



**Research Programme**  
**- Short Calls, Final Report -**

|                        |                                                                                                                            |
|------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Lead Applicant Name    | GAVIN DUFFY                                                                                                                |
| Email                  | gavin@realsim.ie                                                                                                           |
| Host Organisation name | RealSim Limited                                                                                                            |
| Project Title          | The development of the CoastSim platform: a virtual coastal landscape time travel experience exploring landscape evolution |
| Contract Number        | 2017-sc-052                                                                                                                |

Date:

**This report covers the period November 1<sup>st</sup> 2017 to October 31<sup>st</sup> 2018**



## 2. (a) Project information:

Final project report (*max 2500 words, excluding figures and headings*):

- (i) Progress of objectives and scientific/engineering targets beyond the state of the art & methods used

The overall objective of creating a coastal evolution simulation platform 'CoastSim' has been achieved by merging high resolution marine and terrestrial mapping data, game engine technology, scientific research and 3d graphic design.

The over-riding aim of CoastSim is to improve communication on environmental change issues to people outside the GeoScience community and assist with the GSI's Education Outreach and Development Programme (EODP). As referenced many times at the recent annual GSI conference in Dublin Castle recently, the GeoScience community has not been very good at communicating it's activities and the value of the GeoScience related activities to the economy. The GSI and industry must become smarter about how they communicate their subject matter. Environmental research and activities must be made more accessible to a non-technical audiences from school children to politicians, legislators, financial decision makers and the general public.

Good communication generally involves some visual component. CoastSim is entirely visual and therefore offers the opportunity to reach a very broad audience from the very young to the more mature. The project focused on two case study areas, one of which changed from the initial proposal as stated in the interim report and again in section (ii) below. Each one was looking to prove different scientific and technical outputs which pushed beyond current state of the art.

**1. Galway Bay Evolution:** This produced the first;

- detailed multi-phased environment reconstruction at three different locations around the bay for four time periods, 15,000BP, 10,000BP, 5,000BP and present day.
  - multiple level of detail model going from wide area lower resolution model covering the entire Galway Bay area, (110km x 55km) to smaller finer detailed model areas (300m x 300m)
- and;

**2. Streedagh Beach Armada Model:** This produced the first;



- web hosted 3d model of a coast mapped by drone. This is accessible to anyone with a browser but is designed for desktop access only, i.e. not mobile

<http://streedaghbaycoastsim181119.s3-website-eu-west-1.amazonaws.com/>

- model showing the position of the three Armada wrecks discovered in the 1980's but since surveyed in more detail by the Underwater Archaeology Unit.



**Figure 1:** Location of two coastal areas worked up in detail from different mapping and graphic design techniques.

- (ii) Implementation (please include any issues with timelines, milestones, management etc. or deviations from the original implementation plan)

As previously stated in the interim report, the originally proposed main case study site of Dublin Bay was changed to Galway Bay due to the lack baseline sediment core data and water penetrating LiDAR to facilitate a seamless land-sea model. The implementation of the two coastal simulations will now be discussed separately.

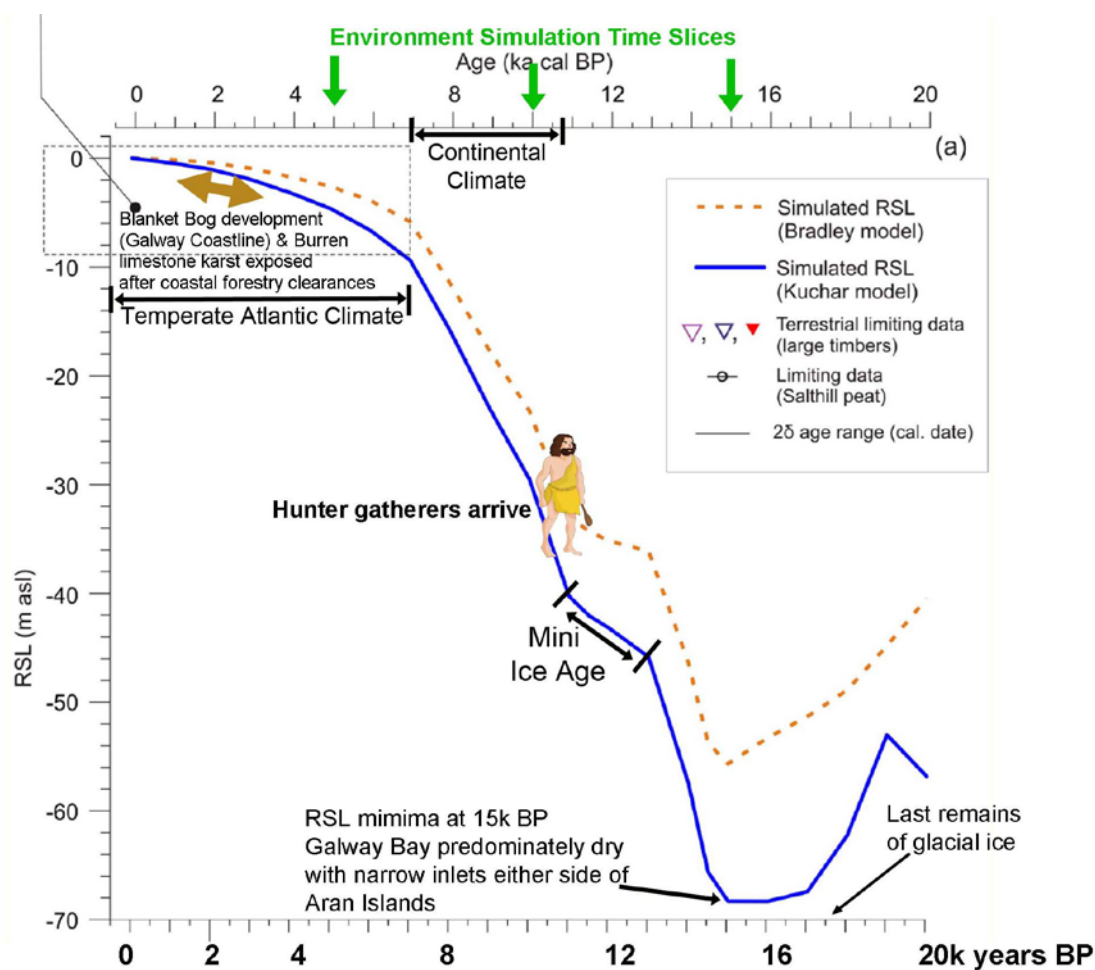
### Galway Bay Evolution from Last Ice Age to Present

The aim of this project was to look at how the coastline of Galway Bay evolved from the end of the last ice age, roughly corresponding to the sea-level minima (Kuchar et al, 2012). The bathymetry and the coastal LiDAR data acquired by the Marine Institute in 2008 was used as the baseline model.



**Figure 2:** Shaded relief digital terrain (white) and bathymetry (blue) model for Galway Bay.

Figure 2 above shows the extent of the bathymetry and water penetrating LiDAR data acquired by the Marine Institute in 2008. This data was augmented by World Map imagery and ASTER Digital elevation data to fill out the model area to a bounding box shown in Figure 4.



**Figure 3:** Annotated sea-level change graph that appears on page 17 of O'Connell, M. and Molloy K, (2017)



**Figure 4:** Screenshot from landing page of interactive Galway Bay CoastSim model, showing coastline boundary at roughly 10,000 years BP and three clickable areas highlighted in red from which the user can take a ground view of the coast from four different time slices

The mapping data was compiled in Global Mapper and exported in to 5km x 5km tiles for importation in to the Unity game engine. RealSim have an established workflow which allows us to convert elevation data into height maps suitable display and interrogation in the Unity game engine.

A paper published by Michael O'Connell and Karen Molloy (NUI Galway), 2017, *Mid- and late-Holocene environmental change in western Ireland: New evidence from coastal peats and fossil timbers with particular reference to relative sea-level change*, was identified as the best academic reference to interpret sea-level and landscape change in Galway Bay since the end of the last ice-age. Figure 10, page 17 from the paper (Figure 3 in this report) was particularly useful. Figure 3 shows an enhanced annotated version of this figure which we compiled in consultation with Dr. Karen Molloy.

From this graph we were able to plot the relative sea-levels at different points in time over the past 15,000 years. Figure 4 above shows the sea-level stand at 10,000 years BP.

Aside from sea-level change, the other significant visual change on the landscape over time is the flora and fauna that exists. This can be inferred from pollen analysis of cores. The cores referenced in the paper by O'Connell and Molloy come from various locations from Lough Atalia, a brackish lake just on the south eastern edge of Galway City, to Spiddal, some 20km west of Lough Atalia along the coast. The simulation here does not delve in to these specific pollen and ecology results as they cover too narrow a time period of up to just 3,000 years BP. Instead we took a more general view landscape change and in consultation with Dr. Molloy used the information compiled in Table 1 to inform the historical landscape modelling process.



### Spiddal, Burren and Lough Atalia View Points

|                    |                                                            |
|--------------------|------------------------------------------------------------|
| <b>Time Slice:</b> | <b>15,000 BP</b>                                           |
| Relative Sea-Level | -68m                                                       |
| Climate            | Tundra - Continental                                       |
| Flora              | Juniper, Birch, Scrub, Grasses (Elephant grass/Ferns etc.) |
| Fauna              | Elk, Bears, Wolves, Boar, Eagle                            |
| <b>Time Slice:</b> | <b>10,000 BP</b>                                           |
| Relative Sea-Level | -30.7 metres                                               |
| Climate            | Continental                                                |
| Flora              | Hazel, Pine, Willow, Oak, Elm, grasses (see above)         |
| Fauna              | Bears, Wolves, Boar, Eagle, Man arrives                    |
| <b>Time Slice:</b> | <b>5,000 BP</b>                                            |
| Relative Sea-Level | -8.5m                                                      |
| Climate            | Atlantic                                                   |
| Flora              | Yew, Pine flushes. Mixed deciduous woodland                |
| Fauna              | Wolves, Boar, Eagle, Man and domesticated animals          |

**Table 1:** Table showing Relative Sea-Level (RSL), climate, flora and fauna associated with the three chosen time slices (15,000, 10,000 and 5,000) to graphically interpret.

Note: Lough Atalia was an enclosed lake until 1,000 BP and so water level did not change much from 15,000 to present day.

### Streedagh Beach Armada Ship Simulation

This was the lesser of the two projects but still involved a considerable amount of work going from drone survey to web hosted interactive 3d model. Ronan O'Toole, formerly of Greenlight Surveys and now full-time staff with the GSI, was contracted with acquiring the drone survey data over Streedagh Beach, Co. Sligo.

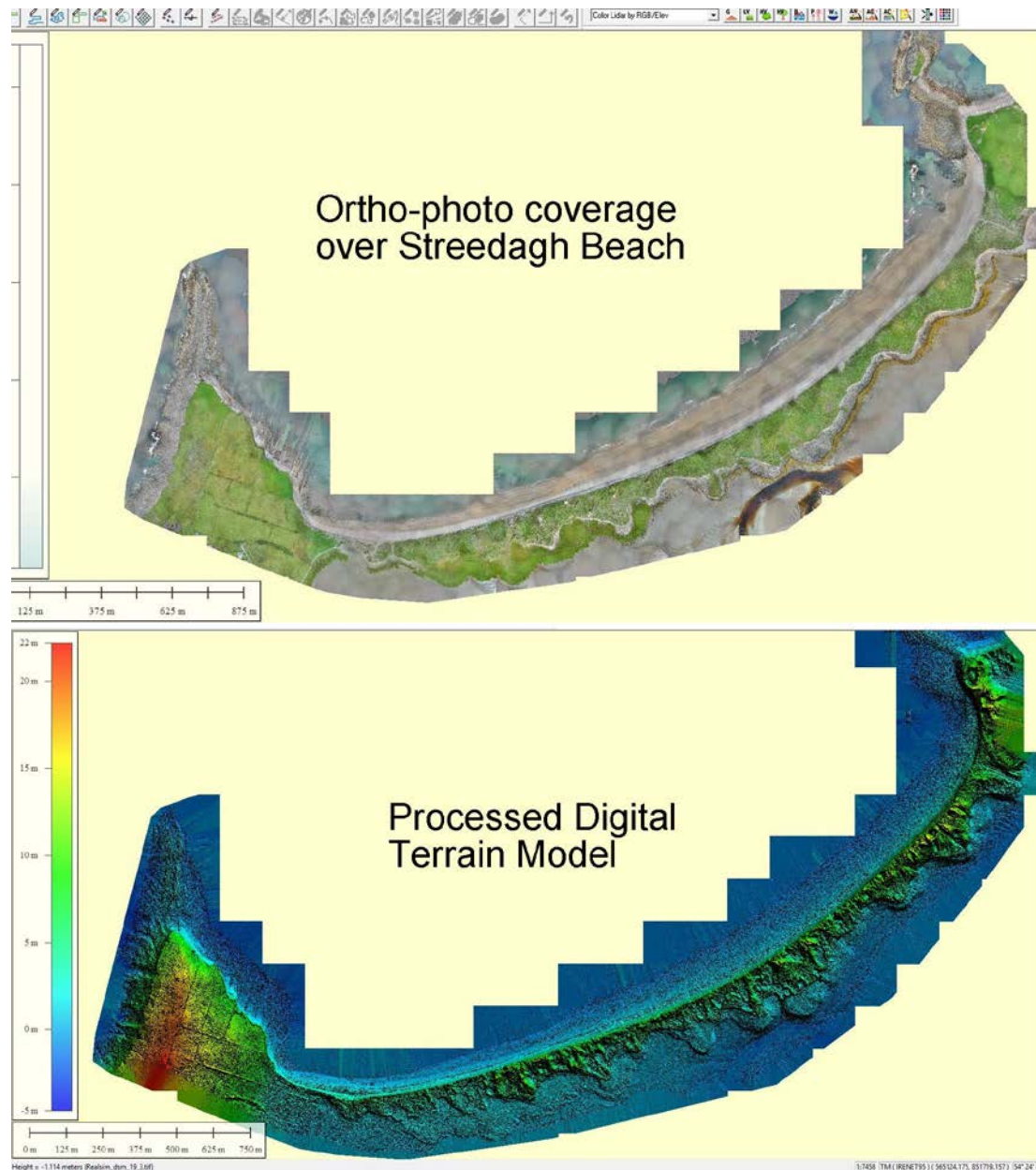
Due to his own contract work, Ronan was unable to do the survey himself so sub-contracted the survey to Korec who flew the beach in September. The area surveyed is shown in Figure 5.

Ronan O'Toole processed the raw drone data in Pix4D and sent RealSim the ortho photo and height map tiles of the survey area, which we further processed in Global Mapper in preparation for importation in to the Unity game engine.

Although this is a considerably smaller model area (2km x 1.2km) than Galway Bay, the ultra high density of the data at 3cm per pixel still makes this a very large dataset. Figure 6 shows a



comparison between the 3cm drone survey data and the 30cm World Map satellite data. As the ultimate aim of the Streedagh beach simulation was to deploy a web link, it was decided to restrict the highest detail of the survey to three viewing points along the beach (Figure



**Figure 5:** Processed Outputs from Pix4D from the drone survey over Streedagh Beach.



## Streedagh Beach Drone & Satellite Imagery Comparison



**Figure 6:** Comparison between the ultra-high resolution drone survey imagery (3cm) and the lower resolution (30cm) satellite imagery over Streedagh Beach, Co. Sligo.





**Figure 7: Viewpoints from within online Streedagh Beach model**

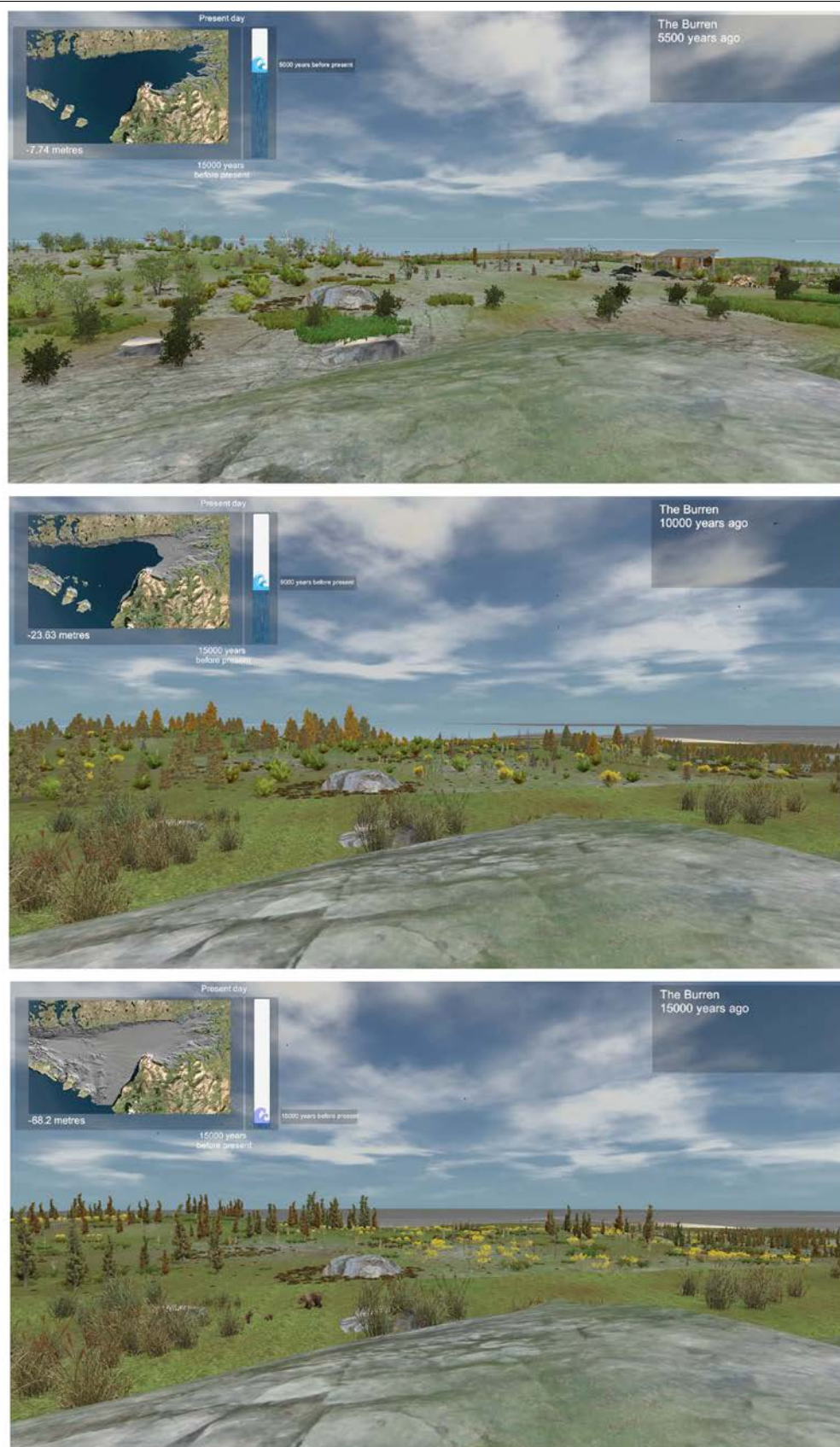
(iii) Outputs (please provide a short description and complete the table below)

#### **Galway Bay Evolution Outputs**

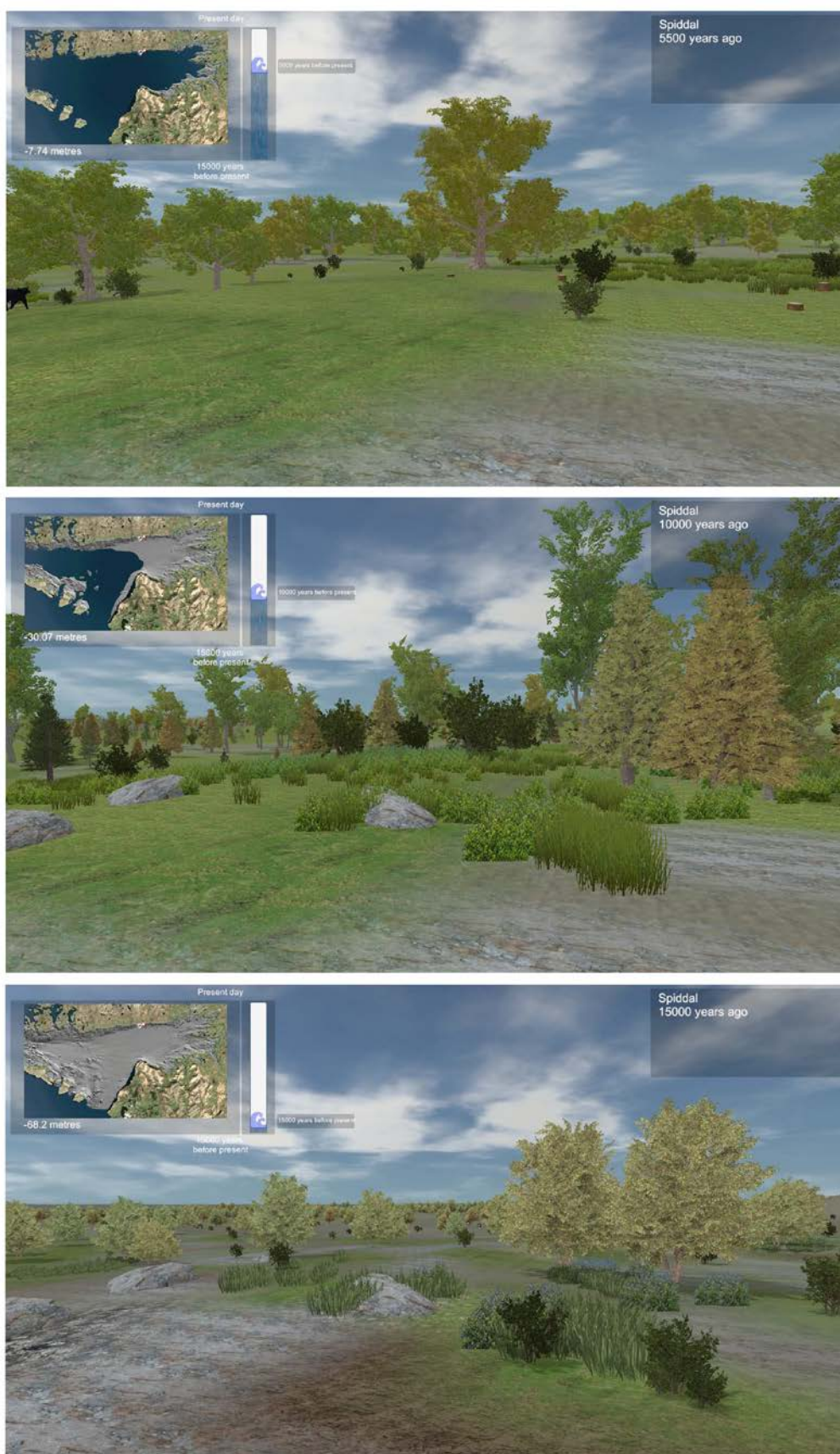
An offline, desktop interactive 3d simulation of Galway Bay with the following elements

- overview scene with time slider showing the relative sea-level at 500 year intervals from 15,000 years BP to present
- Three detailed ground views at Lough Atalia, Spiddal and the Burren with time slider showing three different time slices, 15,000 BP, 10,000, BP and 5,000BP, See Figure 8 - 10.

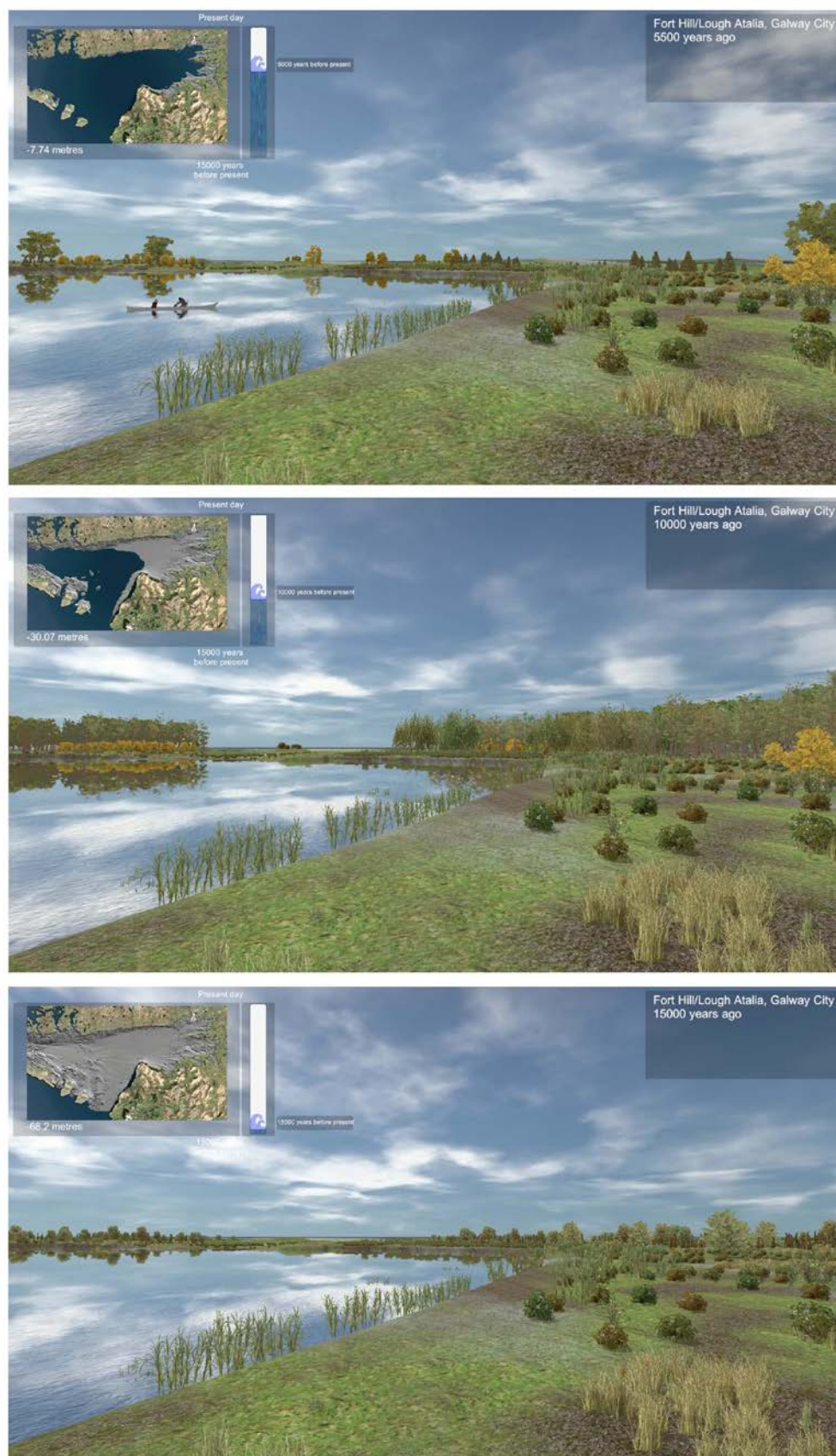
The deliverable is an executable file that will play of any Windows PC or Apple Mac with a dedicated video graphics card. It is intended to further develop this model for eventual public display in the Cliffs of Moher visitor centre and as part of a virtual reality programme experience in 2020 as part of the city's European Capital of Culture festivities.



**Figure 8:** Three time slice views from the Burren for 5000, 10,000 and 15,000 years BP.



**Figure 9:** Three time slice views from Spiddal for 5000, 10,000 and 15,000 years BP.



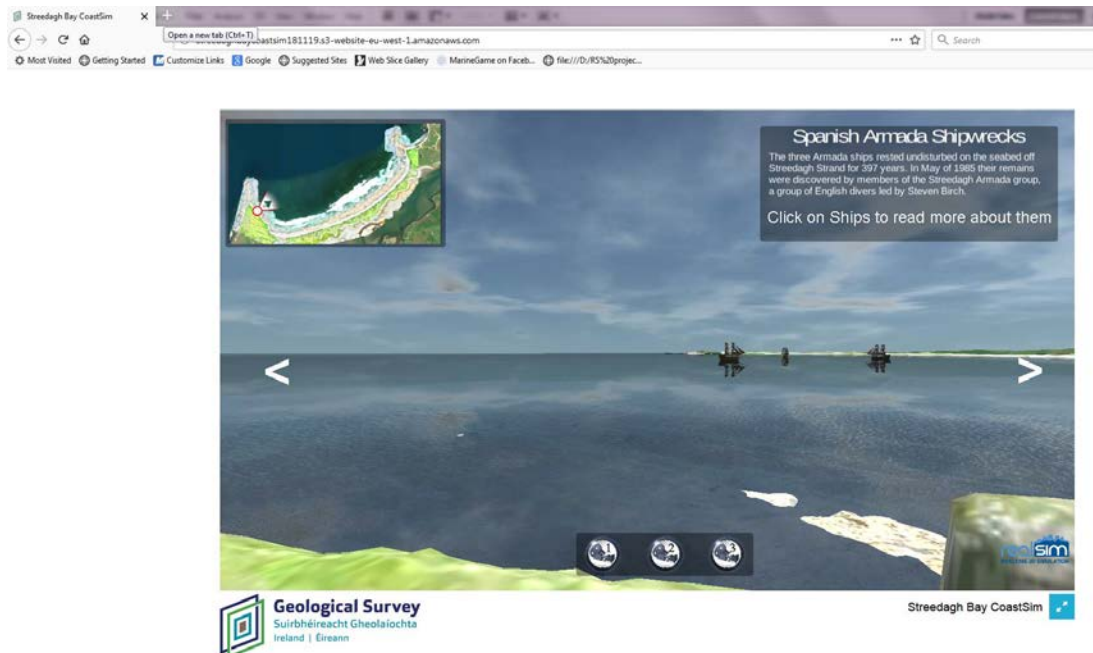
**Figure 10:** Three time slice views from L. Atalia for 5000, 10,000 and 15,000 years BP.



## Streedagh Beach Outputs

Output is a desktop playable web link, see link and screenshot from one of the views ;

<http://streedaghbaycoastsim181119.s3-website-eu-west-1.amazonaws.com/>



**Figure 11:** Screen capture view of the Streedagh Beach online viewer.

Drone survey data can be supplied and is available for use by any 3rd party researcher if so desired.

| Task No. | Deliverable description                                                                  | Planned delivery (as per proposal) | Date of delivery |
|----------|------------------------------------------------------------------------------------------|------------------------------------|------------------|
| 1        | PC based version of CoastSim - the offline coastal paleo-environment simulation platform | Month 9                            | Month 12         |
| 2        | Host WebGL environments on RealSim server                                                | Month 10                           | Month 12         |
| 3        | Report Delivery                                                                          | Month 11                           | Month 12         |

### Publications to date:

No academic publications have been made but the Streedagh beach work will be publicly available to view.



**4. Data/outputs submitted with final report** *(please list the documents, presentations, datasets etc. submitted with this report)*

- a. Web Link to Streedagh Beach viewer
- b. Executable to Galway Bay Evolution Model (sent as a WeTransfer download link)