

# Transboundary water issues in a macro-regional context: the Danube basin

11-12 September 2013. Budapest

## Integrated solutions for waste water treatment in small settlements and rural areas

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# Background and objectives



**Action 5: "To establish buffer strips along the rivers to retain nutrients and to promote alternative collection and treatment of waste in small rural settlements".**

↳ **Milestone n° 5: Promoting best practices in WWT and Programme of Measures for solid waste management and wastewater treatment for small settlements.**

↳ **Work 2: Proposal for a supplementary, eco-friendly and site-specific waste water treatment units for less than 2000 PE small settlements where UWWTPs are financially non-feasible.**

**Output 2: Scenario(s) for local and site-specific solutions of waste water treatment for less than 2000 PE settlements within the Danube region.**

# Why and whose is it important?

Settlement structure in Hungary:

## Settlements < 2000 PE

1.7 Million people  
(17% of population)

2360 settlements  
(75% of total)

Settlement category	Total population	Number of settlements
< 500	277656	1042
500-1000	485142	674
1000-2000	929020	646
2000-5000	1498937	500
5000-10 000	922195	133
10 000-100 000	3067472	134
>100 000	2850431	9
Total	10030853	3138

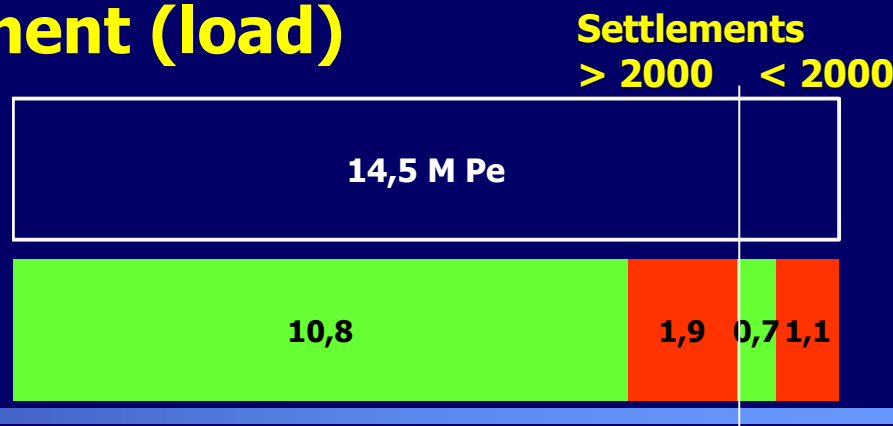
⇒ 68% of them are not sewered

## Impact on the environment (load)

10 Million people  
≈14.5 Million Pe

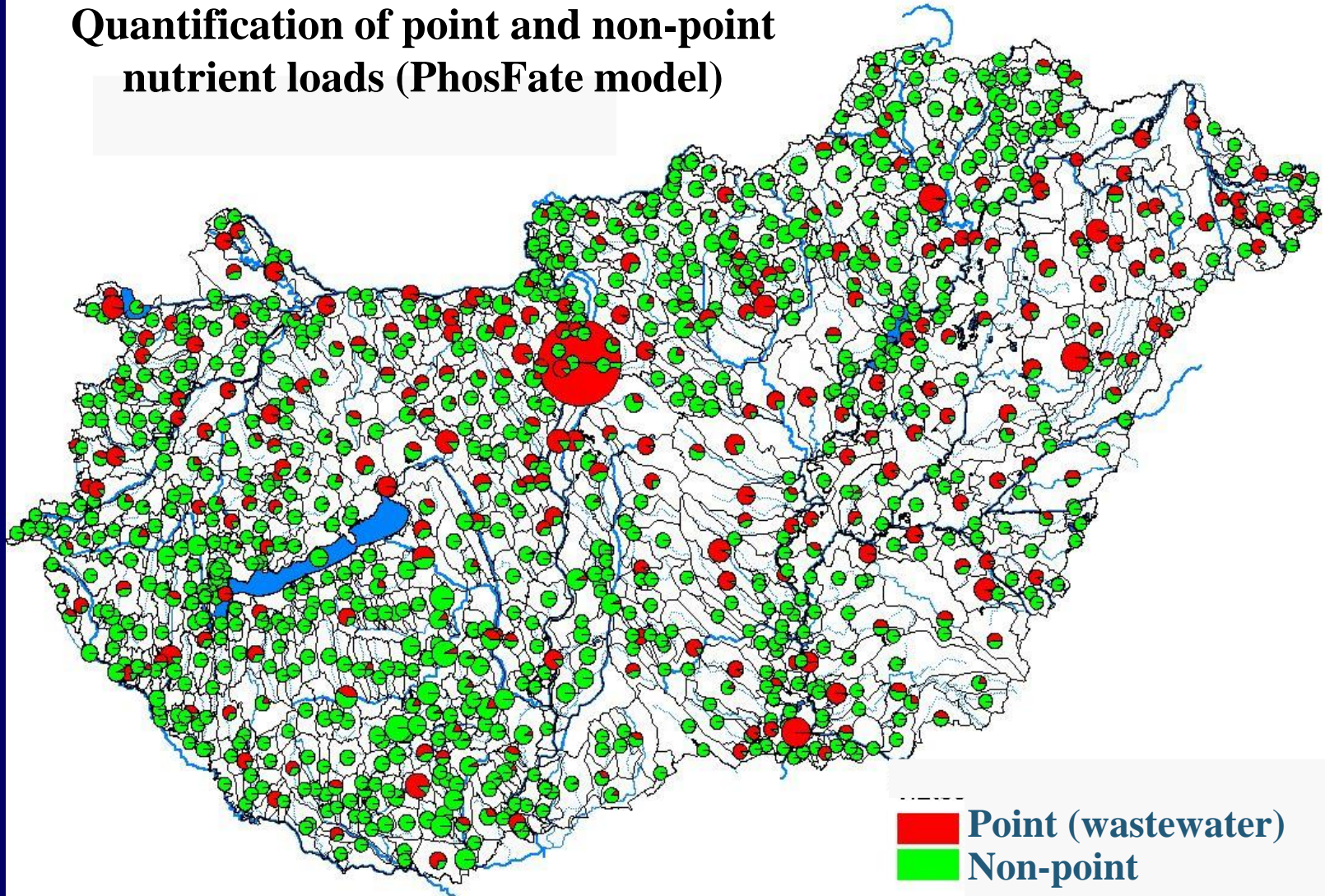
Treated: 11.5 M Pe

Not treated: 3 M Pe



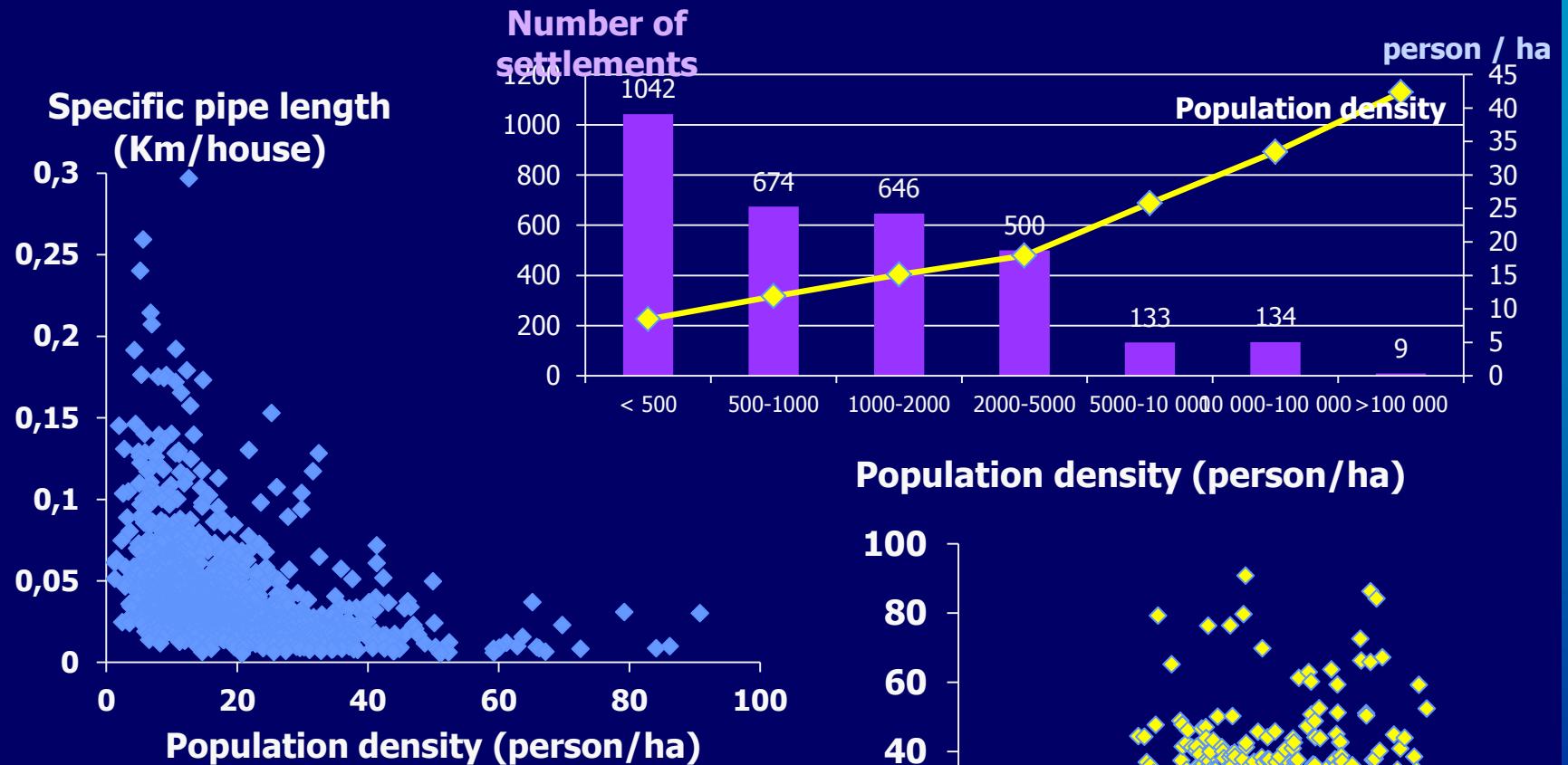
# Share of point and diffuse emissions on catchment level

Quantification of point and non-point nutrient loads (PhosFate model)





# Why sewerage systems are not be economically used?



In small settlements low population density increases the network length resulting high investment costs.

# TRADITIONAL SOLUTIONS FOR WASTE WATER TREATMENT AND DISPOSAL

## CENTRALISED (SEWER SYSTEM + WWTP)

- CONNECTION TO REGIONAL WASTEWATER TREATMENT PLANT (biological and tertiary)
- NATURAL TREATMENT (constructed wetlands, artificial wetlands, biofilters, ponds)

## DECENTRALISED (ON SITE)

- STORAGE AND DELIVERY TO WWTP
- SEPTIC TANK + DRAINFIELD
- SMALL SCALE PLANTS (AS-SBR, fixed-film bio reactors)

Environmental impact  
(receiving water body)

Surface water

Soil and groundwater

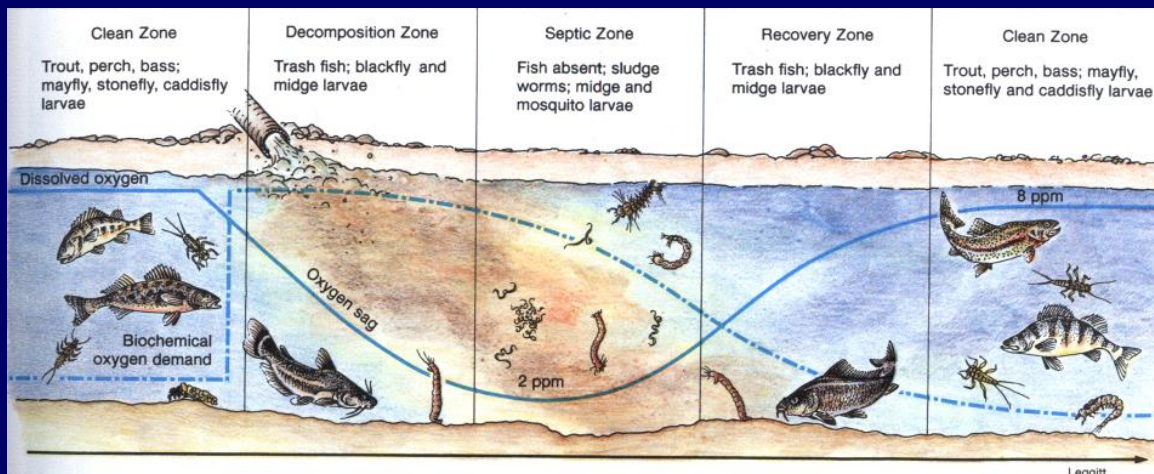
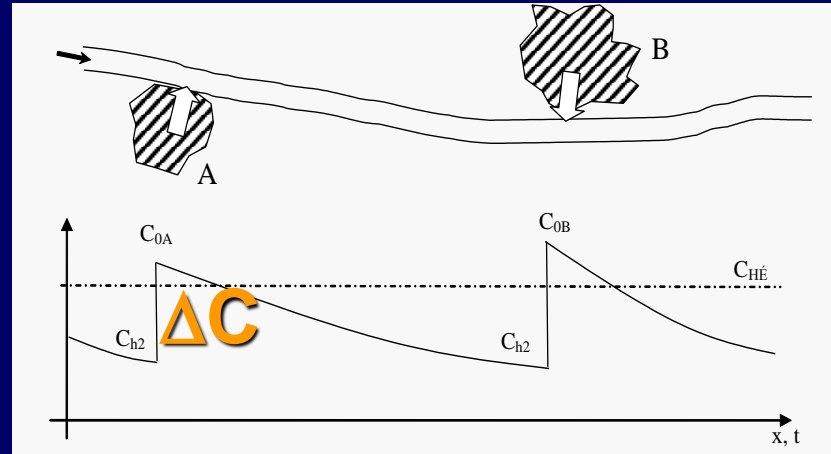
# Impacts on surface water quality

## (1) Local effect:

- Increasing concentration of pollutants (nutrients, salt, metals)
- Oxygen depletion

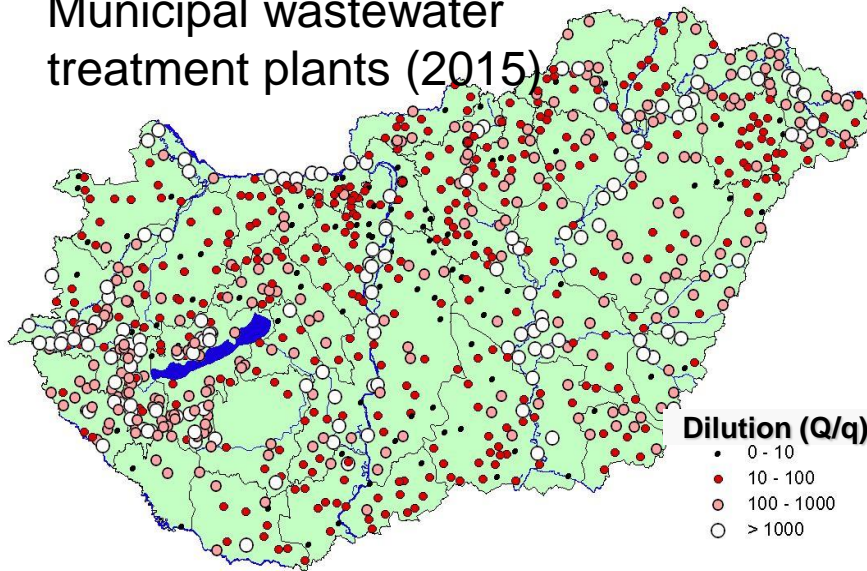
$$\Delta C = f(Q/q)$$

↑  
Dilution



**DO sag:  
Streeter & Phelps  
(1925)**

## Municipal wastewater treatment plants (2015)



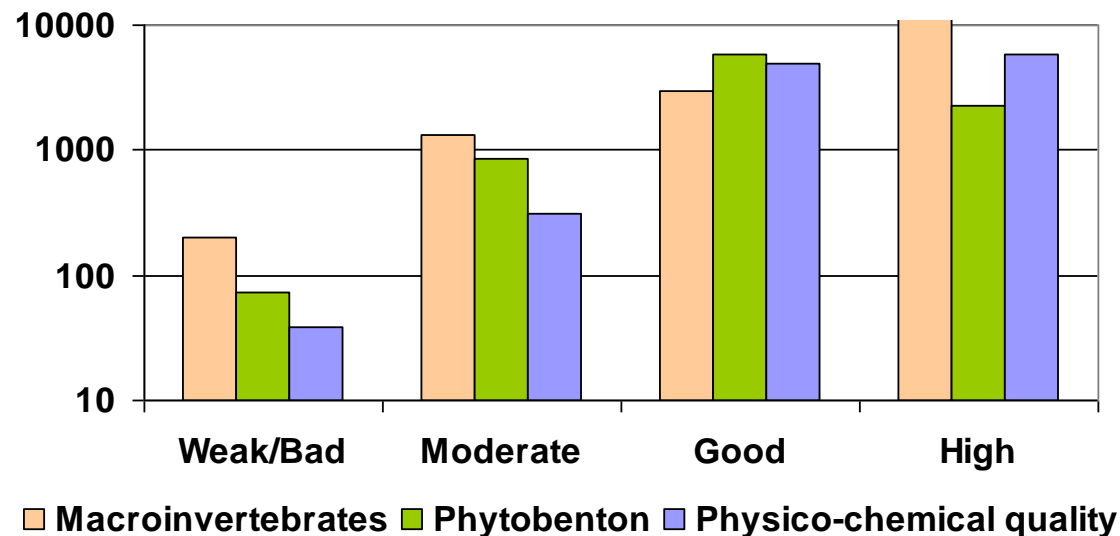
## Impacts on the water quality of receiving surface water

Capacity (PE)	Significant impact
> 100 000	64%
10 000 - 100 000	48%
2 000 - 10 000	47%
< 2000	19%
Total	38%

Significant means if the discharge in itself might deteriorate the receiving water body to fail ambient water quality criteria.

**Ecological status versus dilution capacity of rivers downstream to wastewater discharges**

Dilution rate



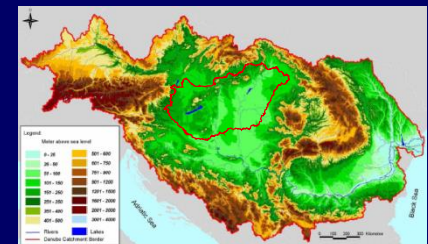
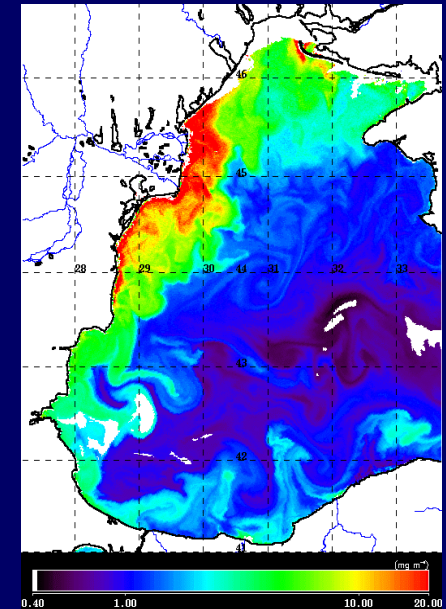
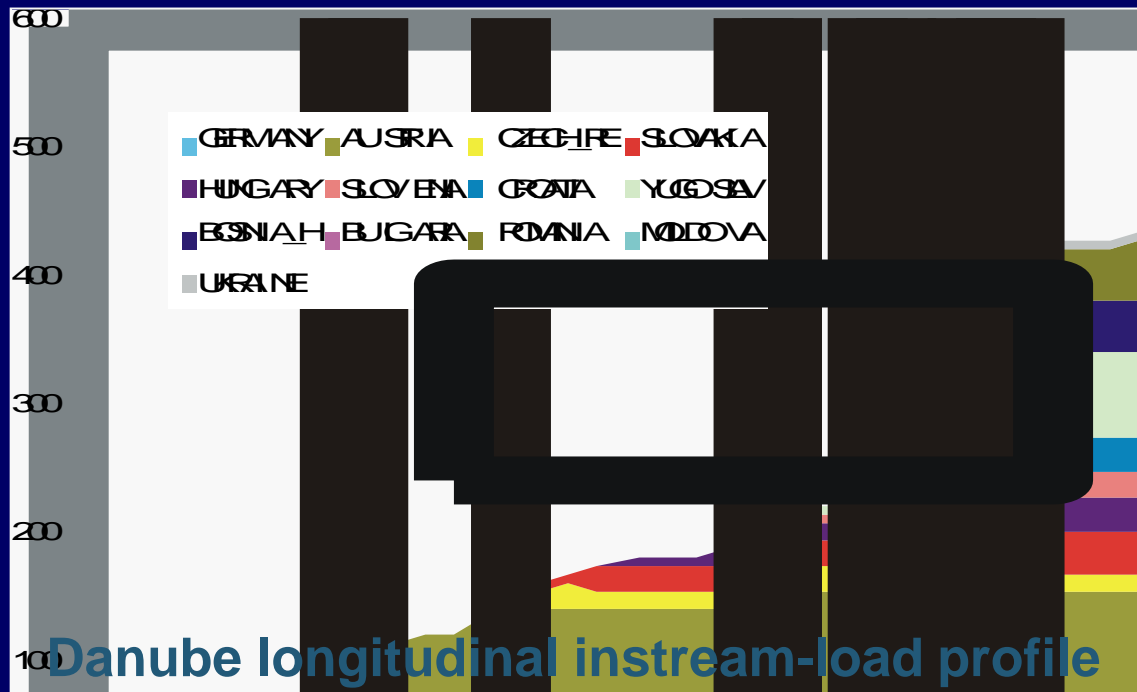


# Impacts on surface water quality

## (2) Eutrophication on large catchment scale

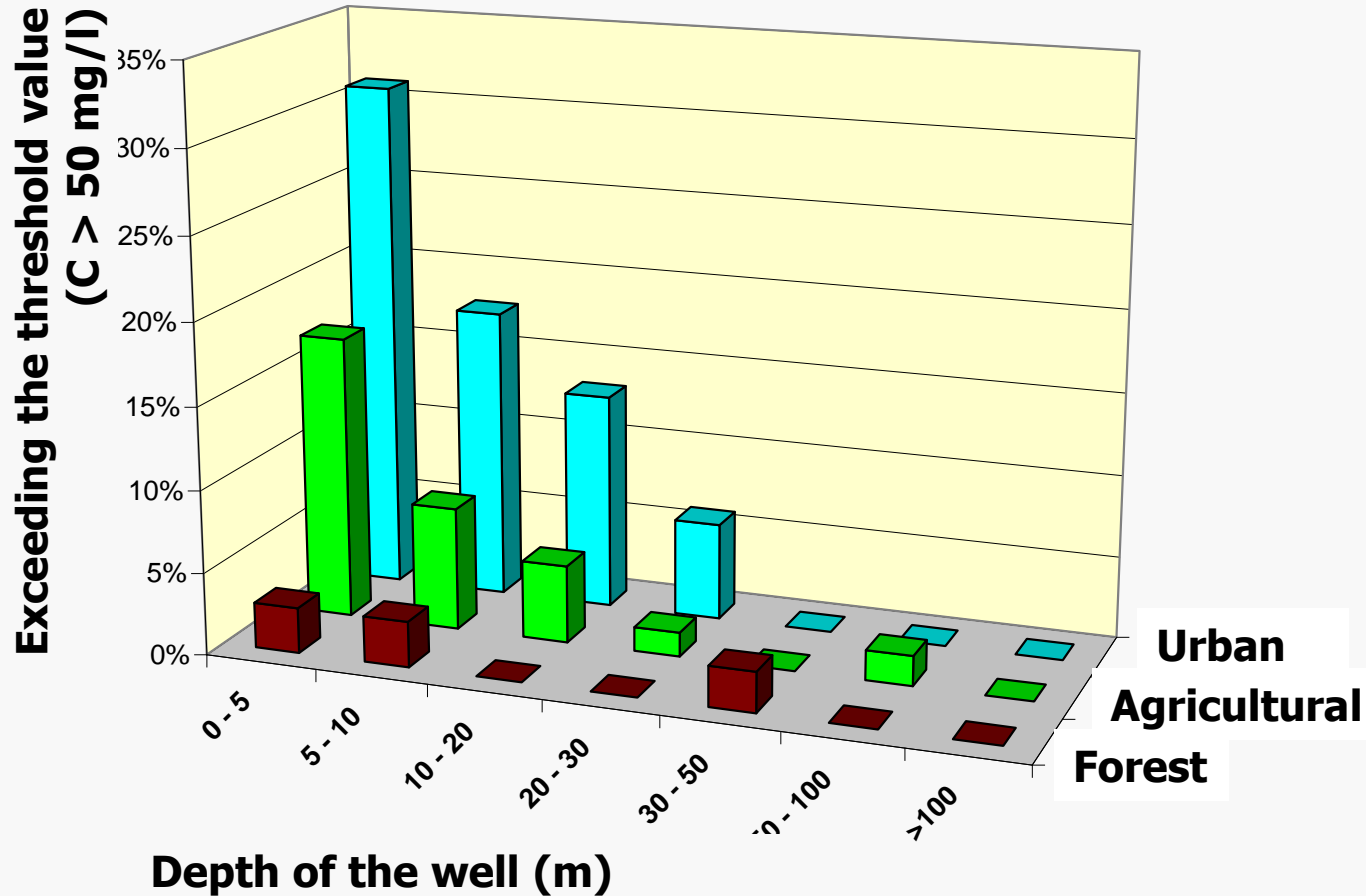
- Lakes
- Large rivers, see bays

Danube Basin and Black Sea

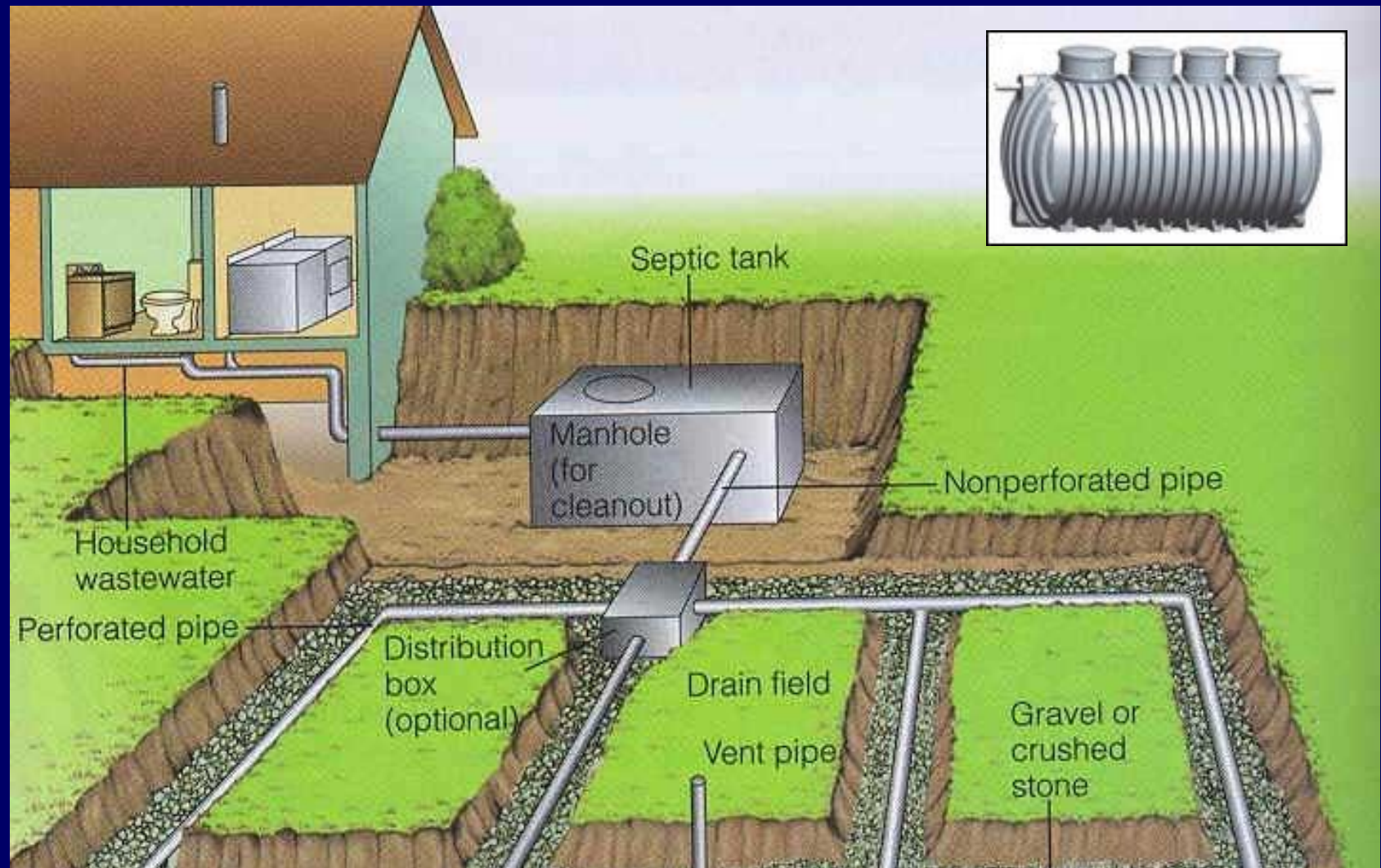


# Impacts on groundwater quality

Frequency of exceeding the threshold value ( $C > 50 \text{ mg/l}$ )

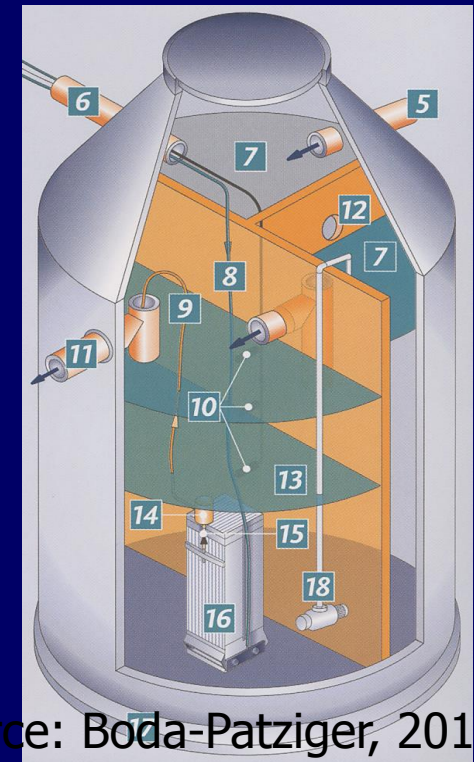
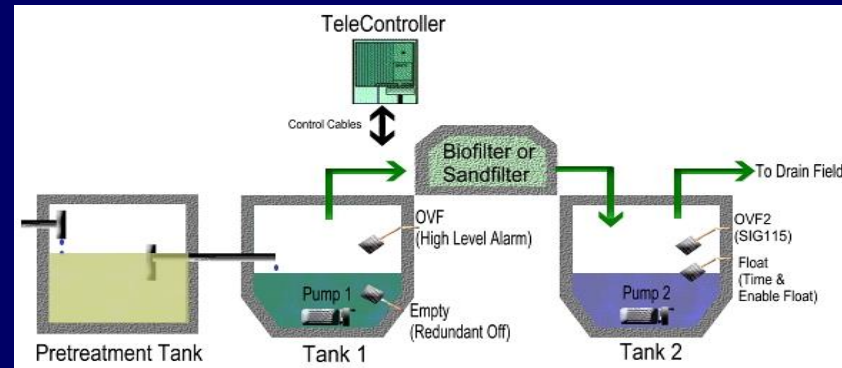
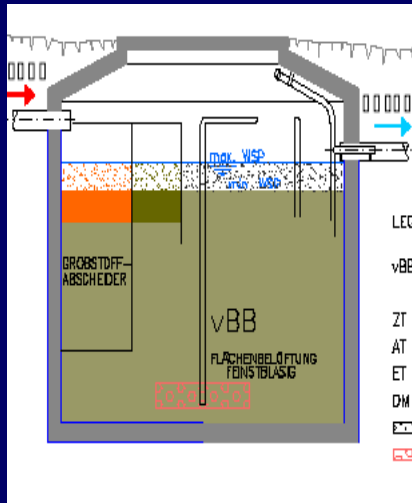


# Technical solutions for on site treatment (1)





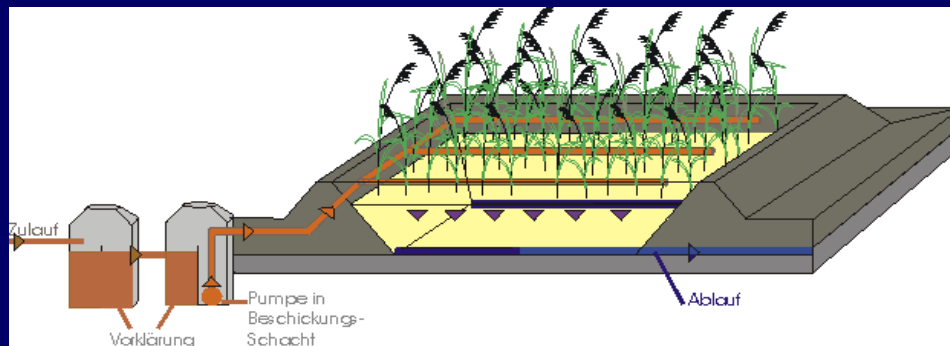
# Technical solutions for on site treatment (2)



Source: Boda-Patziger, 2010



# Natural treatment



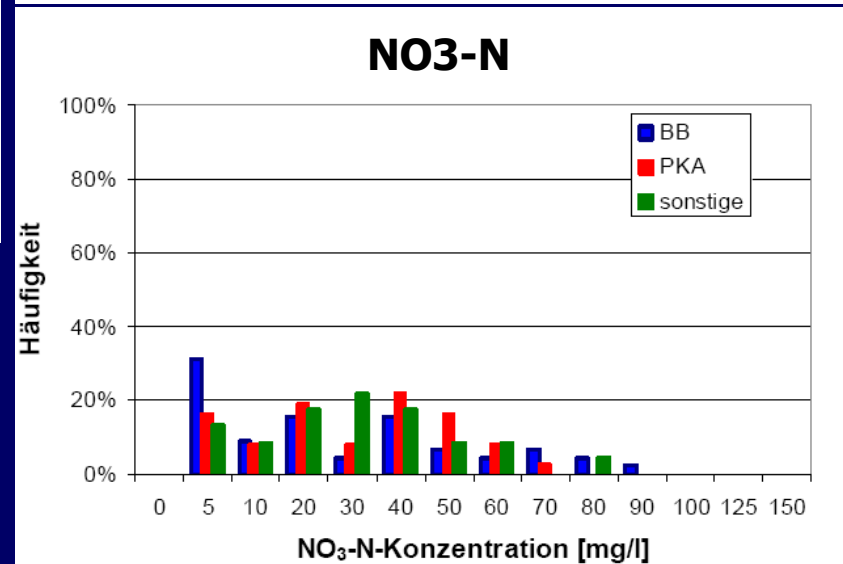
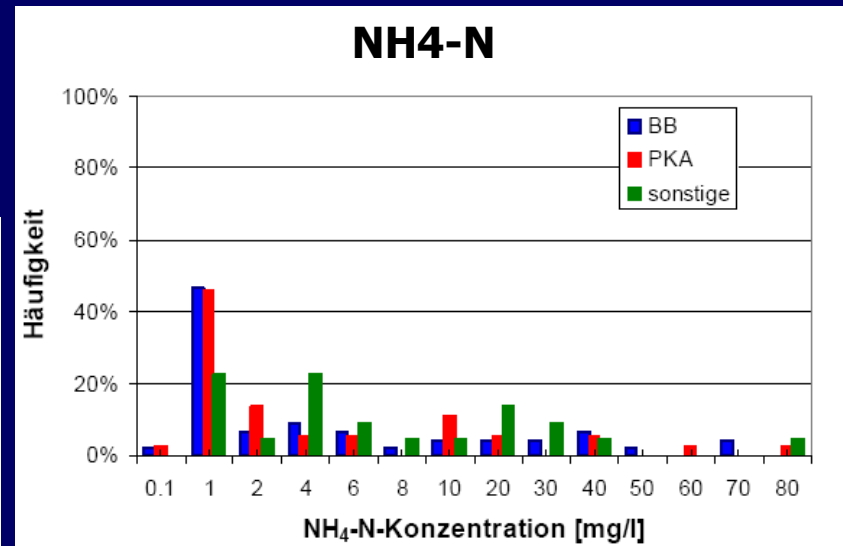
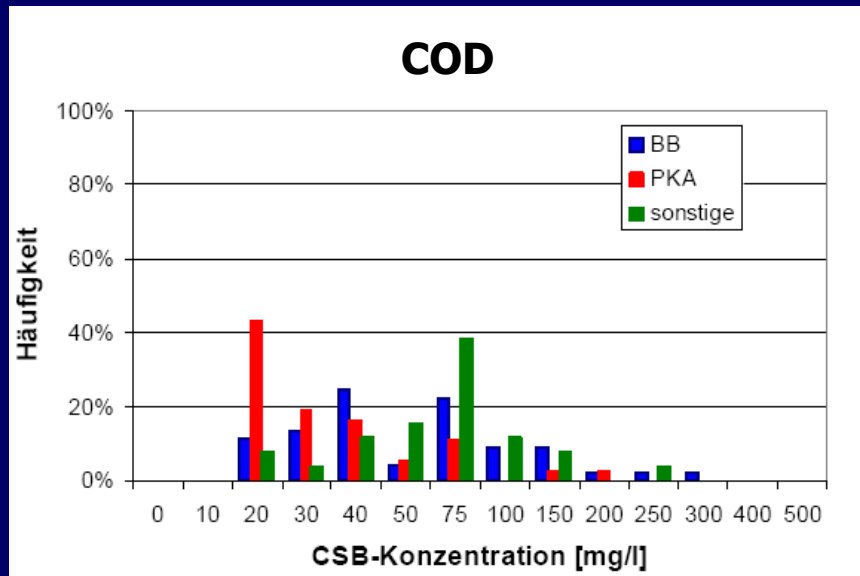
F&N Umweltconsult GmbH



Source: Boda-Patziger, 2010













# Effluent water quality

## (10 < PE < 20)



Source: Boda-Patziger, 2010

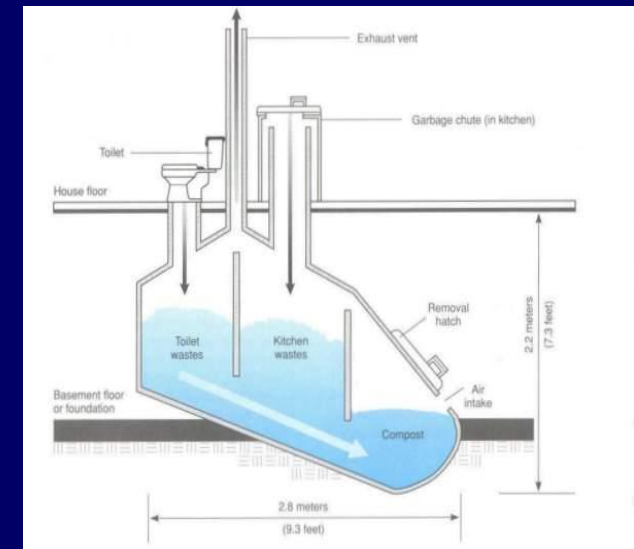
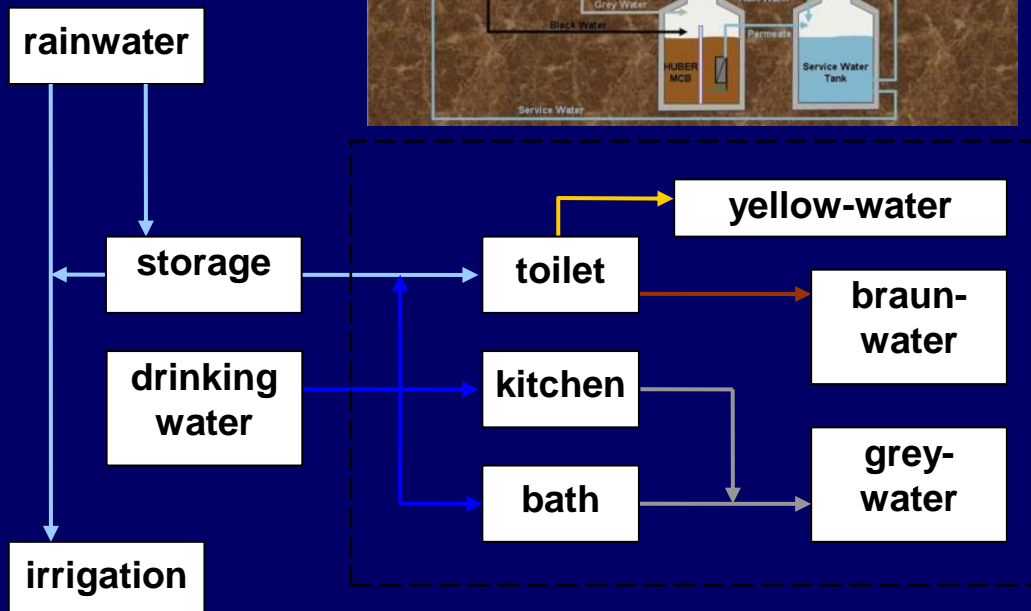
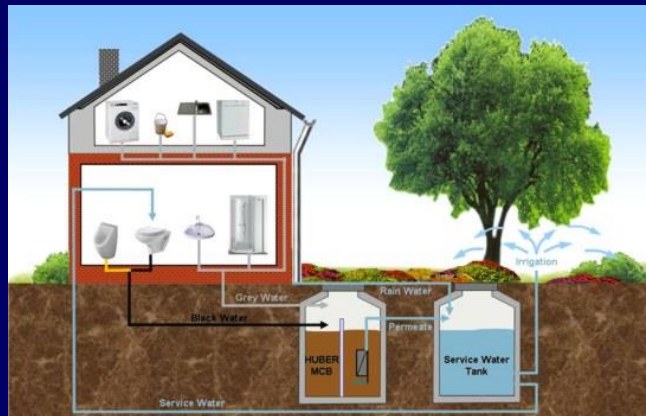
## MULTI-CRITERIA EVALUATION

	Connection to regional WWTP	Sewerage and local natural treatment	Septic tank and drainfield	On site (small scale) treatment
Operation and maintenance				
Costs (investment and operation)				
Legislation, compliance with effluent limits				

# Innovative solutions

## Wastewater treatment by source separation

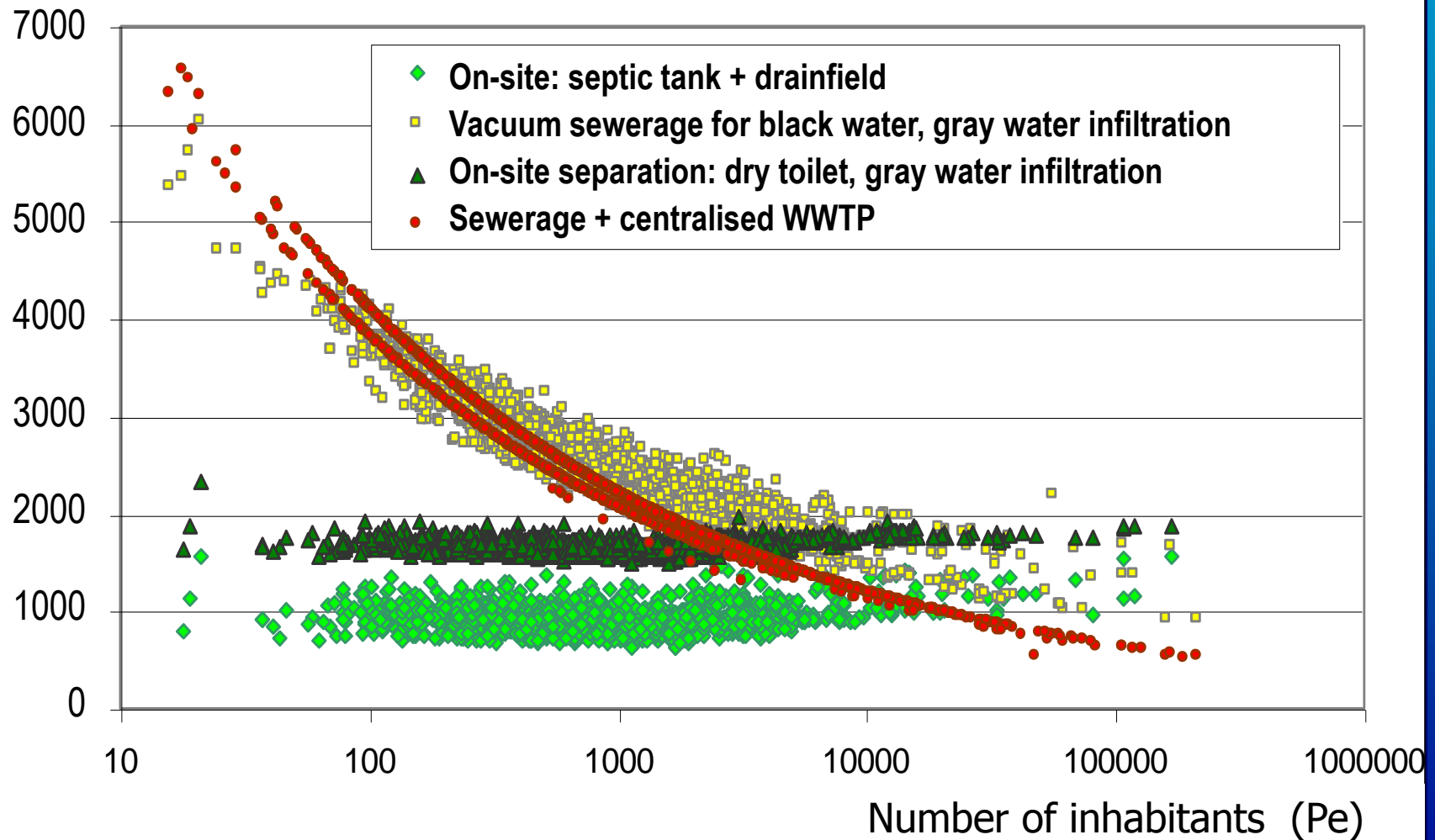
## Closing nutrient cycle, on-site disposal and reuse



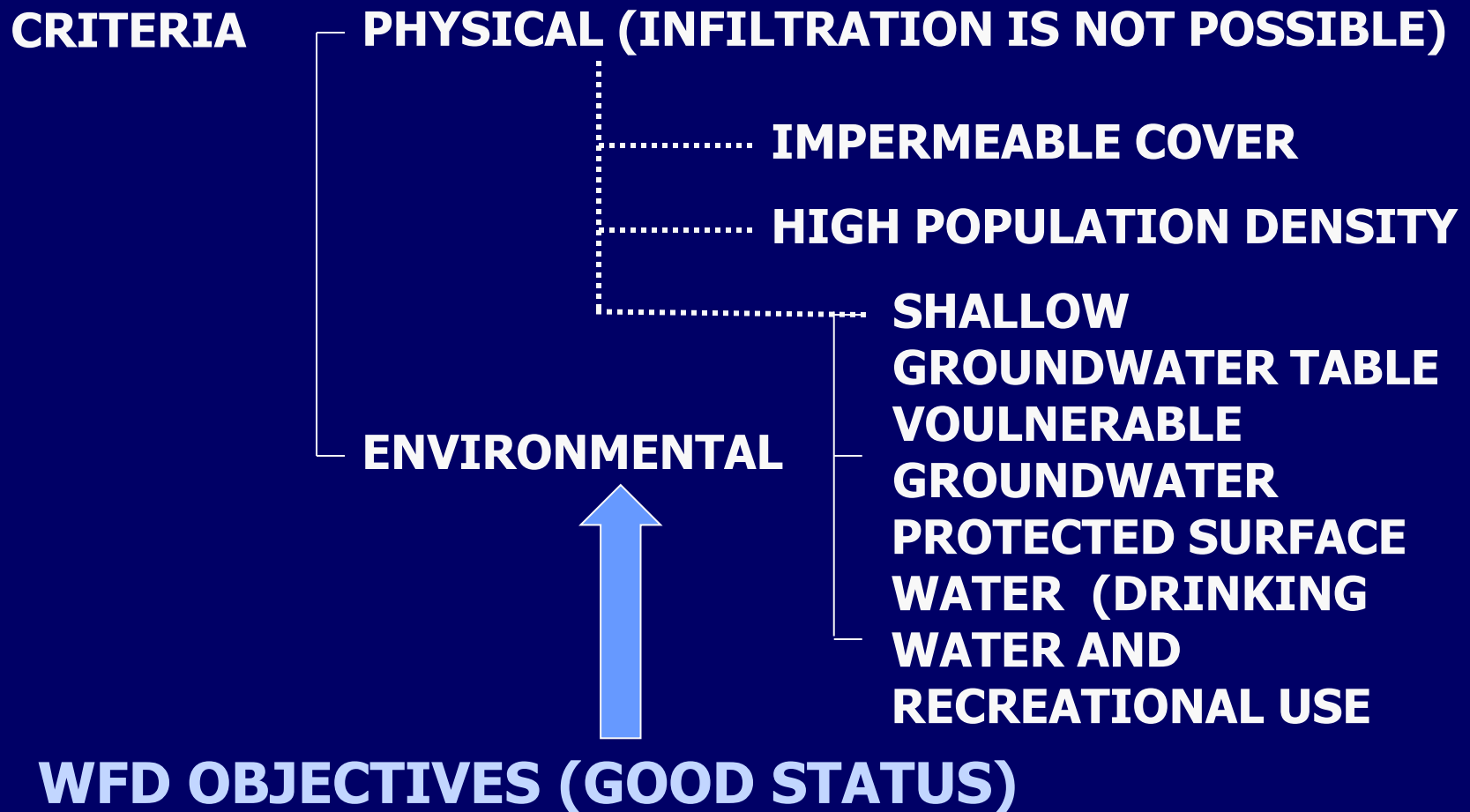


# SELECTION PARAMETERS TO SUPPORT DECISION MAKING (1): COSTS

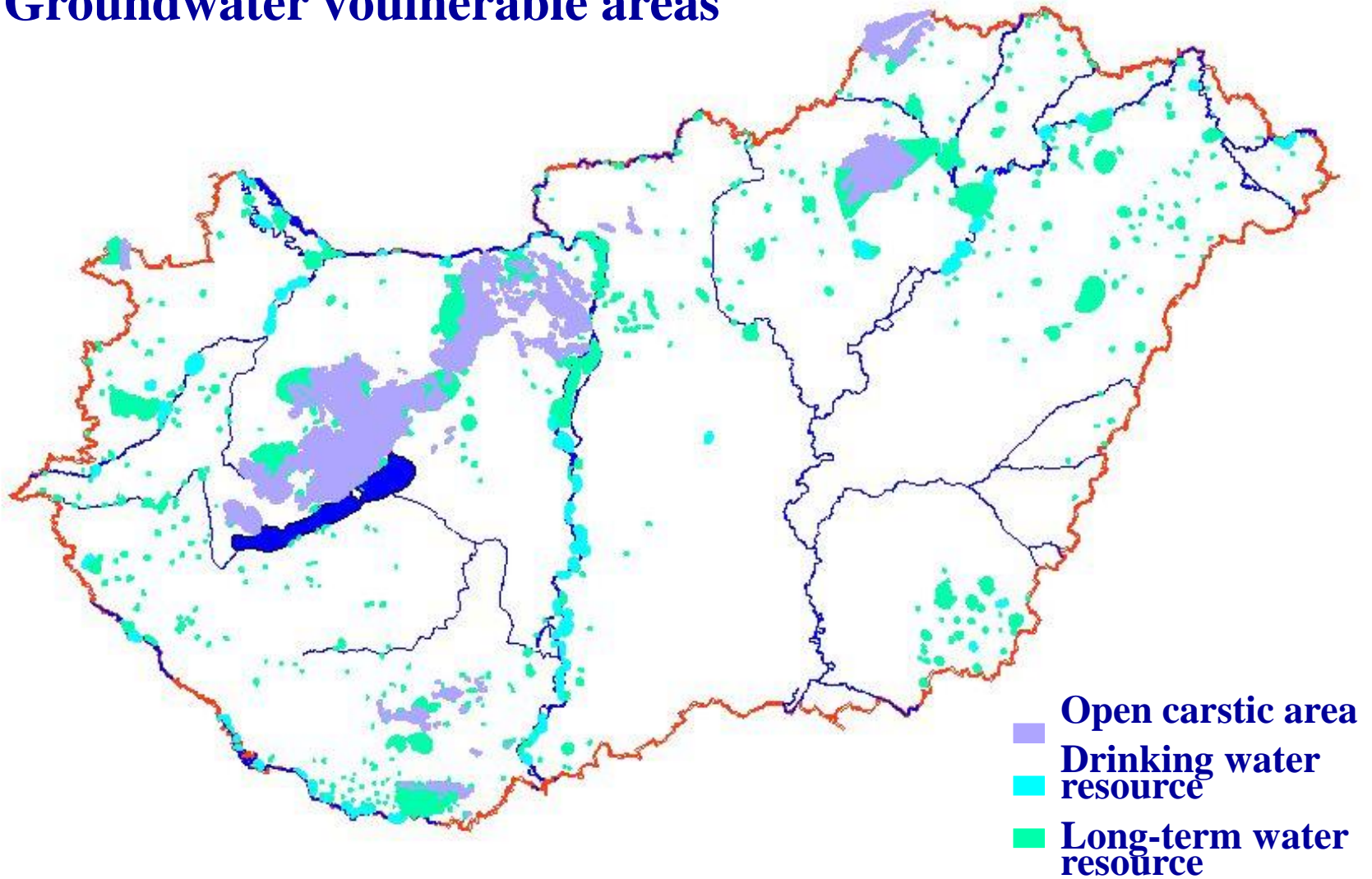
Specific investment cost (EUR/person)



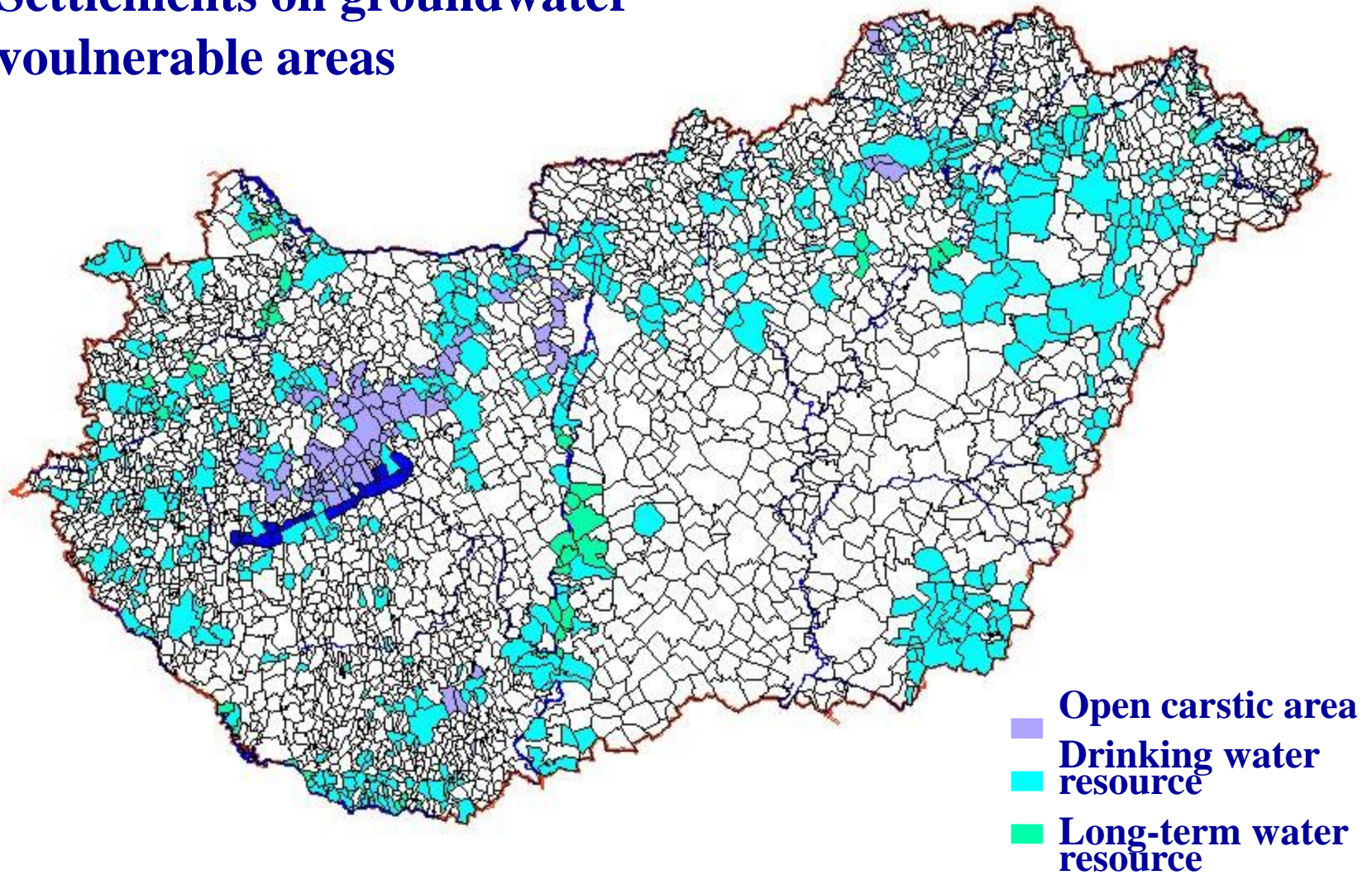
# SELECTION PARAMETERS TO SUPPORT DECISION MAKING (2): ENVIRONMENTAL CRITERIA



## Groundwater vulnerable areas

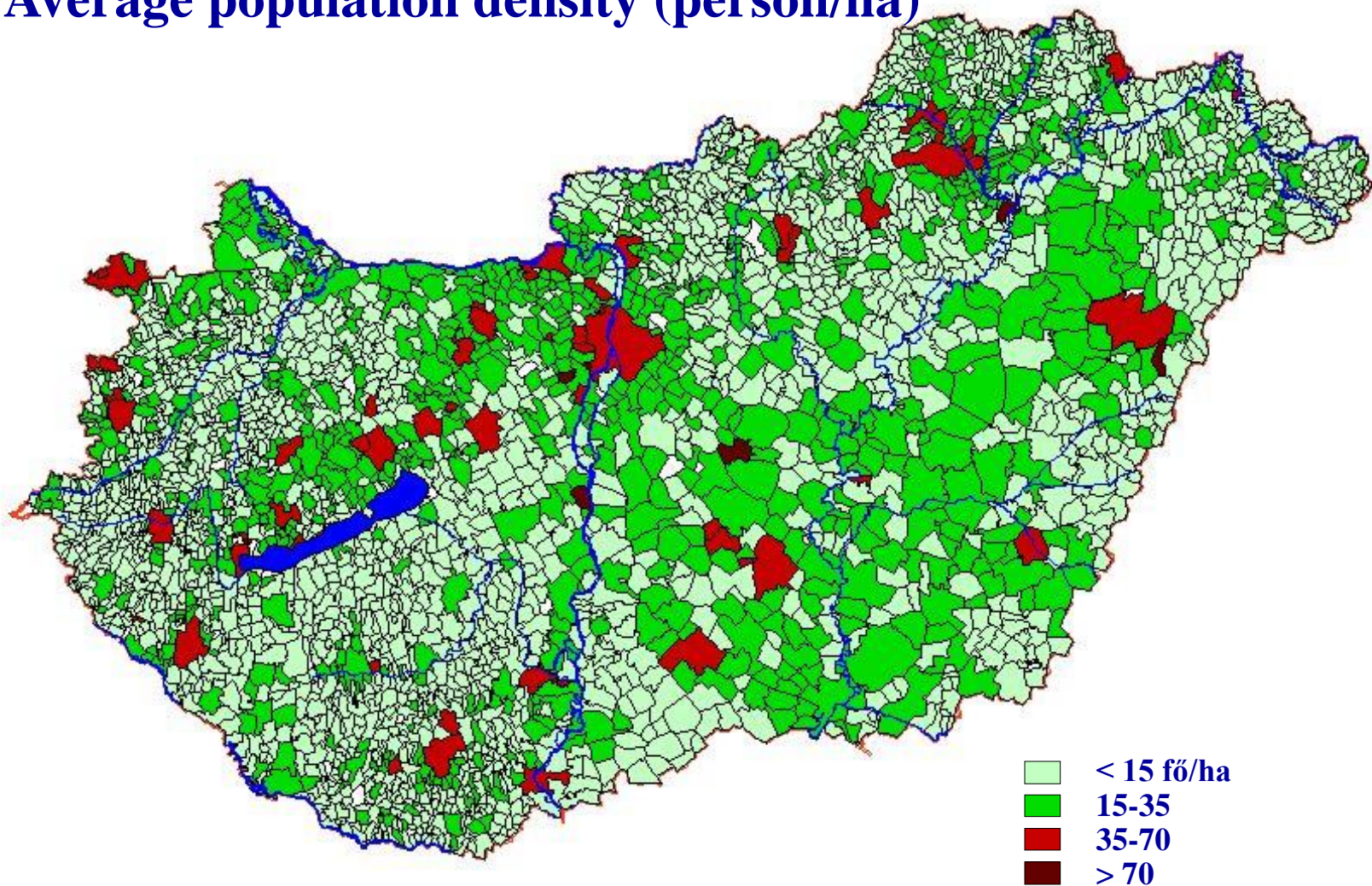


## Settlements on groundwater vulnerable areas



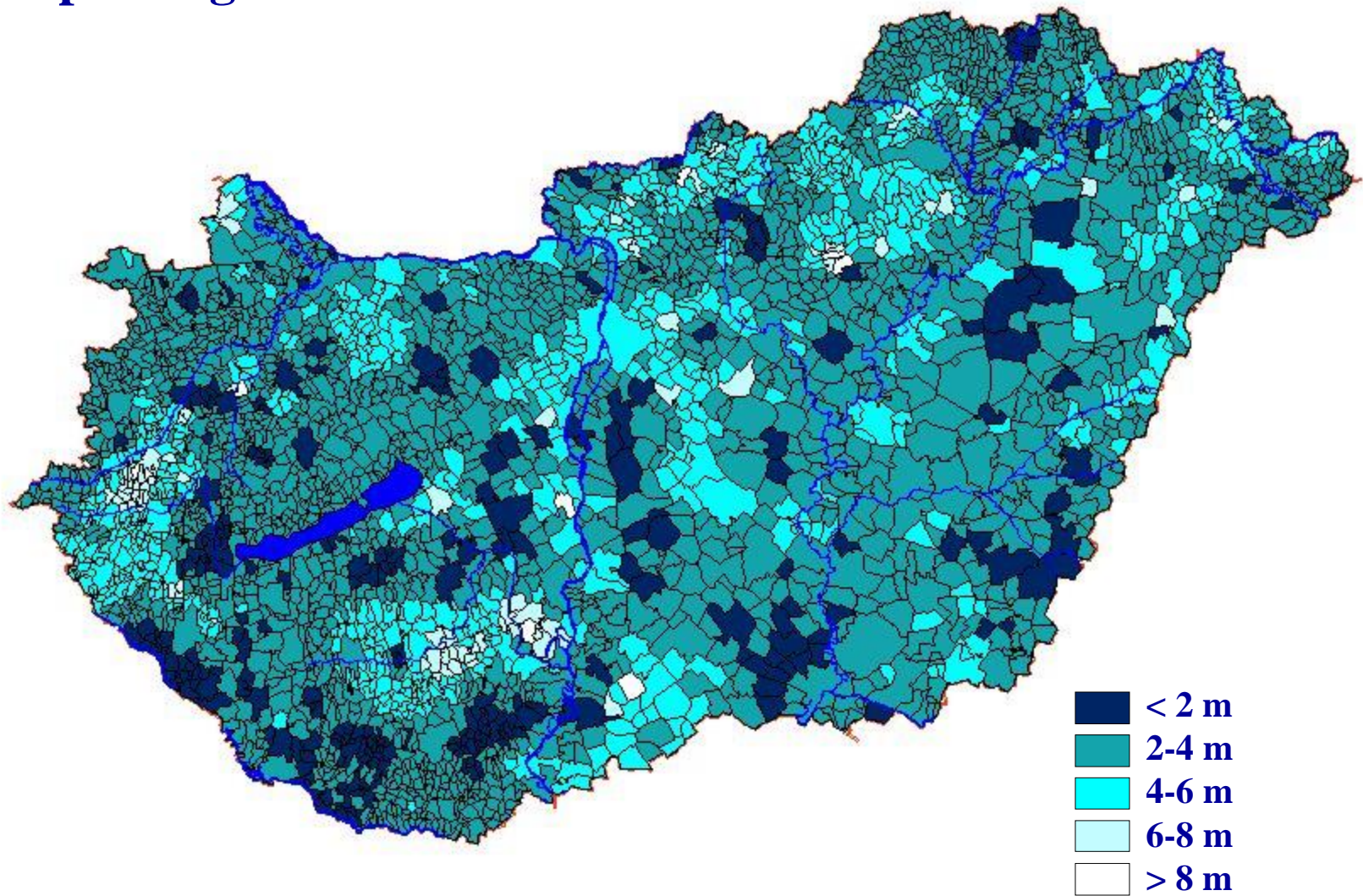


## Average population density (person/ha)

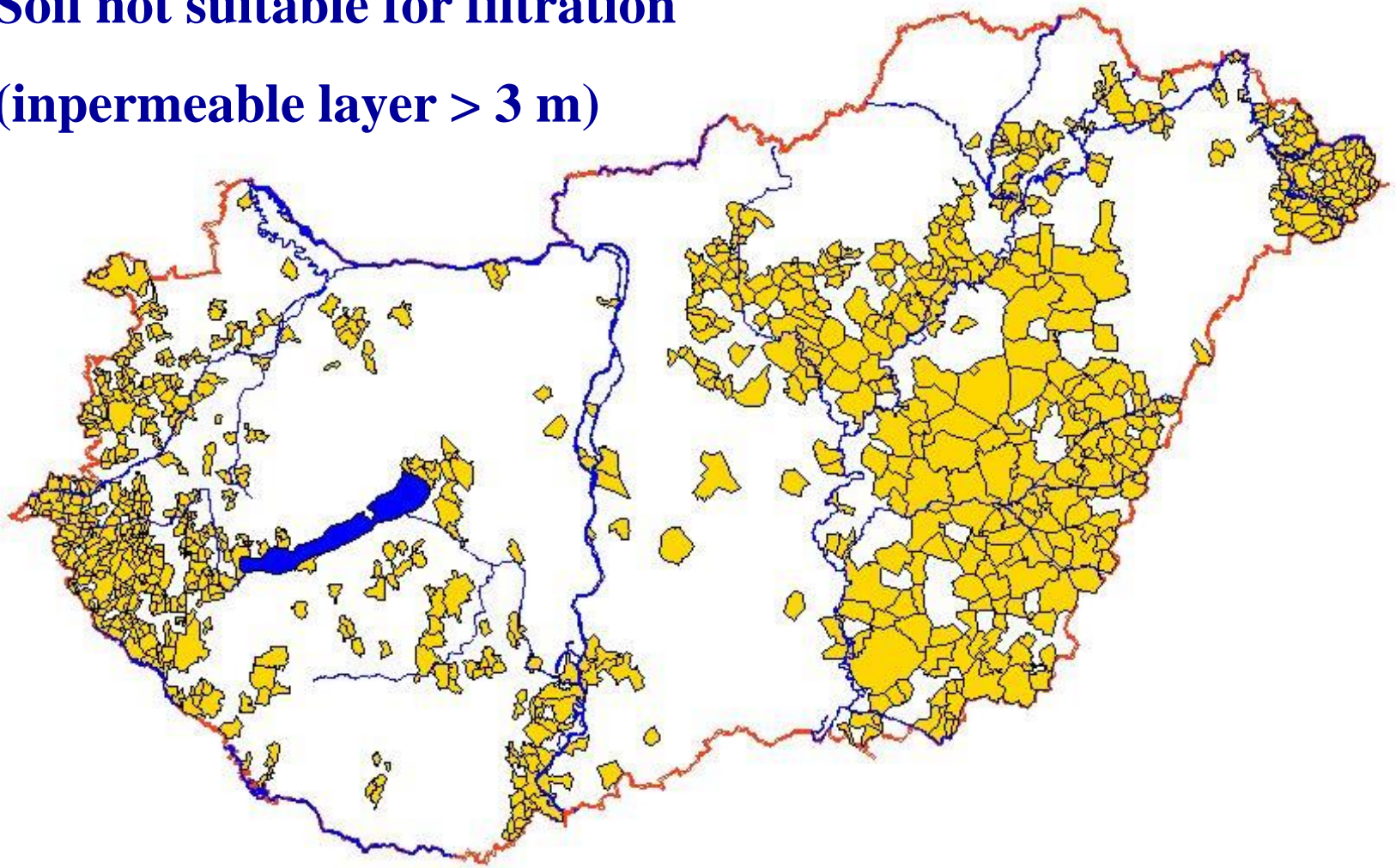




## Depth of groundwater table

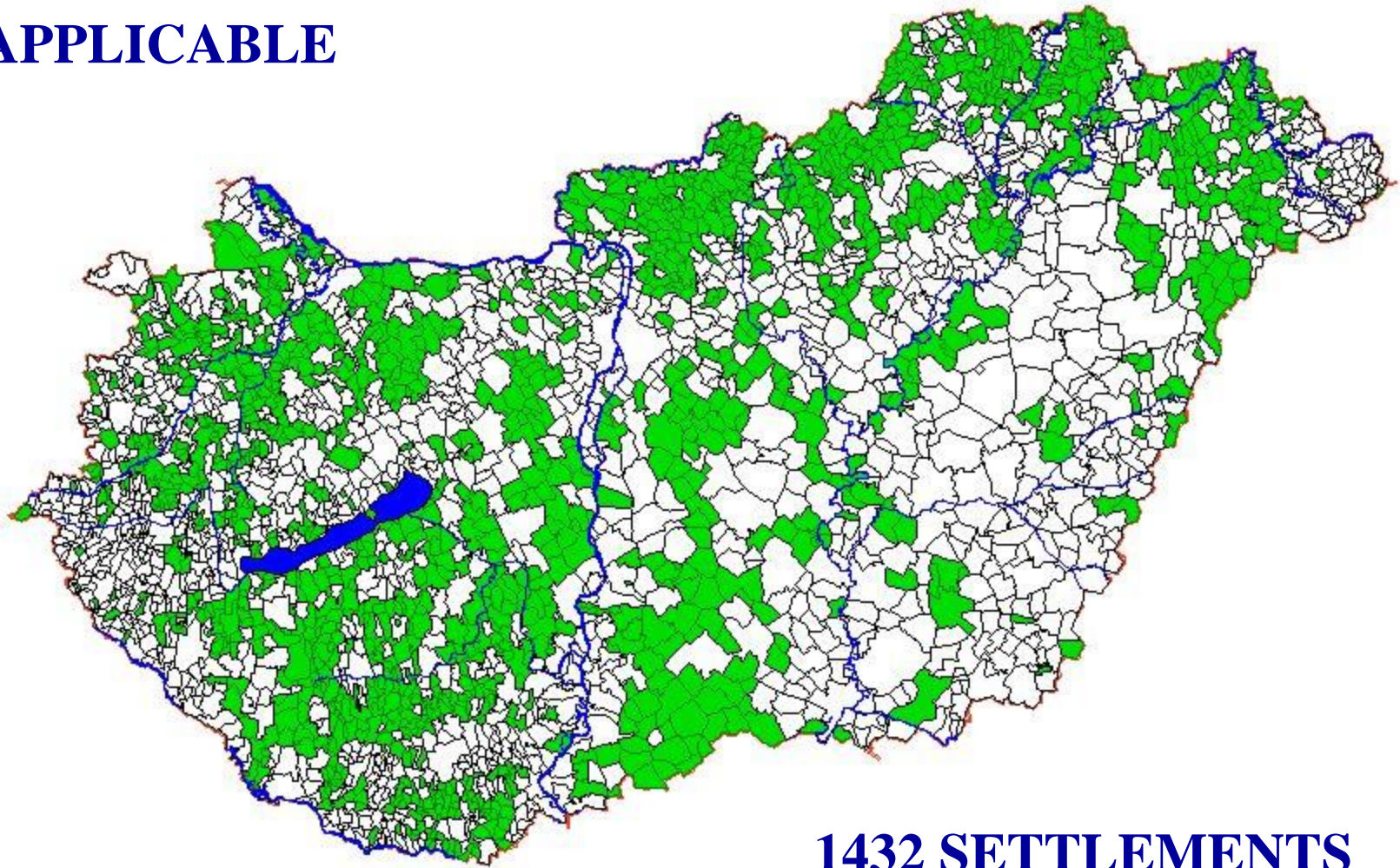


**Soil not suitable for filtration  
(impermeable layer > 3 m)**





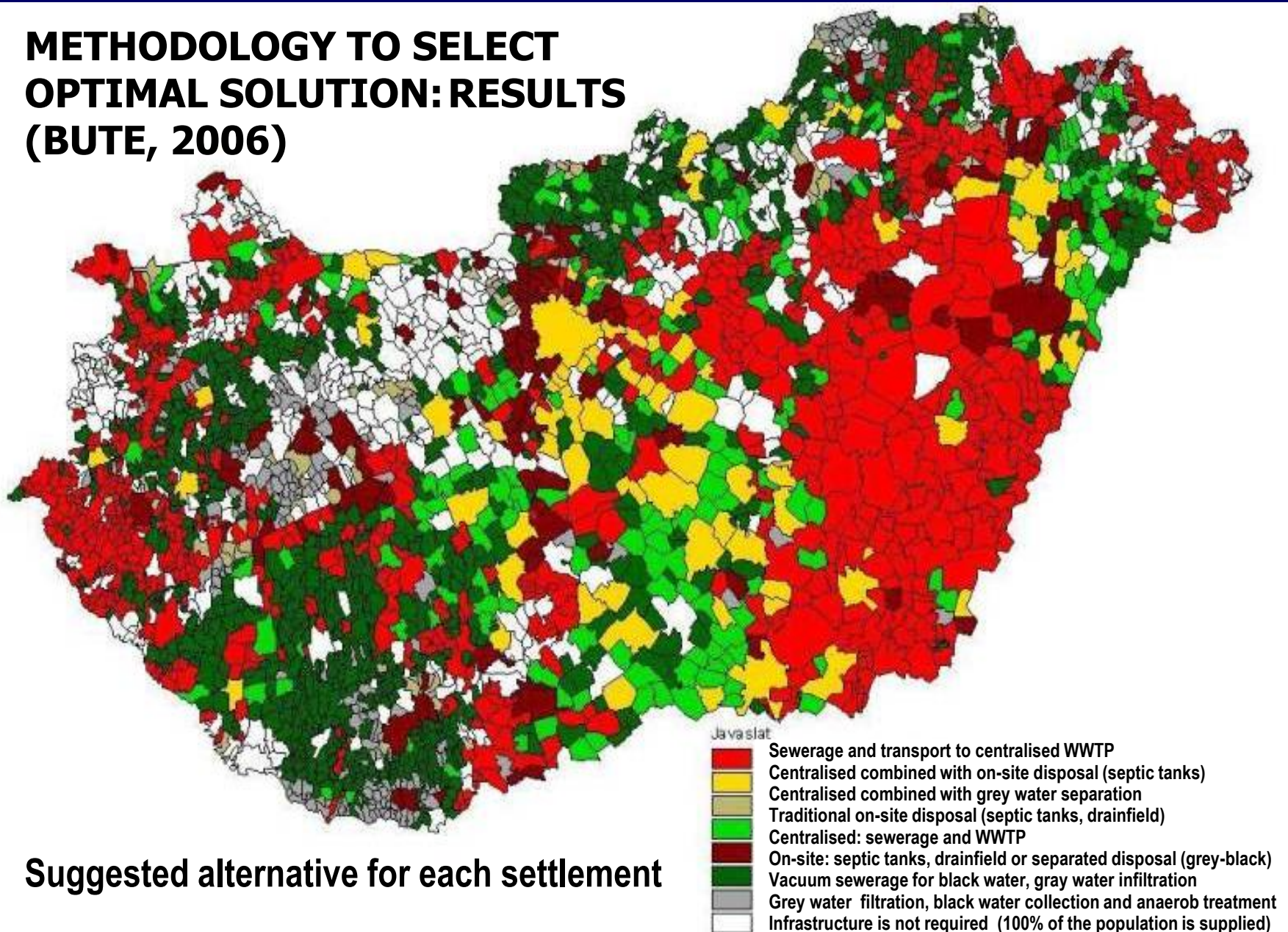
# **ON-SITE TREATMENT AND DISPOSAL IS APPLICABLE**



**1432 SETTLEMENTS**



## METHODOLOGY TO SELECT OPTIMAL SOLUTION: RESULTS (BUTE, 2006)



**Suggested alternative for each settlement**

## **CONCLUSIONS**

**FROM ENVIRONMENTAL AND PUBLIC HEALTH VIEW  
POINTS THERE ARE ACCEPTABLE TECHNICAL  
SOLUTIONS**

**LOCAL SOLUTIONS COULD SAVE 40-60% OF COSTS**

**NATURE OF APPLICATION RESTRICTIONS ARE NOT  
TECHNICAL RATHER:**

- **ECONOMIC (SUBSIDIES)**
- **INSTITUTIONAL (WHO WILL OPERATE?)**
- **REGULATORY AND**
- **SUPERVISION/REJECTION OF EXCLUSIVITY  
OF TRADITIONAL WAY OF THINKING**

**Thank you for your attention!**