4th International Symposium on Flood Defence

# FLOOD DISASTER MITIGATION BY INUNDATION OF THE DEEP FLOODPLAIN


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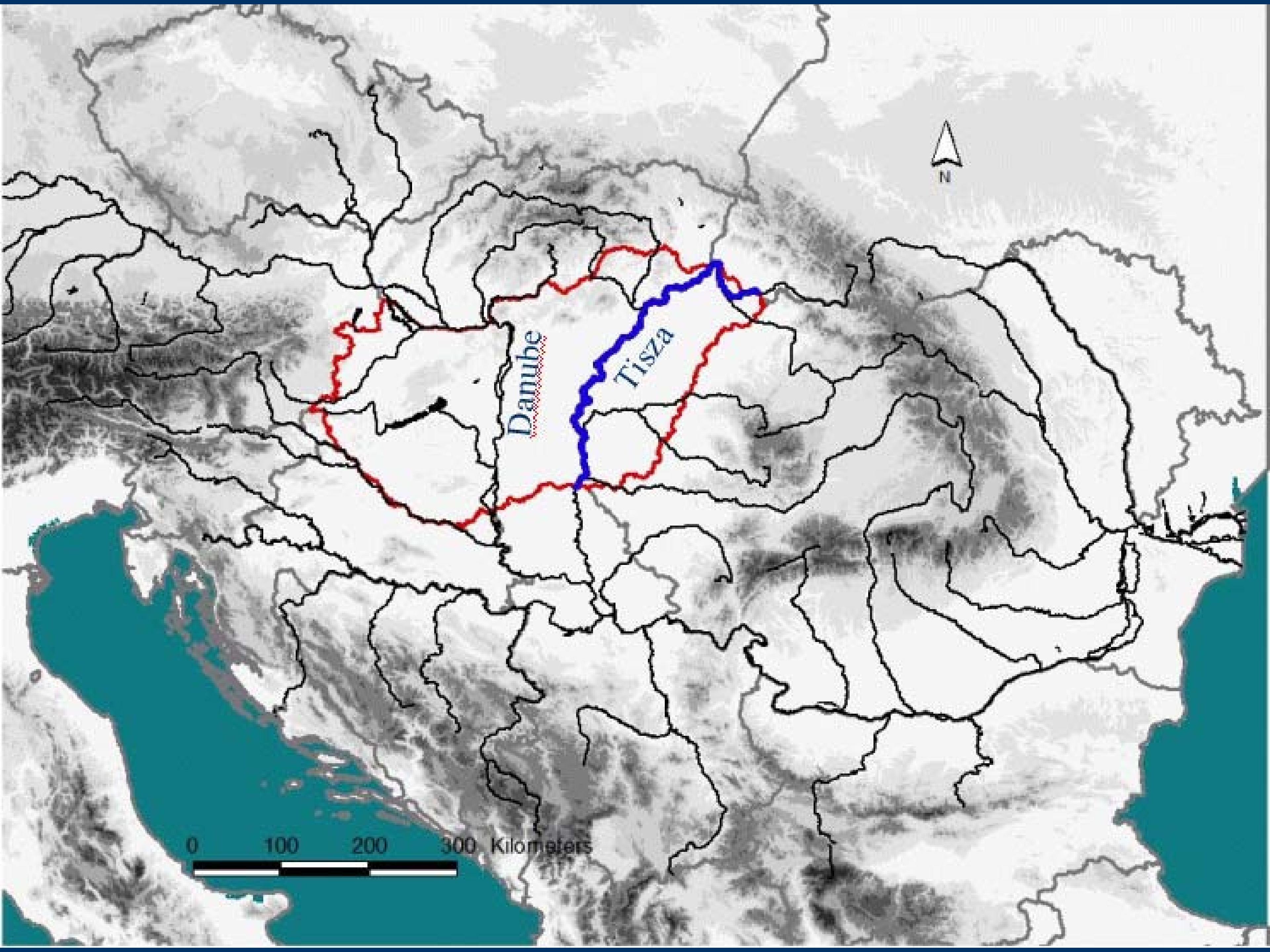
# Flood risk of Hungary

- unfavourable morphological and climatic conditions
  - deepest part of the Carpathian basin
  - ~ 25 % of the area is at risk of floods
  - extreme distribution of precipitation
  - extreme hydraulic conditions
- Danube, Tisza, 16 largest tributaries: frequent flood danger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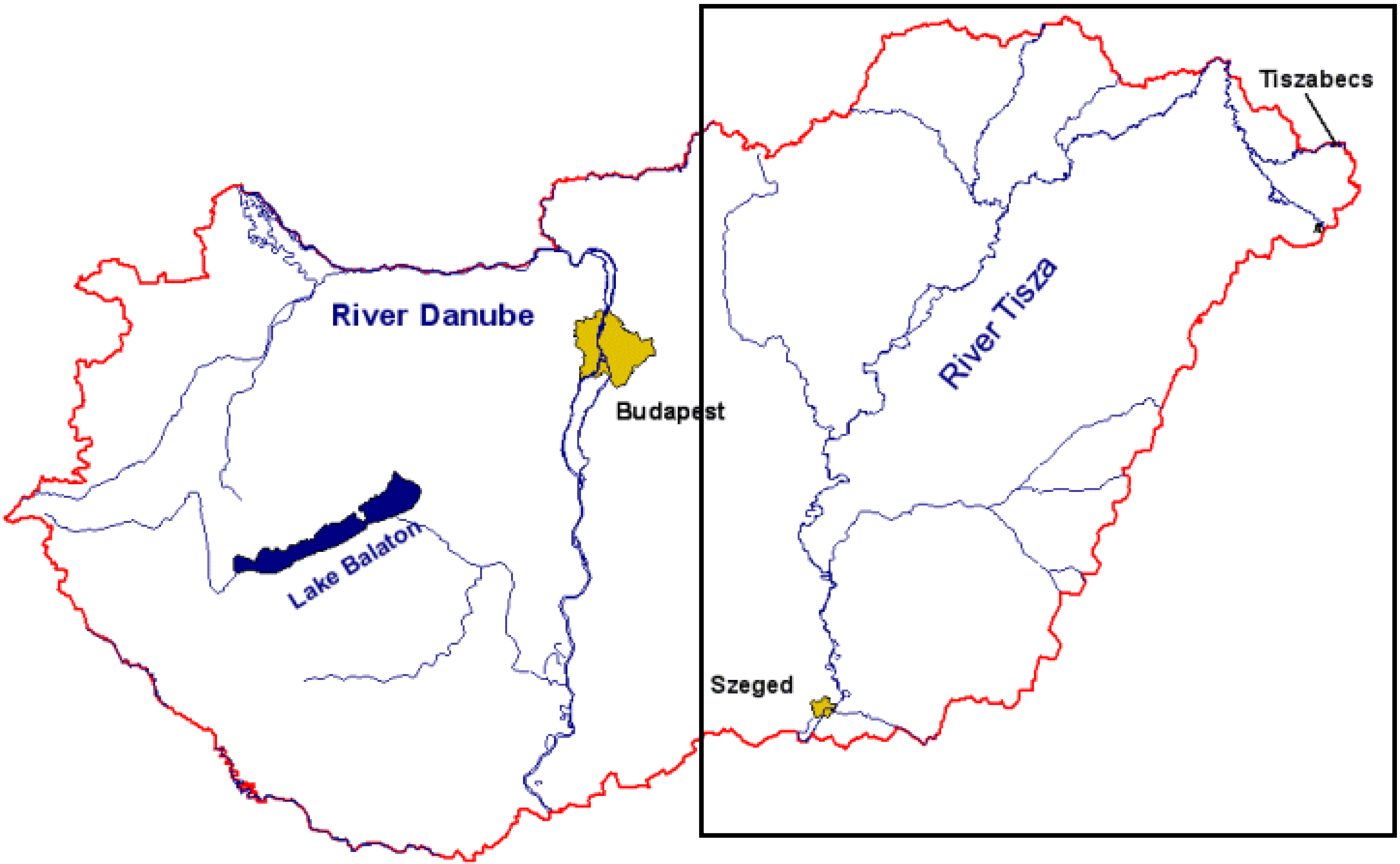
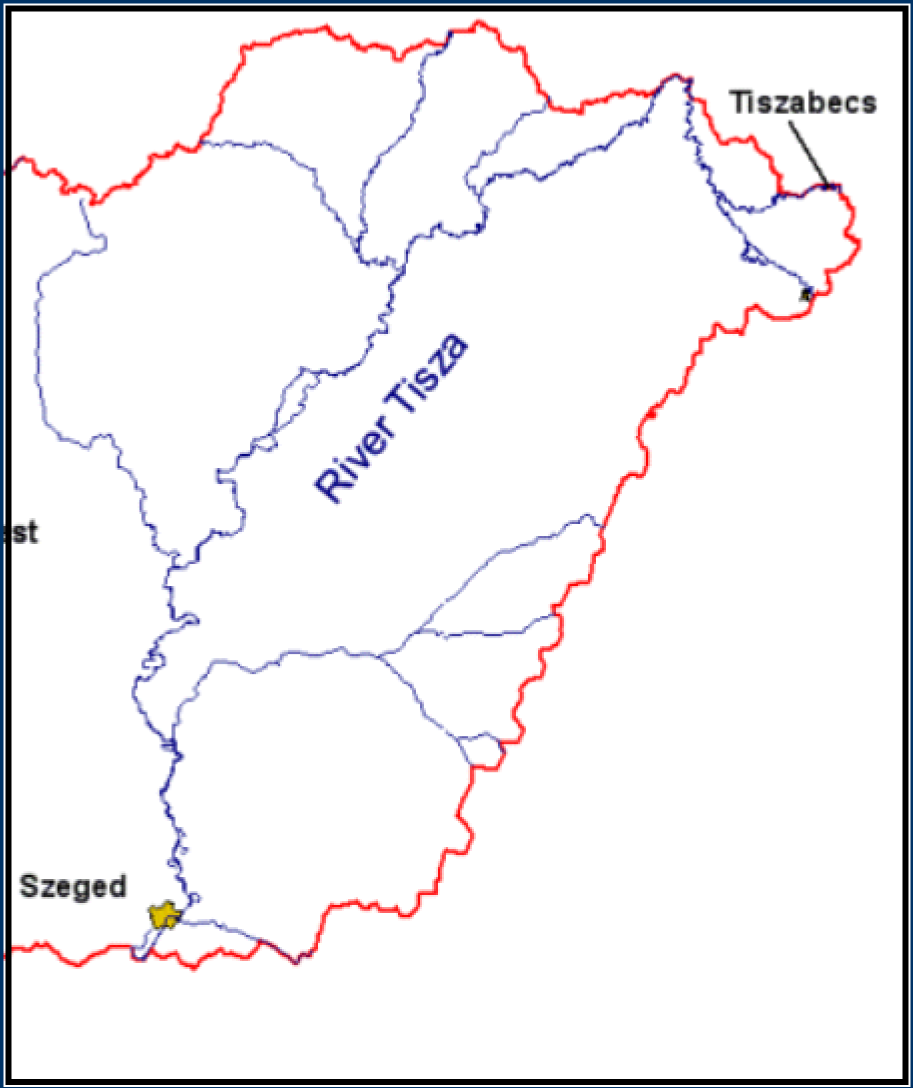
Danube
Tisza
0 100 200 300 Kilometers

# The Hungarian Tisza



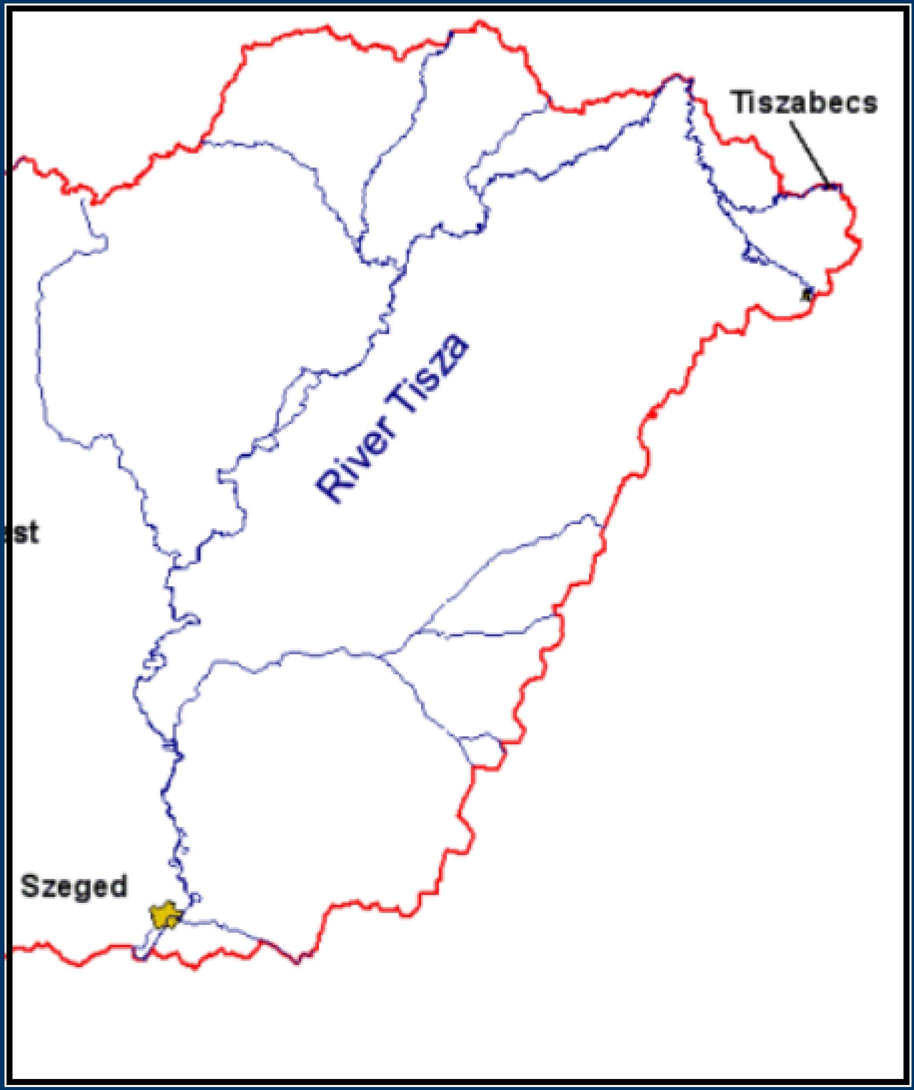
# The Hungarian Tisza

- boundary sections:
  - Tiszabecs
  - Szeged
- frequency of considerable floods : 5-6 years
- max. duration: 15-120 days (Lower-Tisza)
- max. rising rate of water levels: 6 m per day (Upper-Tisza)



# The Hungarian Tisza

- continuous increasing of the highest water levels
  - climate change
  - changing land use on the catchment area
  - floodplain sedimentation
  - construction of dykes
- unexpected floods in the last decade
  - November 1998
  - March-April 1999
  - April 2000
  - March 2001
  - April 2006



The flood in March 2001 resulted in a dam-break.

# The Hungarian Tisza

- need of a novel flood control strategy
  - existing elements of the system
  - novel solutions

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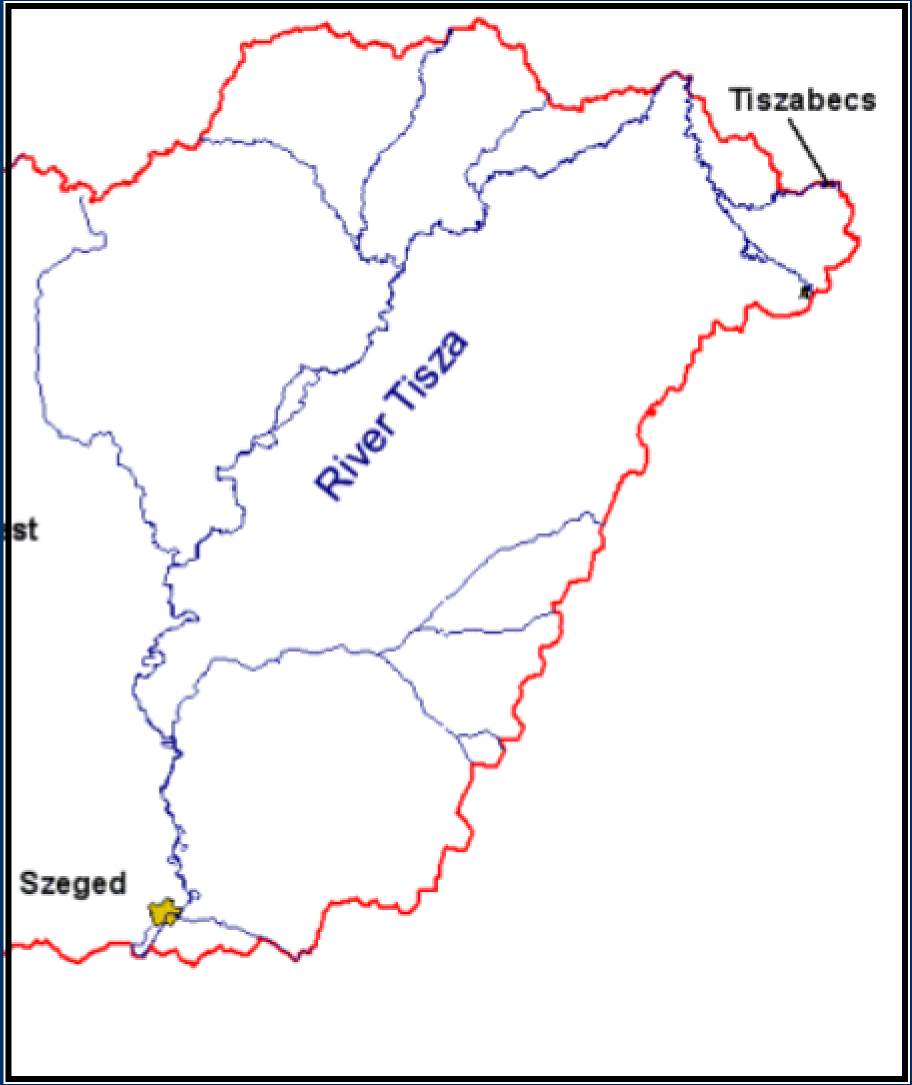
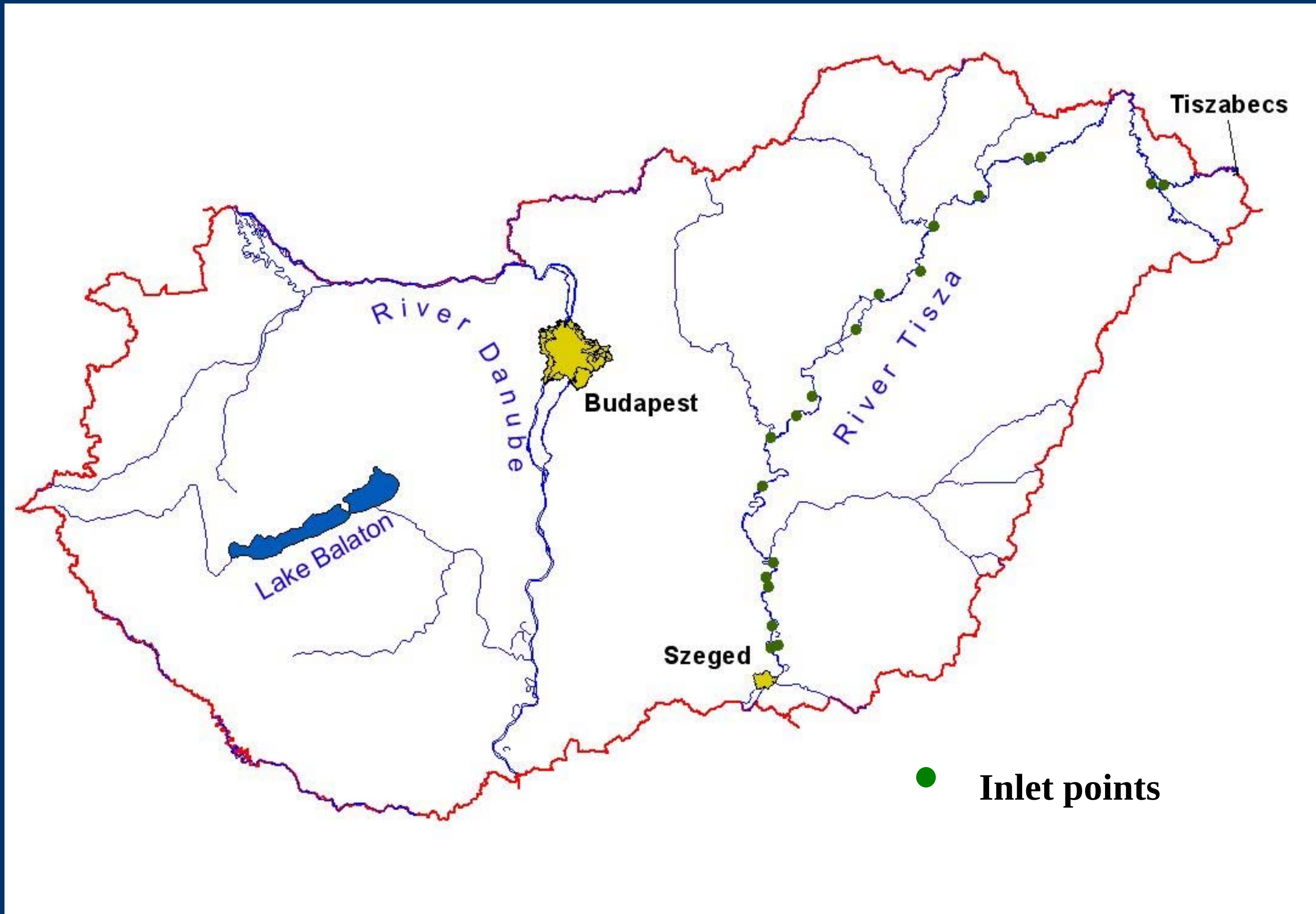
- deep flodplain inundation
  - ecological aspect & landscape protection
  - low construction & maintenance cost

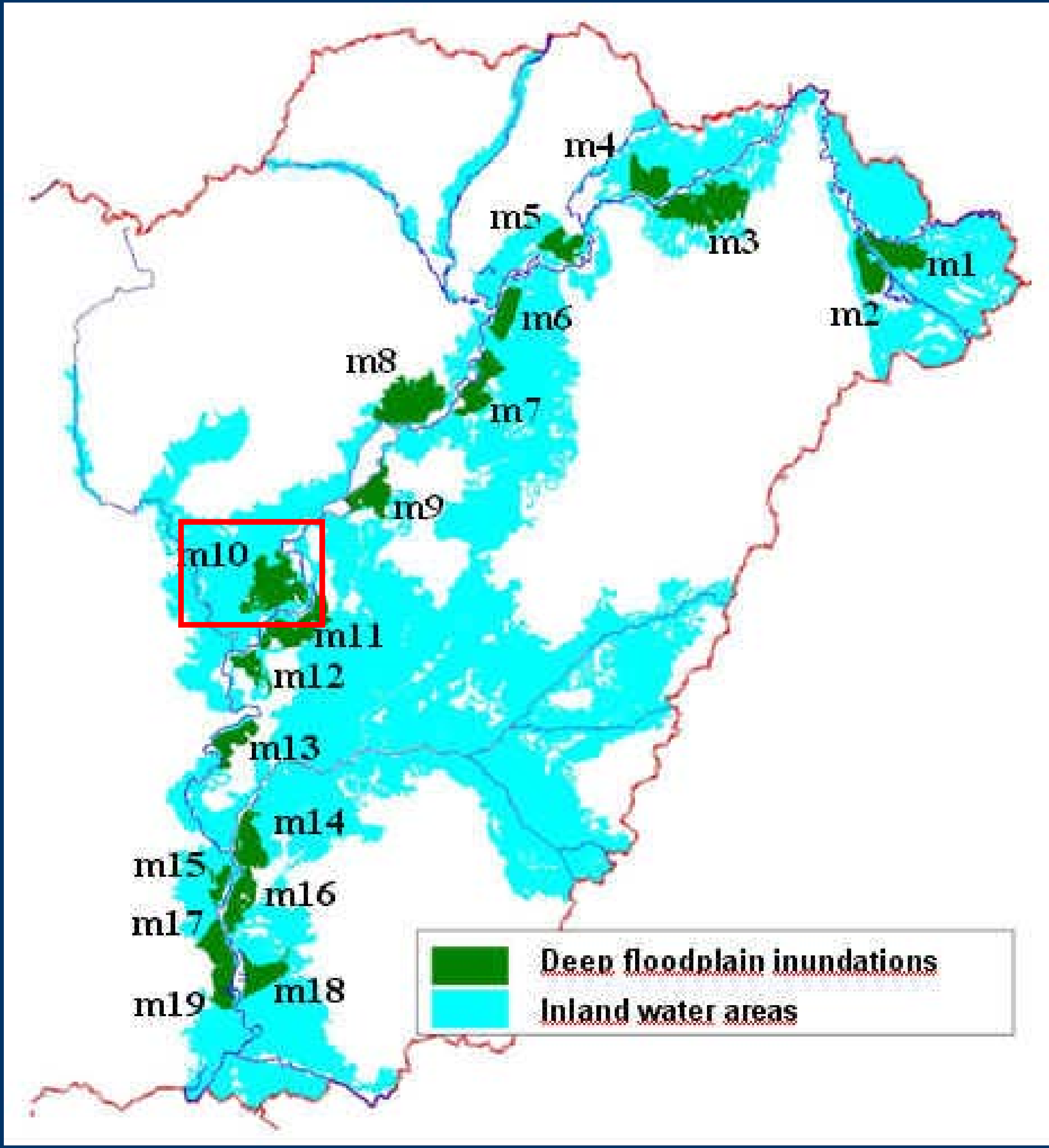


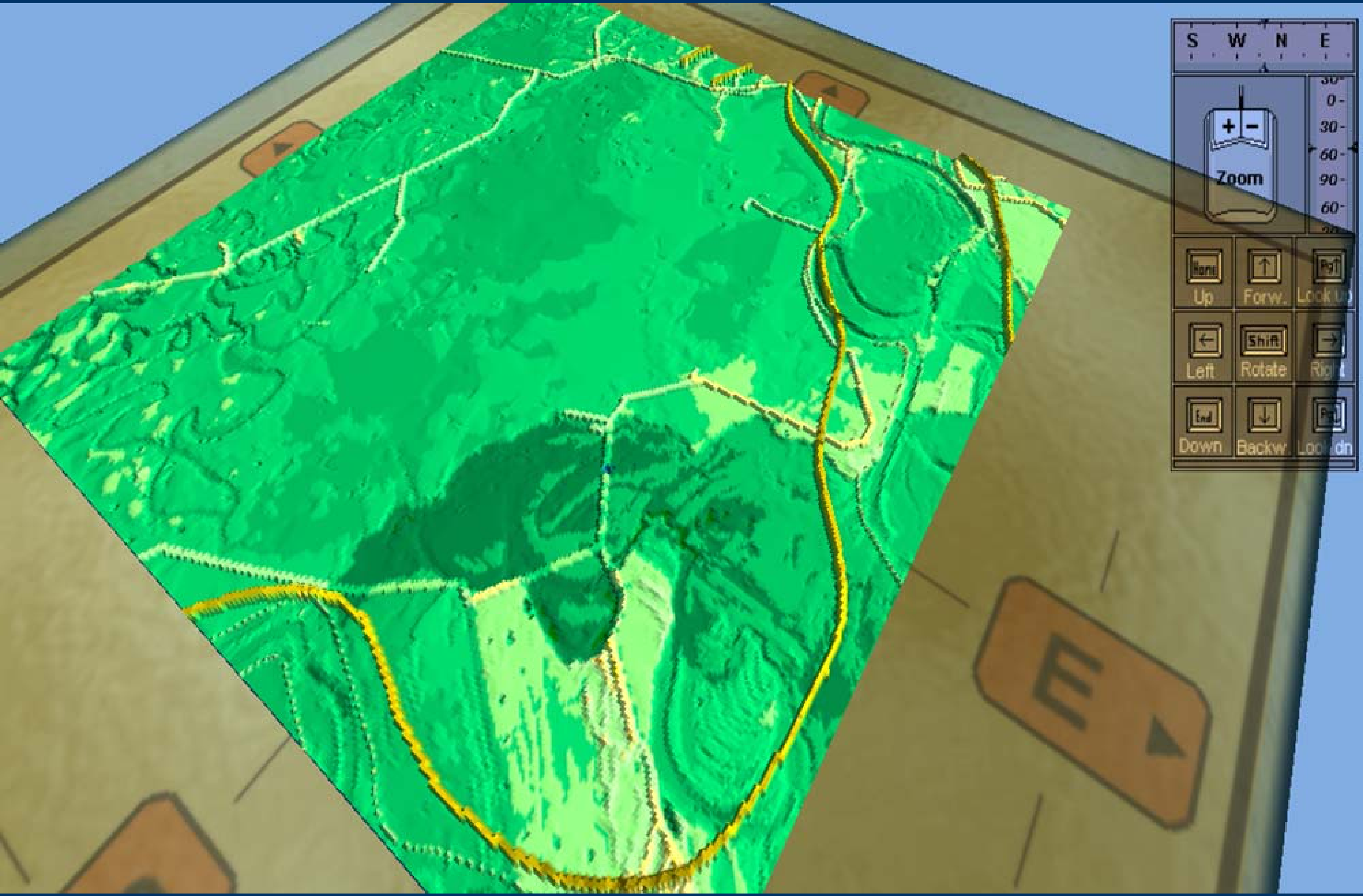
# Methodology I.
## Selecting of appropriate deep floodplains

- 19 morphologically appropriate areas
- storage capacity:
more than 50 million $m^3$
- largest volumetric capacity:
exceeds 200 million $m^3$
- summerized capacity:
exceeds $2 \times 10^9$ $m^3$



# Location of the inundated deep floodplains





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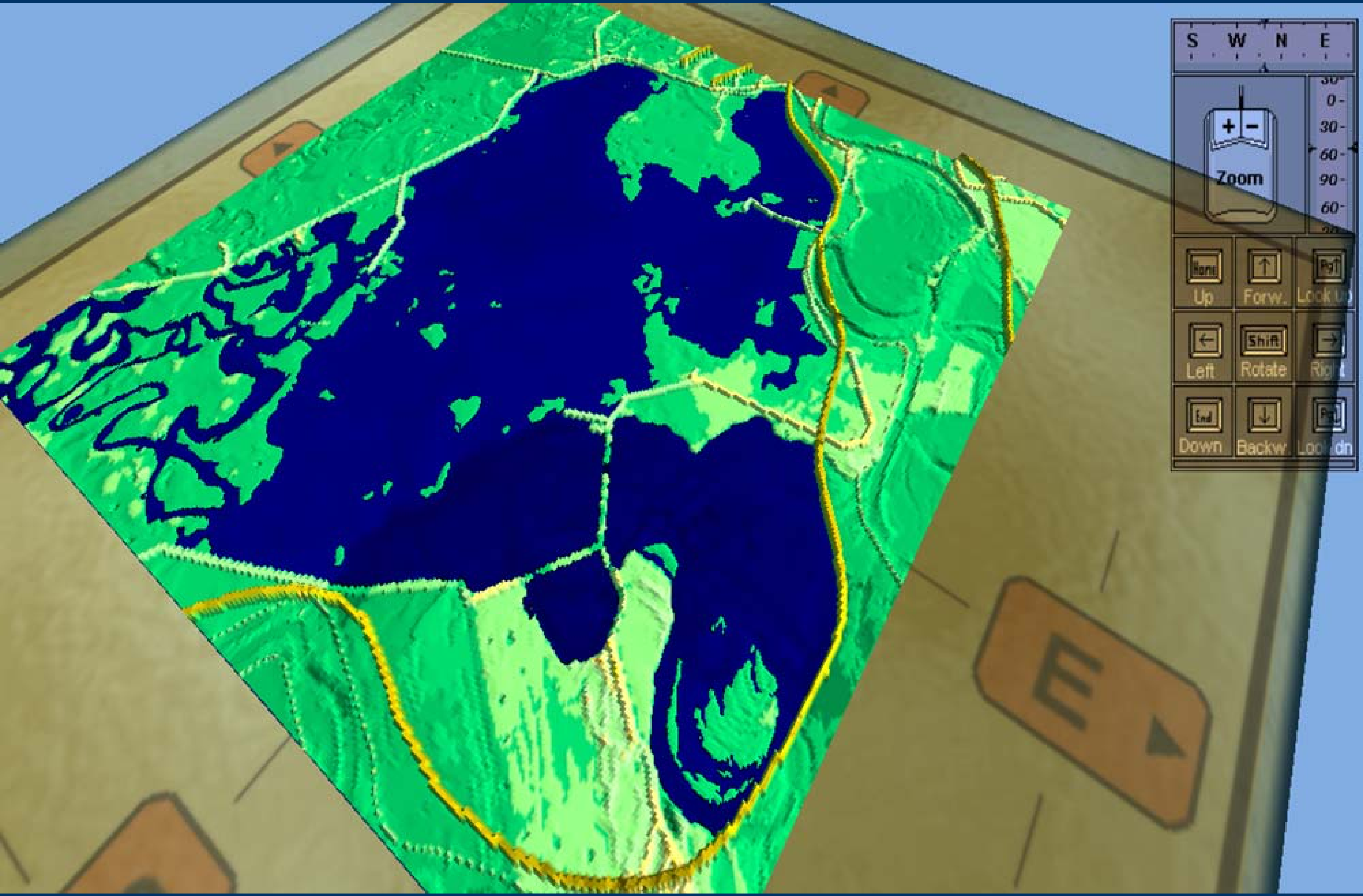
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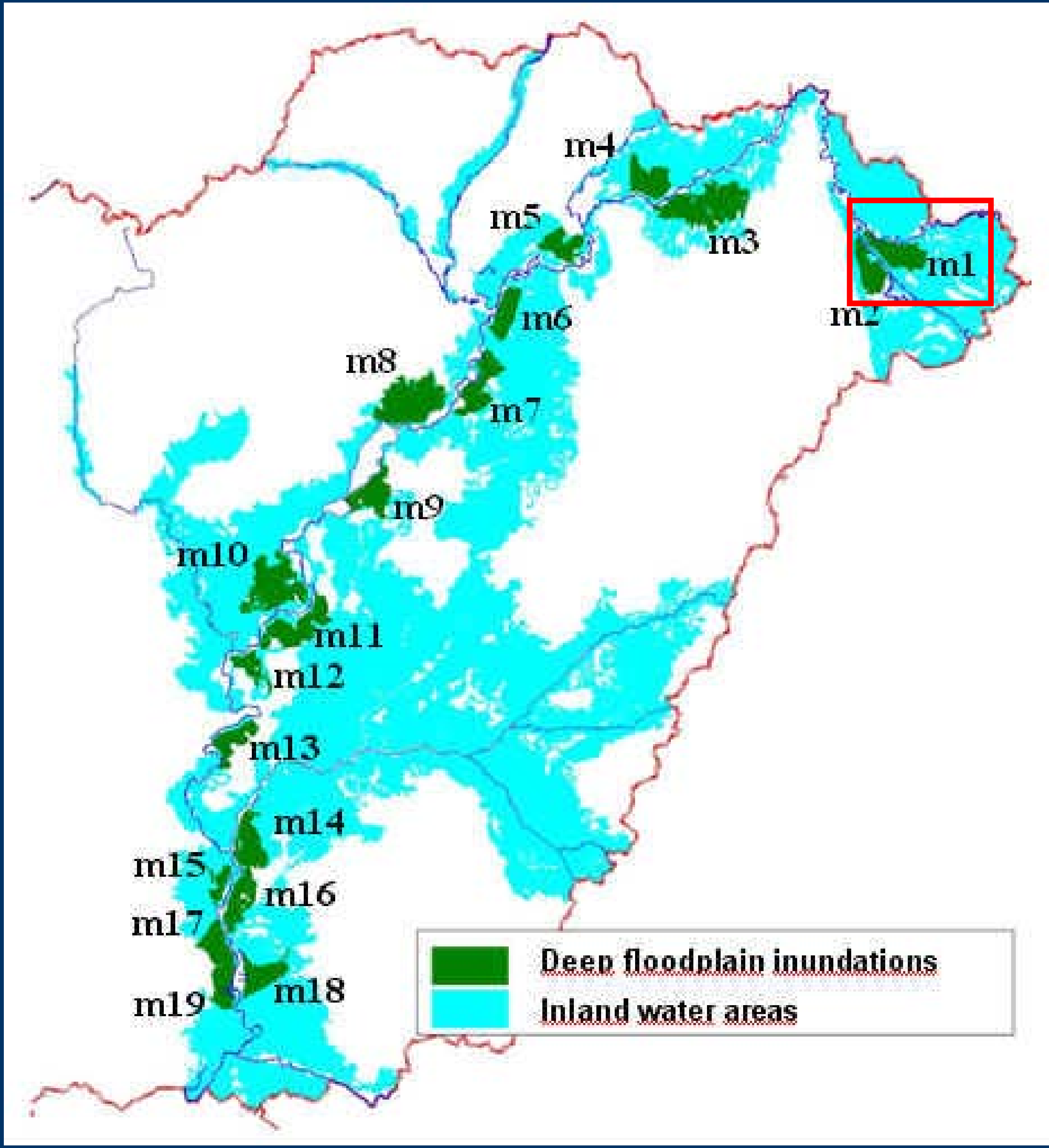
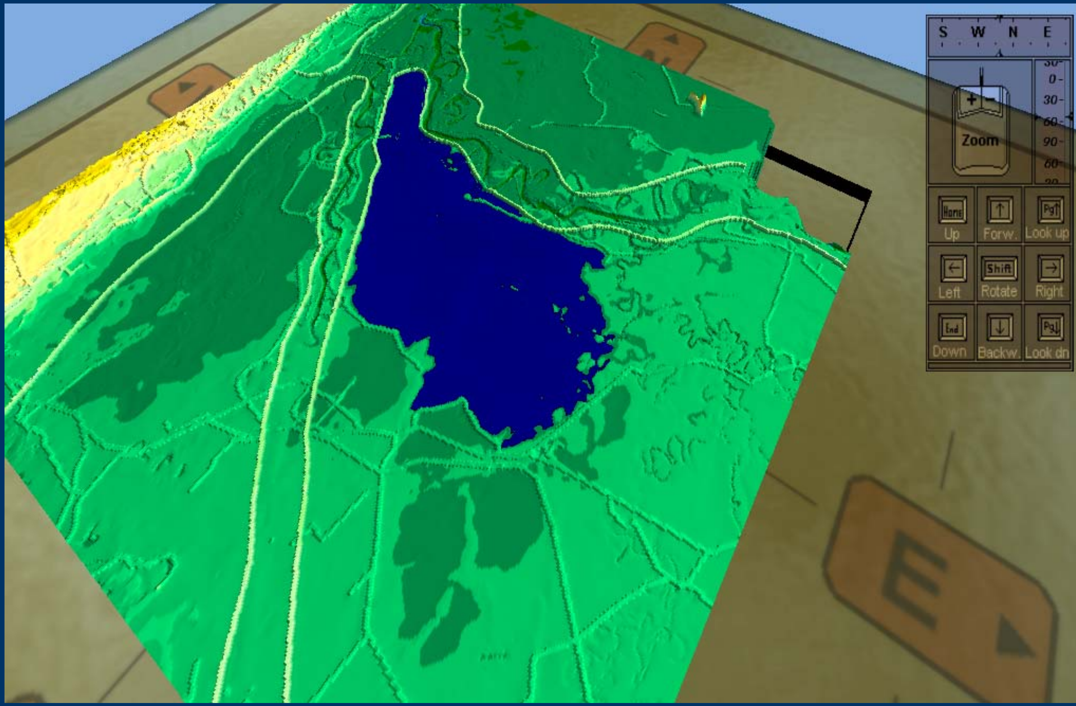
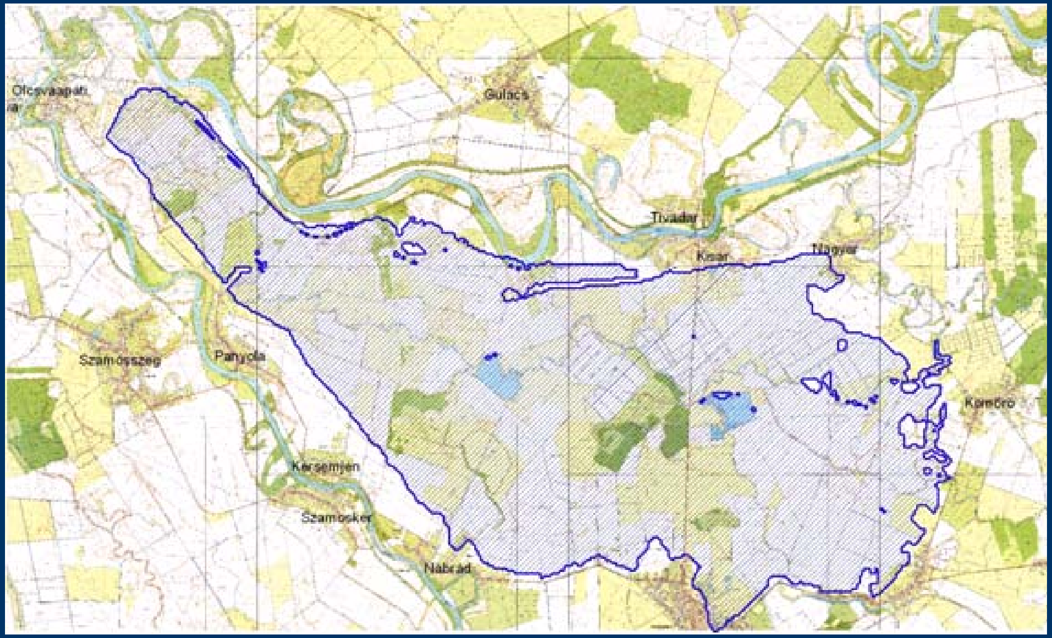
# Location of the inundated deep floodplains



# Inundated deep floodplain („m1”)




3D morphological model




Layout with the affected settlements

# Methodology II.
## Determining of storage functions

- static inundation model
  - matching volume and water level values step by step
  - fitting linear/quadratic function
  - approximate storage curve
- morphological model
  - resolution: 50 x 50 m
  - linear objects !
- simple algorythm
  - comparing of the actual water surface level with the altitude of the cells
  - calculating of the actual volume

# Methodology III.
## Decreasing effect on highest water levels

- 1D unsteady hydrodinamic model
  - based on the Saint-Venant equations
  - boundary conditions: historical discharge data (1998, 2000, 2006)
  - withdrawal discharge: Poleni weir formula
  - current water level in the „reservoir”: theoretic storage function
  - different weir notch widths (0,5m; 1m; 5m; 10m; 20m)
  - result: longitudinal profile of the maximum water levels

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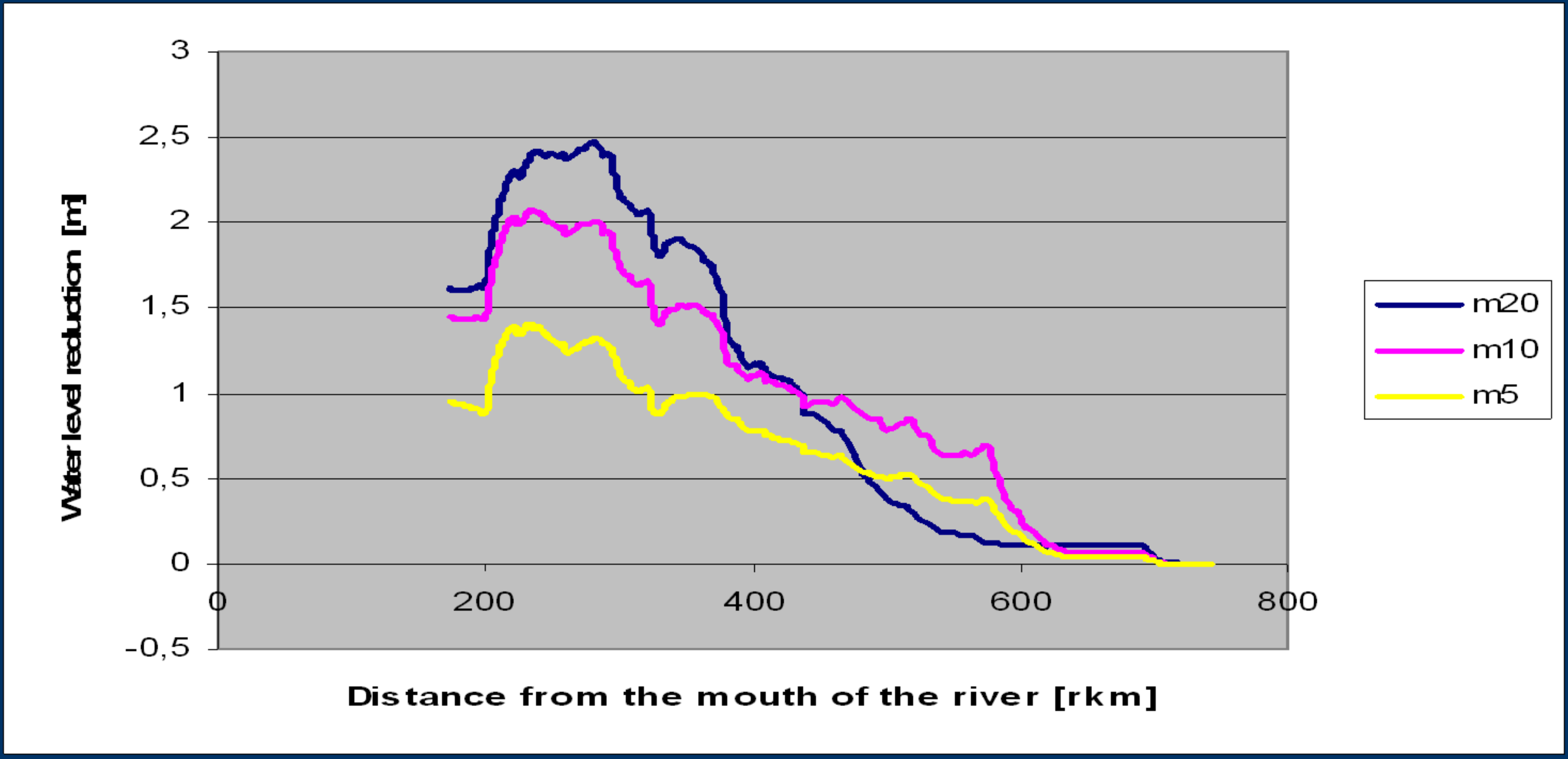
- longitudinal profile of water level reduction

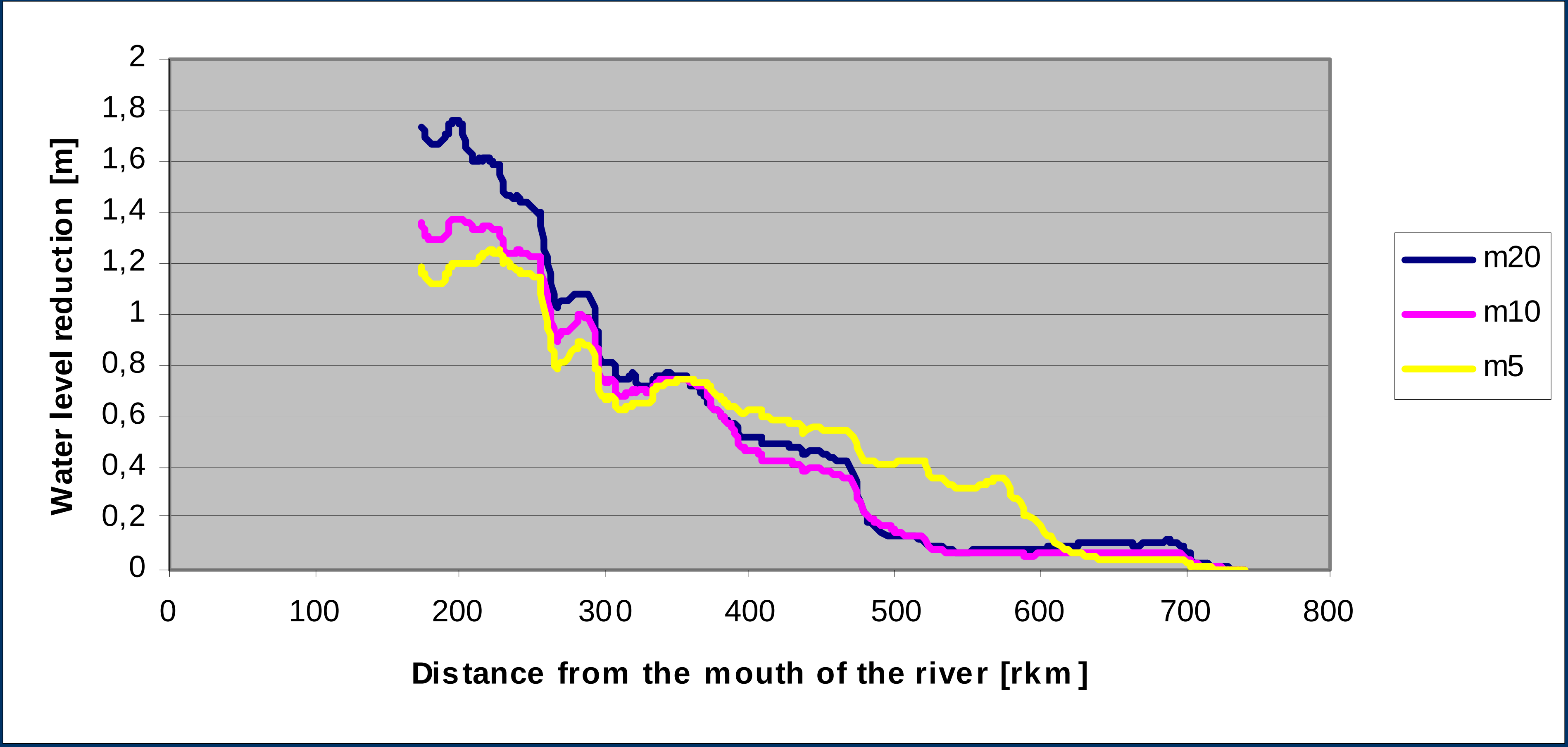
# Results

- flood wave in 1998
- weir notch width: 5m / 10m / 20m



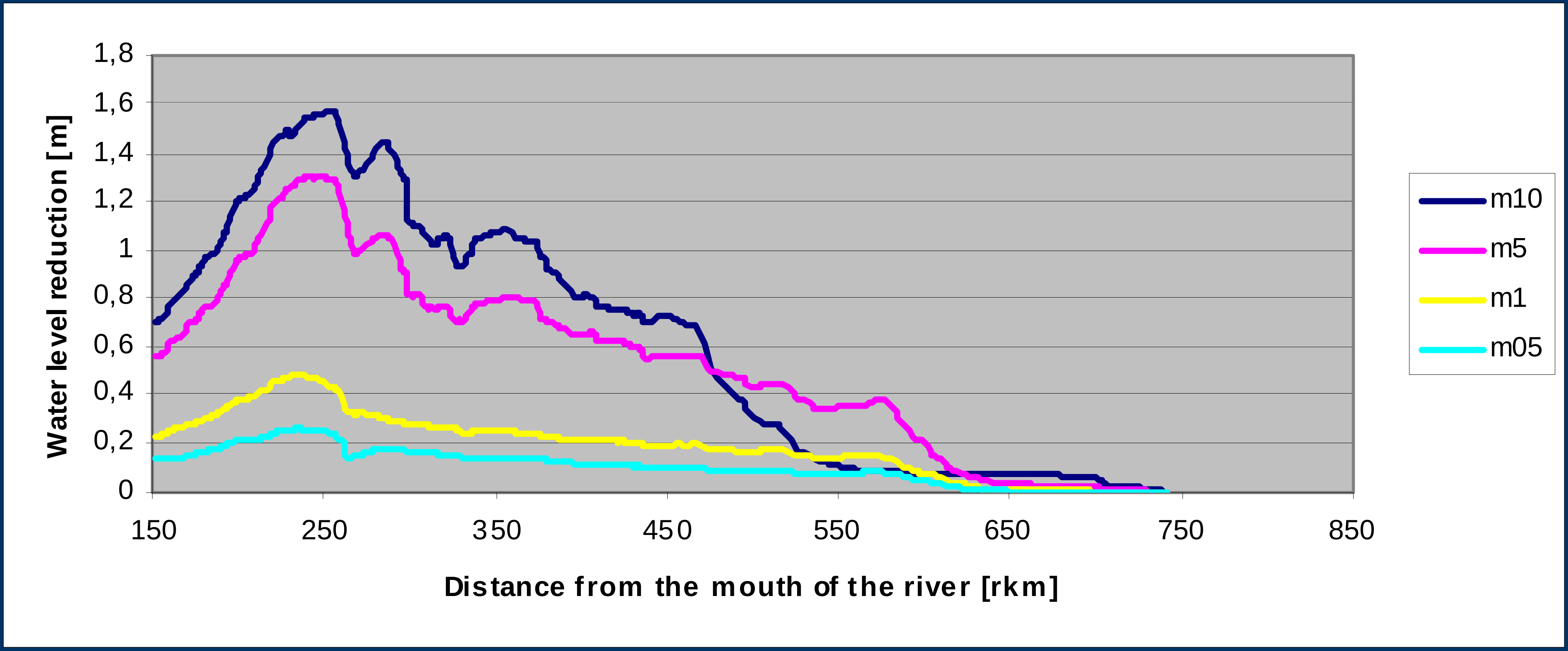
# Results

- flood wave in 2000
- weir notch width: 5m / 10m / 20m



# Results

- flood wave in 2006
- weir notch width: 0,5m / 1m / 5m / 10m



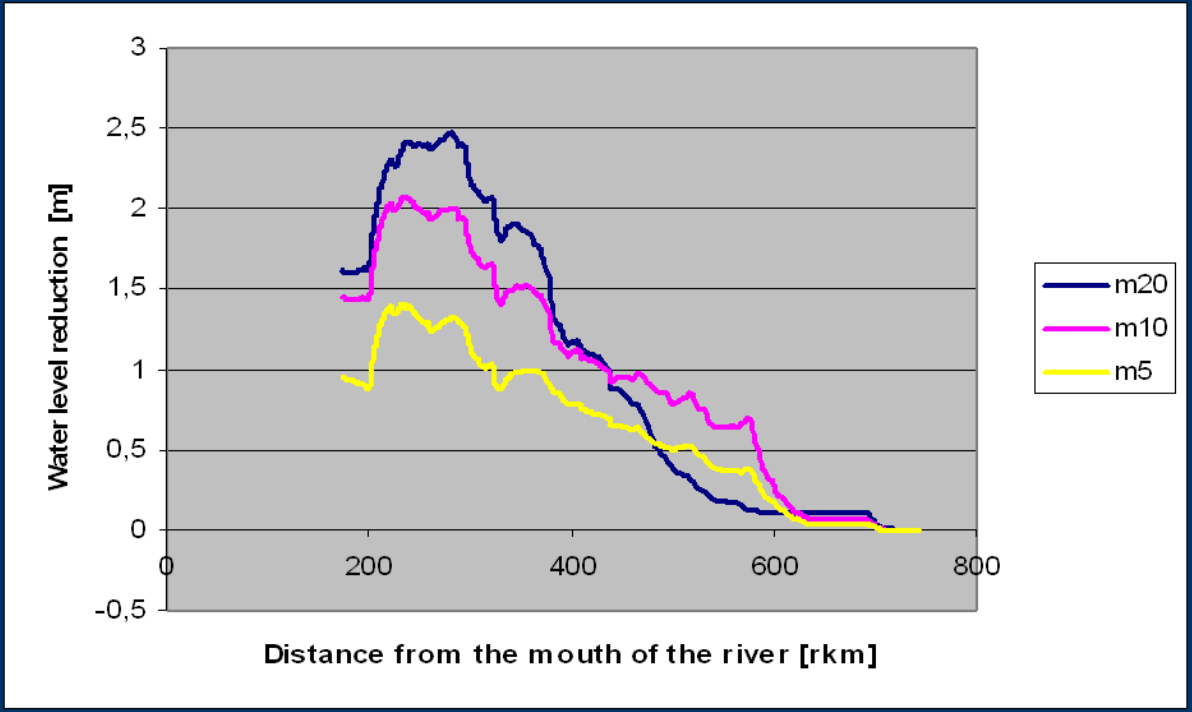
# Results

• significant decreasing in flood water levels (especially on the lower sections)

• the decreasing effect reduces definitely towards the upper sections

• flood wave in 1998:

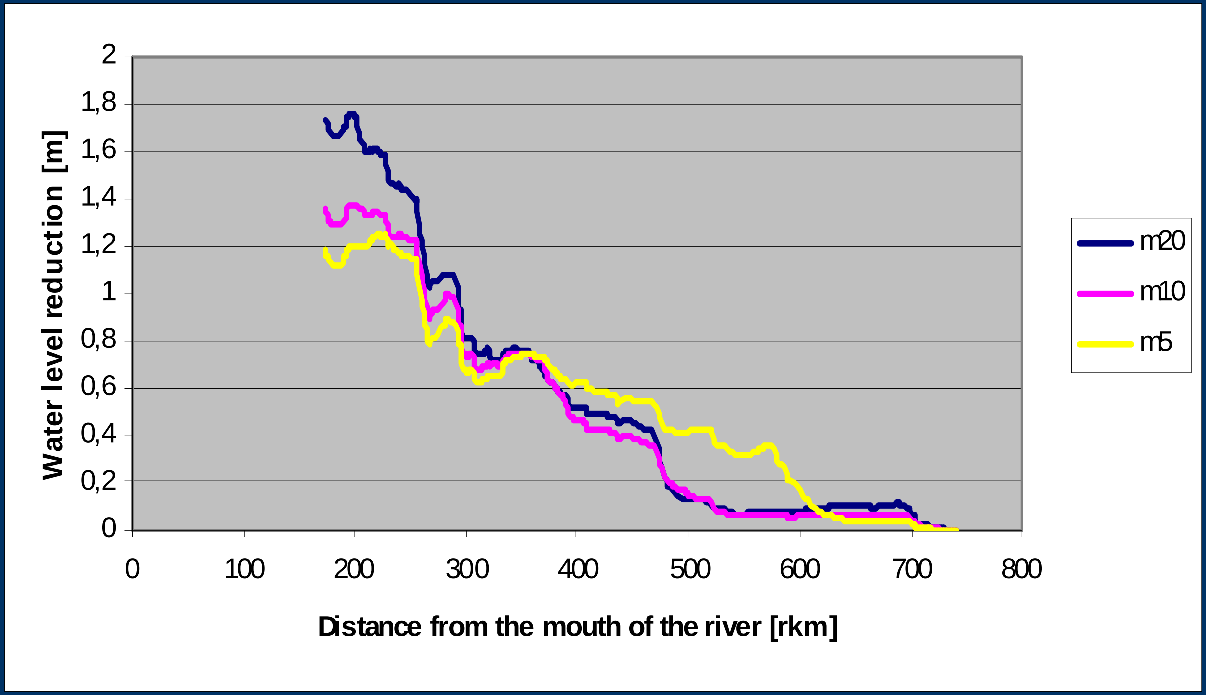
| weir notch width | decreasing effect |
|---|---|
| 20 m | 2,5 m |
| 10 m | 2,0 m |
| 5 m | 1,4 m |



# Results

- significant decreasing in flood water levels (especially on the lower sections)
- the decreasing effect reduces definitely towards the upper sections
- flood wave in 2000:

| weir notch width | decreasing effect |
|---|---|
| 20 m | 1,8 m |
| 10 m | 1,4 m |
| 5 m | 1,2 m |



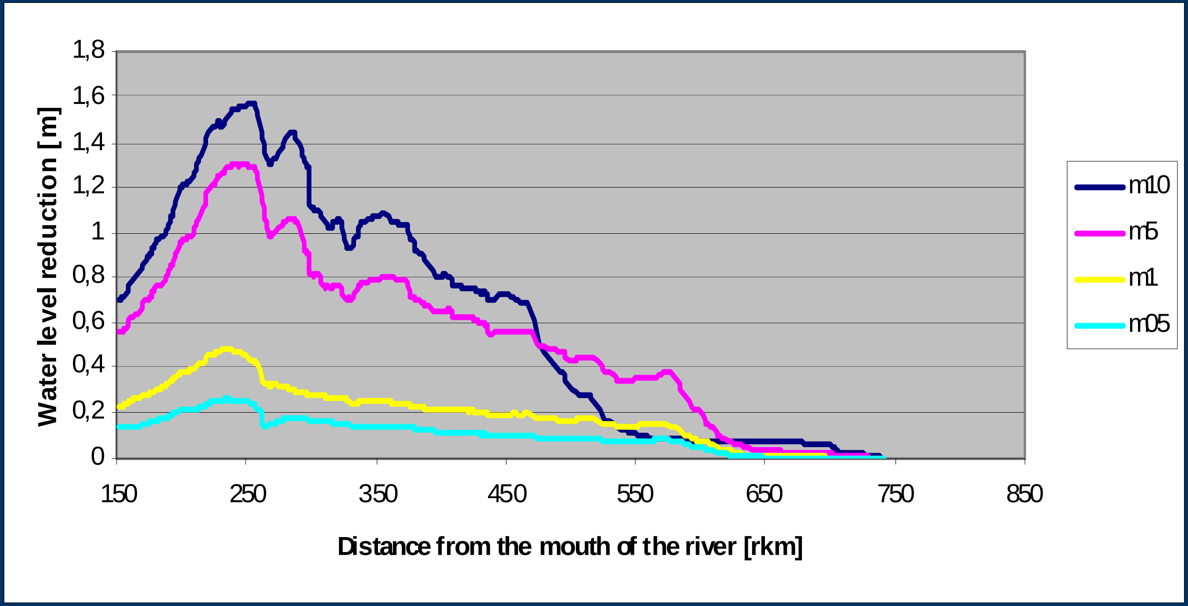
# Results

• significant decreasing in flood water levels (especially on the lower sections)

• the decreasing effect reduces definitely towards the upper sections

• flood wave in 2006:

| weir notch width | decreasing effect |
|---|---|
| 10 m | 1,6 m |
| 5 m | 1,3 m |
| 1 m | 0,5 m |
| 0,5 m | 0,2 m |




• effectiveness of storage on the deep floodplains reaches the efficiency of the emergency reservoirs

# Conclusions

- inundation of deep floodplains is a quite efficient method to decrease the flood water levels
- the decreasing effect is considerable mainly on the middle and lower sections of the Hungarian Tisza
- the decreasing effect can reach even 2-2,5 m - it reaches the estimated efficiency of the planned Hungarian emergency reservoirs
- simple operation strategy
- well-founded estimation would require a more complex indicator (needed costs, prevented damages…)