Why are the world's big rivers so different?

Based on a Monday Night lecture by Professor Phil Ashworth (14/01/13)

Royal Geographical Society with IBG
www.rgs.org

The world's big rivers

Length (km)	Drainage basin (km^2)	Average discharge (cumecs)
1. Nile	1. Amazon	1. Amazon
2. Amazon	2. Congo	2. Congo
3. Yangtze	3. Nile	3. Orinoco
4. Mississippi	4. Ob	4. Yangtze
5. Yenisei	5. Mississippi	5. Madeira

Defining a 'big' river

Greater than 500 meters wide with a discharge greater than 1000 cumecs

Cumec = Cubic metres of water flowing past a point per second

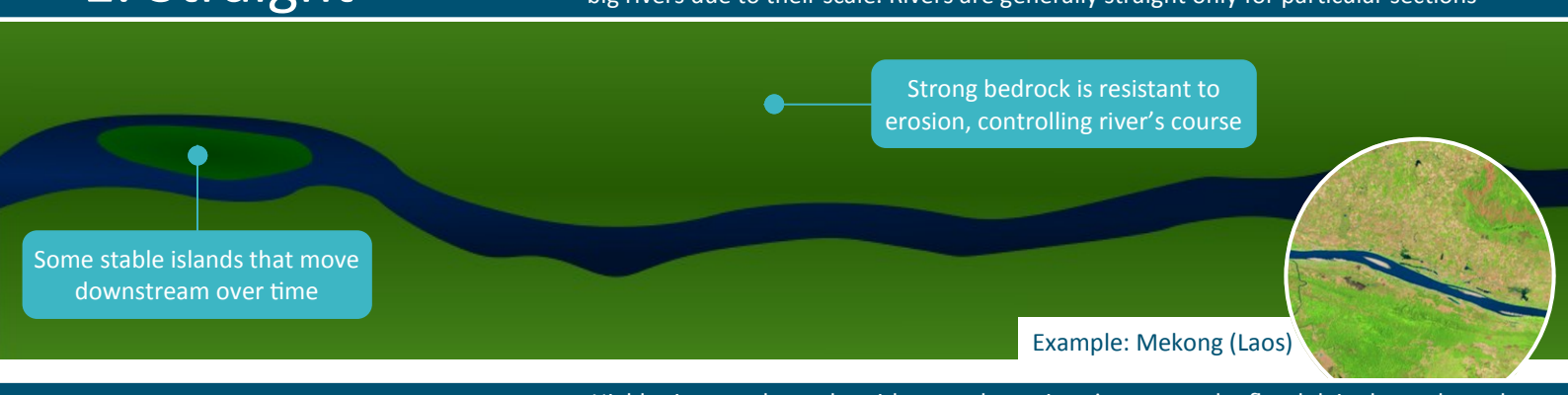
Defining a 'big river' is not easy. There's a range of ways to measure size (length, width, depth, discharge, area of drainage basin etc.). This is Professor Phil Ashworth's definition.

Five shapes of channel

Photos: USGS

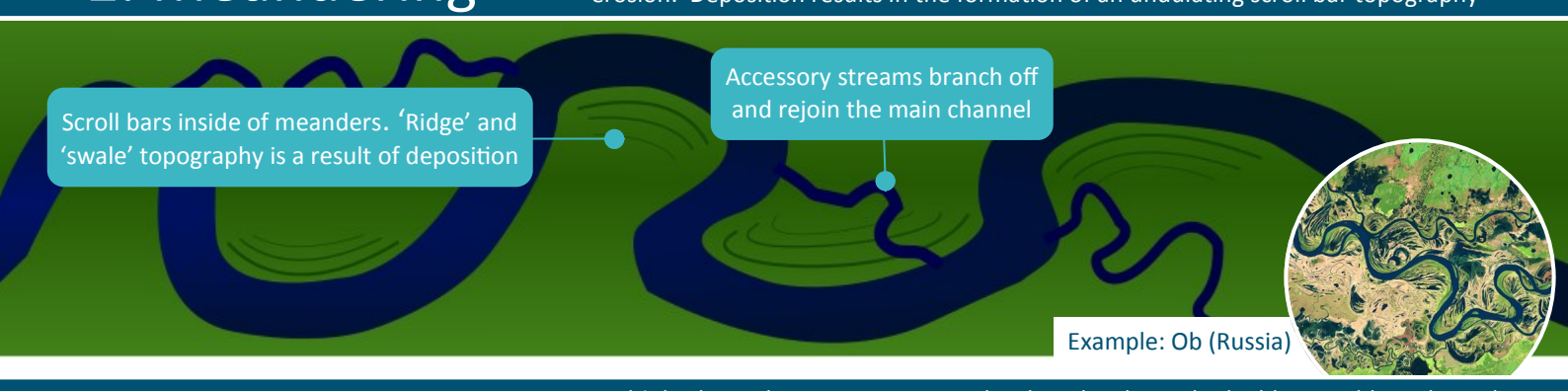
1. Straight

Straight (or non-sinuous) channels are rare in nature. But they are most common in big rivers due to their scale. Rivers are generally straight only for particular sections



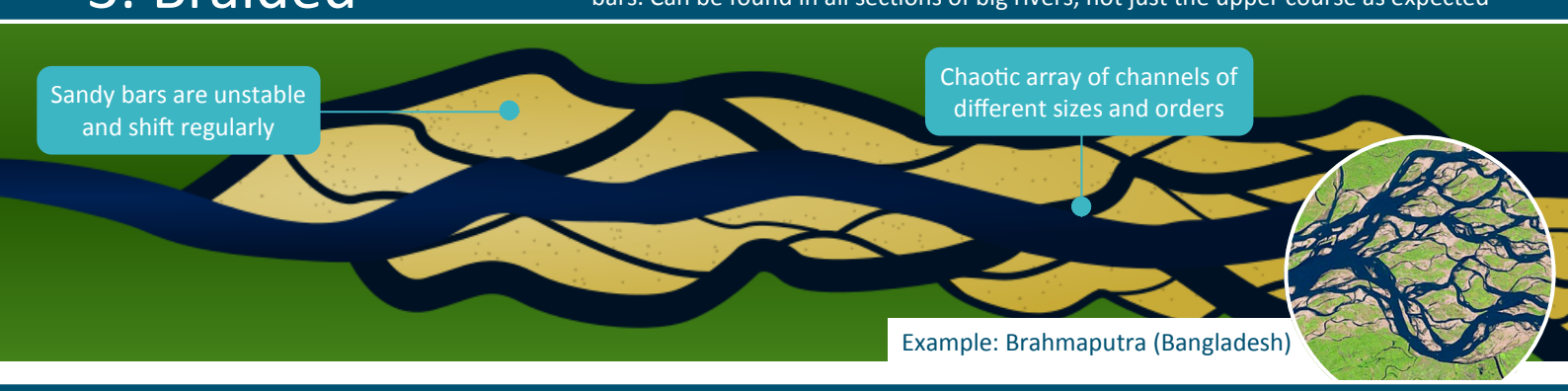
2. Meandering

Highly sinuous channels, with meanders migrating across the floodplain due to lateral erosion. Deposition results in the formation of an undulating scroll bar topography



3. Braided

Multiple channels, varying in size and order. The channel is highly unstable with sandy bars. Can be found in all sections of big rivers, not just the upper course as expected



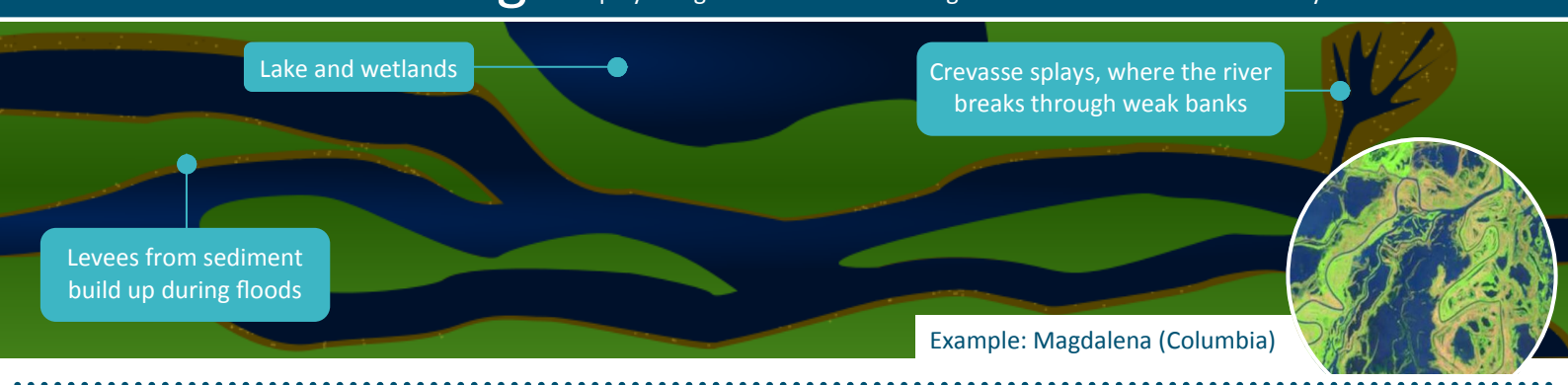
4. Wandering

A transitional phase between braiding and meandering. Relatively permanent and sinuous channel. Both stable islands and unstable sandy bars are present



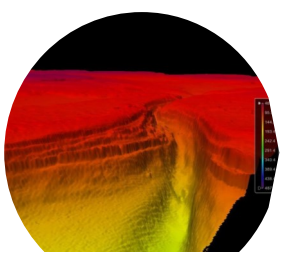
5. Anastomosing

Multiple stable channels. Relatively weak banks can burst, forming crevasse splays. Regular floods result in large-scale wetlands and lakes nearby



Collecting data

To understand how big rivers are shaped, data must be collected and analysed. The only way to measure rivers up to 12 km wide and 100 meters deep is using a boat equipped with remote surveying instruments. This is possible due to recent technological advancements.





Factor	Big river equipment	Local fieldwork equivalent
Velocity	*Acoustic Doppler Current Profiler (ADCP):* Emits sound waves into river. Reflected back, they show how velocity varies across the channel	*Floating object or flow meter:* Provides an approximate value for velocity at one or a few points in the channel
Channel shape	*Multibeam Echo Sounder (MBES):* 512 beams are emitted. Creates a 2D image of the channel, which becomes 3D as the boat moves upstream	*Tape measure and meter rule:* Used to measure width, depth and wetter perimeter. Can create an approximate channel cross-section sketch
Subsurface sediment	*Parametric Echo Sounder (PES):* Emits sound waves, which penetrate the riverbed. Reveals structure of the ground beneath the river.	*Soil profiles or cores:* Gives understanding of soil and surface bedrock near the river, to a relatively shallow depth

Reasons for variation

All big rivers have low gradients, large discharges and carry large amounts of fine sediment. So why are they so different?

1. Strength of banks

Strong banks will control a river's course. Results in a straighter, more confined channel

Weak banks will be susceptible to lateral erosion. Results in a meandering and sprawling river

2. Rate of vegetation growth

Fast growth will stabilise the river banks and bars. Results in few channels that change slowly

Slow growth will cause high levels of erosion. Results in many very wide channels that shift regularly

3. Sediment mobility

Suspension causes sediment to pass quickly through the river. Results in little erosion or deposition

Traction and saltation will shape the river bed through erosion and deposition. Results in many features