Jochem Kail & Christian Wolter
Leibniz-Institute of Freshwater Ecology and Inland Fisheries

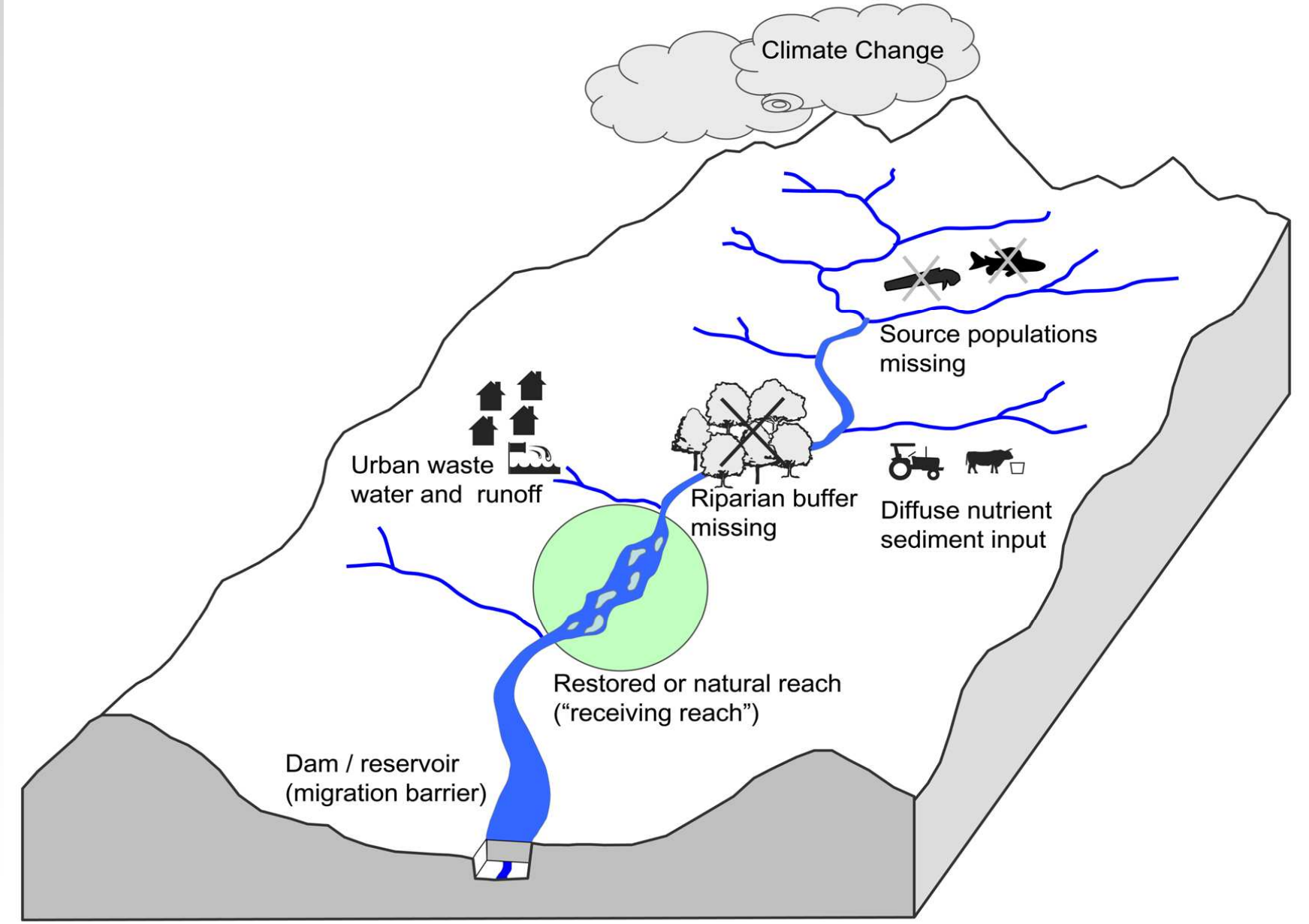
# IMPACT

-

## Developing an **I**ntegrated **M**odel to **P**redict **A**biotic habitat **C**ondi**T**ions and biota of rivers

for application in
climate change research
and water management

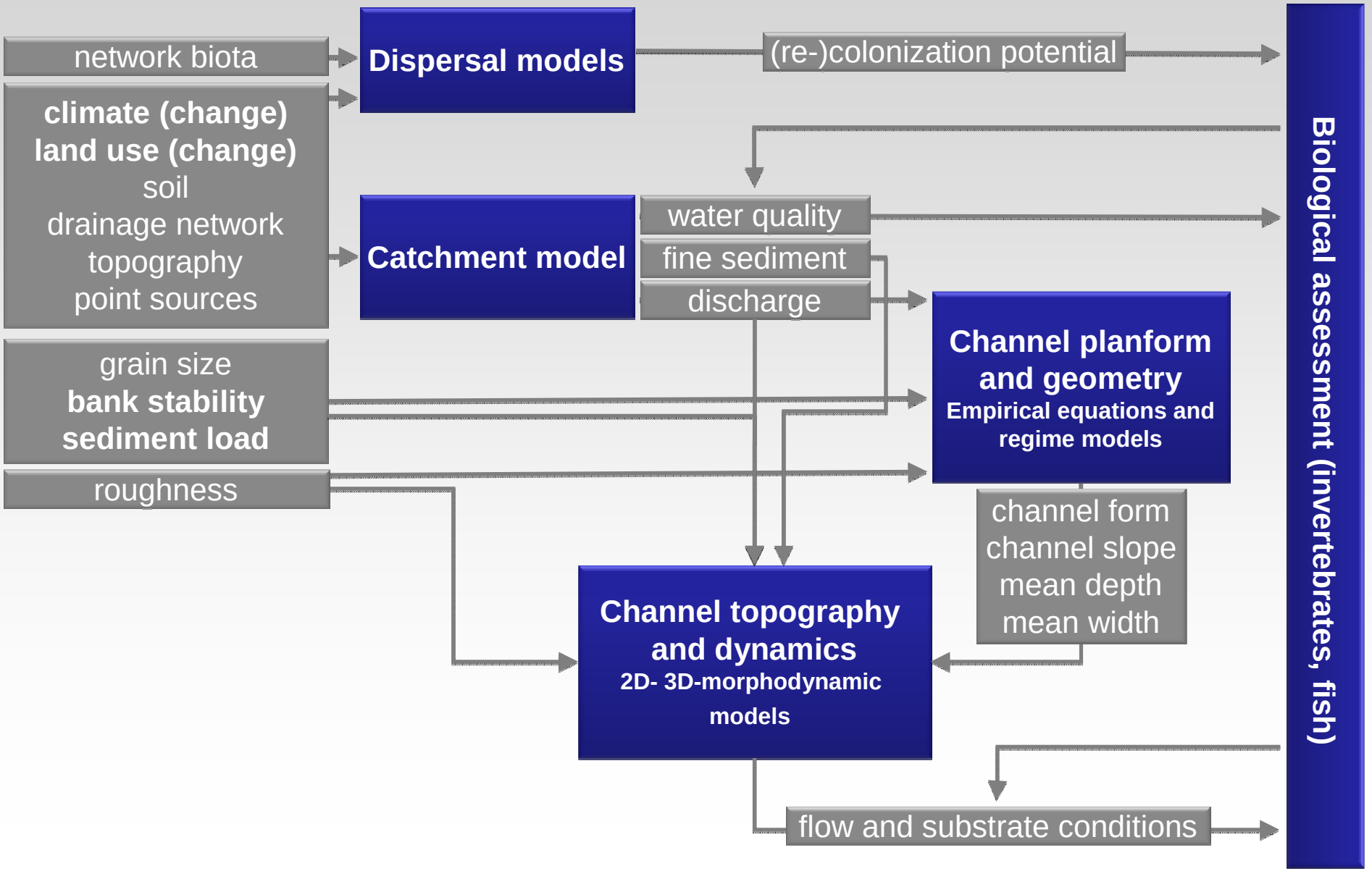
## Introduction: Ecological status depends on stressors at different spatial scales



# Importance of pressures at different spatial scales:

- Effect of reach-scale restoration given remaining pressures?
- Importance of Climate Change (Q changes)?
- Effect of Climate Change on reference conditions?
- Importance of land-use changes?
- Main limiting pressure / bottleneck?

## Modelling approach



# Introduction: IMPACT – an interdisciplinary project

## Catchment model

Christian-Albrechts-Universität zu Kiel

## Channel planform and geometry

IGB

## Channel topography and dynamics

IGB

UNESCO-IHE Institute for Water Education

Universiteit Utrecht

## Dispersal models

UNIVERSITÄT DUISBURG ESSEN

Université Paul Sabatier TOULOUSE III

IGB

## Interaction models

CCMAR CENTRE OF MARINE SCIENCES

## Biological assessment (inverts and fish)

UNIVERSITÄT DUISBURG ESSEN

IGB

## Study reaches (“receiving reach”) – field work

Treene (sand-bed)

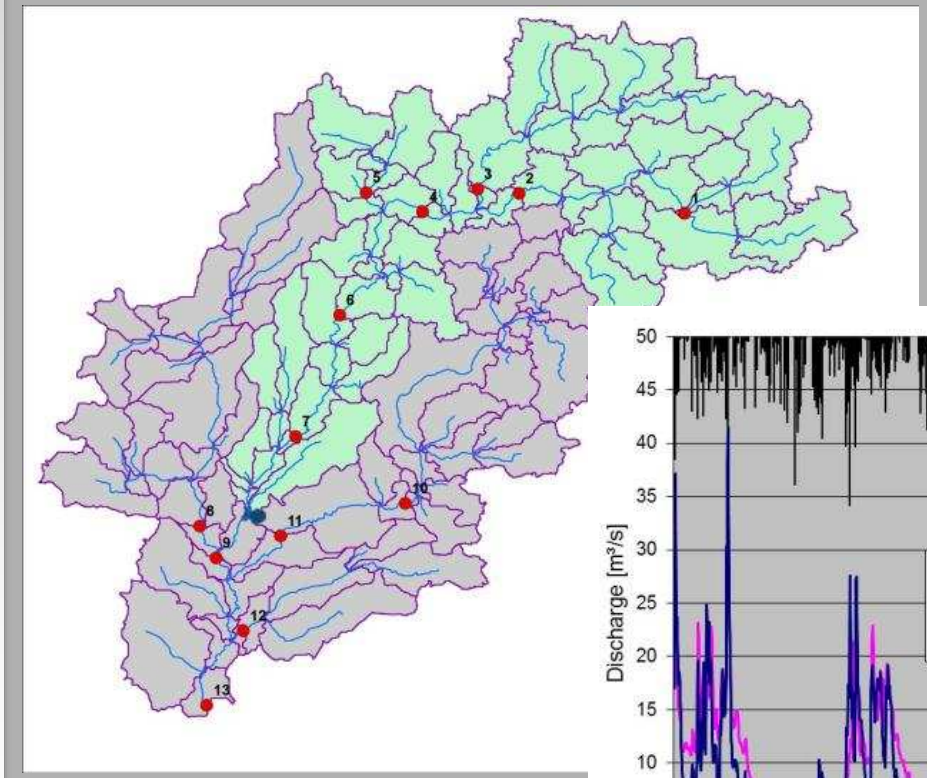
Célé (gravel-bed)

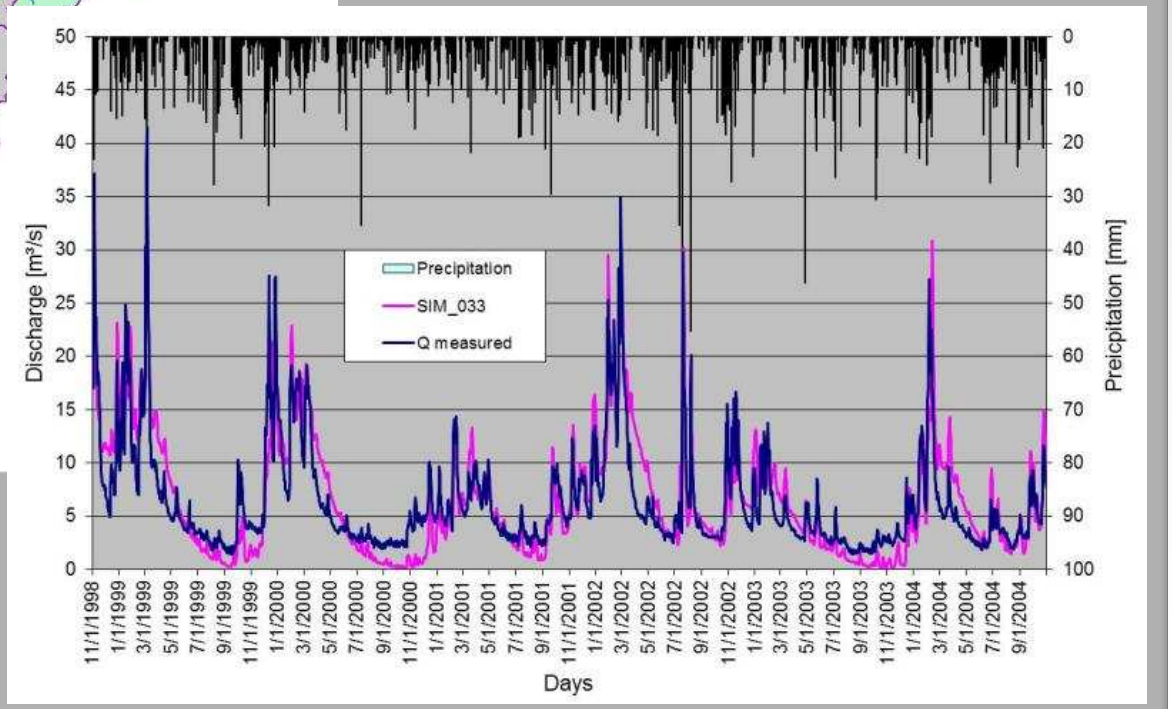
Some insights in our work (09/10 to 10/11)

## Study reaches (“receiving reach”) – field work

- bathymetry
- flow velocity
- grain size
- substrate
- inverts
- fish

## Catchment model - calibrated for Treene catchment

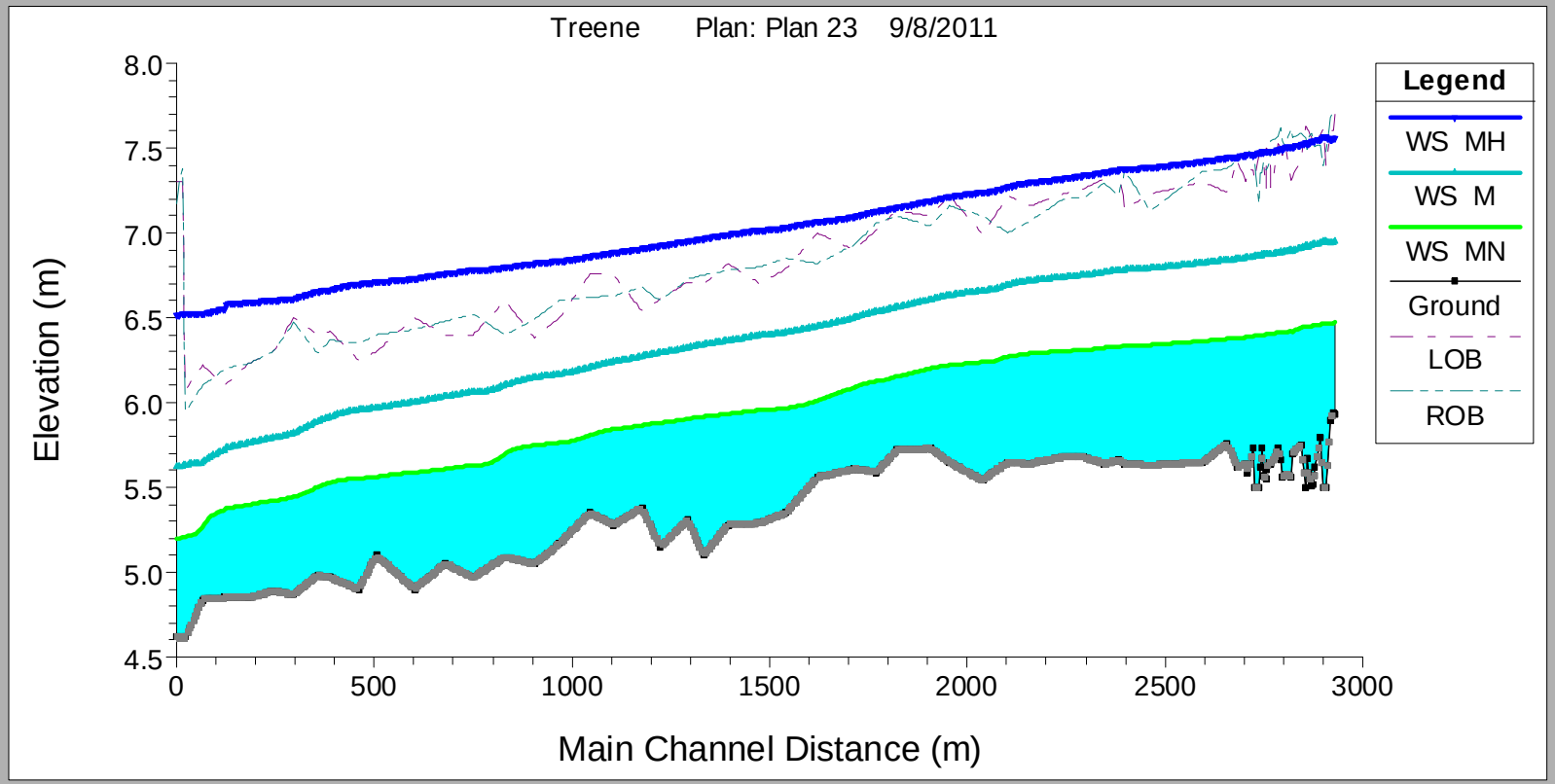



Guse (unpublished)

## Hydraulic model – HEC-RAS model for rating curve at Treene study reach

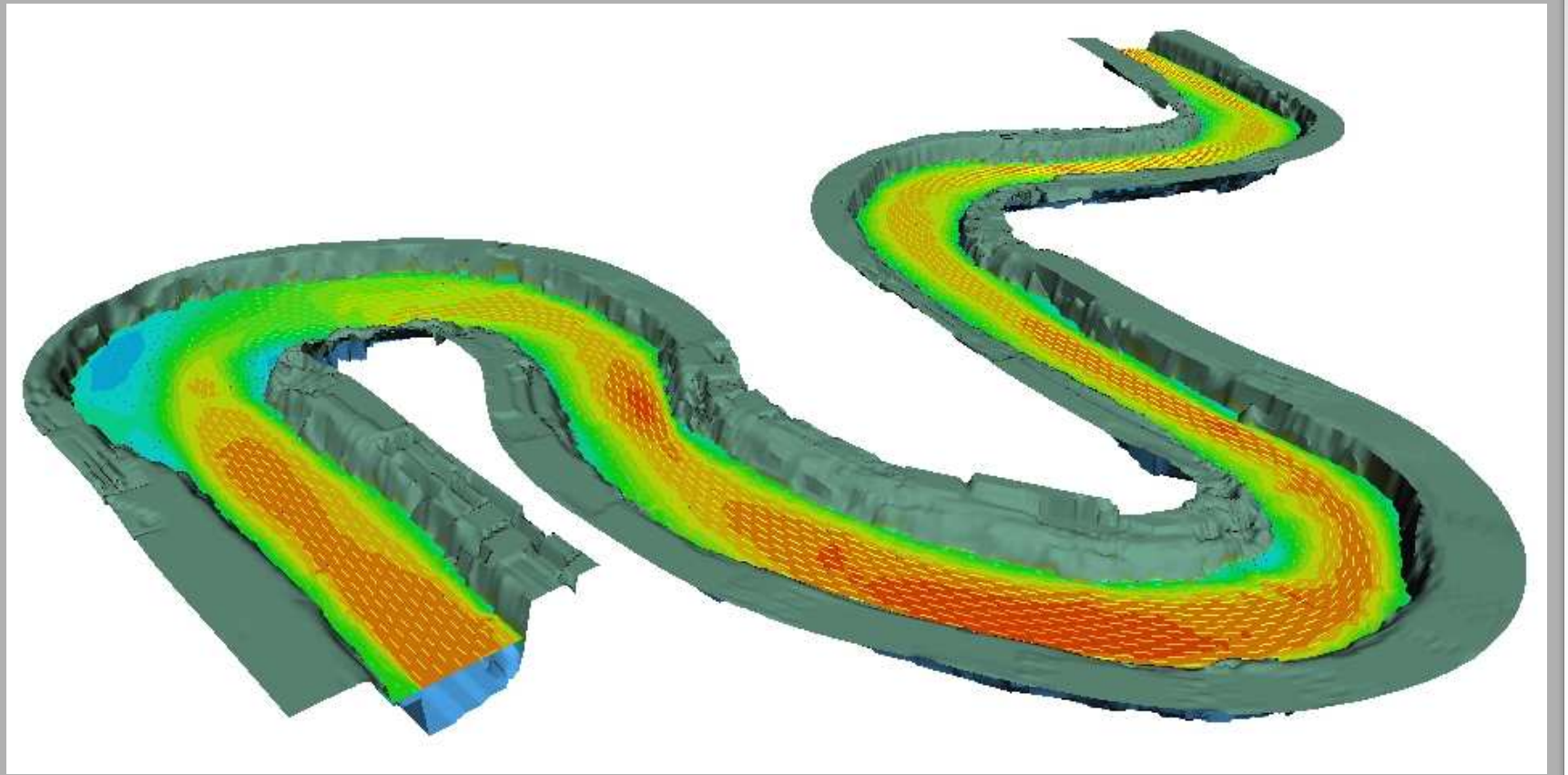
- HEC-RAS 1D-hydraulic model
- measured Q/h at downstream gauging station
- model Q/h (rating curve) for study reach




Guse (unpublished)

## Channel topography and dynamics – hydrodynamic model Treene

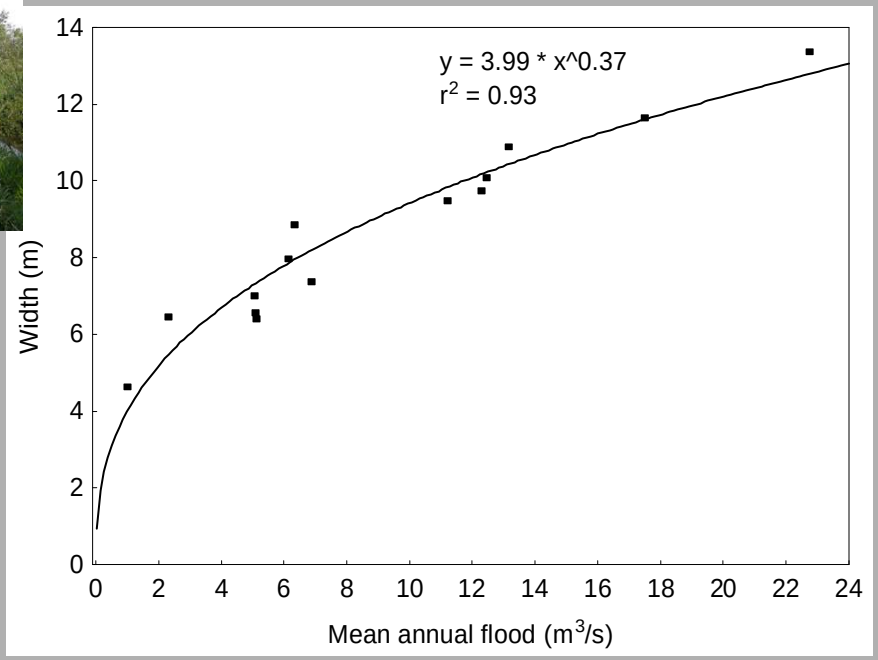
- model present flow velocity, depth, substrate
- model future conditions (Climate Change and land use Q, $Q_{sed}$, but same topo)



Kail (unpublished)

## Channel planform and geometry – regime equations and model for Treene

- model future channel geometry – empirical regime equation with Q as ind. var.




Kail (unpublished)

# Channel planform and geometry – regime equations and model for Treene

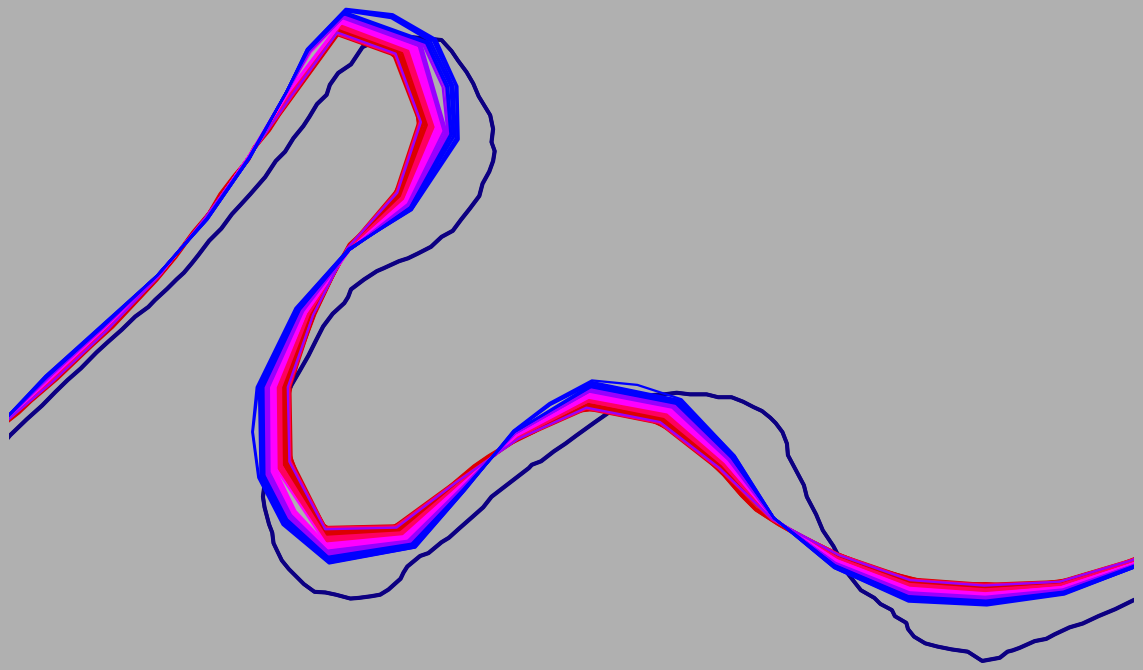
- model future channel geometry – regime model with Q, $Q_{sed}$, C' as ind. var.

| Process | Field Characteristics | | | | Model Variables | | |
|---|---|---|---|---|---|---|---|
| Hydraulics and sediment transport | Formative discharge (Q) | 5,23000 | $m^3/s$ | | Trapezoid bed width | 11,24 | m |
| | Reach average slope (S) | 0,00044 | m/m | | Trapezoid depth | 1,22 | m |
| | Bed material: Grain size (surface D50) | 0,002 | m | | Sideslope angle | 89,0 | degrees |
| | Manning's resistance coefficient (n) | 0,055 | $s/m^{1/3}$ | | | | |
| Bank fluvial erosion (Julian and Torres 2006) | Bank material: Bank silt-clay content | 50 | (%) | | Could be quantified using bank material samples | | |
| | Bank strength vegetation coefficients | 1,0 | (-) | | Calibration parameter | | |
| Bank mass failure (Eaton 2006) | Bank angle | 89 | degrees | | Banks at all study sites are nearly vertical | | |
| | Satured unit weight of soil | 20,0 | $kN/m^3$ | | First estimate based on Charlton et al. (1978) in Millar and Quick). Could be quantified using bank material samples (Eaton 2006 uses 19,5) | | |
| | Bank material (soil) friction angle | 40,0 | degrees | | Calibration parameter (Istanbulluoglu et al. 2005 used 40° for gully erosion) | | |
| | Effective cohesion | 4,95 | kPa ($kN/m^2$) | | Calibration parameter | | |

model for gravel bed rivers from Millar and Quick (1998),
based on Excel Solver model of Eaton 2006, modified for sand bed rivers, Kail (unpublished)

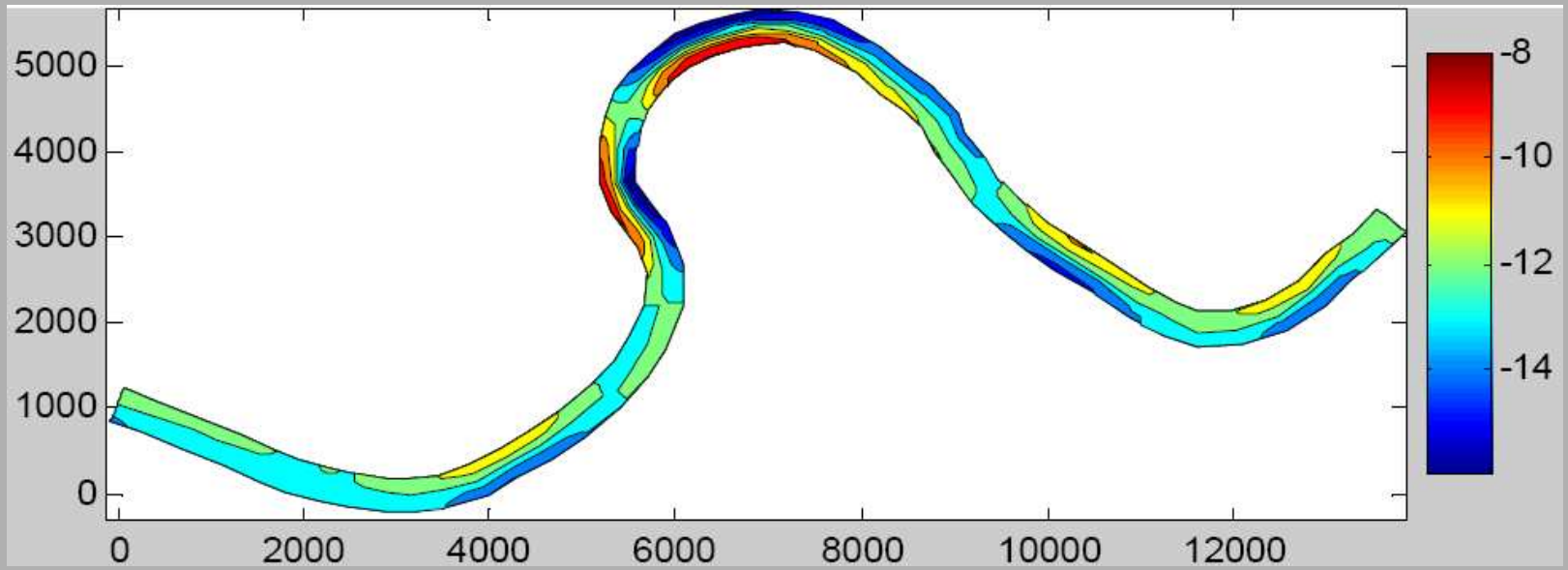
## Channel topography and dynamics – meander migration model Treene

- model future channel topography and dynamics (first preliminary results)



## Channel topography and dynamics – meander migration model Treene

- model future channel topography and dynamics (expected results)



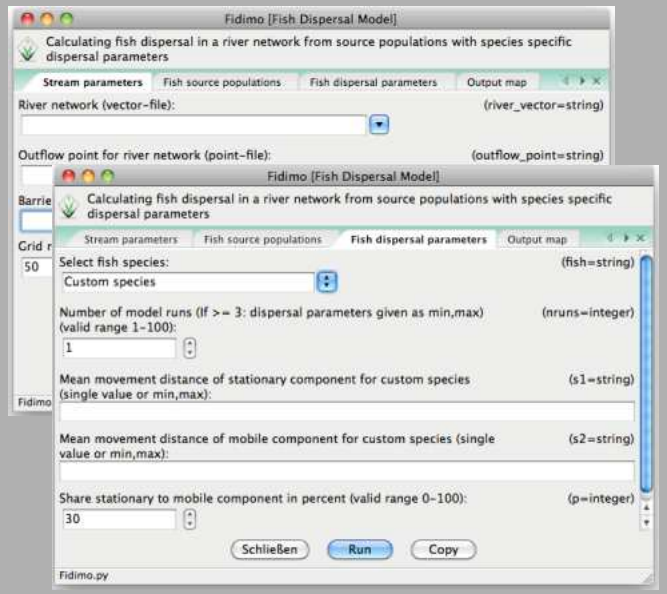

from Crosato (2008)

## Dispersal models – GIS Fish Dispersal Model FIDIMO

- model dispersal of fish and assess which species can reach restored sites

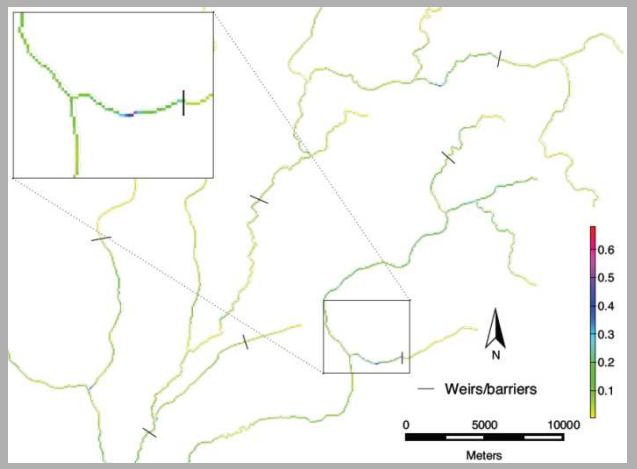
### Input

- fish source populations
- fish dispersal ability
- river characteristics (migration barriers, habitat quality)




### Output

- probability of occurrence in rasterized river network




Radinger et al. (in prep.)

# Climate Change and land-use scenarios:

- Which Climate Change scenarios will be used (e.g. A1B)?
- Which time-interval will be considered?
- CC time-scale similar to other processes considered (e.g. land-use or hydro- morphodynamic changes)?
- Method for downscaling global CC models?
  - Treene: Statistical Regional Model (STAR)
- Which kind of land- use scenarios?
  - Treene: Increase of energy crops (maize), increase of forested buffer strips
  - Portugal, Algarve region?
- Question especially to CLIMAWARE and ICARUS!


http://www.impact.igb-berlin.de/





**Acknowledgements:**
This project is carried out with financial support from the Commission of the European Communities, specific RTD programme “IWRMNET”. It does not necessarily reflects its views and in no way anticipates the Commission’s future policy in this area.

This project has been partly funded by the German Federal Ministry for Education and Research (grant number 02WM1134).