Participatory modelling for sustainable river catchment management

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bettertogether

Contents

* Project background
* Aims
* Methodology
* Results

What is fluvial geomorphology?

Fluvial geomorphology

(Flow and sediment dynamics, channel form and habitats)

Engineering design

(Channel dimensions and hydraulics)

Riverine ecology

(In-channel and floodplain habitats)

Associated impacts

Flooding

Ecology


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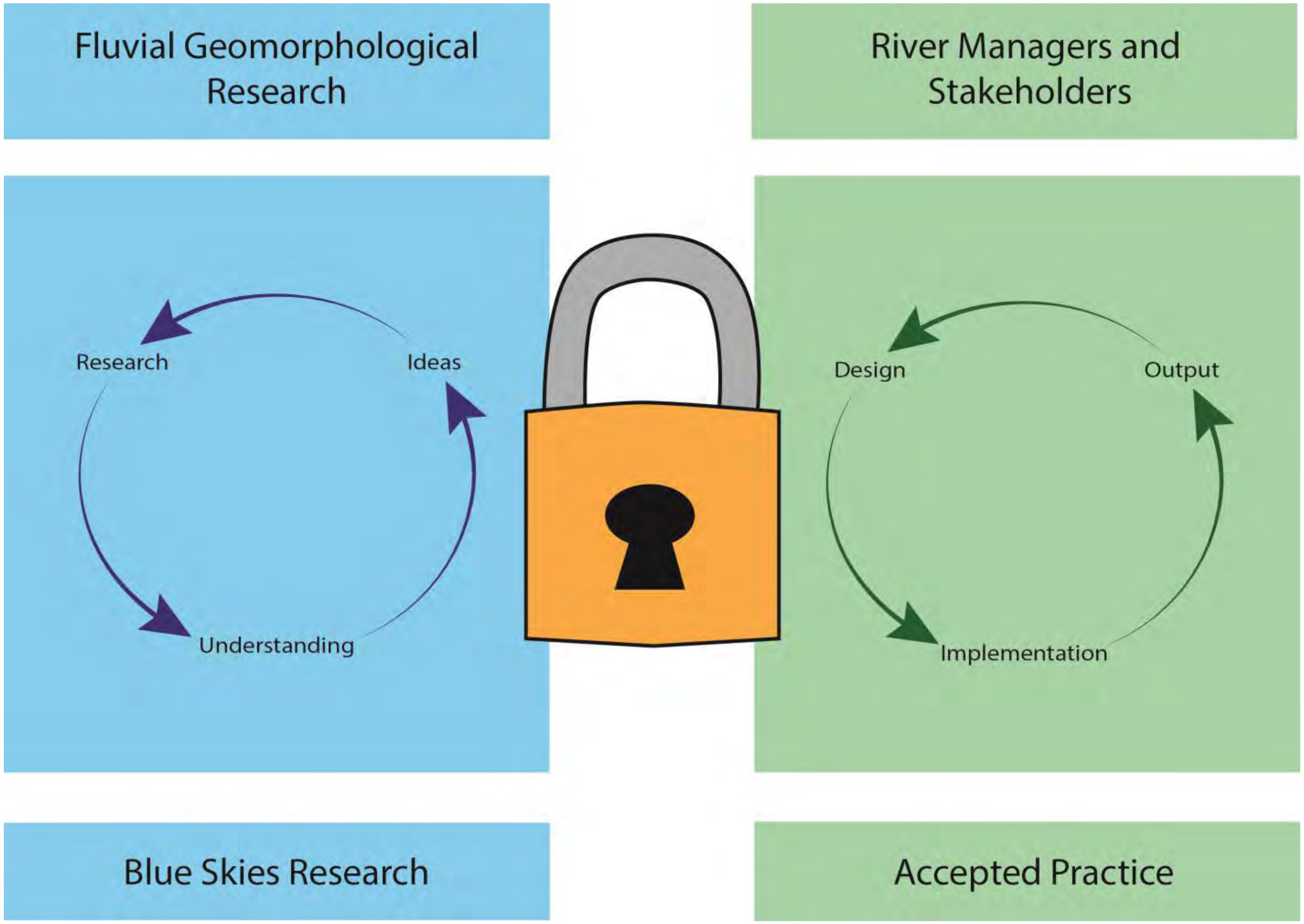
The Water Framework Directive (2000/60/EC)

* The WFD specifically refers to the importance of fluvial geomorphology in achieving a "good ecological status" under 'hydromorphology'
* The WFD recognises the importance of engaging with stakeholders in the process of managing water resources



" The paradigm lock occurs because scientists do not grasp what managers require, and managers and stakeholders do not appreciate the scientific alternatives available" (Gregory et al., 2008)

SIBERIA (Willgoose et al. 1991)

PERFECT (Littleboy et al, 1991)

DRAINAL (Beaumont et al. 1992)

GILBERT (Chase, 1992)

ARCU (Smithers and Caldecott ,1993)

DELIM (Howard, 1994)

GOLEM (Tucker and Slingerland, 1994)

GUEST (Misra and Rose, 1996)

HSPF (Bicknell et al. 1996)

RAT (Graf, 1996)

CAESAR (Coulthard et al. 1997)

A selection of the developed models.

CASCADE (Braun and Sambridge, 1997)

MIKE-SHE (Renard et al, 1997)

ZSCAPE (Densmore et al. 1998)

CHILD (Tucker and Bras, 2000)

EROS (Crave and Davy, 2001)

APERO/CIDRE (Carretier and Lucazeau, 2005)

LAPSUS (Schoorl et al. 2002)

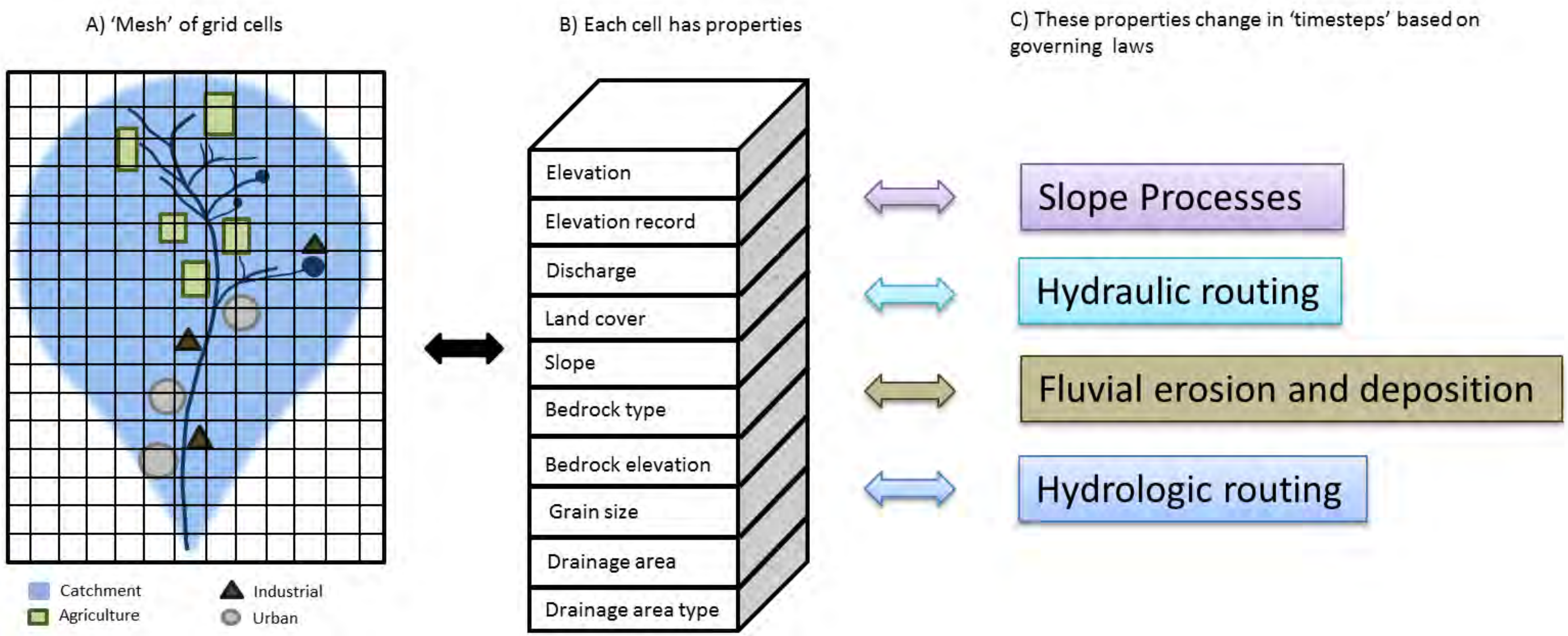
REAS (Wallerstein et al. 2006)

SIAM (Gibson and Little, 2006)

ST:REAM (Parker et al. 2009)

CAESAR-Lisflood (Coulthard et al. 2011)

LAPSUS-D (Keesstra et al, 2013)



"Physical models can be very good at reproducing sediment behaviour though they suffer from a number of disadvantages, mostly relating to scaling, which normally restrict their application to relatively short reaches of river" (Coulthard et al. 2012)

Animation - flow

Example: CEASAR-Lisflood

How do you get stakeholders using these models?

SIBERIA (Willgoose et al. 1991)

GILBERT (Chase, 1992)
DRAINAL (Beaumont et al. 1992)
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GOLEM (Tucker and Slingerland, 1994)
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Participatory modelling

"Participatory modelling describes a diverse range of modelling activities whose common element is that they involve stakeholders in one or more stages of the modelling process, from data collection through to model construction and use." (Hare, 2011)

Hare's participatory modelling framework

Defines seven criteria:

1. Participatory modelling purpose
2. Model type
3. Stakeholders involved
4. Timing of events
5. Participatory methods used
6. Participation mode
7. Skills needed to organize and implement the participatory modelling

Research aims

1. To develop and evaluate a catchment-scale cellular model of sediment dynamics that can be used by stakeholders to engage in decision-making processes of sustainable river catchment management
2. To establish, implement and critically analyse a participatory modelling approach in the process of developing a catchment-scale cellular model of sediment dynamics

1. Participatory modelling purpose

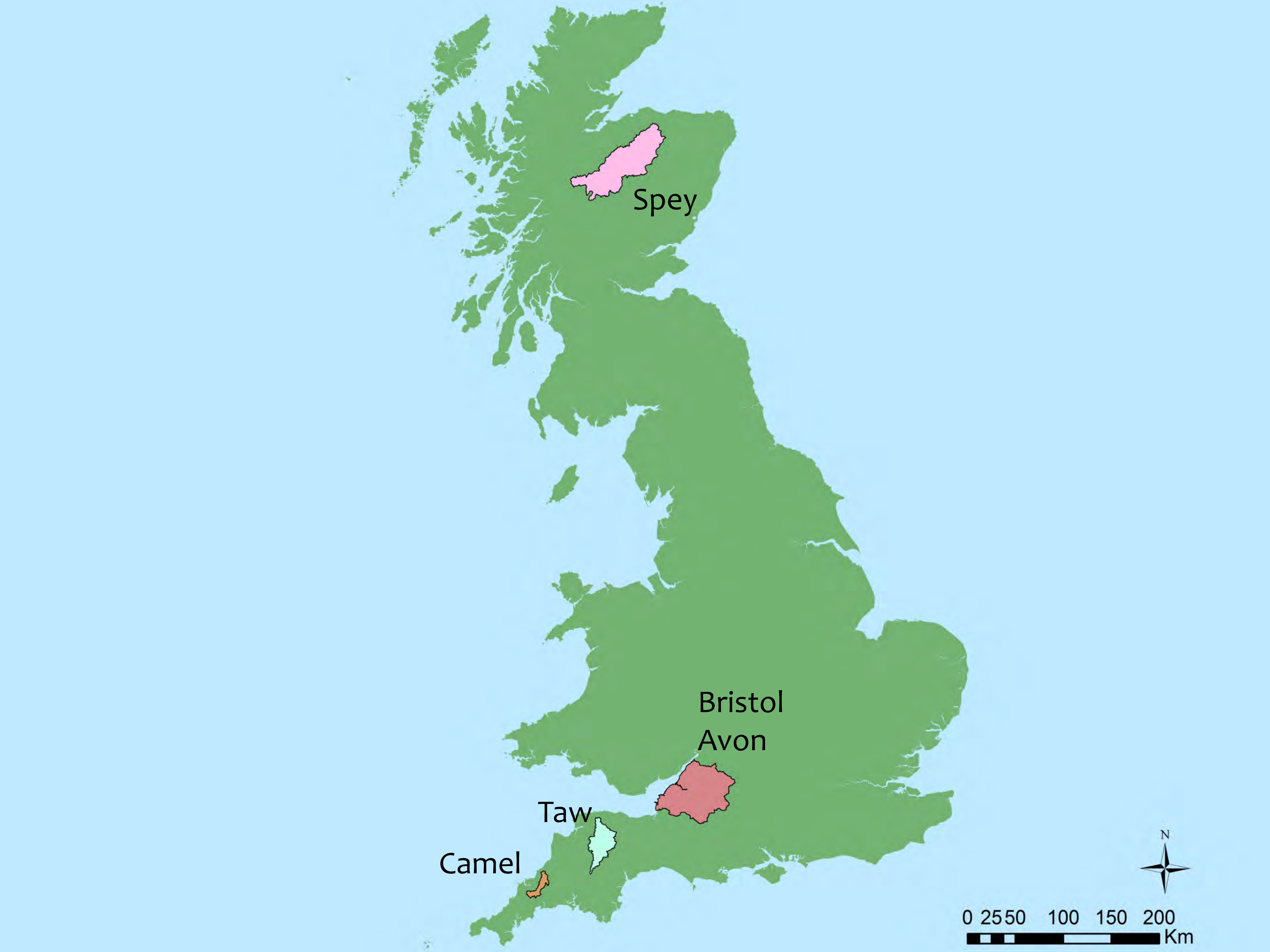
* Quality
* Acceptance
* Integration

2. Model type

```
        (17, "A"): 98, (17, "B"): 98, (17, "C"): 98, (17, "D"): 98, # Supra-litoral rock
        (18, "A"): 98, (18, "B"): 98, (18, "C"): 98, (18, "D"): 98, # Supra-litoral sediment
        (20, "A"): 98, (20, "B"): 98, (20, "C"): 98, (20, "D"): 98, # Littoral sediment

        # Mountain habitat
        (13, "A"): 35, (13, "B"): 56, (13, "C"): 70, (13, "D"): 77} # Montane habitats used -

# Intiatalise the incomming parameters for each cell in the catchment
def __init__(self, precipitation_d, slope_d, land_d, soil_d):
    self.precipitation_d = precipitation_d
    self.slope_d = slope_d
    self.land_d = land_d
    self.soil_d = soil_d

# Method to calculate SCS soil type from HOST data
def SCSsoil(self):
    # Lookup dictionarys for incoming landuse and soil type
    for soil, value in self.HOST_SCS_soil.items():
        if soil == self.soil_d:
            return value

# Method for calculating the CN number from LCM2007 data
def SCSCN(self, SCS_soil):
    # Iterate through the SCS table and match the land cover and soil type to the correct CN
```

3. Stakeholders involved

* The organising team (me and supervisory team)
* Multiple case study approach
  * The stakeholders primarily consist of policy-makers and management groups involved at the catchment scale

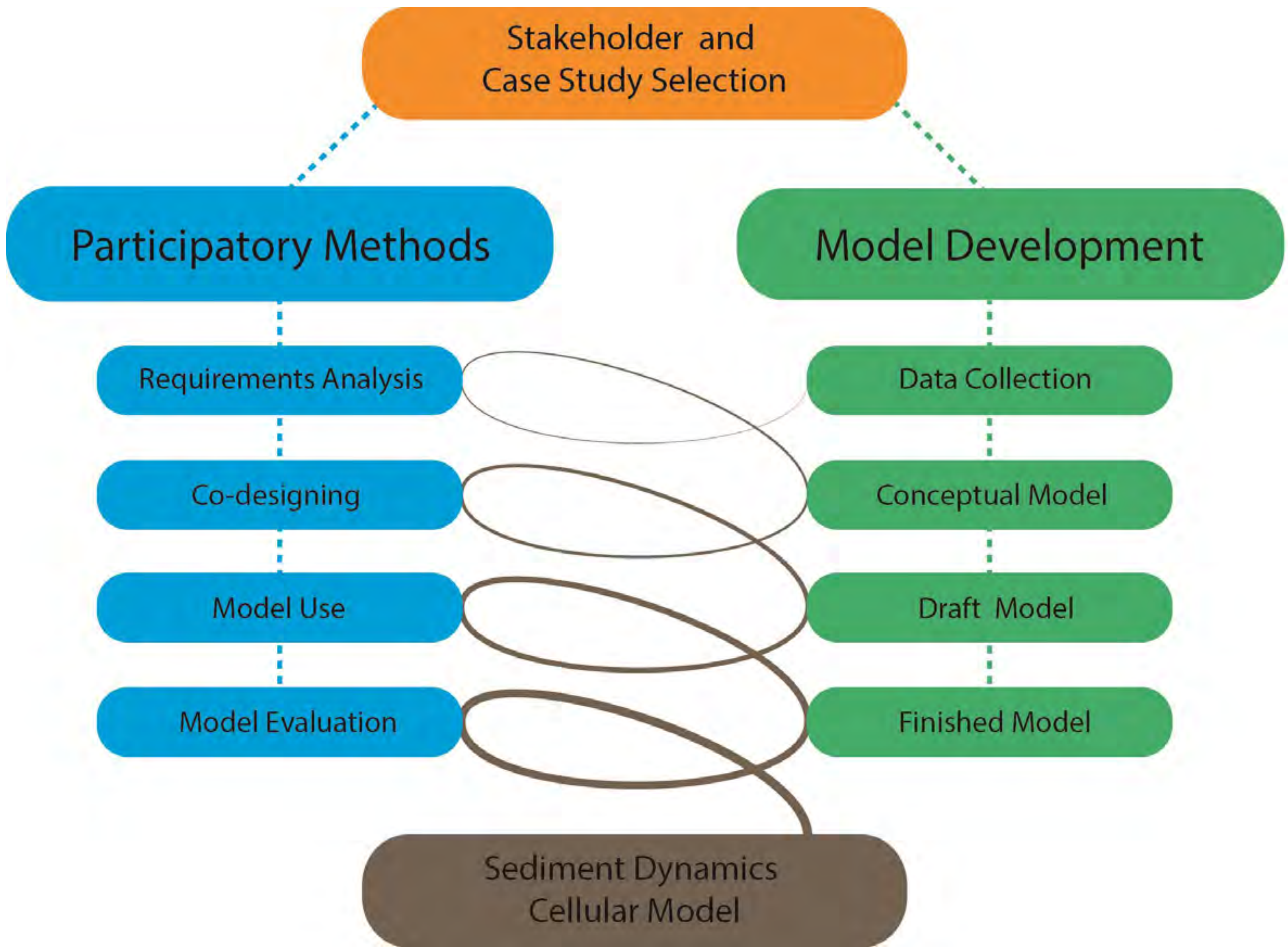

Spey
Bristol
Avon
Taw
Camel
N
0 25 50 100 150 200
Km

Stakeholder Type

River Catchment Management Groups

	Public bodies	Private Bodies	Conservation Organisations (Wildlife Trusts and Rivers Trusts)	Fisheries and Agriculture
Bristol Avon	Environment Agency, Wiltshire Council, Bristol Council, Bath and North East Somerset Council	Wessex Water	Avon Wildlife Trust, Bristol Avon Rivers Trust	
Spey	Scottish Environmental Protection Agency, National Park Authority, Scottish National Heritage		Spey Catchment Initiative	Fisheries board
Taw	Environment Agency		Devon Wildlife Trust, West Country Rivers Trust, Farming and Wildlife Advisory Group, Silvanus Trust, North Devon Biosphere	National Farmers Union
Camel	Environment Agency, Natural England			

4. Timing of events and 5. Participatory methods


Stakeholder and
Case Study Selection
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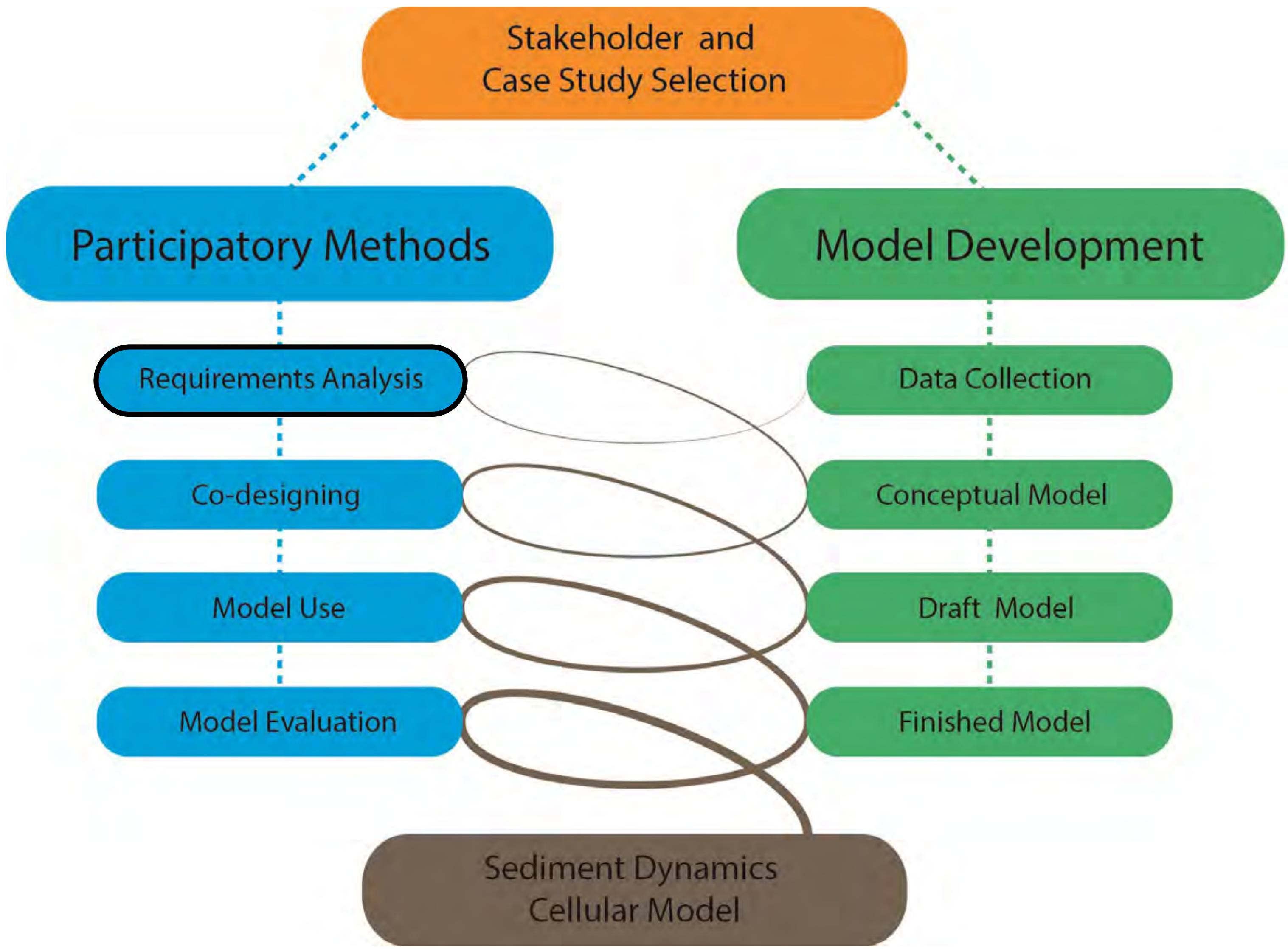
Conceptual Model
Draft Model
Finished Model
Sediment Dynamics
Cellular Model

6. Participation mode and 7. Skills needed

* Participation mode:
  * Stakeholders are involved as a group with homogeneous interests
* Skills needed:
  * Modelling skills
  * Facilitation skills

Results



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Requirements analysis workshop

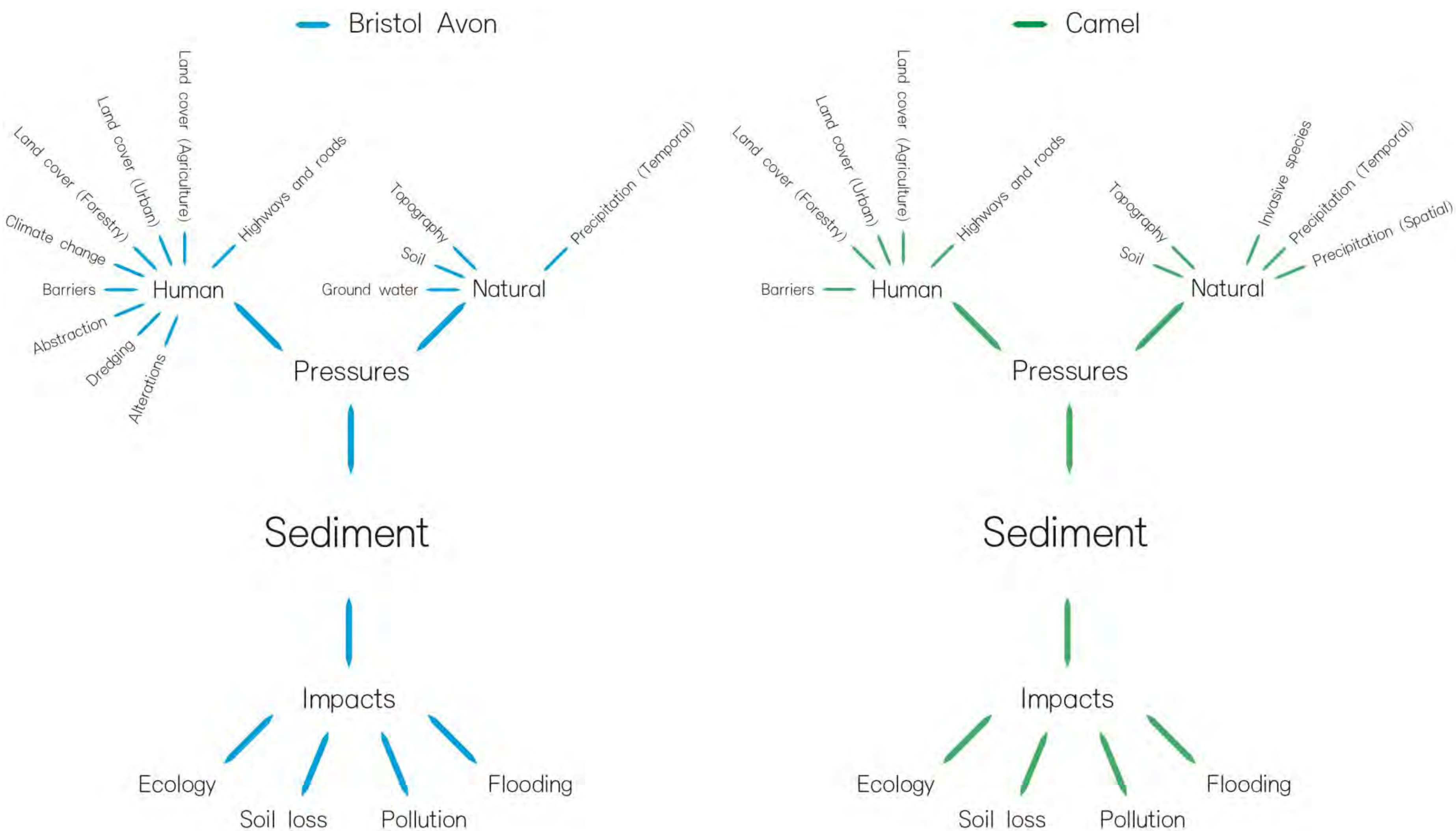
* Two activities:
  * Introduction to cellular modelling
  * Activity-oriented questions
* Thematic analysis using NVivo
* Cross-case analysis and triangulation of data sources was used to create thematic maps

Questions	Bristol Avon	Camel	Taw	Spey
What are the current sediment issues effecting your river catchment?	• Sediment issues from upstream resulting in costly downstream dredging • Diffuse and point source sediment • Agricultural run off • Silting issues • Impacts on fisheries • Land cover change • Phosphate associated with the sediment • Impacts on river ecology • Impacts on flooding • Influence from urban (impoundments and flood defence schemes)	• In the amble tributary (Fish, diatoms, WFD targets): ▪ Land use (exposed ground) ▪ Bank poaching ▪ Tracks/roads/gates (routes for transport) • Camel (SSSI / SAC targets): ▪ Maize ▪ Lanivet Stream ▪ Structures (role in sediment movement) • NIRS – Soil / sediment reporting • Exceedance of NE targets for suspended solids and deposited sediment impacts on in-stream • Risky crops e.g. maize / potatoes • Over-stocked out wintering • Road sides due to narrow lanes and gateways at bottom of sloping fields	• Poorly managed forestry operations on steep ground • Slurry 'Accidents', leaks and spills • Maize growth / cropping • Land use (poor arable land management) • Compacted farmland • River bank erosion (livestock) • Invasive Species (Himalayan Balsam) • Road run-off and road verge erosion (hard surfaces) • Lack of vegetation in head waters • Upland overstocking • Lack of trees and buffer strips in high erosion riparian areas • Increased phosphate (associated with sediment) • Loss of salt marsh habitat through deposition • Deterioration of gravels and spawning habitat	• Abstraction of river flow in the upper catchment for hydro-power. It is estimated 25% of river flow is diverted to the River Tay. There are other sources of abstraction throughout the catchment such as the distillery. • Impact from river impoundments, series of dams (3/4) in the upper catchment. • Large river catchment, with high mountains (Cairngorms) and a wide flat valley floor. A typical Spey tributary would be steep firing lots of sediment down onto the floodplain where it deposits. The Feshie fan is an example of an enormous source of sediment to the Spey. • Sediment transport varies due to the geology and rainfall in the catchment.

Quotes

"I think that is one of the things if you want your model to have ***credibility with stakeholders*** *is they will say it always* ***rains loads more here*** *and it is always* ***more intense here****, compared to down there, so I think there would need to be some recognition of that." (Catchment Co-ordinator, Environment Agency, Camel)*

"Also our rainfall, because you know we have ***practically nothing for months****, but you ask us next month and* ***it probably won't stop raining****, so it can be boom and bust." (Project Officer, Spey Catchment Initiative, Spey)*


Bristol Avon
Land cover (Forestry)
Land cover (Urban)
Land cover (Agriculture)
Highways and roads
Climate change
Barriers
Human
Abstraction
Dredging
Alterations
Topography
Soil
Ground water
Natural
Precipitation (Temporal)
Pressures
Sediment
Impacts
Ecology
Soil loss
Pollution
Flooding
Camel
Land cover (Forestry)
Land cover (Urban)
Land cover (Agriculture)
Highways and roads
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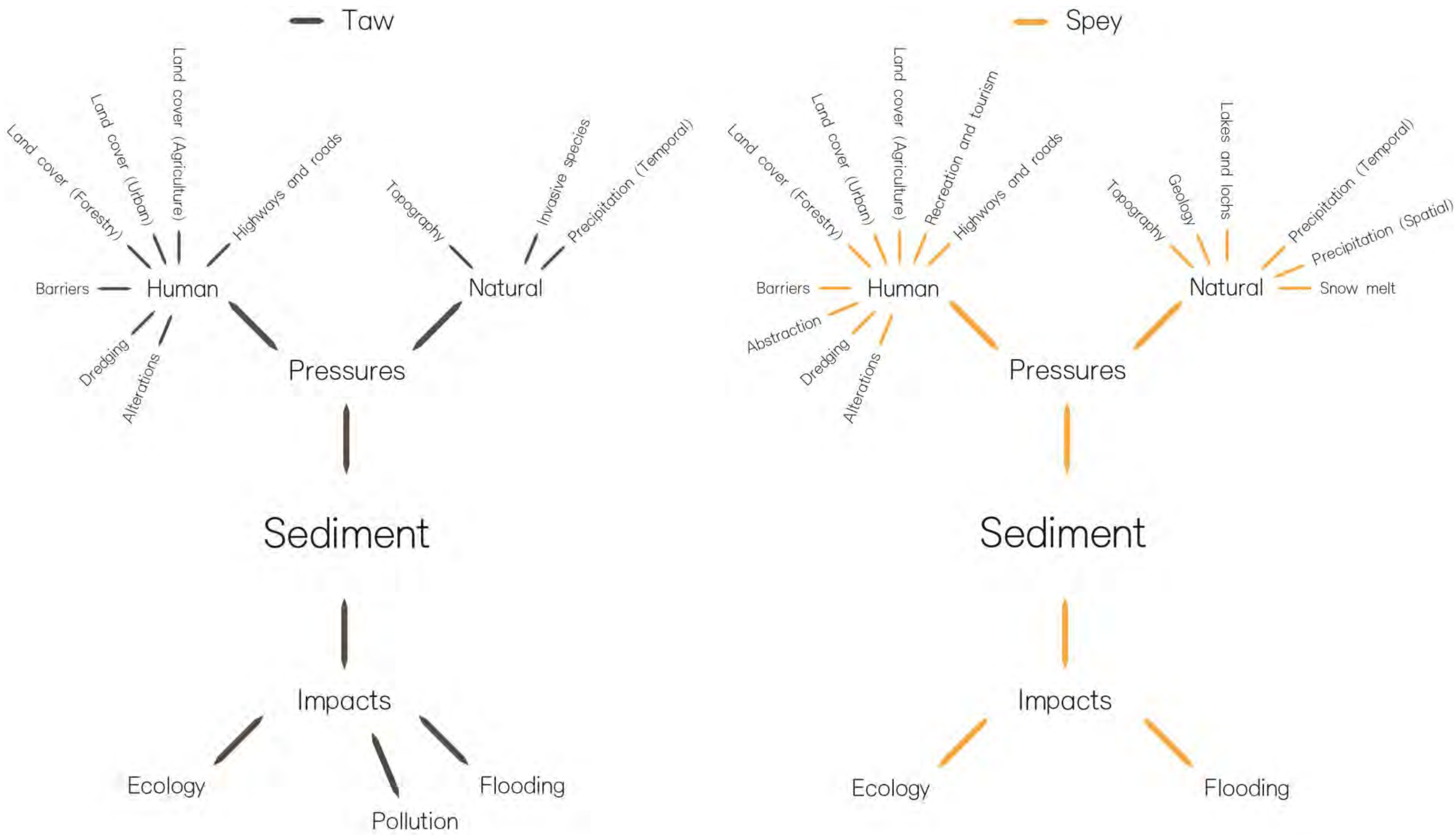
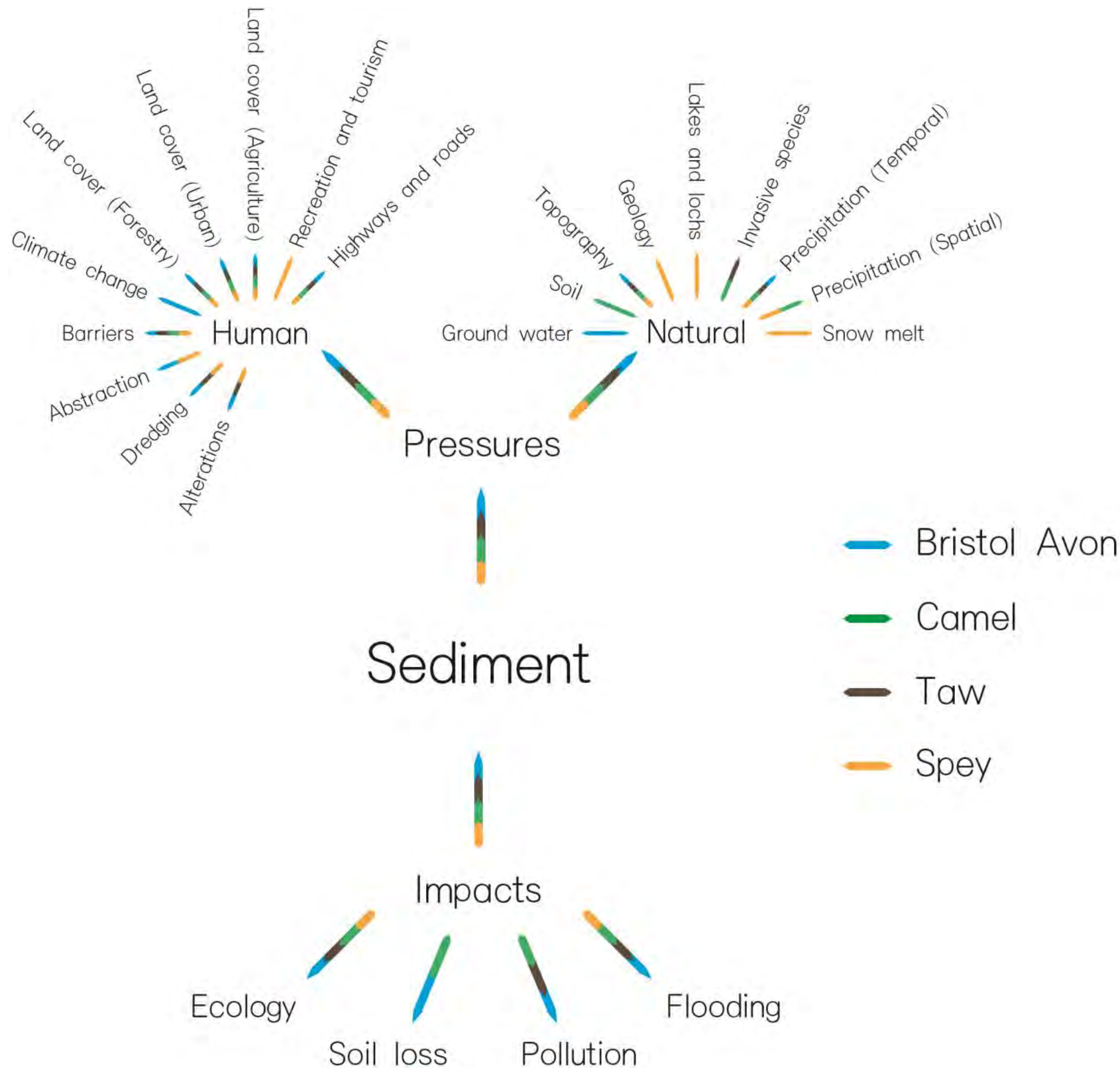


Taw
Land cover (Forestry)
Land cover (Urban)
Land cover (Agriculture)
Highways and roads
Barriers
Human
Dredging
Alterations
Topography
Invasive species
Precipitation (Temporal)
Natural
Pressures
Sediment
Impacts
Ecology
Pollution
Flooding
Spey
Land cover (Forestry)
Land cover (Urban)
Land cover (Agriculture)
Recreation and tourism
Highways and roads
Barriers
Human
Abstraction
Dredging
Alterations
Topography
Geology
Lakes and lochs
Precipitation (Temporal)
Precipitation (Spatial)
Snow melt
Natural
Pressures
Sediment
Impacts
Ecology
Flooding



Land cover (Forestry)
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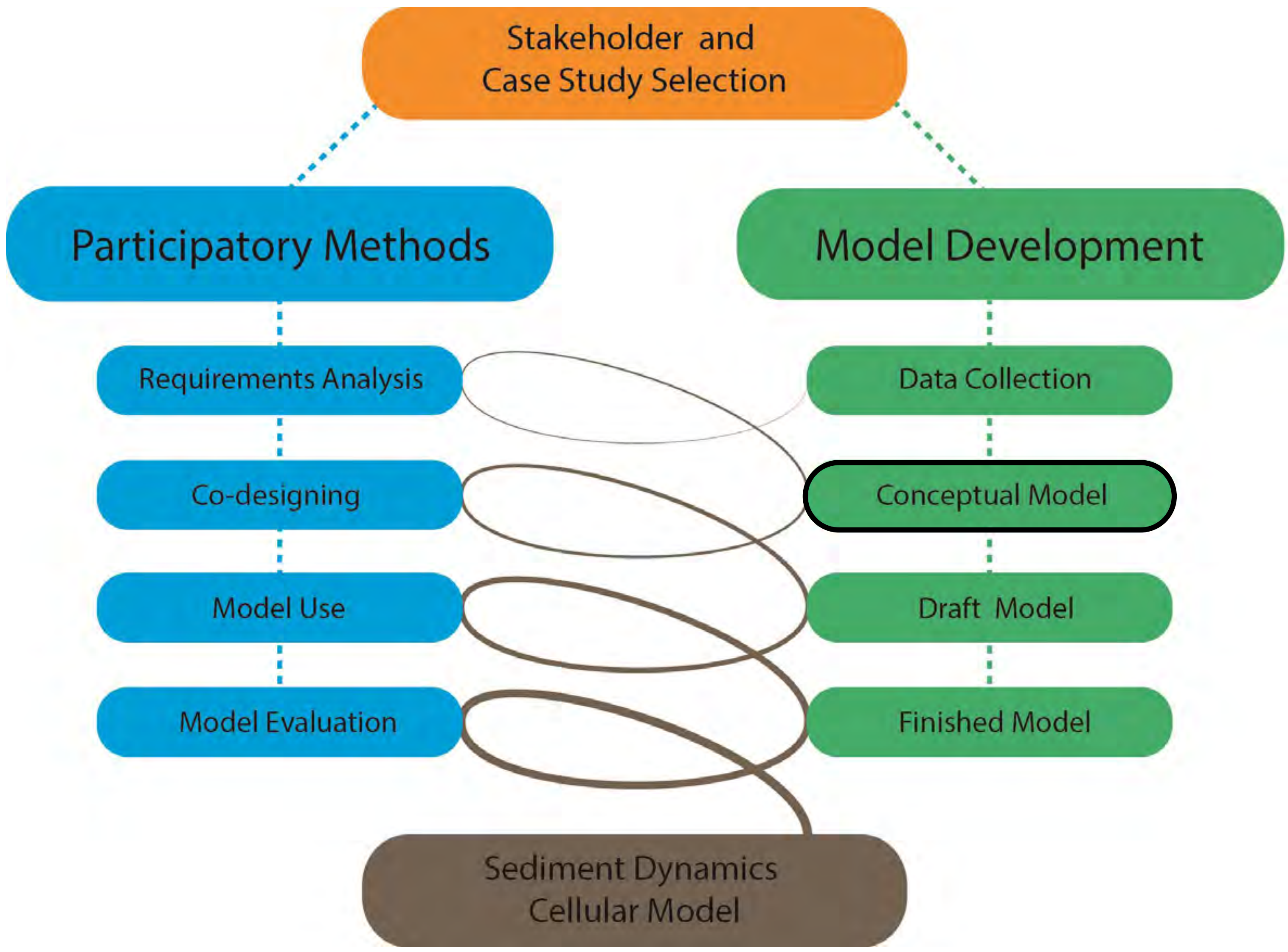
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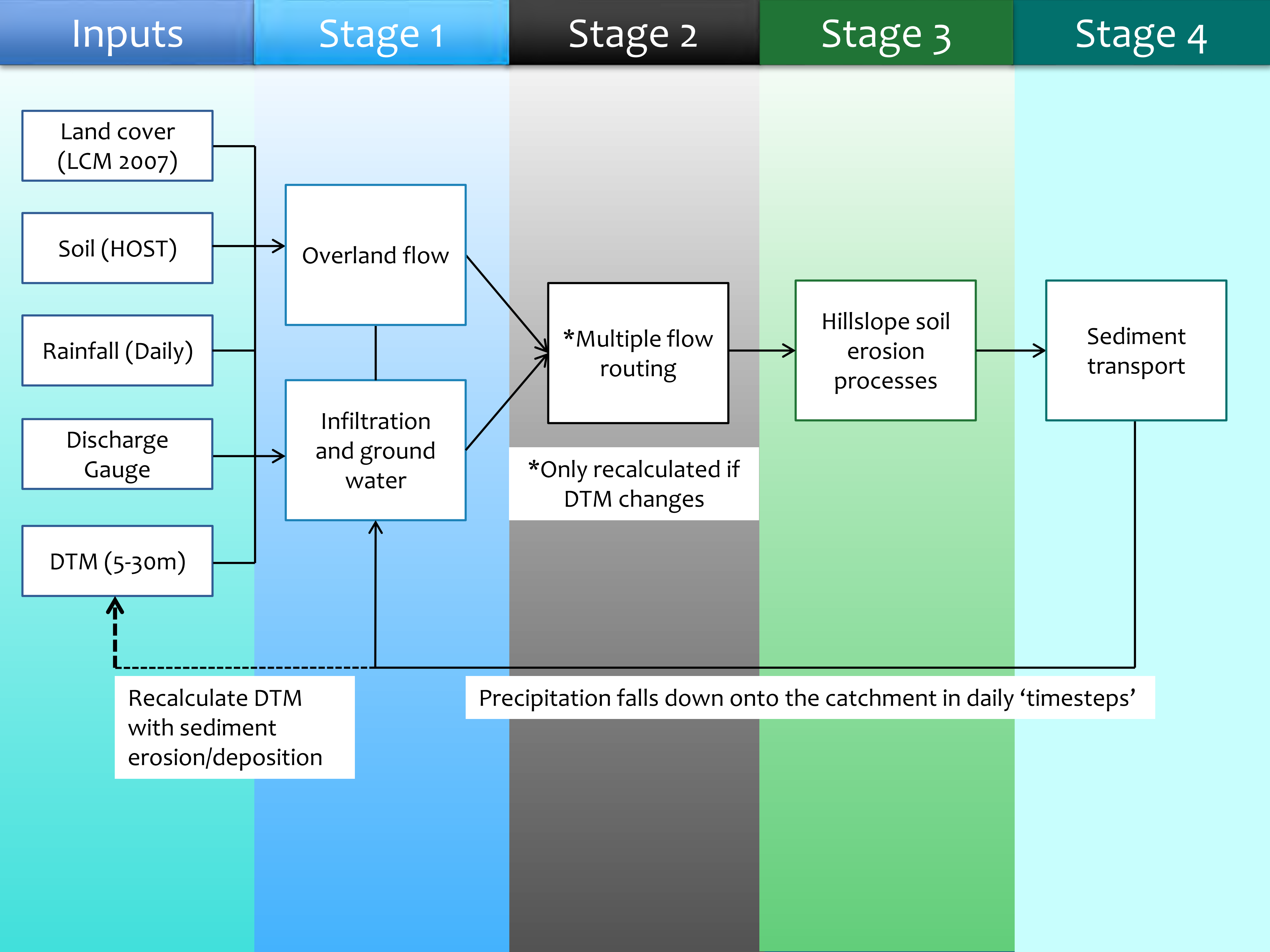


Inputs
Stage 1
Stage 2
Stage 3
Stage 4
Land cover (LCM 2007)
Soil (HOST)
Rainfall (Daily)
Discharge Gauge
DTM (5-30m)
Overland flow
Infiltration and ground water
*Multiple flow routing
*Only recalculated if DTM changes
Hillslope soil erosion processes
Sediment transport
Recalculate DTM with sediment erosion/deposition
Precipitation falls down onto the catchment in daily 'timesteps'

ENGAGE

HOME ABOUT FORUMS DOWNLOADS CONTACT

Welcome to the website for ENGAGE, my PhD research project which uses a participatory modelling methodology to develop a catchment-scale sediment dynamics model. If you want to find out what more about participatory modelling and sediment dynamic models **click here**.

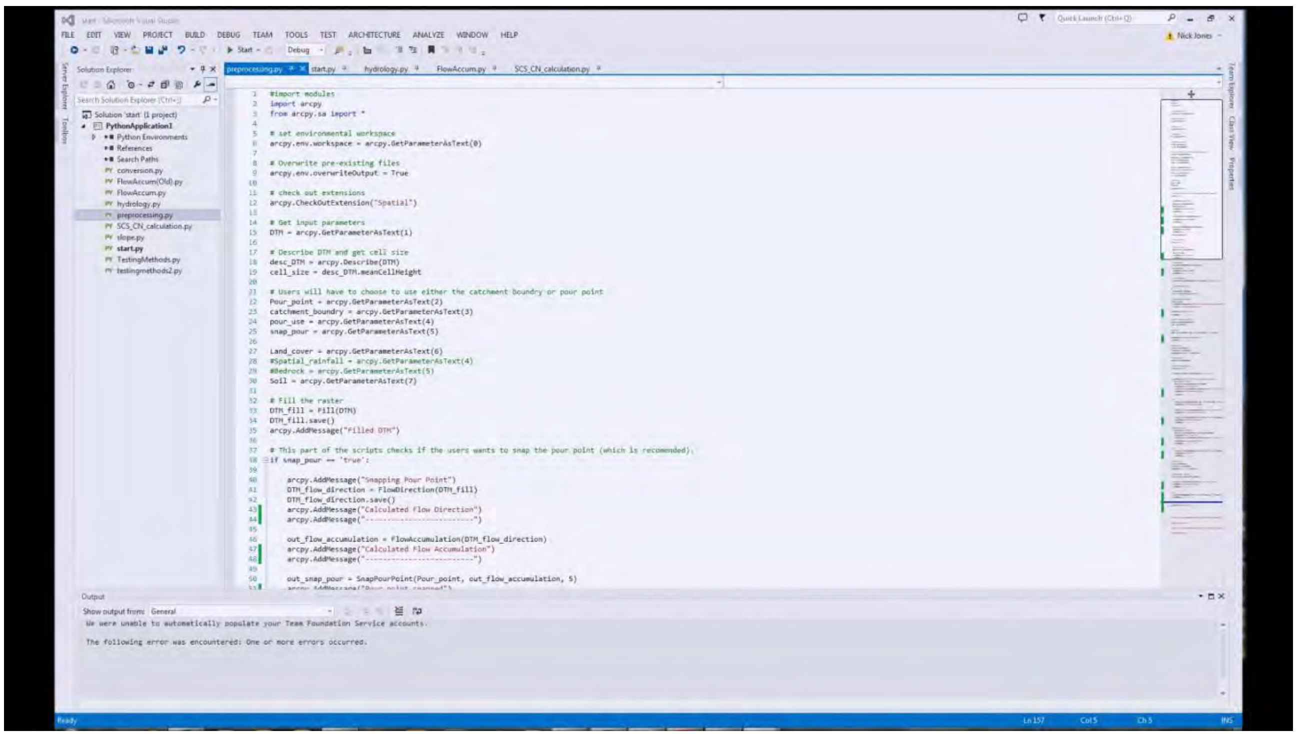
On this website you will find:

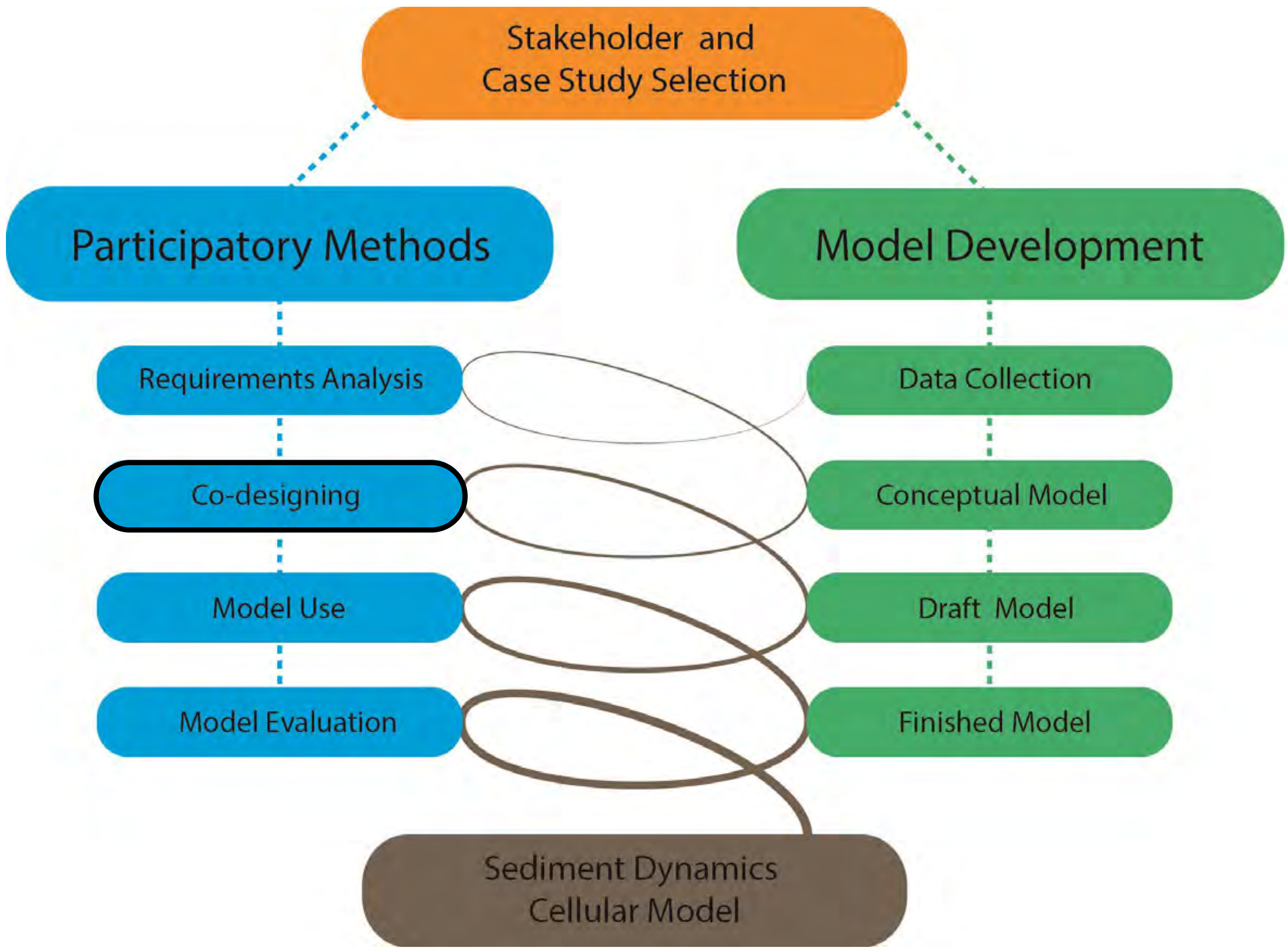
- The latest news
- Background information
- Sections on key concepts and terms
- Forms for model discussion
- Model and related document downloads

LATEST NEWS

06/06/2014 - ENGAGE model demonstration part 1

Model: Data processing demonstration

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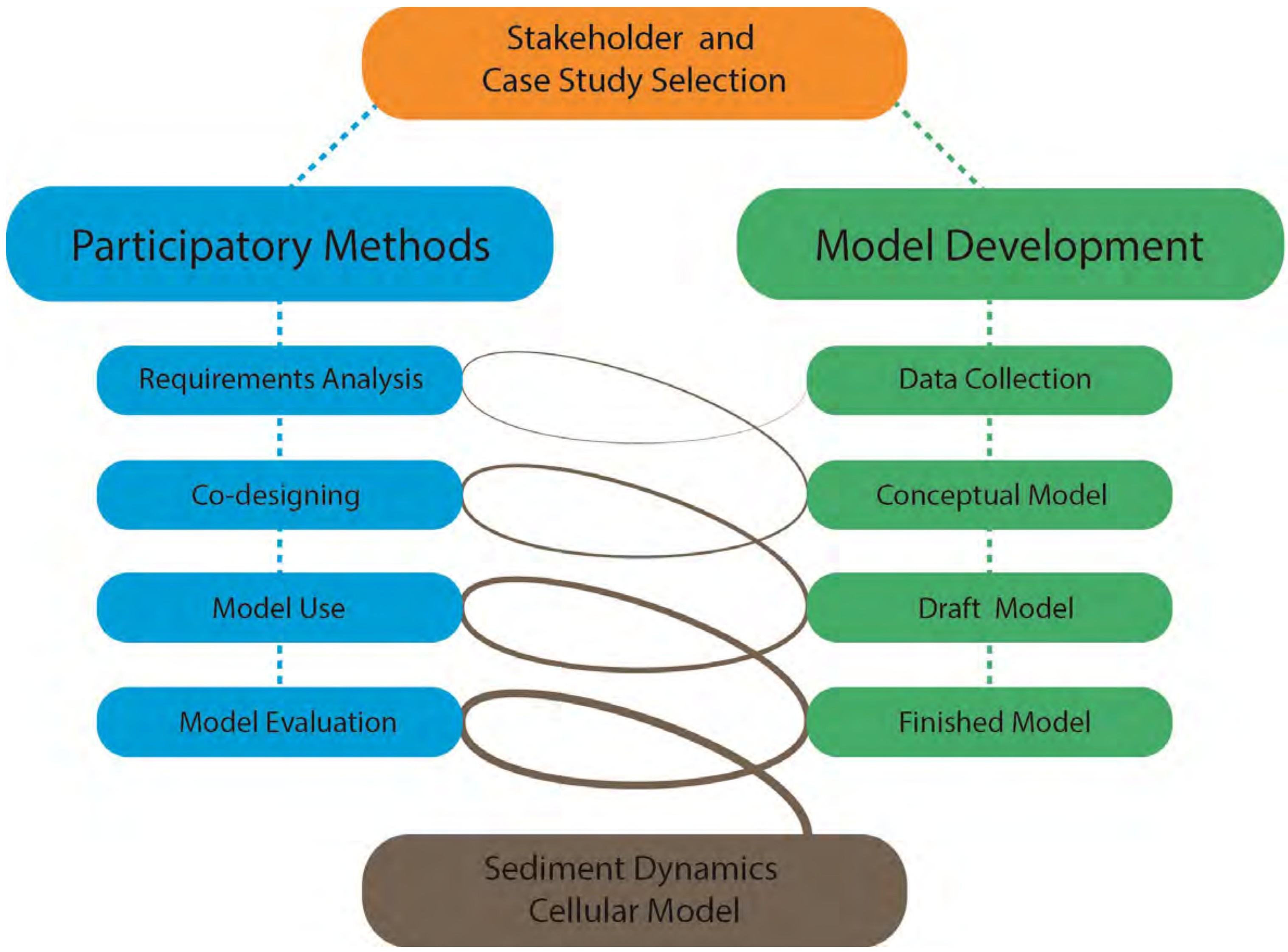
Co-designing workshop

Three activities:

* Conceptual model discussion
* Model influences prioritisation (Bulls-eye – using the pressures from the thematic map)
* Model application (Ranking exercise – using the model applications from the thematic map)

Co-design results

Issue	Group	Supporting material	Suggested incorporation
Overstocking	Camel	CF "If you think of a field over winter with 2 cattle compared to 30 cattle it is a completely different effect."	ST "I think you might just have to run it under different scenarios e.g. good farmer scenario, bad farmer scenario."
Crop Type	Camel	ST "Are we going to sort of put in what farmers management impact is, so what their management impact is so their management decision is, so deciding to have a kale field alongside the camel in heavy soil is a bad decision so you can basically model bad farming, from the environment point of view and good farming."	ST "DEFRA data basically on the single farm payment data. That does say permanent grassland, pasture land and what crop it is, so I think you can make use of that sort of data and fit it into your 10 metre squares"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Water quality in two Icelandic rivers: the influence of impoundment, agriculture, glaciation and permafrost
Nicholas Jones and Chris Parker In Press, Uncorrected Proof, Available online 20 May 2014. doi:10.2166/nh.2014.268

Thank you questions?

Twitter: @NickIceJones
Project website: www.engage-rivers.org.uk