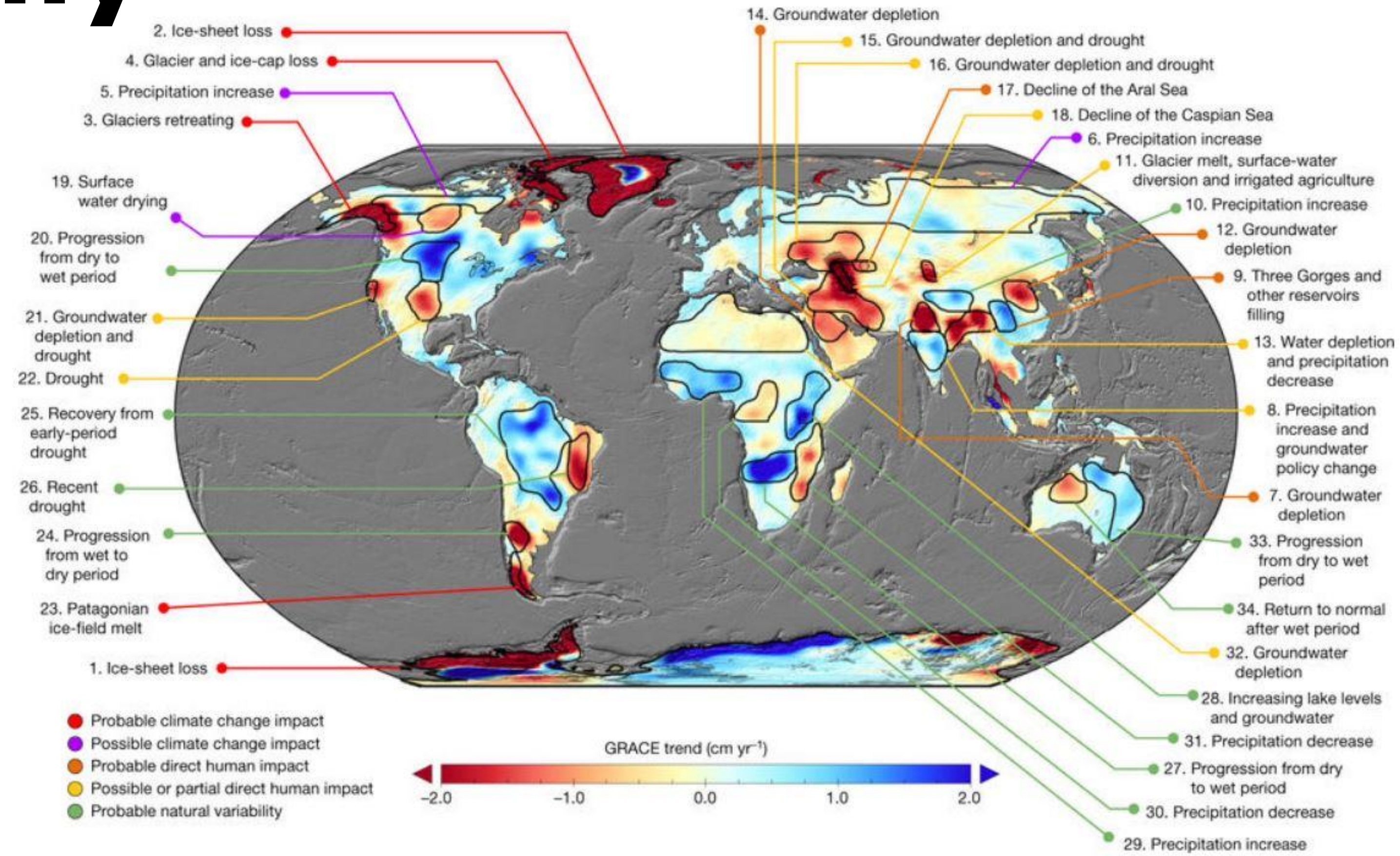
LIFE-MICACC projekt
LIFE16 CCA/HU/000115

Freshwater resources are in decline globally

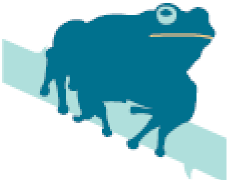
- Gravity Recovery and Climate Experiment (GRACE) satellite senses slight gravitational changes on earth
- Comparison between 2002-2016 reveals large-scale changes
- **Reason:** natural interannual variability, **climate change, or unsustainable groundwater abstraction**

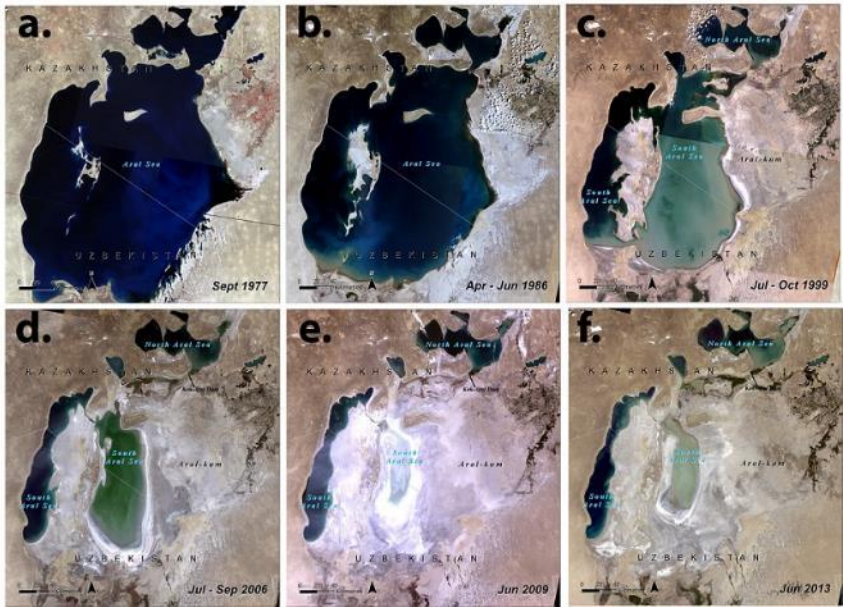


Rodell et al. (2018) Emerging trends in global freshwater availability.

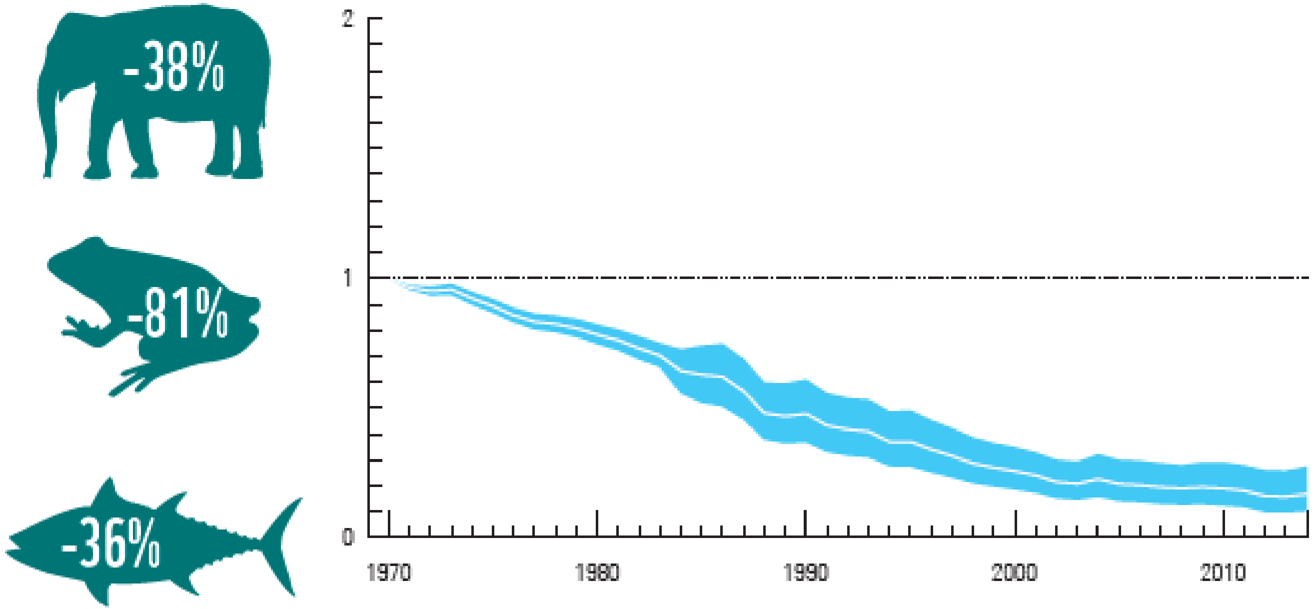
Biodiversity, and especially freshwater biodiversity is in decline globally

87% of freshwater habitats disappeared in the modern age.





The Living Planet Index: global biodiversity is declining globally, but rate is different across taxa.
Freshwater taxa are most heavily impacted. This is mostly due to **habitat destruction.**

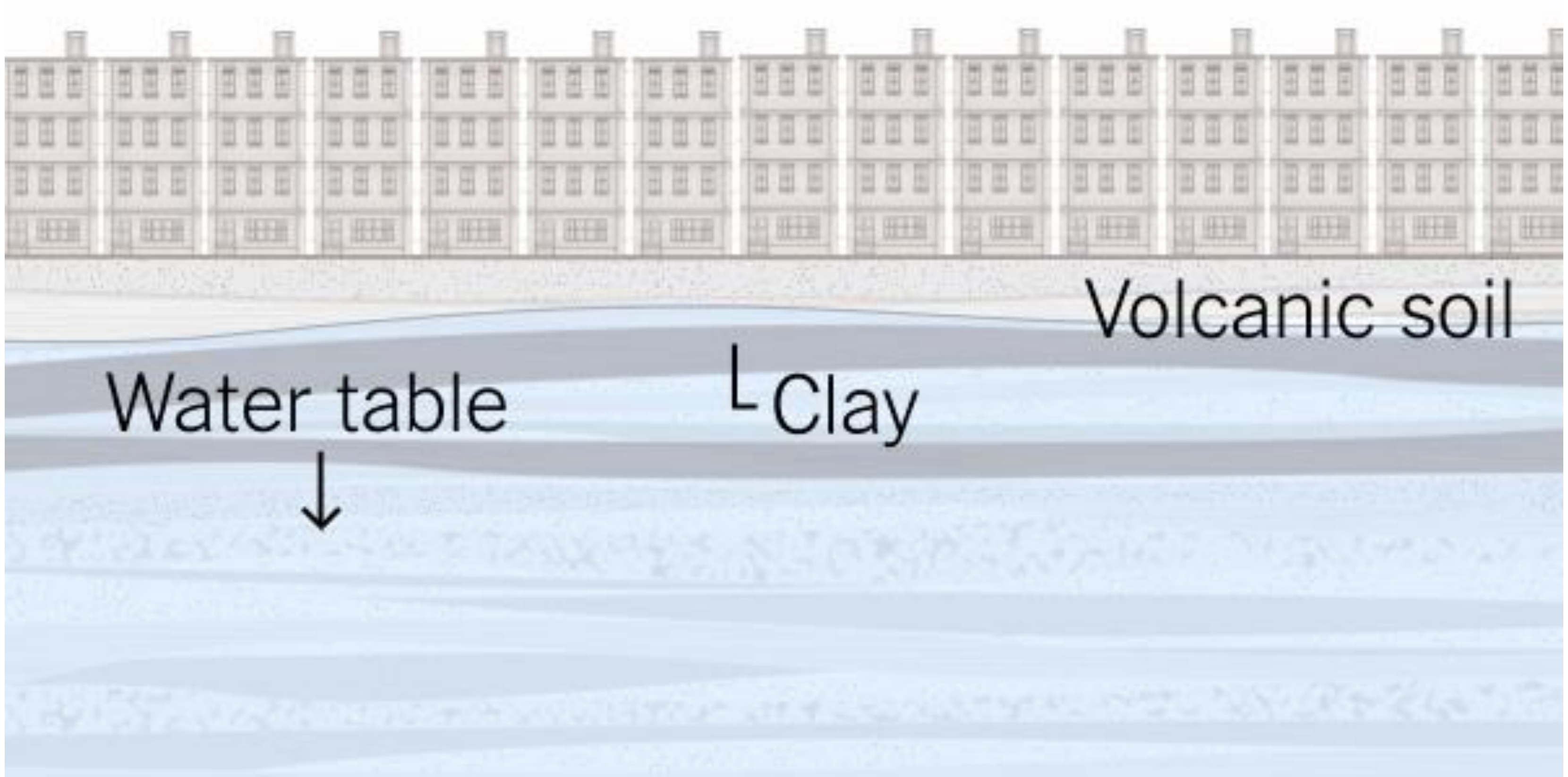


Groundwater depletion globally: Mexico City

- Built on the previous lake Texcoco, was the center of the Aztec empire
- Today it is Mexico City, home to 21M people
- Water abstraction rate is unsustainably high: water abstraction is 2x the replenishment rate
- Water-table drops 40cm / year

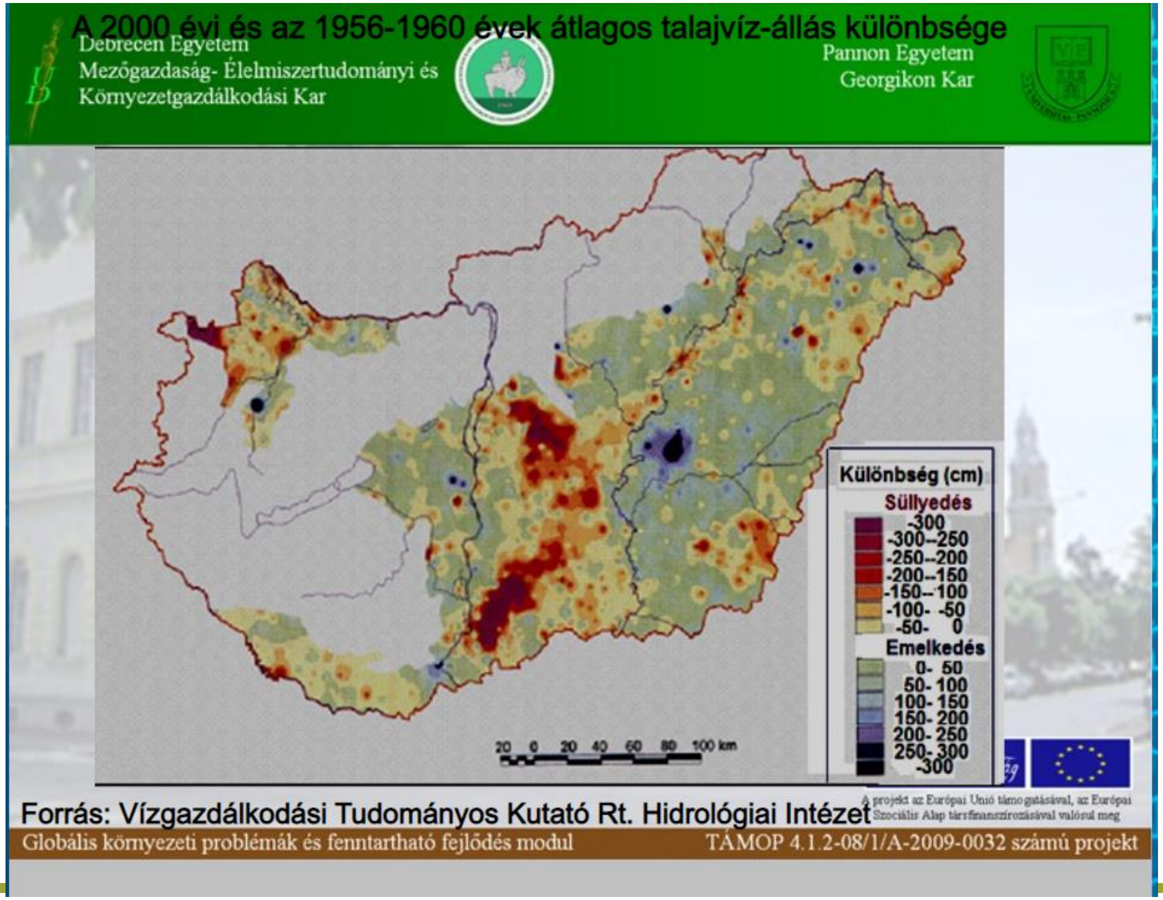
Groundwater abstraction and sinking cities

- Subsurface water abstraction is too high
- There is a layer of clay beneath the city
- As the clay becomes dessicated, it fratrues and compresses, and the city is sinking
- Fratured clay (aquitard) layer lets sewage penetrate to valuable clean belowground water→ contamination of water resources
- Rate of sinkgin can be **30 cm per year.**
- The city sank an estimated **10m in the past 60 years.**



Groundwater sinking in Hungary

- Not everywhere, but some regions are heavily impacted
- Sand ridge between the Danube and Tisza rivers, and of Maros river are worst impacted



Hydrology overview of Hungary

Hydrology:

Mostly basin like

Annual percipitation: 500-750 mm

Potential ET > precipitation

Inflow < Outflow

Water management:

~25% of country former floodplain

Regulated rivers

Dykes: 4200 km

Drainage canals: 40,000 km

Problems:

90% reduction of active floodplain

Sinking groundwater table

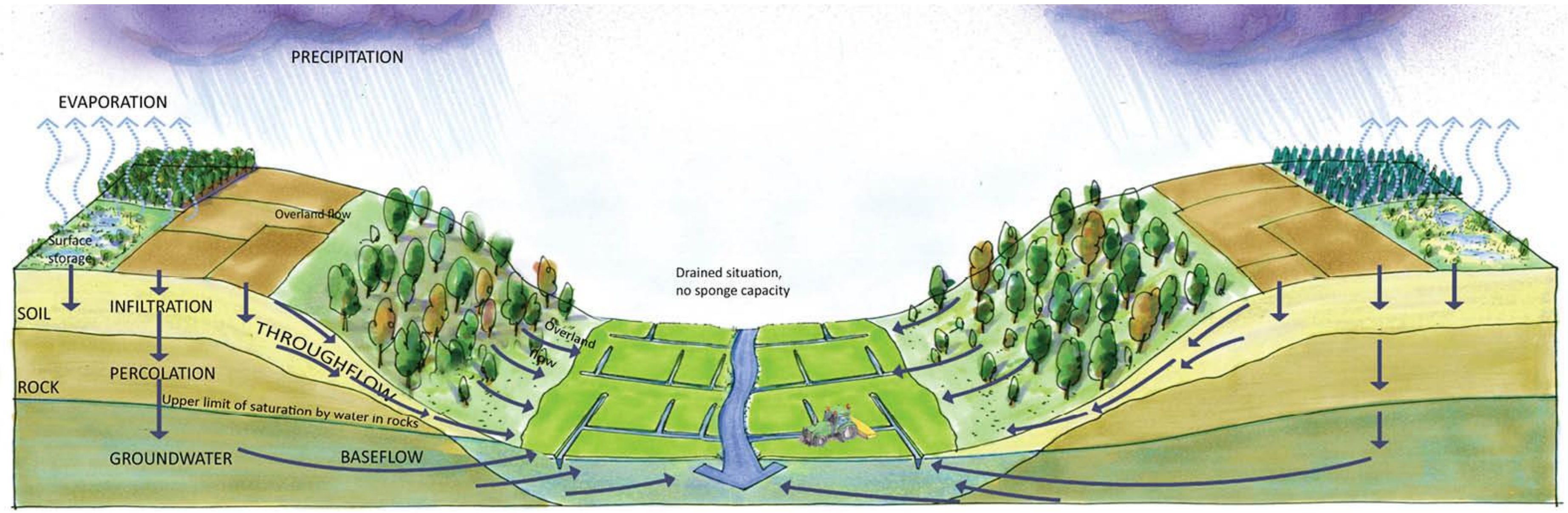
Droughts

Floods, inland water logging

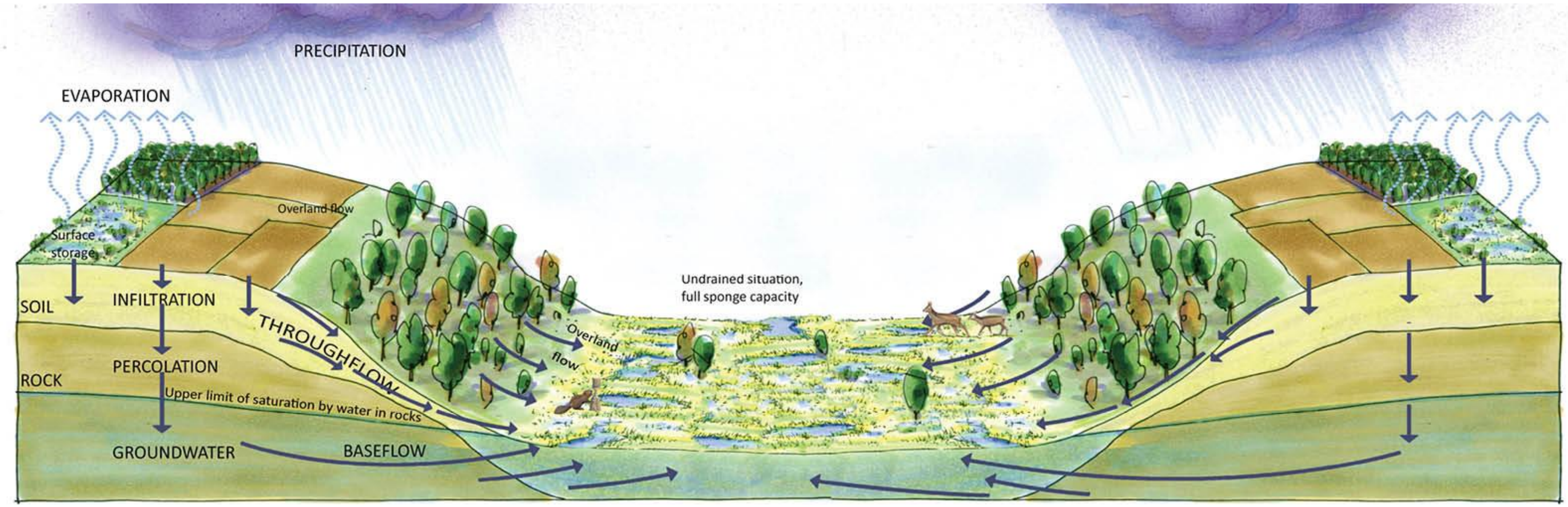
200 ys

Large river valleys

Current: Man made drainage, fast water discharge



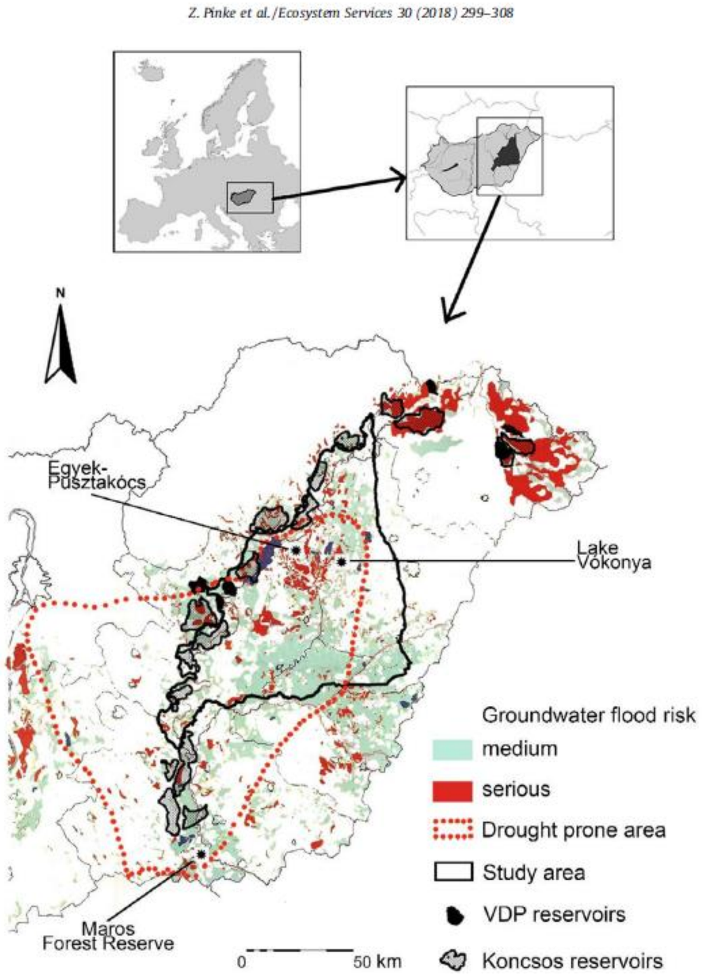
Future: slow **infiltration** and discharge



Major obstacle: current form of land use, agricultural land conflits with water retention.

What could be the results in large river valleys?

- Major barrier to floodplain restoration in Hungary: land use system
- Arable land does not tolerate flooding.
- Other, seemingly less profitable land uses are less frequent due to lower economic returns: orhards, grassland, wetlands.
- Study area: upper tisza flooplains, 9331 km2
- Half of study area highly prone to Groundwater flooding, 30% Hungary's most drought prone lands are here



Pinke et al 2018: Developing an integrated land use planning system on reclaimed wetlands of the Hungarian Plain using economic valuation of ecosystem services

Real costs and benefits

Costs of farming on flood-prone areas

- Cost of protecting land from groundwater flooding: 37.2 EURO/ha/year between 1999-2005
- Only includes cost of pumping and temporarily heigthening flood protection dykes→ underestimate

Felső-Tisza híradó 2021. március

18. kép. Konténerzsákok szállítása helikopterrel a tarpai felső szakadáshoz (2001. március 9.) (Fotó: Vincze Zoltán)

31. kép. Szivattyúzás a tarpai hegy lábánál (2001. március 9.) (Fotó: Vizy Zsigmond)

Unmonetized benefits of wetland and floodplain forest restoration:

- Foregone cost of damage done by groundwater flooding (365,9 euro/ha/year)
- Shallow ecological reservoirs with 0,5m water depth: can replace investment cots of 2150 euro / ha
- Carbon sequestration
- Biodiversity

VDP flood reservoirs vs. shallow ecological reservoirs

Cigánd-Tiszakarád flood protection reservoir

Investment cost / m3 of retained water: 0,28-1,59 EUR
+ farmers must be compensated every time it is used

Egyek-Pusztakócs restored wetlands

Restoration cost / m3 of retained water: 0,04-0,08 EUR
+ nature protection and C sequestration cobenefits

Taking into account flood protection costs

Areas suitable for groundwater retention River-Basin Management Plans (Zone1), (high vulnerability, or moderate vulnerability + protected or prone to salinization)

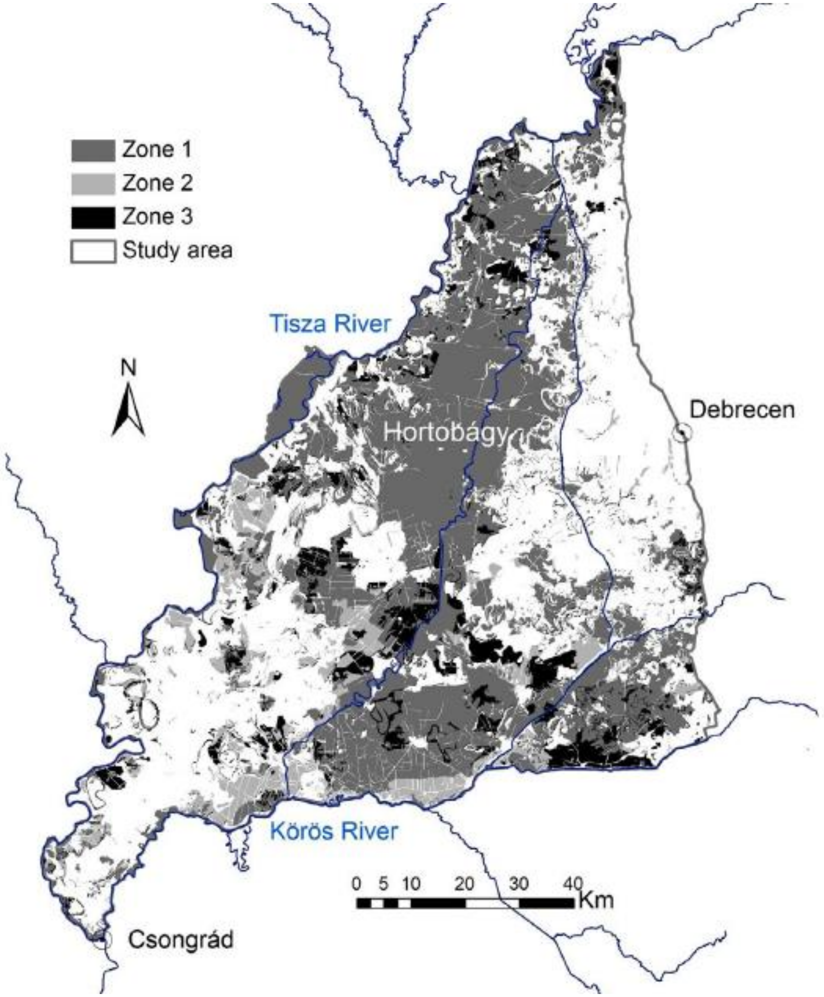
Areas suitable for agricultural land that is also suitable for water retention based on ecological and economic aspects (Zone2)

Areas suitable for reforestation (Zone3)

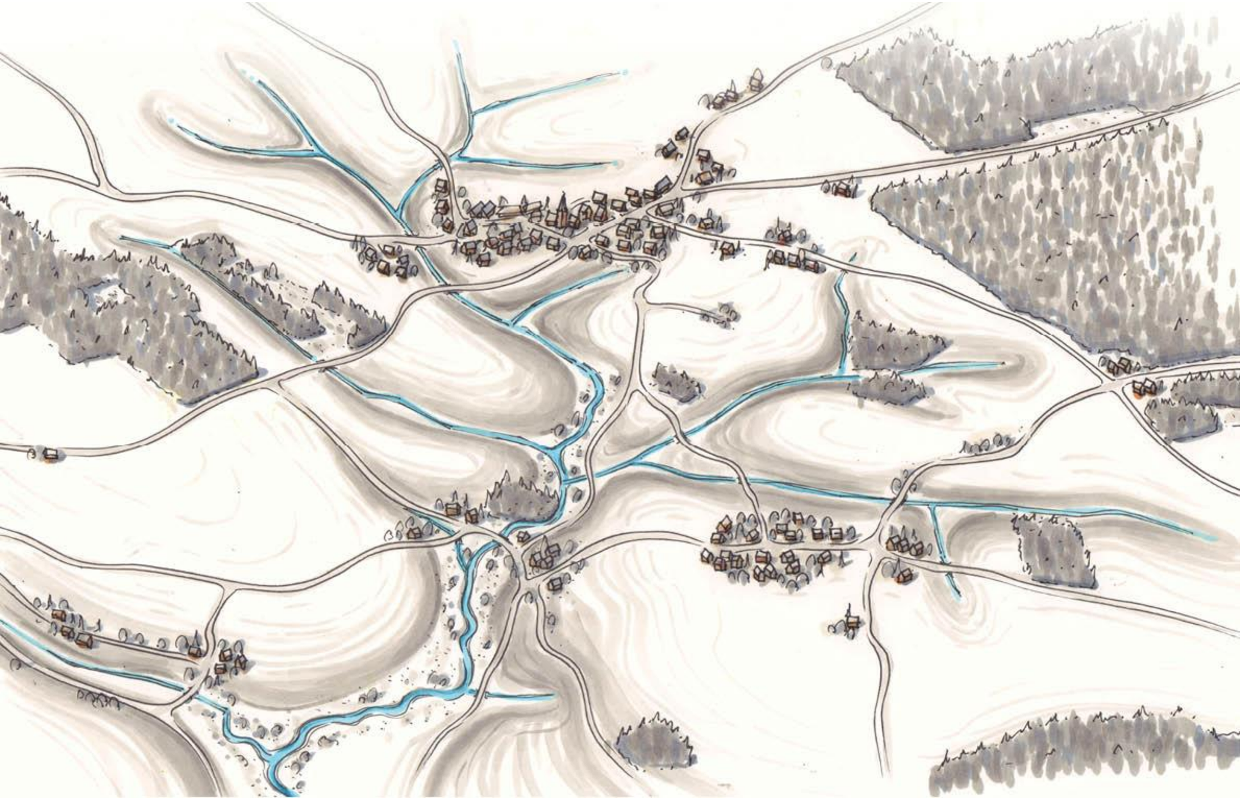
- **Economic valuation suggests strong economic argument for land use change on 52.1% of the study area**

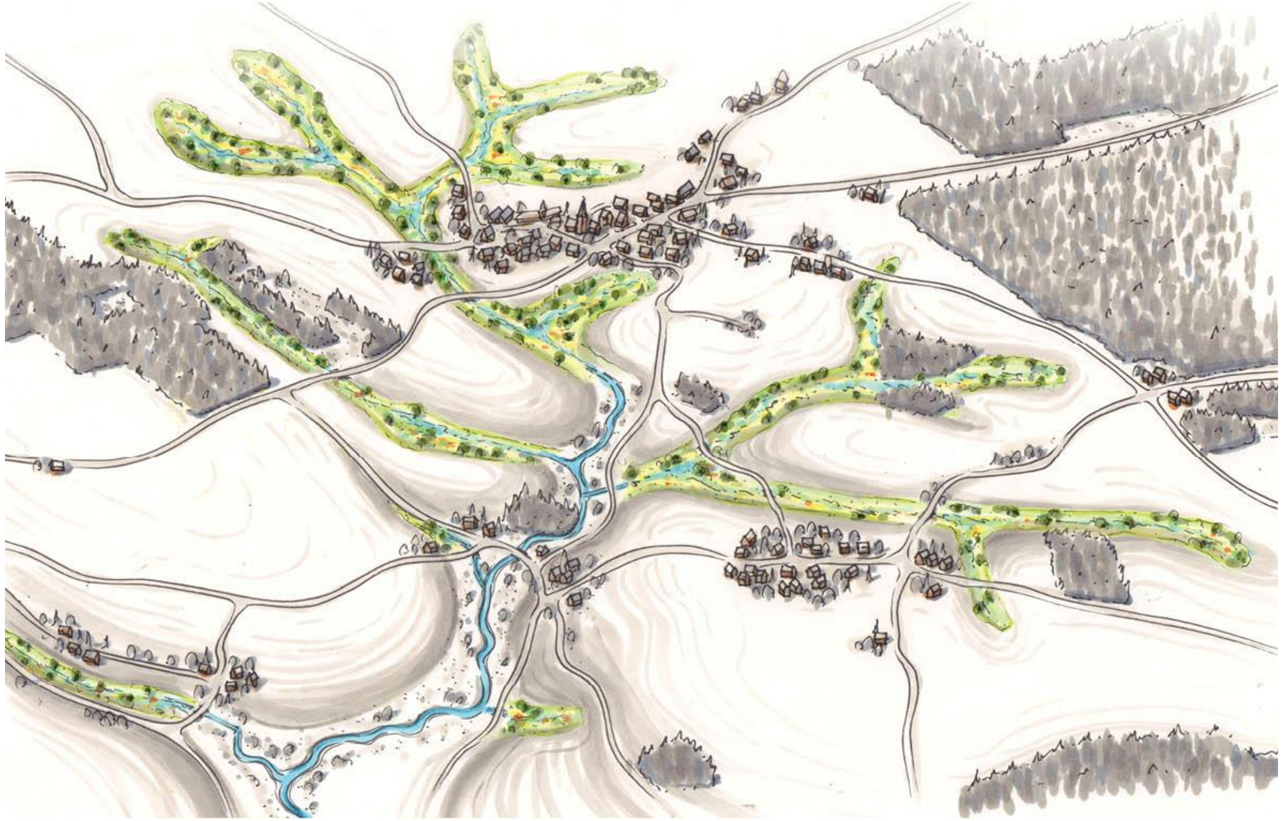
Net profitability of land use categories:

grassland (20,7EUR/ha) > arable land (50.7EUR/ha) > orchards (150.9EUR/ha) > **wetlands (380.6 EUR/ha)**



Small streams





Results on small streams

1. Upstream areas contributed the largest relative amount to the recent peak flood levels

2. Up to **35% peakflow reduction** possible on local scale when restoring natural sponges

3. **10 – 30 % higher baseflow** in dry periods

4. Water quality improvement: Retention of nutrients in upstream areas

5. Farmland to Wetland: 20 ton CO_2 reduction captured per acre per year

Small scale local solutions to global problems: water retention at the Polish National Forests

It is estimated that the unit retention capacity of the water infrastructure (small retention, forest reservoirs, fire protection reservoirs) on the areas under the management of the State Forests is more than 100 million m^3 in total.

SWR in the State Forests in numbers					
	years				
	1998-2005 (finished)	2007-2013 (finished)		2014-2022 (on-going)	
	countrywide	mountain SWR	lowland SWR	mountain SWR	lowland SWR
number of Forests Districts	-	**230**		**160**	
number of SWR objects	**3340**	**3553**	**3644**	**1086**	**1181**
volume of stored water	**8,4** million m^3	**1,5** million m^3	**42,7** million m^3	**0,4** million m^3	**2,1** million m^3
costs covered/ planned*	**9,0** million EUR	**43,2** million EUR	**44,0** million EUR	**48,1*** million EUR	**54,6*** million EUR

Slides from Marek Gozdzik, Lasy Panstwowe, Poland

RESERVOIRS FOR SURFACE RUN-OFF IN HILLY AREAS

Slides from Marek Gozdzik, Lasy Panstwowe, Poland

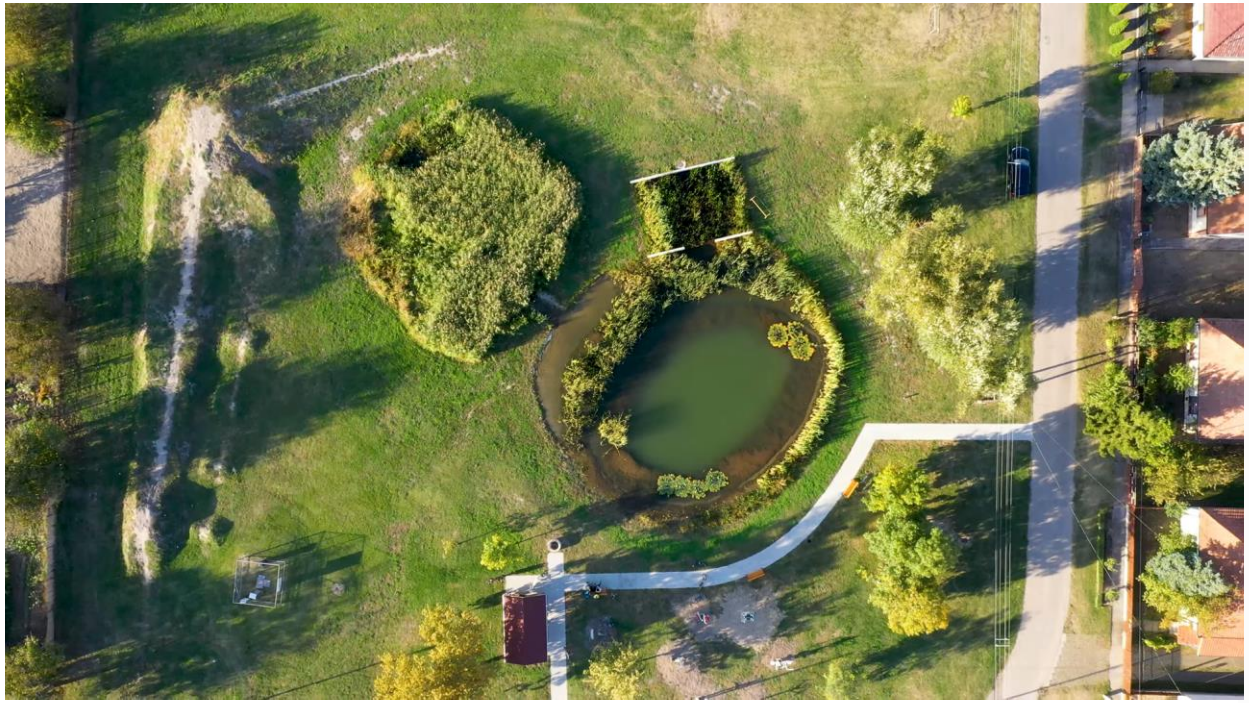
RESERVOIRS FOR SURFACE RUN-OFF IN LOWLAND AREAS

Świebodzin Forest District

Ostrów Mazowiecka Forest District

Slides from Marek Gozdzik, Lasy Panstwowe, Poland

Small scale local solutions to global problems: LIFE MICACC



Thank you for your attention!