coastal Inundation': develop and distribute community risk disclosure information on coastal inundation, adaptation response options, and community and stakeholder education programs through a comprehensive and effective Communications Strategy.

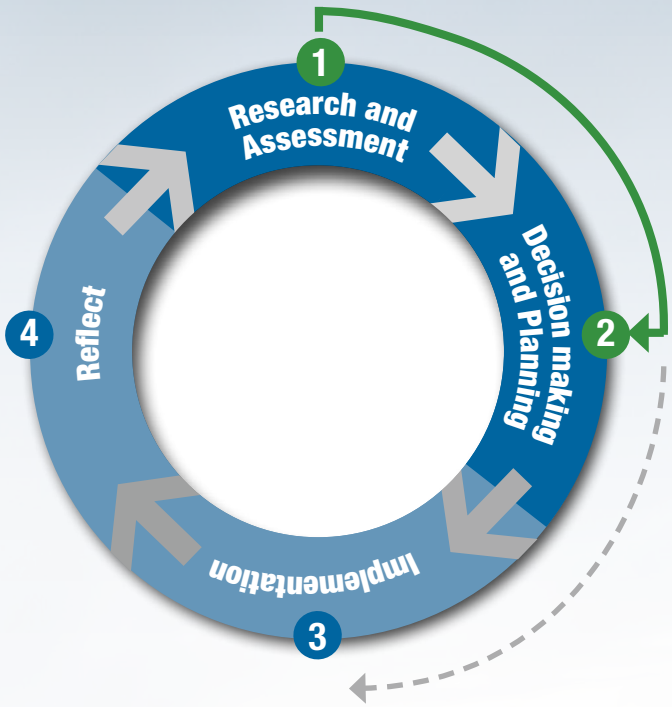

Figure 2: Sydney Coastal Councils Group: Mapping and Responding to Coastal Inundation project Adaptation Good Practice phase

Despite the challenges outlined above, intended outcomes of all 3 phases were delivered and the project culminated in 2012. The key success factors included the dedication of the people who came together with a shared vision to deliver this project, including members of the Expert Panel. Clear and determined leadership among the Sydney Coastal Council Executive also played an important part in supporting the strong research and infrastructure experiences and areas of expertise in the team.

Outcomes achieved

Phase 1 Report - ***Modelling and Mapping of Coastal Inundation under Future Sea Level Rise*** (Feb 2012).

Phase 2 Report - ***Incorporating Coastal Inundation and Sea Level Rise into Local and Regional Planning Responses*** (July 2012).

Phase 3 Report - ***Supporting Local Government to Communicate Coastal Inundation*** (Oct 2012).

Emerging outcomes

Capacity building elements to leverage the project outputs and provide follow-on capacity building for professional staff and key stakeholders

Opportunities for further collaborations with key partnership organisations to drive regional adaptation plans.

The project

All of the 15 SCCG Member Councils see advantages in collaborating to develop evidence-based, pragmatic responses to manage risks of coastal inundation. However, each Council contends with different exposures and sensitivities to climate change hazards, and has different adaptive capacities that reflect the socio-economic profiles of residents, in combination with available financial, technical and human resources. These differences are evident in the relative vulnerability scores in the Table (Figure 3) from the Phase 2 Regional Planning Responses report (section 4.1 p12).

Risks and impacts addressed

SLR is anticipated to expose low-lying coastal areas to increased risks of inundation over the next century. In 2010 the New South Wales (NSW) Government benchmarked expected SLR to be 0.4 m above the Australian Height Datum (AHD) by 2050 and 0.9 m above AHD by 2100 (now withdrawn) (NSW Office of Environment and Heritage 2010).

Anticipated increases in frequency and intensity of extreme weather events will also result in higher risks of coastal inundation events and erosion.

The Phase 1 Inundation Modelling and Mapping report describes how rising sea levels are projected to impact most acutely across the Sydney region during the coincidence of high tides and severe storm events, notably east coast low pressure systems (ECLs), when strong winds and lower-than-normal atmospheric pressure cause storm surges, and high waves to impact on Sydney's open beaches, estuaries, ports and coastal infrastructure.

Council vulnerability to sea level rise and coastal management showing exposure, sensitivity and adaptive capacity components and net vulnerability (from Preston *et al*, 2008)[1]

Local Government Area	Exposure	Sensitivity	Adaptive capacity[2]	Net vulnerability[3]
Botany Bay	5	7	6	9
Hornsby	5	4	4	1
Leichhardt	4	7	1	8
Manly	5	6	1	7
Mosman	4	5	1	3
North Sydney	4	8	1	2
Pittwater	5	7	3	5
Randwick	4	5	4	6
Rockdale	5	8	8	9
Sutherland	5	3	5	4
Sydney	4	5	2	8
Warringah	5	4	2	2
Waverley	5	5	1	4
Willoughby	4	5	1	1
Woolahra	4	7	1	6

1. See Preston *et al.* 2008 p.37 for indicators used to calculate vulnerability components
2. A higher score indicates a lower adaptive capacity
3. Calculated see Preston *et al.* 2008

Figure 3: Phase 2 Regional Planning Responses report

Each Council contends with different exposures and sensitivities to climate change hazards, and has different adaptive capacities that reflect the socio-economic profiles of residents, in combination with available financial, technical and human resources.

These contributing factors are shown on the next page in **Figure 4: Schematic illustrating contributions to coastal sea levels**, from the Phase 1 report. They are key drivers for preparing response strategies and action plans to reduce vulnerabilities and risks of impacts to billions of dollars of built and natural heritage assets in the Sydney coastal region, to acceptable levels.

Information and knowledge gaps

Phase 1 Inundation Modelling and Mapping: the key gap was the need for high resolution hydrodynamic inundation modelling for the Sydney region

Phase 2 Regional Planning Responses: policy guidance for consistent coastal planning frameworks at local, regional, state and national levels

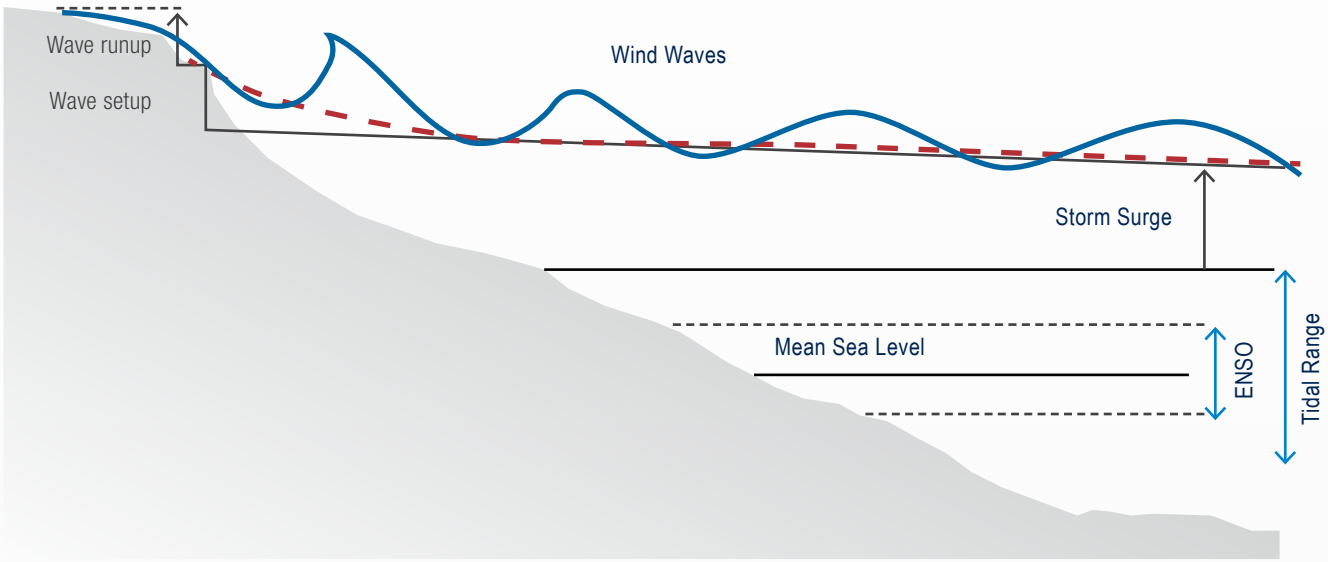

Figure 4: Schematic illustrating contributions to coastal sea levels including the El Nino Southern Oscillation (ENSO) - from Phase 1 from Modelling and Mapping report p.5

Phase 3 Communicating Coastal Inundation: there were huge information gaps to fill, in order to provide clear and consistent advice on communication and engagement with key stakeholder groups. Several Member Councils had previously undertaken work in this space but it tended to be limited, and there was no consistent approach to communication and engagement, across the region.

Response strategy

Key aims, measurable objectives and deliverables in the three-phase study included:

i. Provide Councils and the community with the science, management and planning provisions and community awareness raising materials necessary to effectively incorporate sea level rise and extreme sea level modelling into planning and management systems

ii. Establish an Expert Panel to provide leadership and clarification in scientific and technical issues during the project.

iii. Map hazard areas utilising sophisticated modelling together with Council's information sources (e.g. LiDAR technology) to determine extent of exposure and develop consistent model planning and management responses

Implementation phases

Focus of pre-Phase 1

i. Grant application

ii. Project scoping

iii. Partnership identification, and investment co-contribution from CSIRO

iv. Consultation and surveys with Member Councils to identify key needs and desired outcomes for the project – and funding requirements

v. Establishment of Expert Panel

Focus of Phase 1

Develop a set of high resolution hydrodynamic model simulations incorporating storm tide return level estimates and sea level rise considerations.

Focus of Phase 2

a) Audit of national and international planning principles, policies and legislation for coastal inundation and sea level rise

b) Planning guidelines

To assist local councils in planning and management responses to sea level rise and coastal inundation, to more effectively embed these hazards into environment planning options and instruments

Focus of Phase 3

Develop community risk disclosure information and corresponding community and stakeholder education

programs for Member Councils. Generate templates and other tools to communicate coastal inundation hazards and adaptation responses.

Focus of Phase 4 – Legal advice

Seek legal advice on Councils obligations in relation to the utilisation and disclosure of hazard information.

Focus of Phase 5 – Capacity building

Leverage the project outputs and provide follow-on capacity building for professional staff and key stakeholders.

Outcomes achieved

The following shorter-term intended outcomes of the study were:

Phase 1

The key outcome was sourcing high quality terrestrial elevation data and high resolution bathymetric data using the best available data sources, then meshing these into a single seamless dataset in a common geospatial framework to underpin hydrodynamic modelling.

Phase 2

The first key outcome was a literature review of international and national planning principles, policies and legislation for coastal inundation, undertaken by the NSW Environmental Defenders Office (EDO) to provide background of approaches in other jurisdictions.

The second key outcome was a coastal planning forum. This brought together planners from all the SCCG Member Councils, state agencies and relevant technical experts. The forum drew on outputs from a pre-workshop survey and gathered information relating to risk mapping, planning measures to address SLR and extreme storm surge events, and communicating risks to stakeholder groups.

Phase 3

- Clarification of communication principles and effective approaches including 'framing' to develop a comprehensive Communication Strategy
- Templates and tools targeting key stakeholder groups.

Follow-on Phase 4 - Legal advice

Legal advice on Councils' obligations in relation to the utilisation and disclosure of hazard information was recently presented to SCCG.

Phase 5 – Capacity building elements and outputs

- Project launch workshop
- Conference papers
- Various workshops during previous phases
- Continuous stakeholder and Member Council briefings
- Newsletter and website promotions, distribution of reports and general marketing.

Emerging outcomes

Following on from this project, SCCG is collaborating with the NSW Office of Environment and Heritage to develop impact profiles. These impact profiles entail investigating the exposure of inundation hazards on property, infrastructure and open space for each of the Member Councils, by applying 6 inundation scenarios that the SCCG mapped in Phase 1 of the project. The anticipated outputs of this comprehensive investigation will include all residential, commercial and public addresses, and community infrastructure including roads, railways, footpaths and other assets.

SCCG is also leading or partnering in several follow-on research projects - see page 13 '**Links to more information, projects and people**'.

Critical success factors

AGP analysis of the project

Success of this approach has been driven by strong leadership, excellent connectivity between all stakeholders and a sustainable vision.

This project is strong in:

- **Leadership**
- **Connectivity**
- **Sustainability**

Leadership

Leadership contributed to effective project governance in the following ways:

i. SCCG provided executive leadership in a holistic, integrated approach to identify needs; seek solutions; engage experts and generate tools to communicate coastal inundation hazards and adaptation responses

ii. SCCG Technical Committee, comprised of representatives from professional staff in Member Councils, met bi-monthly to provide guidance and consistent decision-making

iii. An Expert Panel was established early on to provide expert advice and leadership (internally and externally) in clarifying scientific and technical issues, and helped to increase the project's credibility and connections with outcomes of other initiatives. The Expert Panel was comprised of representatives from a diversity of organisations including Local. State and Australian Governments, emergency services, research communities and private sectors.

Leading external stakeholders were engaged via the Expert Panel.

→ Leadership lesson learnt:

Strong leadership from an executive level together with the confidence imparted from an expert panel.

Engagement

Internal stakeholders

Commitment was achieved from coastal modellers, other technical experts, and relevant professionals including strategic planners, engineers, asset managers, communications specialist, and Member Councils.

External stakeholders

Leading external stakeholders were engaged via the Expert Panel.

The Communication Strategy in the Phase 3 report recommends that the following generic key stakeholder groups be identified, analysed and prioritised, in order to provide clear and consistent messages:

- Councillors and elected representatives e.g. for precinct committees
- Internal partners among Council staff
- Existing property owners – segmented by level of risk of inundation to their properties
- Potential property owners
- Property industry – including major landholders, realtors, developers, solicitors, planners, architects, builders
- Local businesses and industries
- Emergency services.

Partnerships made

Members of SCCG Technical Committee are the primary source of internal partnerships. In addition to the project partnership with CSIRO, the Expert Panel brought together a wide range of external partners.

→ Engagement lesson learnt:

Clarifying the messages helped to engage with all stakeholders.

Connectivity

This project involved extensive consultation and communication with SCCG Member Councils ensured the utility of key outcomes from each phase of the study.

Transferability of outcomes to other contexts

i. Only the Sydney region maps are not transferable. Otherwise, all outputs of the physical inundation mapping and modelling methodology can be readily transferred and contextualised by other Local Governments, land managers and other interested stakeholders.

ii. Similarly, the Phase 2 Literature Review, and guidance on planning principles are transferable.

iii. The Phase 3 generic Communication Strategy, templates and tools are intentionally designed to be transferable. They can also be applied to communicate flooding, bushfire and other extreme hazards.

SCCG has consequently issued a licence to the NSW Government to conduct an inundation and erosion impact profile, for

The three-phase study provides an integrated framework to develop planning and communication strategies to protect current and future coastal communities.

use in the development of the Sydney Adaptation Strategy.

➔ Connectivity lesson learnt:

Extensive consultation and communication amongst Member Councils improved the utility of key outcomes.

Sustainability

The three-phase study provides an integrated framework to develop planning and communication strategies to protect current and future coastal communities.

It also provides consistent guidance for good governance of coastal inundation risks and impacts across Member Councils of the SCCG, and beyond.

Positive downstream outcomes and influences include:

i. Licensing of collated data sets, physical mapping and modelling methodologies and associated outputs

ii. Guidance on planning responses

iii. Communications Strategy, templates and tools

All three phases of the study enable Member Councils to develop proactive responses to avoid or minimise maladaptative development in the coastal inundation zone:

- Phase 1 identifies key coastal inundation risks and hot spots to focus on
- Phase 2 provides flexible guidance and toolkits for planning
- Phase 3 provides similarly flexible guidance on developing communication strategies to engage key stakeholder groups.

➔ Sustainability lesson learnt:

Utilising the three phases enables Member Councils to minimise maladaptive development in the coastal innundation zone.

Cost

The SCCG was awarded co-funding to undertake this 3-phase project in 2009, under the Natural Disaster Mitigation Program. An investment co-contribution from CSIRO was also critical to the project's delivery.

➔ Cost lesson learnt:

Making the effort to leverage on available funding, increased the scope of the project to what was required.

Stakeholder: Councillors/elected representatives			
Council's goals	Council elected representatives understand the need to take action on erosion, inundation, sea level rise		
	Council elected representatives understand the rationale and process for community engagement around these issues		
	Council considers climate change, SLR and community when making decisions (also another one about legal ramifications for acting and not acting		
	Council is aware of legal implications of acting or not acting on climate change		
Stakeholder concerns	Changes to the status quo will be unpopular electorally – backlash from community		
	Climate change is not proven/certain		
	Why should Council take action when others don't? Are we/should we act in isolation?		
Key messages	Council presents a united front on these issues and decisions		
	Council has a duty of care to do something – community expectations, litigation , duty of care, responsible government, acting on current science, assisting to ensure good investment		
	There are risks in doing nothing		
Tactic	**Delivery (when, how)**	**Who**	**Measured by**
Information sessions for councillors to discuss hazard maps, communication strategies around maps	Organise for meeting for councillors invite experts where needed (local where possible)	Community engagement & planners, hazard managers	feedback from councillors
Provide councillors with community information	Deliver at Council meeting	Community engagement & planners	feedback from councillors

Figure 5: A 'plan on a page' template

Conclusion

This ambitious and challenging project to map and respond to coastal inundation in all 15 Member Councils generated significant outcomes and outputs from each of the 3 sequential phases. Project partnerships with various divisions of the CSIRO and the Expert Panel provided many opportunities for external collaborations, statewide and nationally. The SCCG will continue to strongly advocate a holistic, integrated approach to managing future impacts of climate change that brings together scientific and technical experts, strategic planners, engineers, asset managers and other professional staff from Member Councils and agencies.

Gaps and future challenges

Phase 1

The first set of challenges were around: Physical acquisition of all data sets

- Assembling, collating and 'meshing' the data sets
- Bringing together physical modelling tools, high resolution mapping techniques and data, to develop a consistent approach for estimating extreme sea levels that contribute to inundation across the entire SCCG region
- Developing a method for calculating and mapping inundation at a scale appropriate and relevant for end users.

The second set of challenge entailed capturing key physical processes – tides, storm surges, wave setup - that contribute to elevated sea levels and inundation on ocean beaches.

Phase 2

Embedding adaptation measures into planning frameworks has long been a complex and difficult task for planners and policy makers. Challenges include:

- Living with legacies of earlier development and managing their downstream effects
- Multi-jurisdictional contexts for planning and development, with different tiers of government and agencies influencing decision-making
- Potential opportunity to develop an alliance on coastal adaptation policy and decision-making between councils
- Inconsistent and changing policies and applications by State Government.

The Phase 2 report (Section 4.1 - p.11) cautions that:

"A changing sea level means that the baseline upon which current inundation risk is being calculated is moving. The challenge of planning with a moving baseline becomes more difficult when considering longer planning horizons and accelerating sea level rise. These concerns are of significant importance for local governments in the diverse and densely populated Sydney coastal region."

Two further challenges to planning are:

- The scientific uncertainty surrounding long-term projections and spatial scales of potential impacts
- Contending stakeholder interests and values in vulnerable locations (Leitch *et al*., 2010).

Phase 3

Very limited guidance was previously available on communicating coastal inundation hazards and associated mitigation or adaptation responses. However, there were several good sources on communicating other sorts of hazards such as bushfire and flooding and as well as storm surge issues for areas with exposure to cyclones.

Next steps

A potential next step will be to initiate community involvement in preparing response plans, by establishing a Community Reference Group, comprising Mayors, Councillors and community leaders from the 15 Member Councils, to assist the SCCG to better communicate the hazard and exposure implications for the Sydney Coastal region

Cost benefit analyses and other economic assessments e.g. of infrastructure damage or ecosystem values were beyond the scope of this project. However, follow-on work is currently being undertaken by the SCCG and other partners to develop detailed impact profiles from the inundation information, which will include economic considerations of impacts on ecosystem values, longer term infrastructure investments, and public and private assets - residences, commercial developments, schools, health facilities, parks, foreshore amenities etc.

Key outputs of this project are further leveraged in other follow-on studies being conducted by the SCCG for the Sydney Adaptation Strategy, and in related research projects listed on page 13.

Links to more information and projects

Links to follow-on research projects led or partnered by SCCG are available from the following web links:

- Coastal Vulnerability to Multiple Inundation Sources Project (COVERMAR)
  www.sydneycoastalcouncils.com.au/node/106
- Demonstrating Climate Change Adaptation of Interconnected Water Infrastructure
  www.sydneycoastalcouncils.com.au/Project/demonstrating_climate_change_adaptation_of_interconnected_water_infrastructure_project
- Prioritising Coastal Adaptation and Development Options for Local Government
  www.sydneycoastalcouncils.com.au/Projects/prioritising_coastal_adaptation
- Assessment and Decision Frameworks for Seawall Structures Project
  www.sydneycoastalcouncils.com.au/Project/assessment_and_decision_frameworks_for_seawall_structures_project
- Quantifying the Value of Sydney's Beaches Project
  www.sydneycoastalcouncils.com.au/Project/Quantifying_Value_of_Sydney_Beaches
- Systems Approach to Regional Climate Change Adaptation Strategies in Metropolises
  www. sydneycoastalcouncils.com.au/ Project/Systems_Approach_Climate_ Change_Adaptation_Strategies
- Audit of Sea Level Rise, Coastal Erosion and Inundation Legislation and Policy
  www.sydneycoastalcouncils. com.au/sites/default/files/Audit%20 of%20Sea%20Level%20Rise%20 Coastal%20Erosion%20 and%20 Inundation%20Legislation%20 and%20Policy.pdf
- Beach Sand Nourishment Scoping Study: Maintaining Sydney's Beach Amenity Against Climate Change Sea Level Rise
  www. sydneycoastalcouncils.com.au/ Project/Sand_Nourishment_Scoping_ Study
- Coastal Councils Planning for Climate Change
  www.sydneycoastalcouncils. com.au/Project/Coastal_Councils_ Planning_for_Climate_Change
- Phase 1 Report - Modelling and Mapping of Coastal Inundation under Future Sea Level Rise (Feb 2012).
  www.sydneycoastalcouncils.com.au/sites/default/files/stage_one_outcome_report.pdf
- Phase 2 Report - Incorporating Coastal Inundation and Sea Level Rise into Local and Regional Planning Responses (July 2012).
  www.sydneycoastalcouncils.com.au/sites/default/files/stage_two_outcome_report.pdf
- Phase 3 Report - Supporting Local Government to Communicate Coastal Inundation (Oct 2012).
  www.sydneycoastalcouncils.com.au/sites/default/files/stage_three_outcome_report.pdf

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