Aide memoire for channel management in a catchment context

- don't confuse land drainage objectives with flood risk management...

In three sections:
A. Understanding channels, flow and stream power
B. Understanding land drainage
C. Understanding river channel sediments

Likelihood of predicted outcome happening:
Always happens 1
Generally happens 2
May happen in certain locations 3

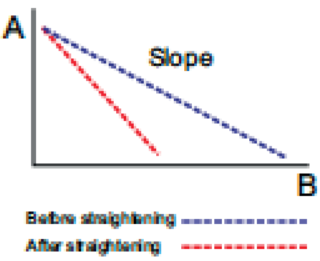
Section A
Understanding channels, flow and stream power

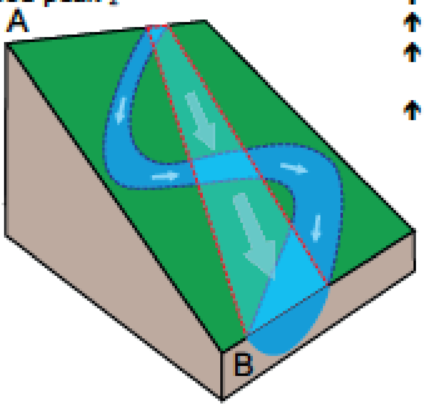
The amount a river can erode comes from the power it is able to generate. Stream power increases with the weight of the water in the channel, and the speed the water moves. Stream power reduces if it is spread over a wider channel. A deep, steep channel generates more power than a shallow, wide channel.

A1. Channel straightening

Straightening a channel means that a river will fall over the same gradient in a shorter distance i.e. make it steeper. This results in:

- ↑ Stream power 1
- ↑ Bed movement 2
- ↑ Incision of channel 3
- ↓ Floodplain storage (disconnection) 1
- ↑ Speed & magnitude of flood peak 2

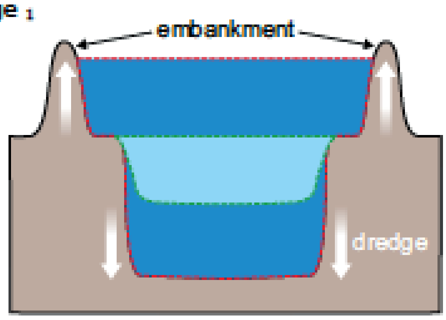




A2. Channel deepening

Deepening a channel by either dredging or embanking allows it to hold a greater mass of water before releasing pressure on to the floodplain. This results in:

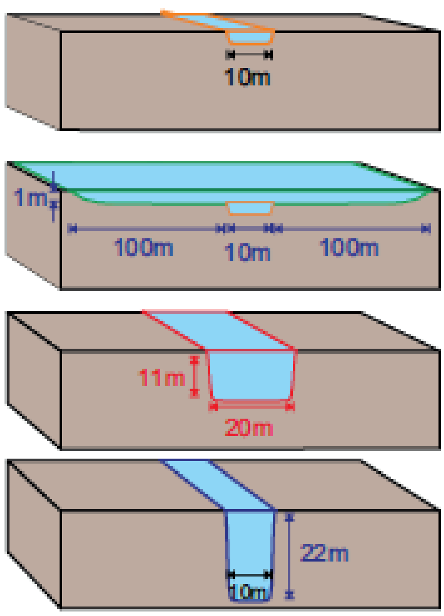
- ↑ Stream power 1
- ↑ Bank erosion 1
- ↑ Exposed bank vulnerable to slippage & weathering 1
- ↓ Floodplain storage 1
- ↑ Bed movement 2
- ↑ Water velocity 2
- ↑ Speed of flood peak 2
- ↑ Incision of channel 3



A3. Increasing floodplain area

Consider floodplain reconnection of a 10m channel, allowed to flood to a metre deep for 100m either side. This is equivalent to dredging the same channel 22m deep, or a double width channel 11m deep, both being infeasible even before considering on going maintenance & unintended consequences. Expand the floodplain to 500m either side, and the advantages of floodplain restoration are unsurpassed. Even setting existing flood banks back can have a benefit.

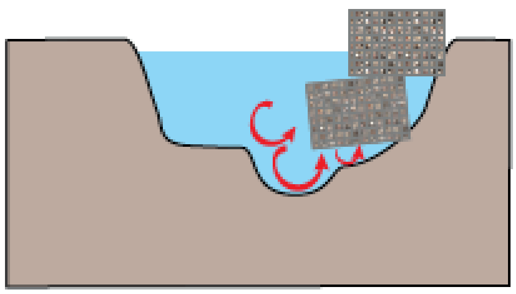
- ↑ Storage of flood waters 1
- ↑ Delay of flood wave 1
- ↓ Stream power to channel 2
- ↑ Temporary habitat 2



A4. Reinforcement of channel

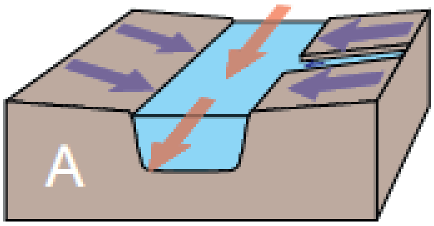
Submerged bank erosion is mostly controlled by strong secondary flow cells at high river levels (forces at an angle to the main direction of flow). These act to undermine reinforcements such as gabion baskets and rip rap, which eventually fall forwards into the channel, with negative consequences to the channel some of which are as a result of localised increase in stream power. Trees and willow spiling have a similar effect, but with other advantages that can offset the overall impact.

- ↑ Local vortex velocity 1
- ↓ Local sediment supply that can increase erosion in other locations 2
- ↑ Aggressive flow 2
- ↑ Depth and length of erosion 1



Section B - Understanding land drainage

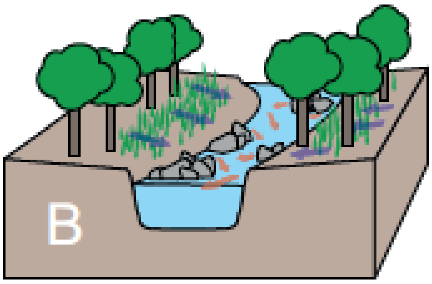
B1. Rough channel



Hydraulically smooth or 'clean' channels transport water at a greater velocity than rough channels. Compare driving down a farm track with driving on a motorway. 'Cleaning' a channel results in:

- ↓ Hydraulic roughness (friction) [1]
- ↑ Water velocity [1]
- ↑ Stream power [2]
- ↑ Erosion processes of bed and bank [2]
- ↑ Speed of flood peak [3]

The same processes apply to the floodplain where slowing return of water to the channel can dramatically slow the flood & reduce its peak at some locations downstream.



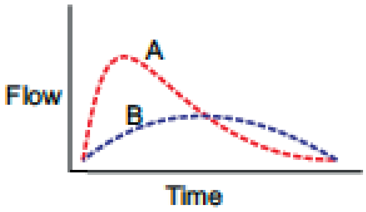
B2. Arterial drainage & hard (impervious) surfaces

Arterial drainage of the landscape for land improvement, and hard surfaces either by urbanisation or soil compaction, increase the volume and speed of water run off from a catchment area and therefore the speed and magnitude of flood peaks. Across the whole UK landscape, surfaces are less water-receptive – climate change isn't 'needed' to explain floods/ siltation.

Arterial drainage and hard surfaces result in:

- ↓ Surface, soil and rock storage of rainwater [1]
- ↑ 'Smooth' surfaces and drain velocities [1]
- ↓ Evaporation from plants and drying of soil [2]

'Sustainable drainage' (green infrastructure or SuDS) seeks to increase water storage in the landscape.

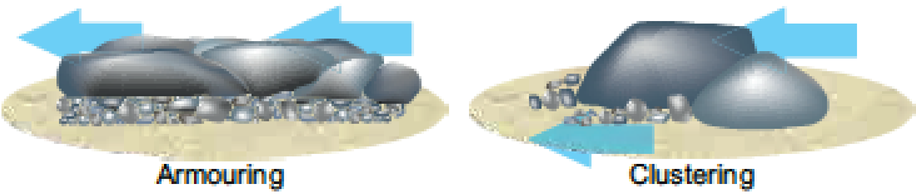


Section C - Understanding river channel sediments

C1. Armouring & clustering

In a coarse natural river bed, large substrate organises itself in a way to protect smaller substrate from movement, either through interlinking like crazy paving (armouring), or shielding (clustering). Removal of this structure by use of a machine results in:

- ↑ Bed movement [1]
- ↑ Erosion and deposition [1]
- ↓ Roughness of channel [3]
- ↑ Velocity [3]

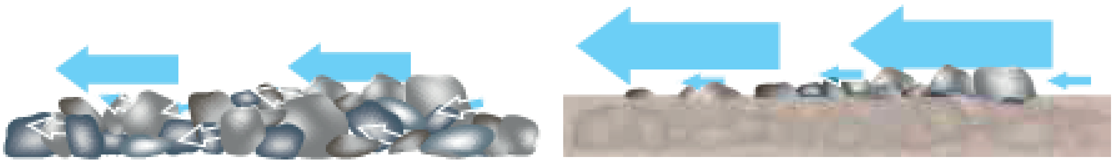


C2. Sediment sources

Soil and river erosion are natural processes but are 'aggravated' by land use and management. An increase of fine sediment into a river channel, from sources such as maize, clearance of forestry or free-range pigs, has the consequence of filling spaces in the river bed and smoothing the channel.

This results in:

- ↓ Habitat [1]
- ↓ Channel capacity [2]
- ↑ Water velocity [3]
- ↓ Ecology [1]



C3. Deposited gravel (bars, points & islands)

Despite what casual observation may at first suggest, deposition is a result of river movement, not the cause of it. At low flows, where it looks like water is being displaced by the deposits, the energy is too low to cause erosion (look at the shape of the opposite bank). Erosion occurs at high flows, when energy is high the deposition itself will also be moving. Gravel deposits where the flows reduce enough to allow it to settle. For consequences of removal see A1, A2, B1 & C1.

Gravel bars (other than some flood deposits - often mid-channel) produce:

- ↑ Temporary storage of bed sediments and channel roughness [1]
- ↑ Habitat quantity and quality and hydromorphological quality [1]