

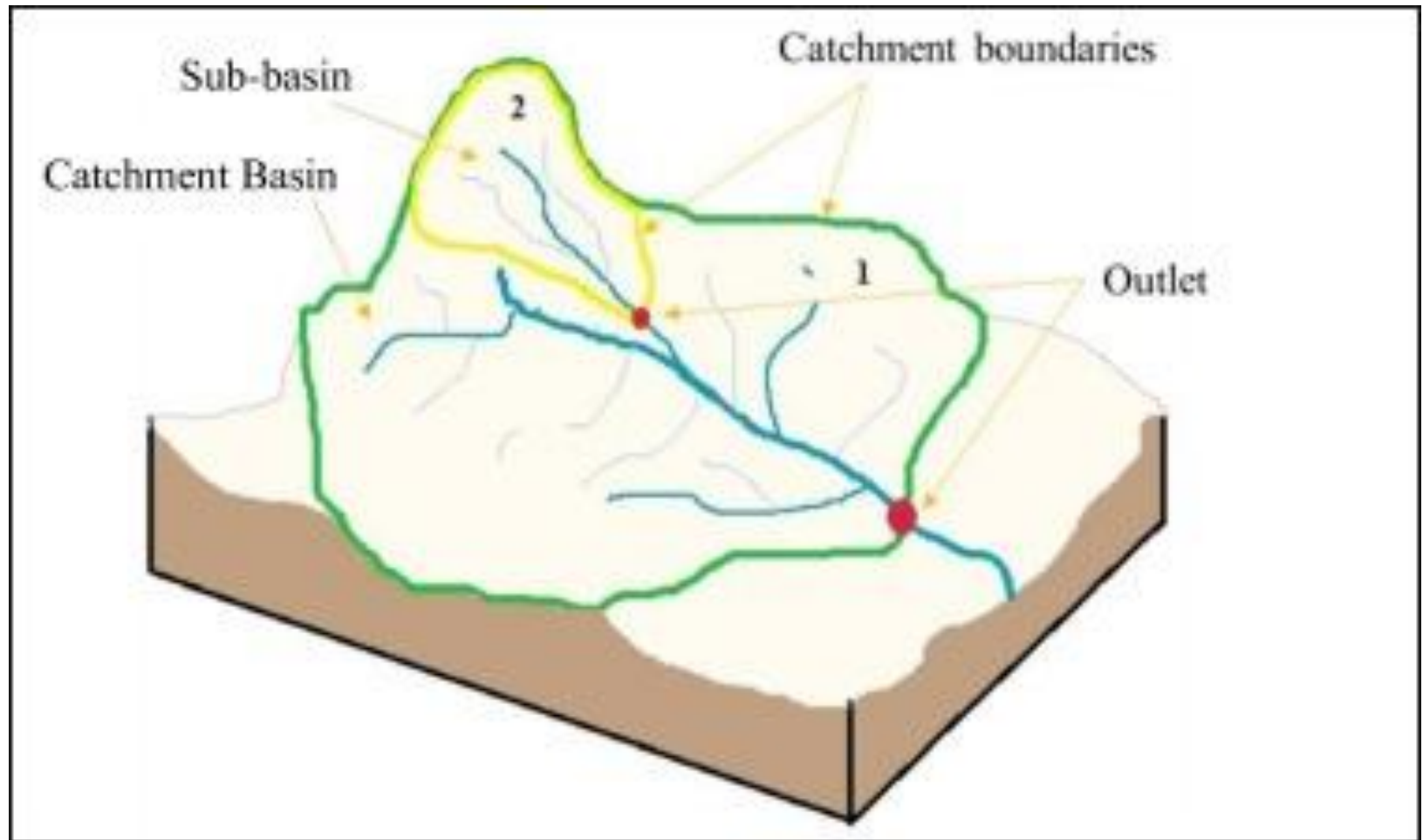
Lowland Rivers & Fluvial landscapes

Dr Alissa Flatley
ACNA4007 – Physical Landscape and the Geosphere

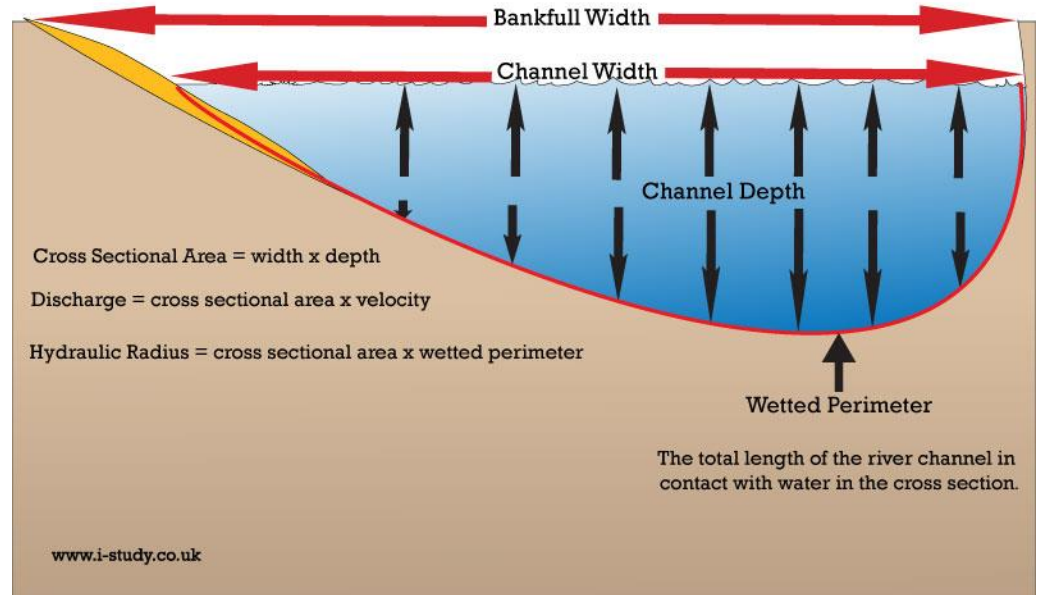


Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

1 Draw a hypothetical catchment.



River Cross Section Measurements



What is a river cross section?

2

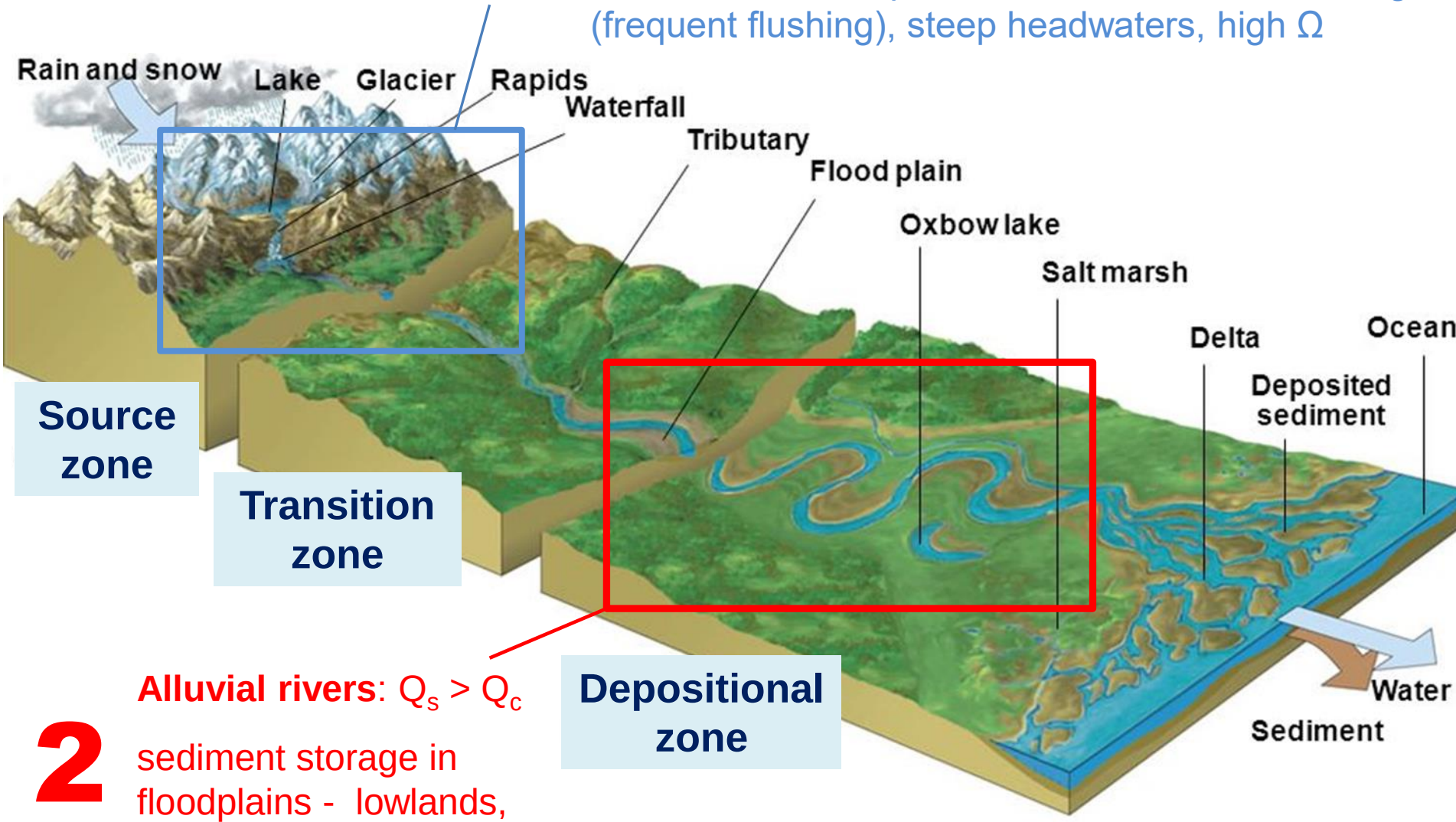
Draw a cross section of a river

Understanding the fluvial system...

1

Bedrock rivers: $Q_c > Q_s$ (i.e. excess power)

>50% 'bedrock' exposed, minimal sediment storage (frequent flushing), steep headwaters, high Ω



Source zone

Transition zone

Depositional zone

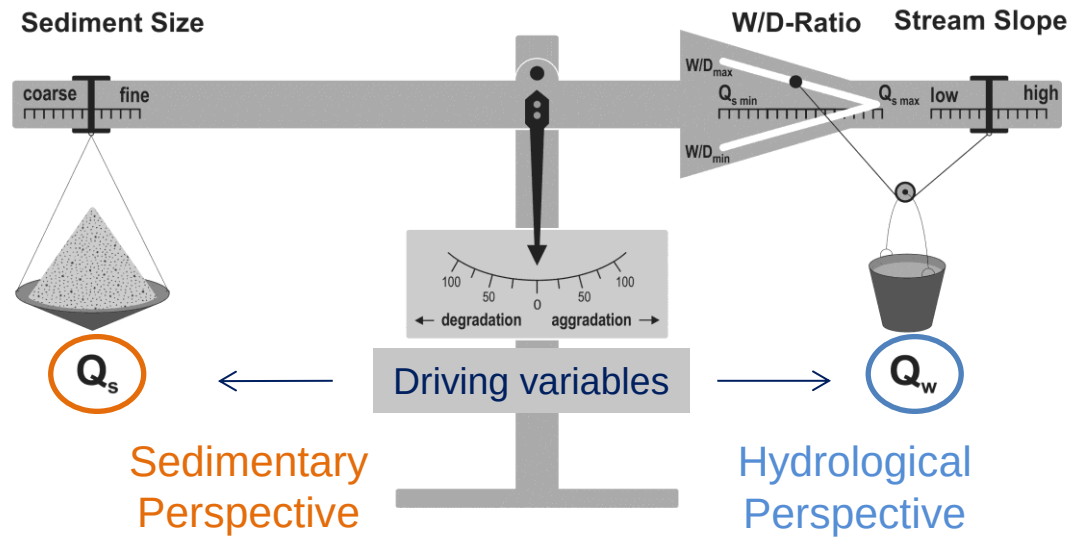
2

Alluvial rivers: $Q_s > Q_c$

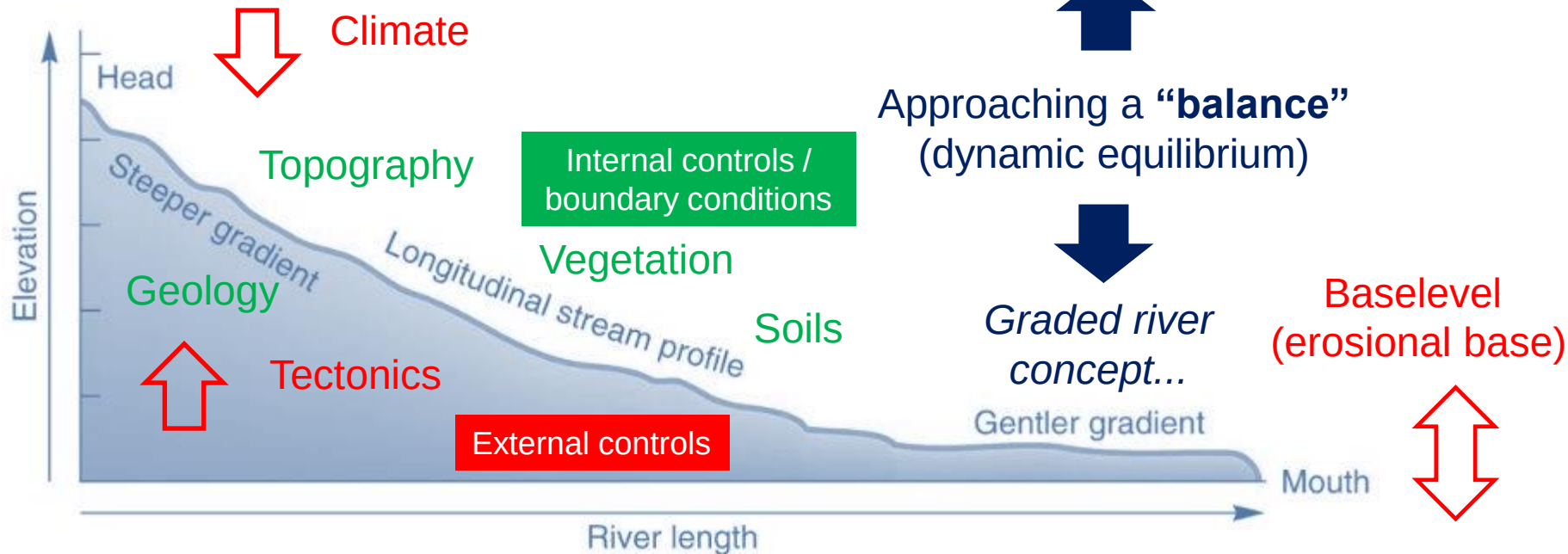
sediment storage in floodplains - lowlands, high Q , low S

Understanding the fluvial system...

- A river at work... (i.e. **energy** consumed to transport **water** and **sediment**)
- **Rivers** only want the energy to transport their water and supplied sediment to ocean basins, and nothing more!

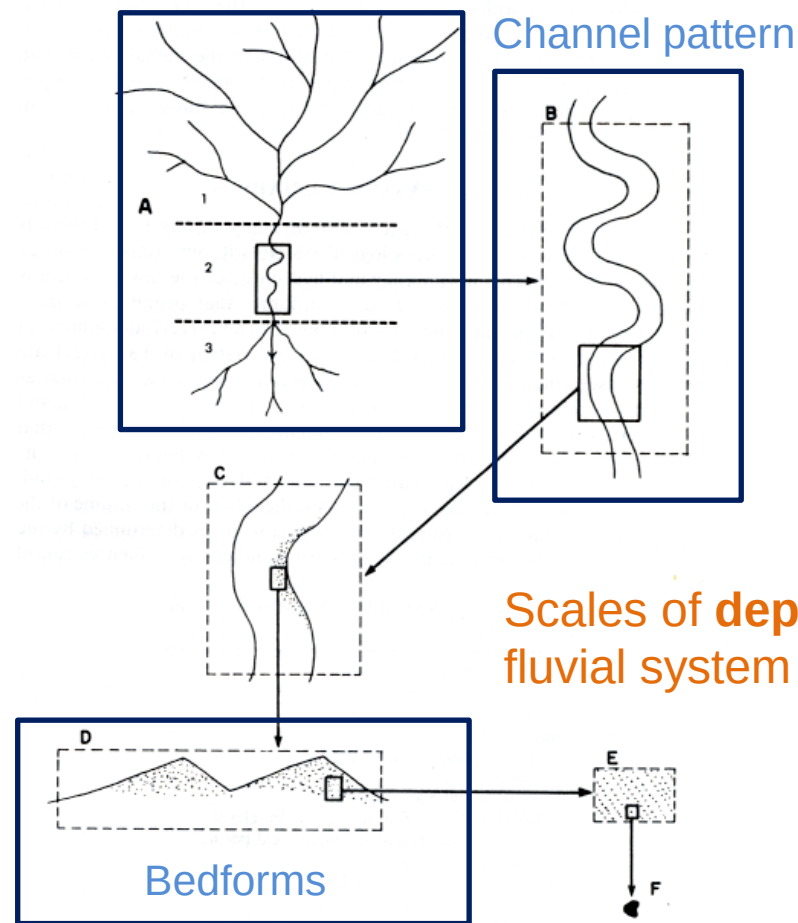


Geomorphic Perspective:



Understanding the fluvial system...

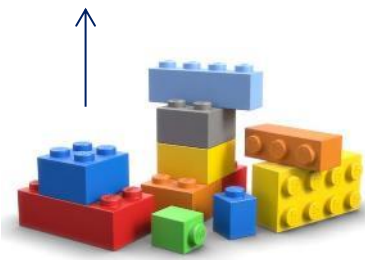
- From small to large-scale...
(from short to long timescale)



- Depositional elements** built with sedimentary characteristics (grain size, structure, lithologies etc.): **Facies**

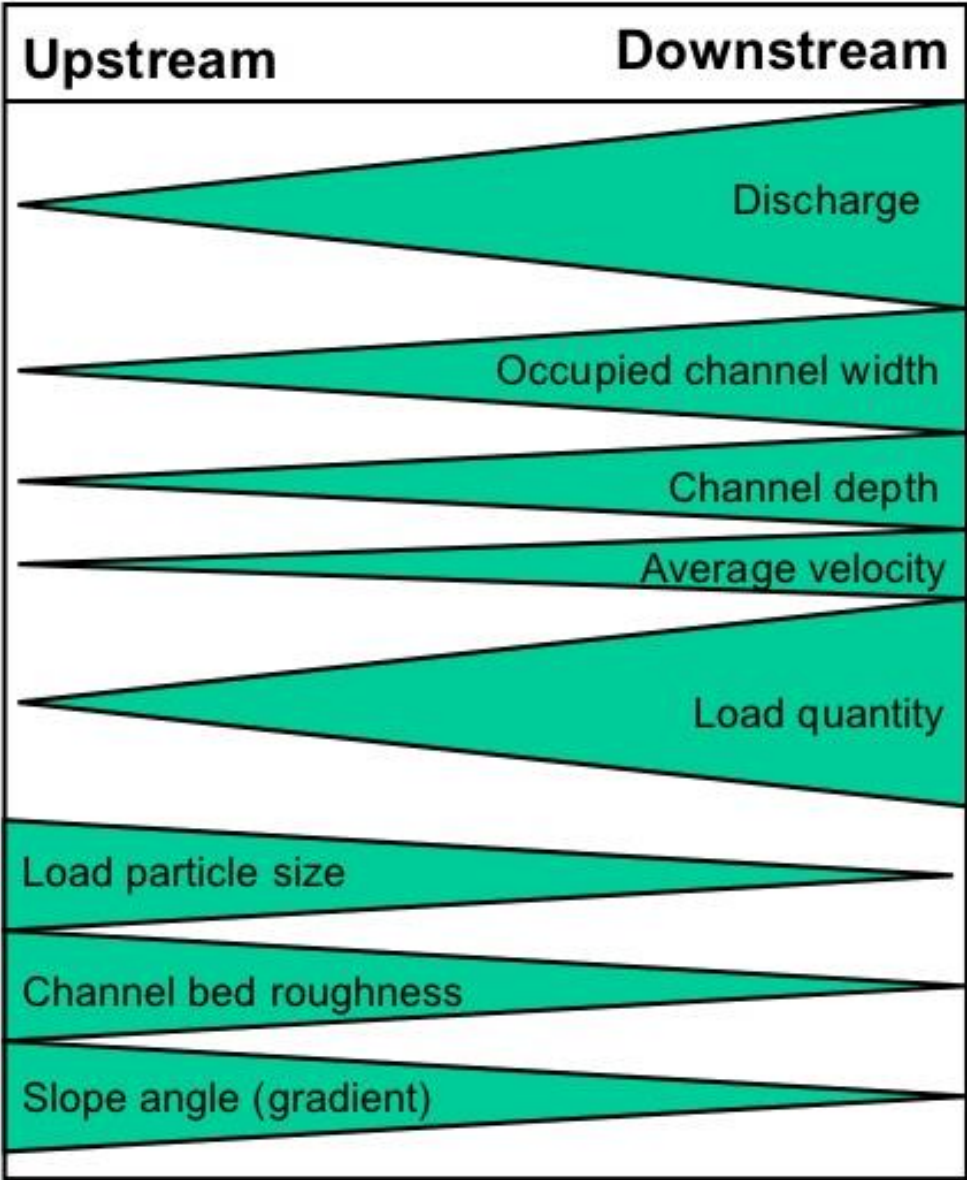
- Characteristics depend on **type of river (depositional style)** = **Channel form**

- Depositional Environment** = specific set of **depositional elements**

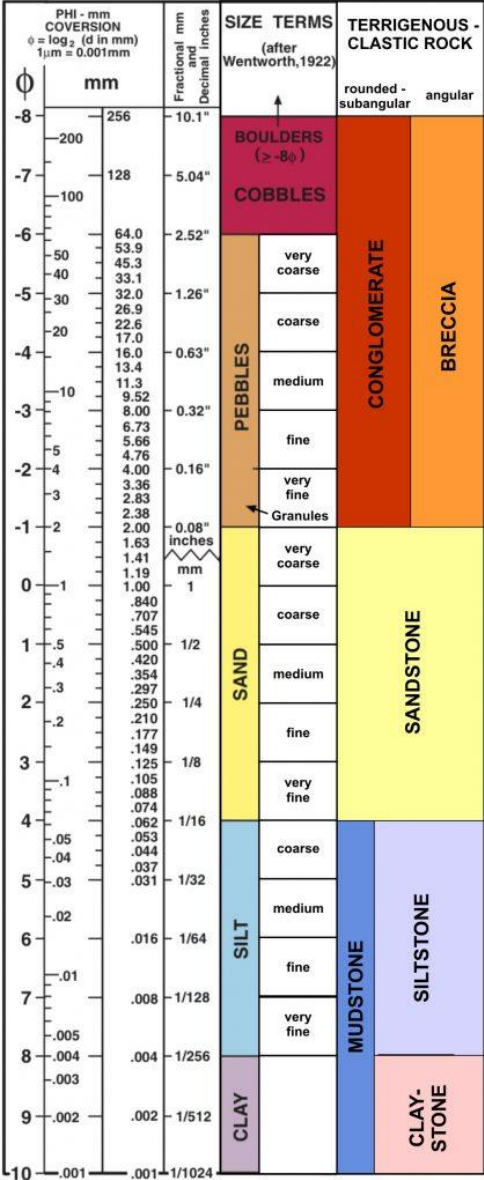


Building blocks of fluvial systems

Sedimentary perspective



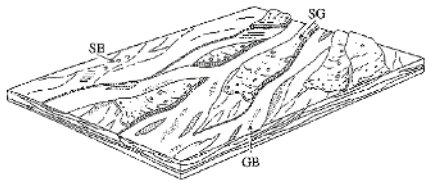
Bradshaw Model



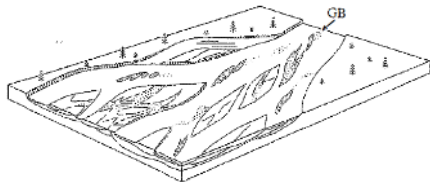
Sediment Size

Channel form and depositional environments

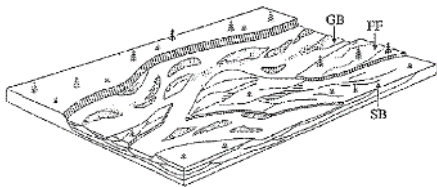
Sedimentary perspective



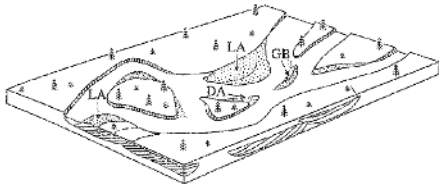
1 Gravel-bed braided river



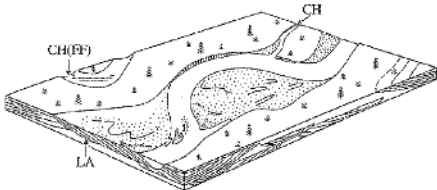
2 Gravel-bed braided river



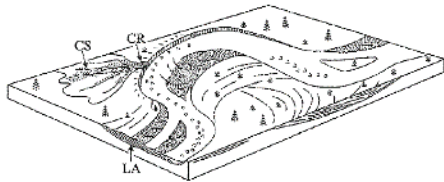
3 Deep Gravel-bed braided river



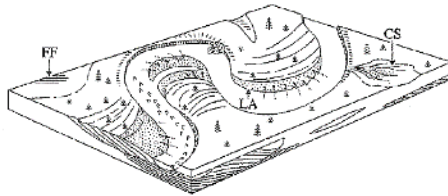
X Wandering gravel bed river



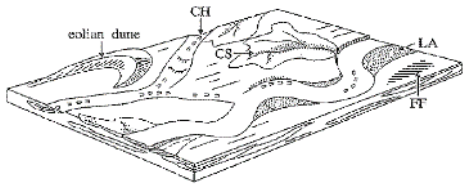
4 Gravel bed meandering river



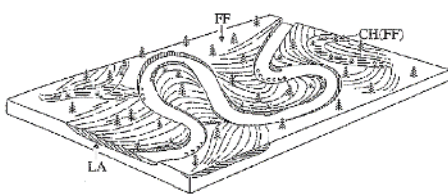
5 Gravel-sand meandering river



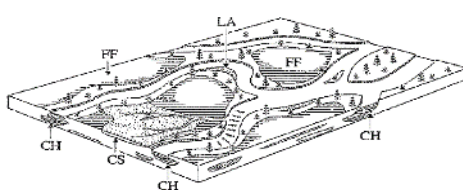
6 Sand bed meandering stream



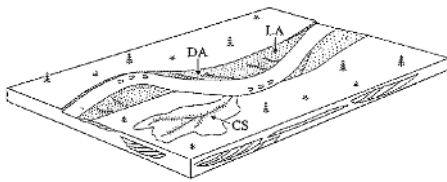
X Ephemeral sand bed meandering



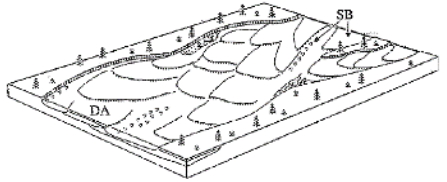
7 Fine-grained meandering river



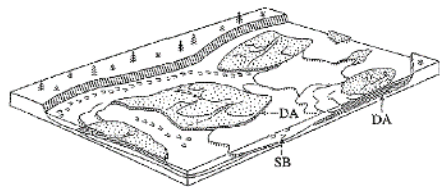
8 Anastomosed river



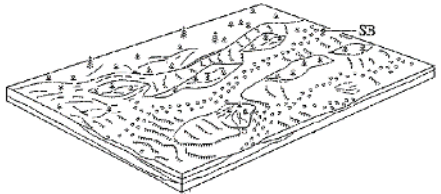
X Low-sinuosity river with alternate bars



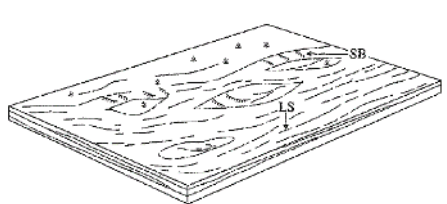
9 Shallow perennial sand-bed braided river



10 Deep perennial sand-bed braided river



11 Distal sheetflood sand-bed river



12 Flashy ephemeral sheetflood sand-bed river

Gravel-dominated Sand-dominated high-sinuosity Sand-dominated low-sinuosity

Sedimentary perspective

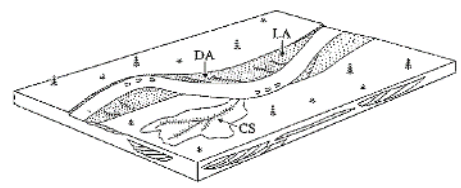
Forms & process



1 Gravel-bed braided river



5 Gravel-sand meandering river



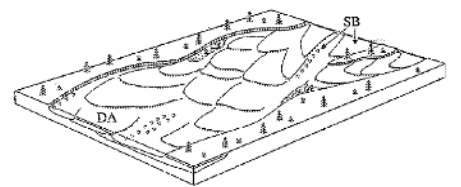
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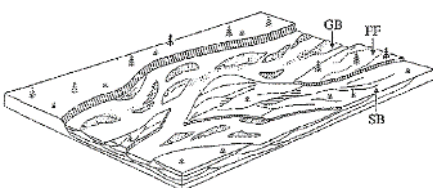
2 Gravel-bed braided river



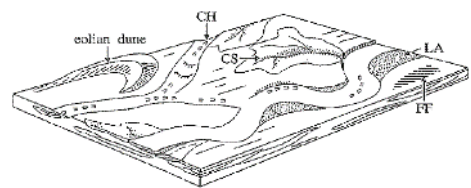
6 Sand bed meandering stream



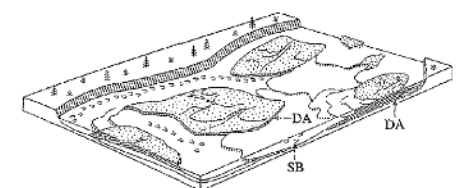
9 Shallow perennial sand-bed braided river



3 Deep Gravel-bed braided river



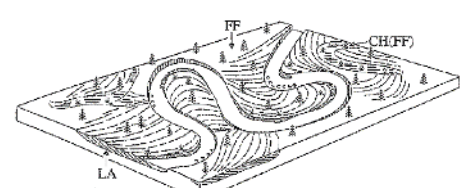
X Ephemeral sand bed meandering



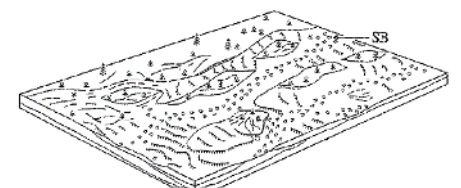
10 Deep perennial sand-bed braided river



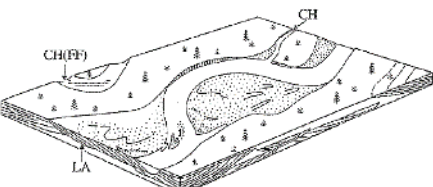
X Wandering gravel bed river



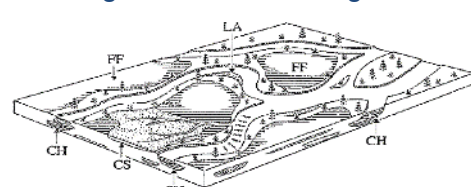
7 Fine-grained meandering river



11 Distal sheetflood sand-bed river



4 Gravel bed meandering river



8 Anastomosed river



12 Flashy ephemeral sheetflood sand-bed river

Q = Discharge

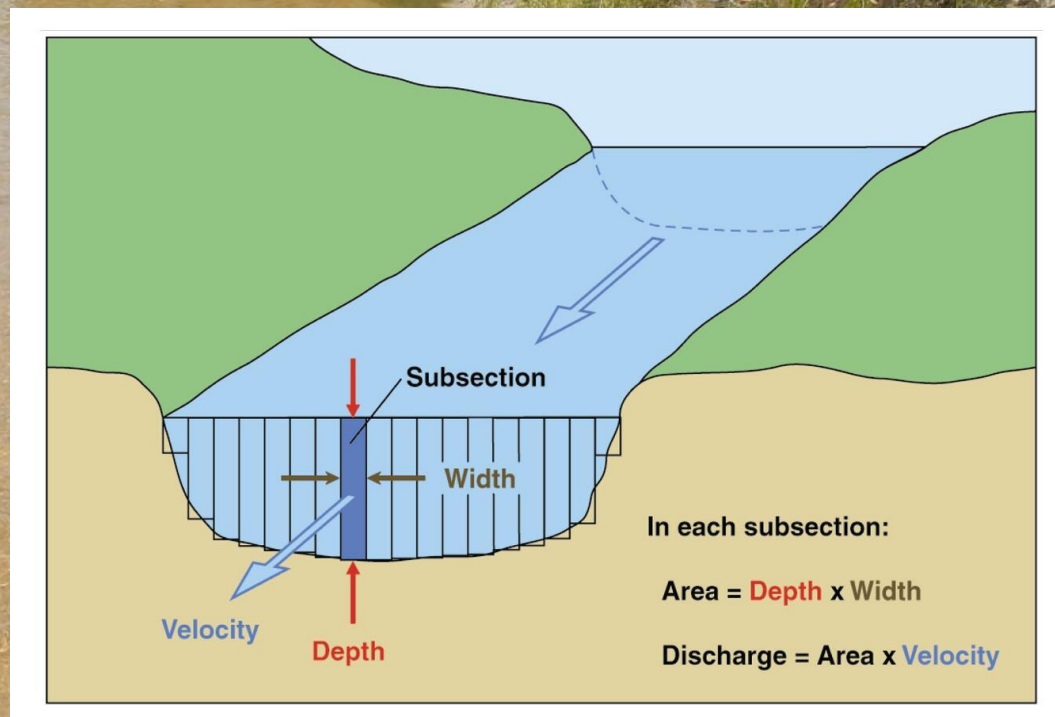
In hydrology, discharge (Q) is the volume of water flowing through a given cross-sectional area of a stream or river per unit of time. It is typically measured in cubic meters per second (m^3/s) or cubic feet per second (cfs).

$$Q = \text{Discharge} = \text{m}^3/\text{s}$$

$$Q = A \times V$$

$$\text{Discharge} = \text{Area} \times \text{Velocity}$$

local shear
stress and
velocity



Stream Power

$$\Omega = \rho g Q S$$

= ... amount of energy the water in a river or stream is exerting on the sides and bottom of the river

Density is 1000 kg/m³

Gravitation 9.8 m/s²

Discharge ~ 2 m³/s (3000 m³/s in flood)

Gradient 0.0025 m/m

Stream power = 49 W = 0.049 kW
(73 500 W = 73.5 kW in flood)

1 kW = 1.34 horsepower...

Specific Stream Power

$$\omega = \frac{\Omega}{W}$$



$$\omega = \tau_0 \bar{v}$$

local shear
stress and
velocity

Stream power = 49 W/m

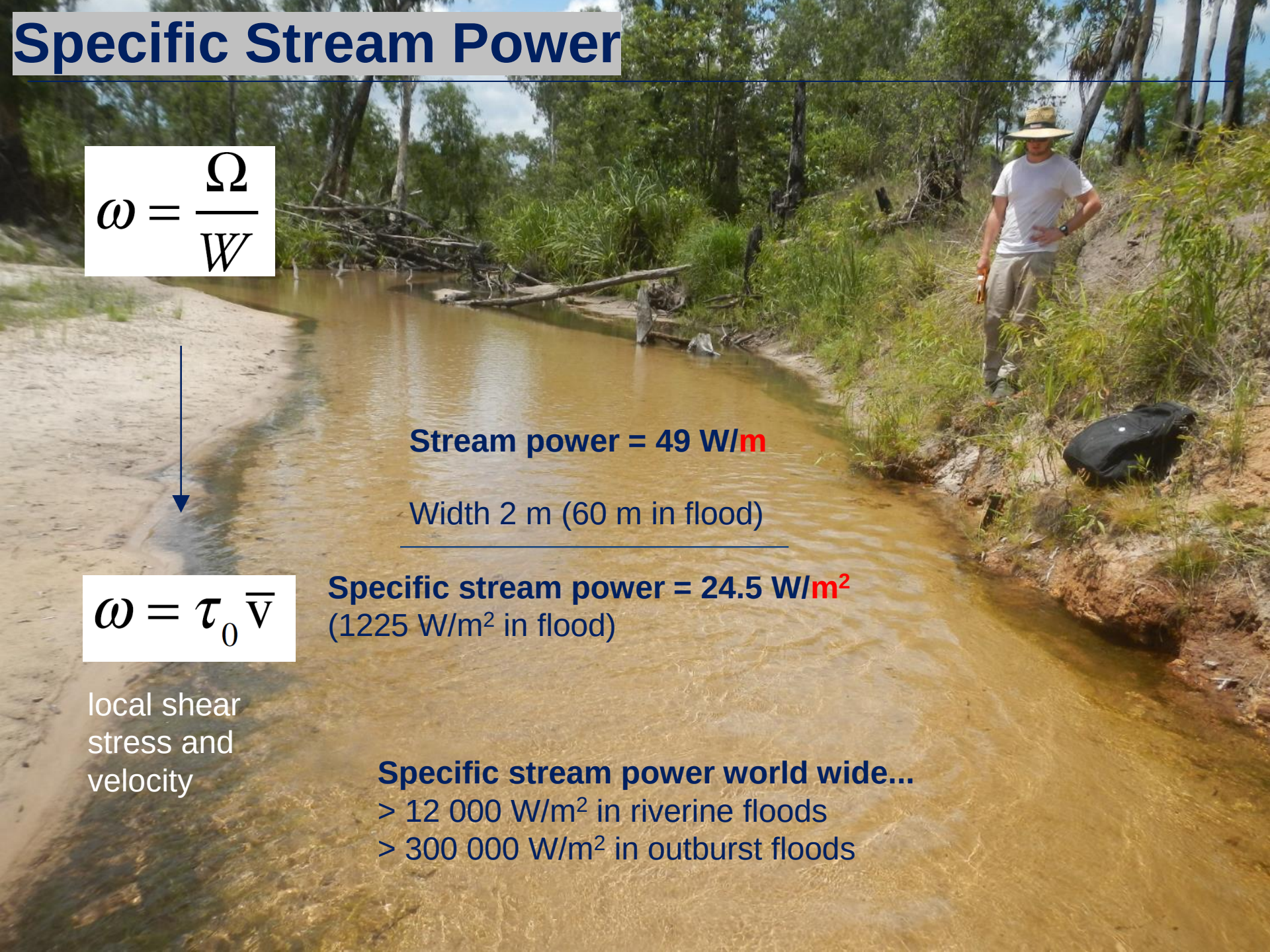
Width 2 m (60 m in flood)

Specific stream power = 24.5 W/m²
(1225 W/m² in flood)

Specific stream power world wide...

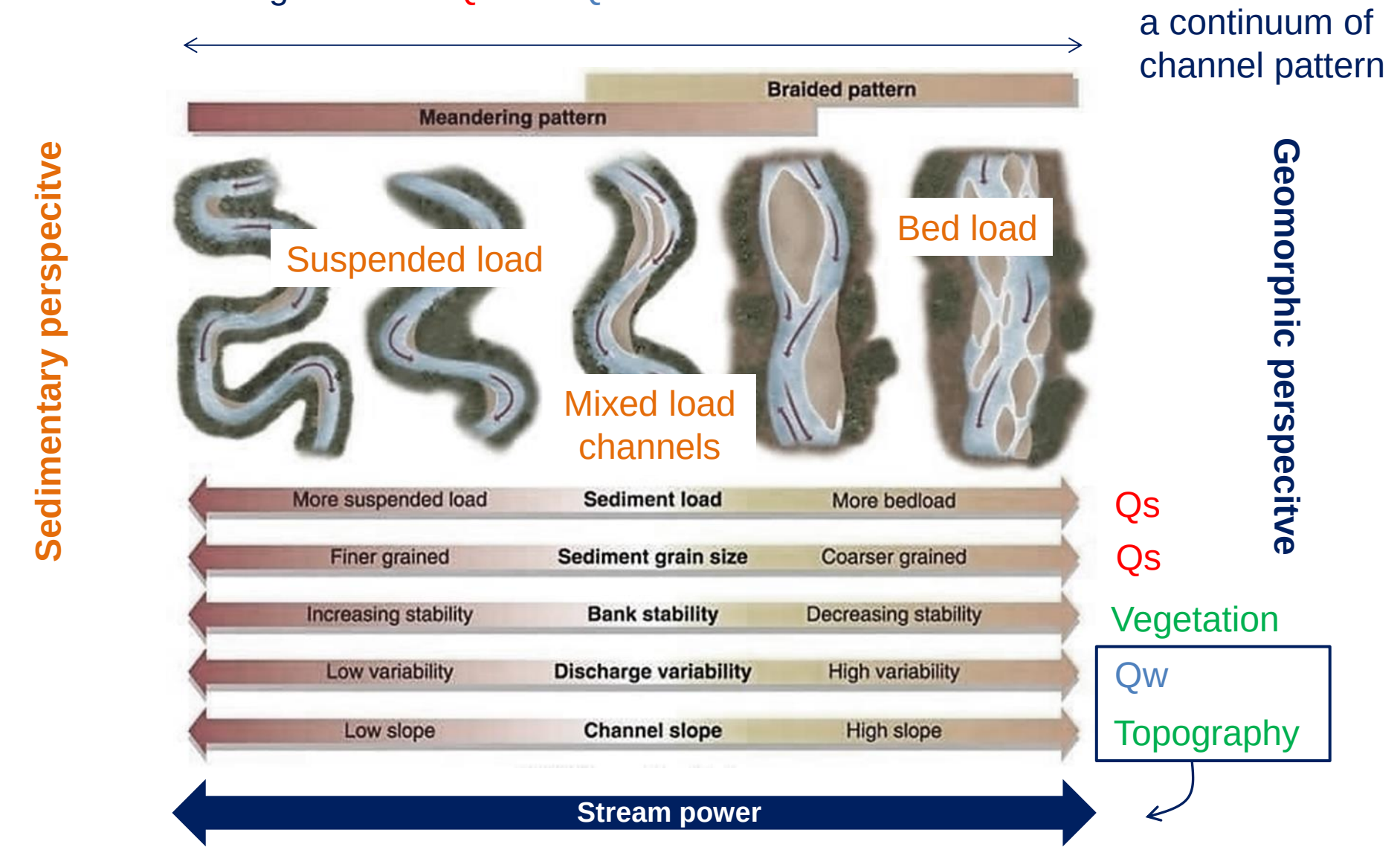
> 12 000 W/m² in riverine floods

> 300 000 W/m² in outburst floods



Channel form and depositional environments

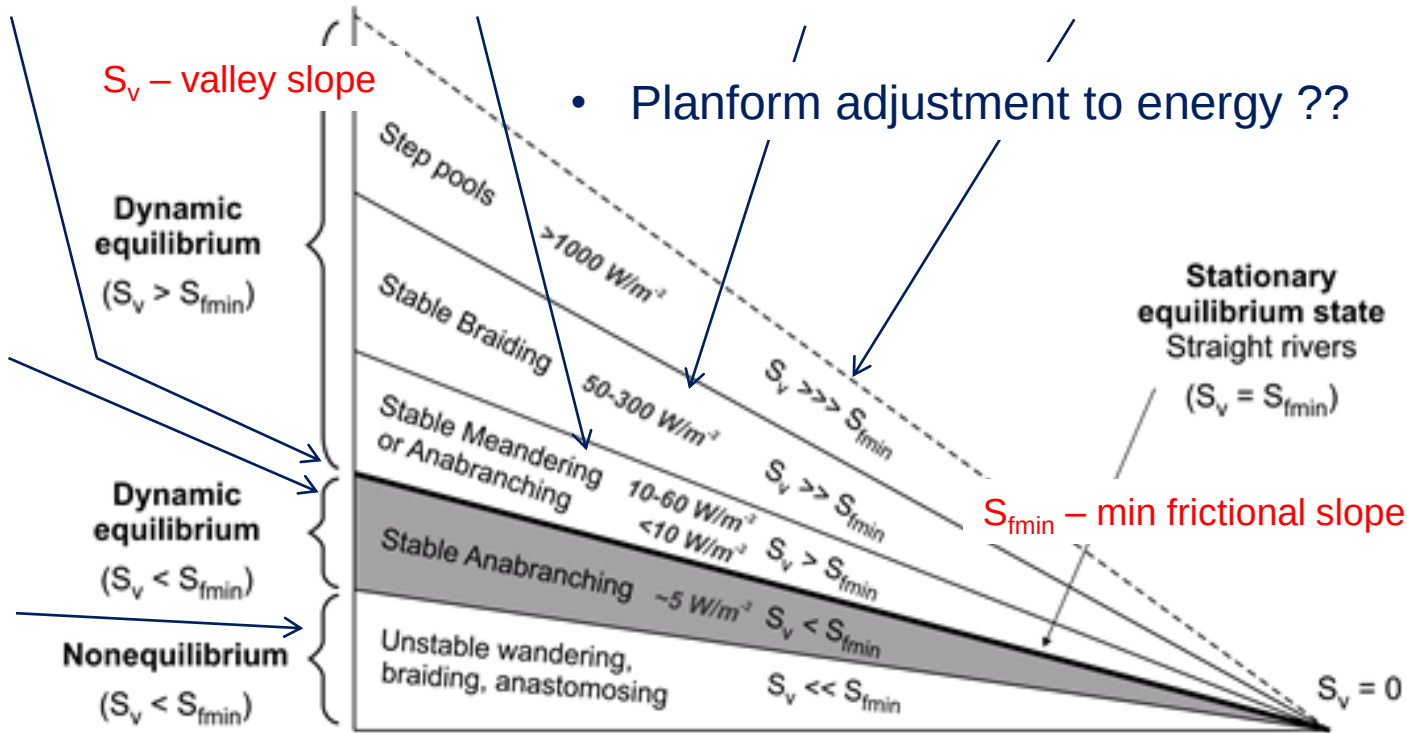
- **River planform** = adjustment to **boundary conditions (internal variables)** + controlling variables Q_s and Q_w



Channel form and depositional environments

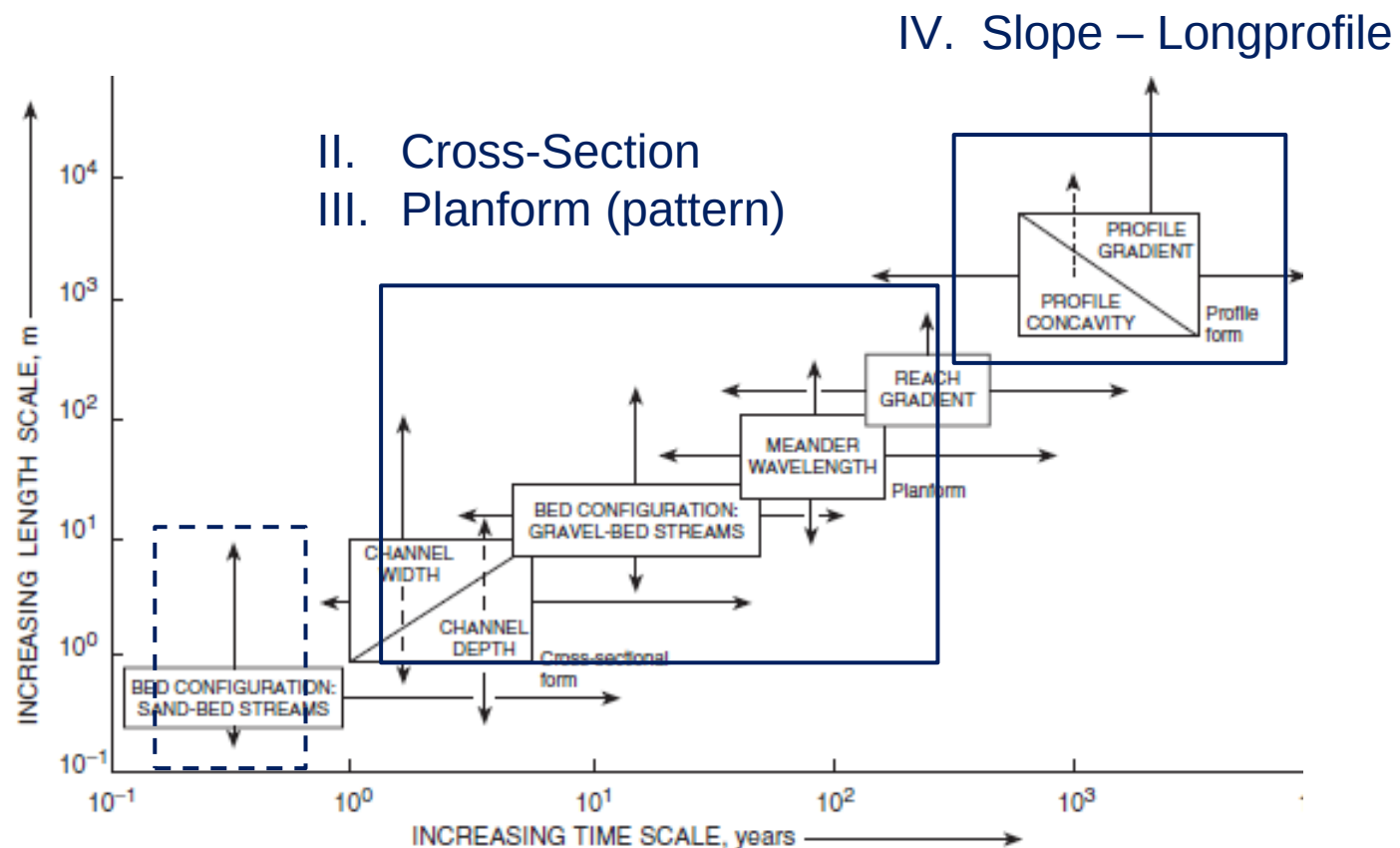


Rivers with **exactly** the energy required to move their bedload are **straight** without bedforms and are in the stationary equilibrium state

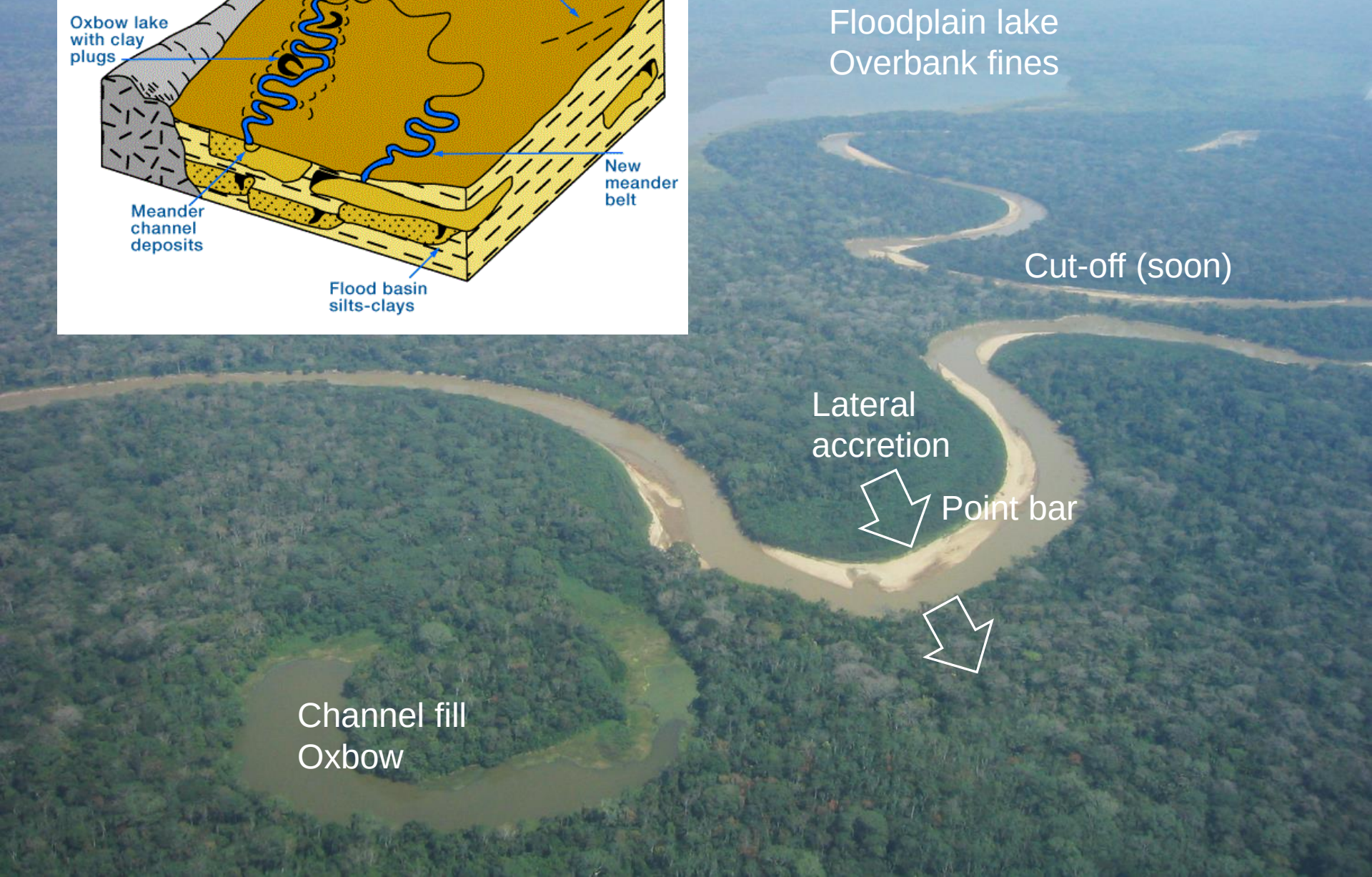
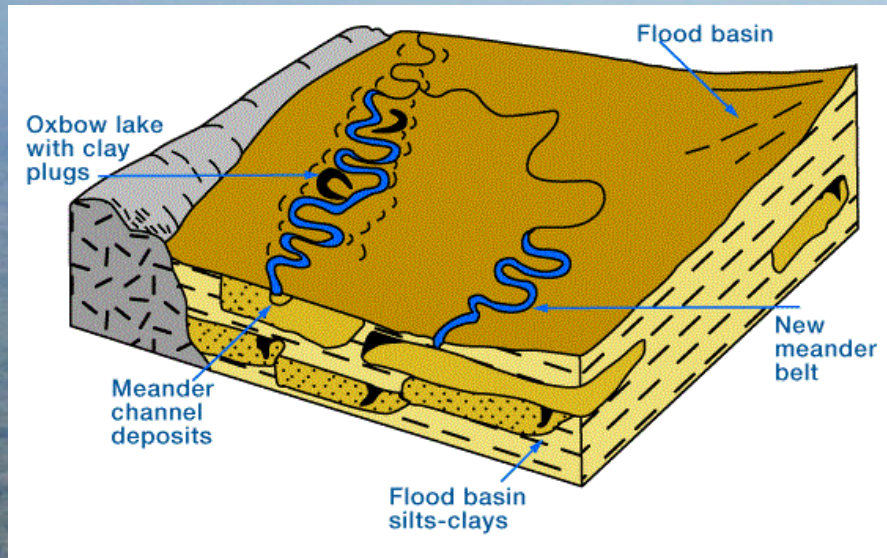


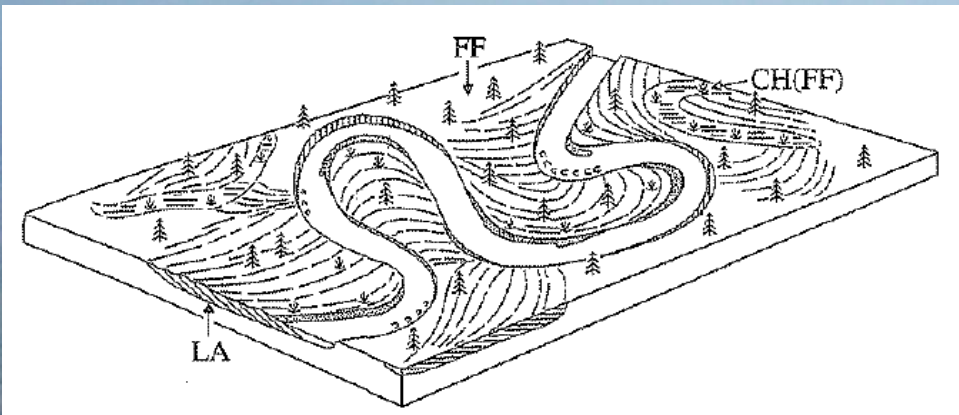
Dynamics – adjustment and change

1. Q_w , Q_s and **boundary conditions** **change downstream** – systematic change in form (pattern) and processes downstream...
2. Q_w and Q_s both fluctuate through time, and **boundary conditions** can change over long timescales - **continuous adjustment** takes place... how?



I. Bed forms and roughness





Floodplain lake
Overbank fines

Cut-off (soon)

Lateral
accretion

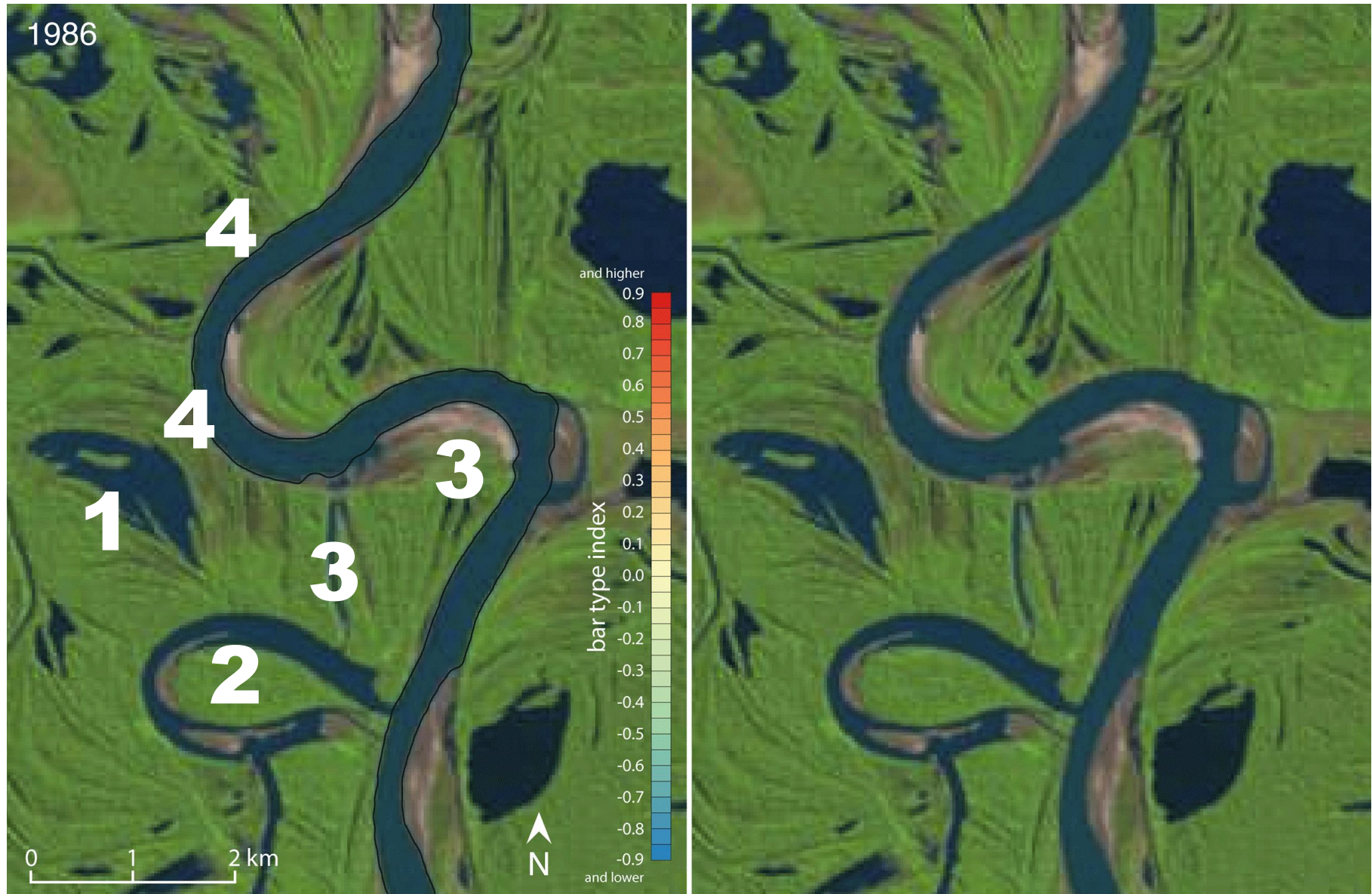
Point bar

... Meandering River

Channel fill
Oxbow



Meandering dynamics – forms

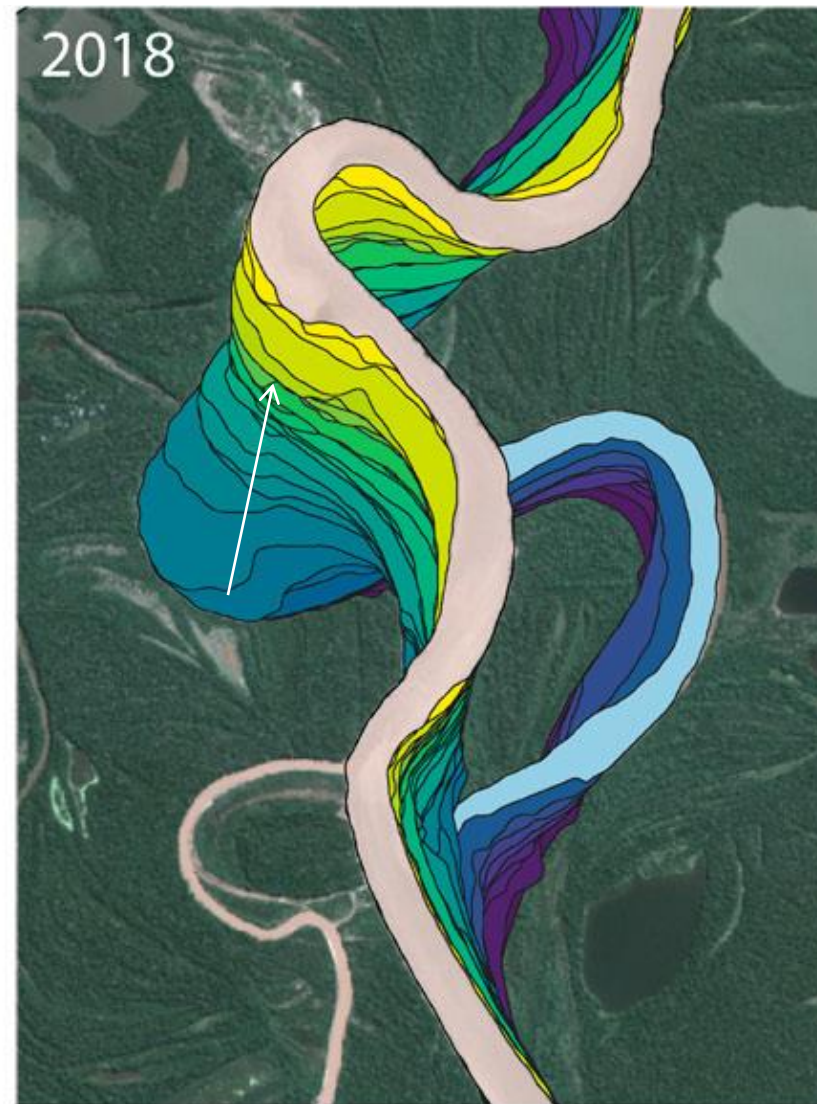


Meandering dynamics – processes and rates



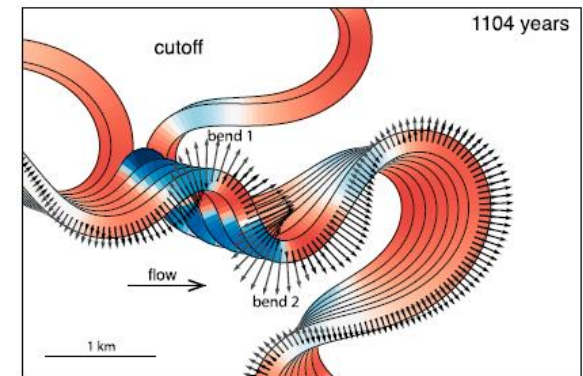
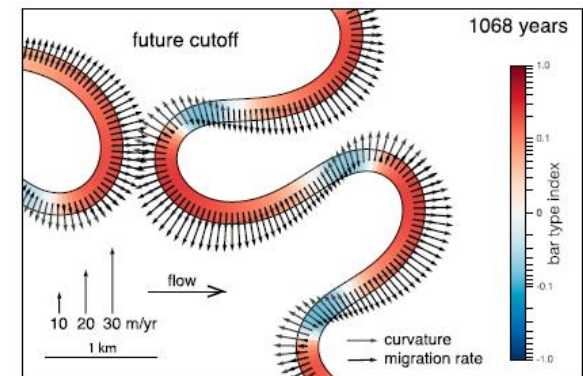
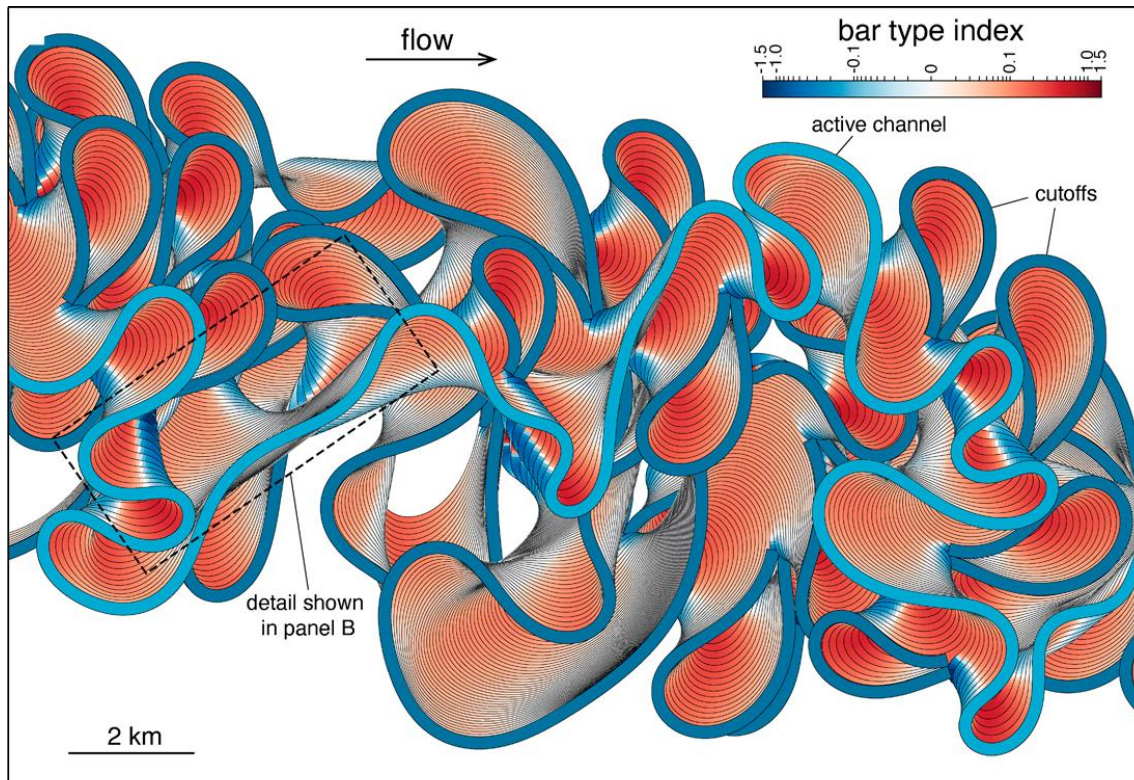
0 1 2 km

flow ↑



age





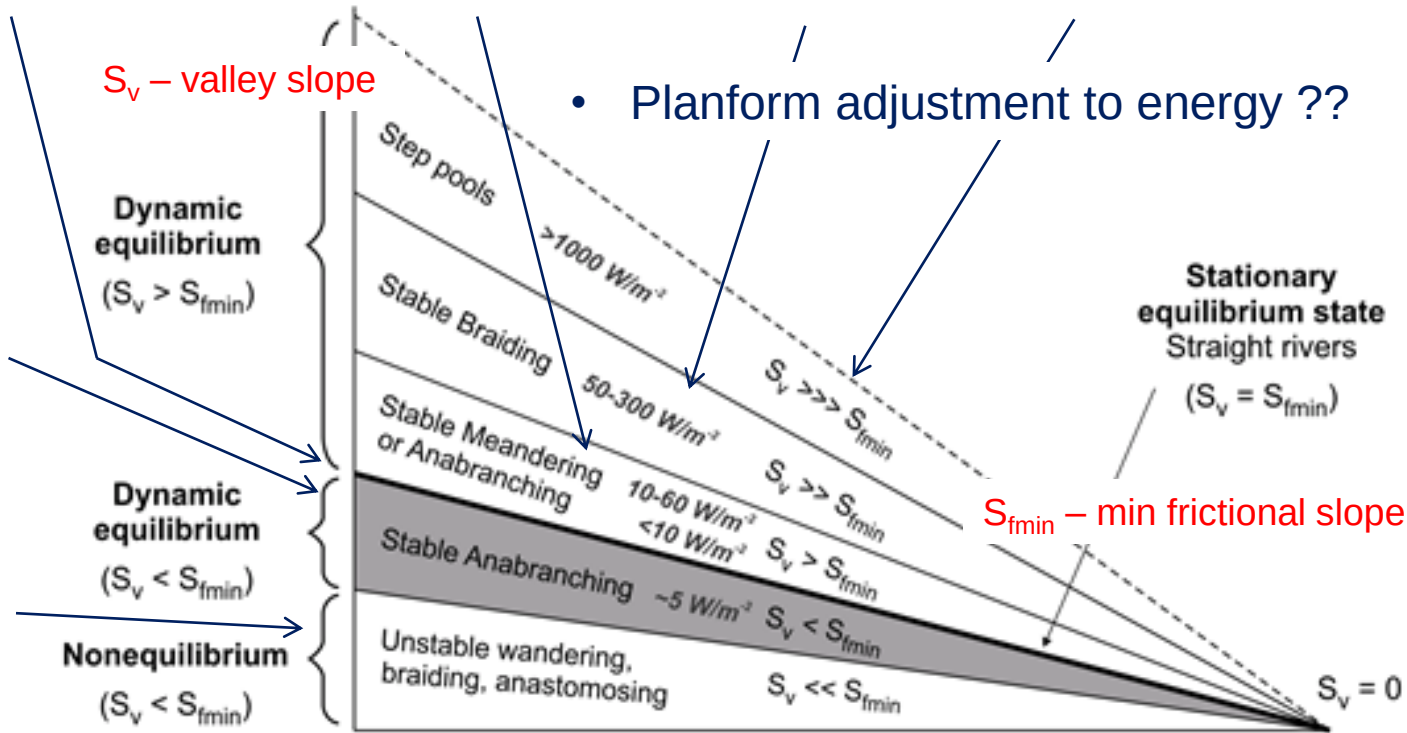
Forward numerical modelling

- What drives meandering rates – discharge/flow or sediment ?

Channel form and depositional environments



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Physical Landscapes Report Session

30 mins Activities
30 mins Q&A



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