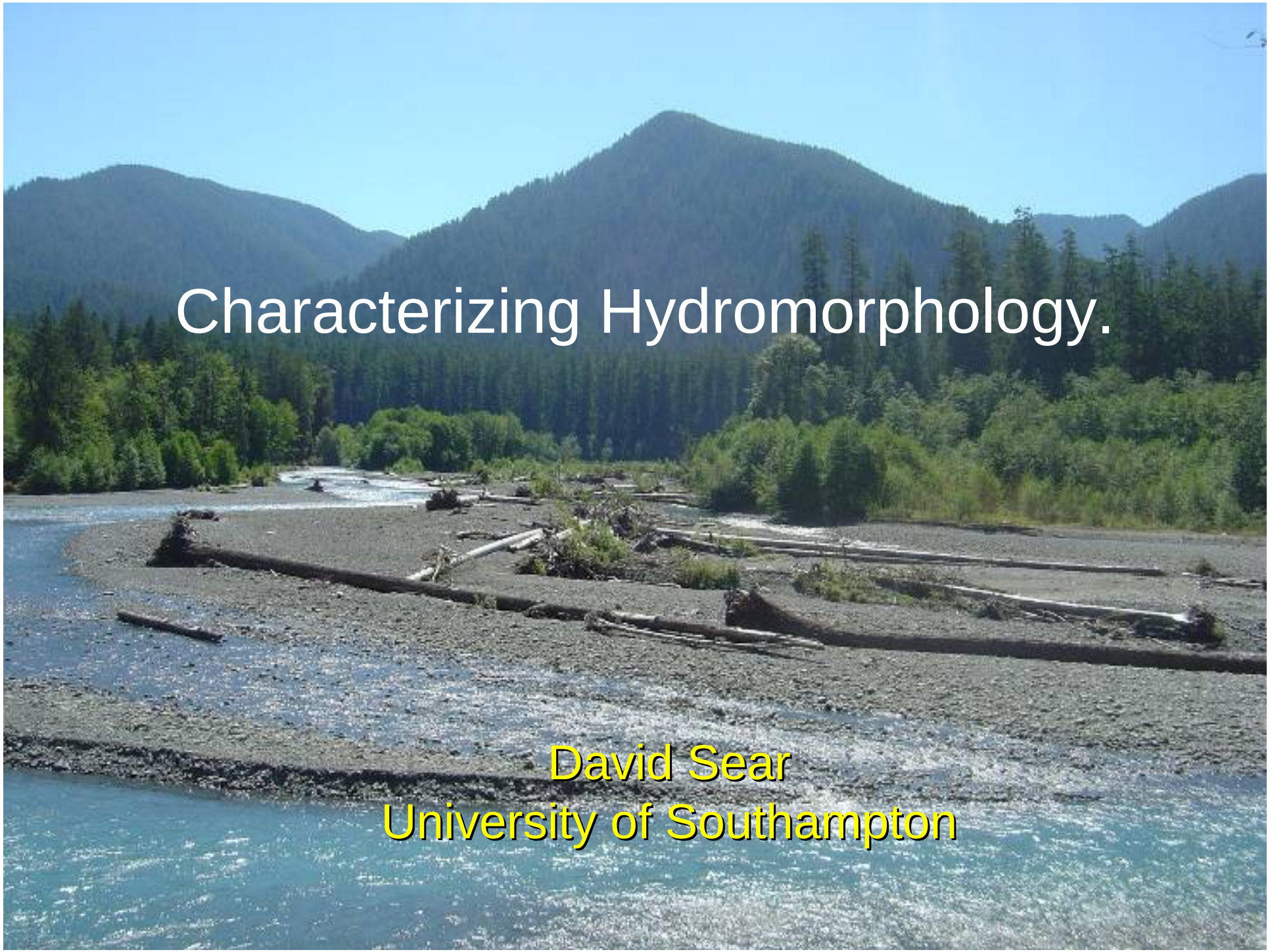
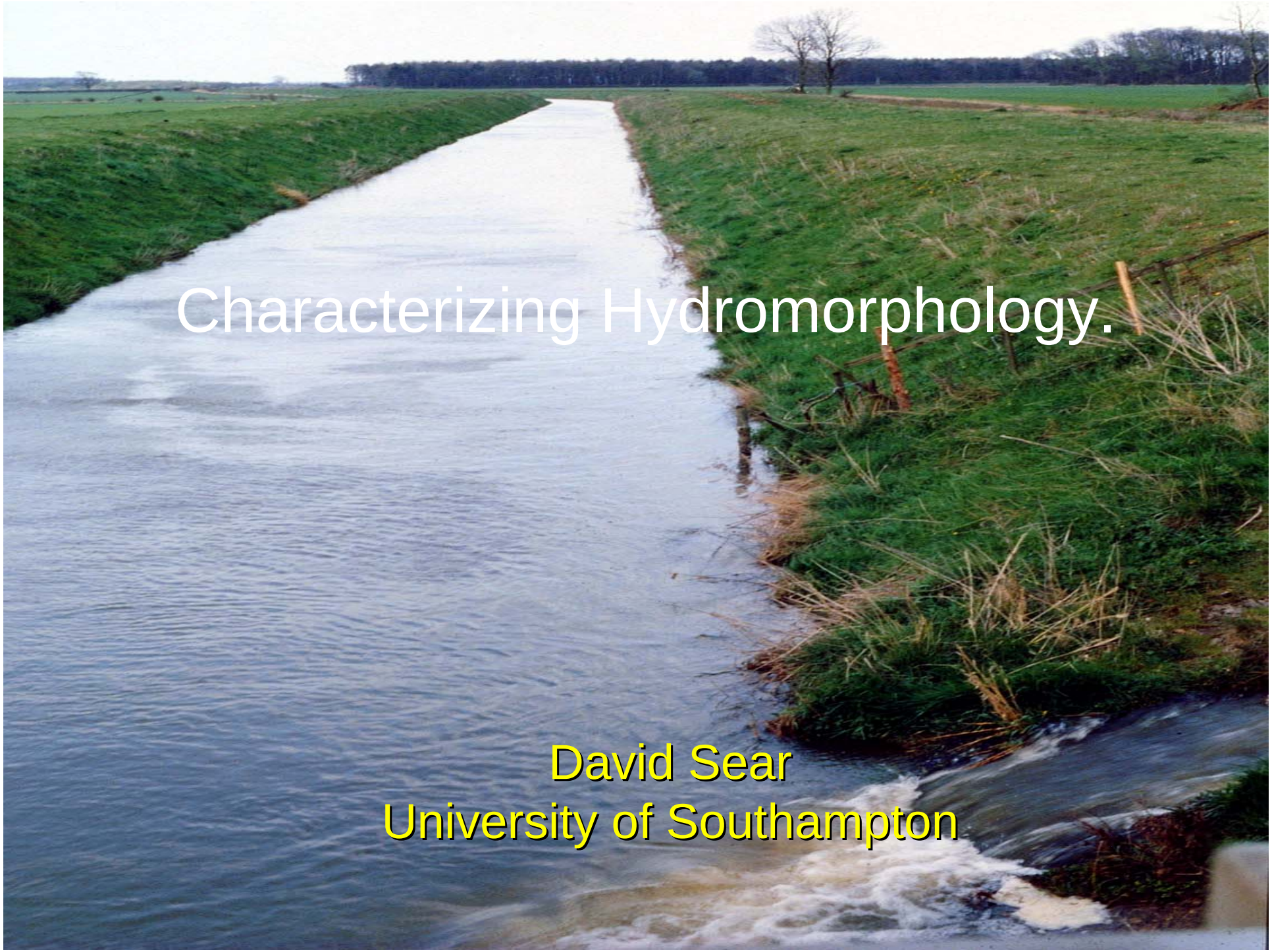

Characterizing Hydromorphology.
David Sear
University of Southampton


Characterizing Hydromorphology.
David Sear
University of Southampton

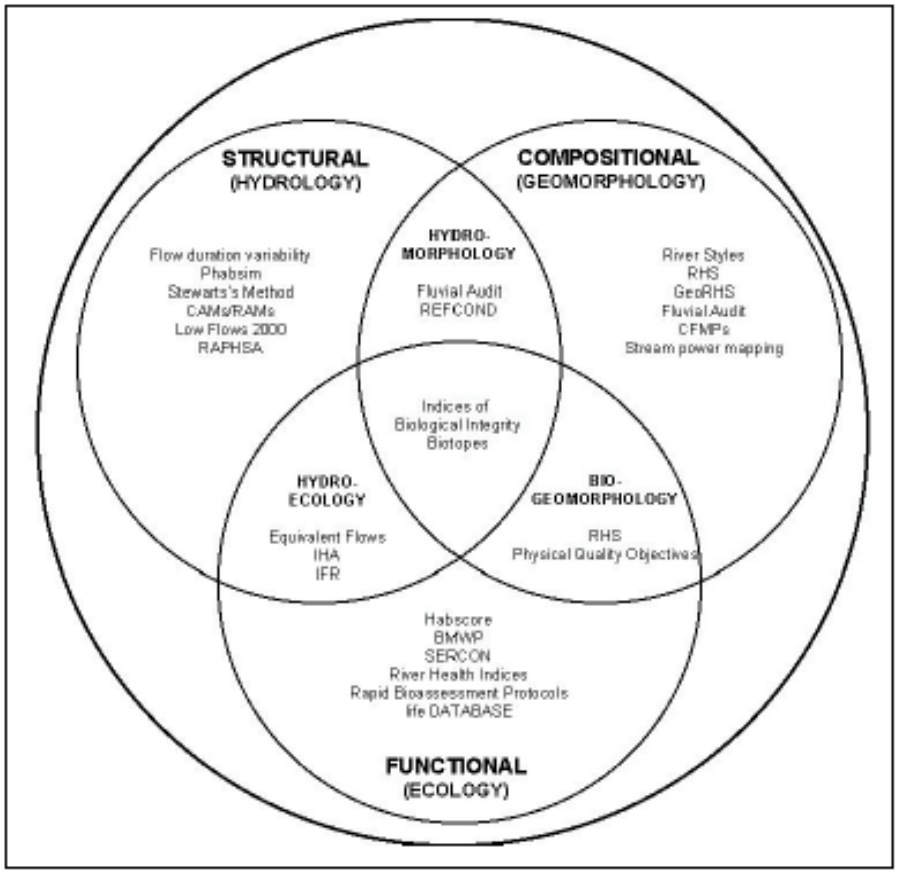
# Where are we going?

- Context for Hydromorphology
- Basic Principles for Hydromorphology
- How do we characterize Hydromorphology?
- Simplifying complexity – Classifications & typologies.
- Summary Points

# Context I: Interdisciplinarity

## Hydromorphology

- New interdisciplinary term.
- Emphasis on interactions.
- Emphasis on Ecological relevance




Large et al., (2006)

# Context II: Management Application

- Geomorphology - Previous focus on flooding, channel stability & sedimentation
- Hydromorphology Emphasis on impact assessment and restoration.

# Context III: Policy & Legislation

- Water Framework Directive
- Endangered Species Act
- Habitat's Directive etc…….

# Requirements of Hydromorphology

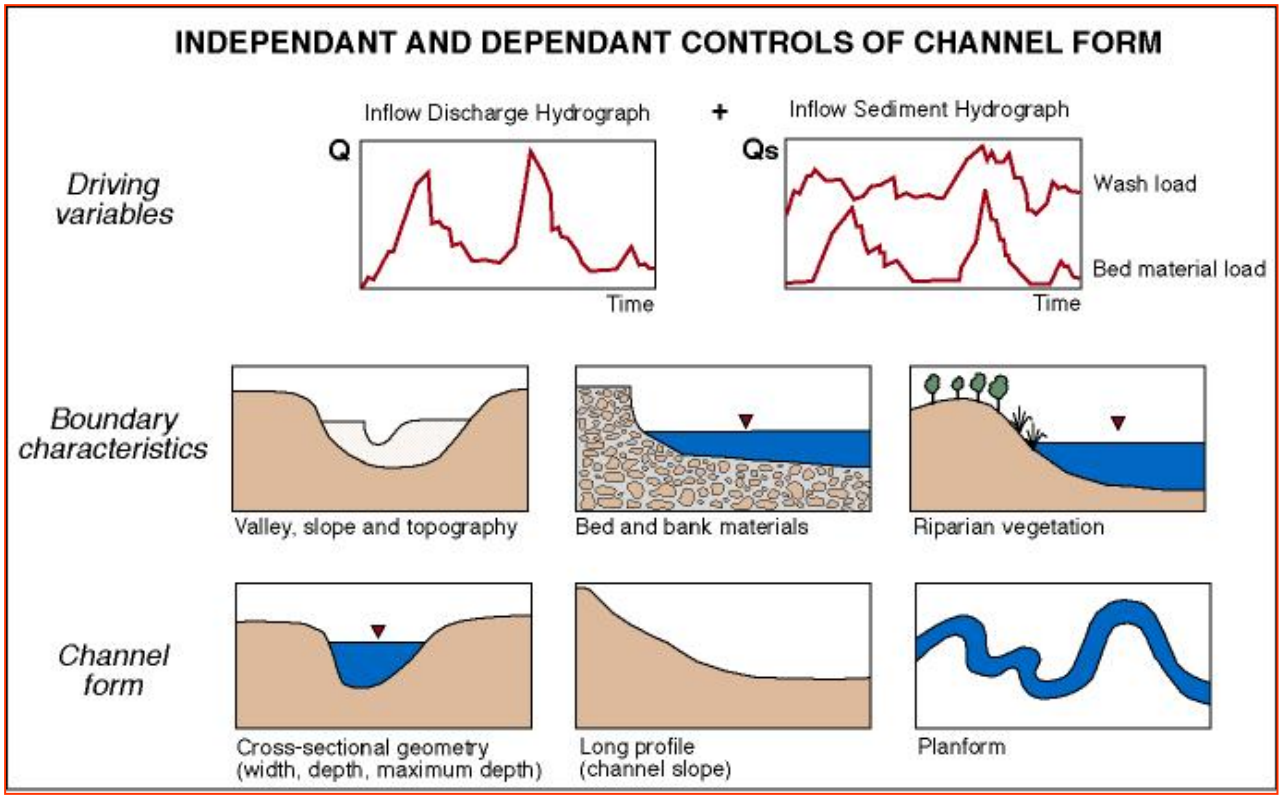
- To be able to identify an un-natural divergence in system processes and form.
- To be able to attribute cause(s) to that divergence.
- Be able to contribute to the design of mitigation measures.
- Contribute robust monitoring procedures to support adaptive management.

# Hydromorphology needs…

1. To have tools and methods for identifying natural vs. impacted hydromorphology. (Reference Conditions)
2. Be able to link hydromorphology to ecological processes and biological responses. (Physical habitat)

# Controls on Hydromorphology

*Factors which explain the presence and absence of a given morphology.*

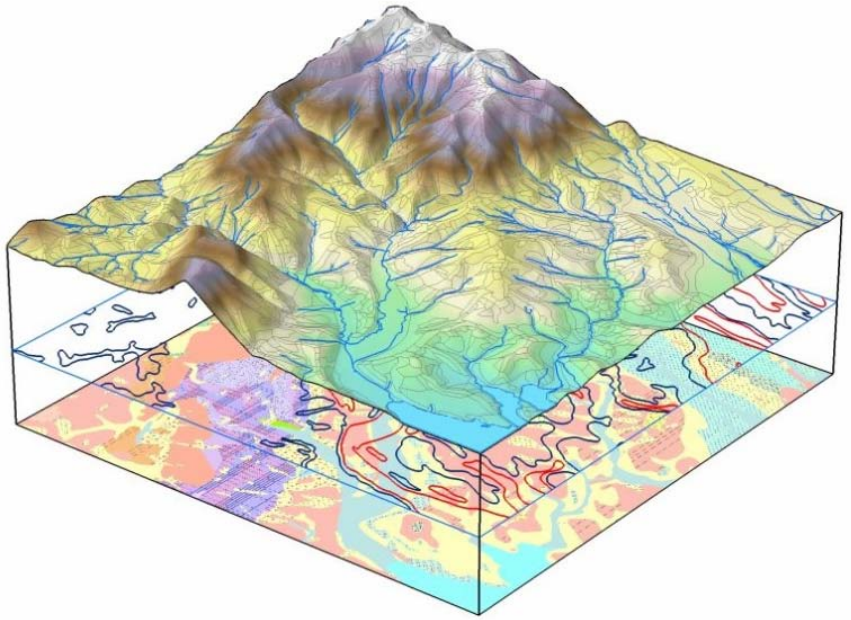



After Thorne 1997

# Further Controls on Hydromorphology

**Landscape Structure**
(geology, land cover, topography, river topology)

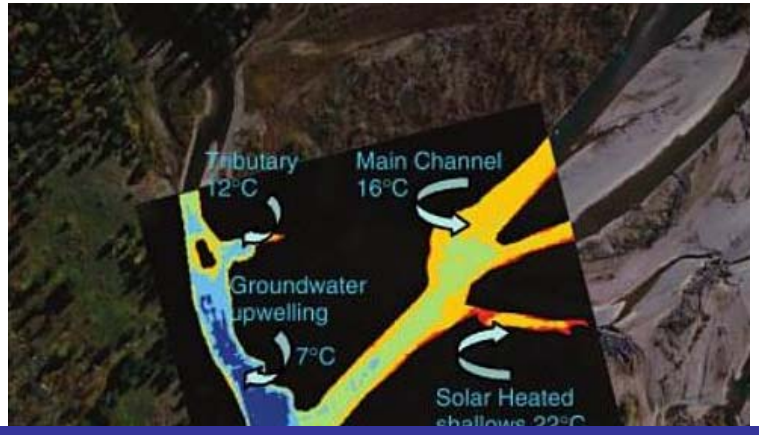
- Scales fluxes (magnitude, frequency)
- Determines gradients (slopes)
- Determines coupling (Qs)
- Determines Discontinuities (river network)



**Creates Regionality** – Large scale spatial variability in controlling factors of hydromorphology.

# Coupling & Connectivity

**Sediment**

- 


**Water**

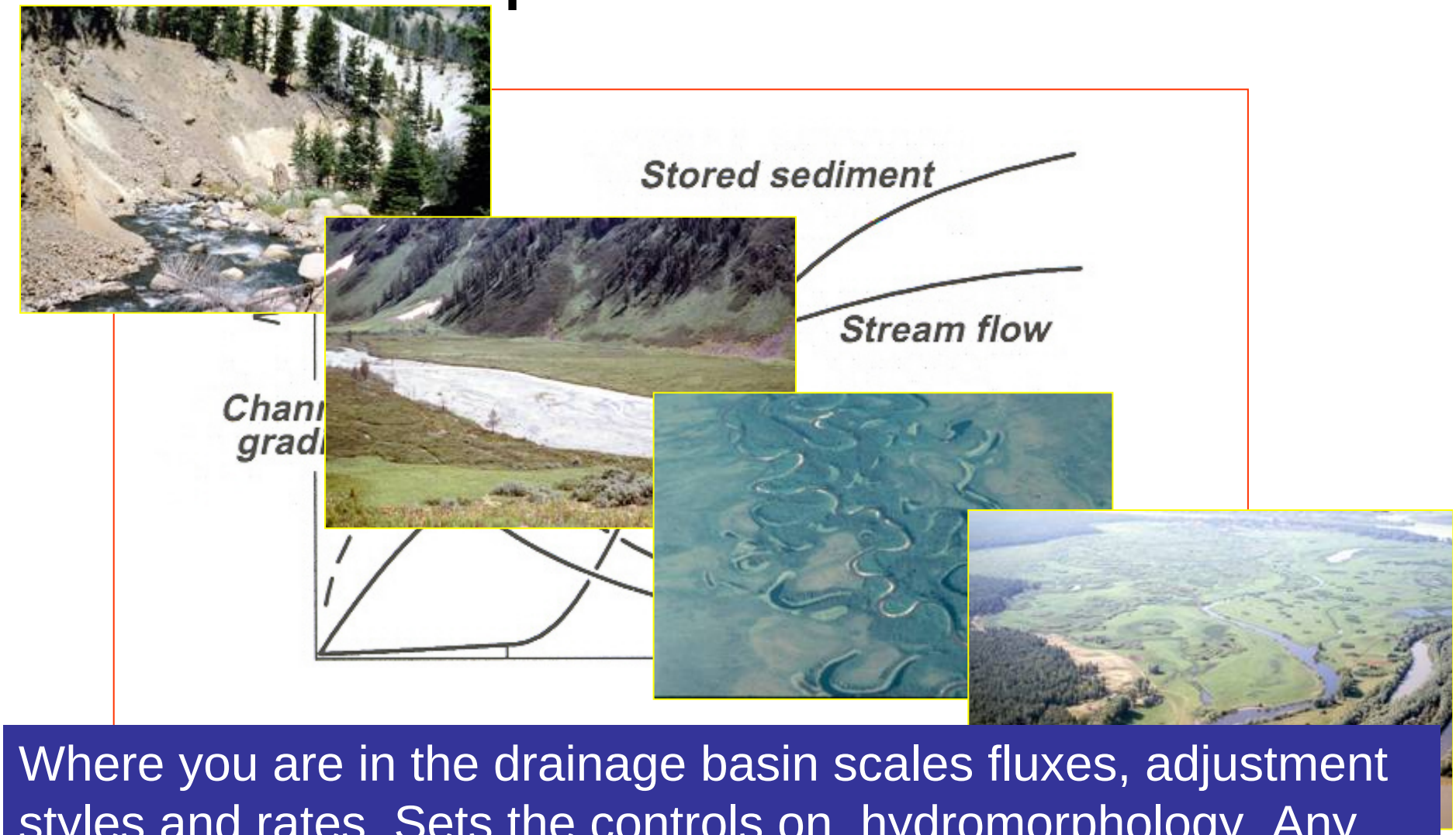
- Defines the quality of water within the channels.
- Defines the hydrological

The affects of change are propagated through the river system by the fluxes of water, sediment and organic matter.

Connectivity or disconnection influence where, how and at what rate changes are propagated.

Any measure must therefore include connectivity

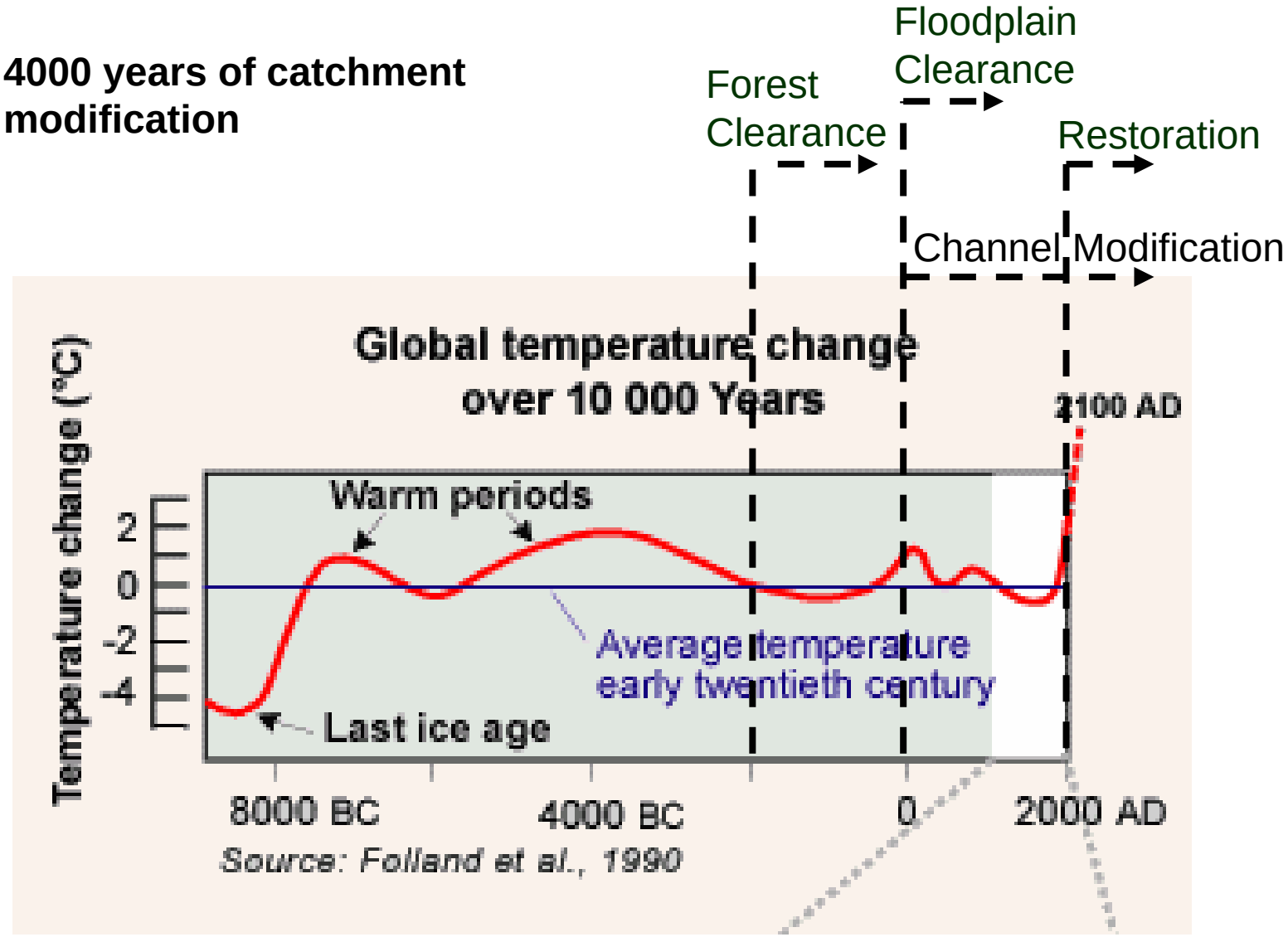
# Spatial Scale




Where you are in the drainage basin scales fluxes, adjustment styles and rates. Sets the controls on  hydromorphology. Any measure must therefore include location in basin!

# Further Controls on Hydromorphology: Disturbance History

**4000 years of catchment modification**



# First Challenge

- Hydromorphological Analysis must be able to decode multiple disturbance signals often resulting from a long and un-documented history of river and catchment management.

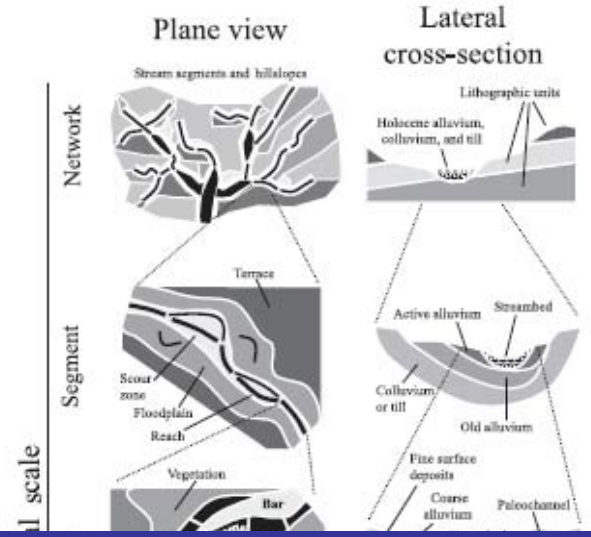
# Second Challenge

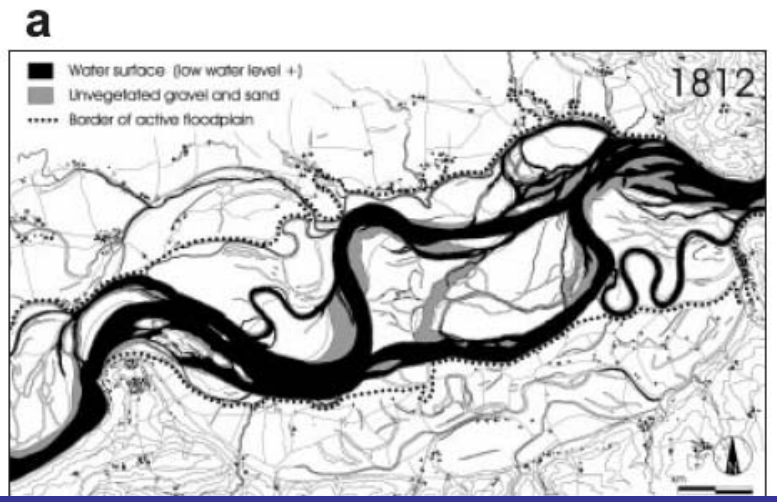
IN many areas of the world, long, undocumented and widespread disturbance histories make the derivation of ‘Reference’ or ‘Target’ states difficult.

- No Natural Analogues
- Modified Boundary conditions (Qs, Q, etc).

# Characteristics of Hydromorphology

# Patchiness & Complexity



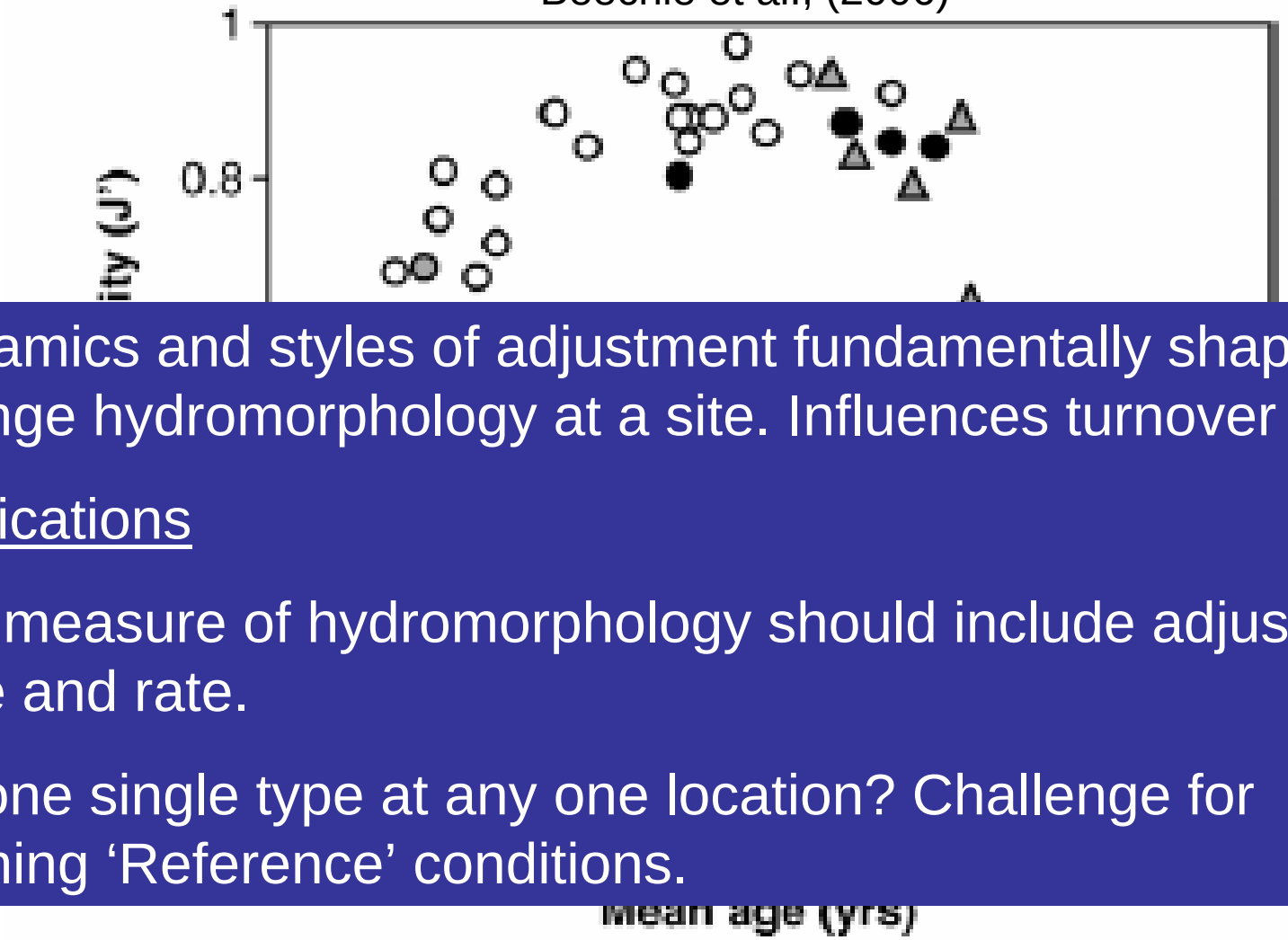

Riverine habitat is structured at a range of scales. This structure is strongly controlled by hydromorphological process activity over time. Ecological processes and organisms are influenced by this patchiness.

<u>Implications</u>

Measures of hydromorphology should reflect this patchiness. – How?

# Dynamics & Adjustment

Beechie et al., (2006)




Dynamics and styles of adjustment fundamentally shape and change hydromorphology at a site. Influences turnover times.

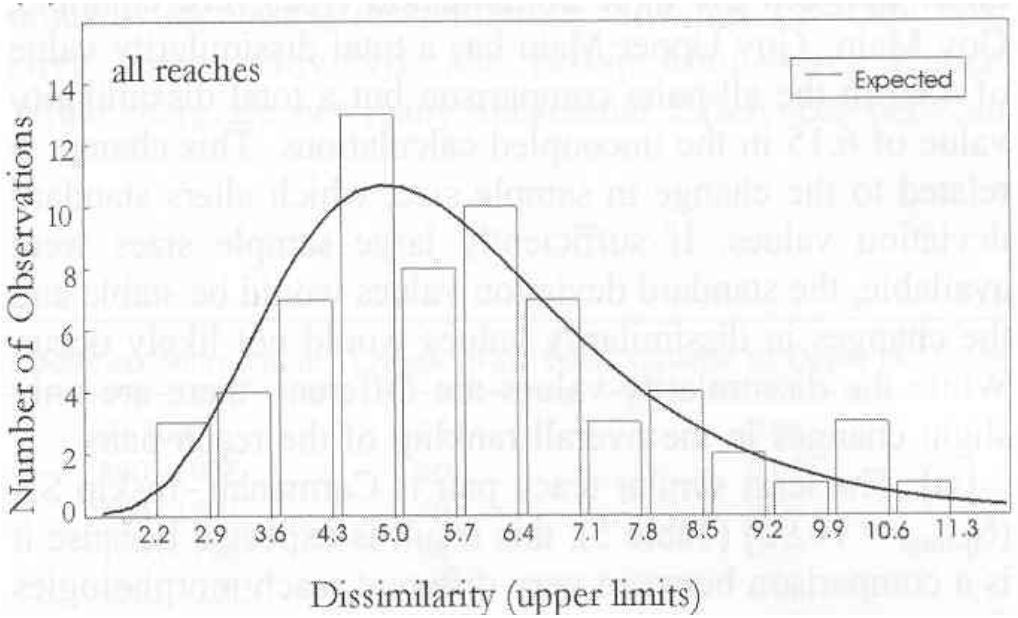
<u>Implications</u>

Any measure of hydromorphology should include adjustment style and rate.

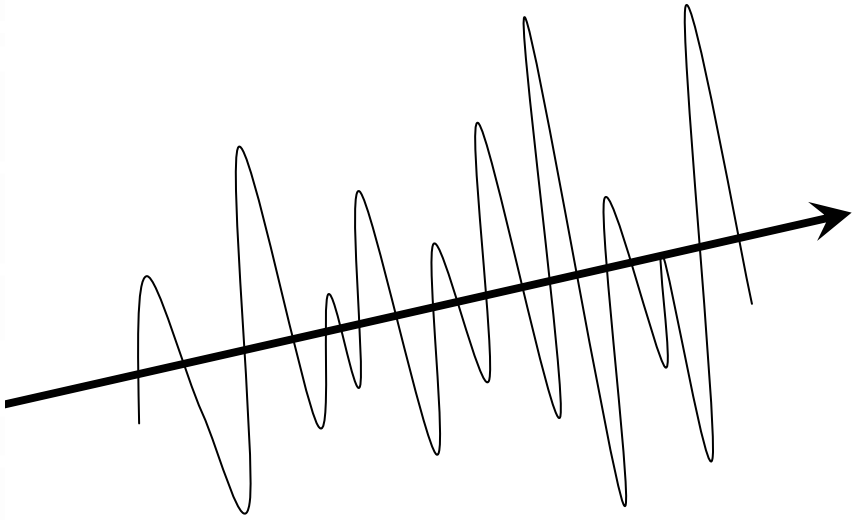
No one single type at any one location? Challenge for defining ‘Reference’ conditions.

# Eco-hydromorphological Interactions

# Third Challenge: Hydromorphology within a Type is variable!

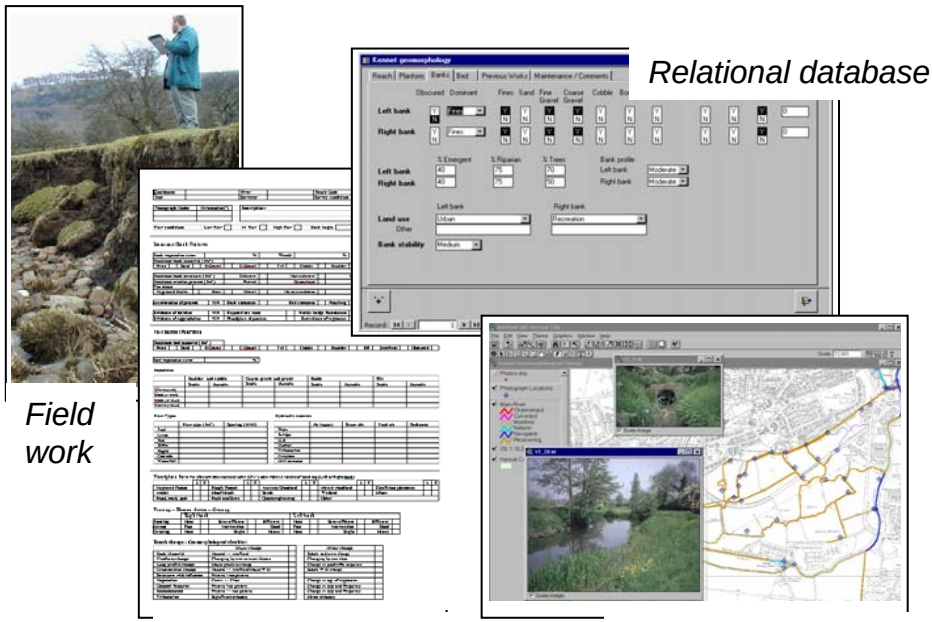



Trainor & Church (2002)



temporal trend

# Measurement of Hydromorphology

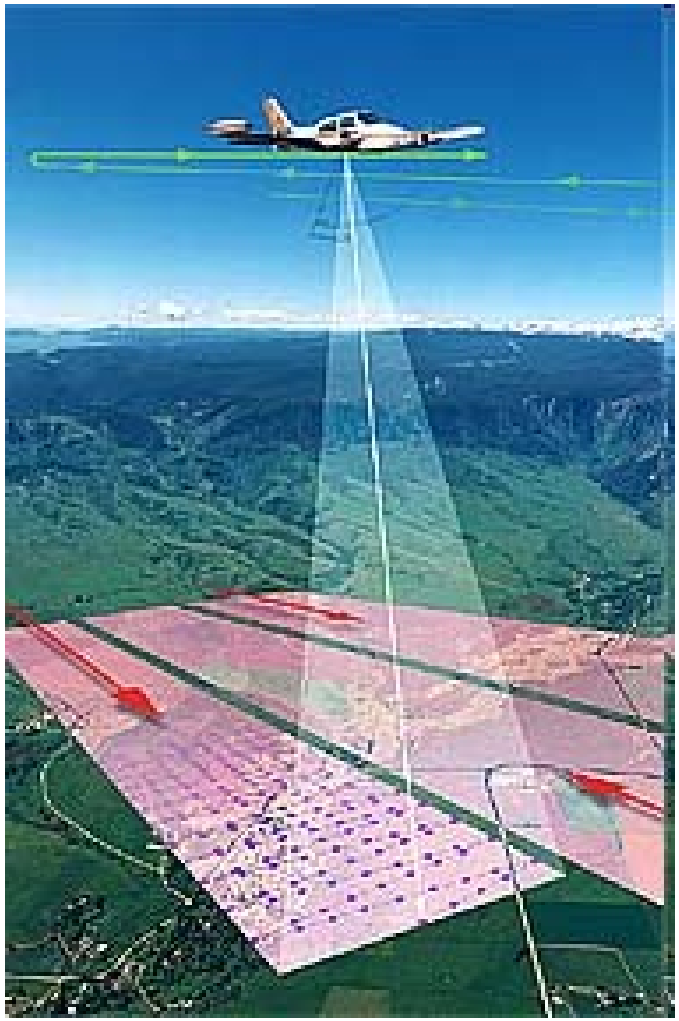


*Field work*

*Relational database*

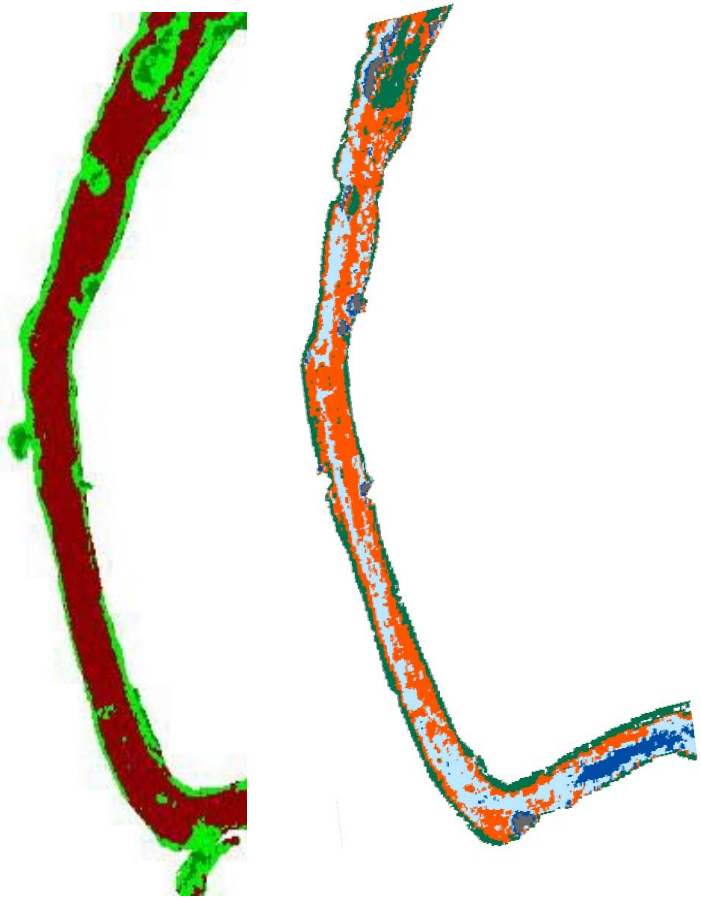
*Standardised forms*

*GIS analysis and visualisation*



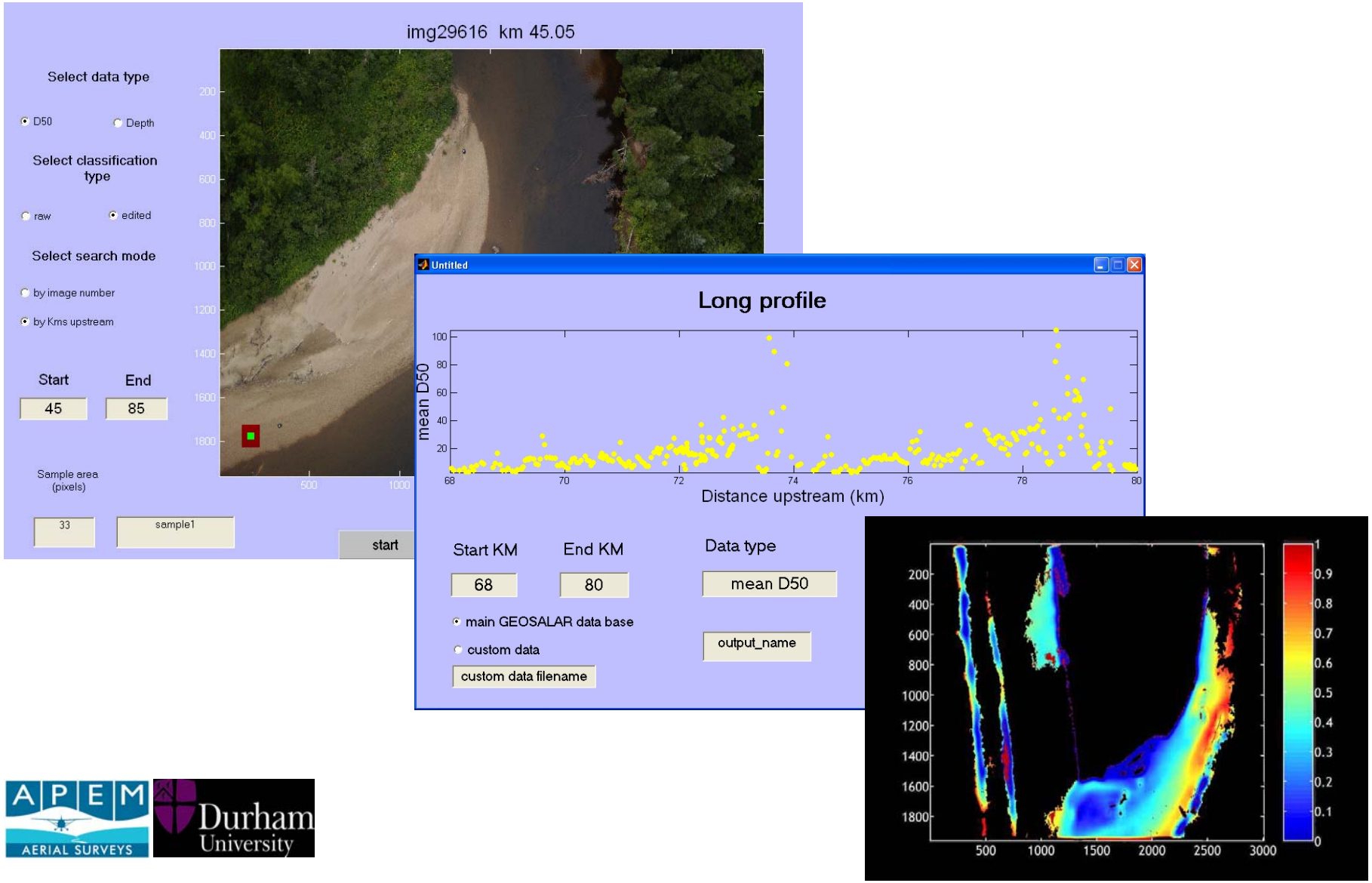
# Remote Sensing of Hydromorphology

Satellite & Airborne Remote Sensing



**Substrate** **Water Depth**

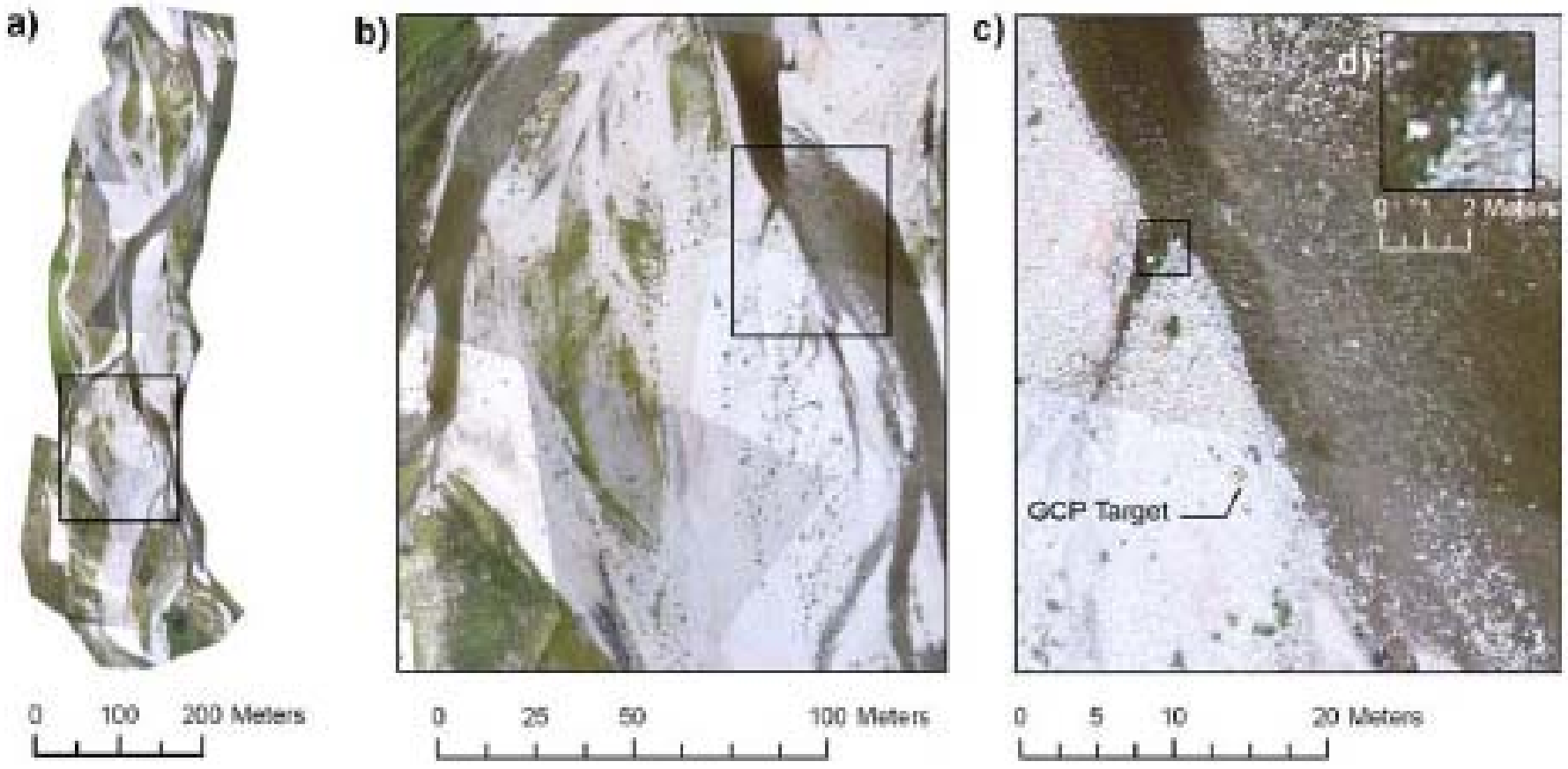
# Hi-res Air Photography & Photogrammetry




APEM AERIAL SURVEYS

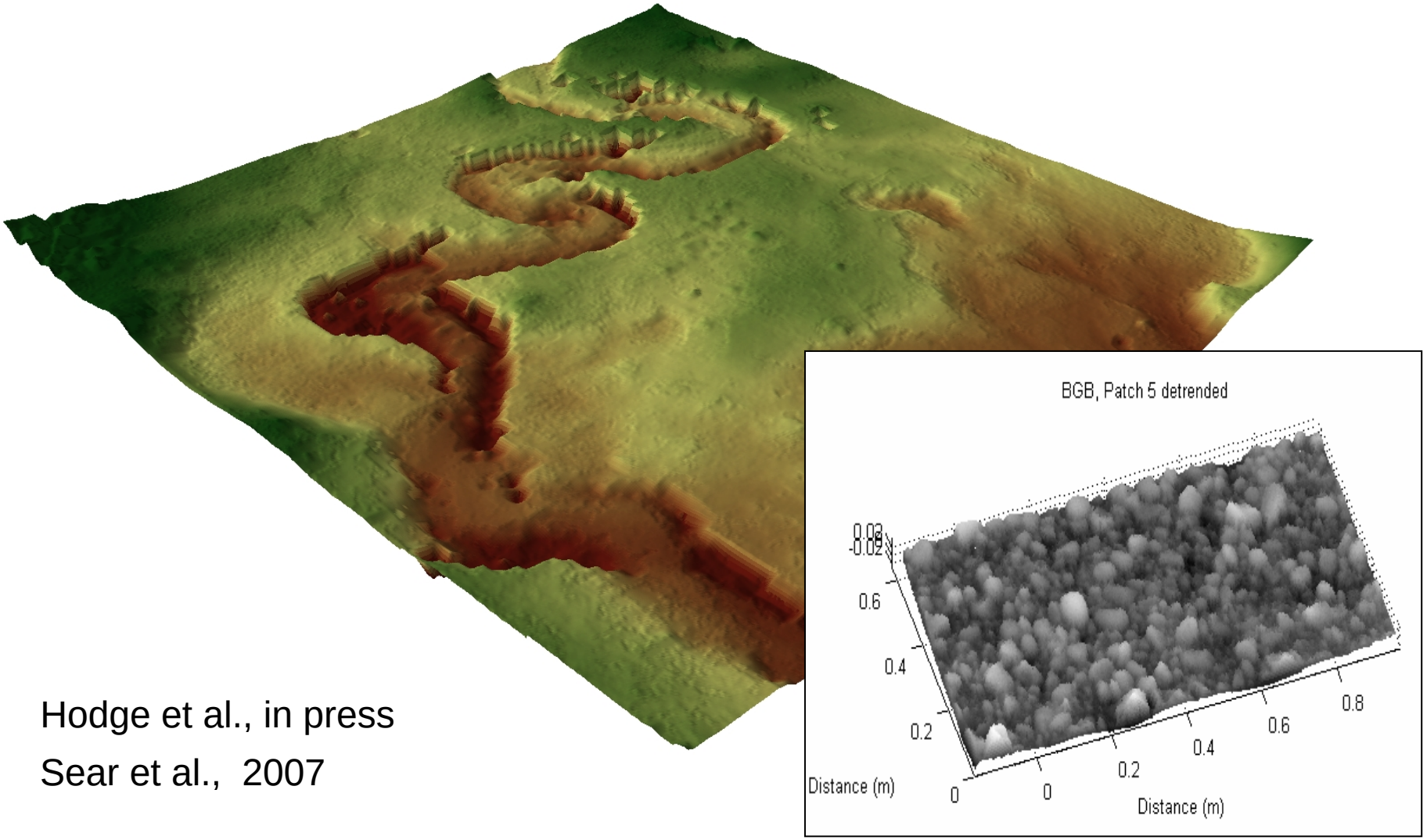
Durham University

# Low Altitude Air Photography: Blimps, Poles. Meso – Micro-habitat




Vericat et al., (2008)

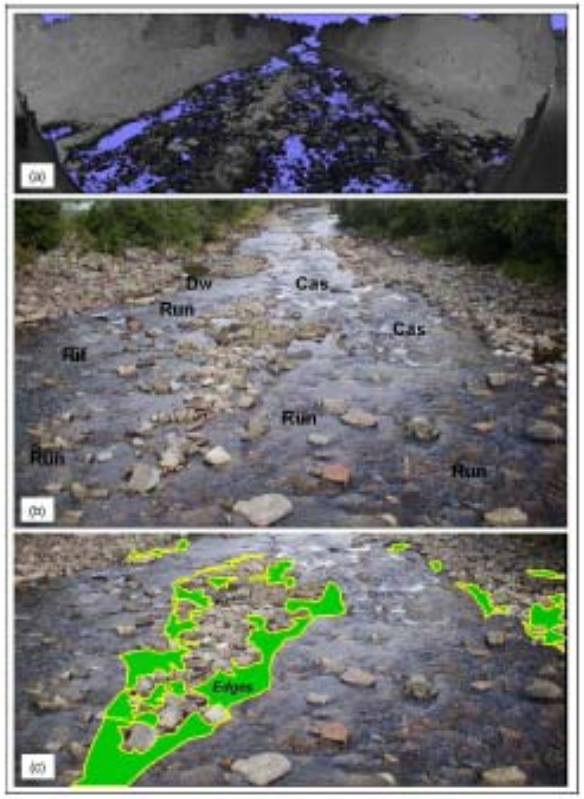
# Terrestrial Laser Scanning – Meso-Micro scales

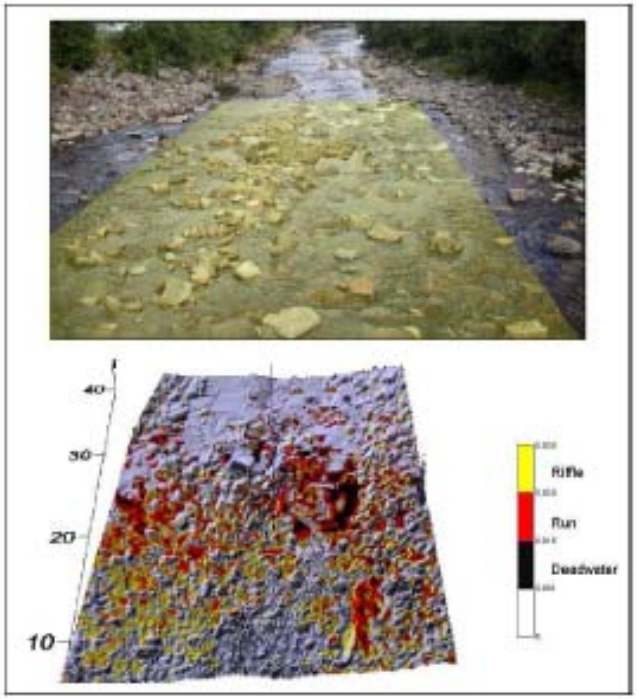



Hodge et al., in press

Sear et al., 2007

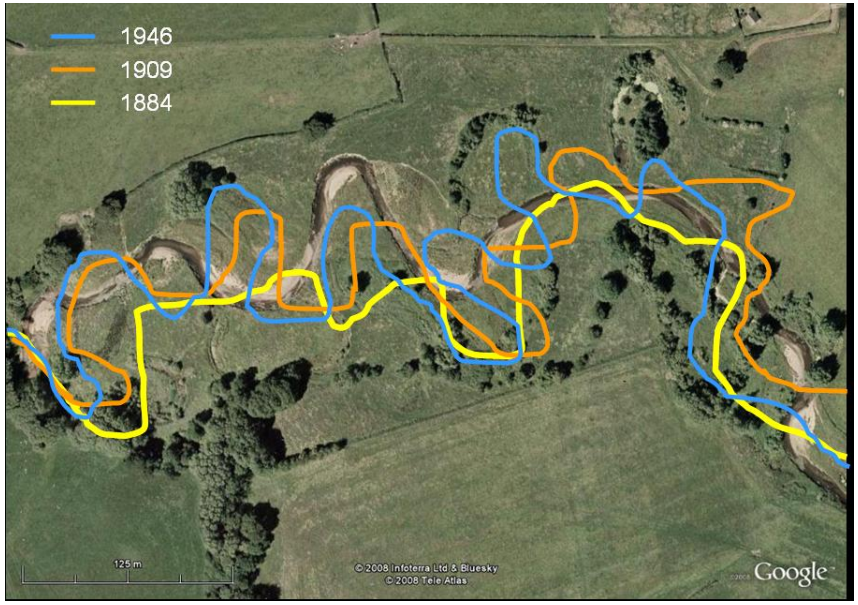
# Quantifying Micro-Habitats

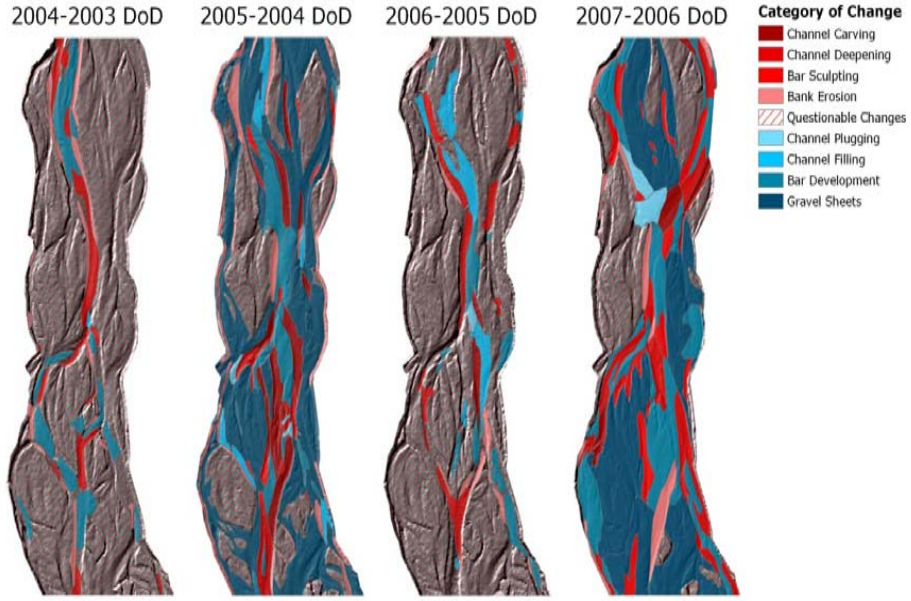



Large & Heritage (2007)

# Quantifying Dynamics



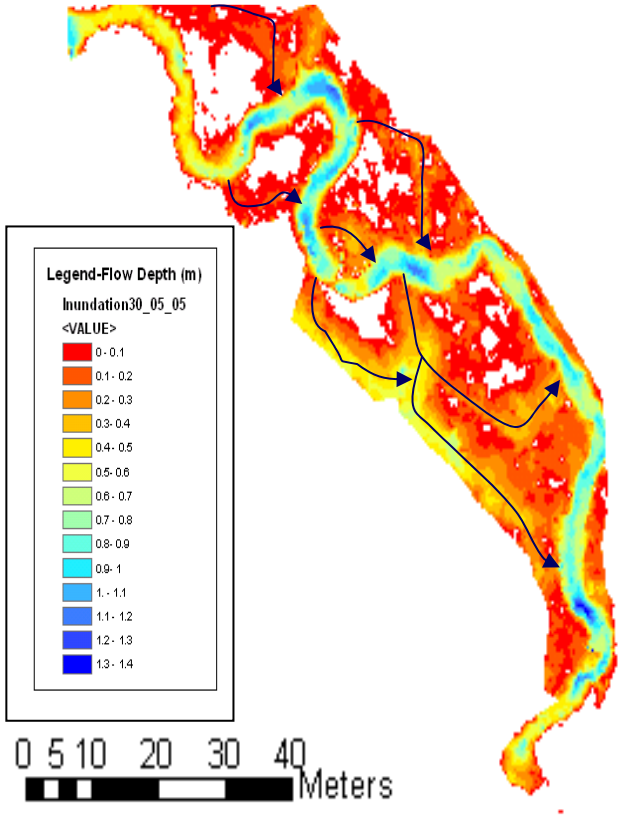




Historical Datasets Exist and have good spatial and temporal coverage (e.g. Europe) but not in others?

Re-Survey captures dynamics & habitat change.

Wheaton et al., (in press)

# Extending the data: Modelling




Sear et al., 2006


Wheaton et al., in press

# Summary so far…..

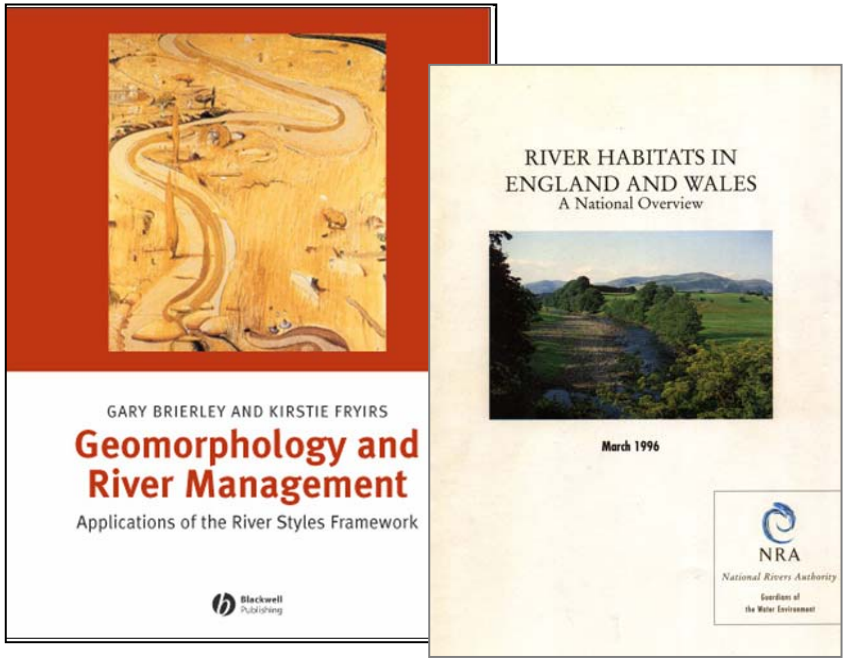
- Controls and characteristics exist that are accepted by most scientists, some cross disciplinary boundaries.
- There are a range of tools available to quantify the controls and characteristics of hydromorphology but they vary in applicability with scale and river type.
- Technology is beginning to enable data capture across scale boundaries.

Still require frameworks for data analysis and defensible methods for transferring data into information that is useful to river managers and other disciplines.

# Frameworks for Analysing Hydromorphological data

**Analysis Frameworks** (many examples)

e.g. River Styles, Fluvial Audit, Watershed Assessment, RHS, $SEQ_{phys}$.



# Classification – Why?

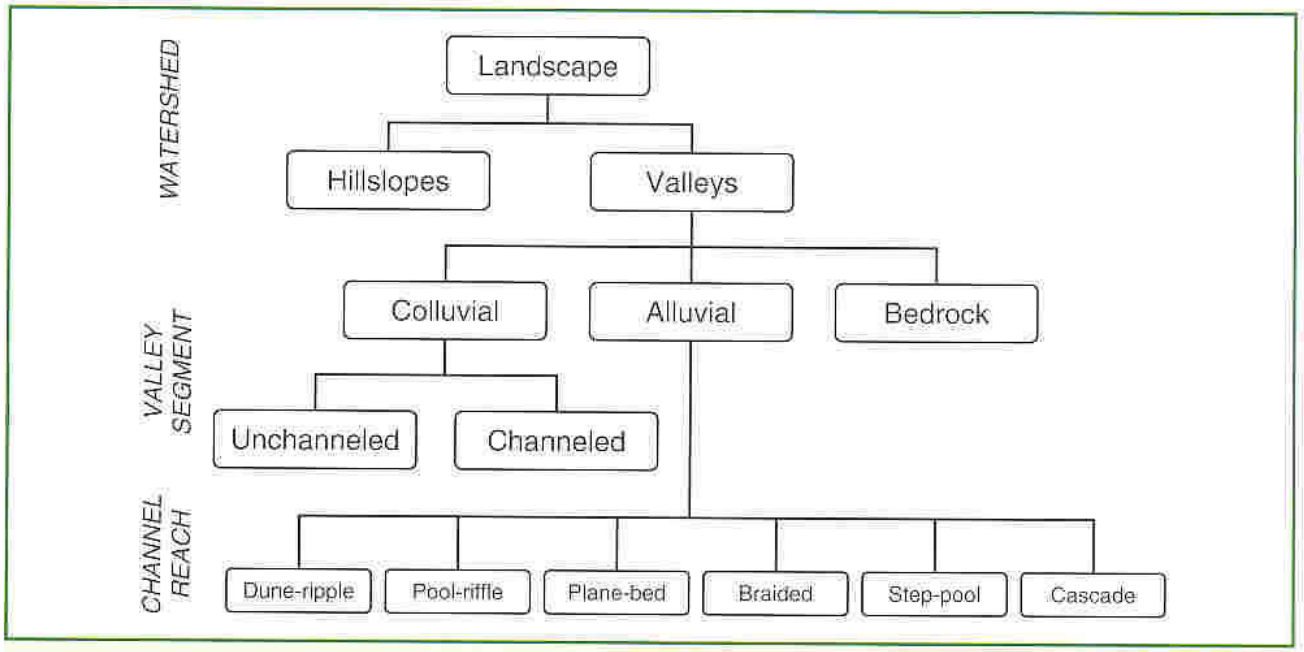
- To permit comparison between reaches
- To facilitate detection of change (Class A – Class B).
- To facilitate management by identification of reaches with similar controls/characteristics.
- As the contextual precursor to more detailed description. (ie my organisms prefer pool-riffle than plane bed).
- To predict behaviour in response to change

To structure the complexity of river ecosystems at spatial scales that permit understanding and communication between disciplines and with end users

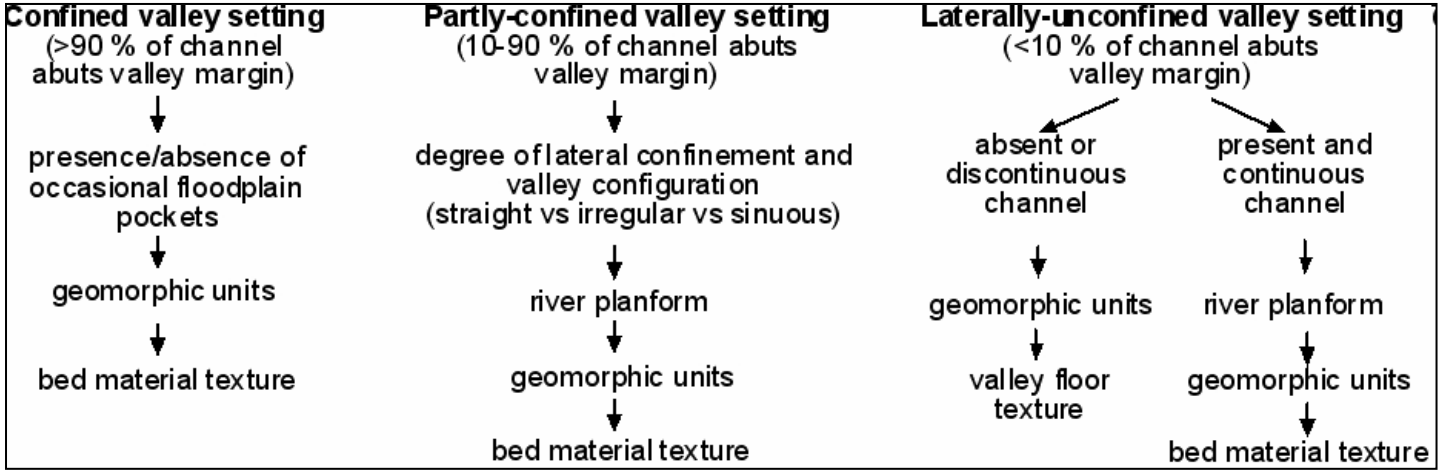
# Approaches to classification

1. Identify relevant variables for classification
2. Collect data characterising these variables
3. Use agglomerative techniques to group data
4. Identify Types.
5. Identify controlling factors on Types.
6. Scale up
7. Apply to other basins, networks.

- Relevance depends on scale, and use.
- Continuous or sampled – how to sample?
- Expert, Statistical, Process?
- What do you do about the transitional types?
- Using what data sources?
- Regionalisation!

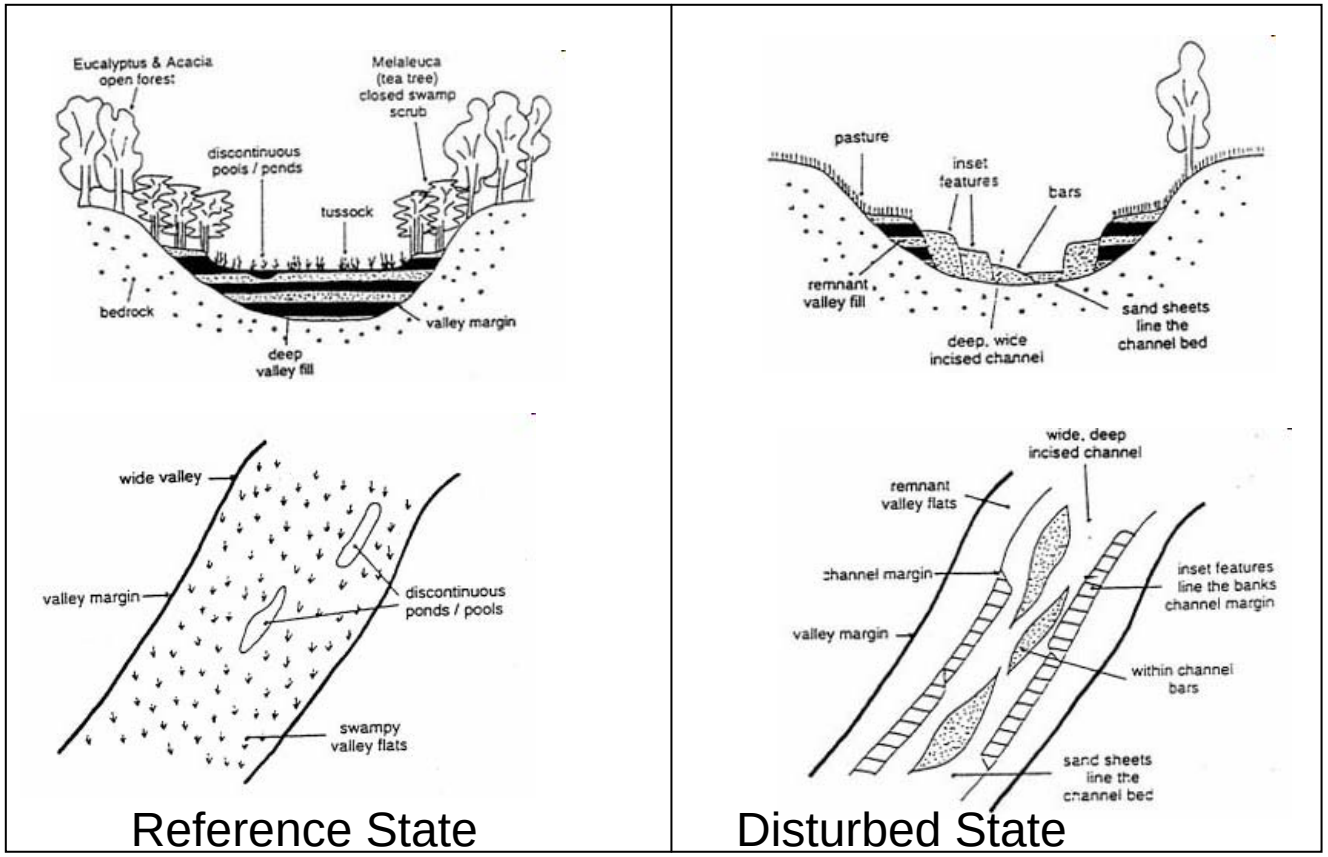



Buffington et al., (2003)



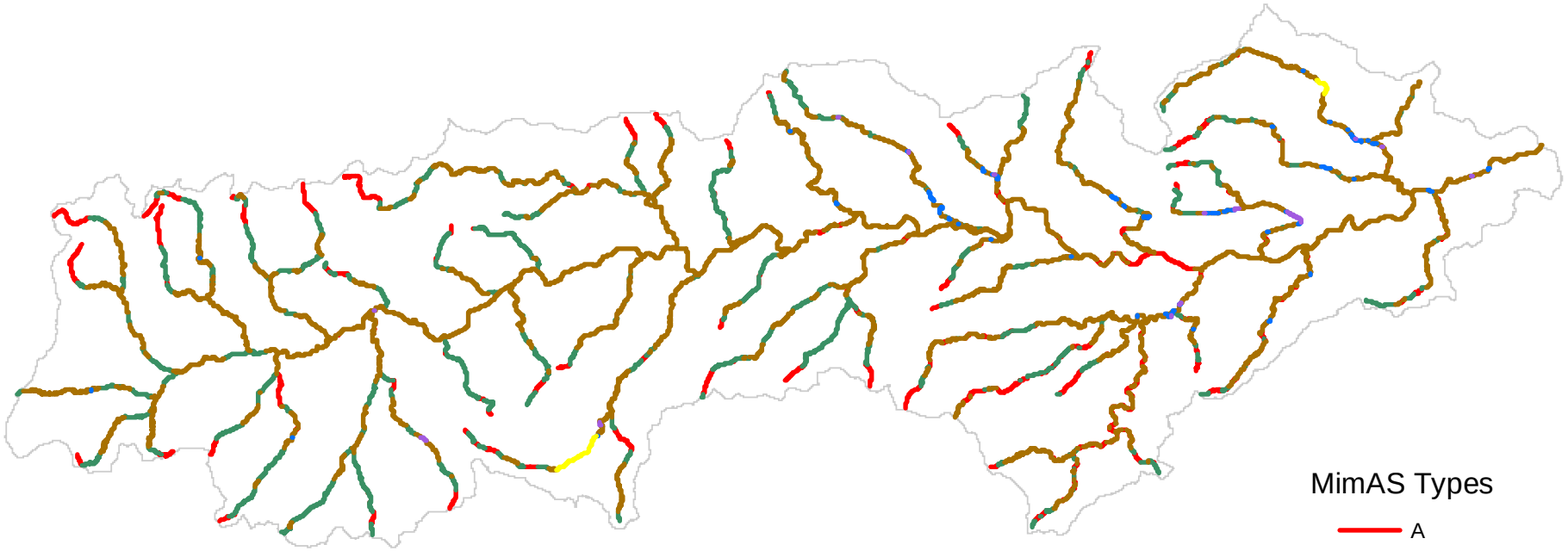

Fryirs et al., (1996)

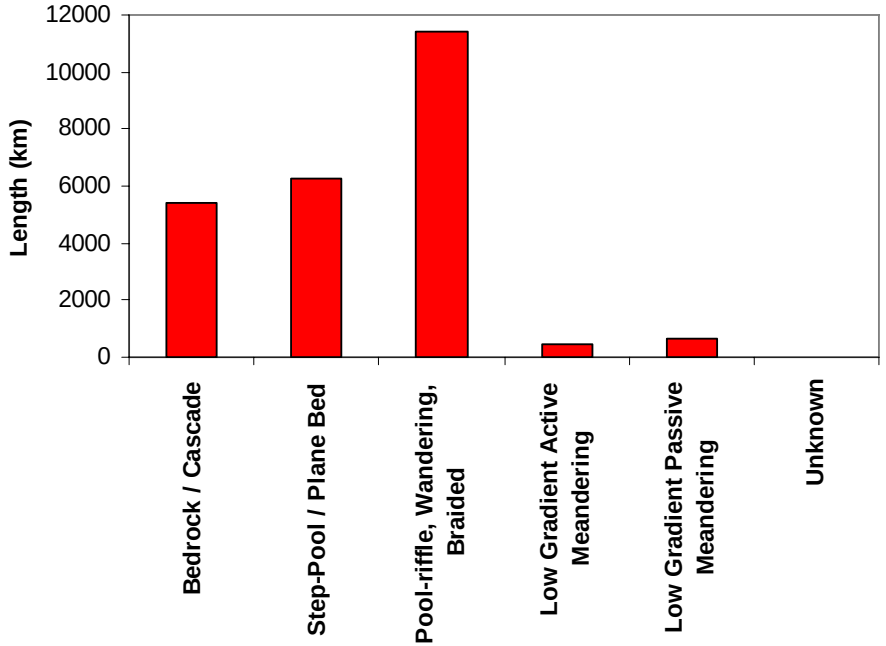
# “Upland” River Styles (Fryirs et al 1996)




Reference State

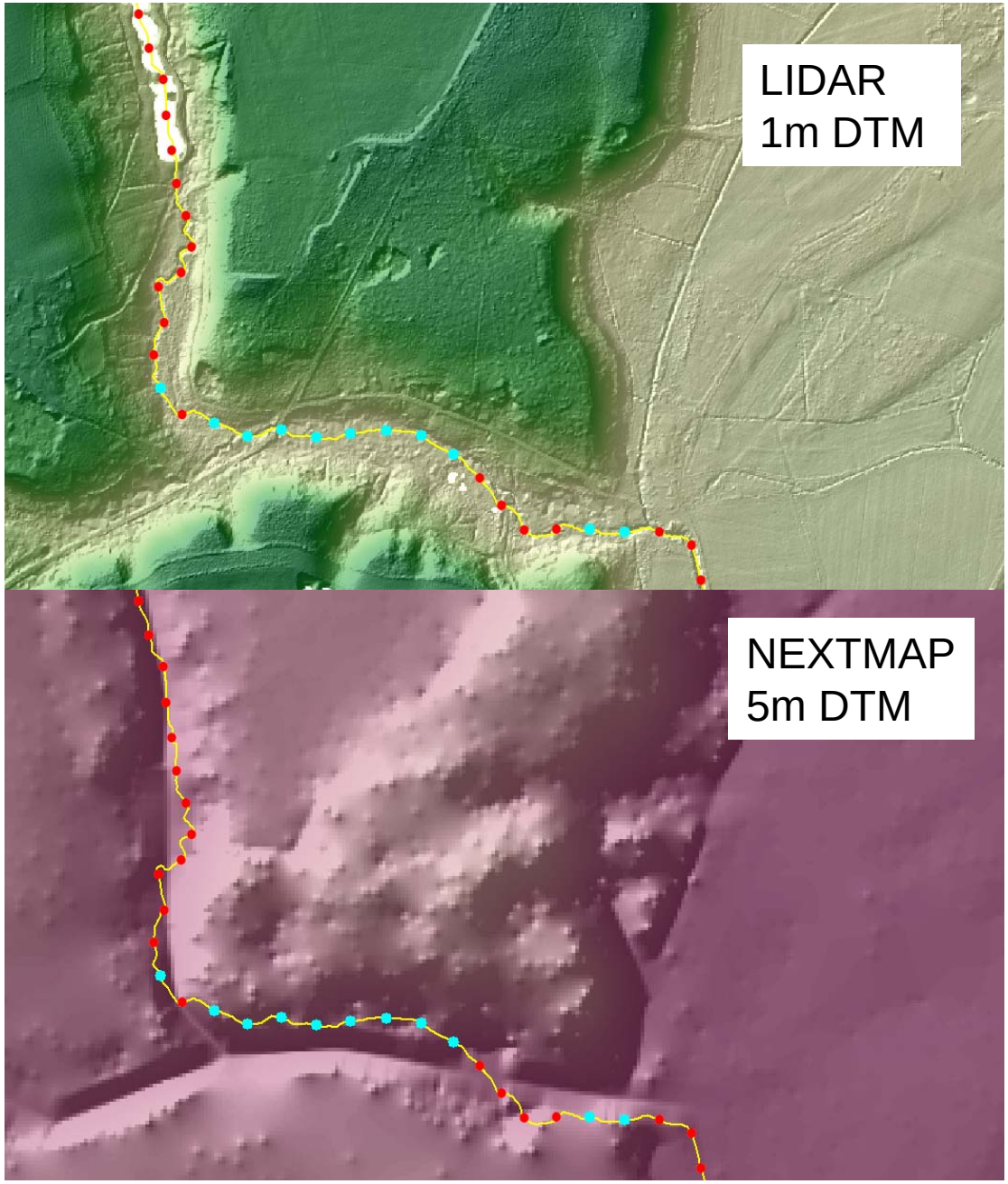
Disturbed State




# Hydromorphological Typology for Scotland

SNIFFER (2008)




# Data Quality

Variables that are map derived are dependant on the resolution of the data.

# Summary

- Hydromorphology is complex and dynamic
- The paradox is that in order to understand hydromorpholgy we frequently simplify this complexity – through classifications and typology.
- Ironically, we are entering a period when data capture is increasing in resolution and scale. So we can now begin to capture complexity across scale boundaries.
- BUT – fundamentally we need to be able to understand the links between this complexity and the biological communities in order to know what we need to measure and what we can and cannot simplify.

# 3 questions

1. What measurements of hydromorphology are truly relevant to biological communities?

2. How do we incorporate dynamics?

3. How do we deal with complexity? (Is Hierarchical Classification sufficient or necessary?).