VCMP Sites

Shorelines (UAV, satellite, aerial imagery), time series, cross-sections, morphology, and coastal structure locations for VCMP survey sites.

Oct 2023

VICTORIA State Government | Energy, Environment and Climate Action

Acknowledgements

The authors express their gratitude to Digital Earth Australia (DEA) and the dedicated team at the Victorian Coastal Monitoring Program (VCMP) for generously providing the data.

Author

Jin Liu, jin.liu@delwp.vic.gov.au

Jak McCarroll, jak.mccarroll@delwp.vic.gov.au

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

ISBN 978-1-76136-501-0 (pdf/online/MS word)

Disclaimer

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Accessibility

If you would like to receive this publication in an alternative format, please telephone the DEECA Customer Service Centre on 136186, email customer.service@delwp.vic.gov.au or via the National Relay Service on 133 677 www.relayservice.com.au. This document is also available on the internet at www.delwp.vic.gov.au.

Contents

Executive Summary

This report offers a concise overview of post-processed shoreline datasets, which include satellite data sourced from Digital Earth Australia (DEA) Coastlines, selected aerial imagery from the Victorian Coordinated Imagery Program (CIP), and periodic unmanned aerial vehicle (UAV or “drone”) surveys conducted by the Victorian Coastal Monitoring Program (VCMP) team. Additionally, the dataset encompasses morphology data obtained from the national "SmartLine" dataset, information on coastal structures from the Coastal Asset Management System (CAMS) database, and state-wide merged topo-bathymetry data from Victorian Digital Elevation Model (VCDEM) 2022.

The term "VCMP Sites" collectively refers to the data product that includes the following datasets:

- Shoreline positions (units: m): Comprising UAV data (VCMP, 2018-2023, 667 surveys), satellite data (DEA, 1988-2021), and aerial imagery (115 surveys).
- Transects (units: m): These are spaced at 30 meters based on satellite data.
- Shoreline trends (units: m/year): Trends and standard deviation based on different datasets.
- Time series (units: m): Time series at Coastal OmniLine.
- Cross-sections (profiles, units: m): Shoreline profiles at Coastal OmniLine.
- Morphology / Substrate type.
- Coastal structures.

Site locations:

- 18 bay sites (16 Port Phillip Bay sites + 2 Western Port Bay sites).
- 22 open coast sites (Gippsland + southwestern Victoria).

Data format:

- Text (CSV).

These datasets are accessible through the following platforms:

- VicCoastData portal (https://viccoastdata.quatrix.it). For access, please contact vcmp@delwp.vic.gov.au.
- CoastKit (https://mapshare.vic.gov.au/coastkit/). Data is available for viewing.
- DataShare portal (https://datashare.maps.vic.gov.au/). Search for "VCMP Sites".

1 Victorian Coast

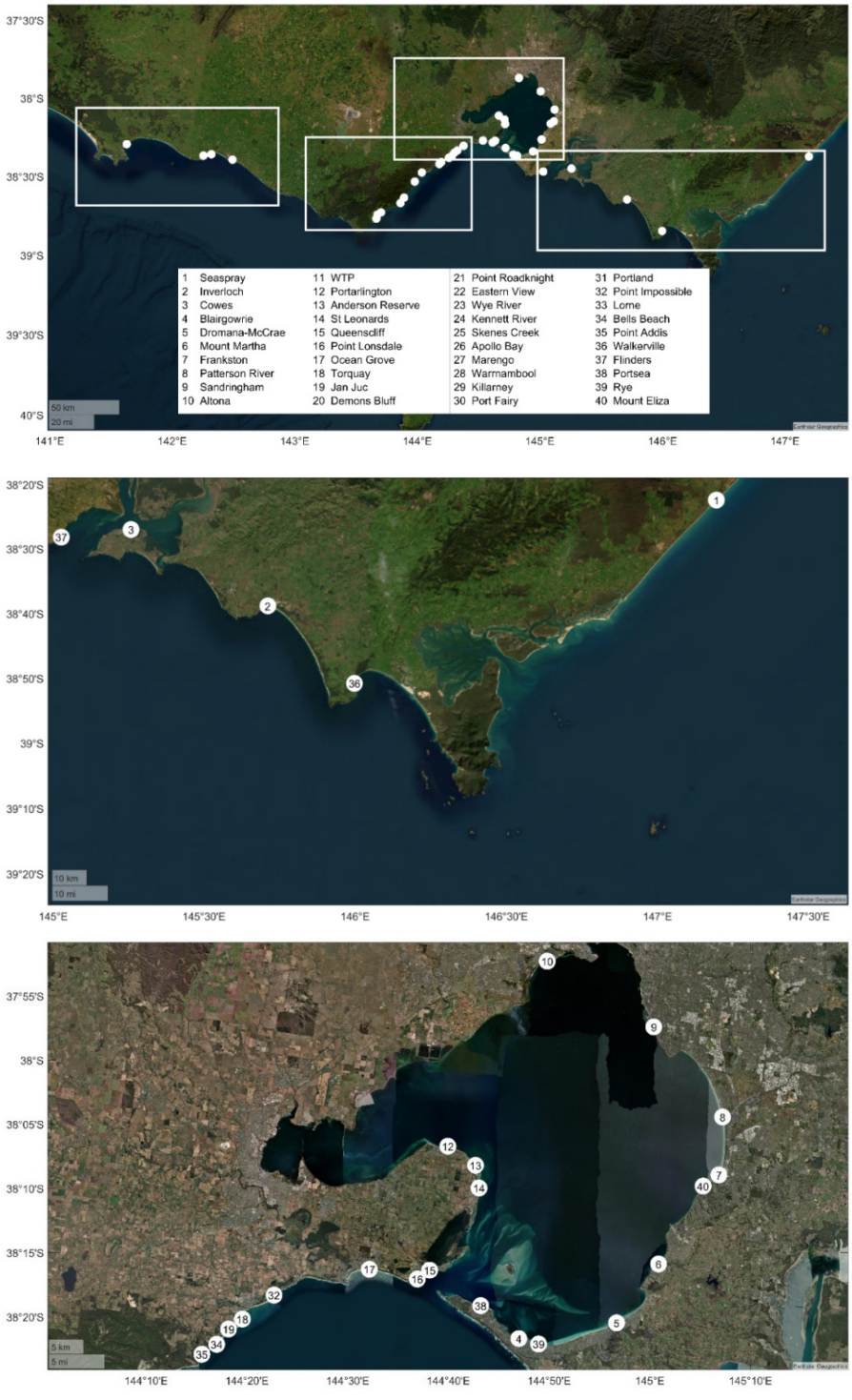
1.1 Transect Framework

The Victorian Coastal Monitoring Program (VCMP) uses a statewide framework of transects, spaced at 30-m alongshore, covering the full extent of the Victorian coast. The framework of transects is referred to as the "Victorian Coastal OmniLine" and uses a universal identifier (UID), numbered sequentially from east to west (Figure 1.1), with Phillip Island added to the end. The Victorian Coastal OmniLine is based primarily on the 2019 Digital Earth Australia (DEA) Coastlines dataset, with gaps filled using 'SmartLine' (Sharples, 2009). All VCMP Site data sits within this framework and can be referenced by the transect UID.

Figure 1.1. Victorian Coastal OmniLine, (top) full extent, (bottom) zoom in around Phillip Island, showing universal identifiers (UID).

1.2 VCMP Drone Survey Sites

The VCMP conducts drone (or Unoccupied Aerial Vehicle; UAV) surveys at approximately 40 coastal sites in Victoria (Figure 1.2), with most sites surveyed at 6-to-8-week intervals. These sites are within Port Phillip Bay, along the Great Ocean Road, and in both western and eastern regions of Victoria.



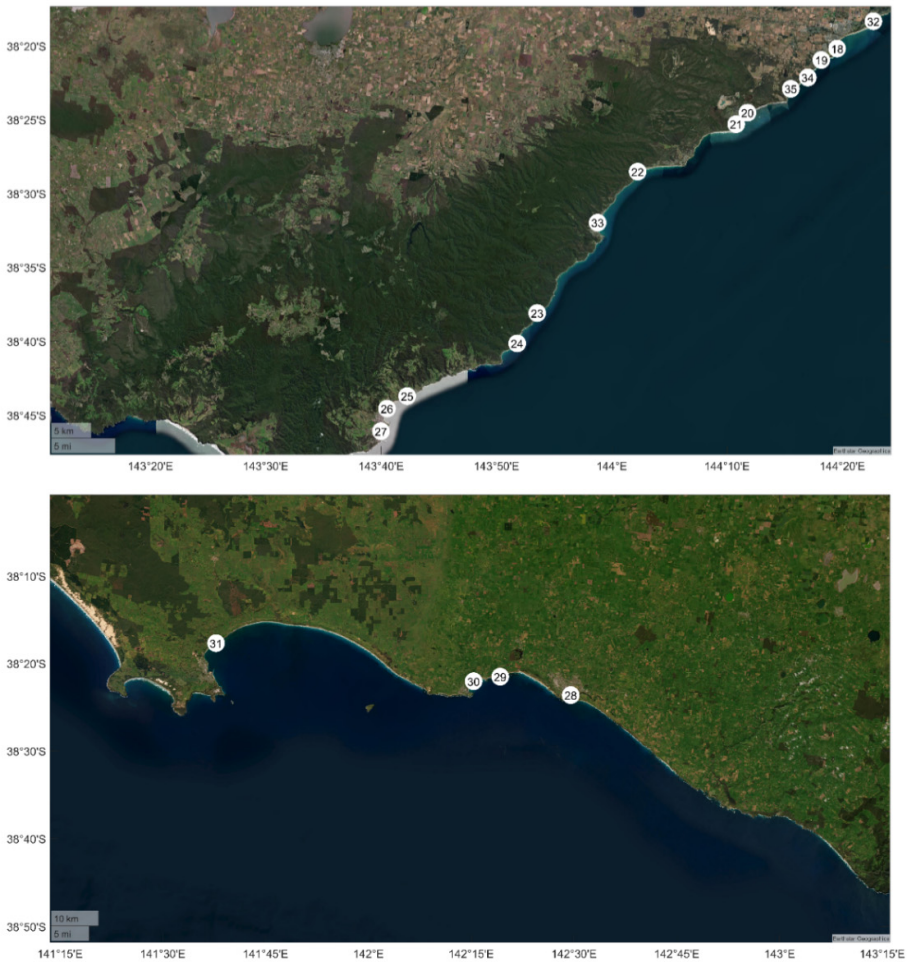


Figure 1.2 VCMP drone survey sites.

Table 1.1. VCMP Sites with UAV and aerial imagery information.

Site ID	Site name	No. of transects	Abbr.	Region	Open Coast / Bay	UAV start / end dates	No. of UAV surveys (total: 667)	Aerial duration	No. of aerial imagery (total: 115)
1	Seaspray	151	SEA	Gippsland	Open	23/08/2018-20/02/2023	31	1965-2019	15
2	Inverloch	182	INV	Gippsland	Open	22/08/2018-06/02/2023	34	1950-2018	14
3	Cowes	151	COW	Western Port Bay	Bay	24/08/2018-13/12/2022	30	1968-2020	18
4	Blairgowrie	136	BLR	Port Phillip Bay	Bay	03/12/2020-06/12/2022	14	1930-2019	12
5	Dromana-McCrae	146	DRM	Port Phillip Bay	Bay	03/12/2020-06/04/2023	16	1930-2019	8
6	Mt Martha	116	MAR	Port Phillip Bay	Bay	22/05/2019-10/02/2023	28	/	/
7	Frankston	30	FRA	Port Phillip Bay	Bay	11/04/2018	1	/	/
8	Patterson River	141	PAT	Port Phillip Bay	Bay	12/03/2021-08/02/2022	15	/	/
9	Sandringham	121	SND	Port Phillip Bay	Bay	04/12/2020-04/05/2023	17	1930-2020	48
10	Altona	221	ALT	Port Phillip Bay	Bay	07/02/2022-22/02/2023	9	/	/
11	WTP	/	WTP	Port Phillip Bay	Bay	/	/	/	/
12	Portarlington	38	PAR	Port Phillip Bay	Bay	06/06/2018-30/01/2023	32	/	/
13	Anderson Reserve	98	AND	Port Phillip Bay	Bay	18/11/2020-16/12/2022	6	/	/
14	St Leonards	156	LEO	Port Phillip Bay	Bay	06/06/2018-28/02/2023	37	1960-2021	42
15	Queenscliff	45	QCL	Port Phillip Bay	Bay	24/08/2018-10/03/2023	30	/	/
16	Pt Lonsdale	68	LON	Port Phillip Bay	Bay	04/04/2019-10/03/2023	9	/	/
17	Ocean Grove	155	OGR	Southwest	Open	02/04/2019-30/01/2023	30	1966-2019	13
18	Torquay	118	TRQ	Southwest	Open	24/06/2019-16/02/2023	6	/	/
19	Jan Juc	101	JJU	Southwest	Open	30/03/2021-15/02/2023	6	/	/
20	Demons Bluff	111	DMN	Southwest	Open	20/06/2018-15/02/2023	36	2007-2019	4
21	Pt Roadknight	110	RDK	Southwest	Open	20/06/2018-15/02/2023	34	1962-2019	18
22	Eastern View	68	EVW	Southwest	Open	18/03/2021-	7	/	/

						01/02/2023			
23	Wye River	40	WYE	Southwest	Open	08/04/2021-30/11/2022	12	/	/
24	Kennett River	32	KEN	Southwest	Open	08/04/2021-29/11/2022	3	/	/
25	Skenes Creek	86	SKE	Southwest	Open	01/06/2018-31/03/2022	5	/	/
26	Apollo Bay	221	APO	Southwest	Open	01/06/2018-15/12/2022	45	1968-2020	11
27	Marengo	105	MGO	Southwest	Open	01/06/2018-28/02/2023	34	1968-2021	10
28	Warrnambool	151	WAR	Southwest	Open	06/03/2014-09/02/2023	37	1947-2019	11
29	Killarney	71	KIL	Southwest	Open	09/10/2015	1	/	/
30	Port Fairy	205	PTF	Southwest	Open	14/03/2018-08/02/2023	39	1948-2021	21
31	Portland	312	PLA	Southwest	Open	26/02/2018-24/02/2023	28	1967-2012	8
32	Pt Impossible	101	IMP	Southwest	Open	24/06/2019-11/03/2022	3	/	/
33	Lorne	160	LRN	Southwest	Open	24/11/2021-30/11/2022	4	/	/
34	Bells Beach	30	BEL	Southwest	Open	26/05/2022-31/01/2023	4	/	/
35	Pt Addis	154	ADD	Southwest	Open	26/05/2022-31/01/2023	4	/	/
36	Walkerville	149	WLK	Gippsland	Open	16/03/2022-15/03/2023	5	/	/
37	Flinders	156	FLI	Western Port Bay	Bay	07/03/2022-07/02/2023	4	/	/
38	Portsea	161	PSE	Port Phillip Bay	Bay	28/02/2022-09/02/2023	4	/	/
39	Rye	136	RYE	Port Phillip Bay	Bay	15/03/2022-18/10/2022	3	/	/
40	Mt Eliza	116	ELZ	Port Phillip Bay	Bay	08/03/2022-28/03/2023	5	/	/

2 ‘VCMP Sites’ Information Product

2.1 Input Datasets

The “VCMP Sites” data product contains a range of shoreline and associated input datasets, listed below. All data are interpolated to a fixed set of transects with unique identifier (UID) within a statewide framework (see Section 2.2).

2.1.1 DEA (Digital Earth Australia) Coastlines

DEA Coastlines (Geoscience Australia) are annual mean shorelines extracted from satellite imagery, spanning 35+ years (from 1988 onwards) for the entire Australian coast (Bishop-Taylor et al., 2021).

2.1.2 ARL (Aerial Imagery)

Victoria has a large collection of georectified aerial imagery available through the Coordinated Imagery Program (CIP; Department of Transport and Planning). A limited number of aerial images have had shorelines and/or vegetation lines extracted (Table 1.1), https://www.land.vic.gov.au/maps-and-spatial/imagery/coordinated-imagery-program.

2.1.3 UAV (Unoccupied Aerial Vehicle)

The VCMP drone pilots periodically conduct surveys at each VCMP site (Table 1.1). The data obtained from these drone surveys can be accessed through the Propeller platform at https://vcmp.prpellr.com/.

2.1.4 VCDEM2022 (Victorian Coastal Digital Elevation Model, 2022 update)

The Victorian Coastal Digital Elevation Model (VCDEM, 2022) is a merged topo-bathymetry product assembled from various topographic and bathymetric surveys across Victoria. The update year (2022) refers to when the merging process was undertaken, not the year of data collection. Much of the nearshore coastal bathymetry survey data is from c. 2008-2010 statewide lidar.

2.1.5 CAMS (Coastal Asset Management System) database

The CAMS database contains spatial data on coastal assets, including protective structures across Victoria. CAMS was originally produced by the Department of Primary Industries for the Future Coasts Program in 2011 using aerial photography from CIP (Sec. 2.1.2). The dataset was further reviewed as part of the Future Coasts SECAP project (2011/2012). Information on the condition of a number of protection structures is available as a separate (restricted) database that links to this spatial dataset. The data was reviewed in 2017, adding asset IDs to enable linking to asset management data.

2.1.6 SmartLine

The SmartLine is a national database of coastal morphology, described in Sharples & Mount (2009). Each segment contains attributes describing the subtidal, intertidal, and backshore coastal landforms and geology within a coastal zone. This description typically extends 500 meters both landward and seaward from the High-Water Mark line. Each segment's boundaries are determined by significant changes in landform

characteristics along the coastline. For instance, a new segment may start or end where there is a notable transition in features, such as the beginning or end of a sandy beach.

2.2 Data Processing

Shoreline extraction methods and uncertainty vary based on survey methodology (UAV, DEA, aerial imagery). All shoreline methods are interpolated to the same set of 30-m spaced alongshore transects, each with a unique UID (Victorian Coastal OmniLine; Sec. 1.1). Uncertainty estimates for all shoreline methods are summarised in Table 2.1.

UAV Shoreline - Data Processing

- VCMP drone survey data collection follows the procedures outlined in Pucino et al. (2021) and Ierodiaconou et al. (2022). Data processing and quality control are carried out using the Propeller platform (https://vcmp.prpellr.com), supplemented by manual quality control checks.
- Output products include Digital Surface Models (DSM) and Orthophotos. Vegetation is included in UAV data (hence 'DSM' rather than 'DEM'). DSMs are down-sampled to 1-m grids for faster processing.
- Vertical uncertainty for the output digital surface model (DSM) is estimated at 0.1 m.
- The shoreline proxy is defined as the point at which each transect first intersect a given contour (m, AHD):
    - 1.0 m AHD for open coasts
    - 0.5 m AHD for bay sites
- Intersection points are joined alongshore to create a shoreline, noting the alongshore spacing (30-m) may be too low to define complex, small-scale features.
- Assuming a beach face slope of 1-in-10, a 0.1 m vertical uncertainty in the survey DSM equates to an approx. cross-shore uncertainty of 1 m in shoreline position.

DEA Coastlines - Data Processing

- A mean annual mid-tide shoreline is extracted from satellite imagery using sub-pixel identification methods, for the period 1988 to 2021, at 30-m alongshore spacing (Bishop-Taylor et al., 2021).
- DEA shorelines have an estimated uncertainty of 1-3 m, with a precision limit on shoreline trends of 0.31 m/yr, i.e., trends below this threshold are insignificant.
- DEA have known issues around cliffed areas, leading to higher (unconstrained) uncertainty in some cliffed areas. DEA outputs in such areas should be treated with caution.

Aerial Imagery Shorelines - Data Processing

- Aerial images are hosted and georectified by CIP. Based on control point checks by VCMP, newer images (approx. post-2000) are estimated to have horizontal uncertainty of 3-m or less. Older images (pre-2000) can have greater uncertainty, estimated at up to 10-m. Very old images (<1960) may have larger errors (unconstrained) and should be treated with caution.
- Backshore line: Extracted for open coast and bay sites. Identified manually as the onshore extent of the active sandy beach. Depending on morphology, the backshore line may be defined vegetation, dune toe, cliff toe and / or a coastal protection structure (sea wall or revetment).
- Shoreline proxy line: Extracted for bay sites only (with low wave energy). Identified manually as the instantaneous wet/dry line, with no tidal correction.
- A robust comparison (conducted at Sandringham Beach) between the UAV proxy shoreline and the Aerial proxy shoreline show good agreement (Fig. 2.1), with bias of 2.4 m and uncertainty (RMSE) of 2.8 m.
- Sites with larger tidal ranges (e.g., Cowes) would be expected to have larger uncertainty in shoreline position and caution is advised.

Shoreline Trends

For all shoreline data sources (UAV, DEA, aerial), trends are calculated as a simple linear regression across the full dataset, at each transect, for each data source. Standard deviations and 95% confidence intervals are also included for each data point.

Cross-sections (profiles)

Cross-sections are extracted for datasets with elevation models, including:

- Digital Surface Models (DSM) from UAV surveys, includes vegetation.
- Victorian Coastal Digital Elevation Model (VCDEM, updated 2022), most coastal survey data are from c. 2008 – 2010, excludes vegetation.

Note and use caution when comparing onshore (backshore) sections of the profile, as the VCMP UAV surveys DSMs include vegetation and cannot be directly compared with the VCDEM (no vegetation).

Morphology / Substrate Type

Extracted from SmartLine, taking fields for offshore, intertidal and backshore. Note that SmartLine contains a ‘primary’ and ‘secondary’ morphology type, while VCMP Sites takes only the ‘primary’ field. This will be amended in future versions.

Coastal Structures (‘wall location’)

The shoreline transects used for VCMP Sites are intersected with the CAMS structures, to determine the presence and cross-shore location of protection structures (e.g., sea walls, revetments).

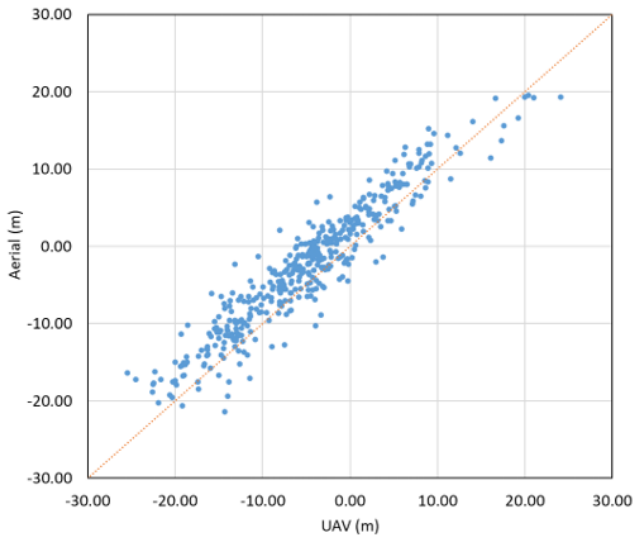


Figure 2.1 A comparison of mapped shoreline position (m) at Sandringham Beach, between **aerial imagery shoreline proxy** (manually identified instantaneous wet-dry line, no tidal correction) and **UAV shoreline proxy** (cross-shore profile intersection with 0.5 m AHD contour), **417** points. The aerial proxy line is **biased 2.4 m** seaward of the UAV line, with an uncertainty (**RMSE**) of **2.8 m**. (Internal report by University of Melbourne for DEECA; David Kennedy and Runjie Yuan, 2023).

Table 2.1. Uncertainty estimates for survey methods and associated shoreline proxy line. ^ For satellite imagery, shoreline position uncertainty is improved from base images using sub-pixel extraction methods (Bishop-Taylor et al., 2021).

	Survey data		Shoreline proxy	
Method	**Horizontal uncertainty (m)**	**Vertical uncertainty (m)**	**Cross-shore uncertainty (m)**	**Reference**
Drone	1	0.1	1	(Duo et al., 2021)
Satellite	15*	/	1-3	(Bishop-Taylor et al., 2021)
Aerial	c. 10 (pre-2000) c. 3 (post-2000)	/	c. 10 (pre-2000) c. 3 (post-2000)	(Kennedy et al., 2023)

2.3 Output Datasets

Output datasets available in CSV format are listed in Table 2.2. Dataset source methods are given in Table 2.3. For output CSVs, the source method is in columns “ds_ID” (integer) and “ds_str” (string, e.g., “1_DEA”). The shoreline extraction methods for the various datasets are listed in Table 2.4, relating to the output field ‘meth_long’. Output CSVs also contain a simplified code for shoreline method (‘meth_shrt’), with codes: 1 – Cross-section (profile); 2 – Shoreline; 3 – Backshore line. Examples from CoastKit for Dataset Type DT1 to DT6 are provided in Figures 2.2 to 2.6.

Table 2.2. Outputs dataset types, included in CSV filename.

Dataset Type	Contents	Units
DT1	Shoreline (UAV, DEA, Aerial)	m
DT2	Transects, 30-m spaced (subset of OmniLine framework, UID identifier is unique to all transects statewide)	m
DT3	Shoreline trends	m/year
DT4	Shoreline time series	m
DT5	Cross-sections (profiles) – UAV surveys	m
DT6	Morphology / Substrate type (SmartLine)	NA
DT7	Coastal structures (DEECA CAMS database)	NA

Table 2.3. Data source method, related to ‘ds_ID’ and ‘ds_str’ fields in output CSVs.

ID	Code	Name
1	DEA	Digital Earth Australia
2	ARL	Aerial Imagery
3	CST	CoastSat
4	UAV	VCMP Drone Survey
5	DEM	Merged Victorian DEM
6	MRG	Merged

Table 2.4. Shoreline method, relates to the ‘meth_long’ field in output CSVs.

ID	Type	Description
1	Profile	Profile extracted from digital surface
2	Backshore line	Back of beach (veg., cliff, wall, etc)
3	Shoreline	Shoreline (Instantaneous wet/dry line)
4	Shoreline	Shoreline (Annual wet/dry line)
5	Shoreline	Shoreline (1m AHD)
6	Shoreline	Shoreline (0.5m AHD)
7	Shoreline	Shoreline (Merged types)

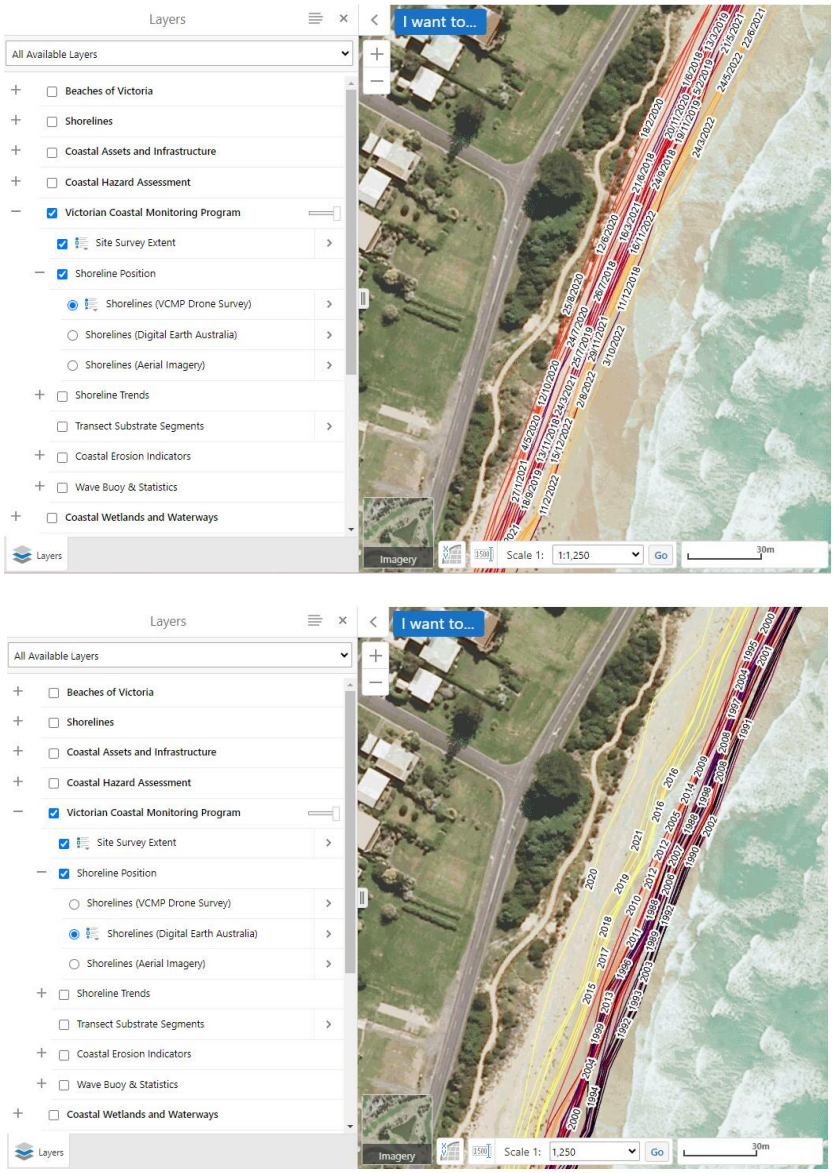


Figure 2.2. Example **shorelines** (**DT1**), including UAV (top) and DEA (bottom), screenshots from CoastKit.

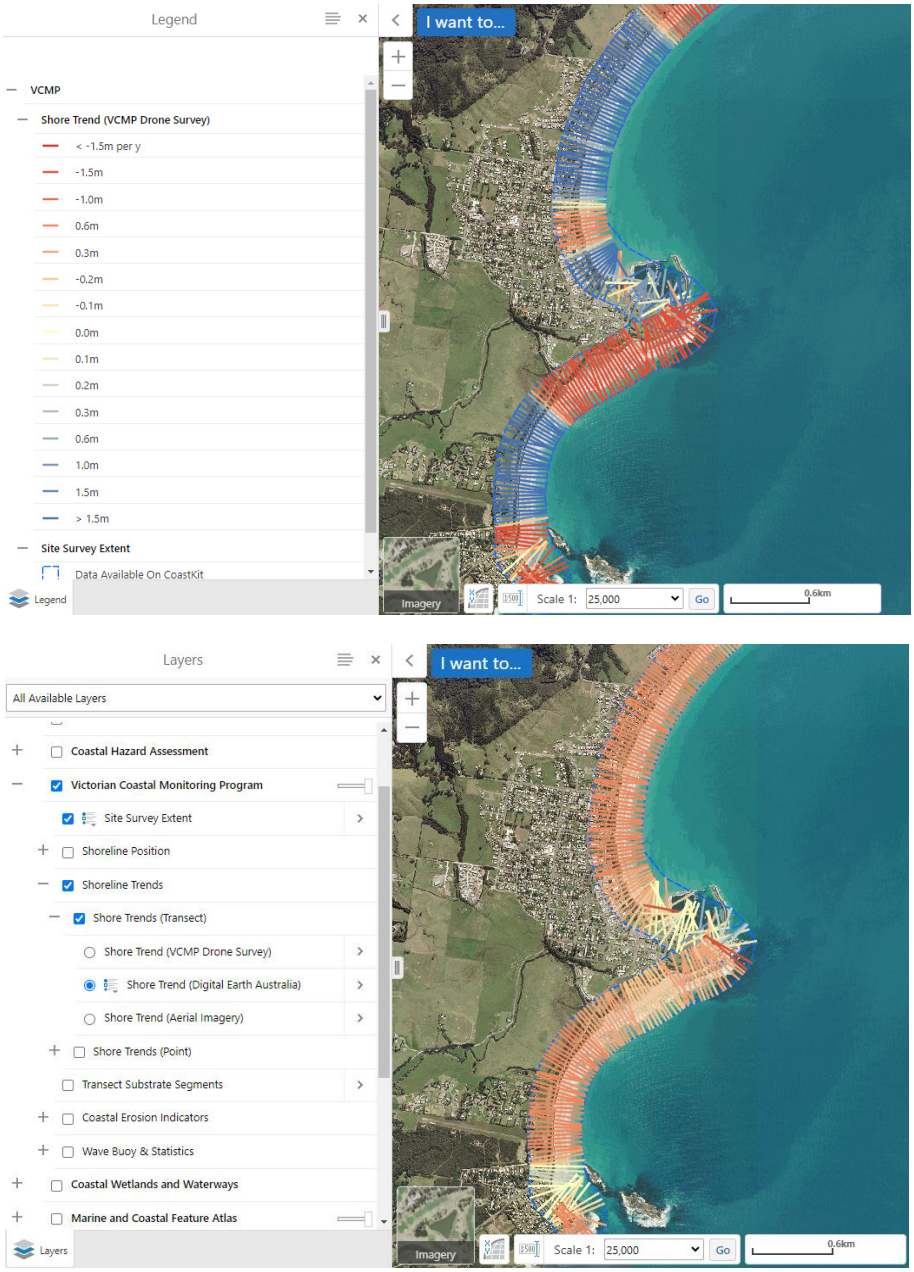


Figure 2.3. Example **transects** (**DT2**), with colour indicating **shoreline trends (DT3)** for UAV (top) and DEA (bottom), screenshots from CoastKit.

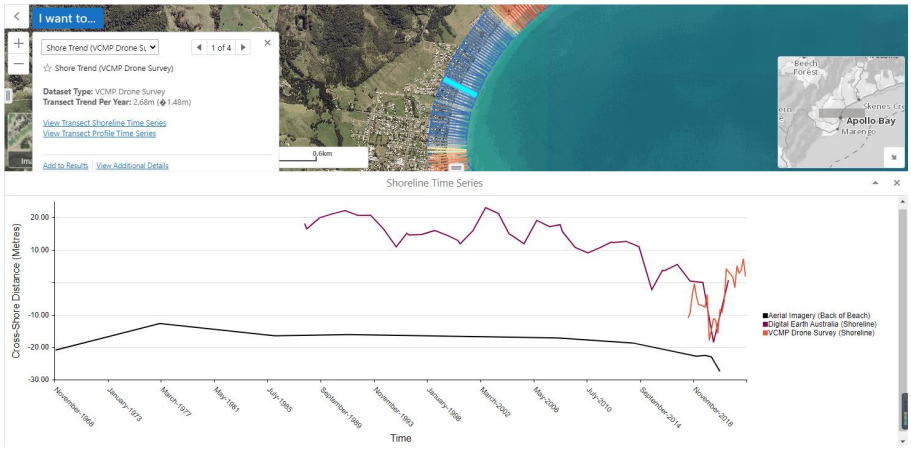


Figure 2.4. Shoreline time series (**DT4**) for UAV shoreline proxy (orange), DEA annual mean shoreline (purple) and aerial imagery vegetation line (black) at a selected transect, screenshot from CoastKit.

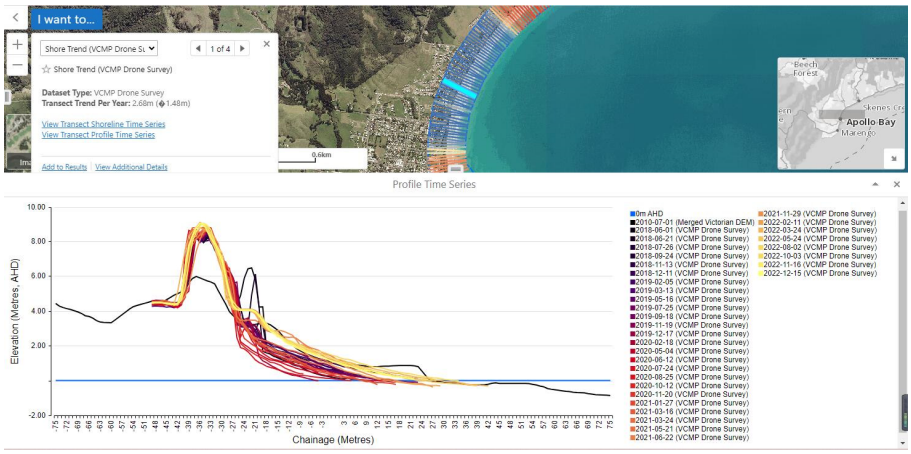


Figure 2.5. Shoreline cross-sections (profile time series; **DT5**) at a selected transect, screenshot from CoastKit.

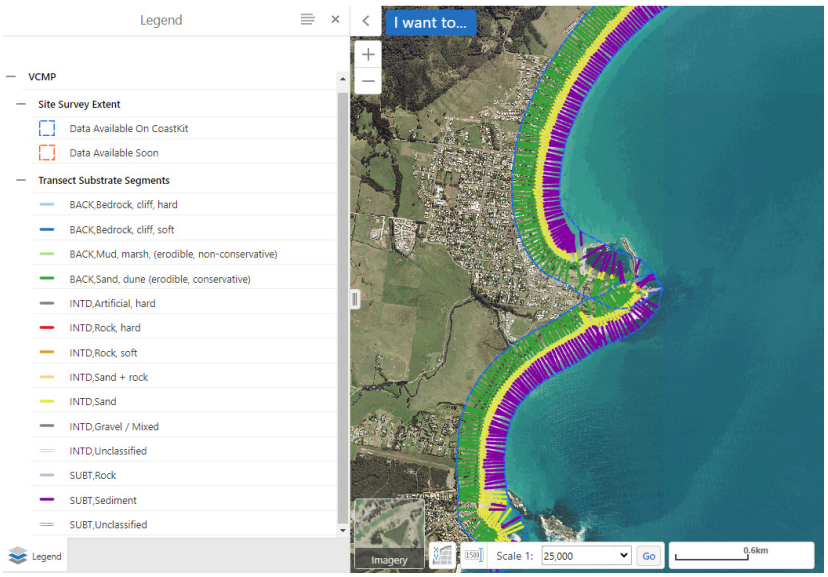


Figure 2.6. Morphology / substrate type (**DT6**), based on SmartLine, screenshot from CoastKit.

3 Access to Data

Data are available through:

- VicCoastData – Cloud/FTP file sharing site.
    - Contact vcmp@delwp.vic.gov.au to create an account.
    - Navigate to: /Projects Shared With Me/_data/VCMP_Sites/text
    - Sites are listed as the three letter abbreviations (Table 1.1), e.g., Sandringham is ‘snd’.
    - Data files are in CSV format, named by dataset type (Table 2.2), e.g., DT3 is shoreline trends.

Other access portals:

- CoastKit – (https://mapshare.vic.gov.au/coastkit/). Data available for viewing by clicking “Victorian Coastal Monitoring Program” on the left side.
- DataShare (https://datashare.maps.vic.gov.au/). Search “VCMP Sites”.

References

Bishop-Taylor, R., Nanson, R., Sagar, S., & Lymburner, L. (2021), Mapping Australia's dynamic coastline at mean sea level using three decades of Landsat imagery. Remote Sensing of Environment, 267, 112734. https://doi.org/10.1016/j.rse.2021.112734.

Duo, E., Fabbri, S., Grottoli, E., & Ciavola, P. (2021), Uncertainty of drone-derived dems and significance of detected morphodynamics in artificially scraped dunes. Remote Sensing, 13(9), 1823. https://doi.org/10.3390/rs13091823.

Ierodiaconou, D., Kennedy, D. M., Pucino, N., Allan, B. M., McCarroll, R. J., Ferns, L. W., et al. (2022), Citizen science unoccupied aerial vehicles: A technique for advancing coastal data acquisition for management and research. Continental Shelf Research, 244, 104800. https://doi.org/10.1016/j.csr.2022.104800.

Kennedy, D. M., McCarroll, R. J., Fellowes, T. E., Gallop, S. L., Pucino, N., McSweeney, S. L., et al. (2023), Drivers of seasonal and decadal change on an estuarine beach in a fetch-limited temperate embayment. Marine Geology, 463, 107130. https://doi.org/10.1016/j.margeo.2023.107130.

Pucino, N., Kennedy, D. M., Carvalho, R. C., Allan, B., & Ierodiaconou, D. (2021), Citizen science for monitoring seasonal-scale beach erosion and behaviour with aerial drones. Scientific Reports, 11(1), 3935. https://doi.org/10.1038/s41598-021-83477-6.

Sharples, C., & Mount, R. (2009), The Australian coastal Smartline geomorphic and stability map version 1: manual and data dictionary.