UAV photogrammetry and 3D scan data for topographic mapping and monitoring of maritime heritage

James Barry, Kieran Craven, Sean Cullen, Ronan O'Toole

Geological Survey Ireland, Dublin, Ireland
* James.Barry@gsi.ie

EGU2020-9519

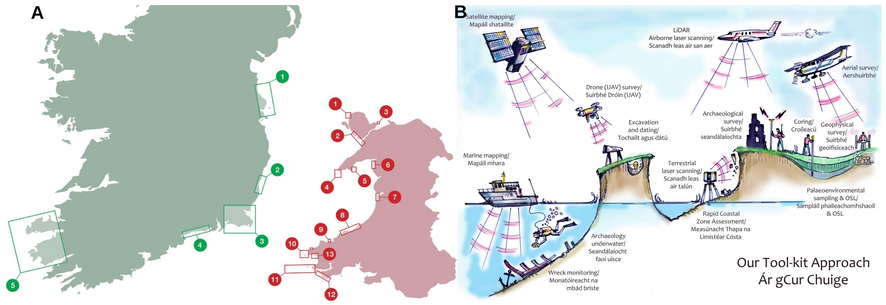

Figure 1: A) CHERISH locations in Ireland and Wales. B) Integrated Tool-kit approach applied in the field to achieve comprehensive offshore-onshore survey

1. Introduction:

Cultural heritage in maritime areas experience changes via natural and anthropogenic processes. This change must be monitored on a range of temporal and spatial scales to understand the evolution of these environments, particularly in the context of projected climate change yielding increased sea-levels and storm frequency.

3D digital data are becoming increasingly important for coastal and heritage managers, engineers and researchers for the understanding and sustainable management of coastal sites. For comprehensive coverage over a range of spatial and temporal scales, an integration of various techniques is required. Here we present data of integrating unmanned aerial vehicle (UAV) and 3D scan data to assist local and national stakeholders to quantify and understand change.

2. Methods:

The CHERISH project is applying an integrative tool-kit approach (Figure 1) at a number of coastal sites around Ireland and Wales to establish baseline data and monitor change to assist in management of cultural heritage.

Here we present data from:

- UAV platforms at priority sites (Sensefly eBee plus, Microdrones MD4)
  - ≥ 5 checkpoints / flight sampling all elevations and ground type
- Scanning total station surveys at eroding cliffs (Trimble SX10)
- Multibeam bathymetry at select sites for seamless maps
- Commercially acquired LiDAR over select island sites

Change detection uses Cloud Compare and ArcGIS to compare time series elevation models

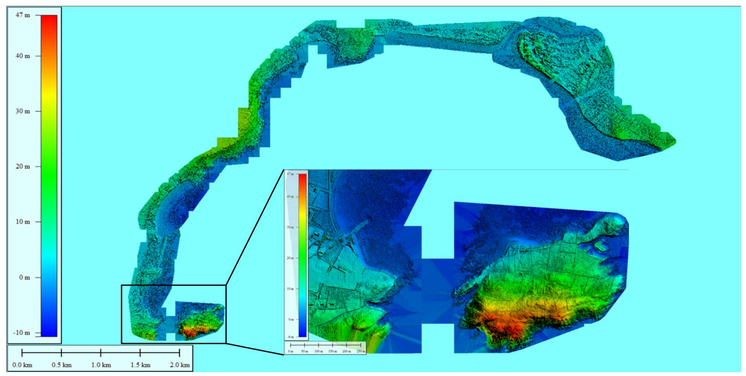

Figure 2: A) DSM of Ballinskelligs Bay, Co Kerry: 12km coastline acquired by UAV (eBee Plus) from 9 flights over 3 days. Ground sampling distance of <0.03 m. Vertical precision <0.15 m RMS / flight

3. Results:

Integrating survey methodologies permit data acquisition on range of spatial scales (Table 1; Figures 2-5).

Table 1: Survey Attributes. Application range refers to preferred application in CHERISH project

	Application range (km)	Point Cloud Density (pt / m²)	Accuracy (m)
Scanning Total Station	0.01 – 0.5	<25600 @ 50m	<0.01
UAV	0.1 - 10	1000 @ 100 m	<0.15
Bathymetry	0.5 - >10	650 @ 5 m	<0.5
LiDAR	1 - >10	30 @ 500 m	<0.1

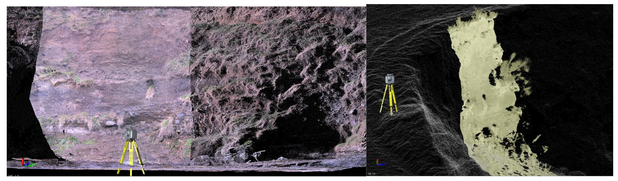

Figure 3: Integration of UAV (1000 pt / m²) and high density STS point cloud (25,600 pt / m²) at Bremore, Co Dublin. Bremore has a 16th Century harbour in proximity to eroding unconsolidated sediment

Figure 4: A) 3D model of Kilmichael Point, Co Wexford which includes 19th Century Coastguard Station, cist and possible promontory fort. B) Integration of laser scan data with UAV to get accurate measurements of eroding boat house, to include vertical and overhang surfaces

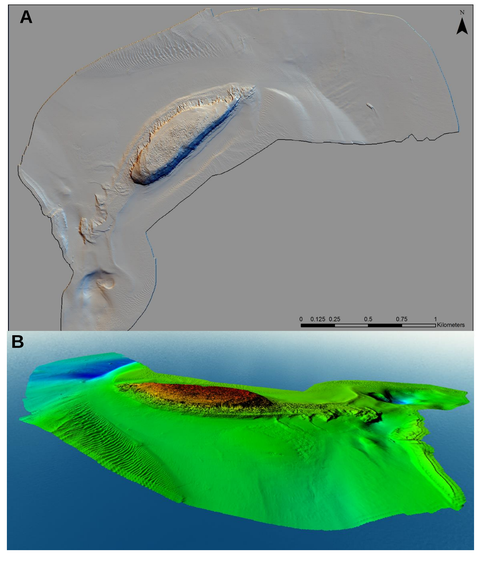

Figure 5: Seamless map (0.25m LiDAR and 2 m bathymetry) of Puffin Island, Anglesey A) Multiple hill shade image (D16, H35) B) 3D image of seamless map. Puffin Island includes medieval monastery and ruined telegraph station

Time series analysis of elevation data using Cloud Compare (Figs 6 & 7).

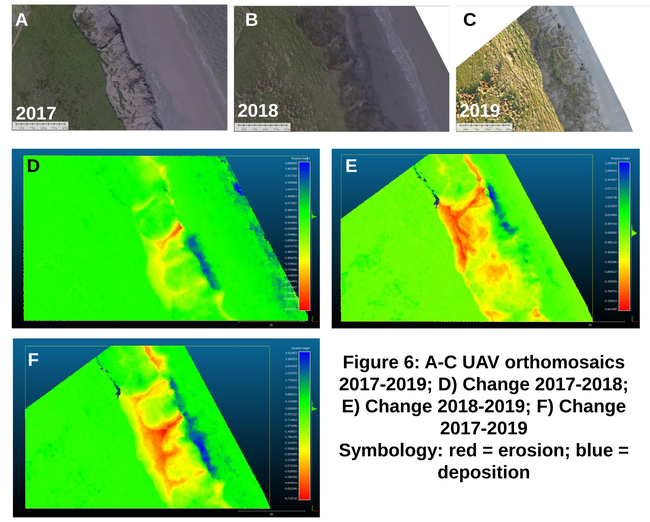

Figure 6: A-C UAV orthomosaics 2017-2019; D) Change 2017-2018; E) Change 2018-2019; F) Change 2017-2019
Symbology: red = erosion; blue = deposition

Table 2: Quantitative analysis of change over 1700 m² of unconsolidated sediment at Rosslare, Co Wexford using Cloud Compare. Clouds registered at 30% (<0.15 RMS)

	Material Removed (m³)	Material Added (m³)	Total Change (m³)
2017-2018	1010	154	-856
2018-2019	924	207	-716
2017-2019	1866	192	-1674

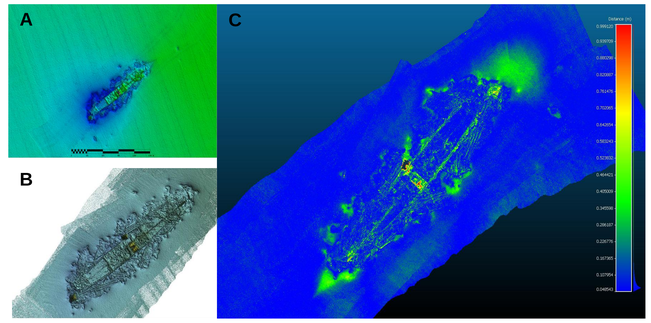

Figure 7: SS Manchester Merchant in Dingle, Co Kerry A) 2009 INFOMAR survey, B) 2019 CHERISH survey, C) absolute elevation change 2009-2019 with up ≤0.5 m change at bow and stern, and ≤ 2m in centre of wreck

4. Discussion and Further Work:

- Different survey methodologies perform better on different spatial scales and surface orientation (horizontal or vertical)
- An integration of methods is required to get comprehensive understanding over change across all spatial scales (km to cm)
- Time series analysis can detect and quantify change on ≥ cm scale
- Methodologies will be applied in further sites around Ireland and Wales to quantify change

Acknowledgements:

Contains INFOMAR bathymetry data (Geological Survey Ireland, Marine Institute). CHERISH project (Climate, Heritage and Environments of Reefs, Islands and Headlands) – 'Climate Change and Coastal Heritage' – is a €6.2 million six year project funded by the European Union's Ireland Wales 2014-2020 European Territorial Co-operation (ETC) programme. www.cherishproject.eu