Coastal hazard assessments in Victoria

Author/affiliations
Brenners V

Works for the Department of Environment, Land, Water and Planning, Melbourne, Victoria

(The Department of Environment, Land, Water and Planning (DELWP) is the successor department to the Department of Environment and Primary Industry (DEPI) and the Department of Sustainability and Environment (DSE), both of which are referred to in this paper.)

ABSTRACT

The Future Coasts program was a 4 year program established in 2008 to assess the vulnerability of Victoria’s coastline to coastal hazards (inundation and erosion) under a changing climate and develop strategies to help communities and industry respond and adapt.

One of the Future Coasts assessment themes was to undertake 4 pilots coastal hazard assessments (CHAs) along different types of coast (at Port Fairy, Bellarine Peninsula-Corio Bay, Western Port, and Gippsland Lakes/90 Mile Beach) that provided a good representation of the Victorian coastline, and as such, the methods used in the CHAs could be applied to future assessments in other coastal locations. The learnings from the 4 pilot CHAs were aggregated for the next generation of CHA projects currently in the development or early implementation stage.

This paper will provide an overview of the similarities and differences in the development and outcomes of the 4 pilot CHAs, what lessons were learnt and how these learnings were aggregated and applied to the next generation of CHAs. This will include looking at technical issues, as well as socio-economic issues raised by communities regarding the sensitivities of how and when the information should be used.
Introduction
Climate change has been a well-known unknown for some time now, but government agencies and local governments are still unsure how to deal with individual issues because of the lack of precedents and the threat of legal responsibility for decisions made and actions taken.

In 2008, the Victorian government established the 4 year Future Coasts program to assess the vulnerability of Victoria’s coastline to coastal hazards (inundation and erosion) under a changing climate and develop tools and products that could be used to help communities and industry respond and adapt. The outputs of the program included:

- Coastal Digital Elevation Models
- Victorian Coastal Inundation Dataset
- Victorian Coastal Hazard Guide
- Coastal Asset Information Library
- Historic aerial imagery
- (Local) Coastal Hazard Assessments

The focus of this paper is on the last output listed above and developments since then. The objectives of the pilot CHA program were to:

- increase awareness and build capacity of coastal land managers/practitioners to assess and understand the relationship between climate change impacts and coastal hazards
- develop and test coastal hazard assessment methodologies for representative coastal landform systems in Victoria
- develop datasets which will facilitate/inform improved and more consistent coastal planning and management practices.

The Victorian Government commissioned 4 pilot coastal hazard assessments (CHAs) along different types of coast that provided a good representation of the Victorian coastline, with the intent that the methods used in these pilot CHAs could be applied to future assessments in other coastal locations.

The 4 study areas were:

- Port Fairy: open coast with headland and river estuary;
- Bellarine Peninsula-Corio Bay; a large peninsula with open coast on one side and large embayment on the other
- Western Port Bay: large shallow embayment
- Gippsland Lakes/90 Mile Beach: long open coastal sand barrier protecting estuarine lake system.

Each of the pilot CHAs adopted different approaches to the management, development and delivery, and community engagement components of the projects. Since their completion, the outputs from each pilot have been used in different ways.

After the CHAs were finalized, a “learnings” project was commissioned to liaise with the stakeholders to analyse the pros and cons of each project in order to inform future policy
and program development, and the next generation of CHA projects, currently in the development or early implementation stage.

**Technical assessment**

*2 stages*

Each of the pilot CHAs used a basic two-stage methodology focused on inundation and erosion hazards.

*Stage 1:* data assimilation and gap analysis (i.e. desktop research) across the entire study area to collate all available information on relevant coastal and catchment processes for use in the coastal hazard assessment and identifying data gaps

*Stage 2:* detailed investigation of prioritised sites, including site visits, additional data collection and modelling work.

Detailed hazard assessment was not feasible across each entire CHA study area. Resources had to be prioritised according to localities and assets of interest. The intent of Stage 1 was to produce a Second Pass assessment, and for Stage 2 to produce a Third Pass assessment, as per the definitions provided in the box below.

| First Pass or Regional Sensitivity Assessment | is a sensitivity assessment that identifies the softer and the more low-lying parts of the coast that are susceptible to instabilities such as erosion and/or to flooding. |
| Second Pass or Regional Exposure Assessment | is an assessment of regional variations in exposure to the drivers of coastal change (which will impact most significantly on the most sensitive coastal types) such as erosion and flooding (eg. sea-level rise, tidal processes, wave and storm climate, also vertical land movement). |
| Third Pass or Site-Specific Assessment | assesses site-specific sensitivity and exposure of high priority sites (where high value assets may be at risk). All local geomorphic and exposure factors are measured, mapped and assessed (eg. bedrock topography, local sediment budget, longshore drift, shoreline planform and bathymetry, dune height, etc) to produce a detailed model of how that particular shoreline segment is likely to respond to coastal hazards such as sea-level rise. |

**Outputs**

For erosion, all 4 pilots considered multiple coastal processes broadly defined into the following main components:

1. short-term storm erosion; a) beach erosion, b) dune stability
2. shoreline recession: a) underlying recession, b) future recession
3. rocky cliff of bluff instability.

For inundation, the following main components were considered:

1. sea level rise
2. storm surge
3. coincident catchment flooding.

All 4 pilots produced mapped and/or tabulated outputs that estimated the following, and with one partial exception, were considered fit for purpose:
• the landward extent of foreshore erosion for a present-day designated storm event, including the landward extent of any zone of reduced foundation capacity
• the extent of oceanic inundation at present, including storm surge computation, wave set-up, wave run-up and dune overtopping and, where relevant, flood extent from an adjacent estuary or catchment
• the impacts of future climate change, based on the time period for the study and the intervals for assessment
• consideration of uncertainty or safety factors based on the adequacy of available data and the existing knowledge of processes and effects.

Divergences
Due to the differing nature of the coastline and size of the project area (see Figure 1), it was not logical for the 4 pilots to use similar project methodologies.

The varying availability of data, approaches chosen to fill data gaps, and local priorities in each project area, also led to different assumptions and modelling approaches / applications being chosen (differing hazard planning horizons, differing local dynamic forcings) for each area, as shown in Table 1.

For example, assumptions had to be made re how parameters such as wind speed, strength, direction, storm frequency and magnitude will change over time. In some scenarios they were assumed to remain the same as at present. Also, due to budgetary constraints, the limited number of scenario and event combinations considered in the assessments did not enable differentiation between locations which may experience very frequent hazard impacts from other areas that would only be impacted occasionally under relatively low probability events. The CHAs are therefore assessments of relative susceptibility of the coast to hazard impacts and not comprehensive coastal hazard assessments at all locations within the project areas.

As a result, it is difficult to compare and contrast the outputs of one CHA with another.

Figure 1: Pilot CHA project areas

<table>
<thead>
<tr>
<th>Pilot CHA size and location</th>
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<tbody>
<tr>
<td>Port Fairy project area</td>
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<tr>
<td>Bellarine project area</td>
</tr>
</tbody>
</table>

2018 FMA conference “Waterways of success”
Table 1: Selected modelling approaches and applications

<table>
<thead>
<tr>
<th>CHA</th>
<th>Inundation model</th>
<th>Erosion model</th>
<th>Hazard horizons</th>
<th>Stage 2 sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Fairy</td>
<td>MIKE</td>
<td>SWAN, SBEACH</td>
<td>current, 2050 (0.4m SLR), 2080 (0.8), 2100 (1.2)</td>
<td>2</td>
</tr>
<tr>
<td>Bellarine Peninsula-Corio Bay</td>
<td>SOBEK</td>
<td>DHI LITPACK</td>
<td>current, 0.2m SLR, 0.5, 0.8, 1.1, 1.4</td>
<td>4</td>
</tr>
<tr>
<td>Western Port Bay</td>
<td>MIKE 21</td>
<td>MIKE 21</td>
<td>current, 0.2m SLR, 0.5, 0.8</td>
<td>4</td>
</tr>
<tr>
<td>Gippsland Lakes/90 Mile Beach</td>
<td>SOBEK</td>
<td>DHI LITPACK</td>
<td>current, 2040 (0.2m SLR), 2070 (0.4), 2100 (0.8)</td>
<td>5</td>
</tr>
</tbody>
</table>

However, the main technical issue highlighted by all the CHA pilots was the inconsistency or uncertainty of available data, or indeed the lack of data, and therefore the validity of the additional modelling undertaken. As there were (and still are) few thorough and consistent background datasets available for coastal hazards, the confidence in the outputs produced is low. In order to address this gap over time, the Victorian Coastal Monitoring Program (VCMP) was conceived. The VCMP is still in its infancy, but it aims to ensure that data collected consistently over the long-term and managed centrally, so that it is readily available for use for future CHAs or revision of existing ones.

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**Project governance / management**

*Partnership agreement*

As these were pilot projects, there was a lot of learning by doing. The first pilot to commence was Port Fairy. Based on the high level guidance provided by the Future Coasts program, the various Port Fairy stakeholders agreed a governance structure and project management process that seemed to suit them. The other 3 pilots looked at this framework and adapted it to suit their circumstances.

As multiple stakeholders were involved in each pilot CHA, a partnership agreement (or MoU) was developed for each to define the roles and responsibilities of each stakeholder. For each of the pilots, it took 1-2 years to agree and formalize the project governance structure before stages 1 and 2 of the technical assessment were started.

In essence, all 4 pilots used the following 3 tier governance structure, although 2 pilots rolled the top 2 tiers into one group.

1. **Project control/steering group (PCG):** strategic/political guidance
2. **Technical reference group (TRG):** subject matter expertise
3. **Project management team (PMT):** operational

While the project management team was led by a government agency, the arrangement was different for each project. However, in the 2 projects where State government (DELWP) wasn’t part of the PMT, DELWP did still provide some inputs, especially during project initiation.

- Port Fairy: DELWP Region/LGA
- Bellarine Peninsula-Corio Bay: LGA
- Western Port Bay: Melbourne Water
- Gippsland Lakes/90 Mile Beach: DELWP Region

**Prioritisation**

At the start of the 4 pilots, there was no clear methodology on how to effectively prioritise sites for more detailed investigation. Each pilot undertook a rudimentary vulnerability and risk assessment process to identify sites most important to their stakeholders or community for further assessment. In Port Fairy’s case, these priority sites were identified through community consultation. For Bellarine, the PCG and TRG agreed on the priority sites based on the consultant’s review of the project area’s coastal compartments. For Westernport and Gippsland, the consultant made recommendations as to which locations warranted further, more detailed local scale investigations, and the PCG and TRG made the final selection based on political, environmental and planning considerations.

**Budget and scope**

As is too often the case, the funding for these projects was secured based on a high level funding application, and then the projects were crafted to suit the budget. Each project would have preferred to do more detailed assessment during Stage 2, but had to limit this to fit the available budget.
Optimally, the issues to be resolved should be articulated in advance so that outputs can be defined, and then commensurate funding sought. In these pilots, the physical extent of the project area was adequately defined, but not the potential assets at risk, nor specifically what outputs are required, nor what these outputs would be used for.

2 stage tendering
As described above, each of the pilots used a 2 stage technical process to 1) gather data and undertake a gap analysis, and 2) undertake more detailed modelling of selected priority sites. They also all used a 2 stage tendering process, and except for the Westernport CHA, a different consultant was selected to complete each stage.

This allowed the client group to amend their initial scope and apply what they had learnt as the project progressed. It also meant that if they discovered they needed more expertise on certain aspects, this could be added to the Stage 2 brief.

Community engagement
The Bellarine, Gippsland and Westernport CHAs had either minimal or only reactive approaches to community engagement. A range of issues influenced these decisions, such as prior negative experiences engaging the community during complex projects, council views that the content of the CHA was not suitable for community engagement, and concerns that once made aware of the project, the community would expect action to be taken.

Port Fairy was the only pilot that undertook highly proactive community engagement activities. The approach sought to tease out relevant local community issues, introduce the community to the consultants undertaking the work, to ensure the final product would be meaningful to the community.

As Port Fairy was the smallest project area CHA and had a discrete and accessible community, the task of engaging with the community would not have been as time consuming and complicated as for the other pilots, whose project areas encompassed multiple councils and towns, with different community interests in each. As such, there is reasonable justification why each of the pilots chose the approach they did.

The post pilot learnings project raised the following 2 points in support of community engagement with more long-term, strategic objectives in mind.

1. considering engagement as part of a longer-term strategy
2. the unknown and potential benefits from involving diverse stakeholders in problem-solving and decision-making.

As CHAs were a new form of assessment, there was lack of clarity about how the outputs of the pilots would be used for longer-term plans and actions. Therefore, any community engagement was seen as relating only to the CHAs, rather than being seen as part of a ‘bigger picture’. From the “big picture” perspective, engagement during a CHA makes good sense as it prepares and engages the community in the longer-term process of
assessing risk, followed by planning and implementing adaptation responses. During the CHA, awareness is increased (not just of the CHA project, but also of the broader program of work on adaptation), and public feedback is obtained on issues of concern to them. Therefore, when the program moves to the vulnerability assessment phase, an already informed and engaged community is able to provide more targeted and meaningful inputs. Based on this work, the community is consulted in the definition of adaptation responses, and hopefully empowered as individuals and communities to make changes to the way they do things.

The second point emphasizes the benefit in involving the community in assessing a problem and, in turn, helping share ideas for issue ownership and potential solutions. This is particularly important when dealing with complex, multi-faceted issues, such as climate change. The Port Fairy approach stands out as a good example of this - early engagement not only helped in community acceptance of the project findings, but also spurred a range of community driven actions that followed on from the CHA, something that did not happen in any of the other pilots. These included a series of 6 posters explaining the results and what they would mean for the community. The posters were the precursor for an online survey, the results of which have helped inform the development of Moyne Shire’s “Port Fairy Adaptation Plan”.

**Post project use of CHA information**

While the pilot projects were all completed by about 2014, it took several years before they were all made available to the public on the following websites.

- Port Fairy: [https://www.pfcg.org.au/resources](https://www.pfcg.org.au/resources)

The websites that house the Port Fairy and Bellarine CHAs, also invite the public to become involved in using the outputs of the pilots for further action. The Port Fairy website also provides information about the community coastal hazards survey, and the on-going citizen science beach monitoring program. The Bellarine website also provides a “coastal impacts solutions” tool that provides links to information to help land managers identify appropriate adaptation options.

The following projects, led by local government, aimed at improving coastal adaptation planning using the data and information developed in CHAs are currently underway or recently completed.

- Port Fairy Coastal and Structure Plan (draft report 2017)
- Port Fairy Climate Adaptation Plan (draft report 2018)
- Greater Geelong and Queenscliffe Flood Adaptation Effectiveness Study (2016)
- Greater Geelong and Queenscliffe Planning Schemes Implementation options (2018)
- Port Phillip Bay coastal planning - land use adaptation project: Development of Coastal Hazard Planning Guide, and preparation of baseline assessments of required planning responses for 10 councils (This project will use information from Bellarine and Westernport projects and will inform brief for PPB CHA). (in progress)
• Lakes Entrance Growth and Adaptation Strategy (in progress)

Also, projects led by the State government related to CHAs have prepared the following outputs:
• Priority locations for detailed coastal hazard mapping and adaptation planning along the Victorian coastline (2015)
• Guidelines for Developing a Coastal Hazard Assessment (draft 2016)
• Local Coastal Hazard Assessment Learnings Project (2017)
• Victorian Coastal Hazard Assessment 2017: A second-pass state-wide assessment of erosion and inundation hazards resulting from future climate change scenarios to inform the Victorian Coastal Monitoring Program (2017)

Post pilot CHAs
Based on the 2015 “Priority locations” document mentioned above, and using the experiences of the pilot projects, 2 new large scale CHAs are being undertaken in the Barwon South West region and Port Phillip Bay.

Figure 2: Future CHA priority locations

Both new projects have the benefit of the learning and guidance documentation prepared after completion of the pilot CHAs to better guide them through the technical, governance and engagement issues described in this paper, as well as the opportunity to consult with stakeholders involved in the pilot CHAs.

Other new actions that have made use of pilot CHAs
Development of the Victorian Coastal Monitoring Program (VCMP) started in 2017. Its aim is to inform spatial prioritisation of monitoring investment effort along Victoria’s coastline and to ensure that data collected is managed centrally and made publicly available. The VCMP will set up targeted data gathering and systematic monitoring programs within four program delivery themes:
1. Embayments and estuaries
2. Exposed sandy beach/dune shores and headland/reef controlled beaches
3. Protection structures and adaptation options
4. Decision support and visualisation tools

A Statewide Coastal Programs team was established in late 2017 to coordinate the statewide delivery of coastal programs, including policy and planning integration, business case development, technical standards and advice, and engagement coordination. One of the roles of this team that will help all future CHAs is to develop a database of coastal protection assets and coastal assets.

Conclusions
To what extent were the objectives of the pilot CHA program achieved? The outputs of the CHAs (with one exception) were considered fit for purpose for further work.

- increase awareness and build capacity of coastal land managers/practitioners to assess and understand the relationship between climate change impacts and coastal hazards – Both awareness and capacity were increased from a very low base, but much more needs to be done to equip them to make appropriate decisions.
- develop and test coastal hazard assessment methodologies for representative coastal landform systems in Victoria – The peer reviews considered that appropriate methods used what data was available to produce the technical outputs. However, no definitive comparison has been made as to which methods may be better suited to which coast types.
- develop datasets which will facilitate/inform improved and more consistent coastal planning and management practices – Datasets were compiled from available data and additional monitoring and modelling. These datasets are now one of the building blocks of the VCMP that will provide readily available data for use for future CHAs or revision of existing ones.

The scope of each project had to be modified to match the limited project budget.

There is better understanding of coastal inundation issues than coastal erosion issues. There is currently inadequate correlation between inundation and erosion.

CHAs are very complex. A single consultant company often doesn’t have all the requisite expertise. Project managers may prefer to consider the consortium approach, or even separate contracts for the technical and community engagement components.

Terminology currently used is complex and not being consistently applied. Some of these concepts aren’t easy for practitioners to understand or assimilate; so how does the coastal practitioner community present all this to the public in a way that can be adequately comprehended?
Egs: What’s the difference between a coastal compartment / unit /cell? Geomorphic and sediment?
What’s the difference between - region / zone; significance / value, etc?
How are exposure, sensitivity and adaptive capacity defined, and then evaluated to provide a vulnerability rating?
There is not enough definitive guidance from state government how technical information developed during CHAs should be applied. Eg. How does an LGA “plan for SLR of 0.8m by 2100”?

- Despite the outputs of the Future Coasts program (including CHAs) being available for at least 5 years, only a few councils have updated their flood planning controls to include sea level rise. No erosion controls have been updated.
- Coastal erosion and coastal flooding go hand-in hand: flood extents will change if the shoreline changes through erosion as a result of storm surge. No conclusion has been reached in Victoria on whether a combined coastal flood and erosion overlay should apply or whether separate flood and erosion overlays should apply.
- There isn’t adequate guidance on what an adaptation plan should contain, or how to prepare strategic planning documents for long term adaptation, that considers transitioning communities that are going to be impacted by sea level rise.

Good progress has been to resolve the following issues identified during the pilot CHAs:

- The inconsistency or uncertainty of available data (or lack of data) meant that the validity of additional modelling undertaken was uncertain: VCMP established.
- Better high level holistic governance of coastal management is required: Statewide Coastal Programs Team established.

What can outputs from CHAs be used for?

- High level adaptation planning
- strategic LUP
- statutory LUP
- emergency response
- to populate databases that can be used for multiple purposes (eg. insurance)

There are still too many blockers of actions rather than enablers. There is still a generic fear of using information from CHAs because not only is it complex, it is also not consistently derived and developed, and is not well understood.

REFERENCES

Port Fairy CHA: https://www.pfcg.org.au/resources
Bellarine CHA: http://www.ourcoast.org.au
Westernport CHA: http://www.secca.org.au
Gippsland CHA: http://gcb.vic.gov.au


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