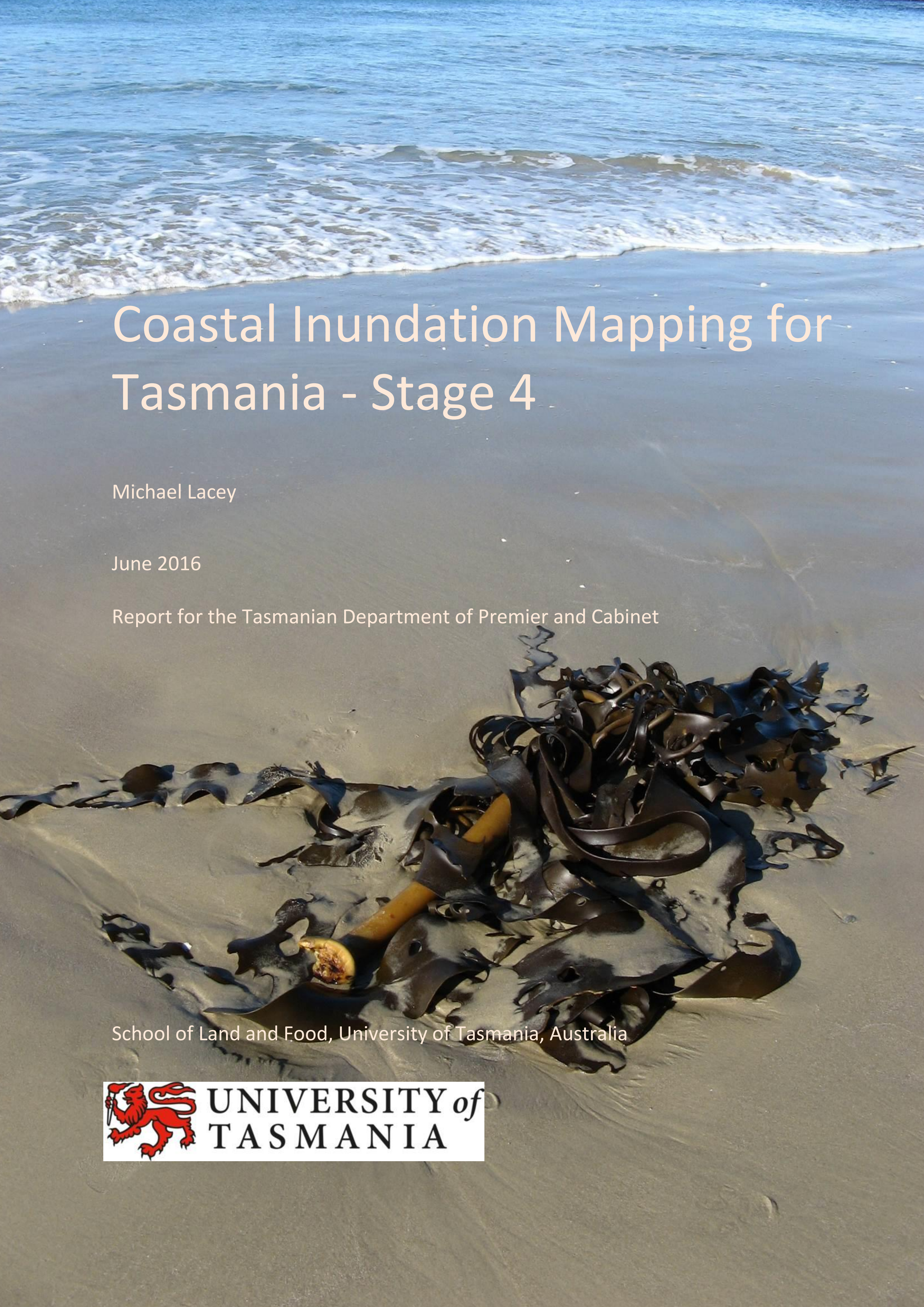

Coastal Inundation Mapping for Tasmania - Stage 4

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UNIVERSITY of TASMANIA

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Summary

This report was prepared for the project “Coastal Inundation Stage 4” for the Tasmanian Department of Premier and Cabinet (DPAC) and accompanies a set of GIS datasets and data tables produced in that project. The project was concerned with mapping of a set of sea-level rise scenarios around the Tasmanian coast and a representation of a set of those scenarios as inundation hazard bands. This report is primarily intended to document the methods used in the project. The sea-level rise allowances used in this project have been supplied by the Tasmanian Government to create coastal inundation area maps to support the development of a coastal policy, and a coastal inundation planning code. This project maps projected inundation associated with updated annual exceedance probability (AEP) and revised local government area (LGA)-specific height allowances data for the IPCC RCP8.5 scenario.

Outputs include:

1. Coastal inundation extent maps
    - 1.1. Revised polygon geodatabase map showing the extent of expected permanent inundation associated with the revised sea-level rise scenarios for the years 2050, and 2100. The map also identifies inundation areas that are contiguous or non-contiguous with the mean high tide line.
    - 1.2. Revised maps of the extent of storm tide inundation associated with 1% AEPs for each of the years 2010, 2050 and 2100, with one polygon geodatabase dataset per specified year. The maps identify areas that are contiguous or non-contiguous with the mean high tide line.

2. Coastal inundation hazard maps and suburb tables

2.1. Revised table giving the height for each hazard band and suburb or locality in the state and maps of the extent of permanent and storm tide inundation associated with the high, medium, low and coastal inundation investigation bands of likelihood. The maps for each of the High, Medium, and Low exclude non-contiguous areas and, for each of the bands:

- **High band** is the area vulnerable to sea-level rise by 2050 from the mean high tide, rounded up to the nearest 100 mm.
- **Medium band** is the area vulnerable to a 1% AEP storm event in 2050 rounded up to the nearest 100mm plus 300 mm added for freeboard.
- **Low band** is the area vulnerable to a 1% AEP storm event in 2100 rounded up to the nearest 100mm plus 300 mm added for freeboard.
- **Coastal Inundation investigation band** is the area below the 10 metre contour and within 1000 metres from the coast in the non-LiDAR mapped areas.

3. Report and analysis of coastal inundation hazard bands

3.1. The following indicators at State level and for each Local Government Area (LGA):

- The area (hectares) of land in each band.
- The number of vacant cadastral parcels in each band.
- The number of residential dwellings. The residential dwellings data is taken from LIST data services and is correct at the time publication for each 1:25 000 topographic maps.

3.2. This report

Contents

Definitions

A1FI	The IPCC's "high emission" scenario as presented in the Fourth Assessment (AR4) report (IPCC, 2007)
AEP	Annual Exceedance Probability
AR4	IPCC Fourth Assessment (AR4) report
AR5	IPCC Fifth Assessment (AR5) report
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	Digital elevation model, a surface representing the surface heights of the land
DPAC	Department of Premier and Cabinet
GIS	Geographic Information System
ILS	Information & Land Services Division of the Department of Primary Industries, Parks, Water and Environment, Tasmania
IPCC	Intergovernmental Panel on Climate Change
LiDAR	Light detection and ranging
LGA	Local Government Area
MHW	The average of all high waters over a period of time (ICSM, 2007). For inundation modelling, the high water used was the "NTC High Water" (see below).
MSL	Mean Sea Level For a tidal station Mean Sea Level is the mean over a period of time of the hourly heights at that station (ICSM, 2007).
NTC	National Tidal Centre, Bureau of Meteorology
NTC High Water	The tidal range grid modelled by the National Tidal Centre (NTC) used to model the approximate high water mark, which in most cases also represents the historically mapped coastline well. The NTC tidal range is the height in metres between Mean Sea Level and Indian Spring Low Water multiplied by two to give an estimate of the complete tidal range. It is twice the sum of the amplitudes of the four main tidal constituents, M2, S2, O1 and K1. For Part a) inundation modelling, the high water used was the NTC modelled high water, which is at a height of half the NTC tide range above Mean Sea Level.
RCP8.5	The IPCC's "business-as-usual" scenario as presented in the Fifth Assessment (AR4) report (Church *et al*., 2013)
SLR	Sea level rise
Storm Tide	A combination of the tidal component plus any raised sea level due to wind set up or reduced air pressure. It is what is measured at tide gauges during a storm event.

Introduction

This report was prepared for the project “Coastal Inundation Stage 4” for the Tasmanian Department of Premier and Cabinet (DPAC) and accompanies a set of GIS datasets produced in that project. The project was concerned with mapping of a set of sea-level rise scenarios around the Tasmanian coast and a representation of a set of those scenarios as inundation hazard bands. This report is primarily intended to document the methods used in the project. The sea-level rise allowances used in this project have been supplied by the Tasmanian Government to create coastal inundation area maps to support the development of a coastal policy, and a coastal inundation planning code. This project maps projected inundation associated with updated annual exceedance probability (AEP) and revised local government area (LGA)-specific height allowances data for the IPCC RCP8.5 scenario.

Project aim and purpose

Coastal Inundation Stage 4 follows on from Stages 1 to 3, also known as the Tasmanian Coastal Inundation Mapping Project, (Mount *et al.*, 2010, Mount *et al.,* 2011, Lacey *et al.*, 2012 and Lacey *et al.*, 2015). Stage 4 updates mapping of coastal inundation extent maps and coastal inundation hazard maps using revised LGA-specific height allowances data and updated storm-tide AEP data for the IPCC RCP8.5 scenario (McInnes and O’Grady, 2016; McInnes *et al.* 2016). Also updated is a summary table for each suburb of the hazard inundation heights and a comparative statistical analysis of the impact of coastal hazards and reporting which are further specified as follows:

1. Coastal inundation extent maps
   - 1.1. Revised polygon geodatabase map showing the extent of expected permanent inundation associated with the revised sea-level rise scenarios for the years 2050, and 2100. The map also identifies inundation areas that are contiguous or non-contiguous with the mean high tide line.
   - 1.2. Revised maps of the extent of storm tide inundation associated with 1% AEPs for each of the years 2010, 2050 and 2100, with one polygon geodatabase dataset per specified year. The maps identify areas that are contiguous or non-contiguous with the mean high tide line.
2. Coastal inundation hazard maps and suburb tables

2.1. Revised table giving the height for each hazard band and suburb or locality in the state and maps of the extent of permanent and storm tide inundation associated with the high, medium, low and coastal inundation investigation bands of likelihood. The maps for each the High, Medium, and Low exclude non-contiguous areas and, for each of the bands:

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3.1. The following indicators at State level and for each Local Government Area (LGA):

- The area (hectares) of land in each band.
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- The number of residential dwellings. The residential dwellings data is taken from LIST data services and is correct at the time publication for each 1:25 000 topographic maps.

3.2. This report

Input Datasets

Input datasets, were as used in Coastal Inundation Mapping Stage 3 (Lacey *et al.*, 2015) except where noted below. Qualifications associated with those inputs and associated methods in the stage 3 mapping also apply for this mapping. The main changes to inputs were revised storm tide AEP data and associated revised LGA-specific sea-level rise allowances.

Updated Storm tide AEP data was used in the stage 4 mapping. A sub-set of an Australia-wide hydrodynamic model developed by Haigh *et al.*, (1914) was adapted by McInnes and O'Grady, (2016) for use in this project and is a representation of the RCP8.5 scenario from the IPCC Fifth Assessment Report (AR5). The RCP8.5 scenario is closely similar to the IPCC AR4 A1FI scenario used in earlier stages of this mapping.

Updated sea-level rise allowances were used in the stage 4 mapping. In the stages 2 and 3 mapping the sea-level rise allowances were 0.2 m for 2050 and 0.8 m for 2100, relative to 2010. These were based on the technique of Hunter (2012), observations of storm tides from the tide gauges at Hobart and Burnie, and regional projections of sea-level rise based on the IPCC A1FI emission scenario (Hunter et al., 2013). In stage 4 the sea-level rise allowances are based on projected sea-level rise in the IPCC AR5 RPC8.5 scenario (McInnes *et al.*, 2016). As with allowances used in the earlier stage mapping the updated allowances have been centred on 2010. Updated sea-level rise allowances for the RPC8.5 scenario produced region specific values averaging 0.23 m for 2050 and 0.85 m for 2100 relative to 2010. The projections vary geographically around the coast of Tasmania, being largest on the east coast and lower on the west coast. Projected allowance heights aggregated for individual LGAs for 2050 and 2100 were supplied by DPAC.

The stage 4 mapping also used an updated version of the LIST coastline (revision date 5/6/15) with the exclusion of offshore rocks and small islands with an area of less than 1000 square metres. Offshore rocks and small islands which represented 102245 out of 104185 features in the dataset were removed to improve processing efficiency without significantly affecting the mapping outcome.

Coastal Inundation Extent Maps

Two mapping approaches were followed for the coastal inundation extent maps; these being an additive approach based on tidal heights and an approach based on storm tide annual exceedance probabilities. The two mapping approaches are discussed below separately under the headings "**Permanent Inundation and Sea Level Rise**" and "**Storm Tide Event plus Sea Level Rise**". The Coastal Inundation extent maps followed the format used in Stages 2a and 3 of the Coastal Inundation Mapping for Tasmania and differ from Stage 2 mapping in that inundation heights are rounded up to the nearest 100 millimetres in LiDAR areas and nearest metre in non-LiDAR ares.

Permanent Inundation and Sea-Level Rise

The "**Permanent Inundation and sea-level rise**" component of this mapping, followed the same method as for the Stage 3 with the exception of use of updated and LGA-specific sea-level rise allowances. A potential consideration in using LGA-specific allowances was in dealing with boundaries between LGAs where there were different allowances values across the boundary, however the process of rounding-up inundation heights prior to mapping meant that this was not an issue for any LGA or inundation scenario.

The primary outputs were a series polygon datasets representing the most likely position of the shoreline for the years 2050 and 2100 according to the RCP8.5 sea-level rise scenario. Datasets were combined into a single polygon geodatabase feature class.

Geoprocessing Implementation – "Permanent inundation and sea Level rise"

Polygon datasets were prepared separately for LiDAR and non-LiDAR areas and then combined into the final dataset. Geoprocessing was conducted using ArcGIS 10.2 with the majority of processing being scripted using Python 2.7. Methods are detailed below. For LiDAR areas the combined tidal inundation and sea-level rise allowance was rounded-up to the nearest ten centimetres. For the 25 metre DEM areas it was rounded-up to the nearest whole metre.

Base coastal high water heights were sourced from the 'Base_Ht' attribute of 'TasHeightsRefV3_4' dataset which has been calculated as described in the Stage 3 report. To these the LGA-specific sea level rise allowances were added before rounding-up to the nearest ten centimetres in LIDAR areas or to the nearest whole meter in non-LIDAR areas. For each target year the relevant point dataset was converted to an inundation surface raster corresponding to the 1000 m TasHeightsRefV3_4 dataset cell spacing. Inundation surfaces were subtracted from the DEM and cells of the resultant inundated DEM surface with a value less than zero were designated as inundated. Outputs were converted to polygon shapefiles which showed areas expected to be inundated under the modelled scenarios. The polygon shapefiles were clipped to a polygon version of the coastline. Polygons intersecting a line version of the coastline were designated contiguous with the coast. LiDAR based and non-LiDAR based datasets were combined into a single state-wide dataset. A polygon mask, identifying location of LiDAR areas, was used to erase the same areas from the 25 metre DEM based outputs. LiDAR and 25 m DEM based datasets were then merged to produce the combined shapefile. Some minor editing was required to add in some of the Launceston flood levees (Fullard, 2013) which were too narrow to show up on the LiDAR DEM.

Output Dataset – "Permanent inundation and sea-level rise"

The output is a single combined polygon dataset representing the areas of permanent (tidal) inundation that can be expected for the years 2050 and 2100 according to the RCP8.5 sea-level rise scenario. Concentric polygon areas represent regions expected to be progressively inundated by sea-level rise in 2050 and 2100 respectively. The LiDAR DEM has been used as the land surface height reference where it was available. The Tasmanian 25 metre DEM was used in all other areas. The sea level reference was the NTC modelled high water except is the Tamar Valley and Macquarie Harbour where alternative published mean high tide heights were used. Figure 1 shows an example of the Permanent Inundation zones.

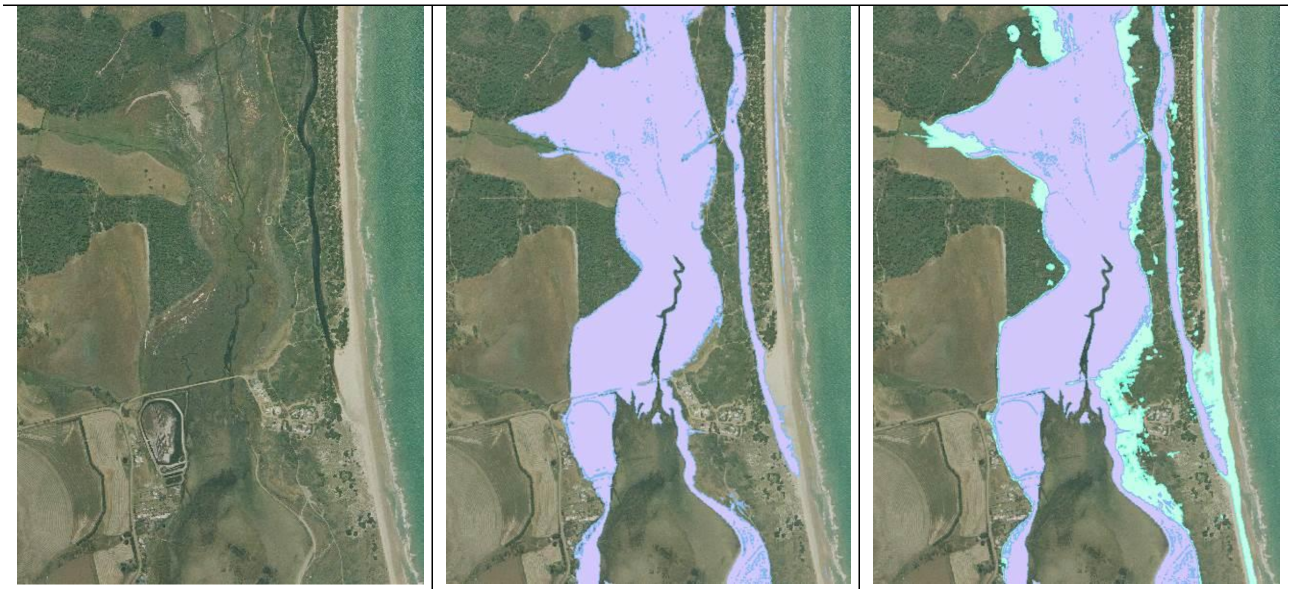
The output dataset name is "**TidalInundationModel_RU_V5"** and is provided in file geodatabase (.gdb) format with the dataset having the same name as the geodatabase in which it is enclosed. The dataset is projected in GDA 94 MGA Zone 55. Attributes are listed in Table 1. Attribution has been included to allow selection of inundation polygons associated with each of the target years and also to distinguish between polygons that are contiguous or non-contiguous with the coast. Table 2 lists queries in ArcGIS that can be used to select contiguous or non-contiguous inundation polygon extents.

Table 1: Attribute fields for TidalInundationModel_RU_V5

Field Name	Data type	Details
TR2050	Text	"2050" indicates projected inundation level in 2050, with heights rounded up to the nearest 10 cm before mapping.
TR2100	Text	"2100" indicates projected inundation level in 2100, with heights rounded up to the nearest 10 cm before mapping.
IC2050	Integer	(1 = contiguous with coast; 0 = not contiguous with coast) at projected year 2050 inundation.
IC2100	Integer	(1 = contiguous with coast; 0 = not contiguous with coast) at projected year 2100 inundation.
SL_Ref	Text	NTC_HW (= NTC modelled high water), MHT (= Mean high tide in Tamar area), MHT Mac Hb (= mean high tide Macquarie Harbour)
SLR_Lev_RU	Text	Projected year in which the polygon appears "inundated".
DEM_Ref	Text	L2 (= LiDAR DEM), DEM25 (= State 25 m DEM) **Note: Inundation heights in the LiDAR areas are rounded up to the nearest whole ten centimetres and in 25 m DEM areas have been rounded up to the nearest whole metre.**
Shape_Length	Floating point	Polygon perimeter in metres.
Shape_Area	Floating point	Polygon area in square metres.

Table 2: ArcGIS queries for selection of inundation extents that are contiguous or not contiguous with the coast from the tidal inundation dataset

To select	Query
Polygons contiguous with the coast that are expected to be inundated in 2050.	"TR2050_RU " = '2050' AND "IC2050_RU " = 1
Polygons not contiguous but potentially inundation in 2050 under some circumstances.	"TR2050_RU " = '2050' AND "IC2050_RU " = 0
Polygons contiguous with the coast that are expected to be inundated in 2100.	"TR2100_RU " = '2100' AND "IC2100_RU " = 1
Polygons not contiguous but potentially inundation in 2100 under some circumstances.	"TR2100_RU " = '2100' AND "IC2100_RU " = 0



Base map | Inundation 2050 | Inundation 2100

Figure 1. Example of sea-level rise permanent inundation zones shown as a series of inundation “footprints” on a base map. Illustrated are projected tidal inundation heights for the years 2050 and 2100 shown as purple and pale-blue respectively. The inner, landward edge of each band is where the specified inundation height applies and any land seaward of that line has a higher probability of flooding. The 2050 band can be counted as having already been inundated prior to inundation of the 2100 band. Inundation heights have been rounded-up to the nearest 10 cm. Note that some areas shown as inundated are not connected (non-contiguous) with the coast and therefore may not be directly inundated but may be affected by impaired drainage. The base map consists of an aerial photo. The mapped area is at Marion Bay and is approximately 1500 m across and north is up.

Discussion – "Permanent inundation and sea-level rise"

It should be noted that not all variables relevant to the accurate modelling and prediction of new shoreline positions are currently available for all the locations of interest around the coast, that is, there are limitations on the available data inputs at the Tasmanian scale. For example,

- The LiDAR DEM currently only covers the more highly populated coastlines.
- The lower resolution 25 metre DEM may give an indication only of potential coastline positions with sea-level rise.
- The tide range data for Tasmania is limited to either direct observations at the main tide gauges or, for other locations along the shore, to modelled estimates. The tides in more enclosed bays and estuaries or around islands can be substantially different to those shown in the available data.
- Also, there is no consideration of the complex interactions between erosion, coastal recession and inundation. The "bathtub" or "still water" method is essentially a passive model and assumes a calm sea surface. It is useful because it is a simple, fast method that indicates locations with the potential for inundation and can, if used judiciously and with other lines of evidence, assist with prioritising further activity.
- The IPCC projections of sea-level rise used in these calculations involve considerable uncertainty, arising from imperfect understanding both of the science and of the world's future emissions.

Storm Tide Event plus Sea-Level Rise

The Stage 4 mapping represents updated storm tide AEP inundation heights for the IPCC RCP8.5 scenario mapped for the Tasmanian coastal regions. Heights are based on a sub-set of an Australia-wide hydrodynamic model developed by Haigh et al., (1914) as adapted by McInnes and O'Grady, (2016) for use in this project. The RCP8.5 scenario is closely similar to the IPCC A1FI scenario used in earlier stages of this mapping. The rationale behind the Storm Tide Event plus Sea-Level Rise datasets is further detailed in the Stage 3 report (Lacey *et al.* 2015).

Only the 1% AEPs for the years 2010, 2050 and 2100 have been mapped in the Stage 4 project, however additional references to inundation heights for 0.005%, 0.05%, 0.5%, 2% and 5%AEPs and for the year 2075 for the RPC8.5 scenario can be found in the attribute table of Coastal Inundation Hazard maps V3 dataset.

Geoprocessing Implementation – "Storm tide event plus sea-level rise"

Three "Storm tide event plus sea-level rise" height datasets representing the 1% AEP heights each of the years 2010, 2050 and 2100 under the RPC8.5 sea-level rise scenario were geographically mapped. Each of the AEP height datasets represented calculated storm tide plus sea-level rise exceedance heights for sea-level rise scenarios as specified by the Tasmanian Government to create coastal inundation area maps to support the development of a coastal policy, and a coastal inundation planning code.

GIS processing was conducted using ArcGIS 10.2 with the majority of processing being scripted using Python 2.7. The main geoprocessing steps are summarised as follows.

The input AEP dataset was a set of modelled 1%AEP heights, corresponding spatially to the 1km grid cells points of the TasHeightsRefV3_4 dataset. 1% AEP heights for the years 2010, 2050 and 2100 were used. For each target year the relevant point dataset was converted to an inundation surface raster corresponding to the 1000 m TasHeightsRefV3_4 dataset cell spacing. For LiDAR areas inundation heights were rounded-up to the nearest 10 cm and in the 25 metre DEM areas it was rounded-up to the nearest whole metre. Inundation surfaces were subtracted from the LiDAR and 25m DEM surfaces and cells of the resultant surface with a value less than zero were designated as inundated. Outputs were converted to polygon shapefiles which showed areas expected to be inundated under the modelled scenarios. This polygonisation step used the "no_simplify" option. The polygon layers were then clipped to a polygon version of the coastline. Polygons intersecting a line version of the coastline were designated contiguous with the coast. LiDAR mapped regions were merged into a combined shapefile for each target year. A polygon mask, identifying location of LiDAR areas, was used to erase the same areas from the 25 metre DEM based outputs. LiDAR and 25 m DEM datasets were then merged to produce combined state-wide polygon shapefiles for each target year. Datasets were converted to geodatabase format to reduce file size and to speed up screen refresh times. Some minor editing was required to add in some of the Launceston flood levees which were too narrow to show up on the LiDAR DEM.

Output Datasets – "Storm tide annual exceedance probabilities"

Storm Tide 1% AEP datasets are listed in Table 3 and are provided in file geodatabase format with the dataset having the same name as the geodatabase in which it is enclosed. All of the datasets are projected in GDA 94 MGA Zone 55. Attributes of the datasets are listed in Table 4. An example of the Storm Tide AEP bands is shown in Figure 2.

Table 3: Storm Tide 1%AEP RU V5 Datasets

Dataset Name	File geodatabase	Target Year
StormTide_1PctAEP_RU_2010_V5	Storm_Tide_1Pct AEP_RU_2010_V5.gdb	2010
StormTide_1Pct AEP_RU_2050_V5	Storm_Tide_1Pct AEP_RU_2050_V5.gdb	2050
StormTide_1Pct AEP_RU_2100_V5	Storm_Tide_1Pct AEP_RU_2100_V5.gdb	2100

Table 4: Attributes of the Storm Tide 1%AEP RU V5 Datasets

Field Name	Data type	Details
IC1pct_RU	Integer	(1 = contiguous with coast; 0 = not contiguous with coast) at 1% AEP level.
SLR	Text	Target year (2010, 2050 or 2100).
DEM_Ref	Text	L2 (= LiDAR DEM) DEM25 (= State 25 m DEM) **Note: Inundation heights in the LiDAR areas are rounded up to the nearest whole ten centimetres and in 25 m DEM areas have been rounded up to the nearest whole metre.**
Shape_Length	Floating point	Polygon perimeter in metres.
Shape_Area	Floating point	Polygon area in square metres.

Attribution has been included to allow polygons that are contiguous or non-contiguous with the coast to be distinguished. The IC1pct_RU attribute is equal to 1 for polygons contiguous with the coast and 0 for non-contiguous polygons.

Figure 2. Example of storm tide inundation zones shown as a series of inundation “footprints” on a base map. The sea level heights shown corresponding with 1% AEP storm tide inundation heights for the years 2010, 2050 and 2100 mapped as pink, orange and yellow respectively. The inner, landward edge of each band is where the respective exceedance probability applies and any land seaward of that line has a higher probability of flooding. The 2010 band can be counted as having already been inundated prior to inundation of the 2050 band. The 2050 band can be counted as having already been inundated prior to inundation of the 2100 band. Inundation heights have been rounded-up to the nearest 10 cm. The base map consists of an aerial photo. The mapped area is at Marion Bay and is approximately 1500 m across and north is up.

Discussion – “Storm tide event plus sea-level rise”

Note that it is the landward boundary of the inundation polygons that represent the specified AEP for the specified year and points within the remainder of the polygon have a higher exceedance probability.

These storm-tide coastal flooding zones include the effects of tides, storm surges and sea-level rise only. They do not include the effects of wave set-up or wave run-up. Additional allowances (known as “freeboard”) may therefore need to be made for effects associated with waves.

The IPCC projections of sea-level rise used in these calculations involve considerable uncertainty, arising from an imperfect understanding both of the science and of the world's future emissions.

These results relate to the increase in the probability of extreme events caused by a rise in mean sea level; they do not include any projections based on changes in storm tides.

Coastal Inundation Hazard Maps

Maps showing High, Medium, Low and Investigation bands of coastal inundation likelihood were prepared using a protocol specified by DPAC. In LiDAR mapped areas the High, Medium and Low bands were based on the extent the following permanent and storm tide inundation scenarios.

- **High** (Currently vulnerable to coastal erosion and to future inundation hazard): Area vulnerable to highest astronomical tide now; and inundation from the mean high tide by 2050 rounded up to the nearest 100 mm.
- **Medium** (Vulnerable to Coastal inundation and erosion by 2050): area vulnerable to a 1% AEP storm event in 2050 rounded up to the nearest 100mm plus 300 mm added for freeboard.
- **Low** (Vulnerable to Coastal inundation and erosion by 2100) Area vulnerable to a 1% AEP storm event in 2100 rounded up to the nearest 100mm plus 300 mm added for freeboard.

In addition, those coastal areas outside of the LiDAR mapped areas a band defined as the **Coastal Inundation Investigation** band is the area below the 10 metre contour and within 1000 metres from the coast. Within this band no level of likelihood was assigned.

Geoprocessing Implementation – "Coastal inundation hazard maps"

Geoprocessing was conducted using ArcGIS 10.2. Inputs for the High, Medium and Low bands were prepared from Coastal Inundation Extent datasets or equivalently prepared data. The "Permanent Inundation" dataset for 2050 was the input dataset for the High scenario. Inputs with a 300 mm freeboard allowance (Medium and Low) were prepared in the same way as the corresponding Storm Tide Event plus Sea-Level Rise datasets except that an additional 300 mm was added to the combined AEP inundation and sea-level rise heights before this was subtracted from the DEM height surfaces.

Inundation polygons which were not-contiguous with the coast were removed from the LiDAR sourced 'high', 'medium' and 'low' datasets before these datasets were spatially unioned (combined). Small polygons, with an area less than 5 square metres, were removed by converting them to the same band category as the surrounding polygons. The dataset was then simplified using the ArcGIS Simplify Polygon tool with the bend simplify option, 2.4 metre minimum curve length and topology correction. The Investigation band used in non-LiDAR areas was a polygon representation of the area below the 10 metre contour clipped to 1000 metre from the coast. The hazard bands were then combined with the investigation band using a combination of erase and merge steps. The Identity tool was used to extract attributes from the 'Tasmania_Coastal_Heights_Ref_V3_4' dataset and AEP percentage data for the RPC8.5 climate scenario. Additional attribute fields were added and calculated.

Output Dataset – "Coastal inundation hazard V3_1"

The dataset **"Coastal_Inundation_Hazard_V3_1"** is provided in ESRI file geodatabase **"Coastal_Inundation_Hazard_V3_1.gdb"**. Attributes are listed in Table 5. The dataset is projected in GDA 94 MGA Zone 55 and heights are in metres AHD. An example of the Coastal Inundation Hazard bands is shown in Figure 3. As mapped, the bands do not overlap and the area within each band is counted at the hazard level in which it is first shown as inundated.

Table 5: Attribute of Coastal_Inundation_Hazard_V3

Field Name	Details
Disclaimer	"Hazard Planning Maps produced by the Department of Premier and Cabinet (this map being such a map) are produced and released for the purpose of informing actions taken and decisions made by local or state government under relevant provisions of the Land Use Planning and Approvals Act 1993 and Building Act 2000. Whilst every care has been taken to prepare this map, the Government of Tasmania makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose other than its intended purpose. Hazard bands as depicted in this map may not accurately represent the existence or otherwise of hazards in the mapped area. Independent expert advice should be sought if action is to be taken that may be impacted by the existence or otherwise of hazards in the mapped area."
Hazard_Band	"High", "Medium", "Low" or "Investigation"
Hazard_Exposure	If "Hazard_Band"="High", "This area is vulnerable to the highest astronomical tide now, and to inundation from mean high tide by 2050." If "Hazard_Band"="Medium", "This area is vulnerable to a 1% AEP storm event in 2050 and inundation from mean high tide by 2100." If "Hazard_Band"="Low", "This area is vulnerable to a 1% AEP storm event in 2100." If "Hazard_Band"="Investigation", "This area is outside the LiDAR-mapped area and as it is below the mapped 10 m contour may be partly vulnerable to sea-level rise but data used for this analysis were not sufficient to further determine potential inundated areas. In areas adjacent to rivers the cumulative impact of riverine flooding with storm surge has not been assessed."
Inland_Flood_Risk	In estuarine areas within the LiDAR mapped areas: "The cumulative impact of riverine flooding with storm surge has not been assessed. For further information please contact your local council."
Height_High	Inundation height in metres for the "High" scenario. Calculated as = INT((TR_20SLR +0.1)*10)/10
Height_Medium	Inundation height in metres for the "Medium" scenario. Calculated as =(INT((AEP1pct_2050 +0.1)*10)/10)+0.3
Height_Low	Inundation height in metres for the "Low" scenario. Calculated as =(INT((AEP1pct_2100 +0.1)*10)/10)+0.3
LL_Pos_EN	Tile lower left eastings and northings in kilometres, (eg. e473_n5448).
Easting	Tile centre easting in metres (MGA zone 55)
Northing	Tile centre northing in metres (MGA zone 55)
Base_Ht	Interpolated reference high water mark height at the centre of tile. In most cases this will be based on NTC tide range. See note 1.
Base_Ht_Ref	Source of height reference used in tile (NTC TR, NTC tide range; MHT Mac Hb, mean high tide for Macquarie Harbour; MHT Tamar, mean high tide Tamar).
TR_0SLR	Modelled inundation height for tile with 0 sea-level rise at 50% probability level.
TR_10SLR	Modelled inundation height for tile with 10 cm sea-level rise at 50% probability level.
TR_20SLR	Modelled inundation height for tile with 20 cm sea-level rise at 50% probability level.
TR_30SLR	Modelled inundation height for tile with 30 cm sea-level rise at 50% probability level.
TR_40SLR	Modelled inundation height for tile with 40 cm sea-level rise at 50% probability level.
TR_50SLR	Modelled inundation height for tile with 50 cm sea-level rise at 50% probability level.
TR_60SLR	Modelled inundation height for tile with 60 cm sea-level rise at 50% probability level.
TR_70SLR	Modelled inundation height for tile with 70 cm sea-level rise at 50% probability level.
TR_80SLR	Modelled inundation height for tile with 80 cm sea-level rise at 50% probability level.
TR_90SLR	Modelled inundation height for tile with 90 cm sea-level rise at 50% probability level.
TR_100SLR	Modelled inundation height for tile with 100 cm sea-level rise at 50% probability level.
TR_110SLR	Modelled inundation height for tile with 110 cm sea-level rise at 50% probability level.
TR_120SLR	Modelled inundation height for tile with 120 cm sea-level rise at 50% probability level.

HAT	Modelled Highest Astronomic Tide from NTC. This data is included for reference and has not been used in tide height calculations. “-999” = No data. See Note 2.
Local_Storm_Surge	Local storm surge if known.
Wave_Setup	Wave setup if known.
Wave_Runup	Wave runup if known.
AEP_005pct2010	Modelled 0.005% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP_05pct2010	Modelled 0.05% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP_5pct2010	Modelled 0.5% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP1pct2010	Modelled 1% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP2pct2010	Modelled 2% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP5pct2010	Modelled 5% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP_005pct2050	Modelled 0.005% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP_05pct2050	Modelled 0.05% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP_5pct2050	Modelled 0.5% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP1pct2050	Modelled 1% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP2pct2050	Modelled 2% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP5pct2050	Modelled 5% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP_005pct2075	Modelled 0.005% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP_05pct2075	Modelled 0.05% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP_5pct2075	Modelled 0.5% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP1pct2075	Modelled 1% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP2pct2075	Modelled 2% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP5pct2075	Modelled 5% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP_005pct2100	Modelled 0.005% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP_05pct2100	Modelled 0.05% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP_5pct2100	Modelled 0.5% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP1pct2100	Modelled 1% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP2pct2100	Modelled 2% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP5pct2100	Modelled 5% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
Shape_Length	Tile perimeter length in metres
Shape_Area	Tile area in square metres

Note 1

In most cases the reference height if from the National Tidal Centre modelled tidal range grid (i.e. “NTC High Water”). For the Tamar region, mean high tide (MHT) heights were used as published by Foster *et al*. (1986). Base height in Macquarie Harbour is from Koehnken (1996). Figures are a best estimate based on the input data but may not reflect actual conditions, particularly in rivers and estuaries, and require verification.

Note 2

Modelled HAT (Highest Astronomic Tide) has been included for reference and has not been used in tide height calculations. Interpolated values for rivers and estuaries are approximate and should only be used in those areas with caution. Values for locations inland from the open coast have been designated “no_data” and have been given a value of “-999”.

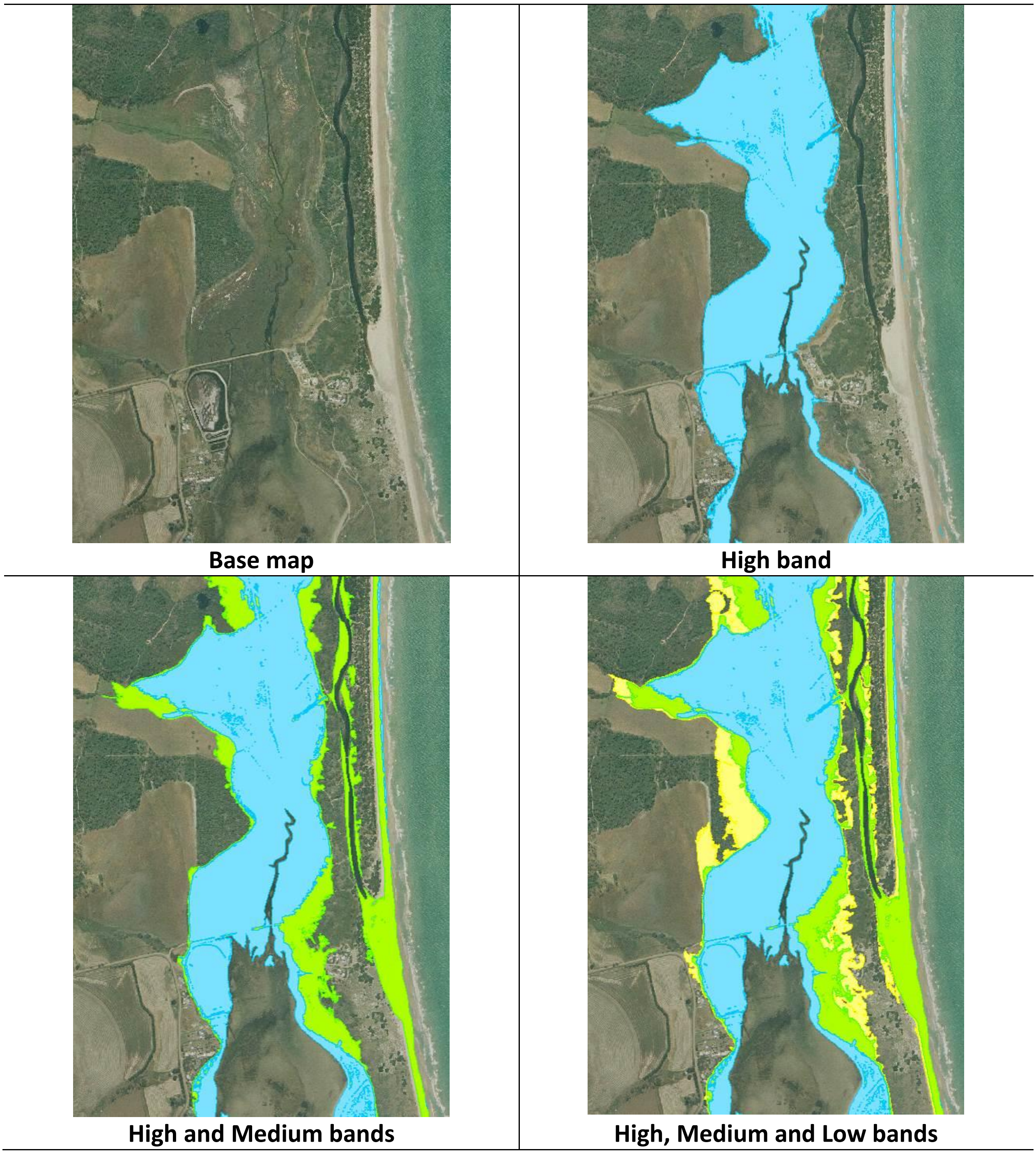


Figure 3. Example of coastal inundation hazard bands shown as a series of inundation “footprints” on a base map. High, Medium and Low bands are shown as blue, green and yellow respectively. The inner, landward edge of each band is where the specified inundation probability applies and any land seaward of that line has a higher probability of flooding. The High band can be counted as having already been inundated prior to inundation of the Medium band. The Medium band can be counted as having already been inundated prior to inundation of the Low band. Inundation heights have been rounded-up to the nearest 10 cm. Not shown is the Investigation band which is used in non-LiDAR areas only. The base map consists of an aerial photo. The mapped area is at Marion Bay and is approximately 1500 m across and north is up.

Analysis of the Coastal Inundation Hazard Bands

The area (hectares) of land, the number of vacant cadastral parcels and the number of residential dwellings within each of the Coastal Inundation Hazard bands were determined for the State and for each LGA and are summarised below following the criteria outlined by DPAC in Anon. (2016). These were first processed in Microsoft Access then exported to Excel format. Data tables with a larger selection of attributes have also been prepared in Excel format for DPAC to conduct further analysis. Specific details of methods were as follows.

Area of land in each band

The Coastal Inundation Hazard Map version 3 was combined spatially with LGA datasets (munylwm.shp and HSA2.1) using a series of spatial union and identity steps to bring together the attributes of the input datasets. The attribute table was then exported and opened in Access. A series of database queries were used to aggregate and select the required data. A crosstab query was used to generate the summary in Table 6.

Number of vacant parcels less than 2000 square metres in each band

A subset of the data in the file 'Cadastre_VG_Address_vacent' was selected in ArcMAP by selecting LANDUSECODE=V1 to V9, Cadtype1=Private Parcel and COMP_AREA=less than 2000 square metres. The resultant data was combined spatially with LGA datasets (munylwm.shp and HSA2.1) and Coastal Inundation Hazard Map version 3 using a series of identity steps. The attribute table was then exported and opened in Access. A series of database queries were used to: 1) identify which parcels had greater than 10% of their area within the combined bands; 2) identify which intersected band had the maximum area. A crosstab query was used to generate the summary in Table 7.

Number of residential dwellings in each band

The point file 'Buildings_Cadastre_VG_Address' was the source of buildings data from which a subset was selected where 'BUILD_TYPE'='Residence'. From the resultant points those that were within 10 metres of the Coastal Inundation Hazard Map version 3 polygons were selected. The resultant points were buffered 10 metres to create 'building envelope' polygons. The Coastal Inundation Hazard Map version 3 was combined spatially with LGA datasets (munylwm.shp and HSA2.1) using a series of spatial union and identity steps to bring together the attributes of the input datasets. A spatial join with multiple joins per feature was used to join the LGA and hazard map data into the building envelope features. The attribute table was then exported and opened in Access. A series of database queries were used to: 1) aggregate features with the same unique building and band combination; 2) for each building envelope identify which of the intersected bands is the highest hazard band and; 3) populate the LGA information. A crosstab query was used to generate the summary in Table 8. Another crosstab query was used to generate a suburb summary of the building numbers.

Table 6: The area (hectares) of land in each Hazard Band, listed by LGA

LGA Name	Hazard Band				Total for High, Medium and Low bands	Overall Total
	High	Medium[1]	Low[2]	Investigation[3]		
King Island	6.4	9.2	4.1	4321.5	19.7	4341.1
Hobart	1.9	13.5	28.3	0	43.6	43.6
Glenorchy	8.5	25.0	34.8	0	68.2	68.2
Burnie	21.6	26.1	25.5	0.4	73.2	73.6
West Coast	28.8	68.4	31.0	9374.3	128.2	9502.5
Waratah-Wynyard	52.0	41.5	43.9	2.0	137.5	139.5
Devonport	79.8	45.0	29.0	0.0	153.8	153.8
Brighton	68.1	109.6	22.8	0.0	200.4	200.4
Flinders	43.3	116.9	41.9	24146.7	202.1	24348.8
Derwent Valley	71.5	130.2	37.5	0.0	239.3	239.3
George Town	81.3	90.4	75.6	555.7	247.2	802.9
Dorset	152.7	90.1	89.6	9230.9	332.4	9563.3
Central Coast	256.4	159.0	126.0	0.0	541.4	541.4
Kingborough	114.8	383.9	184.8	1485.3	683.5	2168.8
Sorell	330.8	248.1	127.2	162.4	706.1	868.6
Latrobe	387.7	256.6	160.6	1.8	804.9	806.7
Tasman	217.1	477.9	181.6	940.9	876.6	1817.5
Launceston	377.5	439.2	93.0	0.0	909.7	909.7
Break O'Day	253.7	410.0	253.1	3521.8	916.8	4438.5
Huon Valley	636.2	300.4	159.1	10303.1	1095.8	11398.9
West Tamar	462.8	631.3	267.1	0.0	1361.1	1361.1
Clarence	375.0	651.4	578.9	3.6	1605.3	1608.8
Glamorgan-Spring Bay	1781.7	969.0	802.1	5000.0	3552.7	8552.7
Circular Head	1138.6	2347.7	1615.4	10529.1	5101.7	15630.8
State Totals	6948.0	8040.3	5013.0	79579.3	20001.4	99580.7

[1] Excluding areas already counted for the High band.

[2] Excluding areas already counted for the High and Medium bands.

[3] Investigation band is outside the LiDAR-mapped area and is the area below the 10 metre contour and within 1000 metres from the coast.

Table 7: Numbers of vacant private cadastral parcels with an area less than 2000 square metres and with more than 10% of their area within the hazard bands, listed by LGA [1]

LGA Name	Hazard Band				Total for High, Medium and Low bands	Overall Total
	High	Medium[2]	Low[3]	Investigation[4]		
Glenorchy	0	0	0	0	0	0
King Island	0	0	0	42	0	42
Brighton	0	0	1	0	1	1
Derwent Valley	0	1	0	0	1	1
Dorset	0	0	1	1	1	2
Flinders	0	0	1	4	1	5
Burnie	0	0	2	0	2	2
Circular Head	0	0	2	1	2	3
Devonport	0	0	3	0	3	3
Launceston	0	0	3	0	3	3
Waratah-Wynyard	0	0	4	0	4	4
Hobart	0	0	6	0	6	6
George Town	0	4	3	0	7	7
Break O'Day	1	3	6	14	10	24
Tasman	0	2	9	0	11	11
West Tamar	0	12	2	0	14	14
Kingborough	0	2	16	6	18	24
Sorell	1	7	12	0	20	20
Glamorgan-Spring Bay	0	2	20	14	22	36
West Coast	0	14	12	3	26	29
Central Coast	0	7	21	0	28	28
Huon Valley	0	11	17	0	28	28
Clarence	2	24	8	0	34	34
Latrobe	0	19	19	0	38	38
State Total	4	108	168	85	280	365

[1] Where the parcel intersected more than one band, the band with the greatest intersecting area is counted.
[2] Does not include parcels already counted for the High band.
[3] Does not include parcels already counted for the High and Medium bands.
[4] Investigation band is outside the LiDAR-mapped area and is the area below the 10 metre contour and within 1000 metres from the coast.

Table 8: Number of individual buildings with 'BUILD_TYPE' = 'Residential', listed by LGA.

LGA Name	Hazard Band				Total for High, Medium and Low bands	Overall Total
	High	Medium[1]	Low[2]	Investigation[3]		
King Island	0	0	0	35	0	35
Dorset	0	1	3	1	4	5
Launceston	1	0	4	0	5	5
Burnie	2	3	5	0	10	10
Flinders	1	6	11	80	18	98
Derwent Valley	1	12	7	0	20	20
Tasman	3	16	22	5	41	46
Waratah-Wynyard	0	12	39	0	51	51
Devonport	0	0	53	0	53	53
Circular Head	2	12	40	1	54	55
Brighton	0	18	49	0	67	67
Sorell	3	50	32	0	85	85
George Town	2	23	61	0	86	86
Hobart	2	34	50	0	86	86
Glenorchy	0	8	83	0	91	91
Break O'Day	27	39	56	25	122	147
West Coast	4	120	37	20	161	181
West Tamar	4	83	90	0	177	177
Kingborough	2	80	100	57	182	239
Glamorgan-Spring Bay	1	67	115	34	183	217
Huon Valley	17	123	99	76	239	315
Latrobe	1	125	195	0	321	321
Central Coast	3	98	311	0	412	412
Clarence	9	358	317	4	684	688
State Total	85	1288	1779	338	3152	3490

[1] Does not include buildings already counted for the High band.
[2] Does not include buildings already counted for the High and Medium bands.
[3] Investigation band is outside the LiDAR-mapped area and is the area below the 10 metre contour and within 1000 metres from the coast.

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Appendix 1. Draft Metadata

Coastal High Water plus Sea Level Rise Inundation Modelling metadata – Tasmania, Version 5

Draft metadata prepared by Dr Michael Lacey, University of Tasmania 29th June 2016.

General Properties	
File Identifier	
Hierarchy Level	series
Hierarchy Level Name	series
Standard Name	ANZLIC Metadata Profile: An Australian/New Zealand Profile of AS/NZS ISO 19115:2005, Geographic information - Metadata
Standard Version	1.1
Date Stamp	2016-06-29
Resource Title	Coastal High Water plus Sea Level Rise Inundation Model – Tas., Version 5
Other Resource Details	M.J. Lacey (2016) Coastal Inundation Mapping for Tasmania – Stage 4. Report to the Department of Premier and Cabinet by University of Tasmania
Key Dates and Languages	
Date of creation	2016-06
Date of publication	2016-06
Metadata Language	eng
Metadata Character Set	utf8
Dataset Languages	eng
Dataset Character Set	utf8
Abstract	A digital dataset that represents modelled potential inundation effects of a set of combined sea-level rise allowances and high tide scenarios for coastal areas of Tasmania and adjoining land regions within the extent of a coastal LiDAR DEM or alternatively the Tasmanian 25 metre DEM where the LiDAR DEM was not available. Sea-level rise allowances are based on projected sea-level rise for the IPCC AR5 RPC8.5 scenarios for 2050 and 2100. At each sea-level rise scenario high water modelling is based on modelled tide range data provided by the National Tidal Centre of published Mean High Water heights for the Tamar Estuary and Macquarie Harbour. Some extrapolation of input data was required to extend tide data into the Tamar Estuary. Inundation heights have been rounded-up to the nearest 0.01 metre in LiDAR areas and nearest metre in non-LiDAR areas.
Purpose	This dataset was prepared to assist in the identification of regions that may be subject to the effects of sea-level rise such as coastal flooding.
Metadata Contact Information	
Name of Individual	Name withheld
Organisation Name	
Position Name	
Role	author
Voice	
Facsimile	
Email Address	
Address	 Australia
Resource Contacts	
Name of Individual	
Organisation Name	

Position Name	
Role	pointOfContact
Voice	
Facsimile	
Email Address	
Address	 Australia
Lineage Statement	Inputs: Digital Elevation Models LIDAR information as supplied via the Information & Land Services Division (ILS) of the Department of Primary Industries, Parks, Water and Environment (DPIPWE) or the Land Information System Tasmania (LIST), November 2014. Tasmanian 25 metre DEM (second edition) as supplied via the Information & Land Services Division (ILS) of the Department of Primary Industries, Parks, Water and Environment (DPIPWE) or the Land Information System Tasmania (LIST) Coastline theLIST Coastline, revision date 05-06-2015, excluding offshore rocks and islands with an area less than 1000 square metres. Sea Level Rise Allowances The sea-level rise allowances are based on regional sea-level projections and the RPC8.5 emission scenario. The allowances used in this dataset have been supplied by the Tasmanian Government to create coastal inundation area maps to support the development of a coastal policy, and a coastal inundation planning code. Tidal Range Tidal range modelled data was obtained from the National Tidal Centre (NTC) in the form of a five minute resolution grid of points extending from longitude 111º to 116º East and from latitude 9º to 45º South. This model represents tidal amplitudes in metres between Mean Sea Level and Indian Spring Low Water multiplied by two to give an estimate of the complete tidal range. It includes the four main tidal constituents, M2, S2, O1 and K1, and was calculated as: Tidal amplitude = (M2 + S2 + O1 + K1) amplitudes * 2 The NTC tide range grid needed to be extrapolated to extend into Boullanger Bay and Robbins Passage. This extrapolation incorporated tidal heights for Welcome Inlet and Robbins Passage as published by Donaldson *et al*. (2012). Mean High Water was used for the Tamar Estuary south of 5446000 metres MGA Zone 55 as sourced from Foster *et al*. (1986). A height surface was generated using a spline with barriers interpolation from heights at nine locations along the estuary. For Macquarie Harbour MHW height was used as published by Koehnken (1996). This version has inundation heights rounded up to the nearest 10 cm before mapping in regions covered by coastal LiDAR DEM or rounded up to the nearest metre in regions covered by the Tasmanian 25 metre DEM. Inundation Modelling Method: Inundation modelling used the “bathtub” inundation method (Eastman, 1993). Two coastal high water plus-sea-level rise height datasets representing the specified tidal and sea-level rise heights with specified rounding adjustments were geographically mapped. GIS processing was conducted using ESRI ArcGIS 10.2 with the majority of processing being scripted using Python 2.7. The main geoprocessing steps are summarised as follows. A spline with barriers interpolation method was used to calculate a series of height surfaces from the tidal datasets. Sea level rise allowances were added

to the height surfaces to calculate tidal height surfaces for the years 2050 and 2100. For LiDAR areas the combined tidal inundation and sea-level rise was rounded-up to the nearest ten centimetres and in 25 metre DEM areas rounded-up to the nearest whole metre. The inundation surfaces had a grid spacing of 1000 metre. Inundation height surfaces were subtracted from the LiDAR and 25m DEM surfaces and cells of the resultant surface with a value less than zero were designated as inundated. Outputs were converted to polygon shapefiles which showed areas expected to be inundated under the modelled scenarios. This polygonisation step used the “no_simplify” option. The polygon layers were then clipped to a polygon version of the coastline. Polygons intersecting a line version of the coastline were designated contiguous with the coast. LiDAR based and non-LiDAR based datasets were combined into a single state-wide dataset.
A polygon mask, identifying location of LiDAR areas, was used to erase the same areas from the 25 metre DEM based outputs. LiDAR and 25 m DEM based datasets were then merged to produce the combined shapefile. Some minor editing was required to add in some of the Launceston flood levees which were too narrow to show up on the LiDAR DEM.

The output is a single combined polygon dataset representing the areas of permanent (tidal) inundation that can be expected for the years 2050 and 2100. Concentric polygon areas represent regions expected to be progressively inundated by sea-level rise by 2050 and 2100. The dataset name is “TidalInundationModel_RU_V5” and is provided in file geodatabase (.gdb) format with the dataset having the same name as the geodatabase in which it is enclosed.

Attributes of the TidalInundationModel RU V5 Dataset:

Attribute	Details
TR2050_RU	“2050” indicates projected inundation level in 2050, with heights rounded up to the nearest 10 cm before mapping.
TR2100_RU	“2100” indicates projected inundation level in 2100, with heights rounded up to the nearest 10 cm before mapping.
IC2050_RU	Polygons as mapped: 1 = contiguous with coast or; 0 = not contiguous with coast at year 2050 inundation.
IC2100_RU	Polygons as mapped: 1 = contiguous with coast or; 0 = not contiguous with coast at year 2100 inundation.
SL_Ref	NTC_HW (= NTC modelled high water) MHT Tamar (= Mean high tide in Launceston area) MHT Mac Hb (= mean high tide Macquarie Harbour)
TR_Lev_RU	Projected year in which the polygon appears “inundated”.
DEM_Ref	L2 (= LiDAR) DEM25 (= State 25 m DEM) **Note: Inundation heights in the 25 m DEM areas have been further rounded up to the nearest whole metre.**
Shape_Length	Polygon perimeter in metres.
Shape_Area	Polygon area in square metres.

Inundated areas contiguous or non-contiguous with the coast in each year can be selected using a combination of two attributes. For example query "TR2050_RU" = '2050' AND "IC2050_RU" = 1 will select polygons contiguous with the coast that are expected to be inundated in 2050.

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Koehnken L. (1996) Macquarie Harbour – King River Study. Technical Report, DELM

Jurisdictions	
	Tasmania
Search Words	
	CLIMATE-AND-WEATHER-Climate-change
	CLIMATE-AND-WEATHER-Extreme-weather-events
	HAZARDS-Flood
	HAZARDS-Severe-local-storms
	MARINE
Themes and Categories	
Topic Category	elevation
Topic Category	geoscientificInformation
Topic Category	environment
Status and Maintenance	
Status	completed
Maintenance and Update Frequency	notPlanned
Date of Next Update	
Reference system	
Reference System	GDA94
Spatial Representation Type	
Spatial Representation Type	vector
Metadata Security Restrictions	
Classification	
Authority	
Use Limitations	
Dataset Security Restrictions	
Classification	
Authority	
Use Limitations	
Extent - Geographic Bounding Box	
North Bounding Latitude	-40
South Bounding Latitude	-44
West Bounding Longitude	144
East Bounding Longitude	149
Additional Extents - Geographic	
Identifier	TAS
Distribution Information	
Distributor 1	
Distributor 1 Contact	
Name of Individual	Name withheld
Organisation Name	
Position Name	
Role	distributor
Voice	
Facsimile	
Email Address	
Address	
	Australia

Storm Tide plus Sea Level Rise Inundation Modelling metadata – Tasmania, Version 5

Draft metadata prepared by Dr Michael Lacey, University of Tasmania 29th June 2016.

General Properties	
File Identifier	
Hierarchy Level	series
Hierarchy Level Name	series
Standard Name	ANZLIC Metadata Profile: An Australian/New Zealand Profile of AS/NZS ISO 19115:2005, Geographic information - Metadata
Standard Version	1.1
Date Stamp	2016-06-29
Resource Title	Storm Tide plus Sea Level Rise Inundation Model – Tas., Version 5
Other Resource Details	M.J. Lacey (2016) Coastal Inundation Mapping for Tasmania – Stage 4. Report to the Department of Premier and Cabinet by University of Tasmania
Key Dates and Languages	
Date of creation	2016-06
Date of publication	2016-06
Metadata Language	eng
Metadata Character Set	utf8
Dataset Languages	eng
Dataset Character Set	utf8
Abstract	A series of digital datasets that represent modelled potential inundation effects of combined sea-level rise and storm tide scenarios for coastal areas of Tasmania and adjoining land regions covered by coastal LiDAR DEM or alternatively the Tasmanian 25 metre DEM where the LiDAR DEM was not available. The boundaries of these flooding zones indicate specific annual exceedance probabilities (AEP) of 1% for years 2010, 2050 or 2100 with sea-level rise allowances based on the IPCC RPC8.5 emission scenario. The allowances used in this dataset have been supplied by the Tasmanian Government to create coastal inundation area maps to support the development of a coastal policy, and a coastal inundation planning code. This version has inundation heights rounded up to the nearest 10 cm before mapping in regions covered by coastal LiDAR DEM or rounded up to the nearest metre in regions covered by the Tasmanian 25 metre DEM.
Purpose	This dataset was prepared to assist in the identification of regions that may be subject to the effects of sea-level rise such as coastal flooding.
Metadata Contact Information	
Name of Individual	Name withheld
Organisation Name	
Position Name	
Role	author
Voice	
Facsimile	
Email Address	
Address	 Australia
Resource Contacts	
Name of Individual	

Organisation Name	
Position Name	
Role	pointOfContact
Voice	
Facsimile	
Email Address	
Address	 Australia

Lineage Statement

Inputs:

Digital Elevation Model
LIDAR information as supplied via the Information & Land Services Division (ILS) of the Department of Primary Industries, Parks, Water and Environment (DPIPWE) or the Land Information System Tasmania (LIST), November 2014. Tasmanian 25 metre DEM (second edition) as supplied via the Information & Land Services Division (ILS) of the Department of Primary Industries, Parks, Water and Environment (DPIPWE) or the Land Information System Tasmania (LIST)

Coastline
theLIST Coastline, revision date 05-06-2015, excluding offshore rocks and islands with an area less than 1000 square metres.

"Storm Tide plus sea-level rise" height datasets
The input AEP dataset was a set of modelled 1%AEP heights, corresponding spatially to the 1km grid cells points of the TasHeightsRefV3_4 dataset, from the Haigh *et al.* (2014) model of the RCP8.5 scenario as adapted by McInnes *et al.* (2016). 1% AEP heights for the years 2010, 2050 and 2100 were used.

Three Storm-Tide plus sea-level rise height datasets representing 1% AEPs for the specified time periods were geographically mapped.
GIS processing was conducted using ESRI ArcGIS 10.2 with the majority of processing being scripted using Python 2.7. The main geoprocessing steps are summarised as follows.

For each target year the relevant AEP point dataset was converted to an inundation surface raster corresponding to the 1000 m TasHeightsRefV3_4 dataset cell spacing. For LiDAR areas inundation heights were rounded-up to the nearest 10 cm and in the 25 metre DEM areas it was rounded-up to the nearest whole metre. Inundation surfaces were subtracted from the LiDAR and 25m DEM surfaces and cells of the resultant surface with a value less than zero were designated as inundated. Outputs were converted to polygon shapefiles which showed areas expected to be inundated under the modelled scenarios. This polygonisation step used the "no_simplify" option. The polygon layers were then clipped to a polygon version of the coastline. Polygons intersecting a line version of the coastline were designated contiguous with the coast. LiDAR based and non-LiDAR based datasets were combined into a single state-wide dataset.
A polygon mask, identifying location of LiDAR areas, was used to erase the same areas from the 25 metre DEM based outputs. LiDAR and 25 m DEM based datasets were then merged to produce the combined shapefile. Some minor editing was required to add in some of the Launceston flood levees which were too narrow to show up on the LiDAR DEM.

AEP datasets are listed in Table 1 and are provided in file geodatabase (.gdb) format with the dataset having the same name as the geodatabase in which it is enclosed. All of the datasets are projected in GDA 94 MGA Zone 55. Attributes of the datasets are listed in Table 2.

Table 1: Storm Tide AEP Datasets

Dataset Name	Target Year
StormTide_1PctAEP_RU_2010_V5	2010
StormTide_1PctAEP_RU_2050_V5	2050
StormTide_1PctAEP_RU_2100_V5	2100

Table 2: Attributes of the Storm Tide AEP Datasets

Field Name	Details
IC1pct_RU	(1 = contiguous with coast; 0 = not contiguous with coast) at 1% AEP level.
SLR	Target year (2010, 2050 or 2100).
DEM_Ref	L2 (=LiDAR) DEM25 (= State 25 m DEM) **Note: Inundation heights in the 25 m DEM areas have been rounded up to the nearest whole metre.**
Shape_Length	Polygon perimeter in metres.
Shape_Area	Polygon area in square metres.

Inundated areas contiguous or non-contiguous with the coast in each year can be selected using the IC1pct_RU attribute.

References:

Haigh, I., Wijeratne, E.M.S., MacPherson, L., Pattiaratchi, C., Mason, M., Crompton, R., and George, S. (2014) Estimating present day extreme water level exceedance probabilities around the coastline of Australia: tides, extra-tropical storm surges and mean sea level. Climate Dynamics, 42, 121-138.

McInnes. K.L. and O'Grady, J., (2016) Tasmanian Extreme Sea Level Modelling Assessment, CSIRO Report 20 pp.

Jurisdictions

Tasmania

Search Words

CLIMATE-AND-WEATHER-Climate-change

CLIMATE-AND-WEATHER-Extreme-weather-events

HAZARDS-Flood

HAZARDS-Severe-local-storms

MARINE

Themes and Categories

Topic Category elevation

Topic Category geoscientificInformation

Topic Category environment

Status and Maintenance

Status completed

Maintenance and Update Frequency notPlanned

Date of Next Update

Reference system

Reference System GDA94

Spatial Representation Type

Spatial Representation Type vector

Metadata Security Restrictions

Classification

Authority

Use Limitations

Dataset Security Restrictions

Classification

Authority

Use Limitations

Extent - Geographic Bounding Box

North Bounding Latitude	-40
South Bounding Latitude	-44
West Bounding Longitude	144
East Bounding Longitude	149
Additional Extents - Geographic	
Identifier	TAS
Distribution Information	
Distributor 1	
Distributor 1 Contact	
Name of Individual	Name withheld
Organisation Name	
Position Name	
Role	distributor
Voice	
Facsimile	
Email Address	
Address	
	Australia

Coastal Inundation Hazard Maps metadata – Tasmania Version 3_1

Draft metadata prepared by Dr Michael Lacey, University of Tasmania 29th June 2016.

General Properties	
File Identifier	
Hierarchy Level	series
Hierarchy Level Name	series
Standard Name	ANZLIC Metadata Profile: An Australian/New Zealand Profile of AS/NZS ISO 19115:2005, Geographic information - Metadata
Standard Version	1.1
Date Stamp	2016-06-29
Resource Title	Coastal Inundation Hazard Maps, Version 3
Other Resource Details	M.J. Lacey (2016) Coastal Inundation Mapping for Tasmania – Stage 4. Report to the Department of Premier and Cabinet by University of Tasmania
Key Dates and Languages	
Date of creation	2016-06
Date of publication	2016-06
Metadata Language	eng
Metadata Character Set	utf8
Dataset Languages	eng
Dataset Character Set	utf8
Abstract	Maps showing High, Medium, Low and Investigation bands of coastal inundation likelihood. In LiDAR mapped areas the High, Medium and Low bands were based on the extent the following permanent and storm tide inundation scenarios. - High (Currently vulnerable to coastal erosion with future inundation hazard): Area vulnerable to highest astronomical tide now; and inundation from the mean high tide by 2050 + rounding up to the nearest 100 mm. - Medium (Vulnerable to Coastal inundation and erosion by 2050): area vulnerable to a 1% AEP storm event in 2050 + rounding up to the nearest 100mm + 300 mm for freeboard . - Low (Vulnerable to Coastal inundation and erosion by 2100) Area vulnerable to a 1% AEP storm event in 2100 + rounding up to the nearest 100mm + 300 mm for freeboard. In addition, those coastal areas outside of the LiDAR mapped areas a band defined as the Coastal Inundation Investigation band is the area extending to the coast below the 10 metre contour. Within this band no level of likelihood was assigned. This dataset combines elements from the following datasets (please also refer to metadata from those datasets): Coastal High Water plus Sea Level Rise Inundation Model – Tas., Version 5 Storm Tide plus Sea Level Rise Inundation Model – Tas., Version 5 Coastal Inundation Height Reference (Tas.), Version 3.4
Purpose	This dataset was prepared to assist in the identification of regions that may be subject to the effects of sea-level rise such as coastal flooding.
Metadata Contact Information	
Name of Individual	Name withheld
Organisation Name	
Position Name	

Role	author
Voice	
Facsimile	
Email Address	
Address	
	Australia
Resource Contacts	
Name of Individual	
Organisation Name	
Position Name	
Role	pointOfContact
Voice	
Facsimile	
Email Address	
Address	
	Australia
Lineage Statement	Inputs: Inputs for the High, Medium and Low bands were prepared from Coastal Inundation Extent datasets or equivalently prepared data. The 'Coastal High Water plus Sea Level Rise Inundation Model – Tas., Version 3' dataset for 2050 was the input dataset for the High scenario. Inputs with a 300 mm freeboard allowance (Medium and Low) were prepared in the same way as the corresponding 'Storm Tide plus Sea Level Rise Inundation Model – Tas., Version 5' datasets except that an additional 300 mm was added to the combined AEP inundation and sea-level rise heights before this was subtracted from the DEM height surfaces. Inundation polygons which were not-contiguous with the coast were removed from the LiDAR sourced 'high', 'medium' and 'low' datasets before these datasets were spatially unioned. Small polygons, with an area less than 5 square metres, were removed by converting them to the same band category as the surrounding polygons. The dataset was then simplified using the ArcGIS Simplify Polygon tool with the bend simplify option, 2.4 metre minimum curve length and topology correction. The Investigation band used in non-LiDAR areas was a polygon representation of the area below the 10 metre contour clipped to 1000 metre from the coast. The hazard bands were then combined with the investigation band using a combination of erase and merge steps. The Identity tool was used to extract attributes from the 'Tasmania_Coastal_Heights_Ref_V3_4' dataset and AEP percentage data for the RPC8.5 climate scenario. Additional attribute fields were added and calculated. The dataset **"Coastal_Inundation_Hazard_V3_1**" is provided in an ESRI file geodatabase with the same name. Attributes are listed in Table 1. The dataset is projected in GDA 94 MGA Zone 55 and heights are in metres AHD.

Table 1: Attribute of Coastal_Inundation_Hazard_V3_1

Field Name	Details
Disclaimer	"Hazard Planning Maps produced by the Department of Premier and Cabinet (this map being such a map) are produced and released for the purpose of informing actions taken and decisions made by local or state government under relevant provisions of the Land Use Planning and Approvals Act 1993 and Building Act 2000. Whilst every care has been taken to prepare this map, the Government of Tasmania makes no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose other than its intended purpose. Hazard bands as depicted in this map may not accurately represent the existence or otherwise of hazards in the mapped area. Independent expert advice should be sought if action is to be taken that may be impacted by the existence or otherwise of hazards in the mapped area."
Hazard_Band	"High", "Medium", "Low" or "Investigation"

Hazard_Exposure	If "Hazard_Band"="High", "This area is vulnerable to the highest astronomical tide now, and to inundation from mean high tide by 2050." If "Hazard_Band"="Medium", "This area is vulnerable to a 1% AEP storm event in 2050 and inundation from mean high tide by 2100." If "Hazard_Band"="Low", "This area is vulnerable to a 1% AEP storm event in 2100." If "Hazard_Band"="Investigation", "This area is outside the LiDAR-mapped area and as it is below the mapped 10 m contour may be partly vulnerable to sea-level rise but data used for this analysis were not sufficient to further determine potential inundated areas. In areas adjacent to rivers the cumulative impact of riverine flooding with storm surge has not been assessed."
Inland_Flood_Risk	In estuarine areas within the LiDAR mapped areas: "The cumulative impact of riverine flooding with storm surge has not been assessed. For further information please contact your local council."
Height_High	Inundation height in metres for the "High" scenario. Calculated as = INT((TR_20SLR+0.1)*10)/10
Height_Medium	Inundation height in metres for the "Medium" scenario. Calculated as =(INT((AEP1pct_2050+0.1)*10)/10)+0.3
Height_Low	Inundation height in metres for the "Low" scenario. Calculated as =(INT((AEP1pct_2100+0.1)*10)/10)+0.3
LL_Pos_EN	Tile lower left eastings and northings in kilometres, (eg. e473_n5448).
Easting	Tile centre easting in metres (MGA zone 55)
Northing	Tile centre northing in metres (MGA zone 55)
Base_Ht	Interpolated reference high water mark height at the centre of tile. In most cases this will be based on NTC tide range. See note 1.
Base_Ht_Ref	Source of height reference used in tile (NTC TR, NTC tide range; MHT Mac Hb, mean high tide for Macquarie Harbour; MHT Tamar, mean high tide Tamar).
TR_0SLR	Modelled inundation height for tile with 0 sea-level rise at 50% probability level.
TR_10SLR	Modelled inundation height for tile with 10 cm sea-level rise at 50% probability level.
TR_20SLR	Modelled inundation height for tile with 20 cm sea-level rise at 50% probability level.
TR_30SLR	Modelled inundation height for tile with 30 cm sea-level rise at 50% probability level.
TR_40SLR	Modelled inundation height for tile with 40 cm sea-level rise at 50% probability level.
TR_50SLR	Modelled inundation height for tile with 50 cm sea-level rise at 50% probability level.
TR_60SLR	Modelled inundation height for tile with 60 cm sea-level rise at 50% probability level.
TR_70SLR	Modelled inundation height for tile with 70 cm sea-level rise at 50% probability level.
TR_80SLR	Modelled inundation height for tile with 80 cm sea-level rise at 50% probability level.
TR_90SLR	Modelled inundation height for tile with 90 cm sea-level rise at 50% probability level.
TR_100SLR	Modelled inundation height for tile with 100 cm sea-level rise at 50% probability level.
TR_110SLR	Modelled inundation height for tile with 110 cm sea-level rise at 50% probability level.
TR_120SLR	Modelled inundation height for tile with 120 cm sea-level rise at 50% probability level.
HAT	Modelled Highest Astronomic Tide from NTC. This data is included for reference and has not been used in tide height calculations. "-999" = No data. See Note 2.
Local_Storm_Surge	Local storm surge if known.
Wave_Setup	Wave setup if known.
Wave_Runup	Wave runup if known.
AEP_005pct2010	Modelled 0.005% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP_05pct2010	Modelled 0.05% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP_5pct2010	Modelled 0.5% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP1pct2010	Modelled 1% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP2pct2010	Modelled 2% Annual Exceedance Probability height for

	2010 under the RPC8.5 scenario.
AEP5pct2010	Modelled 5% Annual Exceedance Probability height for 2010 under the RPC8.5 scenario.
AEP_005pct2050	Modelled 0.005% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP_05pct2050	Modelled 0.05% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP_5pct2050	Modelled 0.5% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP1pct2050	Modelled 1% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP2pct2050	Modelled 2% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP5pct2050	Modelled 5% Annual Exceedance Probability height for 2050 under the RPC8.5 scenario.
AEP_005pct2075	Modelled 0.005% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP_05pct2075	Modelled 0.05% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP_5pct2075	Modelled 0.5% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP1pct2075	Modelled 1% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP2pct2075	Modelled 2% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP5pct2075	Modelled 5% Annual Exceedance Probability height for 2075 under the RPC8.5 scenario.
AEP_005pct2100	Modelled 0.005% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP_05pct2100	Modelled 0.05% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP_5pct2100	Modelled 0.5% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP1pct2100	Modelled 1% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP2pct2100	Modelled 2% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
AEP5pct2100	Modelled 5% Annual Exceedance Probability height for 2100 under the RPC8.5 scenario.
Shape_Length	Tile perimeter length in metres
Shape_Area	Tile area in square metres

Jurisdictions

Tasmania

Search Words

CLIMATE-AND-WEATHER-Climate-change

CLIMATE-AND-WEATHER-Extreme-weather-events

HAZARDS-Flood

HAZARDS-Severe-local-storms

MARINE

Themes and Categories

Topic Category: elevation

Topic Category: geoscientificInformation

Topic Category: environment

Status and Maintenance

Status: completed

Maintenance and Update Frequency: notPlanned

Date of Next Update

Reference system

Reference System: GDA94 MGA Zone 55

Spatial Representation Type

Spatial Representation Type	vector
Metadata Security Restrictions	
Classification	
Authority	
Use Limitations	
Dataset Security Restrictions	
Classification	
Authority	
Use Limitations	
Extent - Geographic Bounding Box	
North Bounding Latitude	-40
South Bounding Latitude	-44
West Bounding Longitude	144
East Bounding Longitude	149
Additional Extents - Geographic	
Identifier	TAS
Distribution Information	
Distributor 1	
Distributor 1 Contact	
Name of Individual	Name withheld
Organisation Name	
Position Name	
Role	distributor
Voice	
Facsimile	
Email Address	
Address	
	Australia