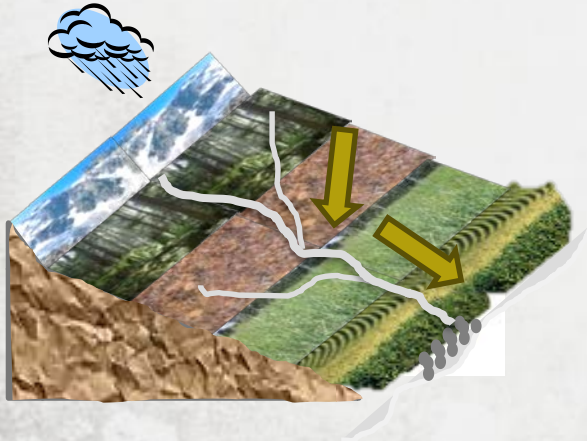
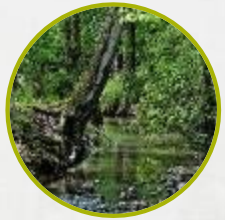
SEDIMENT RETENTION MODEL

MODEL OVERVIEW



Drinking water

Reservoir



Stream health

AIM

Understand the spatial patterns of sediment sources and transport to assess the value of sediment retention by natural landscapes

Supply: Sediment retention → **Service: Water purification** → **Value: avoided treatment/ dredging**

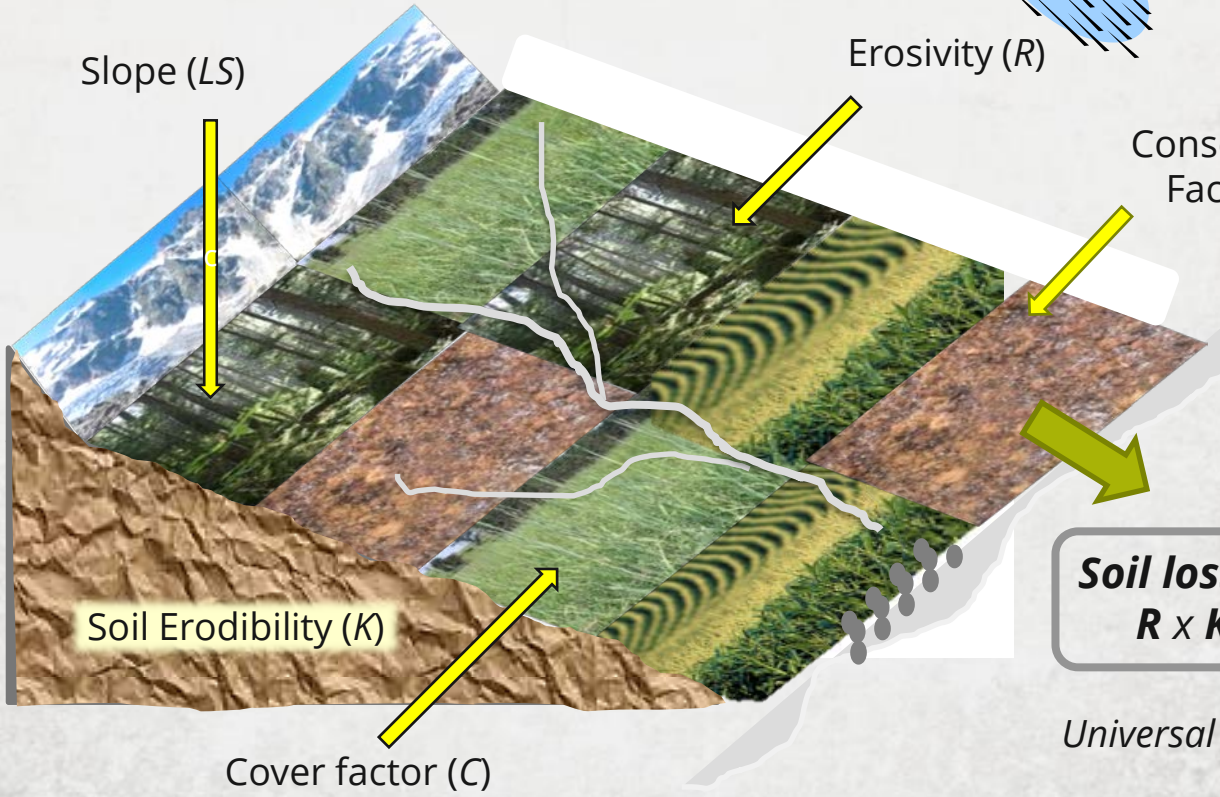
Photo credit: Creative Commons, pixabay.com

MODEL OVERVIEW

AIM
Understand the spatial patterns of sediment sources and transport to assess the value of sediment retention by natural landscapes

Supply: Sediment retention → **Service: Water purification** → **Value: avoided treatment/ dredging**

CONCEPTS
UNIVERSAL SOIL LOSS EQUATION

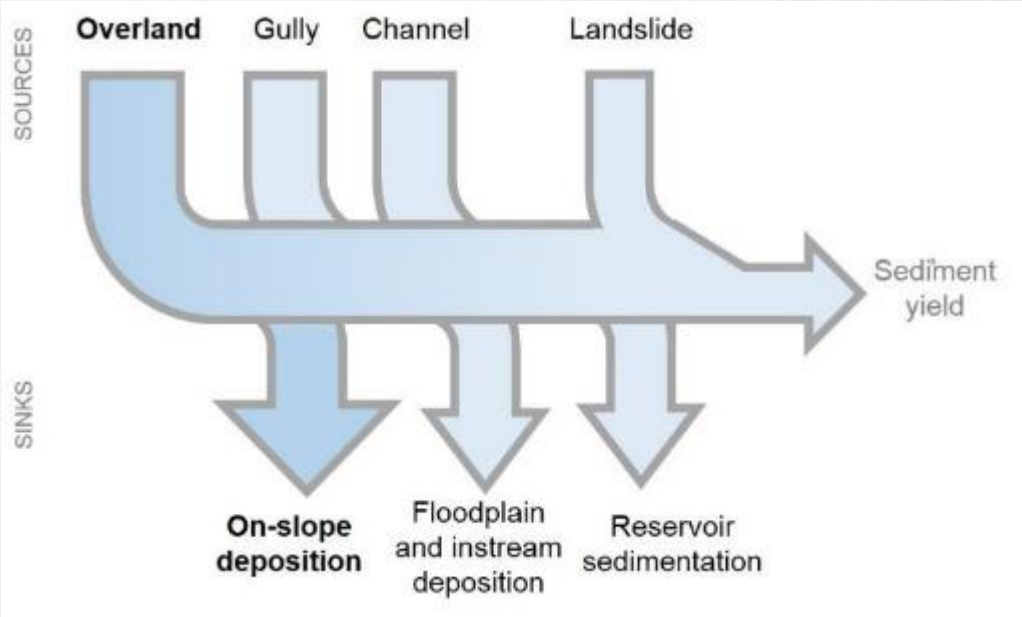


Soil loss (ton/ha/yr)= R x K x LS x C x P

Universal Soil Loss Equation (USLE)

CONCEPTS
UNIVERSAL SOIL LOSS EQUATION

- Very popular method!
- BUT:
  - Only for **rill-inter-rill erosion**
  - Uncertainty in parameters:
    - **LS factor** for high slopes
    - **C,P factors**, etc.
- LOT of **literature**!



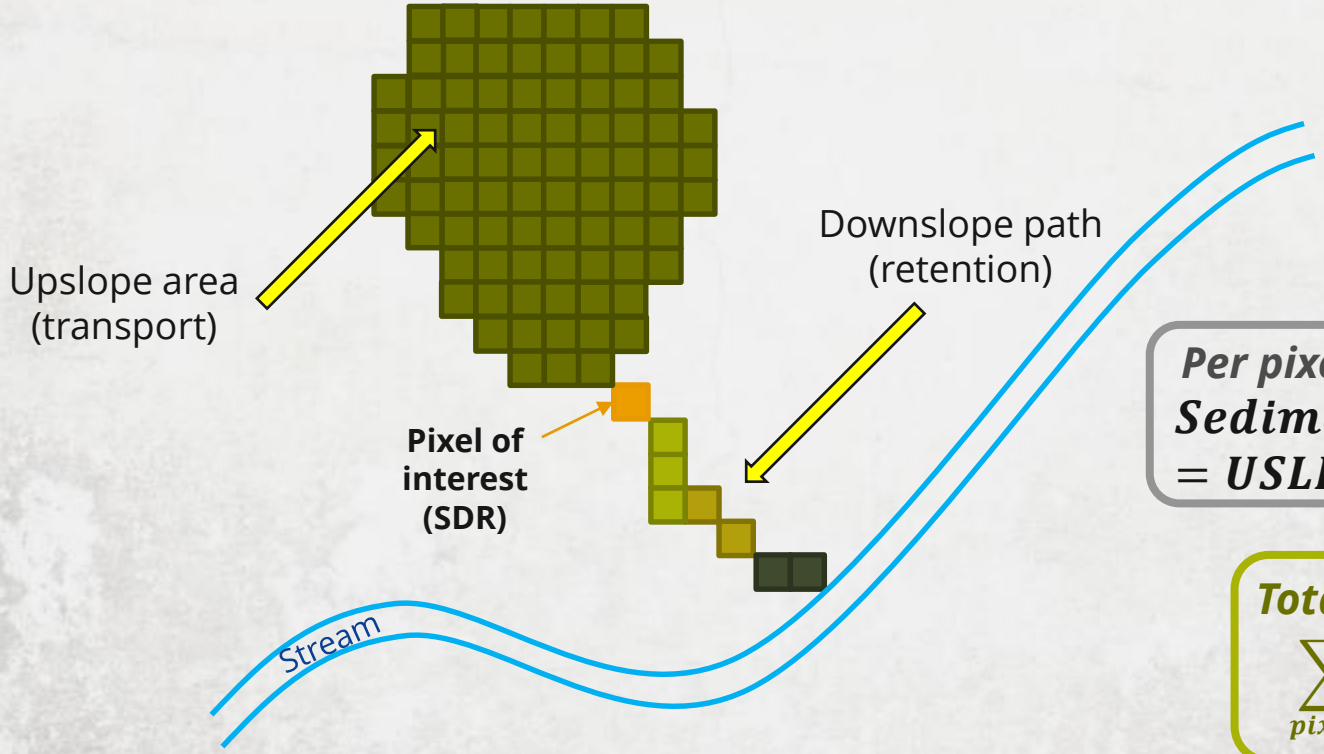
CONCEPTS
SOIL LOSS

- Soil **eroded** from a parcel
- Some of this soil is **deposited** and does not reach the stream

$$SedimentExport = USLE \times SDR$$

Attenuation factor [0;1]

CONCEPTS
TRANSPORT/RETENTION



Per pixel:

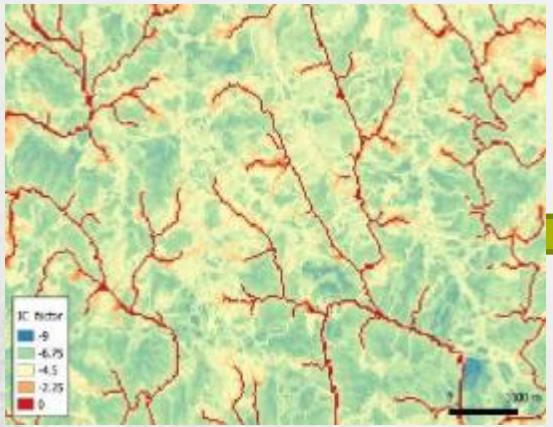
$$SedimentExport\ (ton/yr) = USLE \times SDR$$

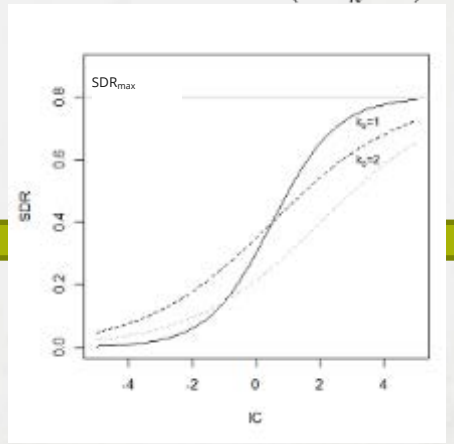
Total export (ton/yr) =

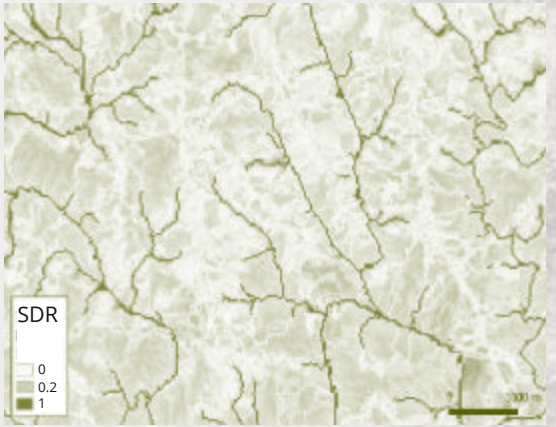
$$\sum_{pixel} SedimentExport$$

CONCEPTS
TRANSPORT/RETENTION

$$SDR_i = \frac{SDR_{max}}{1 + \exp\left(\frac{IC_0 - IC_i}{k}\right)}$$







- Calibration parameters:
  - k_b, IC_0
  - SDR_{max}

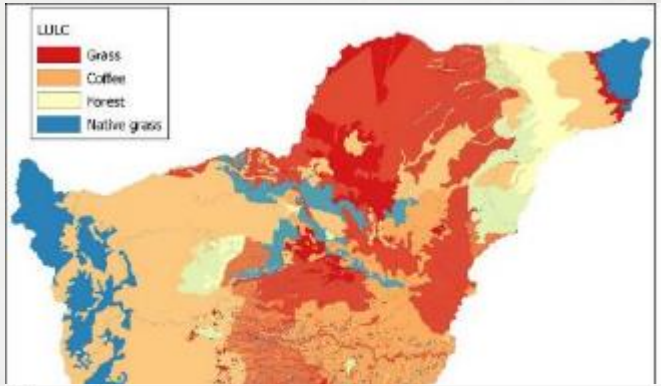
CONCEPTS
VALUATION

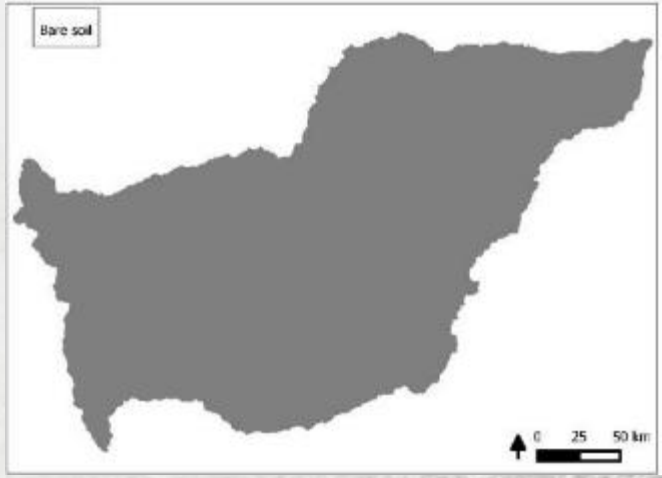
- Very context-specific!
- Two main options:
  - Replacement and avoided cost approaches

ASSUMES that MITIGATION OPTIONS ARE WORTHWHILE!

CONCEPTS
VALUATION

- Very context-specific!
- Two main options:
  - Replacement and avoided cost approaches
  - Contingent valuation (Willingness to pay)
- In InVEST: retention is calculated using a reference scenario of **bare soil**
  - $Retention = Export_{\mathbf{bare\_soil}} - Export_{\mathbf{current\_land\_use}}$





In practice

MODEL INPUTS/OUTPUTS

MODEL INPUTS

Climate

Rainfall erosivity

Soils

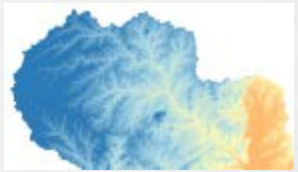
Soil erodibility

Land Use/Land Cover

Crop factor and Practice factor (retention attenuation)

Watersheds

Main and sub-watersheds for point of interest



Topography

DEM, Threshold flow accumulation

Economic

Dredging cost, treatment cost

MODEL INPUTS
DATA SOURCES

Climate
Rainfall erosivity

References in User Guide

→ Erosivity maps! (USGS)
Rain gauges (relationships between precipitation and erosivity in the literature

Soils
Soil erodibility

→ Harmonized World Soil Database
SOTER
SSURGO (US)

Land Use/Land Cover
Crop factor and Practice factor (retention attenuation)

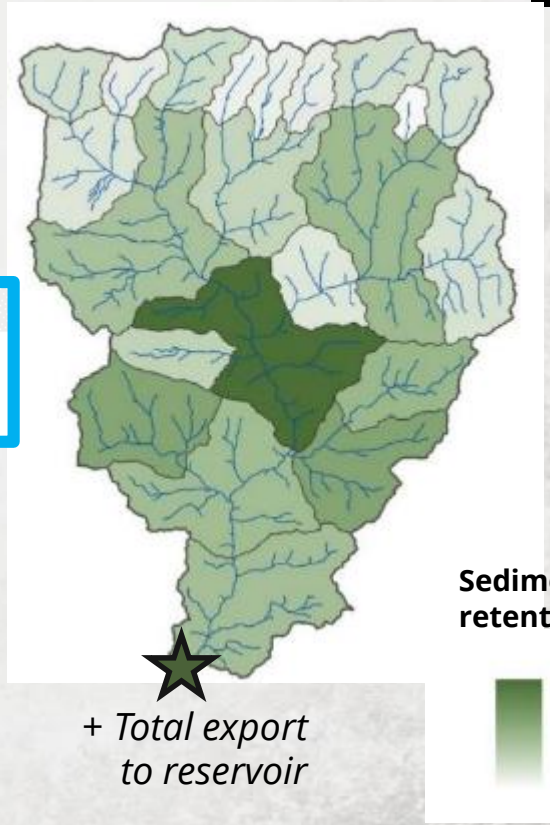
→ MODIS (NASA)
Global Land Cover Facility
NLCD (US-EPA)

MODEL OUTPUTS
MAIN OUTPUT FOLDER

- Shapefile with attribute table (for each subwatershed):

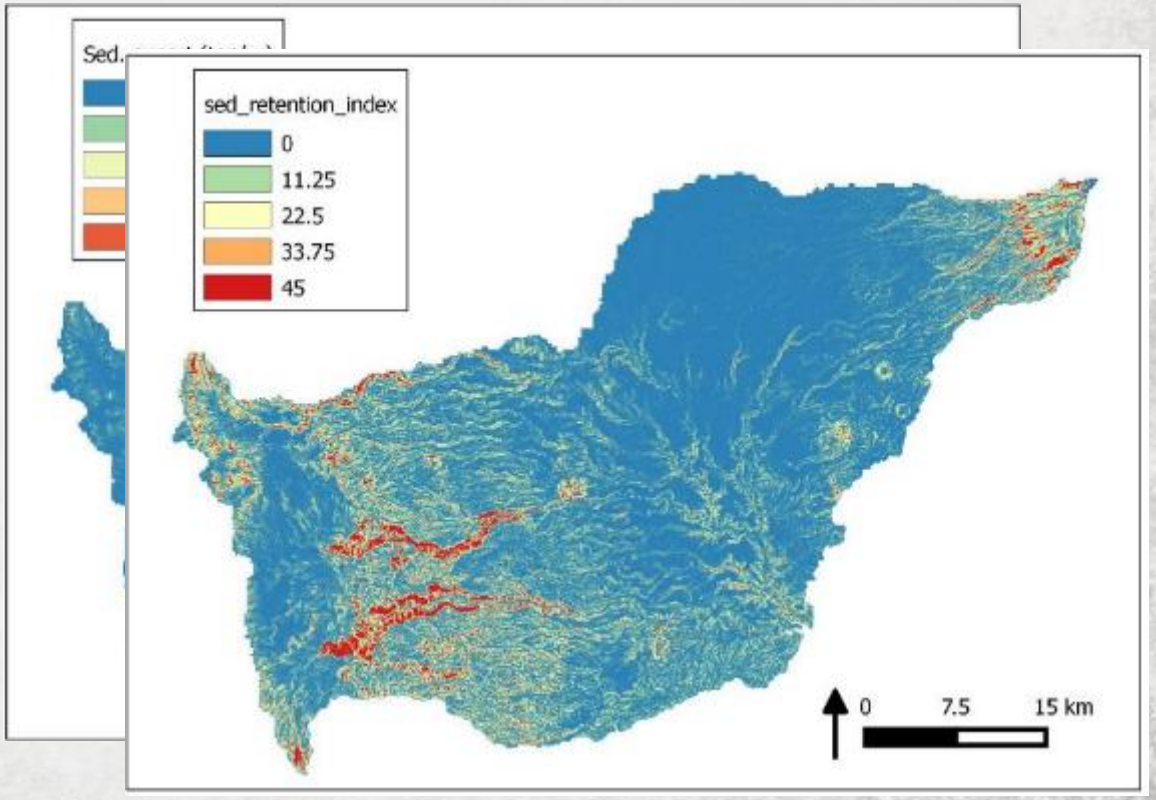
Name	ws_id	subws_id	Area_km2	sed_retent	sed_export	usle_tot
Sagana	1	1	2050	168555021.39...	8949835.8121...	100331790.84...
Up_hydro	2	2	1452	98877762.077...	4606155.1569...	52748729.642...
Gura	3	3	108	12718757.728...	514065.29002...	6769660.2423...

  - Sediment export (ton/yr)
  - Sediment retention (ton/yr)
    - $Retention = Export_{bare\_soil} - Export_{current\_land\_use}$
  - Soil loss (USLE) (ton/yr)



MODEL OUTPUTS
MAIN OUTPUT FOLDER

- Rasters:
  - Sediment export (ton/pixel)
  - USLE (ton/pixel)
  - Sediment retention **index**



LIMITATIONS

- Considers only **one type of erosion** (sheetwash/rill): no consideration of gully erosion, landslides, etc.
- Requires calibration data to increase confidence in quantitative exports (relative differences are better captured)
- Valuation methods are highly contextual (e.g. treatment type, local regulations)

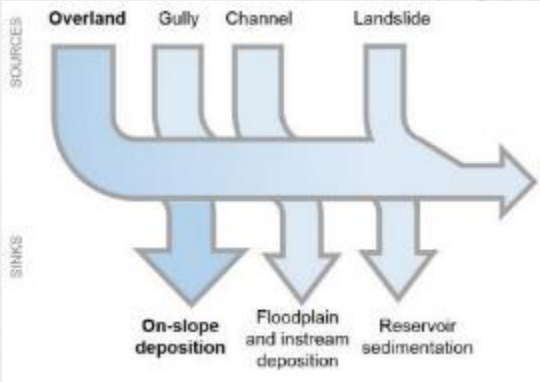
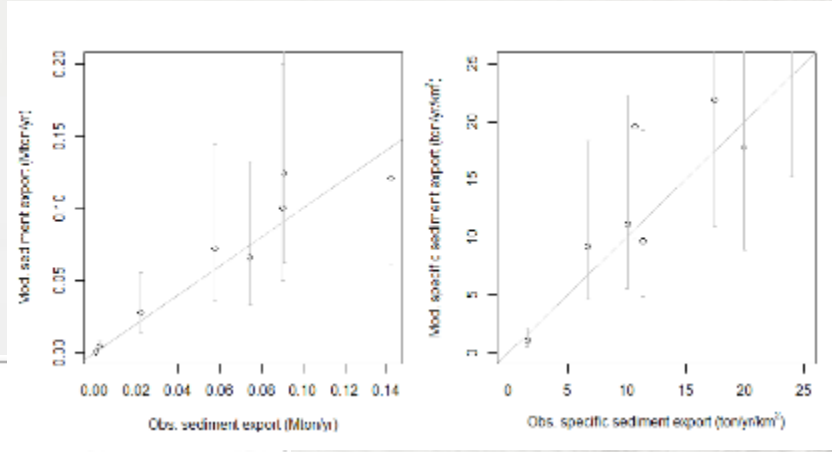


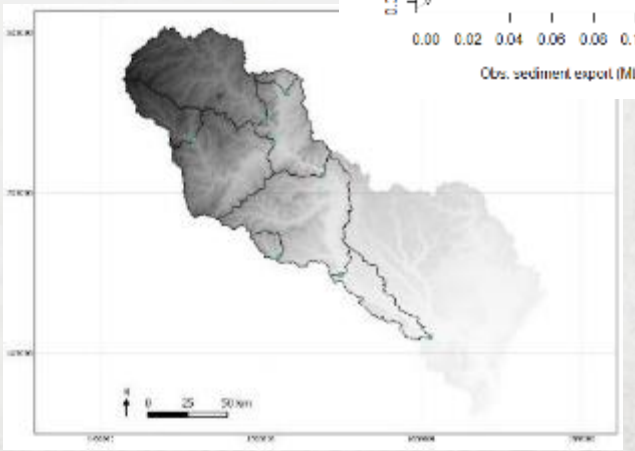
Photo credit : Alain Hamel

MODEL TESTING

- Sensitivity analyses
- If observed data is available:
  - Model calibration
  - Testing of model performance for predicting land use change
    (need several gauges)
- Eg. Cape Fear basin



(Hamel et al., in review)



QUESTIONS?