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4th International Symposium
on Flood Defence

Impact Assessment Study of Planned Flood Retention Reservoirs in the Upper-Tisza Basin, Based on Model Simulations

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Where is Tisza Basin situated?

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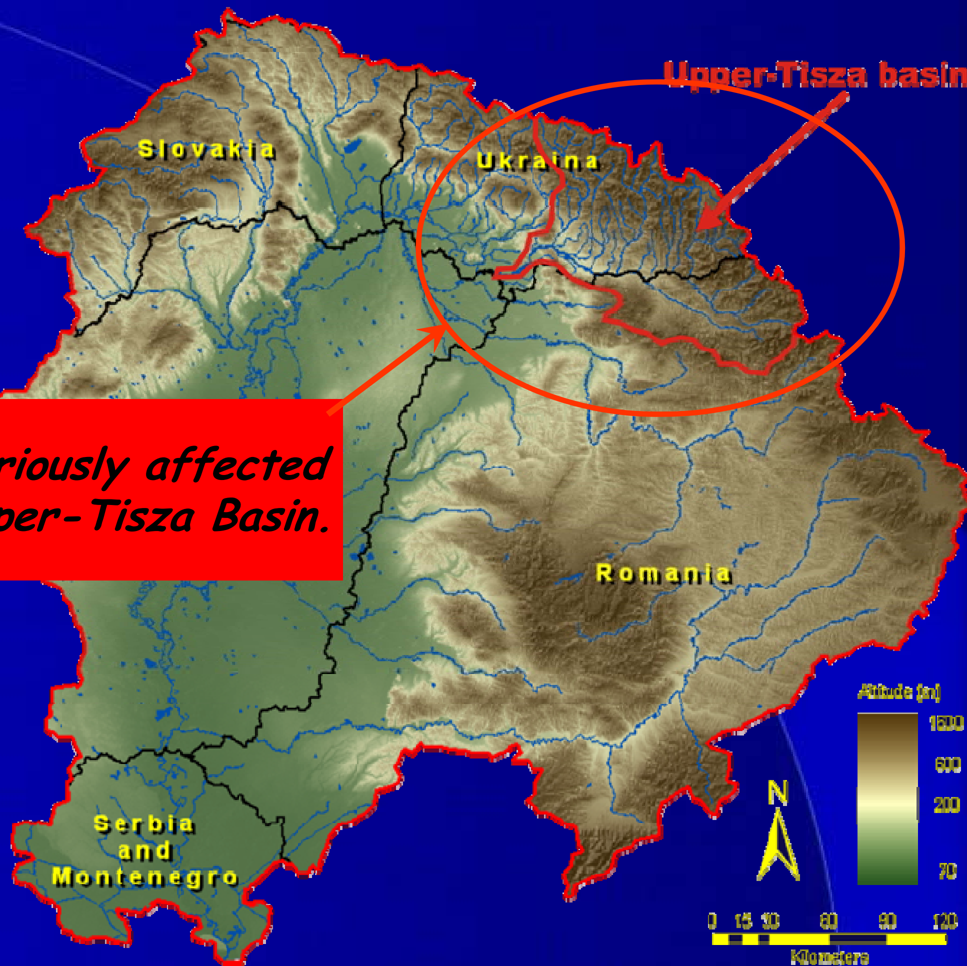
Some important characteristic of the catchment

- Five countries fall within the basin:
  - Ukraine,
  - Romania,
  - Slovakia,
  - Hungary and
  - Serbia-Montenegro.
- Length: 966 km with 154.039 sq km
- Highest point: 2506 m
- Climatic conditions:
  - mean annual t... 10-11 °C on ... 6-9 °C on mountains
  - mean annual precipitation: 500 - 600 mm on the lowland; 1200- 1800 mm on mountains
- Floods:
  - are quite violent,
  - rainfall, snowmelt produced and mixed floods all are frequent
  - During the last 30 years has been effected more than 100 flood events

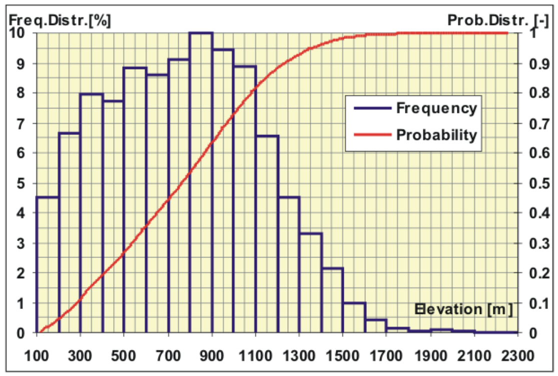
Area that most seriously affected by flood is the Upper-Tisza Basin.



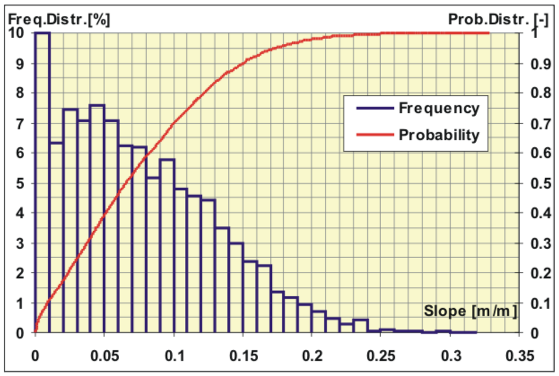
Some important characteristic of the Upper-Tisza Basin

Climatic conditions:
mean annual temperature: 6 - 9 °C
mean annual precipitation: 1000 - 1800 mm

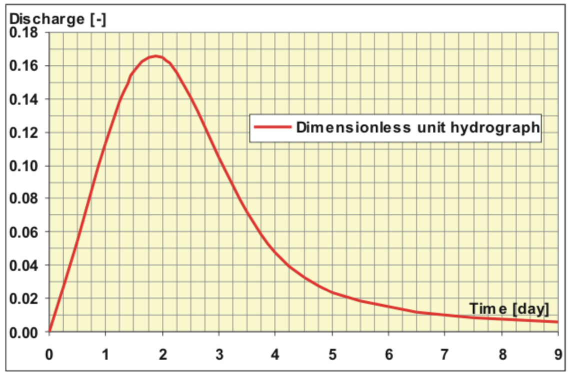
Most catastrophic floods (record):
- *November 1998:*
  - *2984 destroyed houses,*
  - *24340 evacuated,*
  - *48/12 damaged/destroyed bridges,*
  - *96.2 km destroyed roads.*
- *March 2001(record):*
  - *1674 destroyed houses,*
  - *13768 evacuated,*
  - *6/17 damaged/destroyed bridges,*
  - *52.7 km destroyed roads*



Elevation distribution



Slope distribution



dimensionless unit-hydrograph

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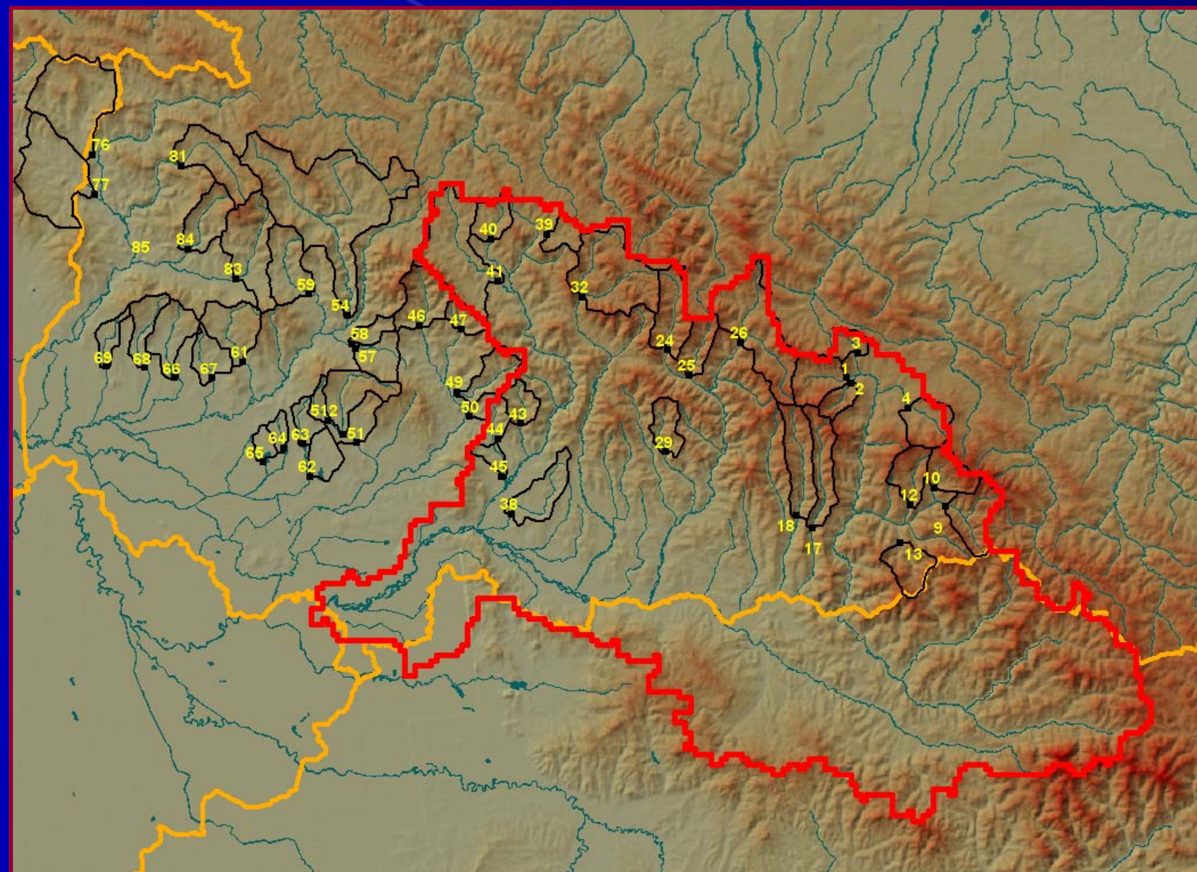
To avoid such damage in the future, the Water Management of Ukraine developed the:
„Scheme on Complex Flood Protection in the Tisza River Basin in Zakarpattia"

This plan (among others) envisages construction of 42 unregulated, flow-through type flood retention reservoirs on the mountainous tributaries of the Upper-Tisza Basin to reduce the flood discharge.



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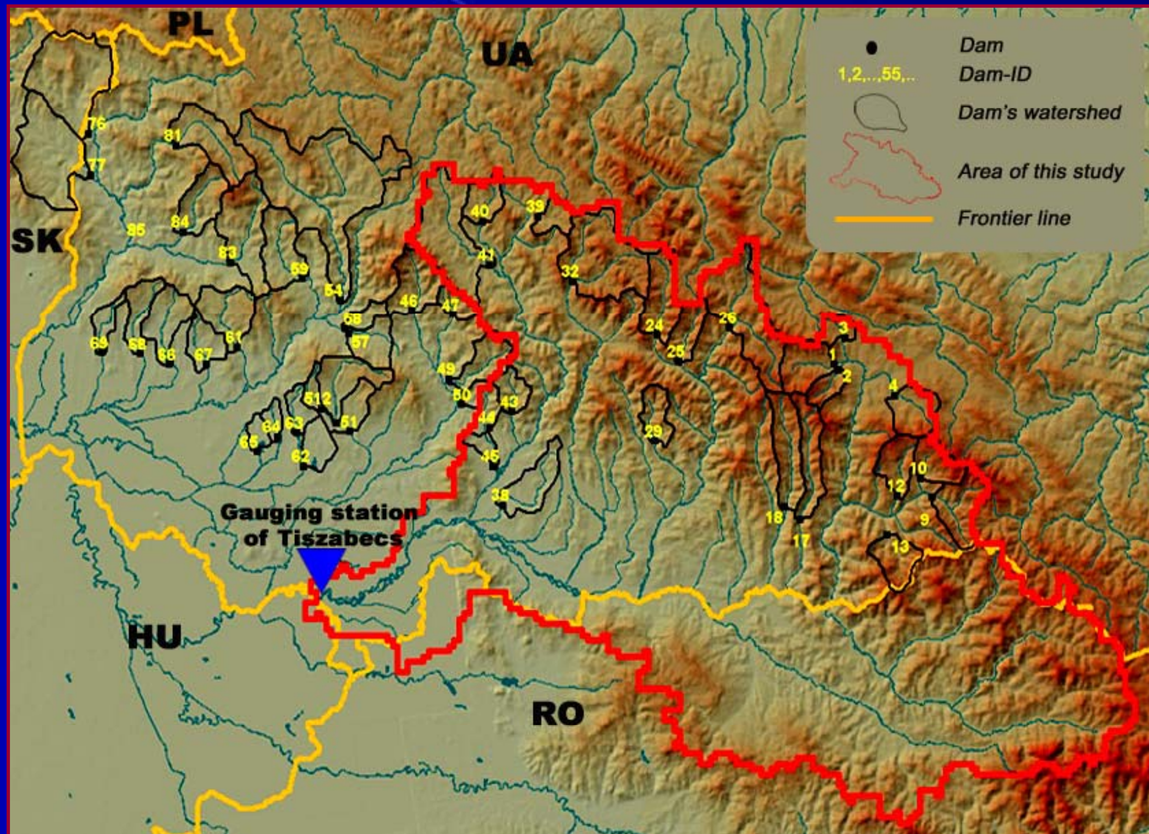
The goal of this study is to analyze the influence of the planned flood retention measures for the Hungarian part of the river on the border-gauge of Tiszabecs

Methodology overview:

analyzing catchment-responses to

- *spatially distributed probable maximum precipitation (SDPMP) for 1, 3 ,and 5 days duration*
- *on the most extreme catastrophic flood event of March 2001*

using the model DIWA (DIstributed WAtershed) based on condition that the reservoirs are implemented already on the basin.



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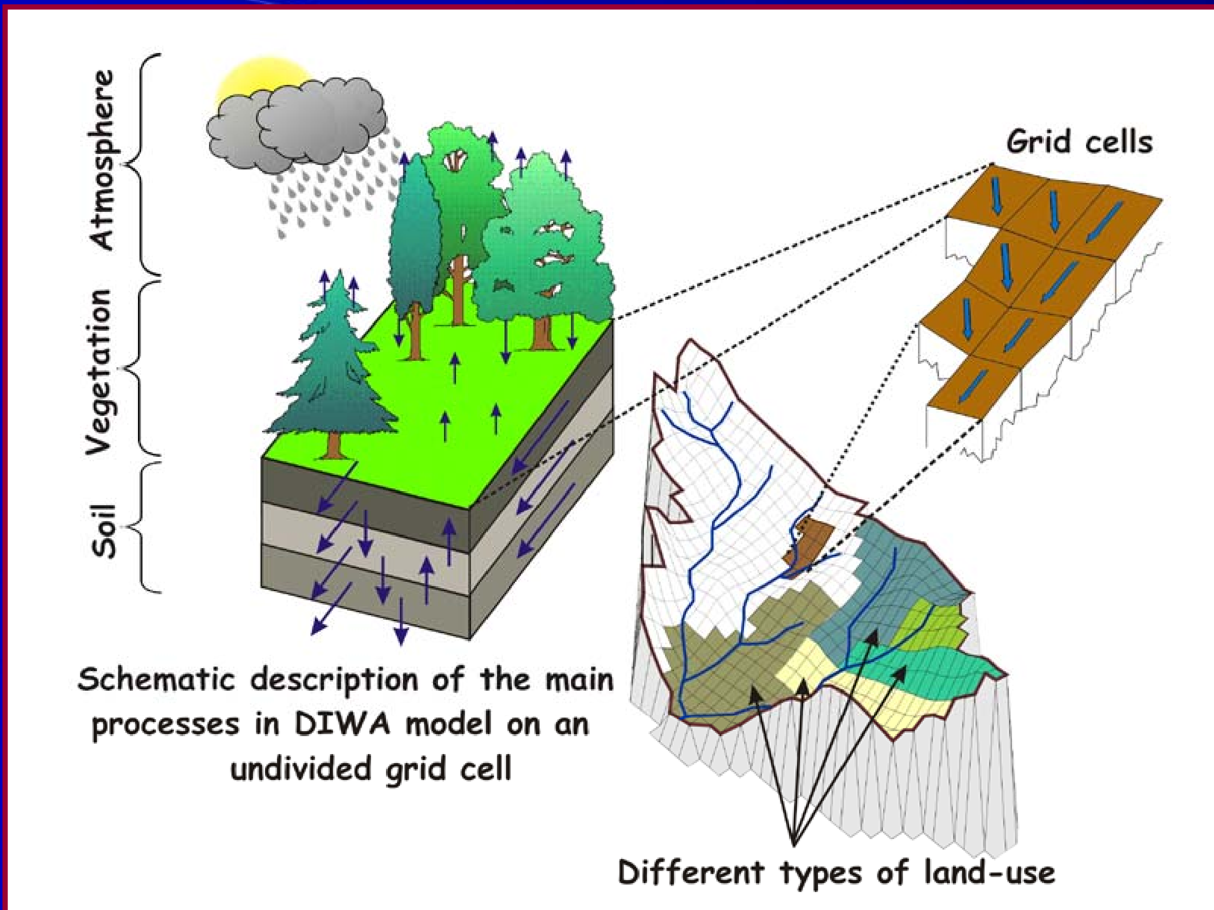
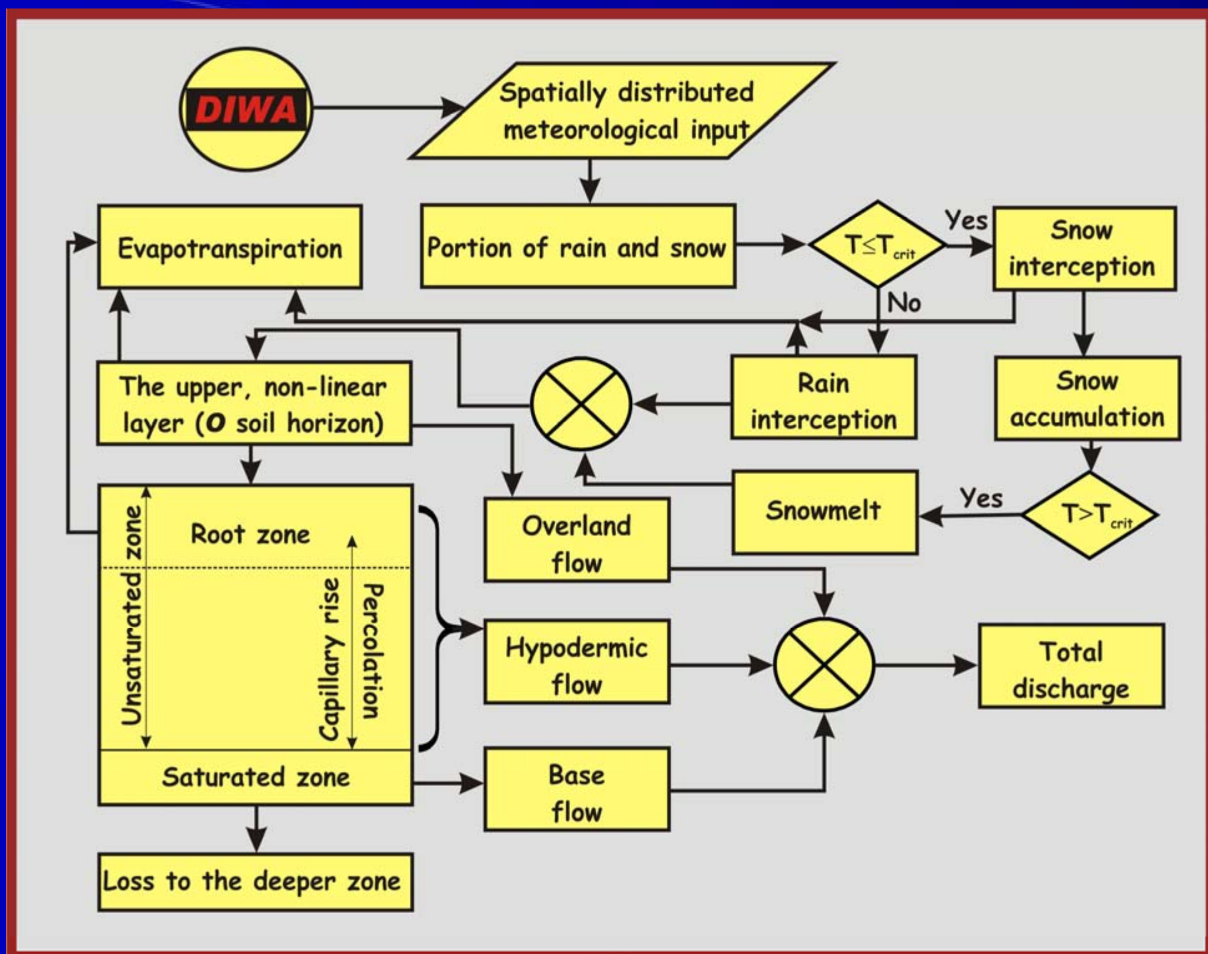
A brief overview of the simulation model DIWA (DIstributed WAtershed)

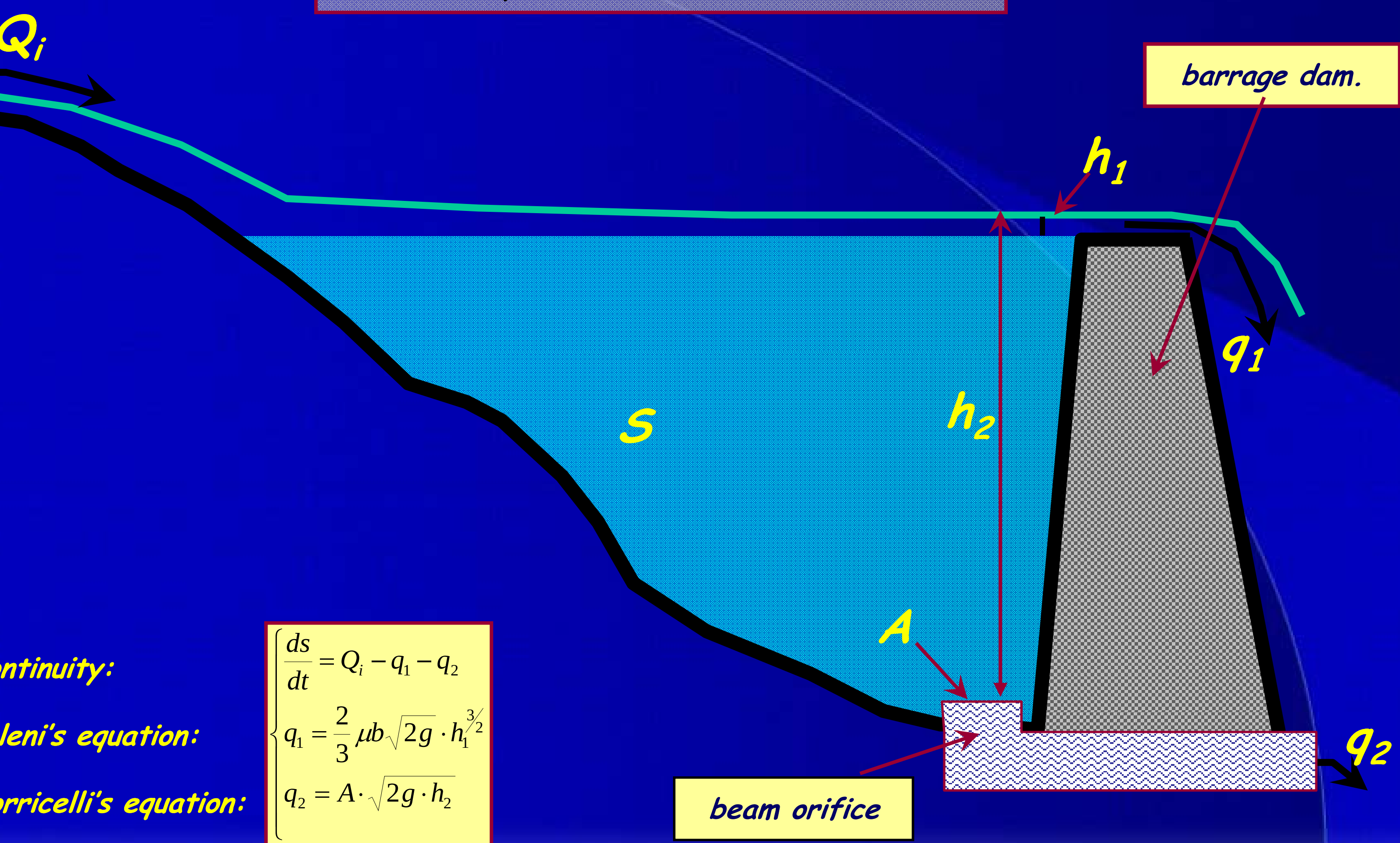


DIWA model is based on the distributed rainfall-runoff model philosophy (catchment is divided into basic elements: cells)



Simplified flowchart of DIWA model

Hydrodynamic sub model to simulate reservoir operation is also included

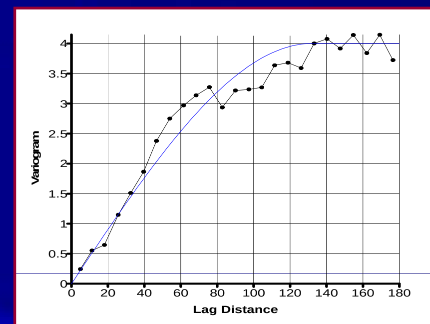


ntinuity: $\frac{ds}{dt} = Q_i - q_1 - q_2$

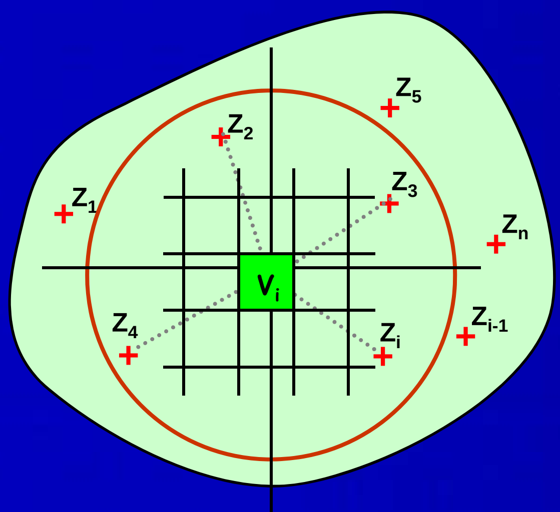
leni's equation: $q_1 = \frac{2}{3}\mu b\sqrt{2g}\cdot h_1^{3/2}$

rricelli's equation: $q_2 = A\cdot\sqrt{2g\cdot h_2}$

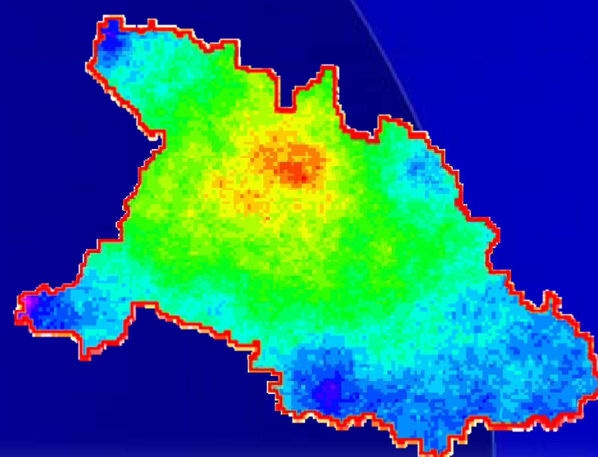
patial distributed meteorological data preparation (based on geostat. approach):



Step 1:
Variogram analysis of the land station data using automatic recognition of local anisotropy



Step 2:
Block-Kriging estimation of cell average value and its error variance



Step 3:
Conditional sequential Gaussian stochastic simulation.

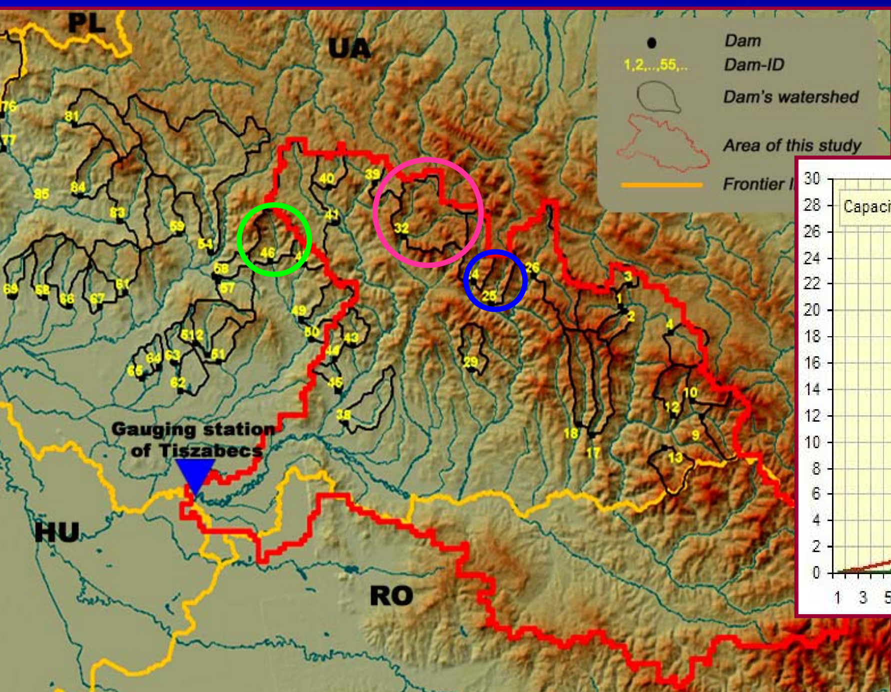
eoinformation data pre-processing and analyses of the reservoir characteristics:

ep 1:

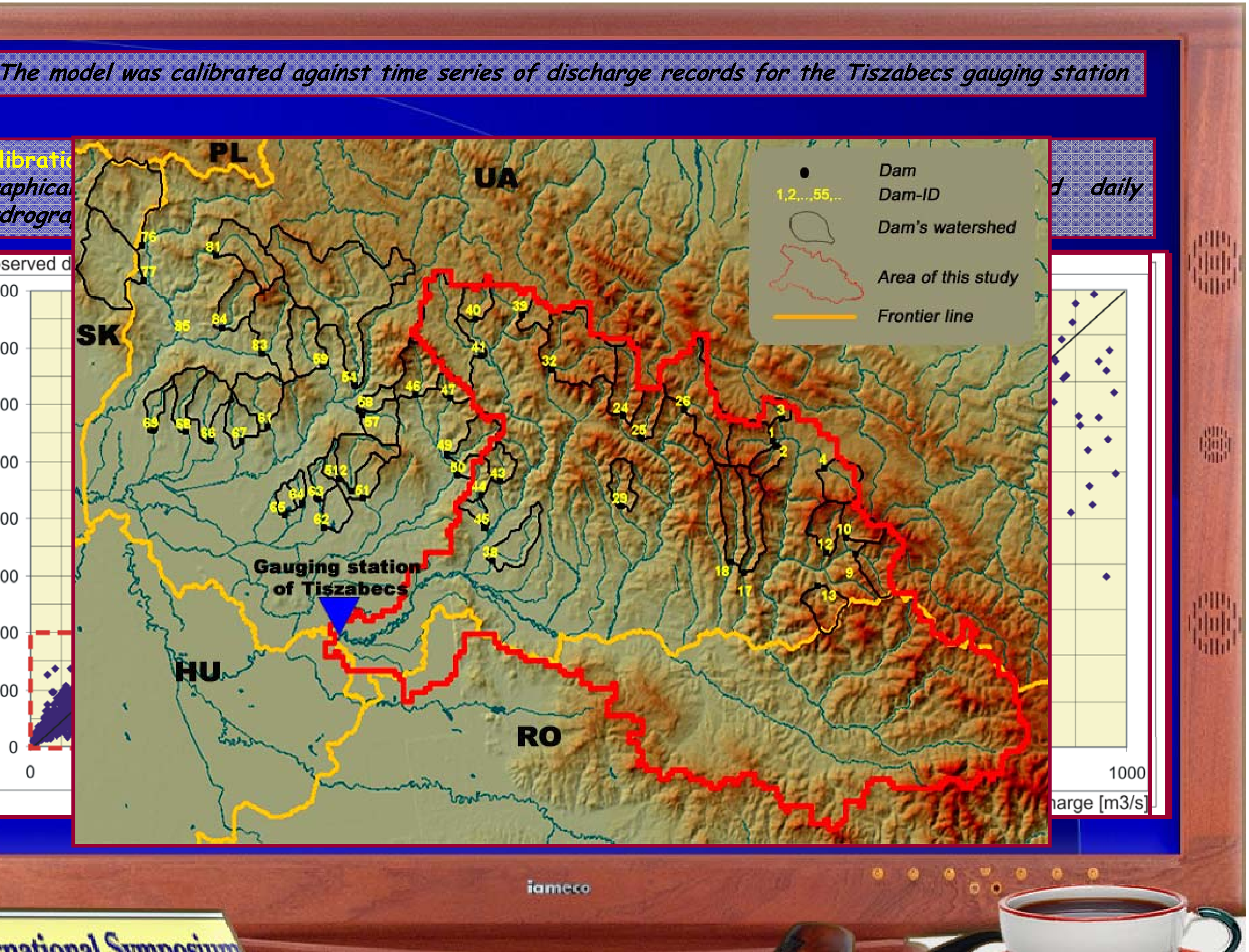
calization of dams using digital elevation model and its derivatives based on high resolution 00x100 meters) digital elevation model, corresponding to a vector river network representing real w-directions

ep 2:

fining capacity curves based on 10x10 meters resolution downscaled DEM.



Calibration and validation of the DIWA model


The model was calibrated against time series of discharge records for the Tiszabecs gauging station
Dam
1,2,..,55,..
Dam-ID
Dam's watershed
Area of this study
Frontier line
PL
UA
SK
HU
RO
Gauging station
of Tiszabecs
1000
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Results of the model runs

Catchment-responses to the spatially distributed probable maximum precipitation:

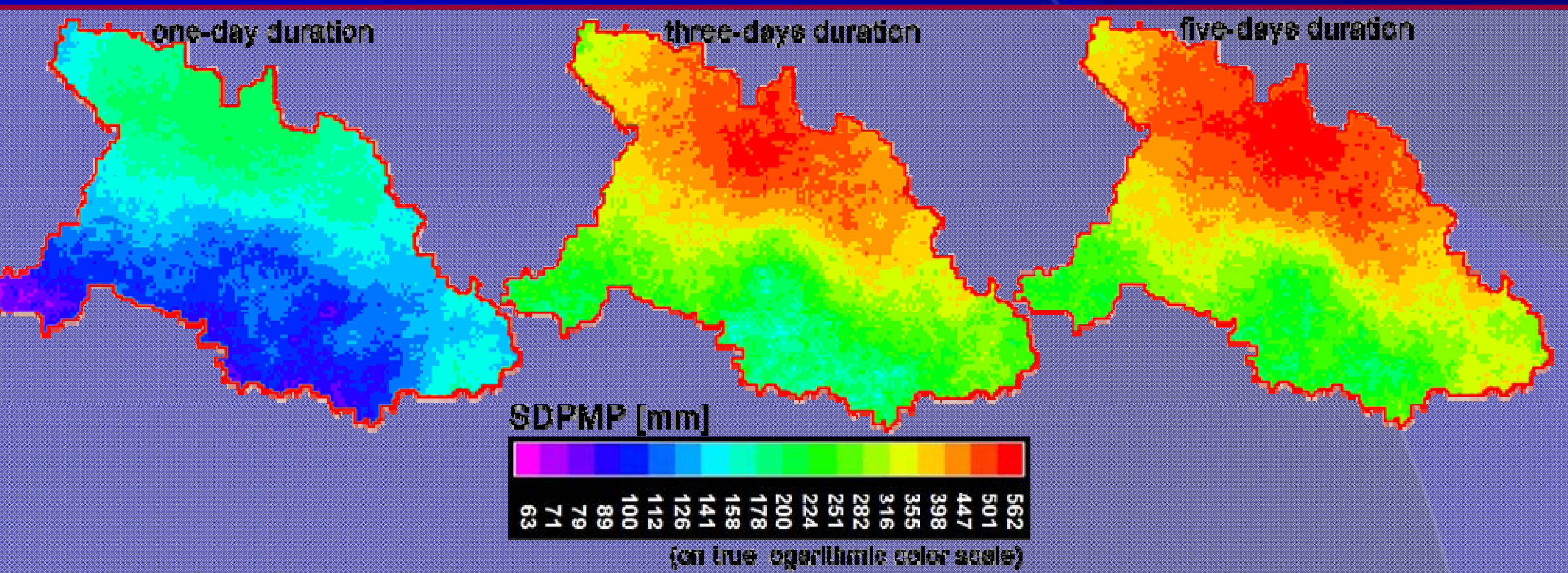
<u>Model run conditions</u>

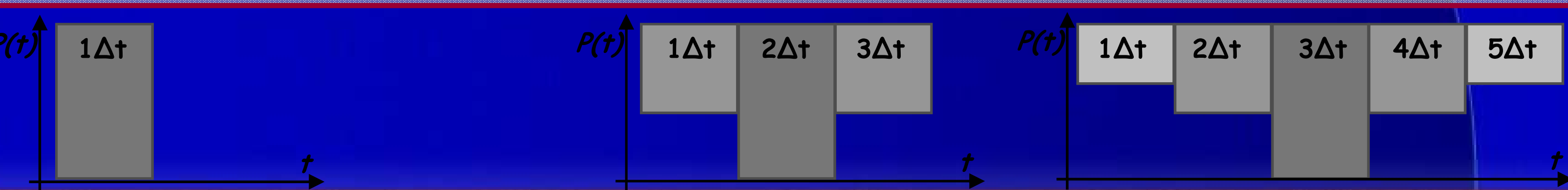
Season: *late spring*

Temperature and soil moisture: *average for the season*

Channel filling: *average for the season*

Precipitation: *one-, three- and five-days duration of SDPMP based on Hirschfield's statistical approach.*

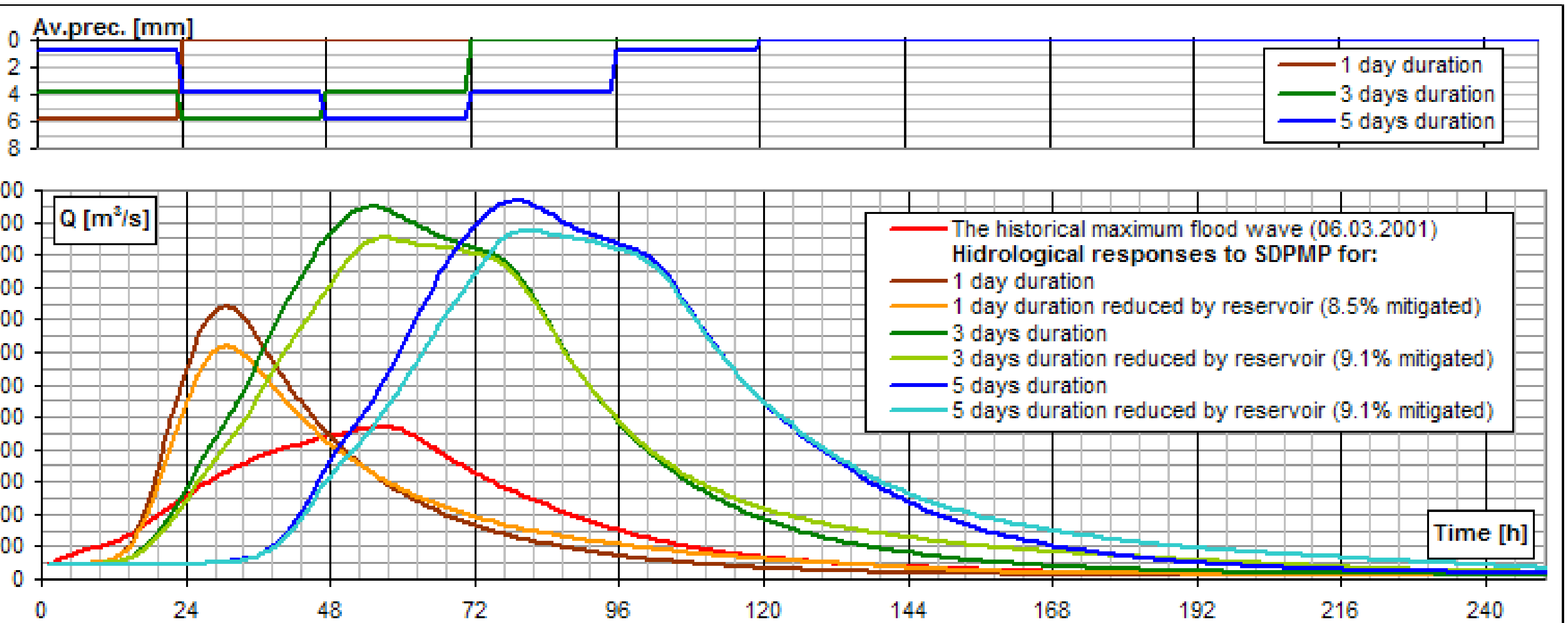




Catchment-responses to the spatially distributed probable maximum precipitation:

sults of the runs:

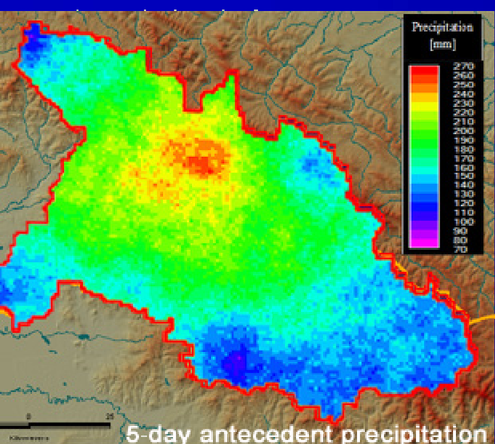
aphical interpretation of the model runs between regulated and unregulated nulations (hourly hydrograph at the Tiszabecs gauging station)



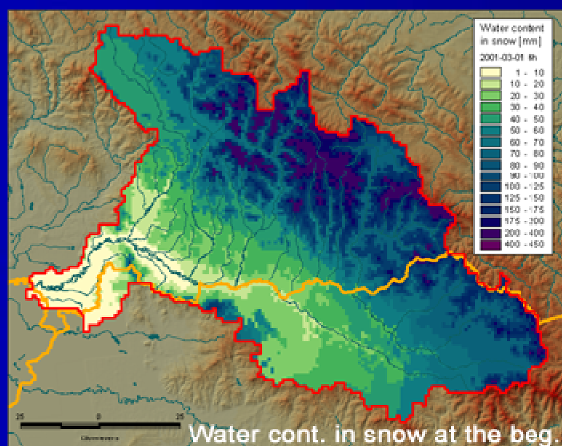
Impact assessment on the historical maximum flood event of 2001:

Model run conditions

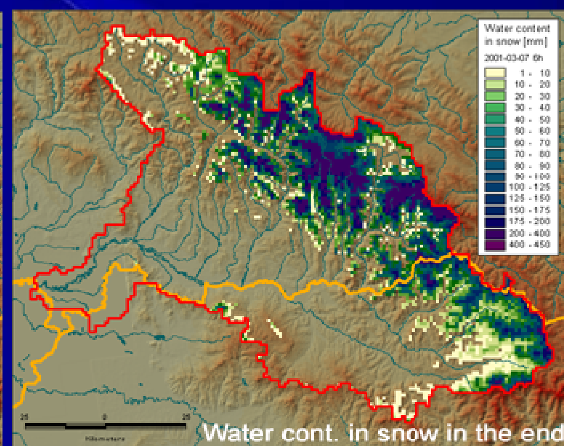
- *Season:* late winter
- *Temperature:* extremely rising gradient of temperature from -5 C^{o} to +5 C^{o}
- *Soil:* frozen
- *Channel filling:* less then the average for the season
- *Precipitation:* heavy rain and rapid snowmelt superposed in the mountains area



Cumulated precipitation for March 1-5 of 2001



Water content in snow at 1st of March



Water content in snow after melting, at 6th of March (c).

. Impact assessment on the historical maximum flood event of 2001:

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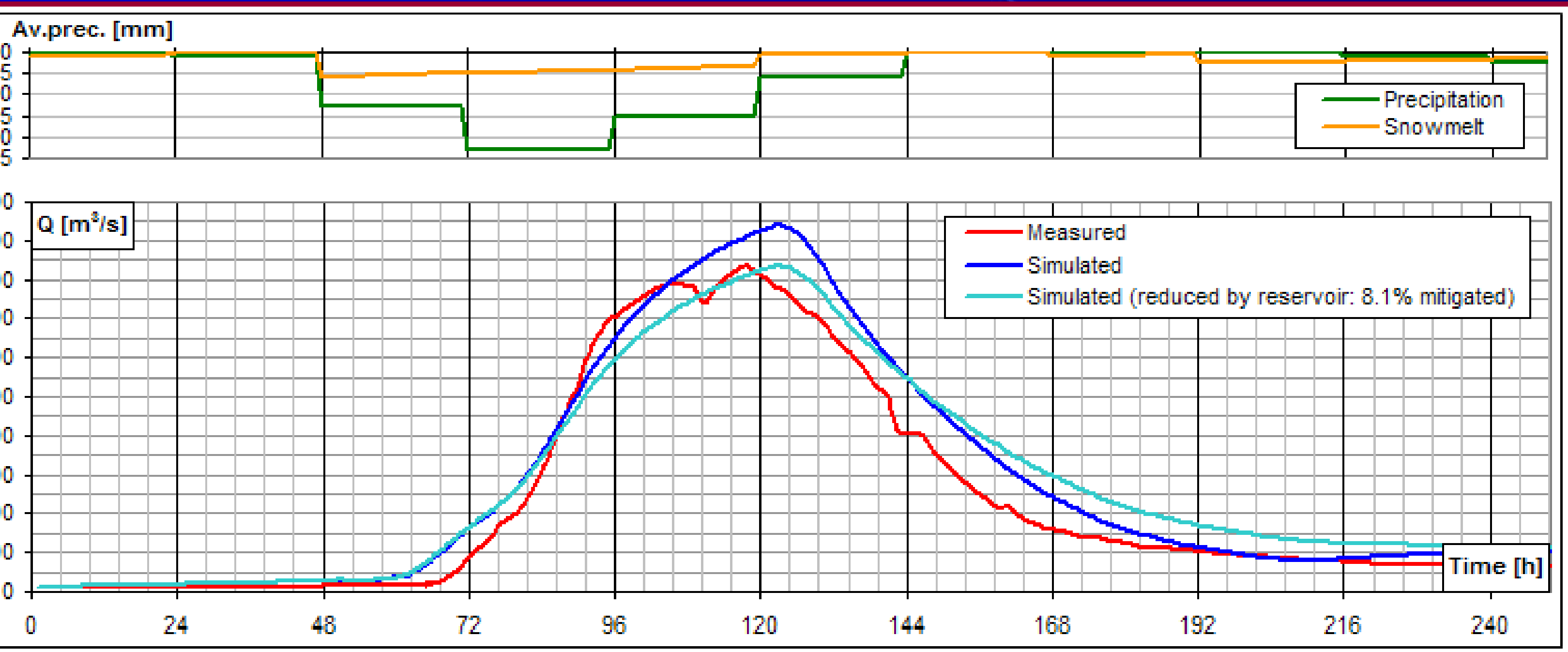
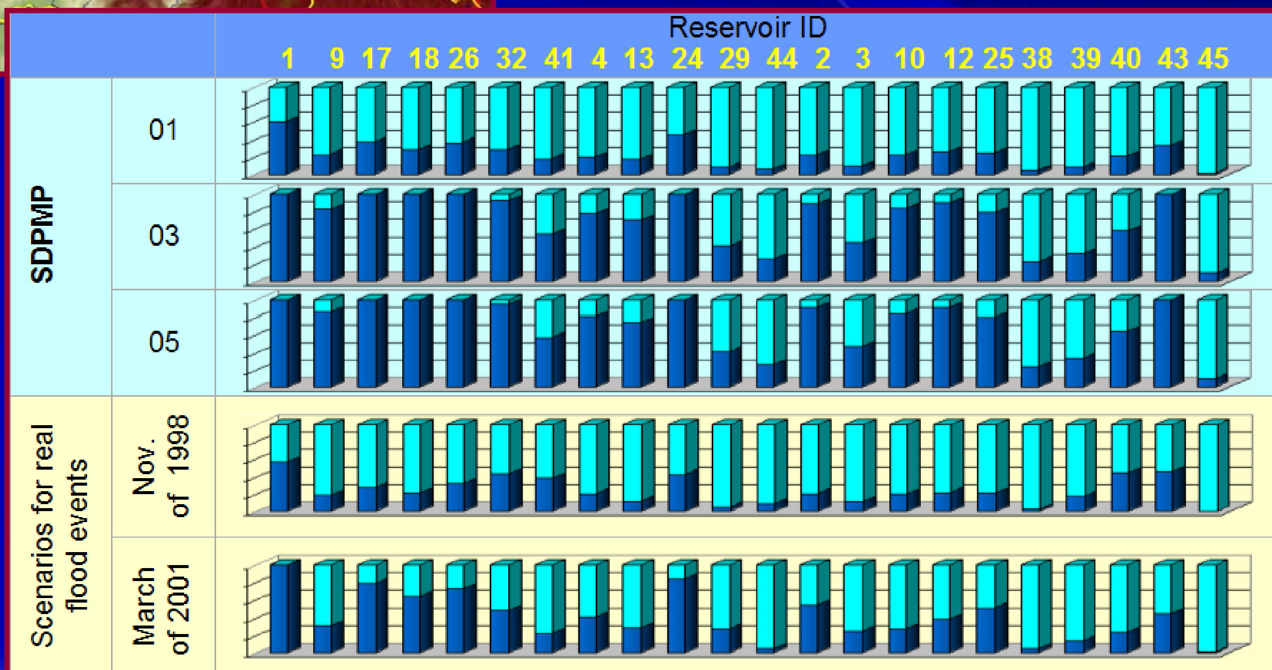


The maximum reservoir filling during the simulations!



nclusions:

Results of the simulations do not really show the expected efficiency of the flow-through type flood retention reservoirs on the main branch of the river.

Cause 1:
Different distribution of the rainfield and that of the reservoirs.

Cause 2:
We can suspect, that releasing structure of the individual reservoirs are over-sized.

ecommendation:

More data is needed to optimize by simulation the diameter of these structures.

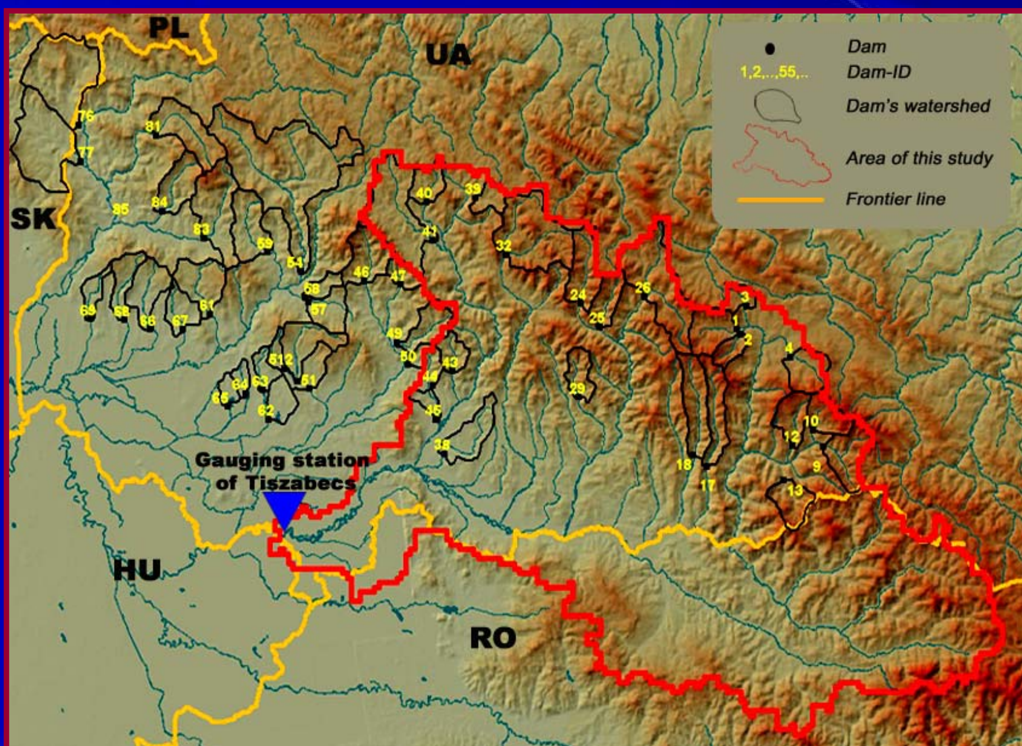
llaboration:

In order to improve efficiency of the system, the results of these simulations are to be shared with the Ukrainian colleagues and in the frame of joint collaboration platforms.

hat's next:

Recasting the results for water level as well, using 1D hydraulic model.

Extension of the analysis for the whole affected area, under wide angle collaboration with the Ukrainian and the Slovakian colleagues



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Thanks for the attention