Physical Geography
CGF 3MI (University/College)

Sediment transportation

A river transports its sediment load in a variety of ways. The methods of transport are also used to describe the various loads of a river, i.e. the bed or traction load, suspension load, dissolved load, and suspended load). The sediment load varies from river to river, along the course of one river or in the same place at different times. This is because the velocity of the water is crucial in determining the way that sediment is transported. The relationship between erosion, transport and deposition of sediment is complex and can be shown by the **Hjulstrom** diagram. This is based on experimental work rather than natural channels, but it shows the principles involved. Entrainment is the process of starting the particles of sediment moving - the opposite of settling.

- High velocities result in sediments being transported in the river flow, while low velocities result in sediment being deposited.
- Medium sand (0.25-0.5 mm in diameter) is moved at the lowest velocities.
- Larger, heavier sediments need higher velocities to start movement.
- Silt and clay need higher velocities than their size would suggest because they are cohesive (they stick together) and so, in fact, are bigger than they should be.
- Once set in motion, fine particles can be transported even if the velocity falls.
- Larger coarse particles are deposited rapidly as velocity falls. In channels with mainly boulders and gravel, transport only occurs at high flows.
- In natural channels the situation will be more complex. For example, small particles may be sheltered by larger particles and therefore they are not moved.
- Velocity of flow is variable across and vertically in a natural channel, and this will affect the processes.
- Sediment transported under lower-flow velocities, as bed load, may become suspended load under high velocities.

A river must have energy available to perform the work of transporting sediment. A river's power is the energy available to overcome friction and to move sediment. This will be greatest in rivers with high discharge, high downstream gradient, and an efficient channel. If the river has just enough energy in a particular section (reach) to transport the sediment available, then it is in equilibrium. If it has more power available than needed to transport its sediment load, the river will have excess energy and will erode its channel. If there is less energy available than is needed to transport its load, then deposition of the sediment will result. Two further terms are useful in describing sediment transport. The competence is the maximum sediment particle size that can be carried at a particular velocity. The capacity is the total load of sediment that the river can carry. These will vary with both discharge and velocity.

Deposition

The velocity at which a sediment particle drops to the channel bed is called the settling velocity . This depends upon the size and shape and density of the sediment particle. Deposition may be temporary on the channel bed and the sediment may be moved again at a time of higher flow. In other situations there is a net deposition of sediment, and a deposition landform results, e.g. floodplains and point bars on the inside of meander bends.

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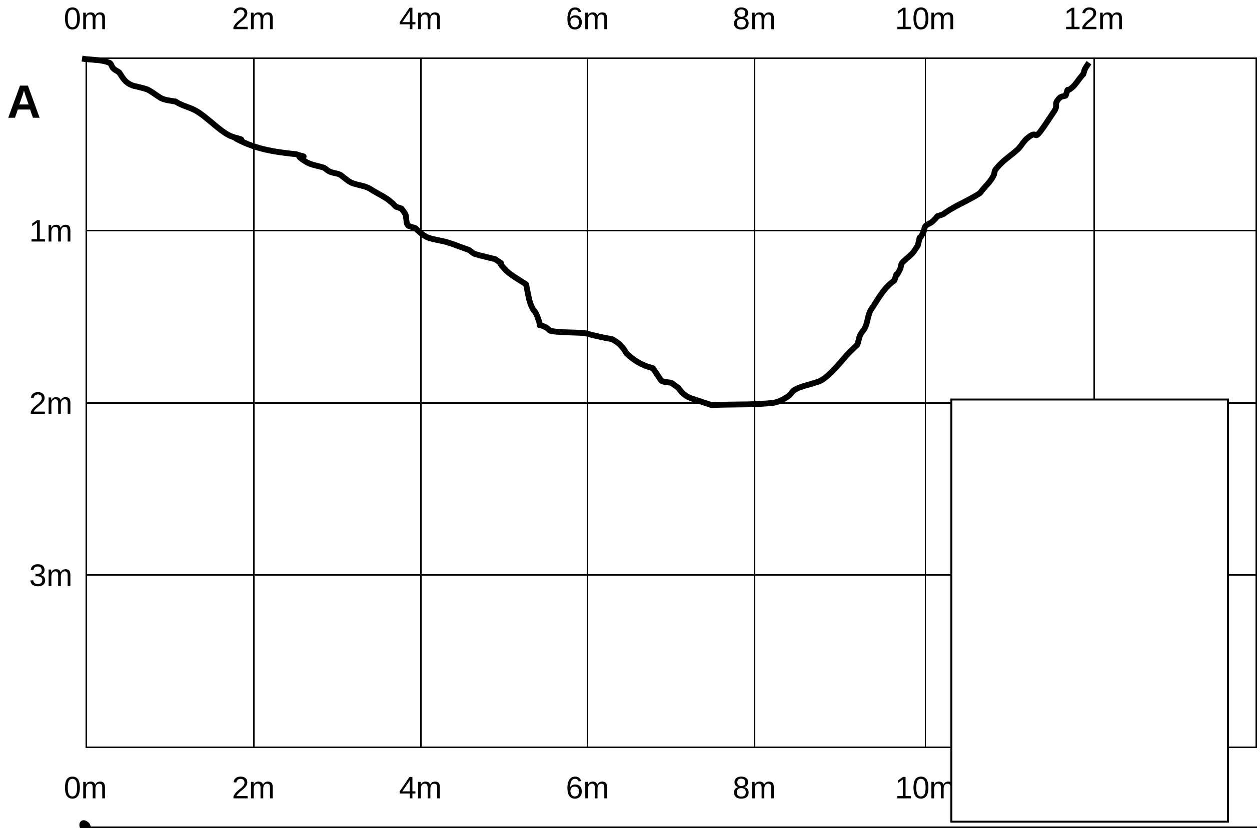
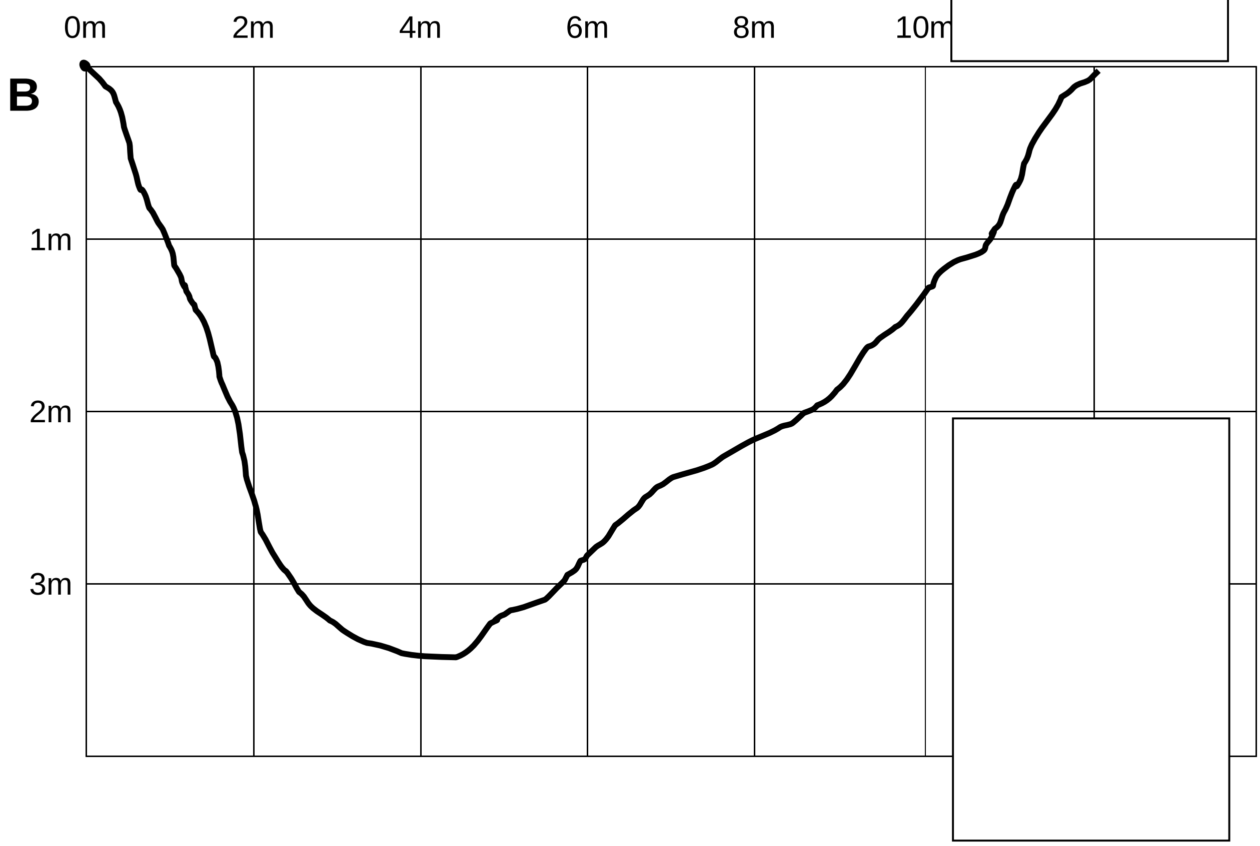
River Cross Sections





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Conducting a "Field Study" of a River…without getting your feet wet.

Refer to "Conducting a Field Study of a River" on pages 192 and 193 of you textbook.

Width (m)	Depth
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

1. For **cross section A**, determine the stream depth at 1 m intervals. Following the procedure in the text book, calculate the cross sectional area in m^2.

2. On the cross section indicate the thalweg.

3. The cross section is taken on a bend in the river. In the blank box at the lower right of the cross section, indicate the direction that the river is bending.

4. Label the areas of likely erosion and deposition in the cross section.

5. An object is dropped into the river and timed over a 10m course. The following times (in seconds) are recorded: 11.5, 12.9, 12.7, 12.3. Determine the average flow velocity in m/second.

6. Calculate the discharge rate for the stream at this cross section.

Width (m)	Depth
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

7. For **cross section B**, determine the stream depth at 1 m intervals. Following the procedure in the text book, calculate the cross sectional area in m^2.

8. On the cross section indicate the thalweg.

9. The cross section is taken on a bend in the river. In the blank box at the lower right of the cross section, indicate the direction that the river is bending.

10. Label the areas of likely erosion and deposition in the cross section.

11. An object is dropped into the river and timed over a 10m course. The following times (in seconds) are recorded: 12.5, 12.9, 14.7, 12.6. Determine the average flow velocity in m/second.

12. Calculate the discharge rate for the stream at this cross section.

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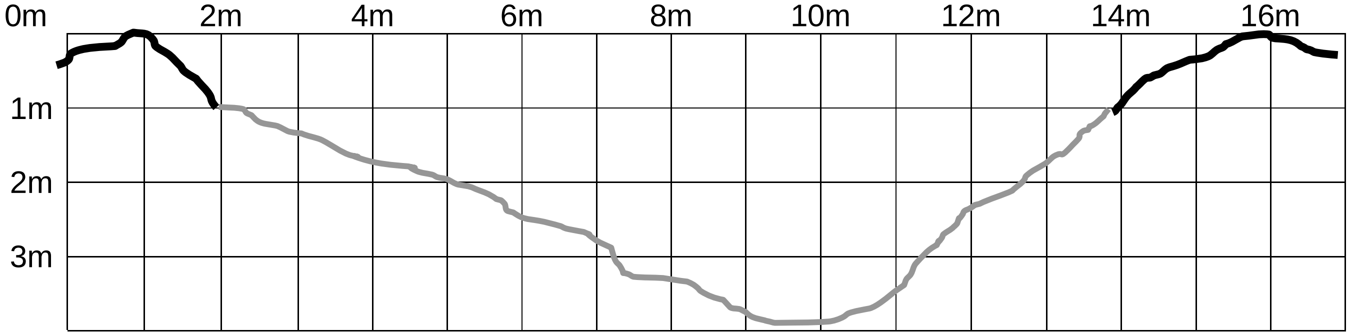

The cross section above represents cross section "A" with the addition of the stream banks. The top of the bank defines the maximum stream capacity. You have already calculated the cross section of the stream (# 1 above)

13. Calculate the additional cross sectional area provided by the banks.

14. Once you have calculated the TOTAL cross sectional area (stream bank maximum), use the flow data from # 5, calculate the maximum stream capacity,

15. Assuming that flows exceeding the volume calculated in question 14 can be expected once every 10 years, what steps could be taken?