How valid is the concept of grade in a river’s long profile? essay sample

A graded channel is a channel with an idealised smooth concave long profile: a steep youthful source declining into an elongated gentle elderly channel downstream toward its mouth. According to Collard ‘ As rivers evolve through time they appear to work towards the achievement of a smooth, concave profile … from which irregularities are gradually removed.’

G. K. Gilbert, an American geomorphologist first put forward the concept of grade believed that as a channel gradually wore away the land to give a flat peneplain resulting in the decline of the gradient downstream whilst upstream the channel continues to eat into the uplands consequently a graded-channel would eventually form. To this graded channel Gilbert devised the following classic definition; ‘ Where the load of a given degree of comminution is as great as the stream is capable of carrying, the entire energy of the descending water is consumed in the translation of the water and load and there is none applied to corrosion.’ Gilbert therefore believed that a graded channel is the inevitable product of a river using up excess energy and once a river reaches a graded condition it is in a state of equilibrium and unable to deepen their valleys or change the form and gradient of their long profiles directly.

According to Briggs & Smithson a graded profile is necessary to erosion and transportation as ‘ In the upper reaches of the stream, the discharge is low and the sediment coarse. A steep slope is therefore necessary to transport the material. Down-slope the discharge increases while the sediment is finer thus more energy is available, but the losses of energy through friction have not increased proportionately. The sediments can therefore be transported over gentler slopes.’ This explanation would tie in with the Hjulstrï¿½m

diagram depicting the higher velocities required to erode and transport pebble and cobble sized particles, found upstream, and the lower velocities required to erode and transport silt and sand sized particles, found downstream.

Theoretically a graded profile is not an unrealistic assumption of the general shape of most rivers however in reality countless factors play a part in creating irregularities in the smooth concave long-profile. Clowes & Comfort outlined and example of this in the creation of waterfalls and rapids resulting in irregular steep drops in the long profile of a river. ‘ Where a river flows from hard to soft rock, the softer is eroded relatively rapidly and the gradient is locally steepened to form a waterfall or section of rapids.’ Where waterfalls and rapids occur an uneven distribution of energy is produced causing an eventual lowering of the gradient in the section of the river immediately followed by the feature.

On a smaller scale that waterfalls and rapids, pool and riffle sequences along a meandering channel produce fluctuations in a streams long-profile whereby a sequence of deposited material, riffles, raise the gradient along the straight section of a meander whilst eroded sections at the apex of the bend, pools, lower the gradient resulting in a fluctuating local-profile.

A short-term irregularity in channel may be caused by a sustained period of heavy rainfall which will increase the amount of discharge in a channel. As the volume of water increases the velocity increases leading to more erosion in the channel until ultimately the extra load is either deposited further down the valley or out at sea.

A major factor in irregular patterns of a long-profile is changes in the base level of a channel. Base level, which is the lowest level to which erosion by running water can take place i. e. sea level in most rivers, can be split into two changes; positive and negative. According to Waugh positive changes occur ‘ when sea level rises in relation to the land. This results in a decrease in the gradient of the river with a corresponding increase in deposition and potential flooding of coastal areas.’ Whereas negative changes occur ‘ when sea level falls in relation to the land. This movement causes land to emerge from the sea steepening the gradient of the river and therefore increasing the rate of fluvial erosion. This process is called rejuvenation.’

Rejuvenation has a larger effect on altering a rivers profile than a positive chance as new land is created which in time will be eroded by the river. According to Waugh, Britain experienced rejuvenation on most coast lines at the end of the Pleistocene glacial period; ‘ Britain was depressed by the weight of ice. Following deglaciation, the land slowly rose again (isostatic uplift). Thus rejuvenation took place on more than one occasion with the result that many rivers today show several partly graded profiles.’

With sufficient time the profile of this particular river may become completely re-graded with the knickpoints, the extent of a newly graded profile often a waterfall, disappearing.

Although hypothetically the idea of grade is certainly a logical and valid concept it does not take into account many of the factors affecting a rivers long-profile. As a river’s circumstances change regularly it is unlikely a river will ever reach a perfectly graded state as equilibrium between erosion and

deposition in a river is not an instant process and by the time it has happened a river’s circumstances will have changed.

References

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