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| The Fluvial System: Lessons using data skills |

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| **Lesson 1**: Hydrographs and their components |

**Lesson Objectives**

* To plot a hydrograph and understand its main components and how they are interrelated
* To understand how hydrograph shape and form might change in response to changing land use

**Setting the Scene**

At least 6 million properties in the UK are at risk of flooding, with the latest floods in December 2015 seeing 16000 properties inundated with insured losses across the UK totalling £1.3billion. The climate change forecast is for an up to 30% increase in monthly rainfall such as to generate a greater number of higher magnitudes, more frequent floods. Consequently, understanding the relationship between the river discharge and time is vital if we are to effectively manage river catchments. This is in terms of predicting how rivers might respond to changes in the discharge characteristics such as to reduce their propensity for flooding, reduce potential damage to critical infrastructure, and increase society’s resilience to flooding.

**1) The Flood Hydrograph**

Discharge in rivers is affected by factors such as local catchment characteristics, rainfall event characteristics and catchment management practices. During rainfall events the response of the river discharge will vary through the rainfall events and can be visualised as a hydrograph which plots discharge through time. The following data is taken from the River Valency in the town of Boscastle. Boscastle is located in the county of Cornwall. A flash flood occurred on the Valency River in Boscastle on the 16th August 2004. The flood was extremely severe yet despite the devastating nature of the flood there were amazingly no deaths or serious injuries. However, about 100 cars, 5 caravans, 6 buildings and several boats were washed into the sea; approximately 100 homes and businesses were destroyed; trees were uprooted and debris was scattered over a large area.

**Task**

* Open the Microsoft Excel Hydrograph data file. In the Boscastle Data tab there are three columns: 1) Time 2) Rainfall (mm) 3) Discharge (cumecs) with a scale which goes from 0 to 120 on the discharge (y axis)
* By hand, plot the Time on the x axis and Discharge on the y axis.

Your graph should look like Figure1.

**Figure 1:** Hydrograph showing the discharge response of the River Valency on the 16th August 2004.

Looking at the raw data and at Figure 1 discuss the findings. You might want to think about:

* Adding labels to the hydrograph with the following: rising limb, falling limb, peak discharge
* What is the peak rainfall on the Boscastle hydrograph? What time did it occur?  
  What time was the peak discharge at Boscastle?
* Do the rising and falling limb look the same?
  + Calculate the length of the rising limb (taken from the time of first reading to the time of the peak discharge) and compare it with the length of the falling limb (taken from the time of the peak discharge to the time of the last reading). Are they the same length?

However, a true hydrograph also plots the rainfall volumes and timing to allow links to be made between rainfall characteristics and river discharge response. Once plotted your graph should look like that in Figure 2.

* Onto the same graph add in the Time and Rainfall. In order to help you visualise the data better plot the rainfall data on a second y axis – to do this, do exactly the same as you did for the discharge data, but draw the second y axis on the right hand side of the graph. The scale should be between 0 and 16 on this axis. Typically, Rainfall data is plotted as a bar graph.

**Figure 2:** Hydrograph showing the discharge and rainfall response of the River Valency on the 16th August 2004.

Looking at the raw data and at Figure 2, discuss the findings. You might want to think about:

* Adding the lag time label to your hydrograph, where the lag time is the amount of time it takes rain to get into a river, calculated as the time between the peak rainfall and the peak river discharge.
* Calculating the lag time - i.e. how long did it take the rain water to reach the river?
* What extra information does adding the rainfall data onto the hydrograph give you?

**Take it Further**

Using Google Maps and Google Streetview, build a case study of the Boscastle flood in 2004. Zoom to the village of Boscastle and have a look around 

* What do you think the function of this village is?
* Zoom in to where the B3263 crosses the River Valency. Just before the bridge, what do you notice? How could this affect the potential flood risk in the area?
* Take a screenshot and annotate with the following:  
  i. Shape of the surrounding land  
  ii. Shape of the river channel  
  iii. Gradient of river  
  v. Proximity of housing
* Watch part of the YouTube video - <https://www.youtube.com/watch?v=xrb0Ea0OkKU>
  + Note down some of the effects of the floodwater on the town of Boscastle and its inhabitants.

**2) The Impact of Land Management Practices on Discharge Characteristics**

To try to improve agricultural land, it is becoming common practice to add drainage to fields, so that water drains away from the soil more quickly, preventing water logging. However, this practice has flood risk implications, since the drained water enters the river channels more quickly following a rainfall event. The following exercises use data taken from a small river in Devon and directly compare data which has been recorded from a field which has been drained with that of one which has no drainage. The drained data measures water entering the stream from a field which is underlain by drains. The un-drained data measures water entering the same stream from a neighbouring field which has no drains.

**Task**

* Open the Microsoft Excel Stage Hydrograph data file. In the Land Use Data tab there are four columns: 1) Date / Time 2) Drained Discharge 3) Un-drained Discharge and 4) Rainfall Intensity
* Plot a graph of Date / Time and Drained Discharge
* Onto the same graph add in the Date / Time and Un-drained discharge data for comparison
* Your graph should look like that in Figure 3

**Figure 3:** Comparison of two river hydrographs comparing drained and un-drained data for the same rainfall event.

Looking at the raw data and at Figure 3 discuss the findings. You might want to:

* Describe the similarities and differences between the drained and un-drained hydrographs
* Discuss why there might be similarities and differences between the hydrographs.

**Take it Further**

Using the raw data, calculate the lag times for the drained and un-drained.

* Are the lag times affected by the drainage?
* Describe the processes which might be occurring within the catchment which are causing the differences between the lag times

**Plenary**

Return to the main lesson question. Discuss:

* What the response of river hydrograph characteristics might be under future climate change scenarios, where a greater number of higher magnitude, more frequent flood events are predicted?
* How would you manage the Boscastle catchment such as to reduce the likelihood of flooding?