Candidate 1 evidence

How do beach profiles and landforms change along the Scottish East coast and why?

Name :

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Word Count : 3,296

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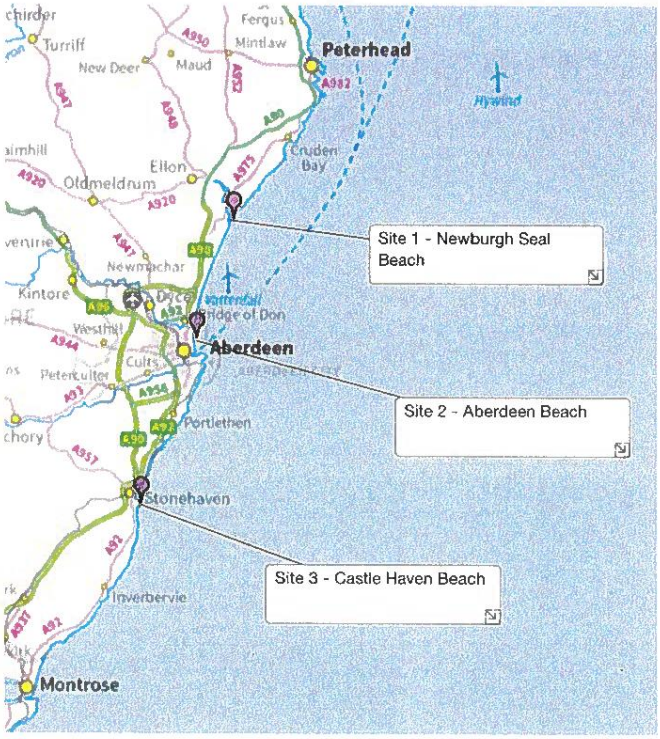


Figure: 1 Digimap For Schools[1]

[1] https://digimapforschools.edina.ac.uk/?error=session&context=/roam/map/schools

Contents

Introduction

The Scottish East coast is a place of outstanding natural beauty with its own unique geography to go along with it, including a vast variety of rocks that date back almost 500 million years[2] and even the famous highland boundary fault line which extends directly through the town of Stonehaven[3]. Hence making Newburgh, Aberdeen and Castle Haven fascinating locations to study.

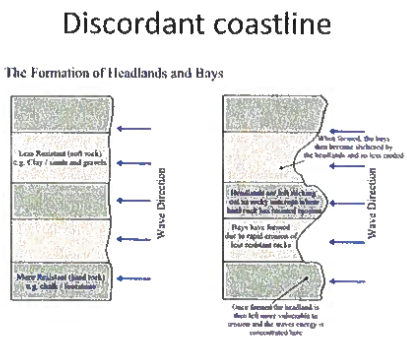
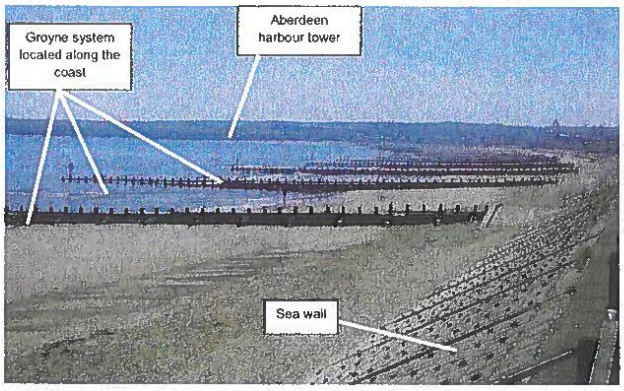


Figure: 2 [4] Coastline Diagram

The Scottish East coast is a discordant coastline as shown in figure 2, meaning it contains bands of differing rock that run perpendicular to the shore. Due to this difference in resistance, differential erosion through processes such as longshore drift takes place and results in the formation of headlands and bays. However where there is coastal erosion there must also be coastal defences to minimise its impact, a prime example is Aberdeen beach as due to continual coastal erosion issues it features both groynes and a sea wall, as shown in figure 3. Groynes are a type of man made structure that are built perpendicular to the shoreline and they are designed to prevent longshore drift from occurring, these were built on Aberdeen beach in 2006 by Aberdeen City Council as it was clear that due to wave action and longshore drift the beach sediment was slowly disappearing and resulting in the failure of the sea wall.[5]

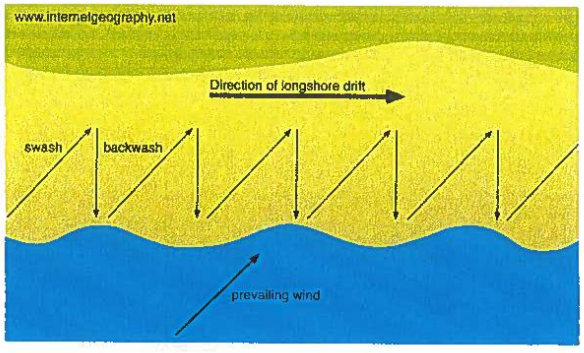
[2] http://earthwise.bgs.ac.uk/index.php/Solid_geology,_Cainozoic_of_north-east_Scotland
[3] https://www.localclimb.cc/highland-fault
[4] https://slideplayer.com/slide/4778618/
[5] https://www.abdn.ac.uk/geosciences/documents/Aberdeen_Beach_-_Case_Study.pdf

Figure: 3 [6] Aberdeen Coastal Defences



Longshore drift is the key process here and it occurs when waves approach a beach at an angle which depends on the direction of the wind. The swash, which is the water that rushes up the beach when a wave breaks the shore, contains sediment and travels up the beach in the direction in which the wave breaks. The water returning back to the sea is known as the backwash and due to gravity it tends to travel in a straight line back down the beach. Hence resulting in beach sediment transported in a zig zag movement known as longshore drift. It tends to occur in one direction only as shown in figure 4, the direction of the prevailing wind.

Figure: 4 [7] Longshore Drift Diagram



[6] https://www.abdn.ac.uk/geosciences/documents/Aberdeen_Beach_-_Case_Study.pdf
[7] https://www.internetgeography.net/topics/what-is-longshore-drift/

To effectively analyse the beach profiles we must take a look at the sea itself, more specifically the waves. Waves form when wind blows over the sea and their size is determined by factors including the strength of the wind and their fetch, which is how far the wave has travelled across the ocean.[8] There are two main types of wave that can occur and this is a result of the differing energy between the swash and backwash. Destructive waves create a steep beach profile and are characterised by a weak swash and a strong backwash that removes sediment from the beach, the waves are taller and break with more energy. While constructive waves create a more gentle beach profile and are characterised by a strong swash that encourages sediment build up and a weak backwash that cannot remove this sediment, the waves are lower and break with less energy.[9]

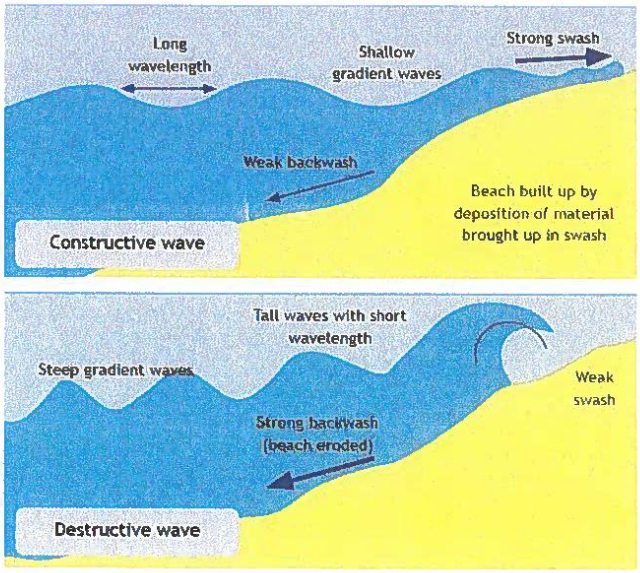
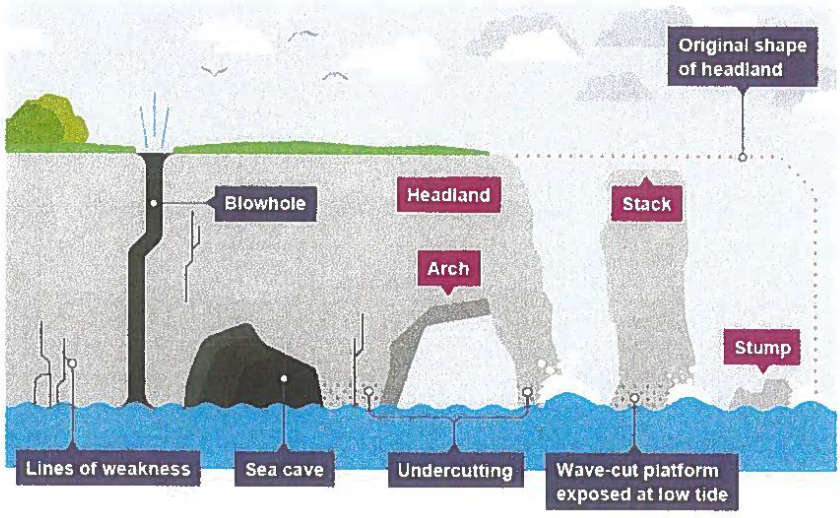


Figure: 5 [10] Wave Diagram

[8] https://www.bbc.co.uk/bitesize/guides/zt6r82p/revision/1
[9] https://www.bbc.co.uk/bitesize/guides/zt6r82p/revision/1
[10] https://app.wizer.me/preview/ONU0Q1

Erosional processes like abrasion, hydraulic action and corrosion result in the formation of fascinating landforms and Castle Haven was chosen as it is a perfect example of this, because it houses caves, stacks, stumps, cliffs, wave cut notches and many more. Each of these landforms is created through its own unique erosion process however some also form as a result of each other as shown in figure 6, stumps are a further continuation of stacks. Caves are constructed through hydraulic action as cracks form at the base of a cliff and over time these cracks are widened by processes including salt crystallisation until they develop into wave cut notches. These then widen further to form caves which due to refraction altering the direction of waves which increases erosion at the base of the cave, there is a possibility an arch will form if two caves form back to back. Over time the roof of the arch is struck by tall breakers and struggles to support its own weight, leading it to collapse to leave a stack which is eroded at its base until it too collapses to finally leave a stump.

Figure: 6[11] Landform Formation Diagram



[11] https://www.bbc.co.uk/bitesize/guides/zsdmv9q/revision/2

Aim & Research Questions

Aim : How do beach profiles and landforms change along the Scottish East coast and why?

Research Questions

1. What impact has the geology had on the erosion taking place?
2. What impact has the coastal defences made to the beach profile and coastal erosion?
3. What impact have the waves had on the erosion of the coastline?
4. Is there a correlation between the erosion taking place and the sediment type?

Methodology

To gather the appropriate data, it was imperative that each beach was unique, for instance Aberdeen beach is perfect for exhibiting the impact of coastal defences, Castlehaven exhibits fascinating landforms and rock formations while Newburgh is your typical flat, sandy beach accompanied by sand dunes. On the 5th and 6th of March 2022 I collected this data and strategically visited each beach before noon to ensure the tide was in a similar place each time, ensuring a valid comparison. In total 12 sites were measured to gain a clear representation of each transect. All through the use of stratified sampling, or more specifically stratified random sampling in which random samples are taken from within certain categories such as each beach. While not as accurate as systematic sampling, it provides greater precision and representation than random sampling.[12]

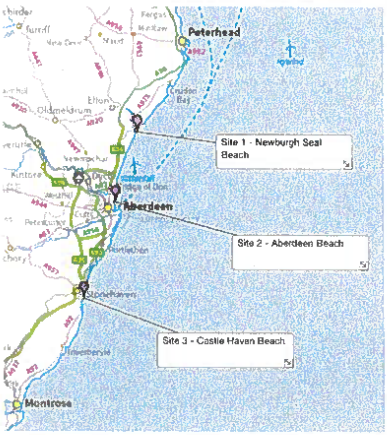


Figure: 7 Digimap

[12] https://www.bbc.co.uk/bitesize/guides/zq42ycw/revision/5

Beach Profile

The first pieces of data that had to be collected were the beach width and slope angle. Ranging poles were placed into the ground as shown in figure 8, to the same degree for an accurate measurement, at every break in the slope and the distance between them measured with a measuring tape, hence again employing stratified sampling. A clinometer was then placed at a specific point on one ranging pole and aligned to the same point on the other so I could look through it and accurately measure the gradient of the slope.

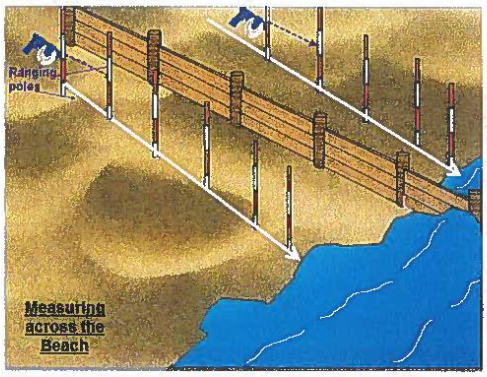


Figure: 8[13] Beach Profiling Technique

Waves

Wave frequency was determined through counting the number of waves over a specific period of time, in this case a timer was set for one minute. After doing this it was discovered that this was a subjective task, for instance as shown in figure 9 the waves at castle haven were generally very small, leaving room for human error. However this data allowed conclusions to be drawn on the wave type and through research the fetch of the waves approaching each beach was determined.

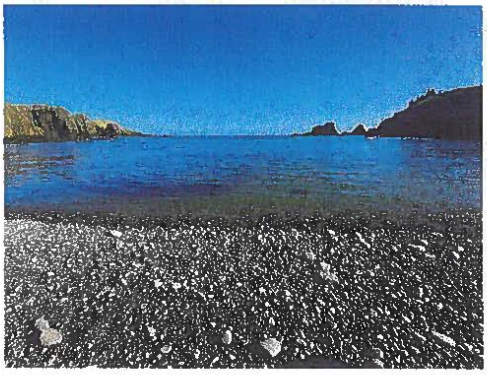


Figure: 9[14] Castle Haven Beach

[13] https://www.coolgeography.co.uk/GCSE/AQA/Coursework/Controlled%20assessment%20COASTS.htm
[14] Mackenzie

Sediment

To classify the beach sediment 5 pebbles were collected, and some sand if there was any, from each site through the use of random sampling as it was the best option to reduce bias and used a ruler to measure the length of each pebble by hand, making sure to measure the longest axis as shown in figure 10 by the letter A.

However in hindsight callipers would have been a more accurate option, in addition the roundness of the sediment was measured through the use of the Power's scale of roundness as shown in figure 11. While this method is one of the most accurate for measuring sediment shape, it is still fairly subjective to the human eye hence making it slightly unreliable. Although this was repeated at every site and the measuring was all done myself which should have helped control the extraneous variable of human perception.

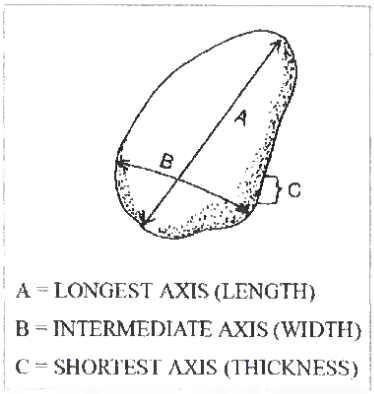


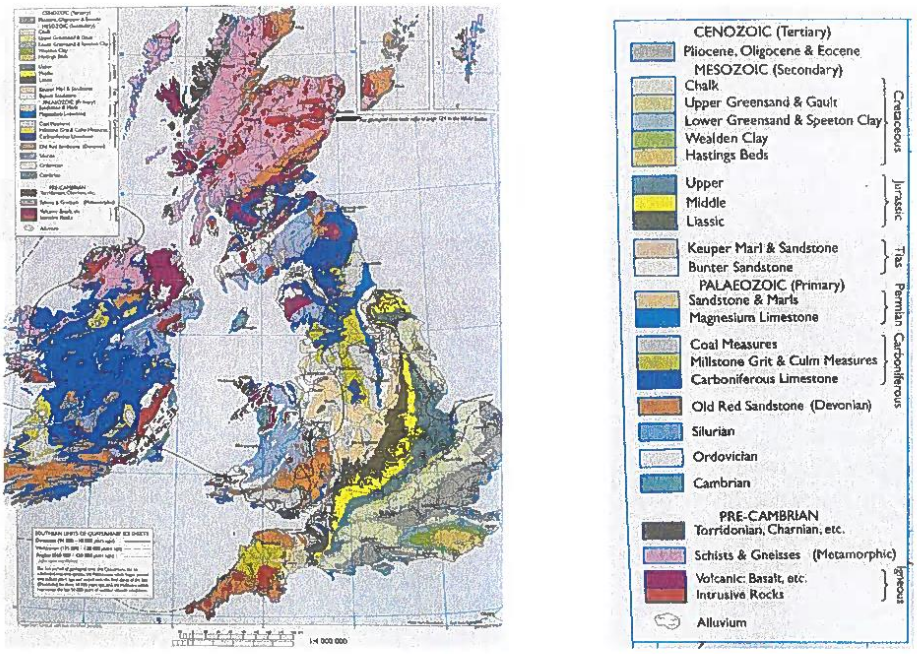
Figure: 10[15] Sediment size technique

Figure: 11[16] Power's scale of roundness

[15] https://andrewsforest.oregonstate.edu/sites/default/files/lter/data/studies/gs002/Wolman_Pebble_Count.pdf
[16] https://www.field-studies-council.org/resources/14-16-geography/coasts/fieldwork/

Geology

Determining the geology of the surrounding rock of each stretch of coastline was simply a task of research and through the use of various websites and above all the Royal Geographical Society's MODERN SCHOOL ATLAS, an extremely reliable source, I was able to determine the varying types of rock present and the impact this has on coastal erosion.



Figure's: 12 & 13 Atlas Geology Map & Key[17]

Landforms and Flood Defences

In terms of the specific landforms and flood defences present at each beach, this was more a case of observing rather than measuring and so I took photographs and did the relevant research afterwards, although this method did risk missing something important while at the beach.

[17] Book - The Royal Geographical Society (2019) MODERN SCHOOL ATLAS 99th Edition, Philip's

Results And Analysis

Aim 1 - What impact has the geology had on the erosion taking place?

As shown in figure 12 the North of Scotland is made of almost completely Precambrian rocks, meaning they relate to the earliest era of geologic history equivalent to the appearance of single celled organisms.[18] Figure 14 shows the highland boundary fault which can also be seen in figure 12 at the line separating the schists & gneisses metamorphic rocks with the intrusive igneous granite in the North (pink section) from the younger old red sandstone Devonian rocks in the South (orange section).

There are three main types of rock, sedimentary which are generally the least resistant, metamorphic which tend to be the most resistant and igneous which are also extremely resistant.[19] Igneous rocks can be extrusive or intrusive rocks like the granite in Aberdeen which form from magma that flows, cools and solidifies underground.[20]

Both Aberdeen beach and Newburgh beach are North of the HBF meaning their coastline is made up of metamorphic rocks, hence making them highly resistant to erosion[21] due to forming through environmental factors such as high pressure and heat. While Castle Haven beach on the other hand is slightly South of the HBF meaning it's coastline is most likely old red sandstone which is a sedimentary rock.

Figure: 14 Highland Boundary Fault (HBF)

[18] https://www.merriam-webster.com/dictionary/Precambrian
[19] https://www.amnh.org/exhibitions/permanent/planet-earth/how-do-we-read-the-rocks/three-types
[20] https://mineralseducationcoalition.org/minerals-database/granite/
[21] https://www.bbc.co.uk/bitesize/guides/z26cy9q/revision/3

Due to metamorphic rocks being much more resistant to erosion than sedimentary rocks, Aberdeen and Newburgh beach coastline should erode considerably slower than the Castle Haven coastline, this is proven by the data collected as Castle Haven features a cliff and has an extensive quantity of landforms as shown in figure 15 such as caves, wave - cut notches and stacks while both Aberdeen and Newburgh beach don't have many interesting landforms

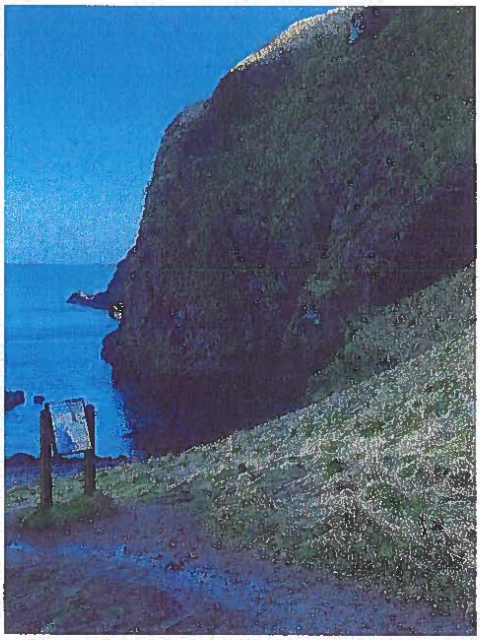
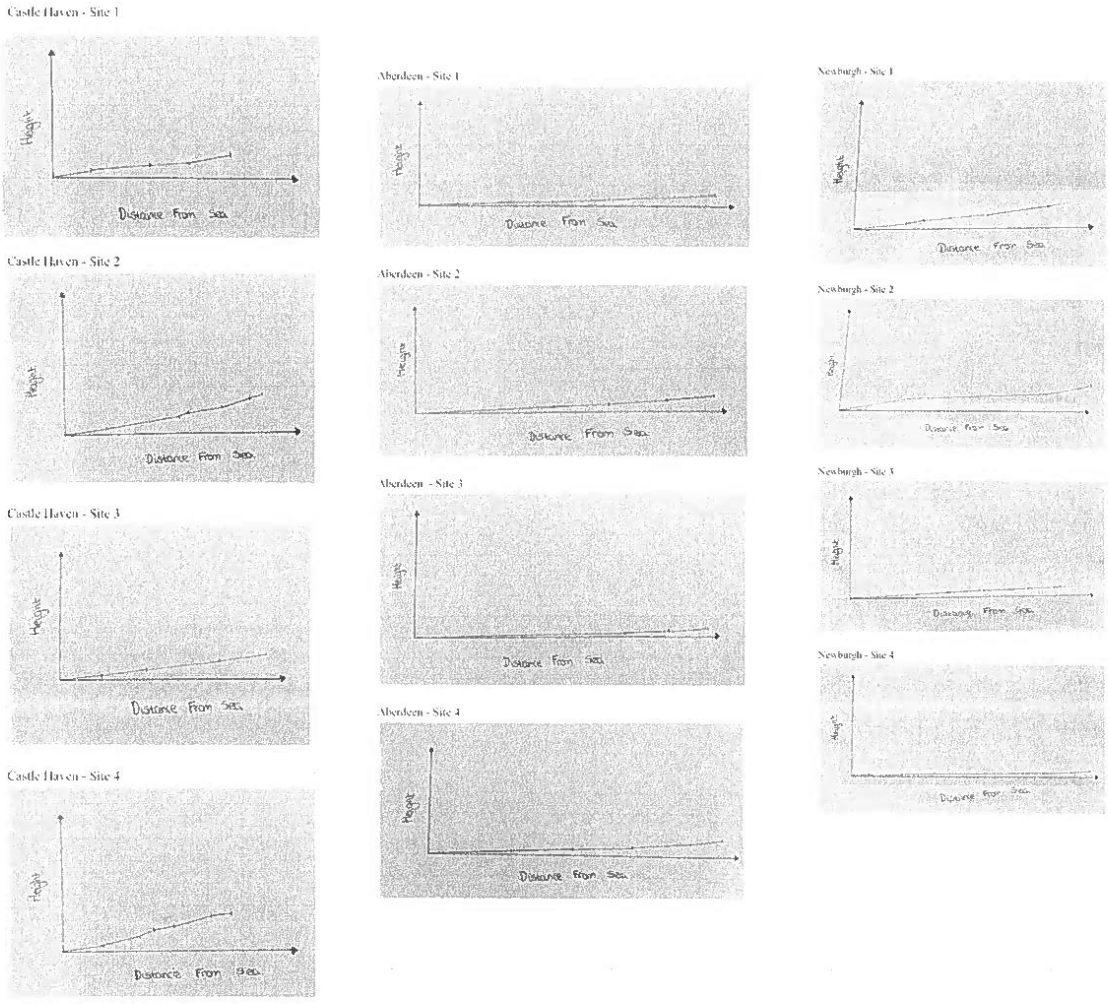


Figure: 15[22] Castle Haven Beach

[22] Mackenzie

Aim 2 - How do the beach profiles compare and what are the reasons for their differences, specifically in terms of coastal defences?



Figures: 16, 17 & 18 Cross Sections

Due to each beach being different lengths in total I used a different scale for each graph, 1cm = 10 feet for Castle Haven, 1cm = 20 feet for Aberdeen and 1cm = 50 feet for Newburgh due to it being the longest beach.

One of the primary reasons I chose these sections of coastline was that they each display a different human influence, for instance Aberdeen beach in particular has historically had many issues surrounding erosion and 'inspections in 2001 & 2004 showed that waves had caused the removal of significant amounts of sediment from the beach'[23]. This threatened not only the beach itself but also the infrastructure along the beach, the sea wall was failing and so action had to be taken through the construction of the groynes we see there today and a beach nourishment programme along 600m of coastline.[24] However the groynes especially have had a massive impact on the Aberdeen beach profile as shown in figure 20, we can clearly see the groyne preventing sediment from moving along the beach by longshore drift while the sand at Newburgh for instance is allowed to move with the processes. This results in Aberdeen beach having a large amount of variation in slope angle depending on where you measure.

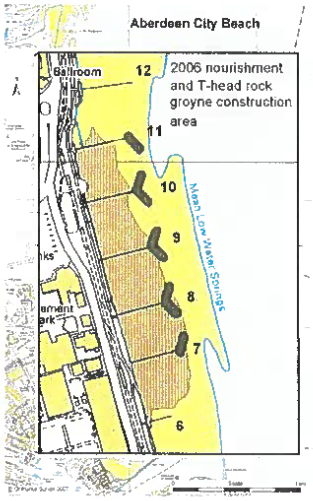


Figure: 19[25] Aberdeen Beach defences Birds Eye View

[23] https://www.abdn.ac.uk/geosciences/documents/Aberdeen_Beach_-_Case_Study.pdf
[24] https://www.abdn.ac.uk/geosciences/documents/Aberdeen_Beach_-_Case_Study.pdf
[25] https://www.abdn.ac.uk/geosciences/documents/Aberdeen_Beach_-_Case_Study.pdf

Figure: 20[26] Groynes

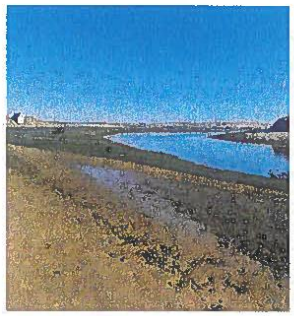


Figure: 21[27] Newburgh Estuary Mouth

As the cross sections show Aberdeen beach is the most level and flat, which is most likely due to human influences like the beach nourishment programme. In that the sediment was placed artificially and strategically by humans who most likely spread it out evenly, not to mention it is a busy beach in general meaning many people are compacting down and possibly eroding the beach and coastal defences prevent movement of sand. As the extensive quantity of erosion occurring from the destructive waves would generally result in a steep beach profile. Not to mention extraneous variables such as seasonal changes in beach profiles such as Winter beaches, which is when the data was gathered, being more concave and flatter than summer beaches. While the steepest beach profile is generally Castle Haven which also shows the most variation in slope angle, this is partly due to the fact that it is on a cliff and so there is constantly scree falling from the rock face and creating more prominent changes in slope angle. Castle Haven is least resistant and hence rocks frequently crumble down from the cliff face, not to mention that the rock surrounding Dunnottar Castle has been through a lot in terms of violence facing its first invasion in 900 AD by a Viking force[28] impacting how the rock has eroded. Finally, Newburgh beach is the most naturally level beach however some measurements at sites 1 and 2 were taken just inside the mouth of the estuary of the river Ythan as shown in figure 21, which resulted in some of the measurements being steeper than the rest of the beach through river deposition.

[26] Mackenzie
[27] Mackenzie
[28] https://www.dunnottarcastle.co.uk/history

Aim 3 - What impact have the waves had on the erosion of the coastline?

It was found that on average Castle Haven experiences 15.7 waves per minute, Aberdeen experiences 9.7 waves per minute and Newburgh experiences 11.7 waves per minute. According to the data collected we could assume that Castle Haven experiences the most destructive waves and that maybe that's why there are wave - cut platforms etc present, because the waves are tall, powerful and frequent. However as you can see in figure 9 they actually aren't, in fact Castle Haven experiences the most constructive waves of all three beaches which begs the question why are the waves more frequent? This is due to a multitude of extraneous variables including the fact that CastleHaven bay is extremely sheltered and the prevailing wind originates from SSW as shown in figure 21, resulting in the waves crashing against Dunnottar castle headland before entering the bay hence reducing their destructive energy.

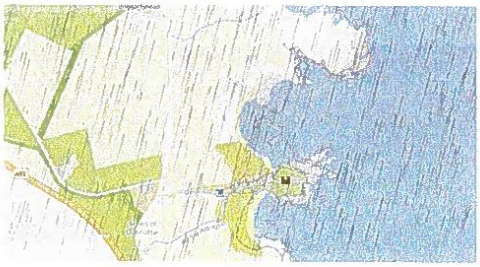


Figure: 22[29] Prevailing Wind

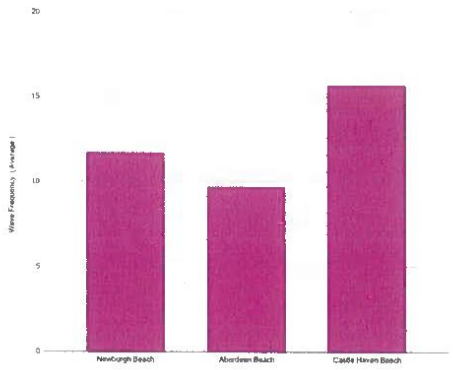


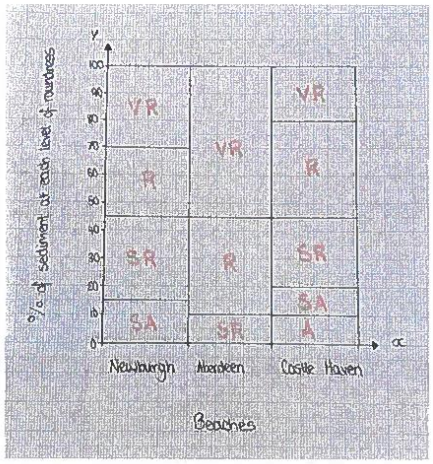
Figure: 23 Wave Frequency Graph

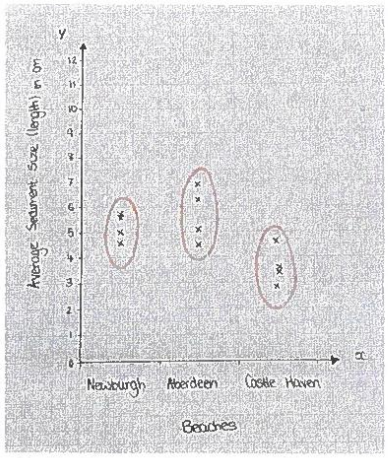
[29] https://www.windfinder.com/#16/56.9475/-2.1947

Although a variable with an even larger impact on the waves is the coastal defences present which is shown through Aberdeen experiencing destructive waves as shown in figure 24 however they are impacted by the many coastal defences that have been implemented as mentioned earlier. Beach nourishment programmes include adding sediment to a beach due to the extensive quantities of erosion and deposition taking place, usually due to longshore drift. This removal of sediment is a key characteristic of destructive waves, hence displaying the inaccuracy with using one singular method such as wave frequency to study a beach, it is often important to take into consideration external factors affecting validity. The sheer quantity of defences that have been used at Aberdeen beach display the waves destructive nature, while the waves at Newburgh beach for instance are somewhere between the two but the waves are not posing any threat to the coastal land and no action has had to be taken there.

Figure: 24 Aberdeen Beach Destructive Waves

Aim 4 - Is there a correlation between the erosion taking place and the sediment type?





Figures 25 & 26 : Graphs displaying sediment size and shape

From the data gathered and displayed above it can be concluded that Aberdeen generally houses the largest and roundest rocks, followed by Newburgh while Castle Haven houses the smallest and most angular rocks. It may be easy to assume that the rocks at Castle Haven should be larger due to recent cliff erosion although there are various reasons why this wasn't the case, including that rocks falling and crashing to the ground erode through attrition, not to mention the fact that sandstone is known for crumbling and I may not have even reached the area where any larger rocks could have been due to safety reasons. However it does make complete sense that these rocks would be most angular as many will have recently fallen from the cliff and not have had time to erode around the edges.

This erosion of Castle Haven cliff face due to biological, physical and chemical weathering results in the formation of scree which is known as an accumulation of loose stones lying on a slope or at the base of a cliff.[30] However there has also been a proven correlation between steeper beach slopes and bigger grain sizes, the primary factor at play being percolation

[30] https://www.merriam-webster.com/dictionary/scree

which is the action of trickling through something porous.[31] This is due to some of the swash disappearing into the sand rather than forming backwash, filtering or percolating its way through the grains. This results in more sediment being moved up the beach rather than down and hence sediment piles up and the beach becomes steeper. This makes sense as the bigger the grains, the more water that is allowed to percolate through the sand and the more sediment that can be deposited.[32] If we look at the type of sand present at each beach this theory is supported by the data collected as Castle Haven does not in fact contain proper sand, just very small rocks which resemble sand as shown in figure 20 while Aberdeen and especially Newburgh both contain finer sand and are much flatter in terms of profile.

Although one reason sediment is difficult to measure is that there is no way of knowing what sediment on Aberdeen beach specifically is native to that beach or if it came from somewhere else during the beach nourishment programme. Despite this, the fact that Aberdeen does house the roundest sediment further supports the theory that Aberdeen has the most destructive waves. This is because increased erosion of the sediment through Attrition and Corrasion (Abrasion) causes sediment to become rounder over time due to tall, high - energy destructive waves hurling sediment with great force onto the beach and other rocks.

Figure: 27[33] Coarse Sand at Castle Haven

[31] https://www.merriam-webster.com/dictionary/percolate
[32] https://magicseaweed.com/news/heres-why-steep-beaches-matter/11028/
[33] Mackenzie

Statistical Test - Chi Squared

Site	1	2	3	ROW TOTAL
Beach 1	11	14	10	35
Beach 2	9	9	11	29
Beach 3	13	14	20	47
COLUMN TOTAL	33	37	41	222

Figure: 28 Results Table

Chi squared shows how closely the data you observed matches the data that is expected, in other words it compares whether the variation in a data set is due to chance or one of the variables you're testing through allowing you to reject or accept the alternative and null hypotheses. In this case I am testing the variation in the data I collected on waves as shown in figure ?, making my null hypothesis:

- 'There is no significant difference between the wave frequency at each of the three beaches'

and my alternative hypothesis:

- 'There is a significant difference between the wave frequency at each of the three beaches'

Wave Frequency	Observed (O)	Expected (E)	(O - E)	$(O - E)_2$	$(O - E)_2/E$
Beach 1					
Site 1	11	5.2	5.8	33.64	6.47
Site 2	14	5.83	8.17	66.75	11.45
Site 3	10	6.46	3.54	12.53	1.94
Beach 2					
Site 1	9	4.31	4.69	21.1	4.9
Site 2	9	4.83	4.17	17.39	3.6
Site 3	11	5.36	5.64	31.81	5.93
Beach 3					
Site 1	13	6.99	6.01	36.12	5.17
Site 2	14	7.83	6.17	38.07	4.86
Site 3	20	8.68	11.32	128.14	14.76
					Total = 59.08

Figure: 29 Frequency table

Once I calculated my column and row totals I constructed the table shown in figure ?, where I found the expected value (E) through the equation 'E = (row total x column total) / grand total' allowing me to perform chi squared analysis. The next step in the process is to calculate the degrees of freedom which can be done using the formula:

DF = (number of rows in the table - 1)(number of columns - 1)
DF = (3 - 1)(3 - 1)
DF = (2)(2)
DF = 4

The final step was to refer to the critical values table and compare them to the chi squared value calculated which was 59.08 and the critical values at 95% (0.05) and 99% (0.01) were identified at 4 degrees of freedom as 9.488 and 13.277.

Critical values of the Chi-square distribution with *d* degrees of freedom

	Probability of exceeding the critical value						
d	0.05	0.01	0.001	*d*	0.05	0.01	0.001
1	3.841	6.635	10.828	11	19.675	24.725	31.264
2	5.991	9.210	13.816	12	21.026	26.217	32.910
3	7.815	11.345	16.266	13	22.362	27.688	34.528
4	9.488	13.277	18.467	14	23.685	29.141	36.123
5	11.070	15.086	20.515	15	24.996	30.578	37.697
6	12.592	16.812	22.458	16	26.296	32.000	39.252
7	14.067	18.475	24.322	17	27.587	33.409	40.790
8	15.507	20.090	26.125	18	28.869	34.805	42.312
9	16.919	21.666	27.877	19	30.144	36.191	43.820
10	18.307	23.209	29.588	20	31.410	37.566	45.315

INTRODUCTION TO POPULATION GENETICS, Table D.1

As the calculated value of 59.08 is greater than the critical value at 99% (13.277) we can reject the null hypothesis and can state that there is a significant difference between the frequency of the waves observed at the three beaches visited.

Figure: 30 Critical Value Table[34]

[34] https://www.mun.ca/biology/scarr/4250_Chi-square_critical_values.html

Conclusion

In conclusion, I can confidently state that there is a vast quantity of variation among the beaches that formed the east coastline of Scotland. A major contributor to this is the unique changes in geology in such a small sample area of coastline. This is largely due to the placement of the Highland foundry fault which sets up Castlehaven to be increasingly vulnerable to erosion and hence the formation of landforms in comparison to areas north of the island boundary fault such as Aberdeen and Newburgh. In terms of the influence of humans it can be concluded that the sea wall, groynes and beach nourishment programme have caused the destructive waves not to steepen the beach dramatically. However in addition to this Aberdeen beach surrounds the city centre meaning flooding is a risk and precautions had to be taken that may not have been at Newburgh for instance. There is also no doubt that the wave type has an impact on the beach profiles however this can be altered by a number of factors including protection from headlands in the case of Castle Haven, the strength and direction of the wind and the fetch of the waves. Finally we can state that the more erosion occuring at the beaches, generally the more angular and smaller the sediment will be.

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Candidate 2 evidence

What factors influence surfing conditions in a bay?

CONTENTS PAGE

What factors influence surfing in a bay?

The coastline of Scotland is constantly changing. Waves persistently erode and deposit along every inch of shoreline. Scotland, and its Isles, cover over 18,500km of coastlines[1], which are forever being beaten by the ocean and winds; they vary from beautiful white sandy beaches in the Hebrides, to towering craggy cliffs, for example, on the north coast at Cape Wrath.

Figure 1- Scotlands' coastline[2]

This geographical area of study is being researched from a recreational point of view, to discover what makes a beach 'good' for surfing. It will be captivating to uncover the causes of wave conditions as there are not many studies covering this topic and to further understand this element of geography will be interesting.

This study will focus on two beaches in East Lothian, as they have been declared as some of the best spots to surf in Scotland[3]: Belhaven Bay, home to Coast to Coast surf school and the Dunbar based Wave Project group, and Gullane beach (see figure 2). Many residents of both East Lothian and the City of Edinburgh surf at the 2-mile-long white sandy beach [4] at Dunbar. Belhaven Bay has gained attraction from its 'Bridge to Nowhere' (see figure 3)[5], as well as being a popular dog walking location based at the end of the John Muir Way[6]. Belhaven beach is backed onto a vast tidal salt marsh, leaving the beach out of site from the car park. Gullane beach, has steep sand dunes leading down to a thin stretch of coastline. The

[1] https://marine.gov.scot/data/facts-and-figures-about-scotlands-sea-area-coastline-length-sea-area-sq-kms
[2] https://www.worldatlas.com/upload/92/72/b1/uks-01.png
[3] https://openroadscotland.com/2014/scotlands-best-surfing-spots/
[4] https://sobt.co.uk/belhaven-bay/
[5] https://www.google.com/imgres?imgurl=https%3A%2F%2Fi0.wp.com%2Funusualplaces.org%2Fwp-content%2Fuploads%2F2018%2F11%2FBelhavenBay.jpg&imgrefurl=https%3A%2F%2Funusualplaces.org%2Fthe-bridge-to-nowhere-belhaven-bridge%2F&tbnid=jQrMLDSk8qyGLM&vet=12ahUKEwipgIm_ouP1AhWIh1wKHQgOATcQMygAegUIARCBAg..i&docid=uAVSb8IzPdcUjM&w=2048&h=1536&q=bridge%20to%20nowhere%20dunbar&client=firefox-b-d&ved=2ahUKEwipgIm_ouP1AhWIh1wKHQgOATcQMygAegUIARCBAg
[6] https://johnmuirway.org/

beach is surrounded by the village of Gullane, primarily known for its golf courses[7] and is used by many windsurfers, but surfers gather when the conditions are favourable.

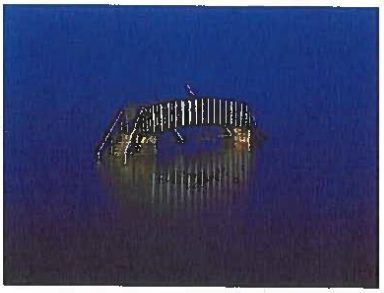
Figure 2- Belhaven bay satelite image[8]

Figure 3- Belhaven salt marsh

Figure 4- Gullane satellite image[9]

Figure 5- Gullane beach[10]

Figure 6: Bridge to Nowhere[11]

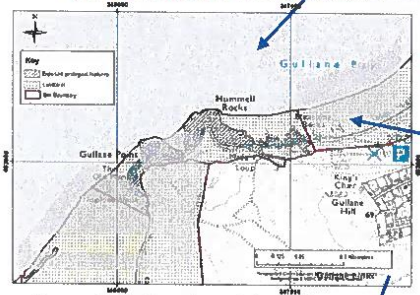


[7] https://www.thebeachguide.co.uk/south-scotland/lothian/gullane.htm
[8] https://www.thebeachguide.co.uk/south-scotland/lothian/belhaven-dunbar-map.htm
[9] https://www.walkhighlands.co.uk/lothian/gullane-beach.shtml
[10] https://www.visitscotland.com/info/towns-villages/gullane-p240821
[11] https://www.atlasobscura.com/places/belhaven-bridge

Figure 7. Area of study- East Lothian[12]

East Lothian is the area outlined in red- east of the capital- Edinburgh

Figure 8: Belhaven Bay boundary



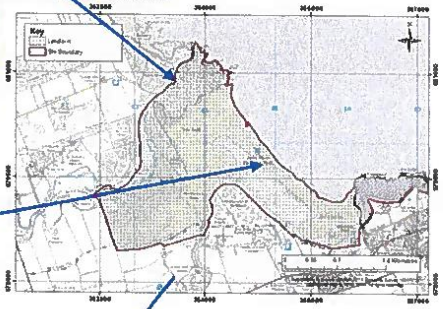


Figure 9: Gullane beach boundary

Gullane beach

- Located east of Edinburgh and faces northwards
- It is within the Firth of Forth
- Coastal landforms include cliffs and coastal platforms along sections of the coast- made of igneous rocks
- Easily accessible from a car park at the top of the sand dunes, with a steep short walk down to the beach

Belhaven Bay

- Located east of Edinburgh, facing eastwards, towards the North Sea
- Coastal landforms include a sand spit, sand dunes, sand flats and a salt marsh
- It is accessible from two car parks, both including a long walk to the water's edge

[13]Belhaven facts. [14]Gullane facts.[1516]

[12] https://datanation.edina.ac.uk/roam/map/datanation
[13] http://earthwise.bgs.ac.uk/index.php/OR/14/063_Site_assessment_-_ELC_28:_Tyne_Estuary_%26_Belhaven_Bay
[14] http://earthwise.bgs.ac.uk/index.php/OR/14/063_Site_assessment_-_ELC_13:_Gullane_Shore
[15] Figure 4: http://earthwise.bgs.ac.uk/images/thumb/f/f4/OR14063fig18.jpg/900px-OR14063fig18.jpg
[16] Figure 5: http://earthwise.bgs.ac.uk/images/thumb/d/df/OR14063fig33.gif/900px-OR14063fig33.gif

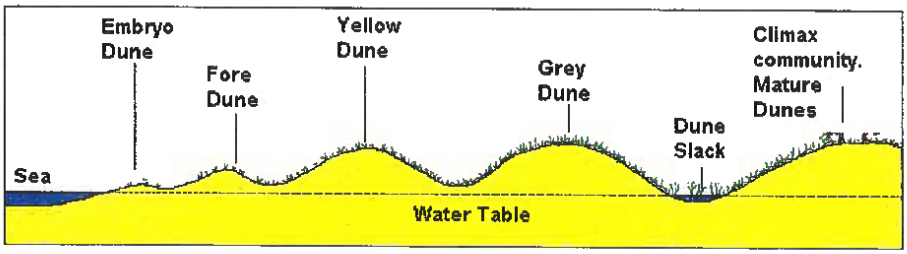
1. To what extent does the psammosere of a beach affect who visits and surfs there?

Hypothesis: The larger the beach and flatter the sand nearest the waters edge (embryo dune) will be the most used and popular beach.

Reason: The more space beach goers have, the more likely they are to visit the beach as they can pursue more activities such as beach volleyball in the summer. Dog walkers can also keep far away from people having picnics and BBQs so their pets are not tempted by the food. Over the past few years, because of COVID, people will be more inclined to visit larger beaches in order to stay far away from potentially contagious humans. A psammosere allows development of dune sequencing. A well-developed psammosere allows space for recreation and can affect the wave type if the embryo dune is developed.

Data collection: A study was conducted along the beaches of Gullane and Belhaven, people were asked if they prefer to walk locally or travel to other beaches. Surveys are a quick and easy method to conduct, with problems including that people may not feel inclined to tell the truth or prefer not to say.

Figure 10: cross section of a beach, psammosere[17]



On average, more people visit Belhaven Bay than Gullane Beach. Belhaven is 2.81 km long and 83.8 metres wide, which is significantly bigger than Gullane, at 1.38km long and 34.5[18] metres wide, at low tide. People may prefer to visit Belhaven because of its extensive size, although that may have some part to play in its number of visitors, it is doubted that it is the deciding factor. The population of Dunbar is 9430[19] people, 6650 more residents than Gullane, which stands at 2780[20]. People will be more inclined to visit their local beach as it means they don't have to travel far and it is familiar, which most people prefer[21], so more people will visit Belhaven as there are most residents of Dunbar.

[17] http://static2.mbtfiles.co.uk/media/docs/newdocs/as_and_a_level/geography/physical/coastal_landforms/48355/html/images/image21.png

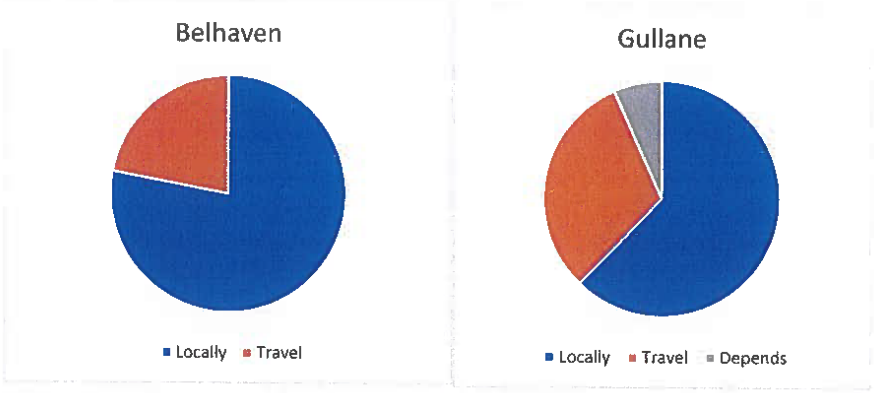
[18] Measured with tools on google maps

[19] https://citypopulation.de/en/uk/scotland/east_lothian/S19000831__dunbar/

[20] https://www.citypopulation.de/en/uk/scotland/east_lothian/S19000919__gullane/

[21] Based off a questionnaire in Gullane

Figure 11: Pie chart sharing where people choose to go for a walk[22]



In Gullane, 56% of people choose to go to their local beach instead of travelling to another beach to go for a walk, which makes up 28% of the survey that was conducted. 6% of people in Gullane stated that it completely depends on the day where they choose to walk. This could be because people would prefer to discover new places when they walk, or that they would prefer to find a larger beach where they feel like they have enough space to stay away from other walkers. They may also prefer to walk somewhere else because of the steep walk up and down from the beach, which could be too challenging for the elderly population of Gullane, which make up 28% of the town[23].

In Belhaven, 78% of people decide to walk locally and 22% choose to walk elsewhere if they have the time to. This could be because of the Coast-To-Coast surf school and Wave Project voluntary work at Belhaven gives the beach more recognition than Gullane, as there is more advertising and publicity, making people more aware of the beach and excited about the activities that take place. In turn, this brings more money into the area, which has helped build a surf centre and keeps the car parks clean. People will also be more inclined to move to places like Dunbar if they are aware of a large community spirit and different events such as the relay for life[24].

The dunes at Gullane provide greater interest for walkers- the undulating terrain gives more variety in terms of plant species compared to Dunbar where salt marsh (dune slack) can be 'boggy' and deter users. Instead they walk at the beach strand only. Therefore, in conclusion, the psammosere system does influence beach users in that they choose to avoid dune slacks.

[22] From a survey that was conducted
[23] https://www.citypopulation.de/en/uk/scotland/east_lothian/S19000919__gullane/
[24] https://www.google.com/search?client=firefox-b-d&q=events+held+in+dunbar&ibp=htl;events&rciv=evn&sa=X&ved=2ahUKEwiYvbuo4fL1AhXrQUEAHWGYAjQQ5rwDKAJ6BAgKEA4#htivrt=events&htidocid=L2F1dGhvcml0eS9ob3Jpem9uL2NsdXN0ZXJlZF9IdmVudC8yMDIyLTA2LTI1fF80MzUwMzc4NjIxMjk4Nzc4MTcx&fpstate=tldetail

2. What factors influence surfing conditions in a bay?

Hypothesis: The higher the wind speeds out at sea, the larger the waves along the coastline.

Reason: Waves increase in height if the wind is stronger, if the wind has been blowing strongly for a few days out at sea, then the waves will form to be of considerable height. Waves form by wind blowing across the seas surface and exerting different friction on the ocean's surface and above it. The distance of water where winds can blow in order to create these waves is called the fetch[25]. This causes the wind to turn in a circular motion, applying downward and upward pressure on the sea. Troughs and crests begin to form and grow larger under the winds pressure, so the greater the wind speed, the larger the waves formed[26].

Data collection: My own observations determined if the waves are impacted by the wind speeds, direction of swell or type of wave. Systematic sampling[27] was used to gather the height of waves along the shore of both beaches. I used this method as it is easy to execute and understand[28]. Secondary data was used, looking at forecasting apps and websites, which are reliable in a short time scale and are site specific[29], supplemented primary data.

On average, waves on both beaches were mostly influenced by the direction of the swell. If the direction of the swell at Gullane came from the Northeast, there is greater chance of larger waves in the bay more conducive to surf. At Belhaven however, if the direction of the swell is more Easterly, waves will be better: 'In order for waves to be nicer to surf, they need to break in one place and follow down the line, instead of the whole wave breaking at the same time or in lots of different places. This means that you can ride the wave for longer.'[30]

21 December, at 2pm, the sea at Gullane was completely flat, the sea temperature was around 6 degrees Celsius, which is about as cold as it is in Winter.[31] There was a family of three in the water stand-up paddle boarding (SUPping) and they had the perfect conditions for it as the wind was only blowing at 3mph. It was not possible to record any data about surfing conditions as there were no waves or surfers. This helps prove winds do impact wave size as there was very little wind, resulting in no waves on this day.

22 December, there were 1-foot waves at Belhaven, again with very little wind, there was nobody in the water, but many dog walkers. Both beaches are made up of fine golden sand, which surfers, especially beginners, prefer. They don't need to worry about hurting themselves on rocks and can go in the water at any place along the beach and still be safe. The material composition of a beach helps decide if the beach is good for surfing to some extent, as the final decider obviously lies within the waves.

The predominant wind direction in Scotland is Easterly[32], which was only recorded once across both beaches. 1 January, the wind was travelling at 25mph, North Westerly. This did not seem to have any impact on the people who were visiting the beach, as they all were prepared for the conditions. 12

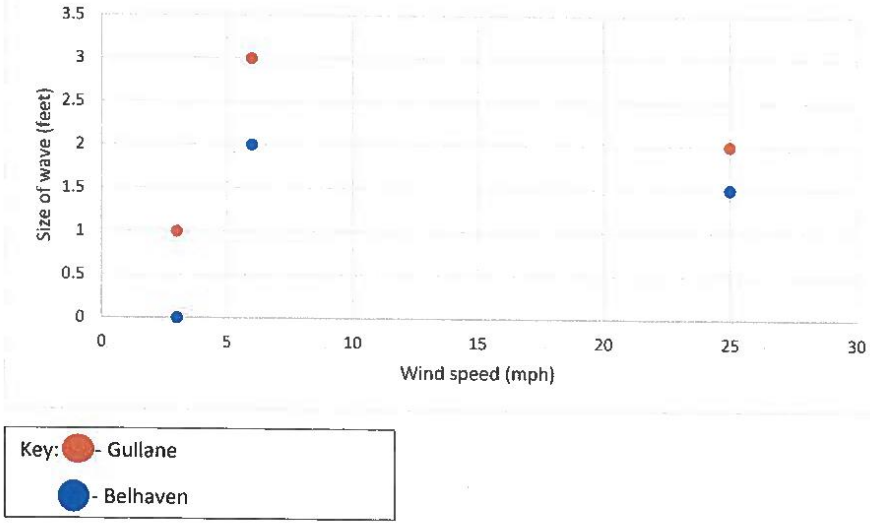
[25] Waugh D- The New Wider World
[26] Physical geography in diagrams- R.B Bunnett page 135

[27] https://www.investopedia.com/terms/s/systematic-sampling.asp
[28] https://www.investopedia.com/ask/answers/042415/what-are-advantages-and-disadvantages-using-systematic-sampling.asp
[29] https://metoffice.com
[30] Quote from a survey that was conducted
[31] https://www.seatemperature.org/europe/united-kingdom/dunbar.htm
[32] https://weatherspark.com/y/40085/Average-Weather-in-Gullane-United-Kingdom-Year-Round

people were windsurfing at Gullane, enjoying the small 2-foot waves to practice tricks, along with many beach walkers and groups of people jumping in the sea. Around 80 people on the beach and in the water at Belhaven, is potentially a higher number of people that would be on the beach on any other given day as people think of it as a tradition to go in the sea and start the year off in the fresh air.[33] The three-foot waves at Belhaven were messy, but fun for the beach goers to play in when they ran into the sea. There were a few people with foam boards, surfing in the white water, as the waves were not large or powerful enough to surf on.

Figure 12: Example of recreational user of the beach at Gullane

Figure 13: Scattergraph showing the effect of wind on the beach on the size of the wave



[33] https://www.theguardian.com/travel/2020/jan/01/my-favourite-way-spend-new-years-day

Figure 13 shows the biggest waves come into the beach when the wind is blowing at 6mph. Not enough data was recorded to expand results to see if more windy days have a different impact on the waves as the 6mph result could have been an anomaly or there could have been larger waves that day because of different variables. In future studies, recording of data over a prolonged period of time will provide more data and prove more useful. Time and COVID isolation restricted further data collection for this study.

03 January, wind was blowing onshore (westerly) at 6mph at Belhaven, resulting two-foot waves. The wind will not have been strong enough to flatten them as they came into the shore, as that is sometimes a problem that surfers have, if the winds are quite strong. There was nobody in the water, but numerous beach walkers, even though it was 3 degrees. At Gullane, on the same day, the swell was 1-2 feet[34] and nobody was in the water. It has been noticed the larger the waves are at these beaches, the more surfers are in the water, but data has not been recorded when there is a good swell forecast, which could change the conclusions drawn. Because of the data being collected in Winter, not many people will be learning to surf or spending much time in the water as it is so cold, the only time surfers will go in the water at this time of year is if the conditions are exceptionally good, which they haven't been whilst this data was collected.[35]

Both beaches are equally good for surfing, but due to Gullane's aspect, the swell must be the perfect Easterly direction in order to reach and come around into the beach. So, the consistency of waves at Belhaven is much higher than the consistency of waves at Gullane. Data from both beaches was collected twice on the same days, in order to improve comparing results.

A lack of data (surfers) will alter results as they are not able to be compared against averages from over the course of the whole year. More people spend more time at the beach in the Summer mainly because of the pleasant weather. Conducting results on New Years Day might not be accurate as beaches tend to be a lot busier because of looney dooks and people especially like to go for a beach walk.

Overall, data indicates wind speed had an effect on surfers but the general use of the water was determined by social tradition at the time of data gathering.

[34] confirmed by https://magicseaweed.com/

[35] https://magicseaweed.com/Belhaven-Bay-Dunbar-Surf-Report/850/

3. To what extent does the psammosere of a beach affect the shape of the waves?

Hypothesis:

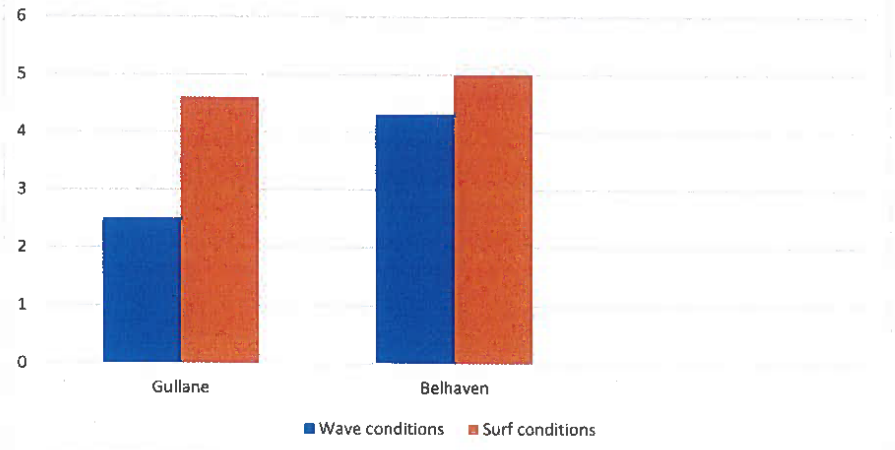
1. The steeper the embryo dune, the shorter the wave break will be.
2. The wave will break close to the shoreline, leaving no distance for the wave to be surfable.

Reason: 'Waves break when the steepness of the wave front exceeds a certain limit'[36] Waves moving along a steep slope underneath the water will break later (closer to the shore) as 'wave height progressively decreases with depth in the surf zone'.

A wave is a moving disturbance in the level of a body of water, an undulation. The surf is the waves that break on an ocean shoreline[37]. The difference between the two will be compared to see if they help decide which beach is more favourable for surfing.

Data collection: Surveys were conducted from beach users to ask what they think about the conditions of the ocean, which is a cheap and easy way of gathering data. Ranging poles were used in order to measure the gradient and height of beaches to see if it affects how close to the shore the waves break, and the power of the waves. The ranging poles may sink into the sand, to avoid any human error, the poles will be placed on the sand and held still as to ensure the pole doesn't sink into the sand.

Figure 14: Wave and surf conditions



[36] http://www.coastalwiki.org/wiki/Breaker_index
[37] https://wikidiff.com/wave/surf

Figure 15: Dune height profile of Gullane Beach

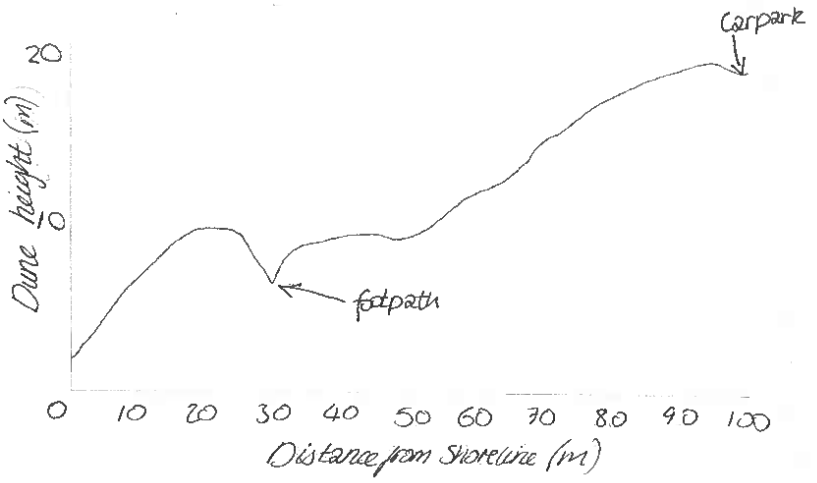
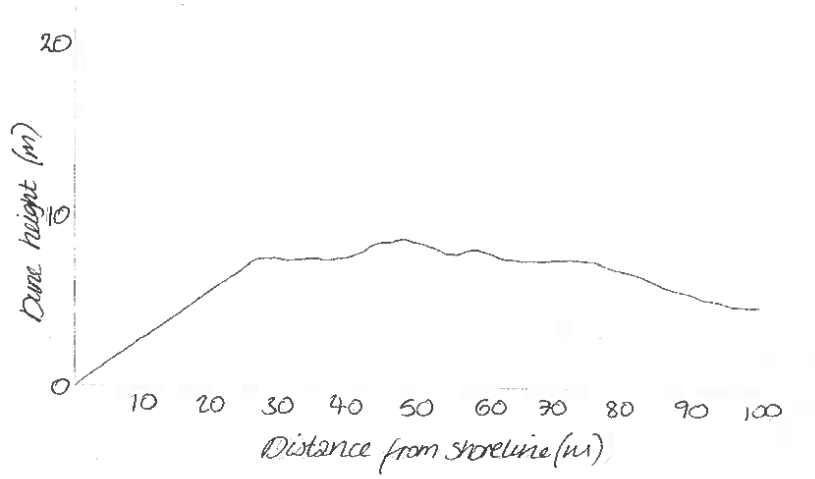


Figure 16: Dune Height profile of Belhaven Bay



Overall, conditions are more favourable for surfing in Belhaven; this could be because the beach faces the ocean, and is more exposed than Gullane. The surf in Gullane is better than the waves, meaning there isn't much swell before the surf appears and breaks. The relief of Gullane beach was measured to be 12 degrees, at high tides, which indicates that the beach is quite steep, so waves will break closer to the shore[38]. This helps prove waves heavily impact the quality of the surf, and because there is a greater body of water, providing bigger waves at Belhaven, it is the preferred place to surf.

[38] Page 113 Geography An Integrated Approach David Waugh

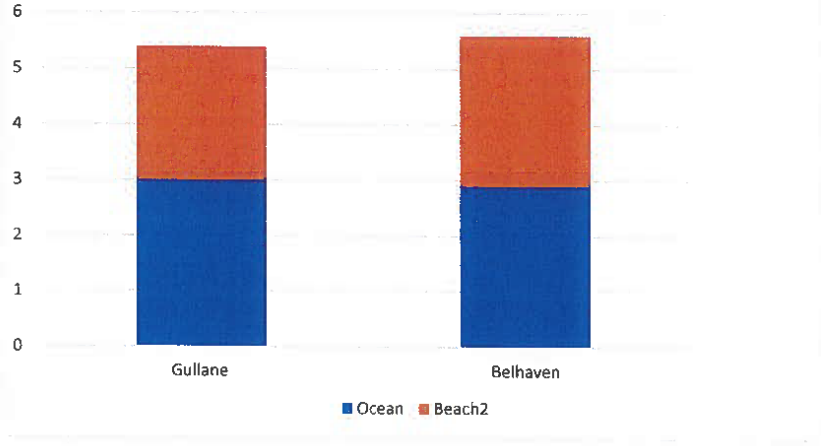
4. Hypothesis: Land users negatively affect the beach and water.

Reason: 'Sand dune development is about the stabilisation of loose sand.'[39] As people use the beach, they begin to erode at the paths and dunes, especially children digging and playing. This trampling will begin to damage intact dunes with stabilising vegetation. These plants will continue to erode away, until areas of open sand are exposed and winds begin to remove the sand, causing blowouts on dunes.

Data collection: Surveys were conducted to ask locals and surfers about the conditions of the beach and waves. Surveys are a fast and efficient method, as well as being cheap. A wide variety of information and questions can be directed to get explicit information able to be gathered[40]. A limitation is that some people do not want to answer question so data can be limited. The conditions of the beach were measured by conducting a look for nurdles along random points on the beach. Nurdles are small, pellet shaped bits of plastic that absorb toxins from the ocean. Each one metre squared segment was sifted through to find nurdles about 10 times each this is time consuming but give first hand quantitative data. Nurdles are best to look for in pieces of vegetation at the edge of dunes or in bits of seaweed, with slight onshore winds[41]. A proportional symbol map was used to show this, which summarises data in a visual form and is easy to read.

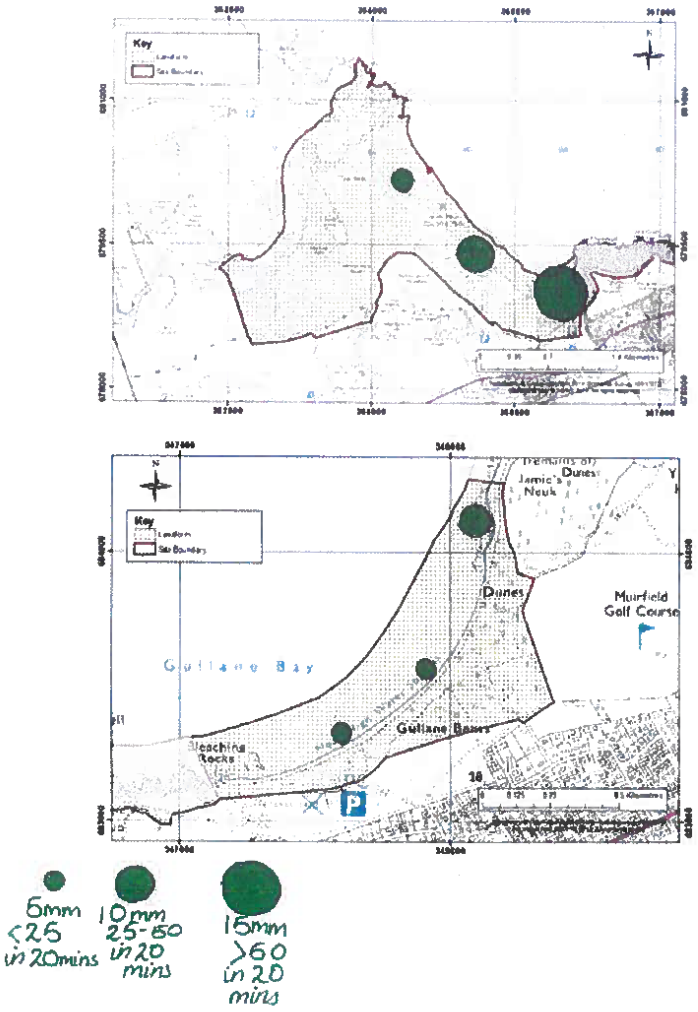
Both beaches are, for the most part, very pleasant and clean of 'Blue Flag standard[42]. This is because Gullane has community beach cleans, where mostly dog bags and small plastic items such as bottle caps[43] are collected. The Wave Project hosts beach cleans at Belhaven regularly, and this helps keep their small part of the world beautiful[44].

Figure 17: Conditions of the beach and ocean



[39] Page 127- Geography an integrated approach by David Waugh
[40] https://www.snapsurveys.com/blog/advantages-disadvantages-surveys/
[41] https://www.nurdlehunt.org.uk/site-map/item/27-how-to-hunt-nurdles.html
[42] https://www.blueflag.global/criteria
[4343] https://www.dolilthings.org/blog/the-big-beach-clean
[44] https://www.eastlothiancourier.com/news/19478023.volunteers-come-together-help-keep-belhaven-bay-clean/

Figure18: Proportional symbol maps showing how many nurdles were found on Belhaven beach (first) and Gullane bay (second)



The conditions of the ocean are very similar for both beaches, this is most likely because they are along the same strip of water along the Firth of Forth, which is much cleaner and less toxic than it used to be[45]. Belhaven beach is in slightly better condition than Gullane, standing at 2.4 and 2.7 on average. Belhaven had many more nurdles than Gullane. This could be because there is more vegetation for the beads to get caught up in, also as a result of currents from all over the world, washing plastics onto the exposed beach. Belhaven will be the first point of deposition when comparing both beaches. In addition, the tidal Firth of Forth will remove material from Gullane which also counteracts the deposition.

[45] https://www.nurdlehunt.org.uk/the-solution/forth-case-study.html

CONCLUSION

In conclusion, the main factors that influence surfing conditions in a bay can be broken down into two elements: physical and human. Surfing conditions are mostly impacted by wind speed, direction, and beach aspect. "Beach exposure is [also] incredibly important," Willis, a surfer from National Geographic, says. "Knowing the way the land faces and any obstructions between the land and a swell's origin are very important."[46] Belhaven's aspect towards the North Sea, means wind and swell hit the beach directly, whereas Gullane directs into the Firth-of-Forth, giving it shelter from harsh open seas. People heavily impact the conditions of a beach, more than the surf, from the way that they use it to how many people visit. Dunes become eroded with increased footfall, as well as general human activity, on busier beaches, such as Belhaven, more litter is left, making the landscape polluted and overall, not as aesthetically pleasing. This will in turn effect the psammosere of the beach as dunes will change over time. Although the coastline of Scotland is constantly changing, it is important that people learn how physical and human factors effect the ocean and beaches as to respect the power and force of it.

[46] https://www.nationalgeographic.org/article/surfs/

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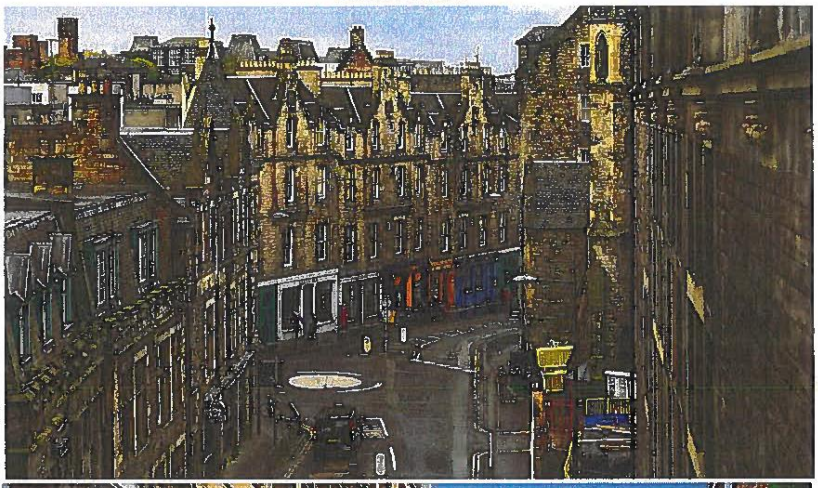
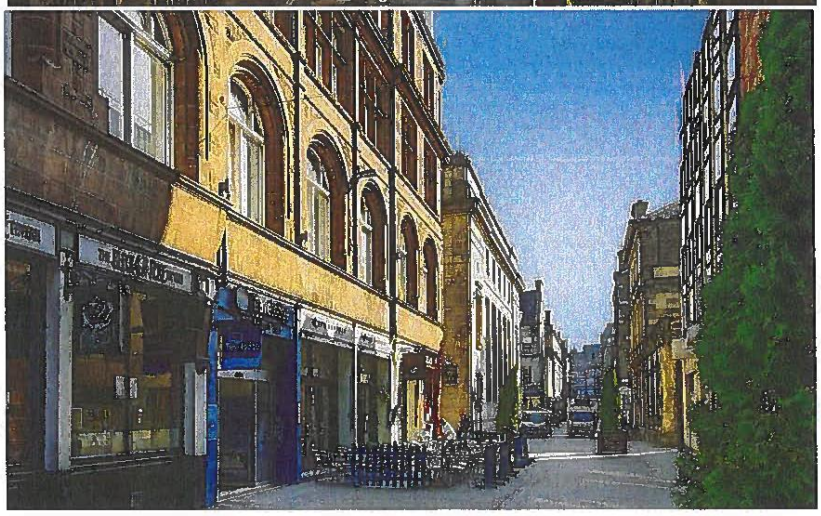
Word count: 2988

Candidate 3 evidence

A COMPARATIVE INVESTIGATION OF URBAN ISSUES IN EDINBURGH'S OLD AND NEW TOWN





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CONTENTS PAGE

INTRODUCTION

The concept of cities not being designed to keep women safe has become increasingly topical in the light of the murder of Sarah Everard. Less commonly thought about is a women's place in the city. Do they feel they have a sense of space in the city or belong there? I wanted to incorporate my interest in women's safety into this study by researching how geographical issues, specifically safety, can impact different groups in Edinburgh's Old and New Town.

But what is safety? Geographical safety is the safety an area holds drawing from the physical urban evidence. [1] This allows us to investigate what makes a place safe and delivers socio-economic and environmental benefits to an area. Factors such as deprivation, poverty and anti-social behaviour and hostile architecture all contribute to a unsafe public space.

What adds to perceptions of safety?

Firstly, poverty which is perceived as an area having more crime, especially by the media who create stories about poor people stealing benefits and homeless people being described as "*druggies.*" Brands, Schwanen and v.Aalst highlight this by stating *The Fear of Crime* is mainly spread by media reports which may in part be untrue, but still have strong impacts on the way people perceive public spaces[2]. This is not often based on concrete reality or the physical space we move through.

Secondly, factors such as land use and public activity, lighting, and pedestrianisation of areas all contribute to the perceived safety of an area. The Safer Sweden Foundation outline nine fundamental aspects important to safety issues, the key ones being "*light, open spaces, and access.*" [3] Brands state that "*light gives people the ability to get an idea and overview of a space. If a space is not well lit and visibility is limited, an increased sense of feeling unsafe is triggered.*" Also, the World Health Organisation finds that "*pedestrianisation not only improves safety for pedestrians but also contributes to lower levels of noise and air pollution.*" [4]

Lastly, accessibility and hostile architecture cause an unpleasant environment to be in and impact on the safety of marginalised people. Specifically, the example of cobbles hampering the mobility of pram and wheelchairs users. Feminist geographers such as Laura Somoggi and Leslie Kern show how cities have been set up by the dominant for the dominant, "*cities have been planned by men, for men.*"[5]

This study will allow me to develop my analytical, data processing and research skills to reach a valid conclusion on how urban issues in Edinburgh can negatively impact those who are excluded within a city.

BACKGROUND KNOWLEDGE AND LOCATION

Edinburgh is located in the Northeast of Scotland, known for many tourist attractions such as Edinburgh Castle and the Royal Mile. Central Edinburgh is split into Old Town known for its hills, steps, closes, alleys, and cobbles which are a UNESCO World Heritage Site and The New Town typically characterised for its newer developments of busy shopping streets and affluent residents living in the Georgian townhouses, exposing the juxtaposition between the two areas. My study will be focused within Central Edinburgh where I have chosen to investigate my hypothesis by comparing Old Town and New Town.

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[1] https://www.ojp.gov/pdffiles1/nij/229228.pdf
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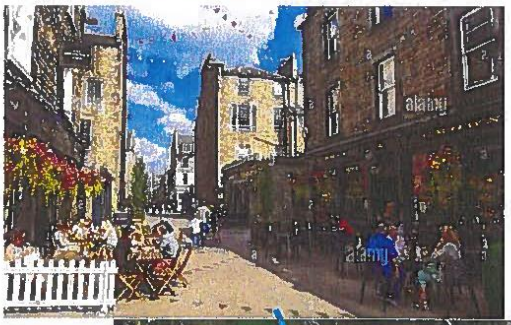
[3] http://kth.diva-portal.org/smash/get/diva2:1354309/FULLTEXT01.pdf
[4] https://hssecurity.com/pedestrianisation-guide/
[5] Leslie Kern, Feminist City, 2020.

Figure 2 - Rose street, which is filled in pubs and bars and expensive restaurants. ***Source*** *alamy.com*



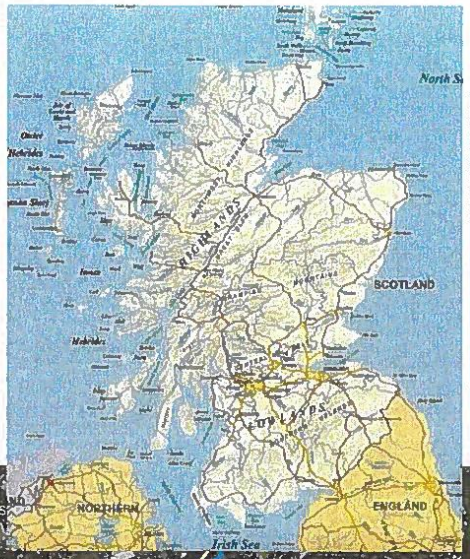
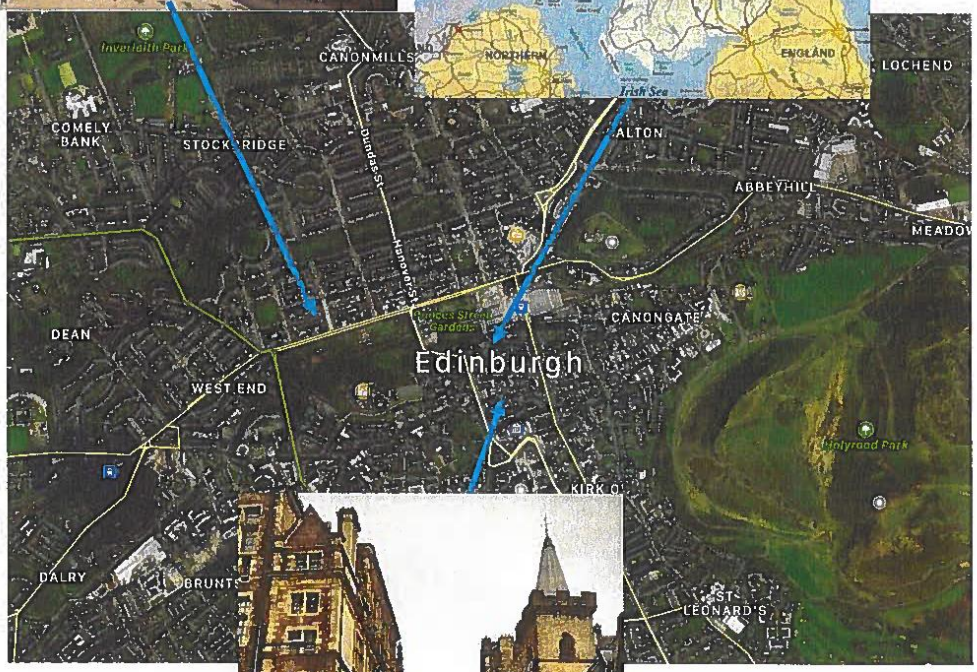


Figure 3 – Map of Scotland

Source *commons.wikimedia.org*



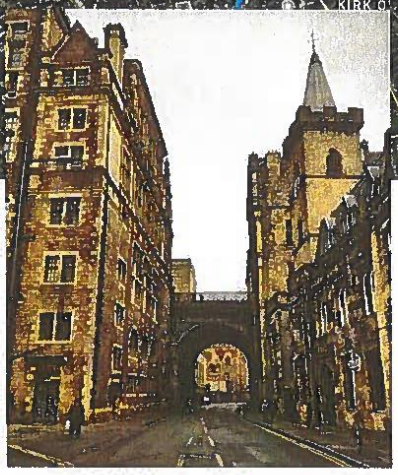


Figure 4 – Cowgate, which offers a busy typically later nightlife with many bars, clubs and student accommodation attached to the Grassmarket. ***Source*** *Pinterest.*

Planning - Before going out and collecting my data I researched the destinations in Central Edinburgh where people said they felt most unsafe on local/tourist websites. *Travelness* confirms my choice of sites by stating that "Grassmarket and Cowgate can be very busy with drunken revellers." [6] I also carried out a pilot study which allowed to me effectively prepare for when I went out to collect my data, showing me that I'd need to gather specific data at night and that Cowgate has a completely different feel in the day than at night.

Justification – I have chosen to compare these two sites as they are known for having volumes of people and being busy at night, which creates hostile and unsafe environment. As a young woman who grew up in New Town, I have perceptions of both these areas and wanted to investigate the impact of perceived and actual safety on different groups. Through drawing on physical urban evidence e.g., paving and land use, I can test to see how safe or unsafe and how accessible or inaccessible both of my areas are.

I used a systematic sampling strategy as it's a straightforward method of gathering a good quantity of data from my study area. I evenly distributed my sites, so they were equal distances from each other along my transect. [7]

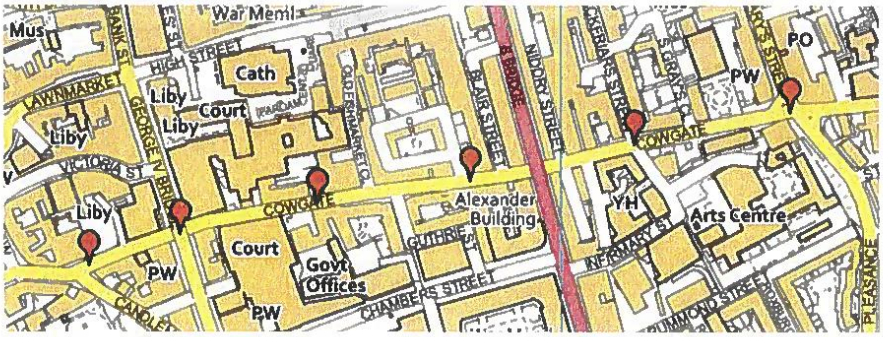


Figure 5 – Plotted sites at my location in Cowgate using Digimaps software, using a systematic sampling strategy.

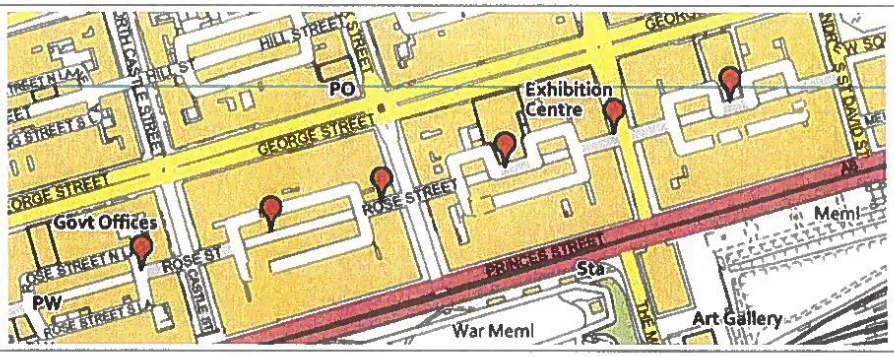


Figure 6 – Plotted sites at my location on Rose Street using Digimaps software, using a systematic sampling strategy.

[6] https://travelness.com/is-edinburgh-safe
[7] https://digimapforschools.edina.ac.uk/roam/map/schools

AIM – To explore how different aspects of urban areas such as social deprivation and infrastructure create safe or unsafe spaces.

HYPOTHESIS

H1 – People base their perception of how safe an area is on their perception of how deprived an area is.

H2 – New Town has greater public activity than Cowgate.

H3 – Old town is more hostile towards/less accessible towards people with accessibility issues than the New Town.

Hypothesis 1 - **'People base their perception of how safe an area is on their perception of how deprived an area is'.**

Technique Used	Justification	Location and Sampling	Methodology	Problems and Solutions
Instagram Poll & Questionnaire. I carried out a pilot questionnaire on survey monkey and then carried out a series of Instagram polls to find out people's perceptions of Edinburgh as a safe city.	To find out different people's views on the safety and security of Central Edinburgh at night. To specify which area of Edinburgh was more dangerous and why. I used two different techniques (quantitative and qualitative) to make my results more reliable and varied.	A series of Instagram polls were taken to ask specifically which area was safer Old Town or New Town and why. Using Rose Street and Cowgate was effective as all my respondents had been there so could provide me with accurate data.	Questionnaires were created so that they were quick and easy to answer to ensure as many people as possible could voice their opinions. They included both quantitative and qualitative data which was effective as this gave answers to Hypothesis 1.	The first questionnaire I used as a pilot study contained biased data due to the responses being only from girls in my year. I think this reduced the reliability due to the created bias as the respondents were privately educated, middle class teens who might have certain preconceptions. However, my Instagram Polls were more effective as I wasn't hindered by a lack of replies as I achieved over 300 responses. To improve, I would ask a wider (e.g., age, ethnicity, sex) demographic.

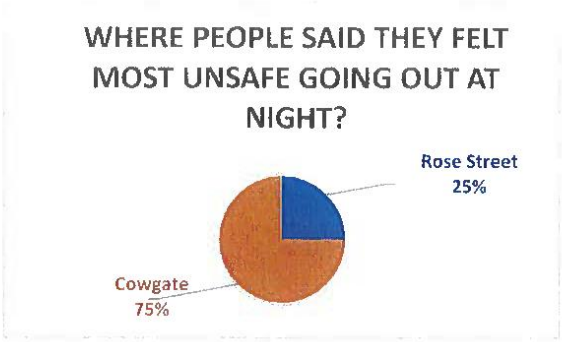


Figure 9.1 - Pie Chart of people saying Cowgate is more unsafe than Rose Street.

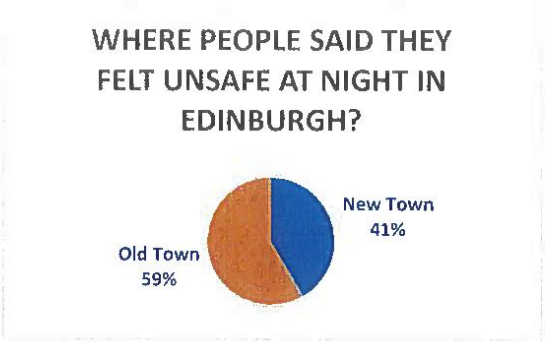


Figure 9.2 - Pie Chart of most unsafe areas in Central Edinburgh.

Figure 10 – Extracts of comments from Instagram survey.

Analysis - When comparing the areas to SIMD[8], I noticed a relationship between the more deprived areas in Central Edinburgh and where people said they felt the least safe. This could be because of the reputation that Cowgate, Hunters Square and Grassmarket have. This is due to these areas being typically less developed and therefore the urban environment can be more challenging to navigate due to lack of public funding. Unlike the New Towns gridiron street pattern, the streets of the Old Town have a lack of space, are less open and are enclosed with dark alleyways making them seen as more dangerous. People also made direct relations to the individuals that are seen to belong in these more deprived areas e.g., "weirdos" or so-called dodgy

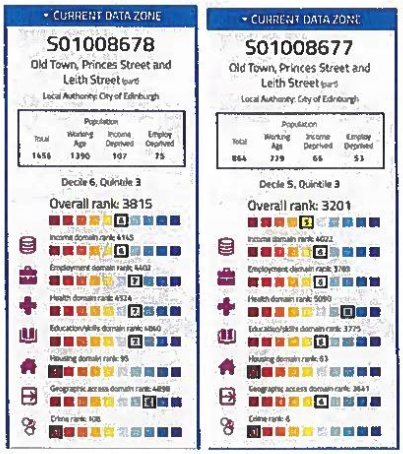


Figure 11 – Scottish Index of Multiple Deprivation showing data of Rose Street (left) and Cowgate (right).

[8] https://simd.scot/#/simd2020/BTTTFTT/9/-4.0629/55.9603/

characters and the greater proportion of homeless people. One person even spoke of "scary" "homeless gangs" showing how people directly perceive deprivation as criminal and dangerous. An article from EdinburghLive [9] highlights this stating that due to a lack of funding in the Old Town the area is becoming a "*no go area*" where crime, anti-social behaviour and abuse is rife.

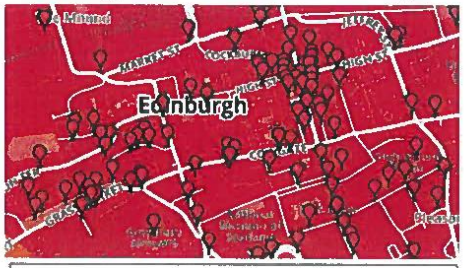


Figure 12 – Inserts of data from Saintamh showing numerous crime/news reports from Police Scotland, Edinburgh Evening News, Reporter and Live from 2010 to today.

When analysing crime data for Rose Street and Cowgate, the data was comparable, perhaps with Rose Street even showing more crime. This does not match to the trends of the mental mapping technique below. This means that people's perceptions of criminal activity are what informed how safe they saw either place. These ideas about criminal activity were based on how an area looked and the people that inhabited it i.e., the darkness and small alleys and homelessness. However, the website states that they have an "*implicit bias*" towards their news report incidents so cannot be fully trusted or taken as "*rigorously accurate.*"

A blank map was handed out to my geography class where they coloured it in using the key. Then, I created an average (shown above) in which it shows the areas that they think are unsafe in Central Edinburgh. As seen the Old Town is mainly coloured in in red and yellow compared to the New Town which is a mixture of blue, yellow and red.

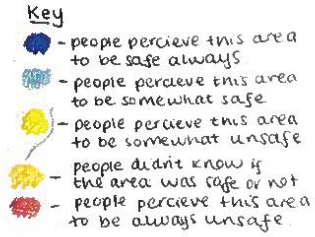
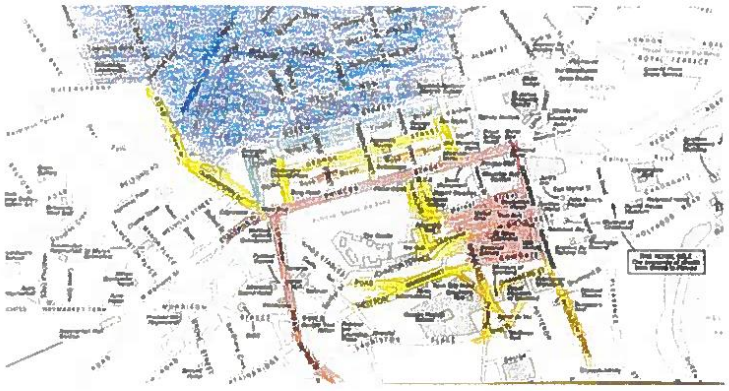
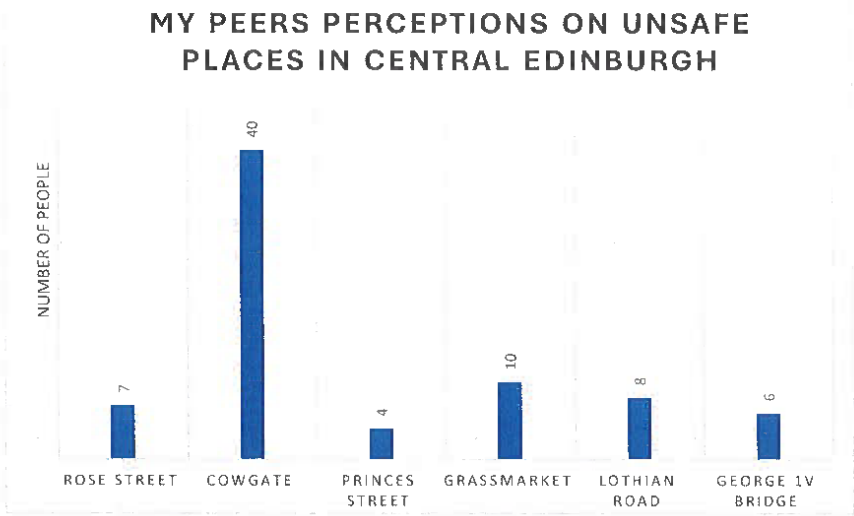


Figure 12 - I used a mental mapping technique to present data and convey where my peers felt unsafe within the city centre providing me with qualitative data on people's perceptions. Therefore, being effective as I was able to see contrasts between areas, so this was good for my comparative study.



[9] https://www.edinburghlive.co.uk/news/edinburgh-news/edinburghs-old-town-under-threat-23184359

Survey monkey results - I chose the most safe and least safe places reported in the questionnaire as my two contrasting areas of study representing Old Town & New Town. I did this as there wasn't a big enough scope for my research to explore further areas of Old and New Town but it means that my data cannot be wholly representative of these two areas even though I represent it this way. This was seen in Hypothesis 1 where people answered differently when asked on how they perceived the safety of Rose Street & Cowgate vs. New Town & Old Town.



Evaluation – These methods of data collection allowed me to gain insights on what people already thought about the city so validating my theory, evidencing what I had researched. Using two survey methods also made my data more reliable. Therefore, I have proved Hypothesis 1 and can confidently say that people basing their perception of how safe an area is on their perception of how deprived an area is, is true.

Hypothesis 2 – '***New Town has greater public activity than Cowgate.***'

Technique Used	Justification	Location and Sampling	Methodology	Problems and Solutions
Pedestrian Count [10] and Traffic Count [11]	My pedestrian count was used to see if the volume of people at night in an area correlate to the safeness. My Traffic Count was used to measure the volume of traffic in Cowgate to see if it has a positive or negative impact on the people passing.	I went down Rose Street and Cowgate, using a systematic sampling strategy as it's easy to compare and execute. Although this meant that I missed out on some busy corners of Rose Street e.g., Hanover Street.	Standing at each site, I counted the number of people and cars passing in the space of 2 minutes and recorded the data on my phone using a tally method. When tallying vehicles, I counted taxis and normal cars so I could see what people's intentions were. I repeated this method for each site.	As I had to carry it out on a busy/lively Friday and Saturday night I was hindered by a lack of time because it was getting dark and unsafe as I was by myself. I had to leave the Cowgate at 22:00 when it was just starting to get busy meaning, I couldn't gather fair data on both locations.

Pedestrian Count Results -

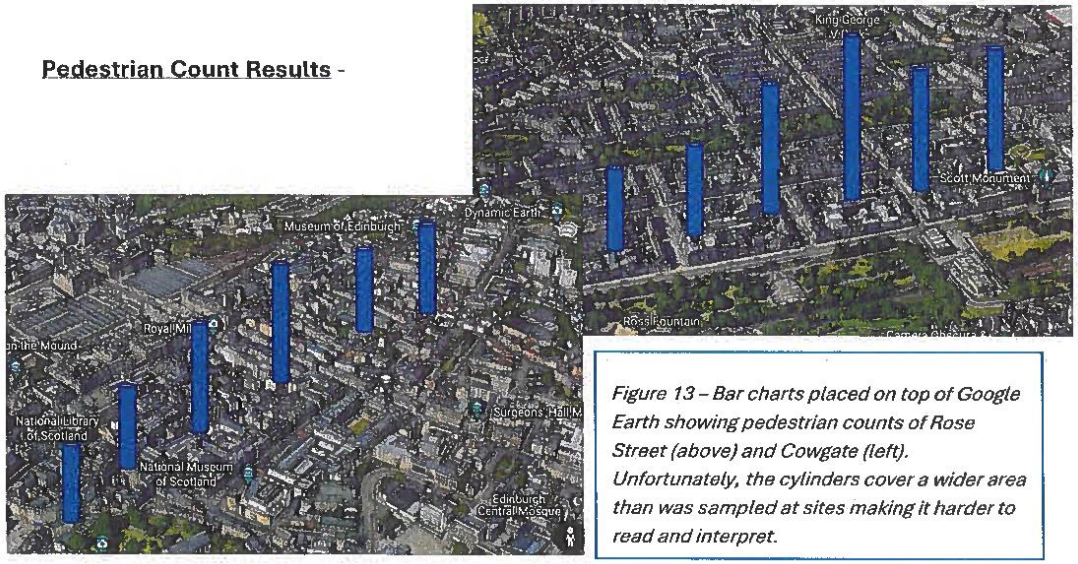


Figure 13 – Bar charts placed on top of Google Earth showing pedestrian counts of Rose Street (above) and Cowgate (left). Unfortunately, the cylinders cover a wider area than was sampled at sites making it harder to read and interpret.

[10] See appendix 2
[11] See appendix 3

Technique Used	Justification	Location and Sampling	Methodology	Problems and Solutions
Land use Mapping I used RICEPOTS scale and made personalised categories so that it would be more tailored to my subject.	My land use mapping was used to see if more entertainment services, specifically pubs and clubs, relate to the busyness of the area and therefore the safety and security they produce.	Instead of using a sampling strategy and potentially missing out on important land uses. I decided to land use map the whole street meaning I could gather data on every service/shop.	Using Google Street View I was able to go down Rose Street and Cowgate and plot my categories using a colour coding method as shown in my key.	As the Street View car was taken in August 2019 it wasn't the most accurate as some shop's fronts had either changed or been left derelict, reducing the precision.

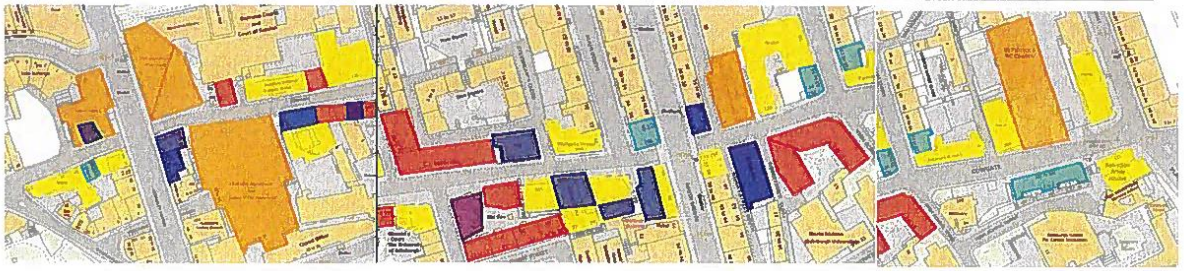


Figure 14 – Transect of Cowgate using Digimaps, where the colours correspond to a different land use from the key.

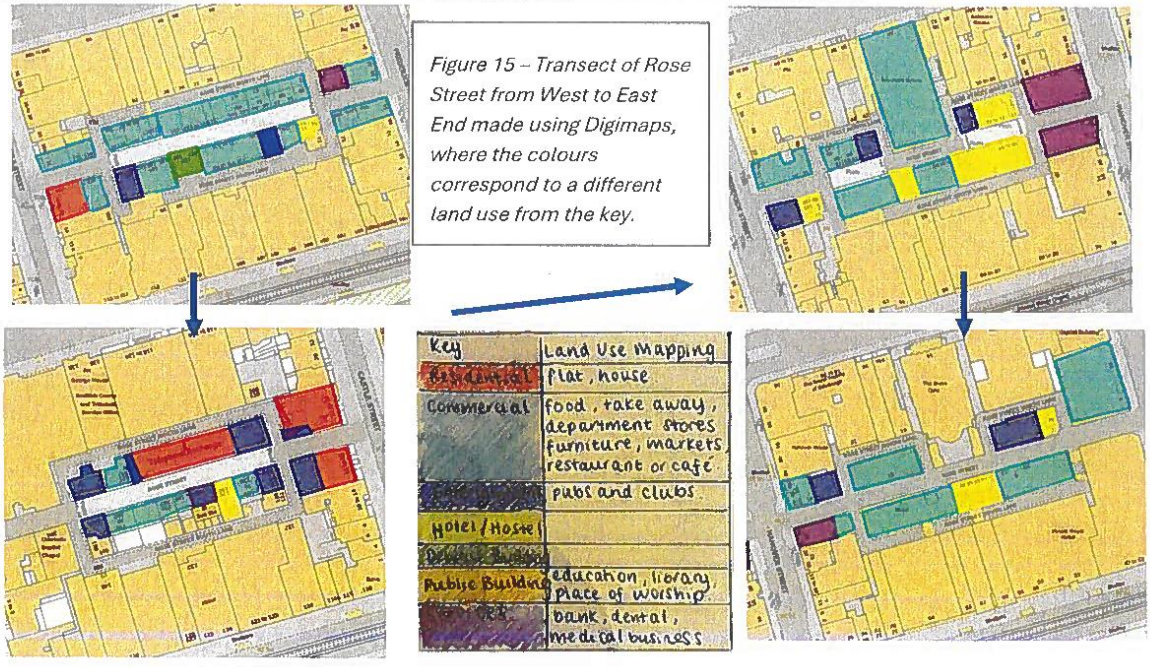


Figure 15 – Transect of Rose Street from West to East End made using Digimaps, where the colours correspond to a different land use from the key.

Evaluation - *Digimaps* didn't allow me to plot some land uses. In the case of Cowgate, 3 or 4 clubs and pubs were under George VI and North Bridge meaning I missed out on valuable data needed to draw my conclusion. This hindered my process and created issues as when mapping my land uses, I was unable to document flats on top of pubs and or commercial shops making it increasingly difficult to keep track of everything. On reflection, my data would have been more useful for my analysis if I plotted clubs and pubs separately as they represent different types of crowds and how late people would attend them.

Analysis – From my results I can see that Rose Street has greater public activity due to it offering more for the average tourist and resident in terms of land uses as there are many different commercial shops who bring different types of visitors. It's semi-pedestrianised as only certain types of vehicles e.g., delivery vans can get down it. It's also more accessible from both Haymarket and Waverly, meaning it has more tourist foot traffic. Furthermore, outside seating from pubs and restaurants generates a more sociable and comfortable environment. Rose Street is also well lit. As stated in my theory, lighting plays an important part in the safety-making of an area as the poor visibility can trigger feelings of unsafeness for people.

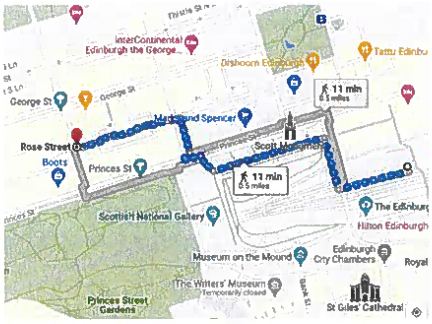
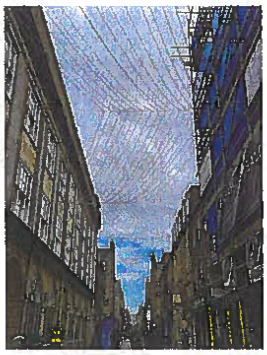


Figure 16 - proximity to public transport on Google Maps.



Cowgate is a wide road with narrow pavements and forms a major route from the Grassmarket to Holyrood and the Pleasance. This is a less pedestrian friendly environment than Rose Street and my traffic survey showed that many vehicles travel down Cowgate, particularly taxis. Cowgate is "lively" making it a centre for nightlife and clubbing. This attracts a different crowd to the shoppers, families, and tourists of Rose Street. However, my land use data was not able to show this as I didn't make a distinction between pubs and clubs.

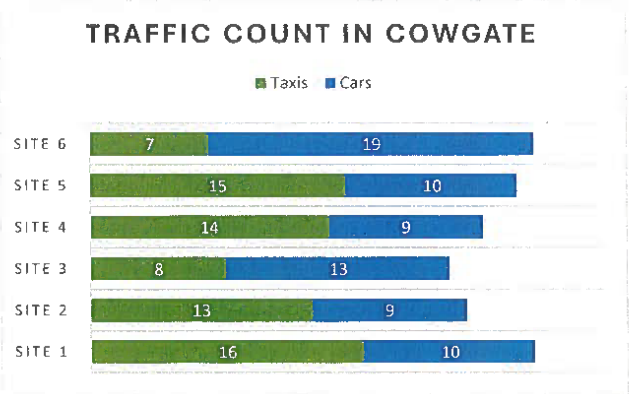


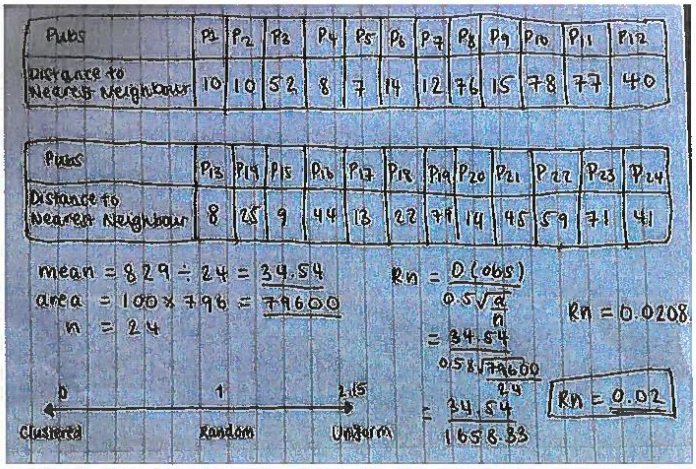
Figure 17 – Stacked Bar graph of Traffic Count in Cowgate

To try and prove Hypothesis 2 and take my analysis further, I carried out the Nearest Neighbour statistical test to try and see if there was a clustering of pubs in the area of New Town from George Street to Rose Street.

For each pub I measured the distance to the nearest neighbour using a distance app on my phone rather than a trundle stick as town was busy and didn't want to get in the way of pedestrians. Although, this reduced the reliability as the app wasn't very precise in counting the exact metres.

Results and Analysis -

It produced a Rn value of 0.02, and when comparing this to the linear significance figure it shows that there is extreme clustering within that area. Therefore, the result was significant as it correlated with the high pedestrian count giving reason to the large public activity of Rose Street. This statistical test allowed me to determine the frequency of pubs and provide a numerical value for the clustering of a geographical singularity. However, as I used fewer than 30 sites, I cannot confidently say the distribution is clustered.



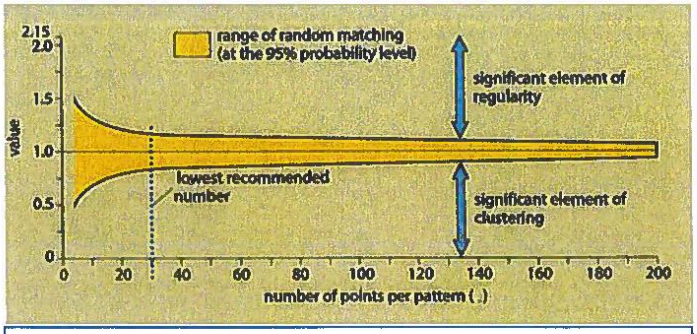


Figure 18 – Nearest Neighbour statistic with linear significance. Source https://geographyfieldwork.com/nearest_neighbour_analysis.htm

Hypothesis 3 – **'Old town is more hostile towards/less accessible towards people with accessibility issues than the New Town'.**

Technique Used	Justification	Location and Sampling	Methodology	Problems and Solutions
Accessibility Survey [12]	I used an accessibility survey to see if marginalised groups safety within a city links to how freely they can move around the built environment. By using a survey, I was able to get sufficient data on each of my location.	I used a systematic sampling strategy as it eliminates getting clustered data, but this did mean I missed on some litter and bad pavements.	I went to each site taking photos and filling in my survey by recording the condition of the pavements. Travelling down the Cowgate I recorded any obstructions that would hinder people with limited mobility's ability to travel around the environment.	As I was recording the data, there was personal bias. Therefore, to improve, I would use a partner to gather two sets of data then average it as two opinions are more reliable than one because there is less chance of human error. I also only investigated women and wheelchair users as marginalised groups.

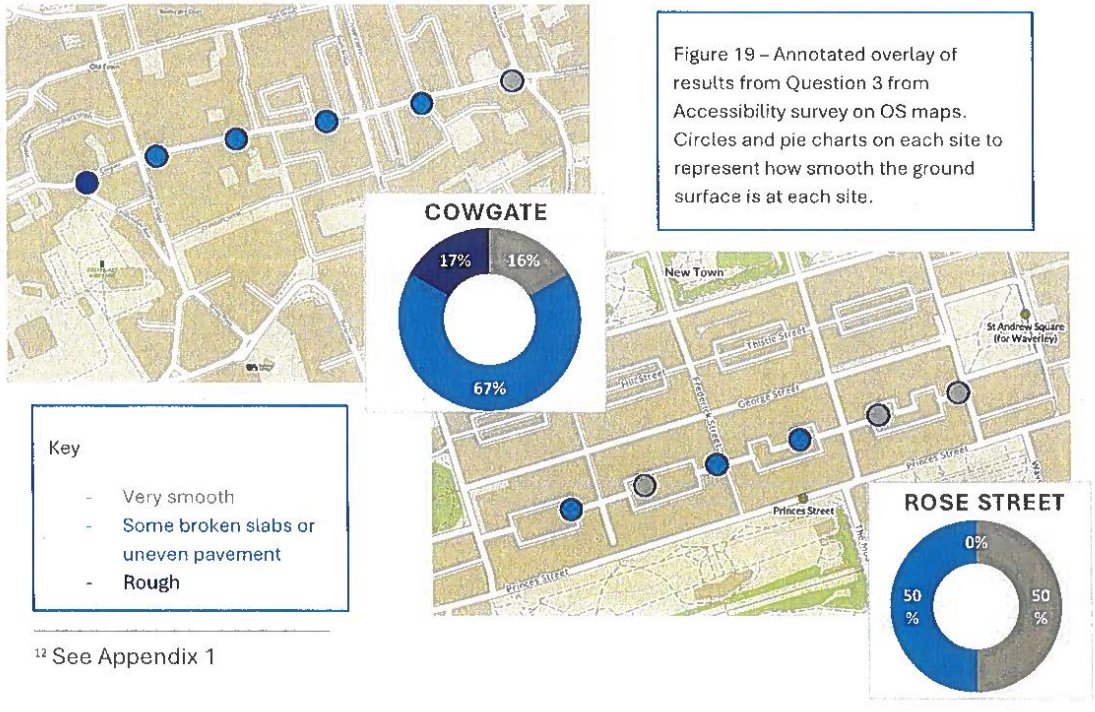
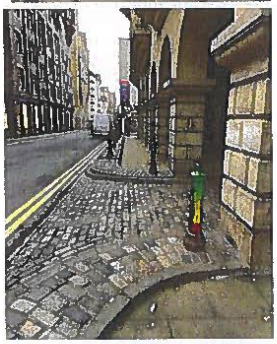


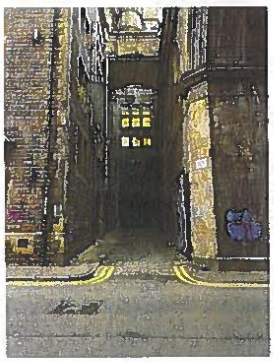
Figure 19 – Annotated overlay of results from Question 3 from Accessibility survey on OS maps. Circles and pie charts on each site to represent how smooth the ground surface is at each site.

[12] See Appendix 1



Analysis – Marginalised groups safety within a city links to their accessibility as described in my theory. As seen in the photos and data collected from my Accessibility survey, Cowgates pavements cause many problems in terms of accessibility. Uneven paving and cobbles create many difficulties for wheelchair users especially if it's a manual wheelchair. Most sections of the pavement are less than a metre wide meaning people must walk in the road, thus being unusable for a person in a wheelchair or pushing a buggy. There is also a big issue with street clutter which reduces the environmental quality making Cowgate less attractive for people with limited mobility. Additionally, there is poor connectivity to other parts of the city shown by the lack of well-lit links through closes and the lack of buses. High traffic volumes, undue waiting times at crossroads and poor air quality all create a hostile pedestrian experience. Although, secondary data found from Edinburgh council states that they understand the issues and have plans to "*improve the connectivity and usability*" by providing vertical connections such as urban lifts from George IV Bridge down to Cowgate. [13]

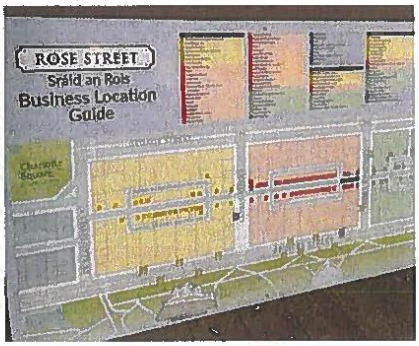
Whereas Rose Street has wide, open, and even pavements making it easier to navigate for wheelchair users and prams. The use of signage increases accessibility by instructing people on how to behave safely e.g., this sign which states no cars during peak times.



Figures 20.1-7 – Photographs of Cowgate taken on the 6th of December 2021

[13] https://www.edinburgh.gov.uk/downloads/file/28882/chapter-3-the-strategy-pages-24-to-49-

Evaluation - My use of annotated photos highlights the differences on Rose Street and Cowgate. It means my judgements about the quality of environment enables my Accessibility survey to be more accurate as there is evidence. Because of my narrow scope of data, I was only able to use wheelchair users to represent the marginalised groups. However even with my limited data I was able to consider the intersections with other marginalised groups discussed in feminist geographical theory e.g., mothers using prams.



Figures 21.8-11 – photographs of Rose Street taken on the 6th of December 2021.

CONCLUSION

Overall, my data made valuable conclusions on not just what areas were safe, but what safety means to people in Edinburgh. I can accept Hypothesis 1, as my primary and secondary data collection proved that people associate their perceived safety to the perceived deprivation of an area. This is backed up by Brands theory as people make mental notes on the areas, they have heard to be unsafe when passing through similar places. Here, I was able to explore and analyse social structures as well and their effect on perceptions around safety by being critical, not just descriptive. I can also accept Hypothesis 2 that Rose Street has greater public activity than Cowgate but only to a certain degree as I made errors on data collection e.g. land use mapping categories and timings of pedestrian count. Lastly, by drawing upon the physical urban environment and photographs that show Old Town as less accessible I can accept Hypothesis 3. As I chose varied and wide topics of research for my hypotheses, it meant that my data was only able to scratch the surface and I relied heavily on secondary data and the geographical theory researched.

In conclusion, my research has contributed to further urban planning and raised awareness of issues around the safety of public spaces creating a good foundation for further research into any future hypothesis. My research can be used to inform future urban planning decisions in Edinburgh. For example, a vision for Cowgate to become pedestrianised involving a whole new build and redevelopment to the road which would make a huge difference to the safety and accessibility of the street. Additionally, Edinburgh council has stated the importance of working with groups such as Living Streets whose aim is to "*promote walking as a safe, enjoyable and easy way to get around Edinburgh.*"[14]

Figure 22 - Before and after pictures to show what Cowgate could look like once pedestrianised. Source Edinburghlive.

[14] https://www.livingstreets.org.uk/get-involved/local-groups/edinburgh

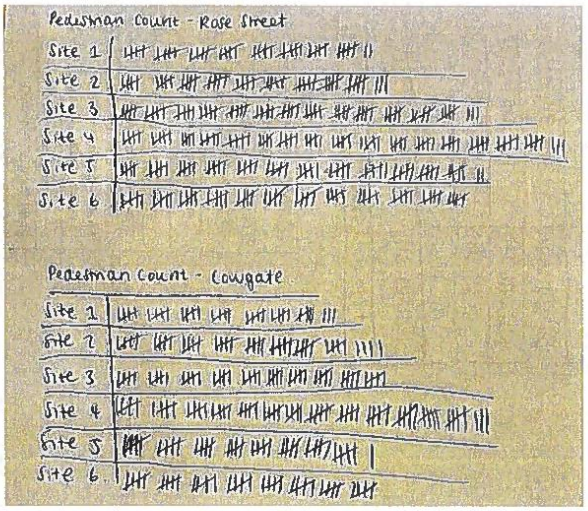
Appendix

1. Accessibility survey

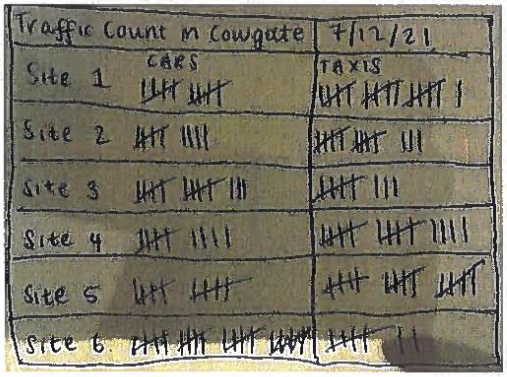
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Question 1 - Is the pavement wide enough for a wheelchair and pram? - **Yes or No**	Rose Street – Yes Cowgate – No.	Rose street – Yes Cowgate – Yes	Rose street – Yes Cowgate – No	Rose street – Yes Cowgate – Yes	Rose street – Yes Cowgate – Yes	Rose street – Yes Cowgate – Yes
Question 2 - How smooth is the ground surface? - **Very smooth, some broken slabs or uneven pavements, rough.**	Rose Street – uneven pavement Cowgate – Rough	Rose Street – very smooth Cowgate – Uneven pavement	Rose Street – uneven pavement Cowgate – Uneven pavement	Rose Street – uneven pavement Cowgate – Uneven pavement	Rose street - Very smooth Cowgate – Uneven pavement	Rose Street – very smooth Cowgate – Very smooth
Question 3 - Are the signs easy to read? - **Yes (low signs), No.**	Rose Street - Yes Cowgate – No	Rose Street - No, high sign Cowgate – N/A	Rose Street – Yes Cowgate – No	Rose Street – Yes Cowgate – N/A	Rose Street – No, high sign Cowgate – N/A	Rose Street – Yes Cowgate – Yes
Question 4 - Is the kerb	Rose Street - N/A	Rose Street - N/A	Rose Street – Yes	Rose Street – Yes	Rose Street – N/A	Rose Street – N/A

dropped at crossings? - **Yes, No.**	Cowgate – No	Cowgate – No	Cowgate – No	Cowgate – Yes	Cowgate – N/A	Cowgate – Yes
Question 5 - Are there many obstructions? - **Scaffolding, bollards, litter?**	Rose Street – No Cowgate – Yes, lots of scaffolding	Rose Street – No Cowgate - No	Rose Street – No Cowgate – Yes, bollards	Rose Street – No Cowgate – Yes, litter.	Rose Street – Yes, scaffolding Cowgate - No.	Rose Street – No. Cowgate – Yes, lots of scaffolding

2. Pedestrian count



3. Traffic Count



4 . GE Graphs

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