Victorian Coastal Monitoring Program

Open Coast Sub-Program

Research Project Summaries - March 2019

1. Theme: Shoreline sediment dynamics

1.1. Project title: Satellite-based Victorian shoreline monitoring

Project Leader: Nicolas Pucino

Project team: Rafael C. Carvalho, Daniel Ierodiaconou (Deakin), David Kennedy (UoM)

Collaborations: Geoscience Australia, FrontierSI, DEA

Description: This project aims to create an automatic geospatial routine to extract and monitor Warrnambool and Port Fairy shoreline evolution with Sentinel-2 and Planet imagery. The scripts must be written in Python in a way to allow the analysis to scale-up to the Victorian, and possibly Australian coastlines. The shoreline trends will give us insights into meso-scale geomorphic processes which will be linked to small-scale site-specific subaerial analysis (see "*Sediment facies mapping of Port Fairy and Warrnambool coastal compartments*" and "*UAV spectroscopy and machine learning for monitoring subaerial sediment dynamics of sandy beaches*").

Methods: Digital Earth Australia (DEA) open data cube (ODC) will be used for processing Sentinel-2 Analysis Ready Datasets (ARD). DEA allows for near real time ARD cloud processing via the National Computing Infrastructure (NCI) by using interactive programming virtual environments (Jupyter Notebooks). This platform will allow to apply the algorithms utilised for the local-scale analysis (Warrnambool and Port Fairy compartments) to the whole Victorian and possibly Australian coast. For Planet imagery, another approach will be attempted. DEA ODC does not include Planet Labs ARD. Being part of the Planet Research and Education program allow me to get an API for programming routines. This time, Google Earth Engine (GEE) platform will be used to cloud process Planet imagery. The Planet APIs will allow us to request filtered data and process it within GEE. We have the great advantage to have citizen science UAV timeseries, which will be used as ground-truth or calibration for shoreline extraction.

Hurdles: A priority is to find a method to identify shorelines which is time and tide independent. This means that time of acquisition and tidal conditions are taken into account when extracting vector shorelines. Also, being a geoscientist and not a programmer, my limited coding experience might make the process last longer than expected.

Journals Selection:

ISPRS Journal of Photogrammetry and Remote Sensing

Remote Sensing of the Environment

PLoS ONE

What	When	Who
Project design	September - November 2019	Pucino
Coding and Analysis	November 2019 – April 2020	Pucino, Carvalho
Paper writing	March - May 2020	Pucino, Carvalho

Contact: Nicolas Pucino, npucino@deakin.edu.au

1.2. Project title: Field-based sediment facies mapping of Port Fairy and Warrnambool coastal compartments

Project Leader: Nicolas Pucino

Project team: Rafael C. Carvalho, Daniel Ierodiaconou (Deakin), David Kennedy (UoM)

Description: The purpose of this project is to classify supra and intertidal sediments based on their spatial, sedimentological and optical properties. The classification maps will provide a spatially explicit view of the distribution of classes of "sands" with distinct properties, revealing significant insights about the importance of marine, erosional and aeolian processes in shaping the modern Port Fairy and Warrnambool shorelines. Also, a spectral library will be compiled and used to ground-truth further aerial analysis (see "*UAV spectroscopy and machine learning for monitoring subaerial sediment dynamics of sandy beaches*").

Methods: Sand samples and radiometric measurements (~200 per location) will be sampled from the top layer of the Warrnambool and Port Fairy beaches following a survey grid of cross-shore transects (from backdune to swash zones) covering the two embayments. The sample locations will be recorded with RTK-GPS and a field VNIR spectroradiometer (400-900 nm) will be used to collect spectral signatures on the spot. In the lab, grain-size distribution, organic matter content, carbonates content and composition, water content and iron-oxide parameters will be extracted. Random Forest classifier will be used to predict classes of sediments based on their physical, spectral and spatial properties. The classes will describe sediments coming from different sources, such as offshore marine, supratidal dry, intertidal wet, foredune eroded dry, backdune terrigenous dry, and so on. Spectral endmembers from each class will be also extracted and a spectral library created.

Hurdles: The field spectroradiometer must be borrowed from Geoscience Australia and might take a long time to get to uni. Also, the fieldwork required for this project is extensive, labour intensive and might take more time than expected to get the data ready for machine learning analysis.

Journals Selection:

Remote Sensing of the Environment

Continental Shelf Research

Journal of Coastal Research

Marine Geology

What	When	Who
Project design	October - November 2018	Pucino
Fieldwork and Sediment analysis	December – March 2019	Pucino, Carvalho
Statistical analysis	February – March 2019	Pucino, Carvalho
Paper writing	January - April 2019	Pucino, Carvalho

Contact: Nicolas Pucino, npucino@deakin.edu.au

1.3. Project title: UAV spectroscopy and machine learning for monitoring subaerial sediment dynamics of sandy beaches

Project Leader: Nicolas Pucino

Project team: Rafael C. Carvalho, Blake Allan, Alex Rattray, Daniel Ierodiaconou (Deakin), David Kennedy (UoM)

Description: This project aims to monitor distinct sediment class dynamics from the supra-intertidal part of Port Fairy and Warrnambool beaches, with an unprecedented high spatial accuracy. It will also allow us to couple citizen science UAV volumetric analysis to the previously created sand classes, adding important information about the source of the sediments that have been eroded or accumulated across the sites.

Methods: Two photogrammetric and two multi/hyperspectral UAV surveys will be conducted across Port Fairy and Warrnambool bays. The obtained surface reflectance maps will be segmented and classified with supervised classification algorithms, based on the spectral library previously compiled. Sand samples will also be collected during the aerial campaigns and used as ground-truth for the classified images. Citizen-science volumetric differences could potentially be linked to sediment facies mapping, thus providing a much clearer view of subaerial sediment processes across sandy beaches. Satellite imagery might also be investigated, by resampling the spectral libraries to Planet RapidEye and Digitalglobe WorldView-3 multispectral band widths and check the output of supervised classification.

Hurdles: We still do not know the availability of the hyperspectral sensor. We might be limited to a VNIR multispectral sensor, in that case, we need to test the accuracy of the classification output from such a sensor. The aerial surveys are quite extensive and might require several weeks to complete. Due to the wide aerial coverage that we mean to analyse, data handling and computing power might be some major limiting factors.

Journals Selection:

Remote Sensing of Environment

ISPRS Journal of Photogrammetry and Remote Sensing

Geomorphology

Journal of Coastal Research

What	When	Who
Project design	March - April 2019	Pucino
Fieldwork and Sediment analysis	April – June 2019	Pucino, Carvalho, Allan
Statistical analysis	June – August 2019	Pucino
Paper writing	August - October 2019	Pucino, Carvalho, Allan

Contact: Nicolas Pucino, npucino@deakin.edu.au

1.4. Project title: Volumetric calculations using historical aerial photographic archive: moving beyond shoreline extraction in coastal Victoria

Project Leader: Rafael Carvalho

Project Team: Nicolas Pucino, Blake Allan, David Kennedy (UoM), Daniel Ierodiaconou

Description: Digitally rectified historical aerial photographs are an invaluable tool in shoreline mapping and change detection in coastal landscapes. In this project, we move beyond the extraction of 2D features such as shoreline position from georeferenced images and report the use of Structure-from-Motion (SfM) method to generate Digital Surface Models (DSMs) from historical aerial photogrammetric archive of coastal Victoria provided by DELWP.

The approach is suited to sets of images with a high degree of overlap by solving the camera pose and scene geometry automatically. The DSMs allow 3D reconstruction of coastal landscapes and calculation of volumes since 1940s, when aerial photogrammetry started in Victoria. The initiative aims to provide communities with information on past coastal condition, change, trends, and the expected longer-term impacts associated with climate change.

This will support decision making and adaptation planning. The DSMs represent the benchmarks for monitoring sediment dynamics and changes in height, extent and volume of sediment on beaches located at coastal towns including, Portland, Port Fairy, Warrnambool, Apollo Bay, Lorne, Anglesea and Barwon.

Methods: DSM reconstruction from aerial photographs, topographic LiDAR and UAV data (citizen science). Article to be submitted to *Remote Sensing of the Environment or Earth Surface Processes and Landforms.*

Potential extension: To other coastal sites in Victoria.

Hurdles: None.

What	When	Who
UAV fieldwork data collection	Ongoing	CS Groups, UAV Science team
Historical DSM processing	November 2018- January 2019	Rafael
Data analysis & maps	February 2019	Rafael
Paper writing	February- April 2019	Rafael
Paper revision	May 2019	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

1.5. Project title: Towards a better understanding of secondary level sedimentary compartments in Victoria

Project Leader: Rafael Carvalho

Project Team: David Kennedy (UoM), Daniel Ierodiaconou

Description: Secondary level compartments are subdivisions of the coastline based on medium landforms and regional sediment processes. This project aims to improve coastal risk assessments at regional levels by integrating available and recently acquired terrestrial and marine data to better manage the coastal zone of southwestern and central Victoria. It builds on the existing knowledge of 6 secondary level compartments from Point Danger (west) to Point Lonsdale (east) available on CoastAdapt.

Methods: This is a desktop study of compartments: Cape Nelson (VIC 03.03.04), Portland (VIC 03.03.03), Warrnambool (VIC 03.03.02), P.Campbell-Otway (VIC 03.03.01), Great Ocean Road (VIC 03.02.02), Hobsons Bay (VIC 03.02.01). Possible datasets to be incorporated include: terrestrial and marine LiDAR, MBES, tow video, wave and wind data, geological maps, MARS database, historical aerial photos and satellite images. Article to be submitted to *Ocean & coastal management*.

Potential extension: Study area might be extended eastwards to encompass other secondary compartments depending on working load. Beach sediment sampling may be incorporated to this project depending on acquisition/analysis schedule.

Hurdles: None

What	When	Who
Literature review	Nov 2018	Rafael
Desktop analysis (LiDAR, MBES, waves and winds)	Nov 2018- Jan 2019	Rafael
Tow videos analyses	Nov 2018- Feb 2019	Rafael
Georeferencing of historical aerial photos	Feb 2019	Rafael
Data analysis & maps	Mar 2019	Rafael
Paper writing	Mar-Apr 2019	Rafael
Paper revision	May- Jun 2019	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

1.6. Project title: Coastal landscape modification as a function of equivocate management decisions: a study case from Lady Bay, southwestern Victoria

Project Leader: Rafael Carvalho

Project Team: David Kennedy (UoM), Alexandre Schimel (NIWA), Silvia Quiñones, Daniel Ierodiaconou (Deakin)

Description: Lady Bay, the main beach of Warrnambool located on the wave exposed southwestern Victoria, has been subject to rapid sediment accretion and progradation of over 300 m on its western side, following a succession of coastal management decisions which included the construction of the aqueduct and the breakwater in the early 1900s. This study will analyse historical and recent bathymetric data, marine LiDAR and aerial photograph in order to showcase the volumetric changes experienced in this embayment. This study builds on the works of Schimel et al (2015) and Silvia S. L. Quiñones.

Methods: Historical data includes bathymetrical studies collected in the 1800s, 1900s and historical society photos. Aerial photographs provided by DELWP will be used to derive shoreline positions and volumes in the past 7 decades. Several MBES collected in July 2013 onwards and Marine LiDAR. Shoreline evolution and volume analyses will be carried on DSAS and ArcGIS, respectively. Article to be submitted to *Continental Shelf Research.*

Schimel et al. (2015) 'Accounting for uncertainty in volumes of seabed change measured with repeat multibeam sonar surveys'. *Continental Shelf Research* 111: 52-68

Potential extension: No spatial extension. However, depending on the quality of historical and LiDAR datasets, a decision will be made whether the study site will encompass the whole embayment of focus on the western part only. Depending on how study develops, sedimentary data might be incorporated to highlight low hydrodynamics on the leeward side of breakwall.

Hurdles: A complete MBES survey of Lady Bay might be needed and this is subject to Yolla schedule.

What	When	Who
MBES fieldwork data collection	Oct 2018-July 2019	Yolla crew
Data analysis & maps	Aug-Oct 2019	Rafael
Paper writing	Nov-Dec 2019	Rafael
Paper revision	Jan-Feb 2020	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

1.7. Project title: Surficial beach sediment characteristics of western Victoria

Project Leader: Rafael Carvalho

Project Team: VCMP PhD student (UMelb), Nicolas Pucino, David Kennedy (UoM), Daniel Ierodiaconou

Description: Likewise shoreface sediments, surficial beach sediment characteristics are poorly understood along the Victorian beaches. Current knowledge of sediment characteristics is mainly derived from sparse sampling by Davis (1989) and other academic and consultancy studies. This project aims to conduct a thorough investigation on most important beach deposits along the western and central beaches of Victoria (from Point Danger to Point Lonsdale) that would provide insights into sediment characteristics, provenance, sources and sinks to coastal compartments, headland bypass, carbonate production, etc…

Methods: Sediment samples will be collected in the swash zone of most important and accessible beaches. A minimum of three samples per beach will be collected in order to account for alongshore variation in small beaches. Beaches longer than 2 km such as Port Fairy, Fairhaven, Torquay and Barwon will be sampled at 1 km interval, whereas longer embayments such Discovery Bay, Dutton Way-Yambuk will be sampled at larger intervals. Laboratory methods similar to marine sediment project. Article to be submitted to *Sedimentology.*

'Texture, Composition and Provenance of Beach Sands', Victoria, Australia. *Journal of Coastal Research* 5(1): 37-47.

Potential extension: There's a possibility to extend this project to the carbonate-poor beaches to east of Port Phillip Bay, depending on workload and/or priority sites within the VCMP.

Hurdles: None identified so far.

What	When	Who
Fieldwork data collection	Jan - May 2019	Rafael, Nicolas
Lab analysis	Feb – July 2019	Sed lab RA, Rafael, Nicolas, VCMP PhD student (UMelb)
Data analysis & maps	Aug – Sep 2019	Rafael, Nicolas, VCMP PhD student (UMelb)
Paper writing	Oct - Dec 2019	Rafael
Paper revision	Feb-Mar 2020	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

1.8. Project title: Port Fairy: sediment mobility in a wave-dominated environment

Project Leader: Rafael Carvalho

Project Team: Nicolas Pucino, Richard Zavalas, David Kennedy (UoM), Daniel Ierodiaconou

Description: This project will look at mobilisation of shoreface sediments by waves at an erosion hotspot site in Western Victoria. This will be achieved by characterising underwater sediments, modelling wave refraction and sediment entrainment by waves. The Port Fairy embayment has been subject to a lot of erosion and coastal management actions to prevent beach scarping and reduce sediment loss from the system in the past century. The site is an ideal field laboratory especially after the deployment of the wave-rider buoy at 30 m depth and the citizen science group activism.

Methods: MBES and backscatter will guide sediment sampling, mapping distribution of unconsolidated sediments and geomorphic features (ripple marks, heights and spacing). Current meters will be deployed at the seafloor to measure wave activity near the bottom. Wave data will calibrate wave model and provide annual statistics. Wave parameters along the bay will be derived from satellite (Dove) images. Article to be submitted to *Marine Geology*.

Potential extension: This study may be extended and linked to onshore erosion by incorporating historical aerial photos, past studies and UAV data.

Hurdles: Current meter deployment might have to be limited to shallow water (18 m) to comply with Deakin's diving policy. Deployment locations and duration subject to offshore energy conditions (further investigation needed).

What	When	Who
Sediment sampling	Oct 2018	Yolla crew, Rafael, Daniel
Current meter deployment	Mar- Jul 2019	Rafael, Richard
Satellite image and sed analysis	Mar- Jul 2019	Nicolas, Rafael
Modelling, data analysis & maps	Sep-Oct 2019	Rafael
Paper writing	Nov 2019- Feb 2020	Rafael, Nicolas, Richard
Paper revision	Mar-Apr 2020	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

1.9. Project title: Shoreline orientation during millennial-scale climate change in a large sediment compartment: The foredunes of 90-mile Beach, Gippsland, SE Australia.

Project Leader: David Kennedy

Project Team: David Kennedy (UoM), Tom Oliver, Toru Tamara, Bruce Thom, Colin Murray-Wallace, Colin Woodroffe, Teresa Konlechner, Daniel Ierodiaconou (Deakin)

Description: Foredunes are continuous ridges parallel to the beach. On the eastern Gippsland coast at 90-Mile Beach foredunes constitute the major landform systems which protect coastal settlements from Corner Inlet to Lakes Entrance. The morphology of the outermost barrier is however highly variable suggesting a different evolution and therefore a variable resilience to future climate change. This project focusses on unravelling the evolution of this section of coast during the Holocene (last 10,000 years) with particular an emphasis placed on the mid-Holocene highstand (6-4,000 years) ago when sea levels were up to 1.5 m higher than present.

This project is funded through the Australia Research Council.

Methods: LiDAR data (Future Coasts) is combined with subsurface sediment sampling and dating using luminescence techniques. Ground penetrating radar and hand augering is used to provide a chronology of landform evolution. This dataset is also combined with unpublished field data from Prof Bruce Thom collected and radiocarbon dated in the early1980's. The results are then compared with numerical modelling of wave and current conditions predicated to occur along this coast in the near future.

What	When	Who
Field sampling and data collection	Jan 2017 – June 2018	All
Lab processing	Jan 2017 – June 2018	Oliver, Tamara, Kennedy
Data analysis and maps	June – December 2018	Kennedy, Oliver
Paper writing	November 2018 - February 2019	All, Kennedy lead

Contact: A/Prof David Kennedy, davidmk@unimelb.edu.au Tel: (03) 8344 9168.

1.10. Project title: Foredune Dynamics in Port Phillip Bay

Project Leader: Zhenni Jiang

Project Team: David M. Kennedy, Teresa Konlechner (UoM)

Description: Foredunes are continuous ridges parallel to the beach. They are formed and stabilised by the aeolian transport of sand trapped by vegetation. Foredunes are protective barrier features guarding the coastal assets and infrastructures against the climate change induced sea level rise and erosional events such as storms. The embayment environment and the seasonally variable wind regime of Port Phillip Bay result in its periodic calm and stormy conditions. Thus, this project aims to investigate the foredune dynamics in Port Phillip Bay. To do so, it requires us to quantify and analyse the foredune building potential around the bay area based on environmental requirements for foredune formation, development, and recession. These requirements will be determined by examining the boundary conditions of existing foredunes, which incorporates control factors including wind, wave, sediment, vegetation, and human activities. Predictive maps of future foredune distribution will be created to show the spatial (where will have foredunes forming and where will not) and temporal (where should have foredunes but no foredunes present) differences in the foredune building potential around the bay.

Methods: LiDAR data (Future Coasts) and drone aerial images will be used to create a current foredune distribution map. By combining collected and analysed sediment sampling data and beach-dune profile survey data with available wind and wave data, a prediction model for foredunes can be developed and predicted foredune distributions can be mapped. Then, an analysis comparing the current distribution map and predicted distribution map can be conducted to quantify the spatial and volumetric differences. Under sea level rise scenarios, many parameters can be affected and thus will augment the effect of sea level rise. For this project, projected sea level rise will be retrieved from IPCC report and analyse the correlations with parameters such as wave run-up distance, significant wave height, increased storm surge height, increased high tides height, and increased frequency of erosional events.

Other potential application: The developed model can be applied to other estuary or embayment areas. The results of analyses are also expected to be referred to by other relevant projects in Victoria.

What	When	Who
Field sampling and data collection	July 2018-Feburary 2019	All
Lab processing	August 2018-Feburary 2019	Jiang
Data analysis and maps	December 2018-April 2019	Jiang
Thesis writing	March-October 2019	Jiang
Paper writing	October-December 2019	All

Contact: Zhenni Jiang, zhennij@student.unimelb.edu.au Tel: 0452 288 703

1.11. Project title: Mobility of coastal dunes: A global review

Project Leader: Jinjuan Gao

Project Team: Dave Kennedy, Teresa Konlechner,

Description: Coastal dunes are aeolian sand deposits found in above the high-water marks of sandy beach worldwide. There are two main types of dunes; (1) foredunes at the foremost seaward position impacted by waves and (2) transgressive dunes which occur further landward. These dunes contain a mosaic of habitats for endemic flora and fauna, many of which are rare and endangered species.

Coastal dunes range on a continuum from completely mobile to fully vegetated (stable). Their position on this continuum is determined by boundary conditions, specifically sediment supply, wind and vegetation. High sediment supply can maintain dune mobility through reducing the ability of vegetation to establish. A decrease in wind power, on the other hand, can encourage vegetation colonization.

There appears to be a global trend of increasing coastal vegetation cover and subsequent decrease in dune mobility. Changes in boundary conditions (e.g. climate) and human activities are hypothesised as drivers of this change. In Victoria invasive grasses appears to be a leading cause of declining mobility. Stabilization of coastal dunes is an important issue as it can lead to the loss of natural habitat. Unintended and undesired consequences of dune stabilization have made it urgent management issue in Europe with a number of measures being conducted to restore the active landscapes and recover their morphological and ecological functions.

Methods: This project will quantify the mobility of coastal dunes in a global scale by synthesising published literature around the world's coast. The aim is to identify the precise boundary conditions (such as changes in wind and rainfall, planting and forestation) that control dune stability in order to predict how these systems will behave in the future.

Literature review using online databases such as Web of Science, GoogleScholar. Data mining and statistical analysis (SPSS) to identify trends and drivers.

What	When	Who
Published data collection	Sep 2018 - Dec 2018	Gao
Data analysis	Nov 2018 - Dec 2018	Gao
Paper writing	Jan 2019 – Mar 2019	Gao, Kennedy, Konlechner
Thesis writing	Mar 2020 – Sep 2020	Gao

Contact: Jinjuan Gao

1.12. Project title: Mobility of active coastal dunes over the past century in Victoria

Project Leader: Jinjuan Gao

Project Team: Dave Kennedy, Teresa Konlechner (UoM)

Description: Coastal dunes show a bi-stability trend in that both mobile and stable dunes can co-exist under the same climate conditions. Bi-stability of dunes are determined by wind-vegetation relationship. A decrease in wind power allows vegetation to establish, resulting in dune stabilization. Once stabilized, a much higher wind power is needed to re-active the dunes given that established vegetation such as the grasses and shrubs could protect the dunes from surface erosion. Many coastal dunes show a stabilizing due to planting of exotic species such as marram to urbanisation and this pattern also appears to be occurring in Victoria. This project aims to: 1) quantify the spatial distribution of coastal dunes in Victoria; and 2) examine changes of active dune mobility during the last century and their driving factors; 3) compare the dune mobility trend with identified global patterns. This project aims to provide an quantification of the primary drivers of dune dynamics in Victoria, specifically the balance between climate and management in determining landscape mobility.

Regional settings in Victoria: Victoria coast features many well-developed coastal dunes. Large dunes include those in the Discovery Bay and Bridgewater Bay in the westernmost Victoria, two barrier dune systems near the Wilsons promontory and the Ninety miles beach, dunes along the Croajingolong coast between Point Richardo and Rame Head, and the easternmost Mallacoota-Cape Howe dune system which is the largest active dune system in Victoria which spills over into New South Wales. The climate in Victoria is complex. The subtropical ridge, which can strongly reduce rainfall in eastern Australia, has undergone a marked southward shift. Southern Annular Mode, which can result in enhanced rainfall and decreased temperature in southern Australia, shows a northern expansion. These changes suggest a major shift in the climate over Victoria which in turn will affect storm activity and dune stability. Vegetation management in Victoria coast changed greatly during the past 200 years. Pre-European vegetation in the coastal area was regularly burnt by aboriginal people. Deforestation occurred near the coast since settlement expanded in the late 18th and the early 19th centuries. About 66% native vegetation has been cleared since European colonization in Victoria. In 1970s, marram grass and some other secondary plantings (e.g. *Acacia sophorae*, *Olearia arillari* and *Helichrysum paralium*) were planted to stabilize coastal dunes.

Methods: 1) High resolution LiDAR data collected by the Future Coasts Program will be analysed in ArcGIS to identify current dune extent; 2) Historical aerial images from the 1930s/1940s to present will be mapped to identify decadal changes of bare sand and vegetation cover; 3) Meteorological (e.g., wind and rainfall) and coastal management data (e.g., grass planting) will for each site will be compared with the GIS results.

Hurdles: Lack of aerial images at early time, and low resolution or quality of early images will make it difficult for imagery interpretation.

What	When	Who
Data collection	Jan 2018 – Dec 2018	Gao
Data analysis	Jul 2018 – Mar 2019	Gao
Paper writing	Apr 2019 – Jun 2019	Gao, Kennedy, Konlechner
Thesis writing	Mar 2020 – Sep 2020	Gao

Contact: Jinjuan Gao

1.13. Project title: Patterns of vegetation colonisation of active coastal dunes

Project Leader: Jinjuan Gao

Project Team: Dave Kennedy, Teresa Konlechner

Description: Vegetation protects dune surfaces by covering the ground, trapping sand and reducing air flow momentum. Vegetation species and their growth form play an important role in the determining the dune morphology present on the coast. Primary results on dune mobility in Victoria show a tendency towards stabilizing with an increase of biomass since the 1930s. Vegetation colonization and expansion play an essential role in dune stabilization process, but the way how vegetation colonized the dunes is not yet clear.

This project aims to identify how vegetation stabilizes active coastal dunes. The dominant vegetation types and species will be examined on stabilizing dunes. The position(s) of vegetation colonization and direction(s) of vegetation expansion will be studied to learn the vegetation patterns in stabilizing coastal dunes. Floristic and climatic factors driving the vegetation pattern will also be analysed. This allows a good understanding in the patterns of vegetation colonization and the processes of dune stabilizing. This can provide vital information for coastal dune management in the light of dune stabilization and remobilization.

Methods: Two specific dune sites will be selected based on the dune mobility patterns study in the whole Victoria coast. Aerial images and high-resolution LiDAR data will be used for mapping the spatial distribution and change of vegetation based on the ArcGIS platform. Vegetation surveys will be conducted to learn the dominant species in each selected dune site. Cluster analysis will be used to classify vegetation patches to build the patterns of vegetation colonization on stabilizing dunes.

Hurdles: poor quality and low resolution of early aerial images limit the ability to study vegetation species.

What	When	Who
Fieldwork data collection	Mar 2019 – May 2019	Gao
Data analysis	May 2019 – Jul 2019	Gao
Paper writing	Jul 2019 – Aug 2019	Gao, Kennedy, Konlechner
Thesis writing	Aug 2019 – Sep 2019	Gao

Contact: Jinjuan Gao

1.14. Project title: Sediment budgets of active coastal dunes

Project Leader: Jinjuan Gao

Project Team: Dave Kennedy, Teresa Konlechner (UoM)

Description: Littoral transport is an essential sediment supply for coastal dune development. Various of sediment budget can result in different topographical and morphological features of coastal dunes. High sediment supply can bury vegetation and is favourable to maintain dune mobility. When sediment input is low, erosion and blowouts development occur on foredunes, and sand can transport inland through these inlets, leading to the formation of transient mobile dune forms in the landward. However, dunes will be finally stabilized because lower sediment deposition may encourage vegetation colonization and growth.

Mobility of coastal dunes and patterns of vegetation colonization are two-dimensional analysis in the coastal dune system. This project aims to show the three-dimensional structure of coastal dune in Victoria based on a specific dune site in order to quantify the entire sediment budget of a coastal compartment. Sediment volume and volumetric changes will be calculated based on LiDAR data and GPR survey. Factors influencing sediment changes will be identified, such as coastal management. The relationship between sediment changes and dune stabilisation will be analysed.

Methods: One specific site will be selected to study its sediment budget changes based on the vegetation pattern analysis. The surface elevation can be measured from airborne LiDAR data. DEMs will be built derived from LiDAR data. Auger and GPR will be used to calculate sediment budget. Specifically, GPR survey will be conducted to get the internal architecture of coastal dune, and topographic correction will be conducted with an RTK GPS. Hand drilling by Auger will be used to identify buried soil profiles, which recent studies have indicated represent the pre-1800 surface.

What	When	Who
Fieldwork data collection	Oct 2019 – Dec 2019	Gao
Data analysis	Jan 2020 – Mar 2020	Gao
Paper writing	Apr 2018 – May 2019	Gao, Kennedy, Konlechner
Thesis writing	Jun 2020 – Sep 2020	Gao

Contact: Jinjuan Gao

1.15. Project title: Species-specific aeolian sand deposition above high tide elevations.

Project Leader: Marita McGuirk

Project Team: Dave Kennedy, Teresa Konlechner

Description: Foredunes are primary dunes which form parallel to shore at the rear of sandy beaches. They form a protective barrier between the sea and land, while providing habitat for indigenous species of flora and fauna, many of which are threatened or endangered. Foredunes are the result of aeolian sand transport from the beach which is trapped in flora growing close to the littoral zone. The dependence of foredunes on sediment supply, vegetation, wind and waves means that they are highly susceptible to climate change.

For plants to survive in harsh coastal environments many evolutionary adaptions have been made including the thicker leaf cuticle of *Cakile* species, that reduces water loss from the stomata and the nitrogen fixing ability of Acacia species, which enables it to increase the nitrogen content of the nitrogen deficient coastal soils. The result is the many different species which inhabit coastal dunes have unique life histories, root systems structure and leaf density. Whilst it is known that aspects of plant structure can influence foredune shape, currently there is a deficient in quantitative knowledge of the species-specific role of vegetation in the depositional processes. This knowledge is important by coastal managers in order to plan for conserving the coast in future climate change scenarios where more active manage (eg dune planting) becomes more critical in coastal protection.

Aim: This project will be quantifying aeolian sediment deposition amongst the common Victorian coastal plant species *Spinifex sericeus*, *Thinopyrum junceiforme* and *Cakile edentula*.

Methods: Experiments will be conducted at Summerlands Bay, Phillip Island. The first step is to install posts for the anemometer to be attached to at the experimental site B , which is on the incipient dune located halfway around the bay. Weather forecasts will be monitored, with the plan to go to Summerlands, when there are wind speeds greater than 30km/hr forecast, with the purpose of conducting experiments on the transport of sand in and around different species of plants over a 24hr period. Trisonica mini anemometers, will be used to measure wind speed and Wenglors laser particle counters will be used to measure sand transport and sand traps to quantify sand transport. These experiments will be conducted twice over the next the year, to capture the influence of changes in plants structure on sand trapping. The first experiment will take place at an appropriate wind event between December 2018 and March 2019 and the second experiment will occur between July and September 2019.

What	When	Who
Fieldwork data collection	December 2018 – July 2019	McGuirk, Konlechner
Data analysis	July 2019 - December 2019	McGuirk
Thesis writing	July 2019 - July-2020	McGuirk
Paper writing	July 2019 – December 2019	McGuirk, Konlechner, Kennedy

Contact: Marita McGuirk

1.16. Project title: Monthly-Annual scale dune accretion and its relation to vegetation species

Project Leader: Marita McGuirk

Project Team: Dave Kennedy, Teresa Konlechner

Description: Foredunes form a protective barrier between the sea and inland areas. They are created by the aeolian movement of sand above the high tide line. Depending upon the wind velocity and sand supply, sand will be transported until the wind flow is interrupted by an obstacle on the backshore. It has been established that vegetation is the main factor in providing a substrate for the sand to create form around. Vegetation also plays a role in reducing erosion by wave inundation during storm events. There is currently a deficient in quantitative knowledge of the role which species of coastal plants such as *Spinifex sericeus*, *Thinopyrum junceiforme Ammophila arenaria* and *Cakile edentula* play in the recovery of foredunes after erosion and their role in the formation of incipient dunes. This project will determine the influence of *Spinifex sericeus*, *Thinopyrum junceiforme*, *Ammophilia arenaria* and *Cakile edentula* on sediment accretion after storm events from September 2018 to November 2019 at Summerlands Bay on Phillip Island.

Methods: The study site will be Summerlands Bay on Phillip Island. Research has already begun at Summerlands Bay, from September 2017 to March this year and this data set will be built upon. Conduct Pre/ Post event surveys (RTK, UAV drone, Lidar), every two months at Summerlands Bay on Phillip Island. Quantify the volumetric change in vegetation and sediment using RTK, Lidar and UAV drone, and field surveys using 24 semipermanent monitoring sites amongst the target species. These sites will be established on 14/10/2018 and will be orientated parallel to the shoreline from the backshore and up onto the foredune with measurements taken each month for 15 months. One-time lapse camera has been installed and another will be installed on the 14/11/2018 to photograph the movement of sand and waves and capture overwash and erosion events. The first camera is situated on a pole at the east end of the penguin viewing stand facing east along the beach. The second camera will be installed in the foredune approximately 1km along the beach facing west.

Hurdles: Weather events may bury or wash away the sand erosion/deposition measuring tables and the experiment may need to be started again.

What	When	Who
Fieldwork data collection	December 2018 – November 2019	McGuirk
Data analysis	July 2019 - July 2020	McGuirk
Thesis writing	July 2019 – October -2020	McGuirk
Paper writing	July 2019 – July 2020	McGuirk, Konlechner, Kennedy

Contact: Marita McGuirk

1.17. Project title: Foredune development at Inverloch Victoria

Project Leader: Marita McGuirk

Project Team: Dave Kennedy, Teresa Konlechner, Daniel Ierodiaconou

Description: Studies of foredune dynamics occur on systems that are already established and have often existed for millennia. There is little understanding on the evolution of these systems from the first accumulation of debris to a mature dune form. This project will quantify a complete foredune development cycle at Inverloch. A bare spit formed after 2010, in the former channel entrance to Anderson Inlet, on which a foredune of meter-scale relief as now developed. This project will document dune develop from time-zero and will reveal the role of specific plant species in foredune development.

Methods: Vegetation surveys and foredune mapping form the core of this project. The 2010 Future Coasts LiDAR provides a baseline dataset which will be combined with terrestrial UAV LiDAR collected in 2016 by Kennedy, supplemented by field quadrat-based vegetation surveys collected in November 2016 by Konlechner. Citizen-science surveys as part of the Victorian Coastal Monitoring Program, will continue to monitor the sites using UAV-based photogrammetry supplemented by surveys by McGuirk. Aerial and vegetation surveys will be conducted every 2 months.

What	When	Who
Fieldwork data collection	December 2018 – July 2020	McGuirk, Sorrell, Allan, Kennedy, VCMP
Data analysis	December 2018 - July 2020	McGuirk
Thesis writing	July 2019 – October -2020	McGuirk
Paper writing	July 2019 – October 2020	McGuirk, Kennedy, Konlechner

Contact: Marita McGuirk

1.18. Project title: Determining coastal plant structural parameters

Project Leader: Marita McGuirk

Project Team: Dave Kennedy, Teresa Konlechner

Description: The role of vegetation in numerical modelling of dune growth parametrises plants through their drag coefficient (Cd). This represents the reduction of the total force of the wind by drag on the above ground plant form, often referred to as shearing stress. A number of modelling studies have used the work of Rapauch(1993) as a source of Cd . A problem with the use of the Rapauch (1993,) drag coefficient for plants is that this Cd was derived through laboratory experiments using rigid cylinder shapes which does not take into account the innate movement of plants in the wind. These plant attributes cause a decrease in the wind energy through movements such as bending and swaying. In addition, the values of Cd have been derived from either desert species or agricultural crops with no data for coastal vegetation. Vegetation on the incipient dune and foredune often grows from the extension of rhizomes and runners, which are often seen growing seaward, while in the desert these rhizomes and runners will only survive if they form clumps of growth. This project will determine the drag coefficient for coastal plant species *Spinifex sericeus*, *Thinopyrum junceiforme* and *Cakile edentula*.

Methods: Literature search on previous mathematical formulae used in the determining of plant drag coefficient. Measure plant height using a ruler with mm increments. Measure stem diameter using callipers. Measure leaf area using a Licor LI3000 leaf area meter. Conduct wind tunnel experiments using the wind tunnel in University of Melbourne Engineering Department, to determine the drag force of different plant structural forms. Plastic plant forms similar to the form of the actual plants will be used in the wind tunnel.

What	When	Who
Fieldwork data collection	December 2018 – July 2019	McGuirk,
Data analysis	July 2019 - December 2019	McGuirk
Thesis writing	July 2019 – October -2020	McGuirk
Paper writing	July 2019 – December 2019	McGuirk, Konlechner, Kennedy

Contact: Marita McGuirk

1.19. Project title: Shoreline recovery following storm erosion – implications for little penguins under future climates

Project Leader: Teresa Konlechner

Project Team: Teresa Konlechner, Andre Chiaradia (PINP), Ruth Reef (Monash), David Kennedy

Description: This project evaluates the resilience of penguin habitat at Summerland Beach in relation to coastal erosion. Full recovery following erosion can take years to decades, however partial recovery can be sufficient to maintain penguin access and has the potential to occur rapidly (within months) as wind-blown sand accumulates at the base of the dune scarp. Rapid sand accumulation depends on a range of factors including the wind and wave climate, vegetation cover, and subsequent erosion events; however, there have been surprisingly few studies that evaluate the processes of beach and dune recovery immediately following erosion6. This project will examine the patterns and processes of dune erosion and recovery at Summerland Beach.

Specifically, the research aims to:

1. Determine the magnitude and return frequency of coastal erosion and dune recovery at Summerland Beach over recent decades.
2. Quantify patterns and rates of dune recovery following recent erosion with respect to thresholds in dune shape inhibiting penguin access.
3. Assess how the specific boundary conditions controlling coastal erosion and dune recovery at Summerland Beach will change under future climates.

This project is funded through the Earth System and Climate Change Hub of the Australian Government National Environmental Science program.

Methods: Beach and dune recovery is documented following a known erosion event in 2016 using UAV/drones. Monthly surveys are conducted for a six-month summer period. Changes in vegetation cover and dune shape are quantified. Wind and wave conditions during this period are compared to long term data to quantify the 'window of opportunity' for dune recovery at Summerlands Beach.

What	When	Who
Field data collection	Oct 2017 – Apr 2018	Konlechner, Reef, PINP
Data analysis	Apr – Dec 2018	Konlechner
Paper writing	Jan - Nov 2019	All, Konlechner lead

Contact: Dr Teresa Konlechner, t.konlechner@unimelb.edu.au Tel. 038344 9758

2. Theme: Marine (subtidal) sediment dynamics

2.1. Project title: Victorian marine sediment distribution and characteristics

Project Leader: Rafael Carvalho

Project Team: VCMP PhD student (UoM), David Kennedy (Umelb), Daniel Ierodiaconou

Description: Surficial sediment distribution in Victorian waters (3 NM) are poorly understood and scattered. This study will target unconsolidated deposits guided by backscatter information within the state's waters to build a picture of sediment distribution, texture and mineralogy, which would eventually indicate provenance and inform decision making in coastal management. The project aims to collect and analyse hundreds/thousands of sediment samples in priority sediment compartments

Methods: Intensity returns in backscatter data will guide sediment sampling in areas of different sediment characteristics. Sediment analyses will include grain size (dry sieving and laser), roundness (optical microscopy), mineralogy (XRD), organic matter (LOI), CaCO3 (LOI). Classification, interpolation or machine learning modelling will be used to derive maps of surficial sediments. Article to be submitted to *Marine Geology*.

Potential extension: No spatial extension. Scanning Electron Microscopy (SEM-EDS) analysis might be incorporated on selected samples to distinguish composition, weathering and diagenesis.

Hurdles: Offshore campaigns subject to weather conditions which might delay preliminary backscatter acquisition and sediment sampling. Sampling device still to be purchased/borrowed.

What	When	Who
MBES (Backscatter) and sed fieldwork data collection	Nov 2018 – April 2020	Yolla crew, Rafael
Backscatter and sed analysis	Ongoing- Aug 2020	Jordy, Sed Lab RA and Rafael
Paper writing	Sep-Oct 2020	Rafael
Paper revision	Nov-Dec 2020	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

2.2. Project title: Quantifying the volume of nearshore sediment along Victorian coast using shallow-water seismic and multibeam bathymetry

Project Leader: Rafael Carvalho

Project Team: Geoscience Australia (GA), David Kennedy (UoM), Daniel Ierodiaconou

Description: Offshore unconsolidated deposits can be mapped with MBES. However, volumetric estimations can only be computed with the aid of shallow water seismic techniques and ground-truthing with vibracoring. This project aims to deploy a sub-bottom profiler to calculate sedimentary thickness within Victorian waters (3 NM) that would provide insights into volumetric availability and characteristics of sands to naturally maintain beaches.

Methods: Transect lines with be conducted at unconsolidated deposits identified by MBES and backscatter. Ground truthing with vibracoring will assist interpretation and provide material for sediment analysis. Processing of seismic lines will be benefited from GA expertise in the field. Article to be submitted to *Geophysical Research Letters*.

Potential extension: None. However, depending on expertise advice on trials, vibracoring might not be needed. Insights into palaeo-environments and shoreface transgression might be gained with vibracoring analysis.

Hurdles: Several. Seismic surveys are subject to equipment availability and suitability (resolution x penetration). Squid, Sparkers and other sub-bottom profiler types need to be tested under Victoria geological conditions (Eg. Aelionite substrate). Both testing and deployment rely on Yolla schedule or charter vessel availability. Offshore vibracoring vessel and team still to be sourced.

What	When	Who
Seismic data testing	Jan – May 2019	GA, Yolla crew, Daniel, Rafael
Seismic data collection	Jan- Dec 2019	Yolla crew, Rafael
Vibracoring	Jun- Dec 2019	Vibracoring crew, Rafael
Seismic analysis	Jan-Mar 2020	Rafael
Core analysis	Apr- Jul 2020	Rafael
Paper writing	Oct 2020- Jan 2021	Rafael
Paper revision	Feb 2021	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

2.3. Project title: Modelling carbonate production by temperate reefs in Victoria: relict x modern material

Project Leader: Rafael Carvalho

Project Team: Richard Zavalas, Mary Yong, David Kennedy (UoM), Daniel Ierodiaconou

Description: Carbonate material is a very important component of unconsolidated sediments along the Victorian coast. Previous studies indicate that some Victorian beaches are made of up to 96 % of CaCO3 material (calcite and aragonite). In this project, we will map and model carbonate productivity in southwestern Victoria using onshore and offshore sediments, existing habitat classification datasets and new MBES.

Methods: Areal calculation/estimation of modern sediment producers based on habitat classification. Mineralogy (XRD), carbonate content (LOI) and optical microscopy analyses will be used as proxies for modelling calibration, validation and differentiation between relict and modern material. Article to be submitted to *Sedimentary Geology*.

Potential extension: Study area might be extended eastwards to encompass other priority areas or even the whole state, depending on work load. Possibility to expand study to model carbonate dissolution due to ocean acidification.

Hurdles: Very few studies done on this topic.

What	When	Who
MBES (Backscatter) and sed fieldwork data collection	Nov 2018 – Mar 2020	Yolla crew, Rafael
Backscatter and sed analysis	Ongoing- June 2020	Jordy, Sed Lab RA and Rafael
Mapping and modelling	Jul – Sep 2020	Richard, Mary and Rafael
Paper writing	Oct- Feb 2020	Richard, Mary and Rafael
Paper revision	Mar 2021	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

3. Theme: Coastal compartment modelling & visualisation

3.1. Project title: The Warrnambool coastal budget: a decadal-scale balance of sediment volumes within the compartment

Project Leader: Rafael Carvalho

Project Team: Nicolas Pucino, Blake Allan, Teresa Konlechner (UoM), Chloe Morris (UoM), John Sherwood, David Kennedy (UoM), Daniel Ierodiaconou

Description: A sediment budget is a balance of volumes of sediments entering and leaving a section of coast and the resulting accretion/erosion in the area under consideration. Most of the sand in the coastal section under consideration (VIC 03.03.02) was probably derived from offshore sources reworked landwards during post-glacial marine transgression and wave erosion of Holocene aeolionites and Miocene limestones that constitute the present shoreline. Here, we aim to: define the tertiary-level compartments between Port Fairy and Peterborough; identify sedimentary types, volumes, sources, sinks and transport pathways; and provide predictions of coastal behaviour and insights into future management.

Methods: Comprehensive onshore and offshore sediment sampling. Shallow-water seismic, MBES revisit of targeted areas, hydro/wave modelling (current meters deployment and wave buoy data off P. Fairy), historical aerial photos, sediment mobility by waves (tow videos), shoreline change, UAV revisits. Article to be submitted to *Marine Geology*

Potential extension: This project will link nicely with the spectral signature project lead by Pucino (Chapter 1 PhD thesis) for the same area, shoreline change by Teresa, and modelling by Chloe.

Hurdles: A short–term (sub-decadal) balance can probably be constructed for this compartment. A decadal-scale one might not be feasible as it depends on modelling capabilities and integration of marine LiDAR and MBES revisits. Slight modifications of this project are likely based on involvement/commitment of proposed project team.

What	When	Who
Sediment sampling	Nov 2018 – Nov 2019	Yolla crew, Rafael, Nicolas
Seismic acquisition	Jun – Dec 2019	Yolla crew, Rafael
UAV acquisition	Nov 2018- Nov 2020	Nicolas, Blake, Rafael
Current meter deployment	Nov 2018 – Nov 2019	Rafael, Richard
Hydrodynamic/Wave model	Oct 2018 – Dec 2019	Chloe/ Rafael
Data analysis & maps	Jan 2019 – Dec 2020	Rafael, Nicolas, Chloe, Teresa
Paper writing	Apr 2021 – Jul 2021	Rafael/Chloe/Teresa
Paper revision	Aug 2021	All

Contact: Dr Rafael Carvalho, r.cabralcarvalho@deakin.edu.au (03) 556 33052

3.2. Project title: Predicting the morphological evolution of Ninety Mile Beach, Gippsland, under changing driving conditions: an application of CEM2D

Project Leader: Chloe Morris

Project Team: Chloe Morris (UoM), David Kennedy (UoM), Daniel Ierodiaconou (Deakin)

Description: The direction and magnitude of sediment transport along the ninety-mile beach is largely disputed and there is limited quantitative data to support or test current theories. Understanding sediment transport regimes in this area is important for determining how the system evolves and predicting its future dynamics under changing environmental conditions, including increased storminess, wave climates and sea level rise. This stretch of coastline is particularly vulnerable to these processes, with an estimated 78% of the beach comprised on soft, erodible material which is backed by dune systems. This study will be conducted using the two-dimensional Coastline Evolution Model 2D (CEM2D) to simulate the morphodynamic evolution of ninety-mile beach over centennial scales.

Methods: CEM2D will be used to numerically model the evolution of ninety-mile beach. The model will be set-up and calibrated using data collected as part of the VCMP, namely LiDAR for the creation of a digital elevation model (DEM) and offshore wave conditions (angle, height, period). Predictions of future changes to the wave climate, storm intensity and sea level will be used to predict how the systems might evolve in the future.

What	When	Who
Model set-up, calibration and testing (SA)	Jan 2019 – June 2019	Morris
Run model(s)	June 2019 – Dec 2019	Morris
Data analysis	Dec 2019 – June 2020	Morris
Paper writing	May 2020 - Dec 2020	All, Morris lead

Contact: Chloe Morris, chloe.morris@unimelb.edu.au (03) 8344 0622

3.3. Project title: Modelling the complex sediment dynamics and transport pathways in coastal bays and crenulate shorelines

Project Leader: Chloe Morris

Project Team: Chloe Morris (UoM), David Kennedy (UoM), Daniel Ierodiaconou (Deakin)

Description: Coastal bays and crenulate shaped shorelines present complex geometric challenges for numerical modellers, who aim to simulate the evolutionary behaviour of these systems. Success has been documented using one-line modelling techniques which rely on wave shadowing and diffraction to form log spiral shorelines, under a single wave direction. Other modelling efforts include the use of Delft3D to simulate the evolution of a relatively small coastal stretch over a short time period, but with a high computational expense. The COVE model was developed to simulate high curvature coastlines over mesoscales, balancing complexity with the computational expense.

Examples of bays and crenulate shorelines are found along the Victorian Coastline within the sites of interest for the VCMP. These include Port Fairy, Warrnambool and Apollo Bay. In this study, the COVE model will be applied to such sites to investigate key driving processes in their evolution and predict how they may evolve in the future.

Methods: The COVE model will be set-up and calibrated using data collected as part of the VCMP. This will include LiDAR for the creation of a digital elevation model (DEM) and offshore wave conditions (angle, height, period). Predictions of future changes to the wave climate, storm intensity and sea level will be used to predict how the systems might evolve in the future.

What	When	Who
Model set-up, calibration and testing (SA)	Jan 2019 – June 2019	Morris
Run model(s)	June 2019 – Dec 2019	Morris
Data analysis	Dec 2019 – June 2020	Morris
Paper writing	May 2020 - Dec 2020	All, Morris lead

Contact: Chloe Morris, chloe.morris@unimelb.edu.au (03) 8344 0622

3.4. Project title: A numerical exploration of erosion patterns along Inverloch's Coastline, SE Australia

Project Leader: Chloe Morris

Project Team: Chloe Morris (UoM), David Kennedy (UoM), Daniel Ierodiaconou (Deakin)

Description: Inverloch's coastline, SE Australia, has experienced significant rates of erosion during the past decade and is under threat from increasing rates due to changes in environmental conditions, including sea level rise. In order to manage or build resilience against the threat of continues foreshore recession, more needs to be understood about the nature of coastal erosion in this area and sediment transport patterns.

Coupling of the coast and estuary (Anderson Inlet) at this site may prove important for a more holistic evaluation of the dynamics of this system and highlight whether the inclusion of estuaries in coastal modelling and management is necessary for some locations. This is particularly with regards to the sediment budget and processes of erosion along the foreshore and deposition at the mouth of the Anderson Inlet.

This study will seek to numerically model the dynamics of the open coast along Inverloch's shoreline, with consideration for the interconnect with Anderson Inlet. The modelling work will be carried out using the Delft3D modelling suite which will prove a detailed exploration of the processes at work in this area.

Methods: The Delft3D suite will be the primary numerical model used along Inverloch's coastline, set-up and calibrated using data collected as part of the VCMP. The primary datasets will include LiDAR, wave conditions, wave obstacles, tidal regimes, wind and sediment characteristics.

What	When	Who
Model set-up, calibration and testing (SA)	Jan 2019 – June 2019	Morris
Run model(s)	June 2019 – Dec 2019	Morris
Data analysis	Dec 2019 – June 2020	Morris
Paper writing	May 2020 - Dec 2020	All, Morris lead

Contact: Chloe Morris, chloe.morris@unimelb.edu.au (03) 8344 0622

3.5. Project title: Variations in the spatiotemporal response of the Victorian Coast to changing environmental conditions

Project Leader: Chloe Morris

Project Team: Chloe Morris (UoM), David Kennedy (UoM), Daniel Ierodiaconou (Deakin)

Description: An understanding of the physical processes and evolutionary behaviour of the entire Victorian Coast is of interest to policymakers, residents and businesses who are vulnerable to changes in its morphodynamics. Modelling the entire coastline is a significant challenge given the spatial scale and a vast number of processes that have varying influences on different parts of the system. Key sites of interest are approached in the numerical modelling efforts as part of the VCMP and this study will aim to interpolate these to provide a more holistic understanding of the behaviour of the Victorian coastline.

Insights from each modelling investigation conducted as part of the VCMP will be combined to give a wider spatial evaluation of the linkages, similarities and differences between the morphodynamics and key driving processes of sites along the Victorian coastline over a range of time periods. A key consideration for this overview of the primary modelling exercises of the VCMP will be that different models will generate different types of results, in terms of spatiotemporal resolution and complexity.

The key question for this study is how the results, given their uncertainties and site-specific applications, can improve our understanding of the processes acting along the entire Victorian Coastline. The study will highlight whether similarities can be drawn from its response to changes in environmental conditions including sea level, wave climates and storminess. The results will also serve to highlight whether further numerical modelling studies should be focused.

Methods: The quantitative results from each of the numerical modelling studies from the VCMP will be combined to highlight trends in the morphological behaviour of key sites of interest. This will include investigating sediment transport rates and pathways and processes of erosion and deposition.

What	When	Who
Data collection: VCMP model runs and analysis for site-specific investigations	Jan 2019 – June 2020	Morris
Data analysis	May 2020 - Dec 2020	Morris
Paper writing	May 2020 - Dec 2020	All, Morris lead

Contact: Chloe Morris, chloe.morris@unimelb.edu.au (03) 8344 0622

3.6. Project title: Improve understanding of historical coastal erosion over decadal time scales

Project Leader: Teresa Konlechner

Project Team: Teresa Konlechner, David Kennedy

Description: Rising sea levels are likely to cause accelerated erosion of many Australian coastlines. Although Australia has strong science capability to assess the risks associated with sea-level rise, waves, and storm surge, there remains significant uncertainty around the amount and rate of coastal erosion under climate change, particularly where changes from depositional to erosional shorelines are likely to occur, and at scales relevant to management (i.e., smaller than coastal compartment scales). What is needed is: (i) a greater understanding of historical coastal erosion over decadal time scales and the influence of coastal vegetation and human infrastructure on this process, and (ii) improved linkages between models of coastal erosion and hazards under climate change, to improve predictions of future change and to guide on-ground climate adaptation actions.

This project is funded through the Earth System and Climate Change Hub of the Australian Government National Environmental Science program.

Methods: 1) Quantify decadal beach change (2005-2015). The first analysis will use the 2007 LiDAR survey dataset for the Victorian coast as the benchmark for change. Surveys will be repeated using RTK GPS system and UAV/Drone surveys to quantify the degree of shoreline movement over the past decade.

2) Quantify centennial beach change (1940-2015). The rate of change identified in 2.1.1 will be extended to the mid 20th century using aerial photography and published literature to determine the precise nature of coastal change since instrumented records have recorded acceleration in the rate of sea level rise.

3) Identify causes of coastal change & future coastal sensitivity to climate change. The magnitude of change identified in 1 and 2 will be analysed with respect to instrumented records of climate and sea level change and the widespread exotic revegetation programs from the early to mid 20th Century that have significantly modified the natural dynamics of Australia's sandy coasts.

What	When	Who
Field data collection	Jan 2017 – Dec 2018	Konlechner, VCMP RAs
Aerial photograph collation and rectifying	Jan – June 2019	Konlechner
Data analysis and maps	Jan – June 2019	Konlechner
Paper writing	Jan - Nov 2019	All, Konlechner lead

Contact: Dr Teresa Konlechner, t.konlechner@unimelb.edu.au Tel. 038344 9758

4. Theme: Coastal UAV & Citizen Science

4.1. Project title: Citizen Science Drones

Project Leader: Daniel Ierodiaconou

Project Team: Blake Allan, Nicolas Pucino, David Kennedy (UoM), Rafael Carvalho, Karina Sorrell

Description: The development and refinement of new technology to address increasingly complex research questions and global challenges for monitoring marine coastal environments (e.g. climate change and biodiversity loss) is increasing rapidly.

Recent advances in low-cost unmanned aerial vehicle (UAV) technology and highly spatially accurate positioning systems now allow for the collection of centimetre resolution aerial imagery and topography suitable for assessing change in coastal ecosystems (Ierodiaconou et al. 2016). The Victorian Coastal Monitoring Program (VCMP) aims to provide communities with information on coastal condition, change, hazards, and the expected longer-term impacts associated with climate change that will support decision making and adaptation planning. Central to the success of the VCMP is the community groups (citizen science) working in conjunction with institutions to co-invest in coastal monitoring projects at both regional and local scales.

We present a citizen science coastal monitoring program, integrating low cost UAVs and smart target technology, for high resolution, spatially accurate coastal monitoring. The data collected can be used to assess changes in volume, topography and extent of beach sands and foreshore morphology using structure from motion processing.

Ierodiaconou D, Schimel A, Kennedy D. (2016) 'A new perspective of storm bite on sandy beaches using Unmanned Aerial Vehicles'. *Annals in Geomorphology* 60 (3) 123-137.

Methods: UAV data (citizen science). SFM processing, Cloud processing and scaling. Perhaps a unique pitch for citizen science capable of collection scientifically robust data. With the right angle perhaps *Nature Communications*.

Potential extension: National, Global.

Hurdles: Need to decide when a suitable data volume/ timeseries exists for publication.

What	When	Who
UAV fieldwork data collection	Ongoing	CS Groups, UAV Science team
Trend analysis	Sep 2019	Team
Paper writing	February- Dec 2019	Daniel + team contributions
Paper revision	Dec 2019	All

Contact: Ass. Prof Daniel Ierodiaconou, iero@deakin.edu.au (03)55633322