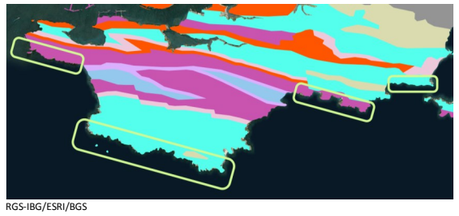
Shoreline sinuosity and geology

Both primary and secondary data can be used to measure and calculate sinuosity at different scales. In this example we use secondary data to evaluate two differing geologies on the south-west Pembrokeshire coastline near to two FSC field centres.

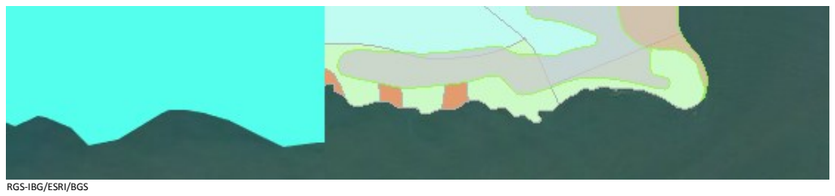
Geological data

Two layers are needed in addition to an **imagery basemap**; search for and add **625k V5** (DiGMapGB—625k V5 Bedrock Geology polygons) and **BGS 50000** (BGS 50000 scale digital geology). Adjust the transparency on each layer to about 50%. Note that the geometry of the 625k layer has been simplified and also that it has a different projection which affects its alignment with the basemap (although this doesn't affect its utility for our purposes).

Four sample sites are identified using the smaller-scale 625k map (which works at a wider range of zoom levels), corresponding to two contrasting geologies; sandstone (red) and limestone (blue).


RGS-IBG/ESRI/BGS

The 50k map is then used, in conjunction with the BGS Geology of Britain viewer, to provide finer detail, and ensure sample sites are consistent by confirming that the underlying geology is unchanged. In the image below, for example, the 625k map on the left is completely uniform whilst the 50k map on the right indicates faultlines, superficial deposits and other geologies (such as Breccia (orange)) that we would want to avoid.

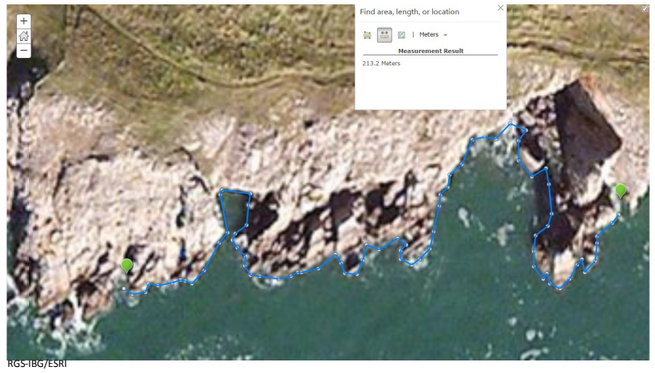

RGS-IBG/ESRI/BGS

Analysis

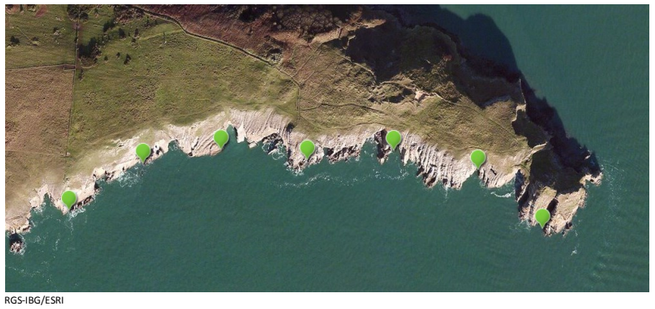
At each sample site, seven 100m segments of coast are measured and marked on the map. Using a new **map notes** layer and the **measure** and **line** tools, the *actual* length of the coastline in each segment is measured.

The sinuosity index of each segment is calculated by dividing 100 by the actual length measured in each segment. Summary statistics are calculated for aggregated data.

A simple initial analysis could evaluate the strength of any correlation between sinuosity and rock hardness (sandstone has a mohr hardness of 6-7; limestone has 3-4).



RGS-IBG/ESRI


RGS-IBG/ESRI

RGS-IBG/ESRI

*(Clockwise from bottom left) At each sample site, use **map notes** and the **measure** tool to mark 100m segments (place these just back from the coastline to make measuring easier later). Using the measure tool, measure the **actual** length of the coastline in each segment, paying attention to shadows and swash—be consistent. Repeat this process for the area of contrasting geology (sandstone).* ***Source**: RGS-IBG, (2017). Arcgis.com. ESRI. Using data from the BGS, (2017).*

Further development

Sinuosity may be related to a variety of variables. We could, for example, formulate a hypothesis and analyse our data with respect to several mechanical properties of the geology, or to the aspect of the coastline. We could extend our study to investigate the potential influence of coastal defences (that might reduce longshore drift and therefore increase rates of erosion). Going further we might analyse additional geologies or evaluate the predictive ability of the data.

In the field we could collect primary data to corroborate our analysis, or evaluate additional variables such as grain size or porosity. With access to a drone, high-resolution aerial photography could further augment this approach or enable simultaneous analysis of cliff profiles to explore any potential relationship.

To evaluate several variables simultaneously using multivariate regression exceeds the requirements of A Level Geography. However you can, and should, evaluate potential individual relationships statistically, paying particular attention to confidence and potentially confounding variables which might affect your conclusions.

Evaluating sources of uncertainty

- To what degree of accuracy are we able to measure the coastline from aerial photography? How can we quantify this in the field? Is any error consistent?
- Are the geological maps used accurate enough?
- Is your information about mechanical properties reliable and accurate?
- Have you collected enough data for your statistical analyses to be significant? Would more data improve your confidence?
- When completing fieldwork, are the methods you use to collect data reliable? Do they have inherent errors? e.g. How accurate is the GPS/smartphone app, did your attention/skill change during the day?
- How did you determine *where* the coastline was? How did you control for the tide? Could you measure the same coastline using aerial imagery, or was it inaccessible? Was this problem consistent? How did you control for it?

Discussing, quantifying, and ameliorating the effects of uncertainty are fundamental to a successful NEA. Uncertainty does not degrade the value of your fieldwork but it should be considered in your conclusion such that you are able to quantify and communicate the statistical confidence you have in your results.

Nuffield Foundation
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