# *A level student worksheet*

# A Level resource: Coastal Data Discovery

## Coastal hazard and response: what actions would you take in the south west?

## Introduction:

1. **Study the PowerPoint on Coastal Hazard forecasting and monitoring in South West of England**

a. Briefly summarise why wave height is important in affecting the overtopping of sea walls.
b. Explain the three main factors that affect wave height.
c. Onshore winds, often during storms cause wave overtopping. Referring to the PowerPoint **and** the maps of Penzance and Dawlish, explain why overtopping is a significant hazard for both rail and road communications and property. Remember to use map evidence in your answer.

**Understanding coastal monitoring:**

**Wave monitoring:** Waves can be monitored using offshore buoys that are tethered to the seabed. These can measure several wave characteristics such as wave height, frequency and direction. Some also measure and record weather information such as wind direction and wind speed. There is a wave buoy just off the coast at Dawlish and a nearby land based met station, at Exmouth, which measures the weather.

2. **Access real time data for the buoy at Dawlish at** https://coastalmonitoring.org/realtimedata/?chart=103

a. Record the live data for the date and time instance when you access the link. Date and time; Wave height (m) Max. wave height (m); Peak direction ( wave direction given in degrees, where coming from the north is 0 degrees and from the south is 180 degrees)
b. Go to data selection and select **date** 21 February 2022 (Storm Franklin) and **one week** and click GO. On what date did the maximum wave height (Hmax) exceed the storm alert threshold?
c. Change data selection to **one year** and click GO.
    i. How many times was the storm alert threshold exceeded between February 21 2022 and end of November 2023.
    ii. What was the highest significant wave height recorded (*Hs* is the significant wave height, which is calculated as the average wave height of the highest one-third of the waves)
    iii. Suggest why the other data such as significant swell height would be useful.

**Monitoring wave overtopping.** In 2018 the National Oceanography Centre constructed a new measurement system to collect information about waves overtopping structures such as sea walls. The WireWall uses a series of electrical wires to monitor and measure spray from waves, recording the speed and volume of a plume of water as it passes through the structure.

3. **Take a look at how water passes through the system at https://youtu.be/O1MK8WV4S-k and how the system works at https://youtu.be/a5Y33SWdNU4**

a. Suggest how WireWall can help engineers in the design of coastal defences?

b. Explain how WireWall can be used to give alerts of hazardous storm conditions?

## **Coastal monitoring in practice**:

The 'CreamT' research project has been monitoring wave hazards at Dawlish and Penzance. 'CreamT' stands for **"Coastal Resistance: Alerts and Monitoring Techniques".**

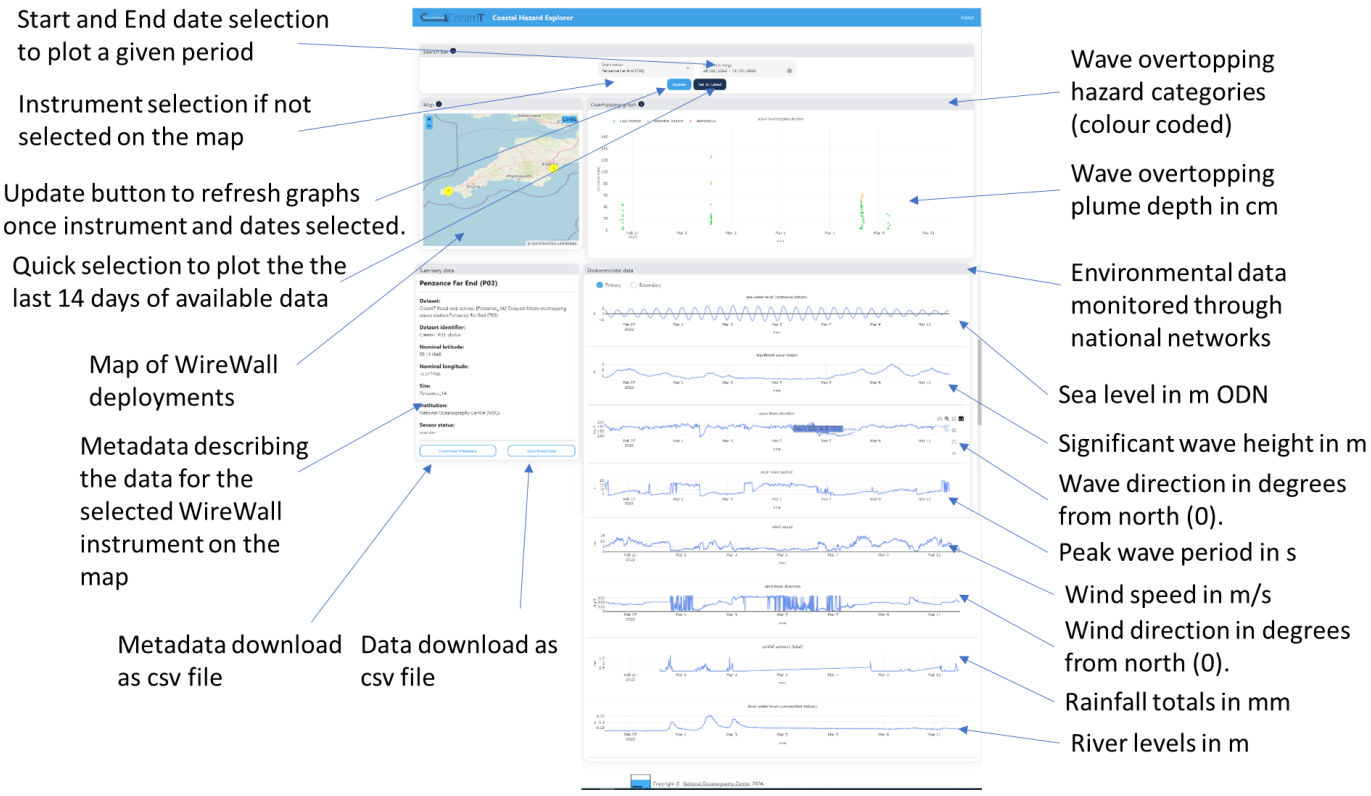
The Dawlish WireWall was installed on top of the sea wall at Dawlish (where the railway line collapsed in 2014) to study wave overtopping for a year from March 2021 – March 2022. Alongside WireWall, the University of Plymouth installed a camera to provide visual information about the overtopping conditions. The aim was to test the technology, linking it to live data from wave buoys and thereby creating a hazard alert system. The research enables scientists to see how the different combinations of waves, winds and tides interact to change the overtopping hazard to pedestrians walking along the sea wall at Dawlish and the train service running on the track just inland of the walkway. Look at the system in operation during windy conditions at Dawlish at: https://youtu.be/82h0HCcQLkQ

**Investigation 1: Investigating wave hazards at Dawlish using the WireWall data.**

The WireWall data can be accessed at https://coastalhazards.app.noc.ac.uk/

The data dashboard pulls together additional coastal, river and weather information from a variety of sources including the National Network of Regional Coastal Monitoring and the Environment Agency. Load the Coastal Hazards Explorer dashboard at https://coastalhazards.app.noc.ac.uk/

This annotated image to help you to investigate the potential hazards.




***Investigation question 1: What wind and weather conditions are likely to necessitate changes in rail operations?***

Network Rail has three options when there is a risk of wave overtopping damaging trains or affecting the track by erosion or flooding.

- Apply speed restrictions to trains.
- Use only the inland track of the two lines, resulting in delays to services due to single track running.
- Cancel trains for the duration of the storm.
- *Additionally in severe storms there may be a need to protect property beyond the railway.*

Look at the different weather, wave and tidal conditions in this YouTube video to see how the wave overtopping hazard varies in response to environmental conditions, https://youtu.be/DvJVQp_zL78. The clips were recorded by the University of Plymouth's camera deployed to allow the scientists and engineers to remotely observe what was happening at site.

Load the Coastal Hazards Explorer dashboard at https://coastalhazards.app.noc.ac.uk/

Select the WireWall systems for **Dawlish** and zoom in on Dawlish using the map in the left-hand corner of the dashboard until you reveal four dots in Dawlish representing the different WireWall systems deployed here.

Hover over the dots so their names come up. Click on the dot that represents the system at the edge of the sea wall '**Dawlish crest (D03**)'. The term 'crest' is the name given to the highest point in the

sea wall profile, close to the seaward edge of the wall which has a lip or return curve to direct the uprush from the waves back out to sea.

Set the start date to **1 March 2022** and the end date to **13 March 2022** and 'update' the graphs (be patient if data takes a few moments to load).

**Question 1:** How is the hazard of wave overtopping related to wind direction, wave direction and sea water level (height of tide)?

Now select the WireWall sensor that is positioned on the wall between the railway line and the walkway **'Dawlish Wall (D02)',** select the same dates and update. Note how this affects the hazard of overtopping nearer the railway. You can download the images to compare them.

Change the start date to the **7 March 2022** and the end date to the **9 March 2022** to look at three days in detail.

**Question 2:** When was the maximum wave overtopping time and depth for these dates?

**Question 3:** Investigate how environmental conditions affect the wave overtopping depth between the morning of March 7 and the morning of March 8. (*Hints – Look at sea water level (high or low tide), wind direction, wave direction, and significant wave height.)*

Based on this evidence, what advice would you have given to Network Rail regarding the hazard from overtopping risk on 7 and 8 March 2022?

**Question 4:** Using the data, find two other occasions between 11 March 2021 and 13 March 2022 when there was a significant hazard from overtopping at Dawlish Wall D02, and look at the environmental data. *Note:* the prevailing (most common) wave direction at Dawlish is from the South West, 225 degrees and Dawlish is partly protected by the headline immediately to the west of the station. You will need to zoom in on the dates you find for more detail.

Prepare a short report of use to Network Rail suggesting the most likely wind speed, wind direction and sea water level (tide state) that would help with forecasting the overtopping hazard and planning to need to modify train movements.

**Investigation 2: Investigating wave hazards at Penzance using the WireWall data.**

Look at the different weather, wave and tidal conditions in this YouTube video to see how the wave overtopping hazard varies in response to environmental conditions, https://youtu.be/VLBf7HaJP2I. The clips were recorded by the University of Plymouth's camera deployed to allow the scientists and engineers to remotely observe what was happening at site.

Load the Coastal Hazards Explorer dashboard at https://coastalhazards.app.noc.ac.uk/

Select the WireWall systems for Penzance and zoom in on Penzance using the map in the left-hand corner of the dashboard until you reveal two dots in Penzance, halfway along the sea wall and at the Newlyn end. Explore the wave overtopping between the dates 16-23 December 2022.

**Question 1:** Using the data for P01, identify the number of days with high hazard of overtopping from 16 to 23 December 2021. What wind direction, wave direction and sea water level accounts for the hazard?

**Question 2:** Now look at the same dates for P03. Suggest reasons for the low hazard at P03. *Look at the image of the coast, and use google earth.*

**Question 3:** Compare the overtopping events between December 7 2021 and December 8 2021, which represents the impact of Storm Barra on 7 December. Write a report comparing the hazard of overtopping on the mid Promenade at P01 referring to number of events and depth of overtopping, with the same dates at Penzance Far End P03.

**Question 4:** Suggest possible reasons for the differences in the hazard as you move further west, referring to wind direction, wave direction, sea water level (tide state) and shape of the coastline.

**Question 5:** Coastal management is needed along Penzance promenade. Write a short report using the data for wind direction, wave direction, significant wave height and sea water height to suggest what weather circumstances are likely to put the coastal promenade at greatest risk. You could look at the effects of Storm Agnes on Penzance on 27 and 28 September 2023 to assist you with your answer. Dramatic pictures show huge waves stirred up by 'dangerous' Storm Agnes - Cornwall Live

**Investigation 3: Comparing the overtopping hazard at Penzance with that at Dawlish for the same storms.**

Look at the sequences of different coastal conditions to see how the hazard from wave overtopping changes at each location in response to the weather, waves and tides. Clips have been recorded for Penzance https://youtu.be/VLBf7HaJP2I and Dawlish https://youtu.be/DvJVQp_zL78 using a camera deployed by the University of Plymouth.

Compare the data for Penzance locations P01 and P03 with Dawlish Crest at D03 for the period **1 March 2022 to 12 March 2022** which includes several overtopping events.

**Question 1:** (a) How is the data for Penzance different to Dawlish? Look at the exact time when the overtopping events occur and the depth of overtopping.

(b) Suggest reasons for the differences (direction the weather system is travelling in, and time of high tide).

**Question 2:** Using all the information you have studied, suggest why precise forecasting of overtopping events can be difficult to achieve in practice for a particular storm event.

John Davidson, July 2024