

Iiston River Study
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Contents

Page number

Introduction.....	3
Risk Assessment.....	4
Methodology.....	5-6
Results and Analysis.....	7-10
Conclusion and Reccommendations.....	11
References.....	12
Appendix.....	13

Introduction

The river Ilston is located in the Gower, Swansea, South Wales. It stretches from its source near Swansea Airfield, all the way to Three Cliffs bay where it discharges into the sea. This river was chosen as its characteristics change a lot, due to the altering landscape. For example, the river source is in a boggy marshland with few trees, before making its way through tree dense areas, and finally ending up on a wide open moorland where it meanders a lot. One of the reasons for the drastically changing landscape is because of the valley walls. The slopes of the upper and middle tracts of the basin are covered with glacial drift, containing sandstones and grits. This drift is spread out over a wide area, and can be found as far south as Kilvrough (see map 1). This implies that it is almost certain that the valley has a fluvio-glacial origin.¹



Map 1 (taken from assignment brief)

The purpose of this investigation was to observe and analyse how the River Ilston changes in different ways, from its source to the mouth of the sea. The following hypotheses were considered:

1. The river becomes wider and deeper downstream
2. The cross sectional area of the river increases downstream
3. The river velocity increases on the outside of a meander
4. The highest velocity is to be found in the centre of the river
5. The river velocity decreases downstreams
6. The size of the bed load gets smaller downstream
7. The shape of the bed load becomes more rounded downstream
8. The discharge of water in the river increases downstream

The experiment was conducted on the 24th of October 2017. Although it was misty and cloudy with a heavy drizzle and light wind, the average temperature was quite mild at about 16°C.

Risk Assessment

- Risk – Weil's Disease (Leptospirosis)
Likelihood – 3
Severity – 3
Risk Rating – 9
To reduce risk – Wear waders/appropriate waterproofs and gloves whenever entering or coming into contact with the water.
- Risk – Could slip on mud/leaves and fall into the river.
Likelihood - 2
Severity - 1
Risk Rating – 2
To reduce risk – Wear suitable footwear and be extra careful if bad weather occurs.
- Risk – Unstable bank or loose ground near river could cause someone to fall in.
Likelihood – 2
Severity – 1
Risk Rating – 2
To reduce risk – Wear suitable footwear and stay away from the edge of the bank whenever possible
- Risk – Loose branches could fall from the trees and hurt someone.
Likelihood – 1
Severity – 2
Risk Rating – 2
To reduce risk – Observe the area of study before starting and be aware that not all risks are within human control.
- Risk – Fast current could cause imbalance in the water.
Likelihood – 3
Severity – 1
Risk Rating – 3
To reduce risk – Do not enter water that is above knee height, and be aware that a change in weather could increase the current speed and turbulence.

Methodology

The aim was to collect data from ten river Sites, but only six were used. This was due to health and safety restrictions because of the bad weather. The work was split between three groups of scientists.

At each site, a tape measure was used to measure the width of the stream. At five horizontal points from the bank, the depth of the river was measured using a metre rule. Readings were taken at 25cm and 50cm intervals, depending on the group. As five readings were taken for the depth, an average value was calculated using the formula:

$$AD = \frac{(\text{points } 1+2+3+4+5)}{(n+1)}$$

where AD is the average depth, and 'n' is the number of readings collected.

The average cross sectional area for each site was then calculated using the formula:

$$\text{Cross-section (m}^2\text{)} = \text{width} \times AD,$$

where 'width' is the average channel width.

See *Figure 1* for further explanation.

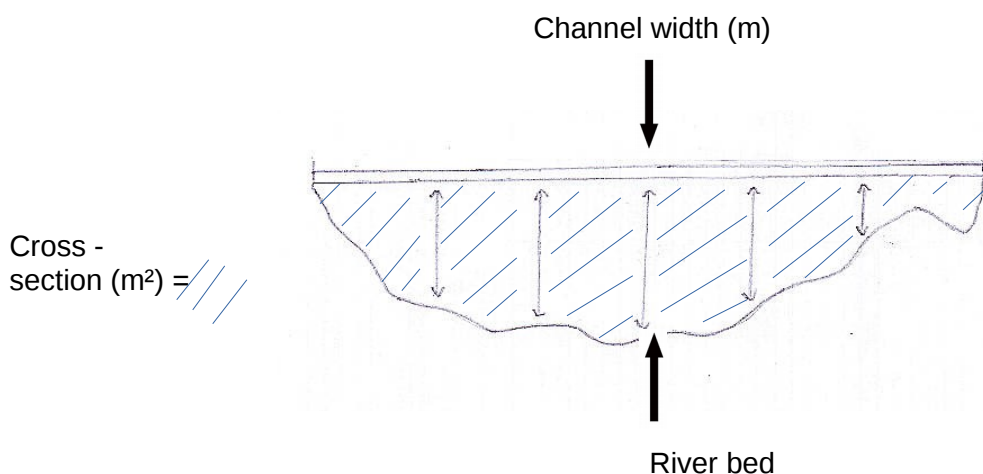


Figure 1

At each site, the river velocity was measured at five different points using a current meter. Two of these points were near the left and right sides of the bank, while the other three were at different depths in the centre of the river. As well as using a current meter, plastic bottles were also used to measure the speed of the river over a 10m stretch at every Site (3m/5m were used where a straight 10m section of river couldn't be found). The distance was measured using a tape measure along one side of the bank. Surveying poles were placed at the start and end points to increase accuracy. The bottle was dropped upstream

in the centre of the river, and a stopwatch used to time how long it took to travel the measured distance. This exercise was repeated at least three times so that an average value could be calculated for each Site. This was done by dividing the total of the five values by the number of values taken. Once an average time was calculated, it was multiplied by 0.85 to enable an average value of stream velocity to be obtained, as opposed to surface velocity. The average surface velocity was calculated using the general formula:

$$\text{Speed (m/s)} = \frac{\text{Distance (m)}}{\text{Time (s)}}$$

(Average values are substituted for the speed and time).

Five sediment samples were taken from each site. Their long axes were measured and their roundness analysed. The long axes were measured using a metre rule, and the Powers Scale of roundness chart was used to determine the shape of each stone. (See *Figure 2*).

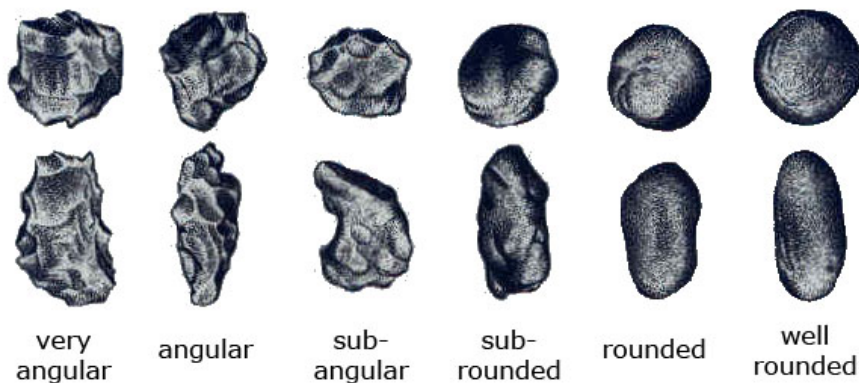


Figure 2, Power's Scale of roundness chart, (Powers, 1959).²

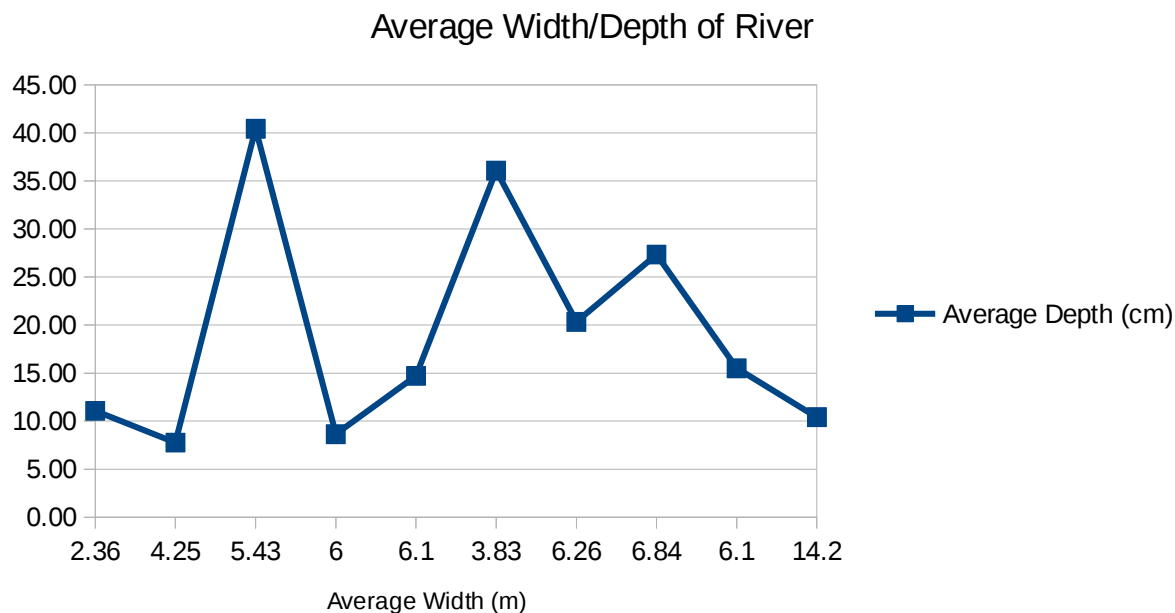
Finally, the average discharge was calculated for each river Site. Only one calculation was done per site, as average values were used for the cross-sectional area and the velocity. The formula used is as follows:

$$\text{Discharge(m}^3\text{/s)} = \text{velocity} \times \text{cross-sectional area}$$

Results and Analysis

Hypothesis 1 – The river becomes wider and deeper downstream

Below is a graph showing how the depth of the river changed with the width, downstream. It is important to note that the data from Sites 6,8,9, and 10 were from previous years, as it was impossible to collect new data due to the bad weather. (See *Table 1* in Appendices to see the data in a different form).



Graph 1

It is clear that there is no definite relationship between the width and depth of the river. However overall, the width of the river does increase downstream. There is one value that attempts to contradict this, which is the depth of 3.83 metres on Site 6. This could have been due to different areas being used as 'Sites' for the collection of previous data. However it is possible that there was simply a narrower, less eroded stretch of river at Site 6. This could have been due to more roots binding the earth, or a higher number of stones in the bank, potentially slowing down the erosion process. Another suggestion is that the soil could have been more clay dominated, as it is less susceptible to erosion than sand and silt (sand and silt are more permeable).

The graph implies that the depth of the river varied drastically from the source to where it discharged into the sea. The depth at Site 3 looks to be an anomaly, but the group of scientists who collected the data from that Site insisted that they were just dealing with a very deep stretch of river. The last three depths are quite low as they were taken from previous years, when the weather was better and there had been less rainfall. However it can be confidently estimated that the depths would still have decreased near the mouth of the sea, as the results shown are decreasing consistently.

Hypothesis 2 – The cross-sectional area of the river increases downstream

Site	Average cross-sectional area (m ²)
1	26.13
2	33.02
3	219.53
4	51.9
5	89.67
6	138.19
7	127.33
8	187.01
9	94.55
10	147.82

Table 2

As a result of the widths and depths of the river, the cross-sectional area increased overall downstream, though it was not by any means a consistent increase.

Hypothesis 3 – The river velocity increases on the outside of a meander

Unfortunately the weather conditions made it too dangerous to investigate this prediction.

Hypothesis 4 – The highest velocity is to be found in the centre of the river

As data was only collected from Sites three and seven (respectively) for this hypothesis, it did not seem logical to compare it to previous data from the other Sites, as it would mostly be based on a different study.

Current tested times	Dist. under the water (cm)	Current Speed (M/sec)
1	15	0.74
2	15	0.19
3	20	0.16
4	40	0.1
5	15	0.17

Table 3

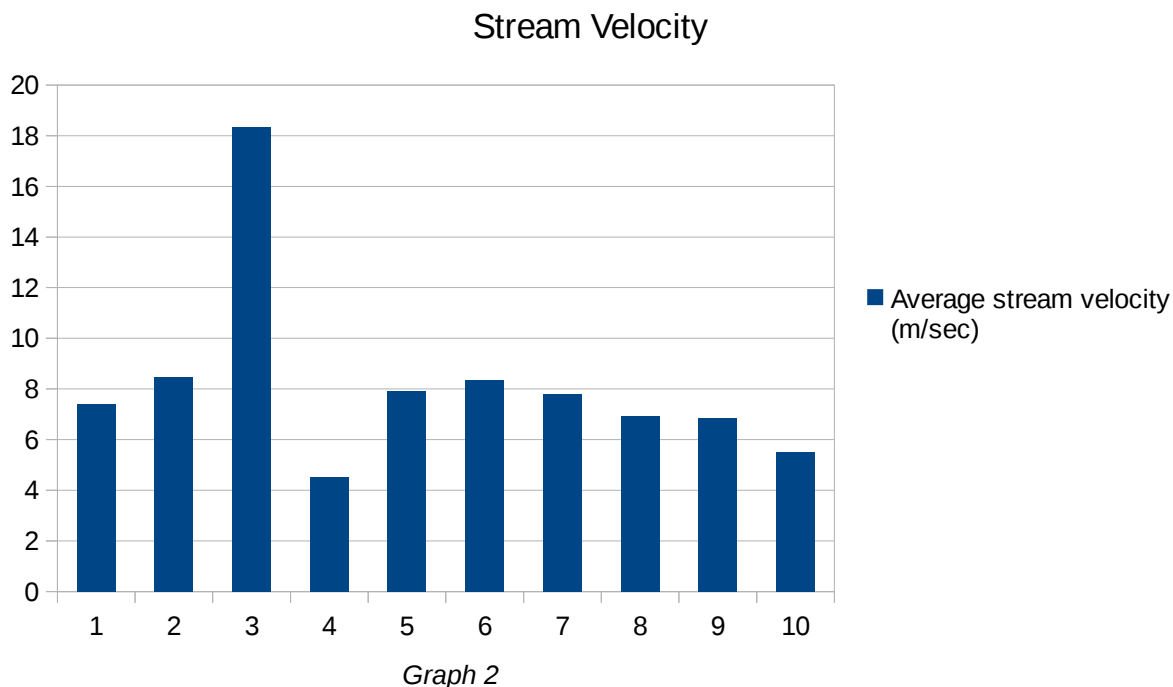
Current tested times	Dist. under the water (cm)	Current Speed (M/sec)
1	12.5	0.62
2	Just below surface	1.16
3	12.5	0.93
4	River Bed	0.65
5	12.5	0.42

Table 4

The readings that were taken in the centre of the river are testing times 2,3 and 4. There is no clear indication as to whether the hypothesis is correct or not, as both tables contradict each other. *Table 3* implies that the current flow is actually slower in the centre of the river, whereas *Table 4* indicates otherwise. Results from at least five sites should be looked at before drawing a conclusion, however it can be guessed that the current meters were not

accurate. This could be due to reasons such as human error or environmental impacts. For example, sediment could have interfered with the propellers on the current meter, which could have had a major impact on the speed displayed.

Hypothesis 5 – The river velocity decreases downstream



Graph 2 shows the average stream velocity for each Site. The results are mostly consistent apart from the one from Site 3. Even though the stream velocity at Site 10 is the lowest, but there is no clear indication that it actually decreases downstream – the results are too similar. As mentioned earlier, Site 3 was a very deep stretch of river. The graph strongly implies that the deeper the river, the faster the flow.

Hypothesis 6 and 7 – The bed load becomes smaller and more rounded downstream

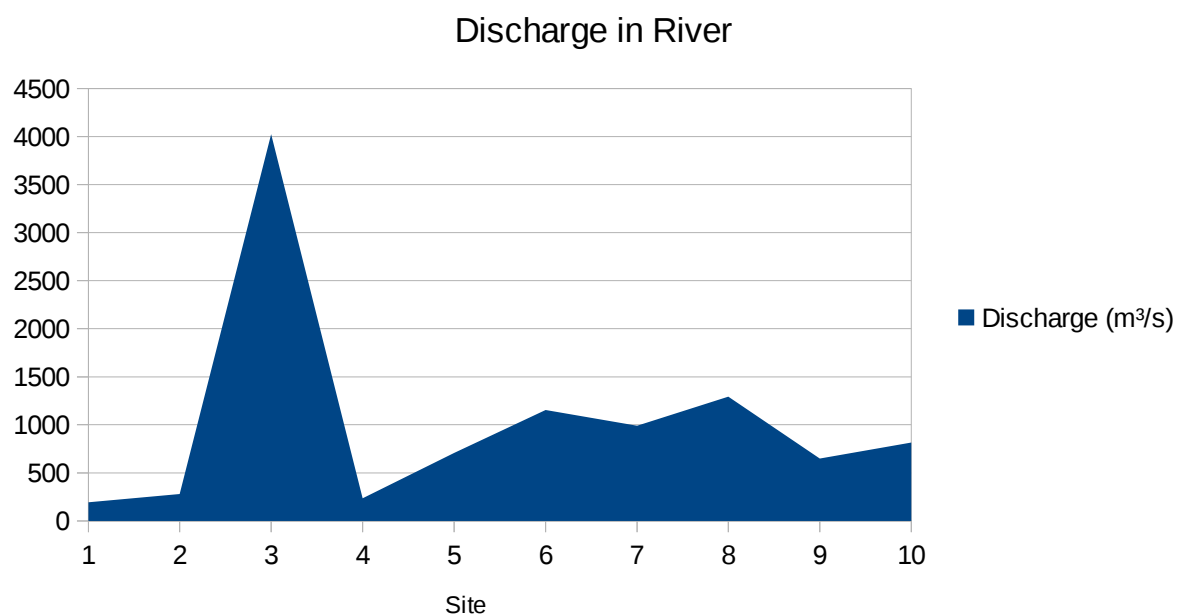
Site	Long Axis (cm)	Roundness
1	7.4	Sub-angular
2	10.7	Sub-angular
3	11.4	Sub-rounded
4	13.3	Sub-rounded
5	14.6	Sub-angular
6	10.2	Sub-rounded
7	20.4	Sub-angular
8	5.8	Rounded
9	4.8	Rounded
10	1.8	Rounded

Table 5

Looking at all the data as a whole for the long axis, the size of the bed load clearly

increases downstream, before decreasing markedly. If plotted on a graph, it would create a bell shape with the result from Site 7 being an anomalie. However looking only at the data collected in 2017, the size of sediment seems to increase downstream, therefore no definite conclusion can be made. As for the shape of the sediment, there was a lot of variation on every Site, so only the average roundness is shown in the table above. To see the full set of data, see *Table 6* in 'Appendix'. It can be guessed that the roundness is somewhat the same, until the surrounding landscape becomes flatter and the earth more sand dominated. As the river was also wider (due to more erosion as sand is very permeable), there was more of a laminar flow. This meant that the sediment experienced less aggressive friction causing them to take on a smoother, more rounded shape. The data from 2017 also strongly supports the idea that there were a higher number of more angular rocks downstream due to saltation (because of the more extreme weather).

Hypothesis 8 - The discharge of water in the river increases downstream



Graph 3

As already discussed, Site 3 was particularly deep, suggesting that the depth of the river has a big impact on the amount of discharge there is. The discharge seems to increase gradually up until Site 8, before decreasing. However this would be due to the fact that data from Sites 8, 9 and 10 were from previous years, where the river levels were much lower. It is probable that Hypothesis 8 is generally true, but the difference in weather conditions means there is not sufficient data to prove this.

Conclusion

In conclusion, the channel width does increase downstream overall. However the channel depth varies a lot, probably due to the changing landscape that the river has to navigate. For example, the river bank included a variety of soil types until it neared the sea. Once the sand content increased and the earth was less bound by roots, erosion increased. It was also concluded that the cross-sectional area of the river increased downstream. No conclusion was drawn for hypothesis 4, due to inconsistent data. The stream velocity stayed mainly same throughout the course of the river, apart from areas where the differing landscape had altered the river's characteristics. There was a slight decrease towards the final stretch of river, but it was not at all significant enough to be able to confidently say that Hypothesis 5 was correct. The long axis of the sediment increases a lot before decreasing near the sea, and the sediment does become more rounded, but only significantly at the last three Sites. The amount of discharge in the river does increase overall, and there is a strong relationship between depth and discharge – they appear to increase together.

Recommendations

If this investigation was carried out again, more images should be taken to help with the comparison of river characteristics and sediment at each Site. It could also be suggested that measuring the width of the sediment would be beneficial as it is not possible to know what the size or overall shapes of the rocks are when only measuring the long axis.

References

1. Saunders, E. (1986). Cambria a Welsh geographical review, 13, (2), p.8.
<https://journals.library.wales/view/1186437/1189151/8#?xywh=-1096%2C-429%2C4711%2C3913>
2. *Powers scale of roundness chart*, (Powers, 1959),
<http://geologycafe.com/class/chapter9.html> .

Appendix

Table 1

Site	Average Width (m)	Average Depth (cm)
1	2.36	11.07
2	4.25	7.77
3	5.43	40.43
4	6	8.65
5	6.1	14.70
6	3.83	36.08
7	6.26	20.34
8	6.84	27.34
9	6.1	15.50
10	14.2	10.41

The red numbers indicate data that was obtained through previous studies in different years.

Table 6 – Roundness of all sediment from each Site (with data from previous years highlighted in red).

Site 1	Roundness		
	angular	Site 6	sub.ang
	sub.ang		sub.ang
	sub.ang		sub.round
	sub.ang		sub.round
	sub.ang		round.
Site 2	Sub rounded	Site 7	Angular
	Sub angular		Sub angular
	Very angular		Sub angular
	Angular		Sub angular
	Rounded		Angular
Site 3	Rounded	Site 8	rounded
	Sub rounded		rounded
	Angular		sub.round
	Sub rounded		sub.round
	Angular		very.round
Site 4	Rounded	Site 9	sub.ang
	Sub rounded		sub.round
	Sub angular		round
	Sub rounded		v.round
	Sub angular		v.round
Site 5	very.ang	Site 10	sub.round
	angular		round
	sub.ang		round
	sub.ang		v.round
	sub.ang		sub.round