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Coastal Climate Change Risk Assessment Methodology

Report

Victoria State Government | Environment, Land, Water and Planning

City of Greater Geelong

Borough of Queenscliffe
Queenscliff & Point Lonsdale, Victoria, Australia

Corangamite CMA

Bellarine Bayside Coastal Management

Barwon Coast

The Geelong-Queenscliffe Coastal Climate Change Risk Assessment

Table of Contents

Overview

This document outlines the methodology used to complete the coastal climate risk assessment associated with the Geelong – Queenscliffe Coastal Adaptation Program. The project was completed over an 18 months timeframe from inception in April 2015 to June 2016.

The objectives of the risk assessment were to:

- Assess the risks of inundation identified in the Local Coastal Hazard Assessment to coastal communities and associated natural areas, in particular private, public, environmental & social/cultural assets.
    - The Local Coastal Hazard Assessment mapped inundation at various sea level rise scenarios and a 1% Annual Exceedence Probability (AEP).
- Where possible identify risks of erosion.
- Prioritise the identified risks to inform adaptation planning

Project context

The Geelong-Queenscliffe Coastal Climate Change Risk Assessment project, was phase 2 of a broader 3 phase project. The three phases included:

- Phase 1 – Local Coastal Hazard Assessment (a final draft was completed 2015)
- Phase 2 – Geelong – Queenscliffe Coastal Climate Change Risk Assessment
- Phase 3 – Adaptation planning.

All three phases of the project have a vision of *'Thriving, vibrant and resilient coastal communities who are successfully responding to sea level rise and maximising the opportunities presented by climate change.'*

The broader project seeks to plan and facilitate appropriate and timely adaptation responses to sea level rise on the Bellarine Peninsula and Corio Bay.

To do this, the intermediate objectives are:

- Plan and prioritise the management of private, public, environmental and cultural assets along the coast that may be impacted by inundation due to projected sea level rise
- Provide strategic guidance on the future planning of coastal towns and communities, including optimising the opportunities presented by climate change.
- Provide strategic guidance on upgrading & maintaining coastal protection installations
- Reduce the need for individual coastal vulnerability assessments for applications relating to the development of coastal land
- Build awareness and understanding of sea level rise including coastal hazards and risks and related opportunities across all sections of the community
- Promote consistent information to coastal communities and decision makers about vulnerability and risk and adaptation strategies
- Promote equitable outcomes in adaptation planning

Project governance

The project governance structures for phase 2, were the same for phase 1. There was a Senior Project Control Group (SPCG) and an operational Project Control Group (PCG).

The role of the SPCG is to work collaboratively on managing coastal hazards, associated risk and the development of adaptation responses in the Geelong – Queenscliff region.

The role of the PCG is responsible for providing overarching strategic oversight of the implementation of the GQCAP

Development of risk methodology

To develop the risk methodology a literature review was conducted. This literature review comprised a comparative methodological review of state, national and international examples of climate change risk assessments and climate change vulnerability assessments. Desk-based research examined literature on well-known and regarded methodologies. Empirical aspects of the review sought input from experts and colleagues in the climate adaptation field.

From this review, no one standard approach was found to have been applied. A number of assessments had used the vulnerability assessment approach, others used a risk assessment approach and some applied a mixture of the two. The assessments had different scopes, and none used the level of detailed mapping available from the Local Coastal Hazard Assessment.

Based on the findings of the literature review, the risk assessment methodology was based on the AS 5334-2013 Climate change adaptation for settlements and infrastructure. However, some modifications were made to the process to make it more appropriate to the local government context and broader project objectives.[1]

The changes were:

- To broaden the consequence categories to meet the project objectives to consider social, economic and environmental considerations in the risk assessment. Consequence categories and category definitions from the City of Greater Geelong's (CoGG) risk framework and the Community Emergency Risk Assessment (CERA)[2] process were also used.
- To identify the risk event as ***the interaction between the hazard, sea level rise and 1% AEP storm event, with an asset***. Then to interrogate the risk further, causal consequences were mapped using a similar process to that used by the Climate Institute – Infrastructure interdependencies.

The AS 5334 suggests the use of a vulnerability assessment for step 4 the detailed risk analysis. Due to resource and timing constraints this was not done for this assessment.

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[1] Project objectives were complete the coastal climate change risk assessment to usefully inform adaptation planning, but to also engage staff on the coastal climate change risks.

[2] http://www.ses.vic.gov.au/em-sector/em-planning/risk-assessment

Risk methodology

The risk methodology followed the steps outlined in the AS 5334 standard – listed beside.

Step 1. Establish risk context

The scope of assessment was to assess the implications of inundation from a 1% AEP storm event and sea level across key private property, public buildings and infrastructure, community, cultural and environmental assets.

The assessment was undertaken at the level of compartments including:

- Breamlea
- Ocean Grove and Barwon Heads
- St Leonards
- Portarlington
- Queenscliff and Point Lonsdale
- Moolap and Geelong CBD

The compartment from North Corio Bay to Point Wilson was excluded from the risk assessment due to the small number of landholders in that area and the land tenure.

The risk assessment was completed based on 2030, 2050, and 2100 projections.

Scenarios of sea level rise (SLR) of 0.2 metres, 0.5 metres and 0.8 metres were used.

- The Geelong – Queenscliffe Local Coastal Hazard Assessment provides information of hazards with between 0 to 1.4 metres of sea level rise (no timeframe was considered for the hazard assessment). The hazard assessment also includes some analysis of trigger points.

Development of maps

Maps were developed to identify which assets would be inundated at the three different sea level scenarios and storm surge AEP events. There were over 90 data layers in the maps, which made up eight maps per compartment including:

- Flora
- Fauna
- Open space and community buildings
- Roads
- Drainage and stormwater systems (largely council)
- Private land and assets
- Buildings
- Utilities.

Numerous government agencies with local data were contacted and data requested. The data requests were broad to ensure that the assets of interest were captured from across the private, public, community and environmental assets.

Development of risk matrices

The AS 5334 standard matrices were used as a basis for the risk matrices, however, additional consequence categories were added to align with the scope of the risk

assessment to include assessment of the risk to private, public, environmental and social and cultural assets.

The definitions of the consequence ratings were defined using AS 5334 where possible, the Community Emergency Risk Assessment (CERA) and the CoGG risk matrices.

Table 1 below outlines the consequence categories that were used and notes which categories were additional to AS 5334.

Consequence category	Reference
Impacts on residents and private property	Added
Infrastructure impacts	
Legal liability	Additional definition was added from CoGG risk framework
Political probity	Additional definition was added from CoGG risk framework
Economy	Additional definition was added from CoGG risk framework
Environmental	Refined
Financial impacts to council**	Refined to highlight financial impacts to council
Human health and wellbeing	Added to highlight specific wellbeing consequences Used definitions of levels from CERA
Social and cultural	Refined to include cultural heritage, with human health considerations separated out.

Table 1: Consequence categories

The likelihood table from the AS 5334 was used for likelihood. For final risk matrices, please see Appendix A.

Step 2: Risk identification

For risk identification, two workshops were held. Each workshop covered three compartments.

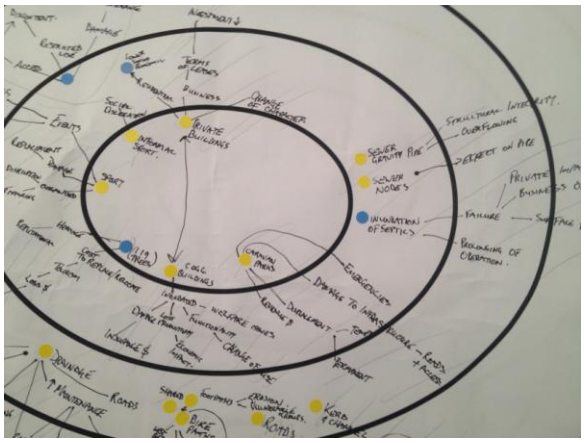
Workshop participants included staff from CoGG, Borough of Queenscliffe (BoQ), Barwon Coast Committee of Management (BCCoM), Bellarine Bayside Committee of Management (BBCoM), Barwon Water, Parks Victoria and the Department of Enviornment, Land, Water and Planning (DELWP).

A pilot of the workshop structure was run with the Project Control Group. This found that participants found it difficult to understand the maps and the legend quickly, which detracted from the risk identification activity. In response, an upfront activity was included to introduce the maps and get workshop participants to understand the maps prior to the risk identification process.

The structure of the workshop included

- Project overview.
- Icebreaker and map introduction.
- Three rotations of risk identification to cover each compartment.
- Workshop reflections and next steps.

Risk identification was structured using consequence concentric circles as used in the Climate Institute's Infrastructure Interdependencies assessment. See diagram beside.



At the end of risk identification step, over 300 risks were identified, along with their consequence chains.

These risks were distributed across the six compartments, and across eight asset groups, and three sea level rise scenarios (0.2m, 0.5m, and 0.8m).

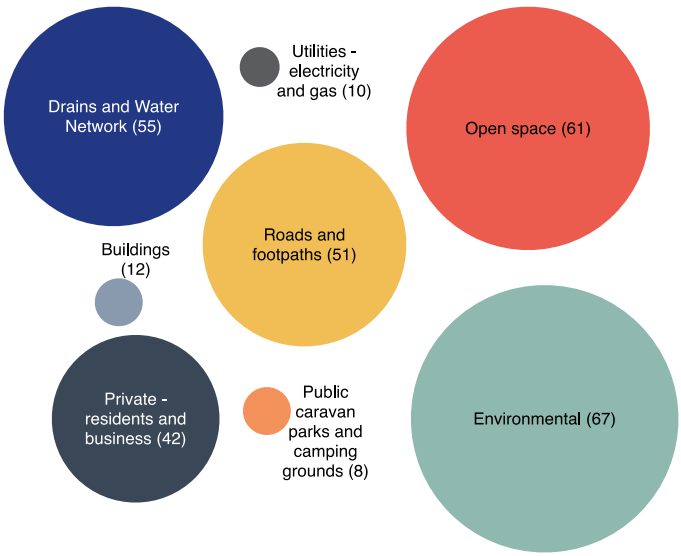


Figure 2: Risks by asset class

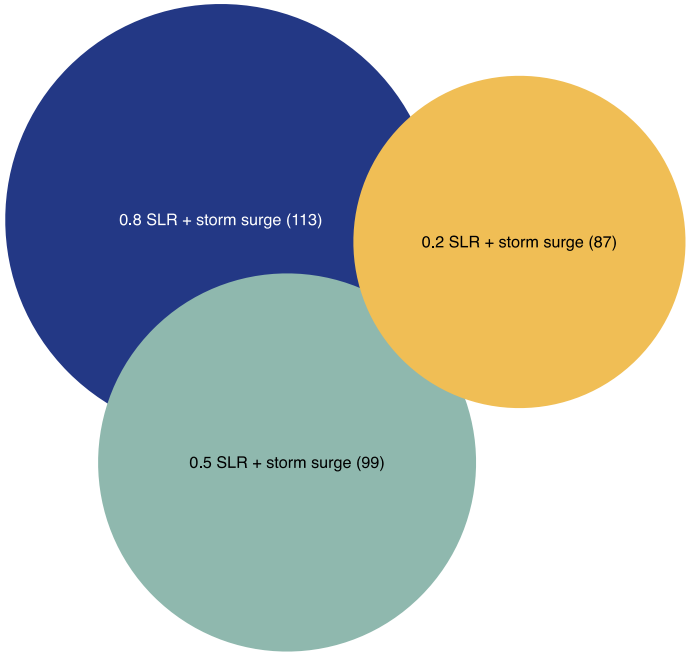


Figure 3: Risks by sea level rise scenario

Reflections on step 2

The concentric circles gave workshop participants a useful structure to understanding the risk and what the risk might result in. There was strong positive feedback about the use of the consequence concentric circles. It also usefully focused on the risk assessment on the interaction of the hazard (sea level rise) and an asset while also capturing detailed consequences.

Step 3: Risk analysis

To rate the risks two workshops were held. The workshops rated the consequences only.

Consequence rating

The consequences of the risks were rated during workshops with CoGG, BoQ, Bellarine Bayside CoM, Barwon Coast CoM, and Barwon Water staff.

The workshop structure for rating the consequences, was two workshops of 4 hours. Instead of separating by compartments, the workshops were split by asset type.

- Workshop 1 – Environment, drains and water, buildings, utilities
- Workshop 2 – Open space, roads, caravan parks and camping, private assets

This provided the workshop participants the opportunity to focus on areas of expertise and enabled participants to review the risks from an asset perspective.

During the workshops the participants were split into four groups and each asset type was rated by two groups.

As part of the workshop introduction, the facilitators worked through an example of rating the consequences of the risks. This provided workshop participants context on how to use the consequence table and rate the risks.

Likelihood rating

Due to the format of the risk identification – risk event with consequence chains – the likelihood was rated for the event. The event being the likelihood of sea level rise occurring with the 1% AEP storm surge event, inundating the particular asset of interest – environmental, social, public, or private.

Therefore likelihoods were rated as the same level for each sea level rise scenario at each of the timescales for the assessment. See table 1 below. The likelihood ratings included consideration of the likelihood of each sea level rise scenario under a changing climate. However, how climate change may affect the likelihood of 1% AEP storm surge events was not considered, due to the difficulties associated with predicting the potential occurrence of storm events.

	2030	2050	2100
0.2m + storm surge	Unlikely (May arise once in 25 to 50 years)	Possible (may arise once in 25 years)	Likely (could occur once per year)
0.5m + storm surge	Rare (unlikely to occur in next 50 years)	Unlikely (May arise once in 25 to 50 years)	Possible (may arise once in 25 years)
0.8m + storm surge	Rare (unlikely to occur in next 50 years)	Rare (unlikely to occur in next 50 years)	Unlikely (May arise once in 25 to 50 years)

Table 2: Likelihood ratings for various sea level rise scenarios at 2030, 2050 and 2100

Results

Step 3 resulted in 327 risks being rated. In 2030, there are 36 high risks with no extreme. This grows to 10 extreme and 127 high risks in 2100. There were 120 risks rated low in 2030. The extreme risks consist of three at 0.2 m SLR and seven at 0.5m SLR.
All 0.8 m SLR risks that are rated high in 2030, remain high and do not increase to extreme at 2050, and 2100.

Reflections

One key difficulty during the risk assessment has been considering the risk of sea level rise with the 1% AEP storm event. The likelihoods of the events are low due to the inclusion of the 1% AEP storm event. It was difficult for workshop participants to conceptualise the temporal nature of the inundation at the 1% AEP storm event.

Furthermore, the number of risks was high, which meant the workshops design had to focus on efficiently rating all risks, rather than engaging workshop participants in the outcomes of the workshops and project.

Step 4: Detailed risk analysis

As part of the detailed risk analysis, micro-location analysis was completed. This clustered the risks by location. The key requirement of the risk assessment is to feed into adaptation planning and this would largely occur on a micro-location scale. Many of the risks at each micro-location would occur together, and some adaptation actions would therefore mitigate more than one risk at a micro-location. Therefore considering risks at the micro-location was deemed to be useful input into adaptation planning.

Refinement of risk list

Prior to the micro-location analysis, a number of actions were taken to refine the final list of risks. For some risks, there was disagreement on the risk rating. Where there was disagreement by one level of consequence rating only, the highest consequence rating was adopted. Where there were two or more levels of difference in a consequence rating, the Project Control Group re-assessed the consequence level (without knowledge of other groups consequence ratings), to determine a final risk rating. Then, all risks rated low at 2030 were removed from the remainder of the analysis.

Some ground-truthing of floor and asset heights was also completed.

Micro-location analysis

The detailed risk analysis has collated the risks into micro-locations. These micro-locations are outlined below by compartment.

1. Queenscliff – Point Lonsdale
   - Lakers Cutting
   - Point Lonsdale West
   - Fisherman's Flat
   - The Narrows
2. Barwon Heads – Ocean Grove
   - Barwon Heads
   - River Parade North
   - East of Carr Street Barwon Heads
   - Ocean Grove East Bank
   - The Spit
3. Portarlington – Indented Head
   - Salt Lake
   - Indented Head
   - Portarlington Esplanade East
   - Portarlington Esplanade West
   - Portarlington East of Point Richards
   - Portarlington Ramblers Road Precinct
4. Newcomb – Moolap
   - Newcomb West
   - Moolap
   - Salt works
   - Point Henry
   - Sands Precinct
   - Geelong Waterfront
5. Breamlea
   - Breamlea
6. St Leonards – Swan Bay
   - St Leonards South
   - St Leonards North

To separate out the risks, the detailed asset maps and sea level rise scenarios were done at the micro-location scale. As part of the separation process, environmental risks inundating EVCs of less than 2 hectares were removed, retaining where the large amounts of hectares were inundated. The micro-location maps provided much more detail enabling some refinement of the risks, and confirmation of exactly which assets were inundated under which scenario.

At the end of the separation process, dividing risks into each micro-location area, there were a total of 240 risks.

In 2030, there are 43 risks rated as high, this raises to 59 in 2050 with two extreme risks and 149 highly rated risks and 10 extreme in 2100. As expected the risk profile increases rapidly towards the end of the century.
In terms of asset types, drains is the largest asset type effected by sea level rise and the 1% AEP storm event, as shown below in figure 4. Open space, private property and environmental assets have similar number of medium, high or extreme risks.

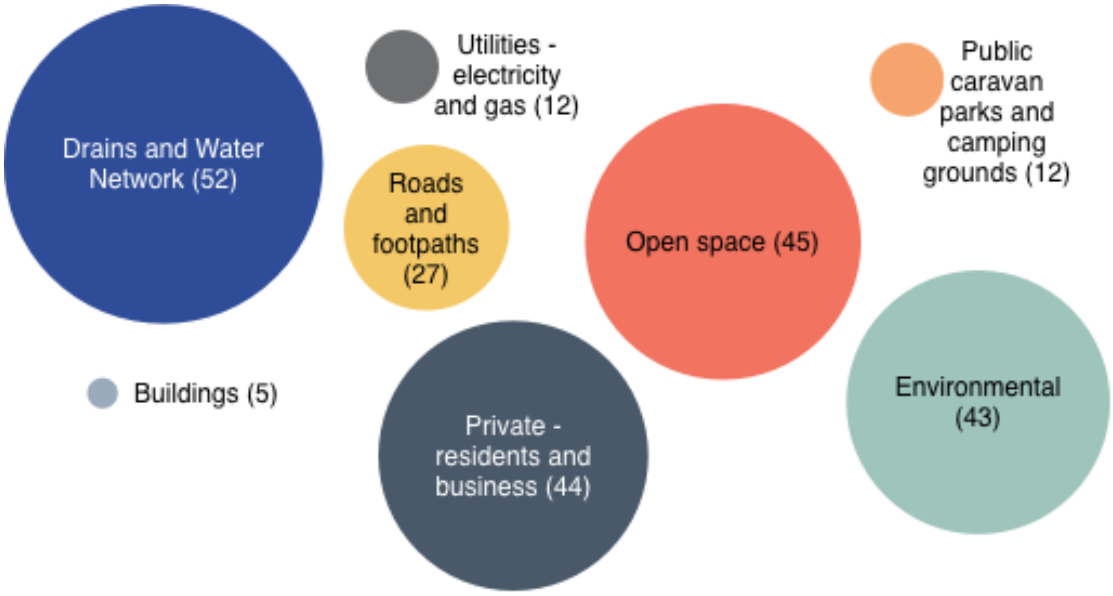


Figure 4: Number of risks by asset type

The number of risks by micro-location is outlined in figure 5. While this shows absolute numbers of risks, this does not demonstrate high risk locations. There more variables that must be considered when determining high risk locations.

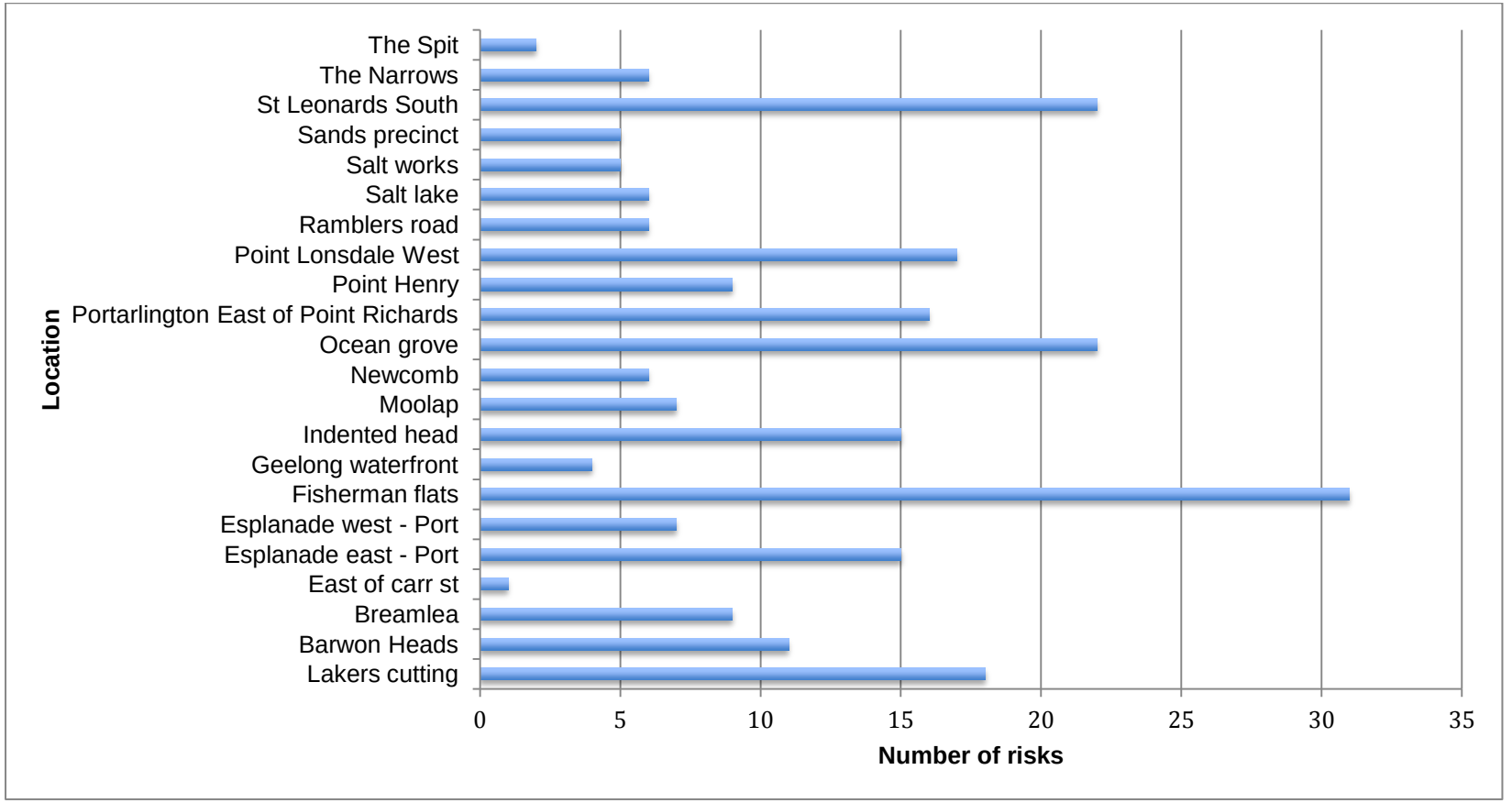


Figure 5: Number of risks by micro-location

Higher risk micro-locations
The variables that have informed higher risk micro-locations include: number of risks, rating of risks, occurrence of risks – either under the 0.2 or 0.8 m SLR scenarios, among other things.

Salt Lake
This micro-location has the highest number of private property inundated at 0.2m SLR – 88 properties. It also has the highest amount of hectares of environmental assets inundated under the 0.2 m SLR scenario – 77 hectares of the Salt Lake lagoon.

Fisherman Flats
Fisherman Flats is a very low lying area and as such this location is effected by SLR earlier than other locaitons, under the 0.2 m SLR scenario. Almost all risks occur under the 0.2 m SLR scenario and simply rise at the higher SLR scenarios. Key risks at this location exists to private property, environmental assets, drainage system, electricity substations and the local Maritime Museum.

Lakers cutting
Risks start to occur at this location under the 0.2 m SLR scenario. However, most noteworthy is that this location represents a risk of inundation of the highest number of private property under the 0.5 m (389 properties) and 0.8m (639 properties) SLR scenarios.

Inundation of environmental assets is also high compared to other micro-locations with 39.63 hectares of EVC 302 – muddy flats inundated under the 0.2 m SLR scenario.

Portarlington – East of Point Richards
This location is a high risk location under the 0.8 m SLR scenario and 1% AEP storm event. At 0.8 m SLR there is a risk of inundation to the Bellarine Bayside Caravan Park. If this occurs at high season, represents a large risk to the local economy and to the Bellarine Bayside Committee of Management. Under the 0.8 m SLR scenario there are also risks to other Bellarine Bayside Committee of Management buildings and local roads in the area.

Asset specific hot spots
Another way to consider the risks of certain SLR and 1% AEP storm surge event is to look across assets.

Private property risks

Properties inundated under 0.2 m SLR scenario
- Salt Lake – 88
- Fisherman flats – 59
- Lakers cutting – 48
- Ramblers Roads – 30

Properties inundated under 0.8 m SLR scenario
- Lakers cutting – 689
- Esplanade East – 219
- Ocean Grove – 208

Environment asset risks
For environmental assets it could be more useful to look across the whole region to understand what is at risk.

From a regional perspective:

- 274.84 hectares of EVCs are inundated at 0.2m SLR
- 321.44 hectares of EVCs at 0.5m SLR
- 372.3 ha at 0.8m SLR.

The hot spot locations – those that account for the highest percentage[3] of losses include:

- Salt Lake – almost 30% of total loss
- Lakers Cutting –18%
- St Leonards South – 10%
- Ocean grove East Bank – 9%

Gravity sewer pipes
In terms of sewer gravity pipes, the key micro locations are similar to the environmental risks.

They include

- Lakers Cutting (40% of inundation at 0.8m)
- Esplanade East (11%)
- Ocean Grove East Bank (10%)
- Salt Lake (9%)
- St Leonards South (9%)

Fisherman flats (23%) and Salt Lake (46%) represent large proportions of the inundation of sewer gravity pipes under the 0.2m SLR scenario.

Reflections

The asset maps at the micro-location scale are more easily read and understood. More detail can be provided on the maps, and the key assets inundated are more readily understood.

Limitations

Data limitations

- When reviewed by workshop participants, there were some assets missing from the data maps.
- Registered businesses were mapped, however, there was no information on the type of business. This could be a gap in the assessment. There were a number of registered businesses in residential areas. It was unclear how or the extent of potential impacts o the business from inundation.
- Floor heights of various assets were not included in the mapping. Therefore some assets may be above the inundation level, with only land inundation occurring. This would modify the risk.
- Due to the combination of sea level rise scenario and 1% AEP storm event, the likelihood of the risks at 0.8 m is very low. This reduces these larger consequence risks.

[3] These are based on approximate figures.