Financial benefits from the implementation of nature-based solutions in the settlements – a case study on a catchment of Lake Velence

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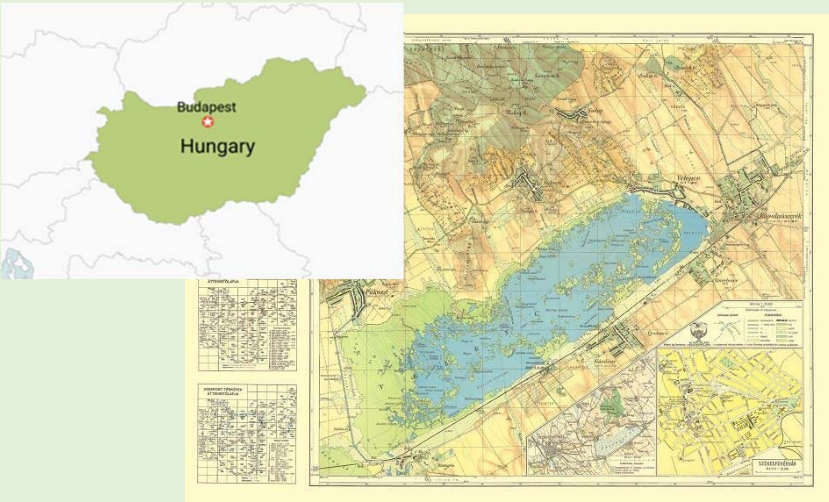
Sharing is encouraged

Changing landscape, land use



Infrastructural developments (1960s-’70s)

highway, railroad, artificial shoreline (concrete wall and ripraps)

Frequented tourist area, urban developments

Moving out of the nearby big cities (2010s)

-> changing landscape, increasing water demand, larger runoff

Land use and climate change, water deficit (2020s)

vineyard/orchard, severe drought, water shortage on catchment

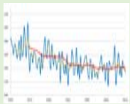
Benefiting from climate change

Nature-based solutions

The catchment with Lake Velence

Changing land use

Area transformation



Climate and demography

Water retention measures

willingness and possibilities

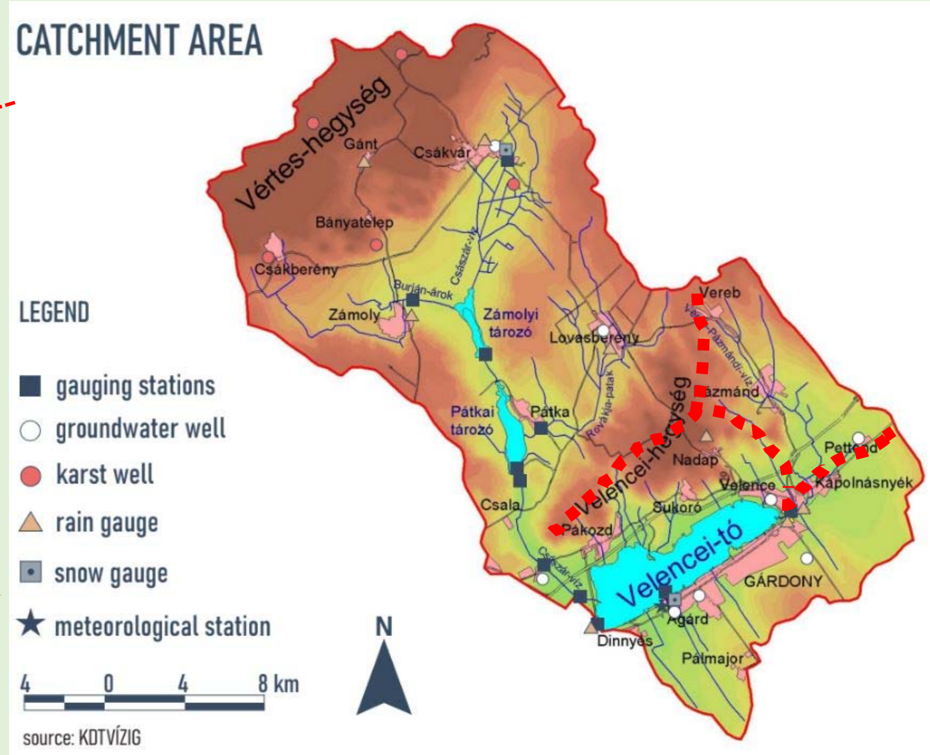
Costs, benefits, opportunities

1 pond + 1 hectare = + 20% GDP (worth it?)

Thank you for your attention!

The research presented in this PICO presentation was carried out within the framework of the Széchenyi Plan Plus program with the support of the RRF 2.3.1 21 2022 00008 project.

Site description – catchment



Catchment: ~ 600 km^2
3 sub-catchments (% is based on rainwater)
- Császár-creek (North/West) ~ 60%
- Southern flatland (South) ~ 20%
- Vereb-creek (North-East) ~ 20%

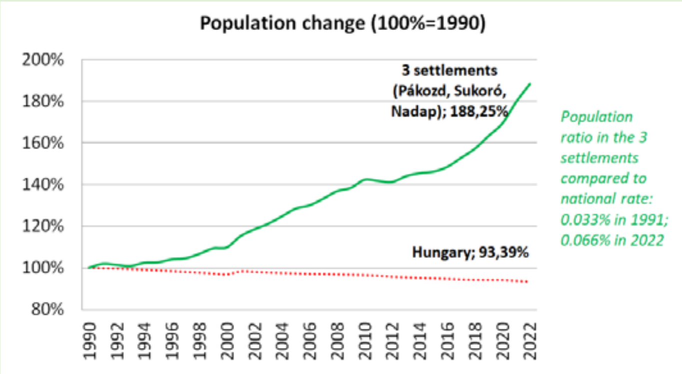
Lake surface area: ~ 25 km^2
Average depth: 150 cm
Water volume: 37.5 x 10^6 m^3

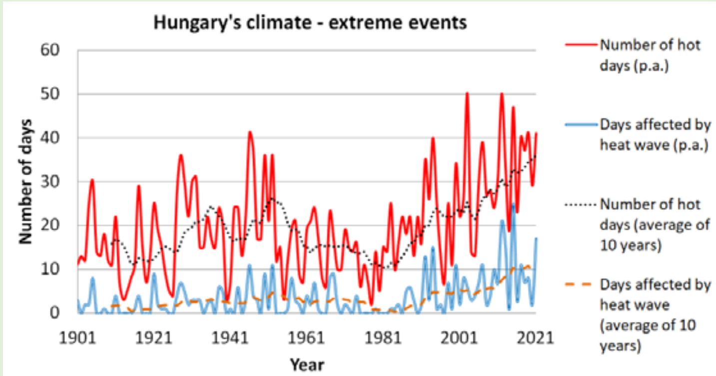
Water balance (1986-2020)

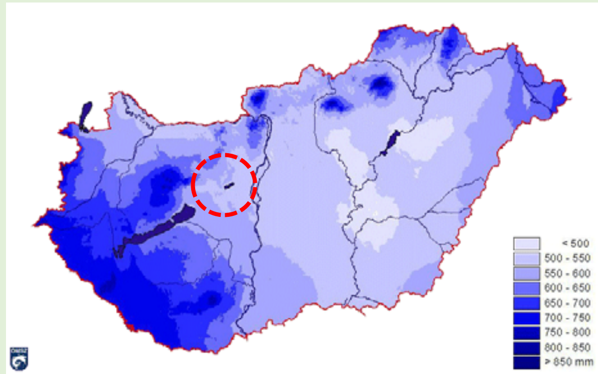
- rain over the lake	+ 54.8 cm
- inflow from catchment	+ 32.3 cm
- inflow from reservoirs	+ 14.9 cm
- evaporation	- 91.3 cm
- drainage (outflow)	- 11.7 cm
Total (annual average):	- 1.0 cm

250,000 m^3 water ≈ 1 cm of lake water level

Site description – climate and demography





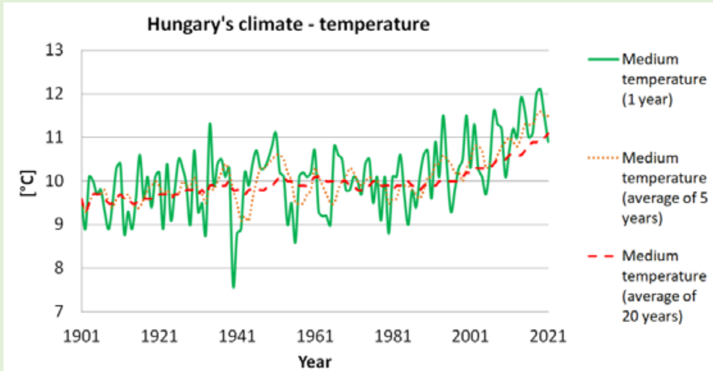


Rapid population growth

- increasing water demand
- infrastructure development
- landscape change

Changing land use needs

- local water shortage



Average precipitation
(for years 1986-2021)
min.: 295 mm,
max.: 973 mm,
avr.: 542 mm
(with 135 mm st.dev.)

Climate prediction: **evaporation + 8%** by 2050 (compared to avr. 2000-2020)
Result: additional 7 cm water level loss from the lake annually

Nature-based solutions

Population growth
- > grey infrastructures spread
- > decrease of green areas.

Result: risk of flash floods increases
drought problems rise
deterioration of human living space
decreasing ecosystems

Negative to natural and social environment.

Grey infrastructures cannot sufficiently fulfill in the changing conditions (e.g., flash floods, heat island effect). Nature-based solutions are sustainable and can provide appropriate, resilient response.

Source: nwrm.eu

Retention (wet) pond
Store runoff
Flood risk reduction
Filtration of pollutants
Water storage
Prevent surface water status deterioration
Prevention of biodiversity loss
Reduce erosion and/or sediment delivery
Create aquatic habitat

Aim:
Drought protection / watering plants
Flood protection / reduce downstream flows
Improvement of water quality

Water retention surfaces and willingness

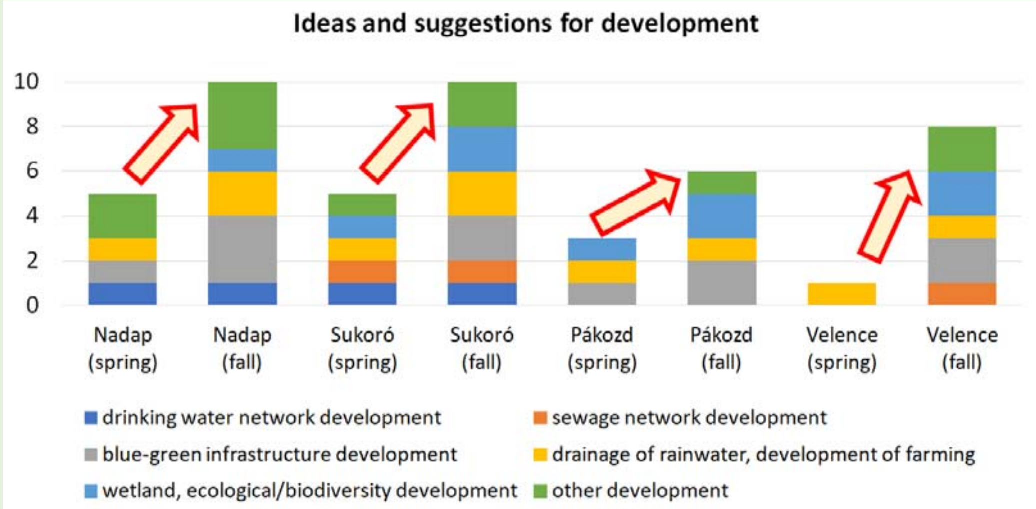
	Pákozd	Sukoró	Nadap
Public streets, main roads and sidewalks (surface in m^2)	152.753 m^2	131.368 m^2	36.074 m^2
Private sidewalks and parking lots (surface in m^2)	43.451 m^2	23.112 m^2	9.875 m^2
Houses' and public buildings' roofs (surface in m^2)	186.219 m^2	99.049 m^2	42.323 m^2
Vineyard, backyard farming, small gardens (surface in m^2)	18.000 m^2	8.000 m^2	22.000 m^2

Total retainable rainwater annually: ~ 3.8×10^5 m^3

$$ERV = \sum_{i=1}^{4} A_i \cdot f_i \cdot p_{est} \cdot ER_i \cdot RET$$

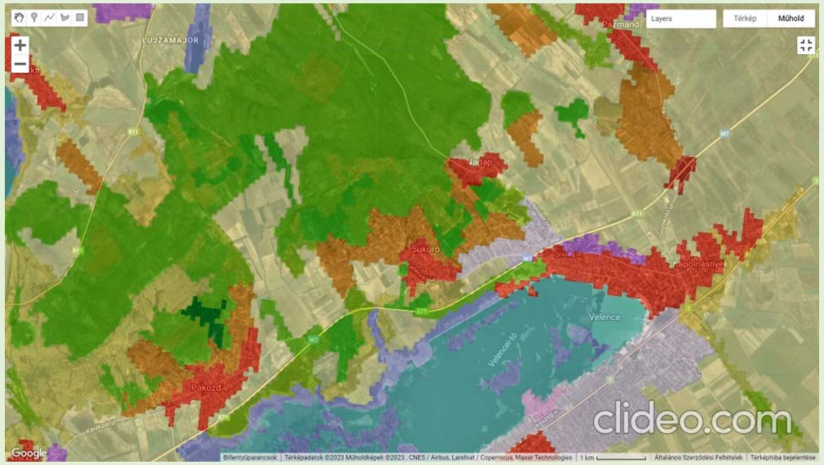
$$REP = \sum_{i=1}^{4} IW_i \cdot FTO_i$$

possible rainwater volume (ERV)
runoff factors (f_i)
surface areas (A_i)
estimated precipitation (p_{est})
estimated error (ER_i)
retention proportion (REP)
implementation willingness (IW)
financial technical opportunity (FTO)



Time of survey	Questions in the survey	Request method and repetition	Approached settlements
February 2022	8 explanatory & 12 multiple-choice questions (true-false or max. 5 pre-given answers)	First invitation and request sent by e-mail. A repeated e-mail request was sent after 2 weeks.	Within catchment 11 settlements were approached, that are boundary or physically very close to the lake.
September-October 2022	16 explanatory & 43 multiple-choice questions (true-false or with given answers)	First invitation and request sent by e-mail. A repeated request during a personal inquiry.	Within catchment 14 settlements were approached only the northern "karts" region was left out.

Landscape change, land use possibilities



From 1990 to 2018

Settlement's grey area doubled -> more paved streets, more roofs, less green cover -> **runoff increased**

Profitable farming requires water retention

Area transformation: orchard and vineyard

Crop water use

$$ET_c = K_c \times ET_o$$

K_c - crop coefficient
ET_o - reference crop evaporation (grass in mm)
Kc = 1 (reference for grass)
Kc < 1 (plant's water demand higher than grass's)

K_c*(grape) = 0.5-0.8 (650-850mm – mostly May-Sept)*
K_c*(sunflower) = 0.35 (late stage) - 1.0 (early stage)*
K_c*(cherries, pears) = 0.75 (late stage) - 1.0 (early stage)*
K_c*(apricot, peaches) = 0.65 (late stage) - 0.9 (early stage)*

Area transformation: from pastures and scrubs to orchard and vineyard

(problem: pastures dry up summertime)

Costs – benefits – opportunity costs (2,8)

Example: *new vineyard planting &*
building a new retention pond

$$\pi = \frac{Y_f \cdot \sum_1^n R \cdot \frac{(1+p)^n}{(1+i)^n} - I + \sum_1^n M \cdot \frac{(1+g)^n}{(1+i)^n} - C}{n+1}$$

$\prod$ - annual average discounted value addition (direct GDP effect)

Y_f – yield factor (0% in 1st year, 100% from 6th year)

R – revenue per hectare (vineyard: 5,526; pear: 10,385 USD)

I – investment cost (11,782 USD / 350m^3 – 1 pond)

C – complete restoration (5,000 USD)

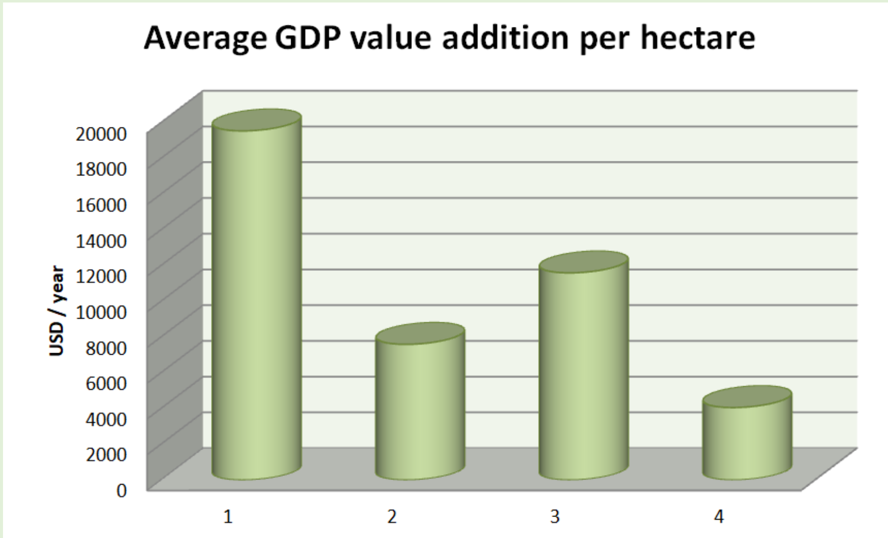
p – price increase („inflation”, 3,50%)

i – interest rate (3,90%)

g – economic growth rate (4,00%)

n – time interval (50 years)

	as of Hungary
1. GDP (Hungary total, average hectare)	100%
2. New vineyard planting with pond	38,9%
3. New pear planting with pond	65,6%
4. New pond for existing vineyard	20,7%



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