Water Lives
new scientific horizons for biodiversity and water policy

Impacts of climate change and land use on freshwater ecosystems
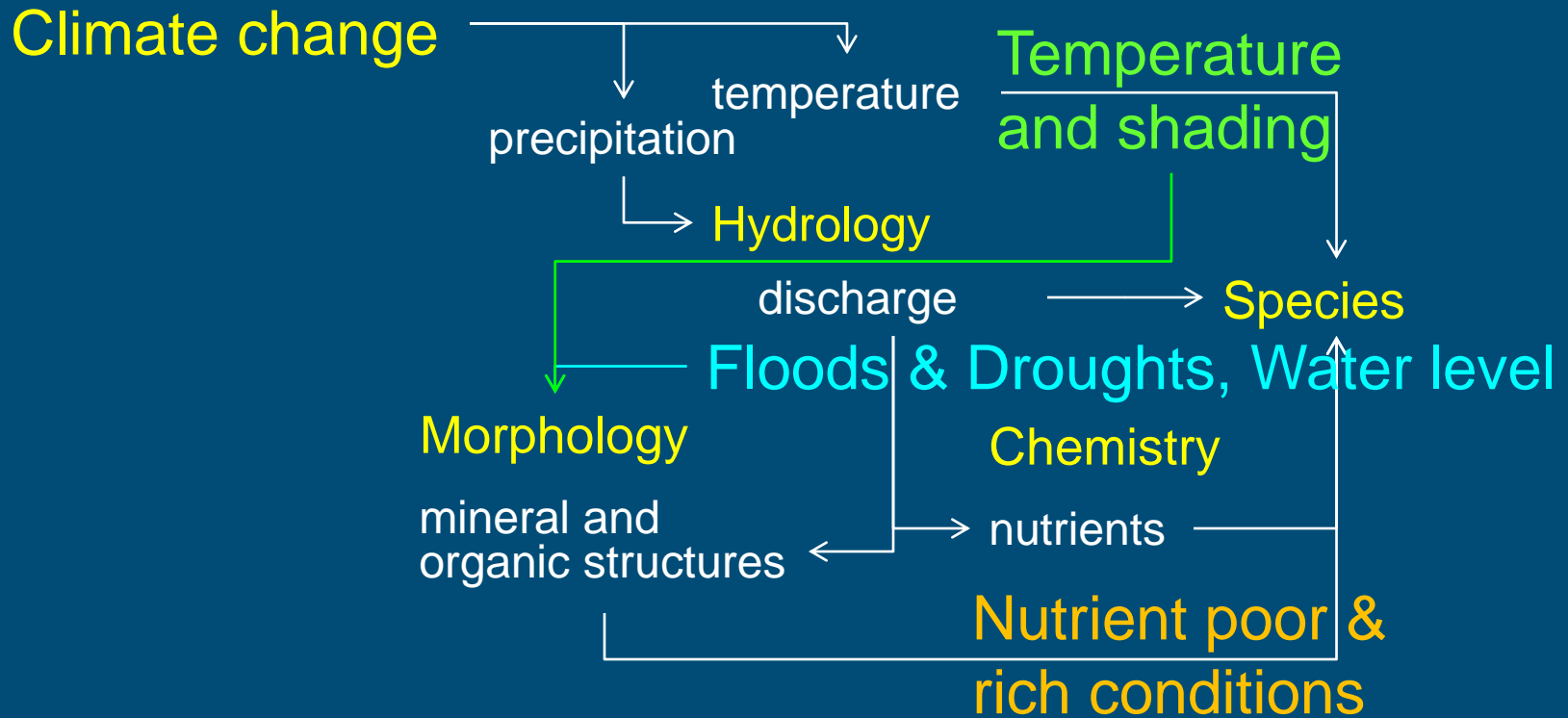
REFRESH partners

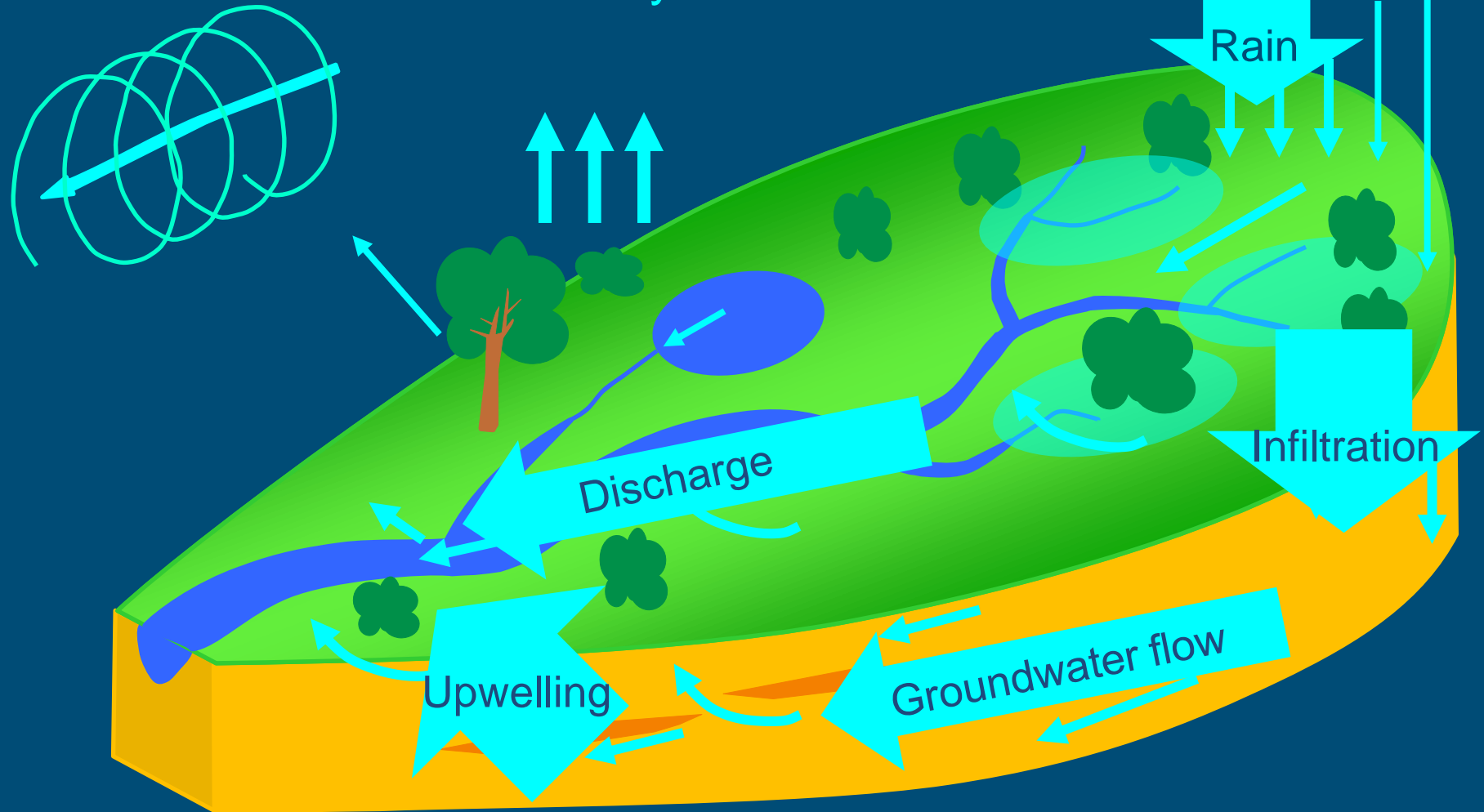*Piet Verdonschot*   *piet.verdonschot@wur.nl*

UNIVERSITY OF AMSTERDAM

IBED

Group of Aquatic Ecology and Ecotoxicology

Freshwater Ecology Group

ALTERRA
GREEN WORLD RESEARCH

WAGENINGEN UR

Key factors

Climate change

temperature

precipitation

Hydrology

Temperature and shading

discharge → Species

Floods & Droughts, Water level

Morphology

mineral and organic structures

Chemistry

nutrients

Nutrient poor & rich conditions

The engine: hydrological cycle

Natural flows

Flow and water level stability

Rain

Infiltration

Discharge

Upwelling

Groundwater flow

Hydrological cycle

Current flows

Flow and water level instability   AND   > nutrient flows

> changes in morphology

Brown flows
- urban
- industry
- agriculture

Green flows
- aquatic & terrestrial biodiversity

Blue flows
- ground water
- surface water

Hydrological cycle

Climate change

> Flow and water level instability

rain

Temperature

droughts   droughts

Brown flows

Green flows

floods

floods

droughts

+

> nutrient flows

Blue flows
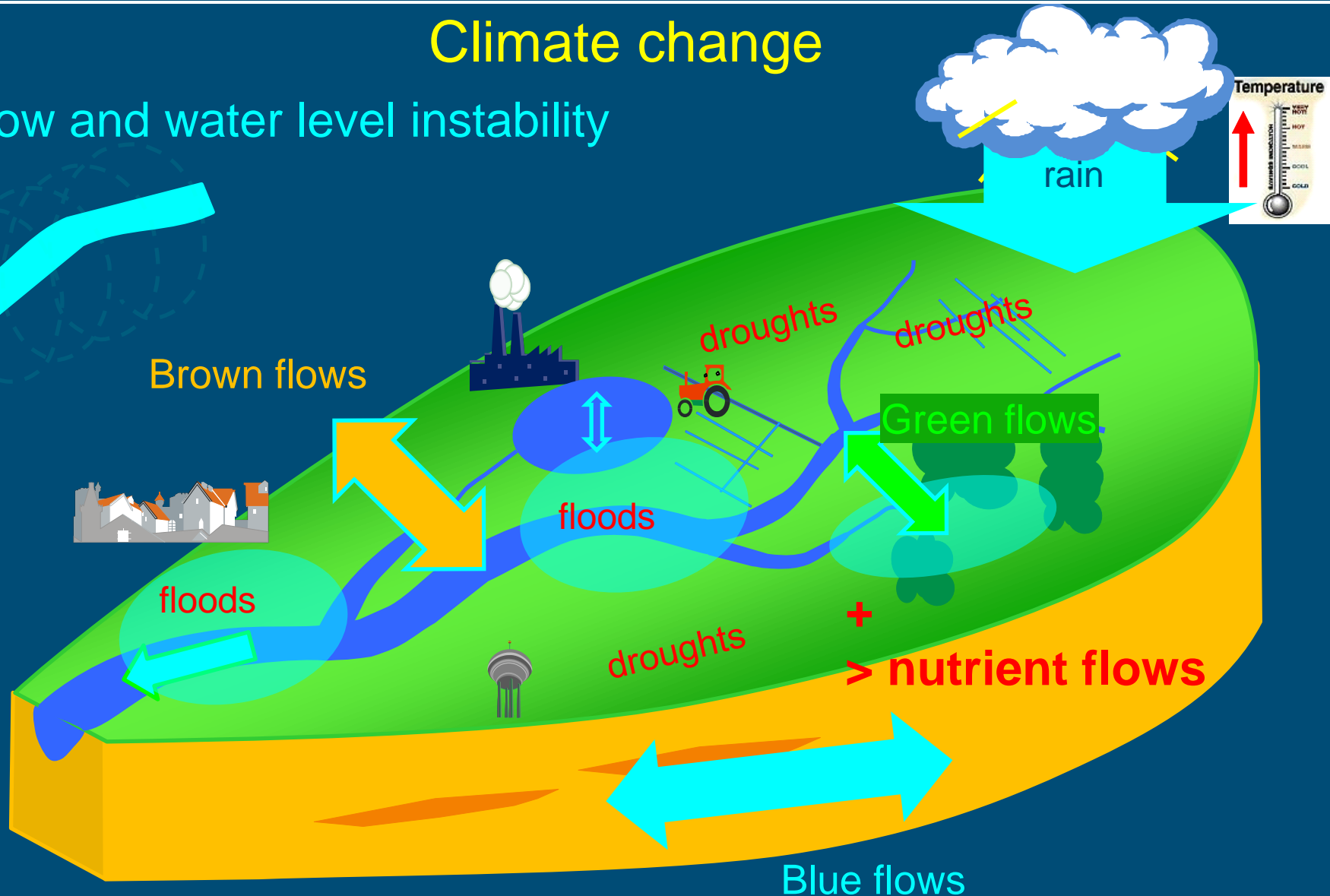
Approach

Field experiments along the Atlantic climate gradient

	Rivers	Wetlands	Lakes
• temperature	x	x	x
• floods/droughts	x	x	water level
• nutrients	x	x	x

Atlantic climate gradient
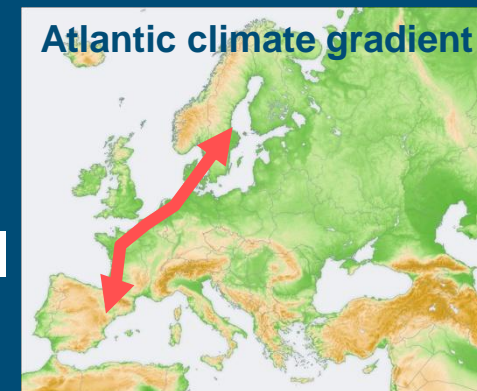
Desk research with reviews / existing data analysis Europe

- thresholds, reference conditions

- vulnerability assessment, indicators

- mitigation, adaptation, restoration

Major conclusions

Land use > Climate change

Temperature
- Shading improves WFD ecological status and mitigates climate and land use change by lowering temperature and increasing naturalness (1 km = -2.5^{0}C and community recovery).
- Current nutrient measures in lakes compensate future increase by rising temperatures.
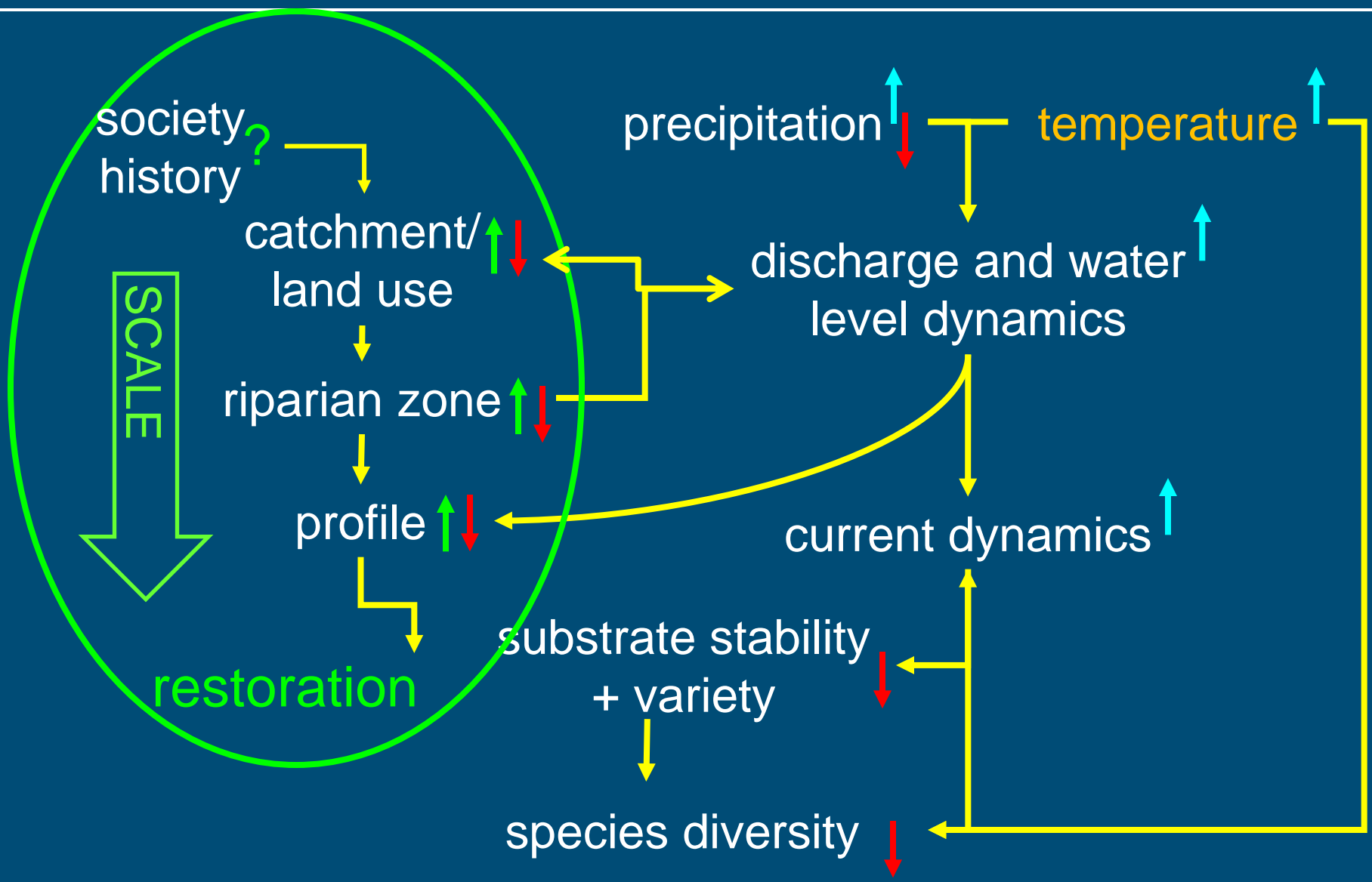
Nutrients
- Temperature increase => > eutrophication in lakes (sediment releases) and rivers.
- Eutrophication => > lake algae blooms, > fish, and masks shading in rivers.

Major conclusions

Hydrology

- River drought is fast and disastrous.
- River stagnation should be avoided to last > 1 week.
- Eutrophied rivers effects stronger due to de-oxygenation.
- Pools do not act as refugia.

- Water level fluctuations => higher temperatures.
- => extra eutrophication.
- => more ions.

Climate and land use stress
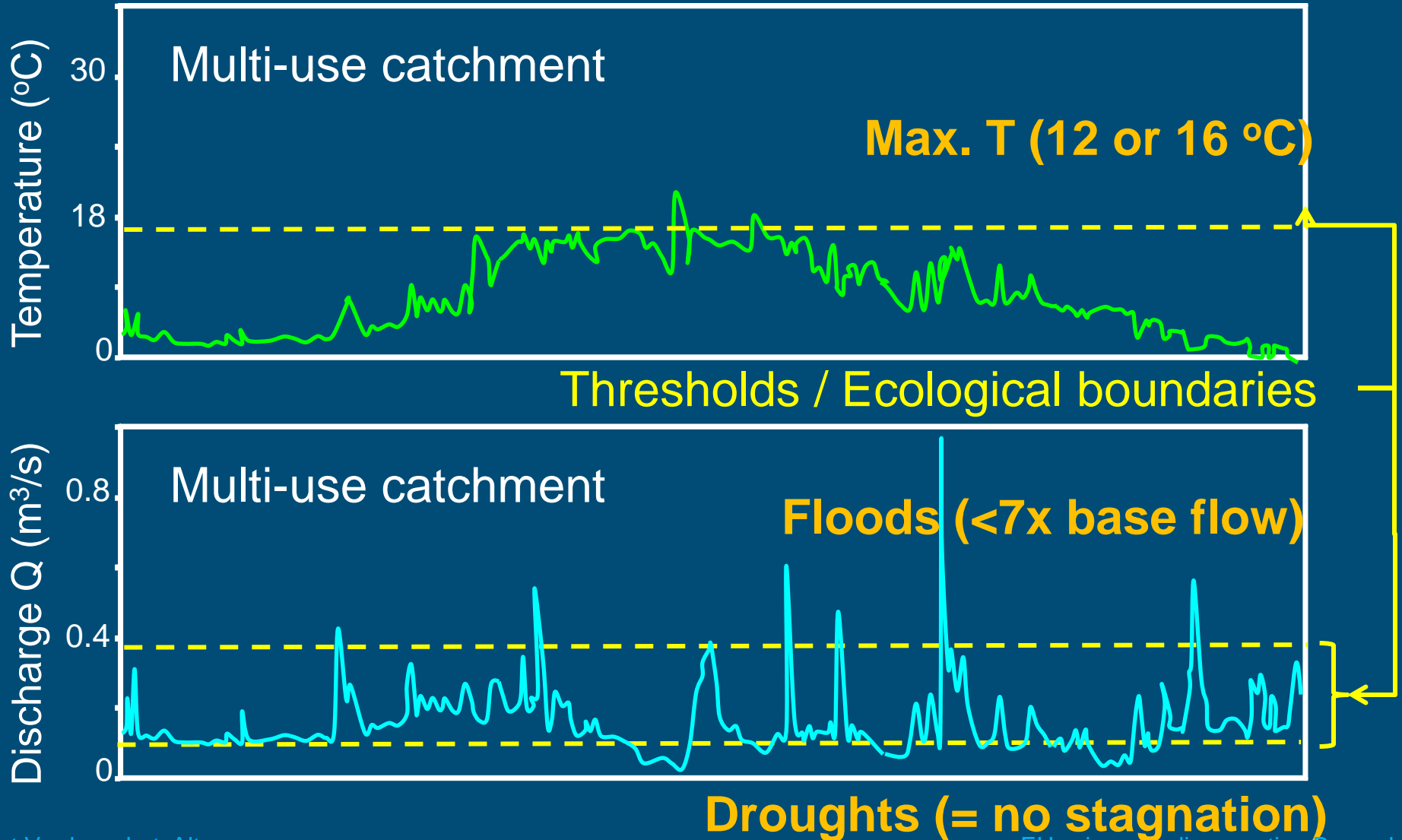
Measures

Measures

www.climate-and-freshwater.info

Table 2. Climate change adaptation labels.

colour code	colour	number of climate induced pressures	explanation
	dark green	4-5 (+++)	win-win measure
	light green	2-3 (++)	win-win measure
	pale green	1 (+)	no regret measure
	yellow	0	
	red	-	regret measure

	adaptation strategies	measures
Lakes	11	40
Rivers	15	51

Top-measures in freshwaters

- Vision on catchment infrastructure

Hydrology

- Store by infiltration
- Retain by inundation
- Retard by profile reduction

Morphology

- Develop wooded riparian zone
- Introduce CPOM or lake shore length
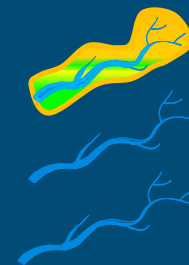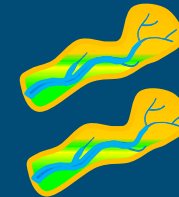- Reduce size profile (supply sand)

Floods:
max. 7 x baseflow

Droughts:
no stagnation
Reduce water
level fluctuations

buffer strips,
1000 m wooded
zone ↓5°C
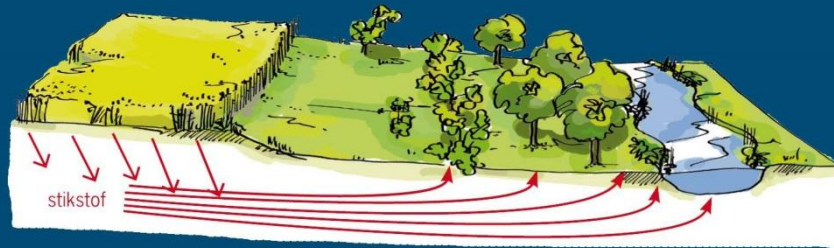littoral & substrate
heterogeneity

Top-measures in freshwaters

Chemistry

- Purify in bleu veins (chemistry)
- Separate urban flows (chemistry)
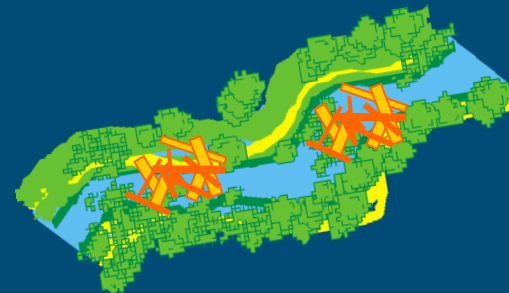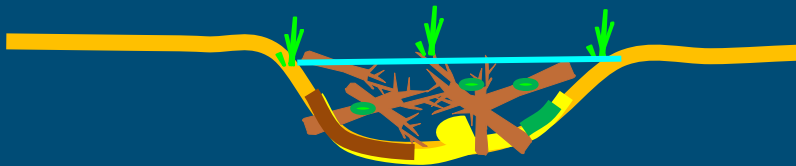
filters in veins,
no eutrophication
O_2>6 mg/l

Biology

- Re-introduce species (biology)
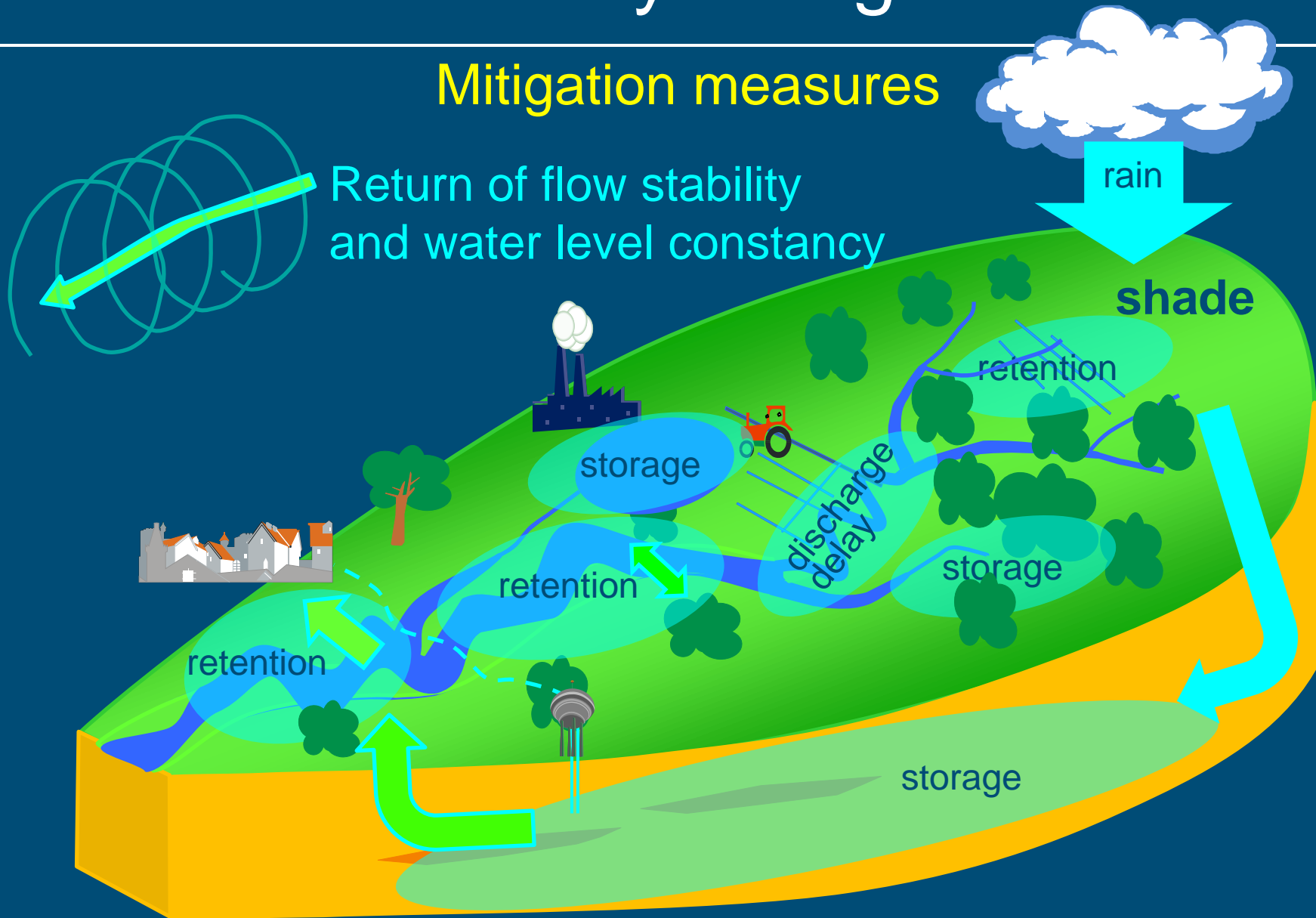- Adapt / abandon maintenance

Active
re-introduction

Catchment: hydrological flows
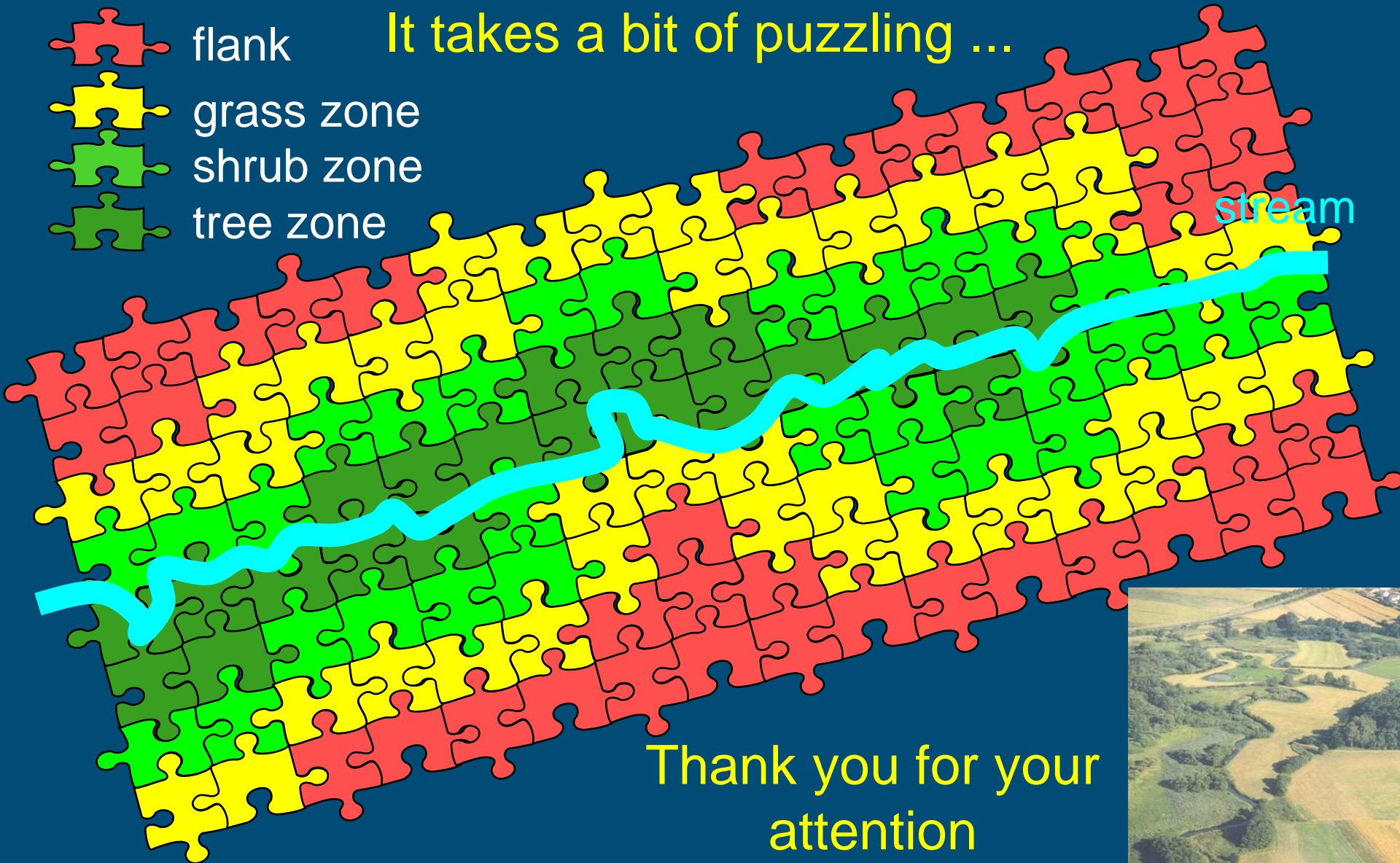
Spatial configuration

flank

grass zone

shrub zone

tree zone

It takes a bit of puzzling ...

stream

Thank you for your attention