W3M conference
for Wetlands: Monitoring modelling and management
Wierzba, Poland, September 22nd-25th, 2005

Vrije Universiteit Brussel

"Distributed Hydrological Modelling And Landuse Scenario Analysis In Three Carpathian Watersheds Using Wetspa"

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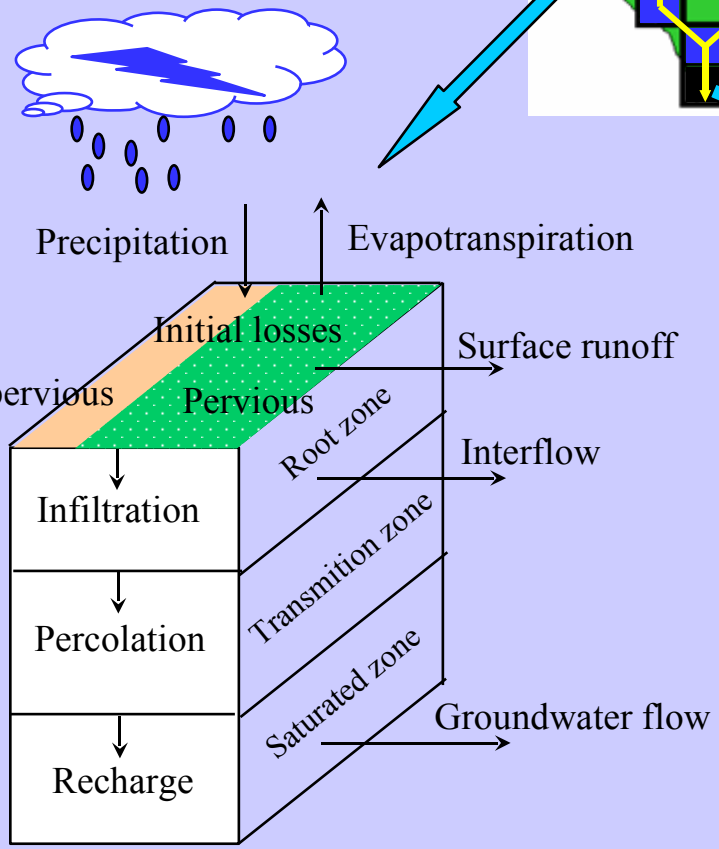
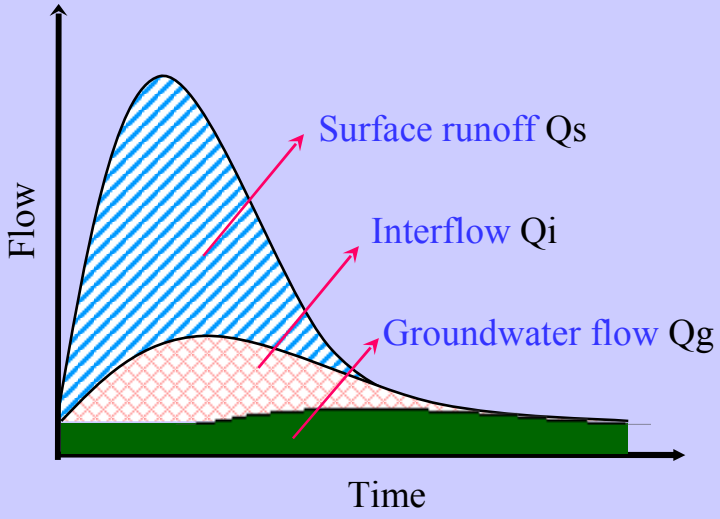
The Wetspa Model - Introduction

- What?
  - A distributed parameter GIS-based precipitation-runoff model
  - + phosphorus transport module
- Aim?
  - Flood prediction
  - Scenario analysis
    - Land use change
    - Climate change
    - River restoration
    - …
  - Phosphorous load prediction in rivers
- Applications?
  - Locations: Europe, Asia, America, Africa
  - Scale: watersheds 100 km^2 – 10.000 km^2

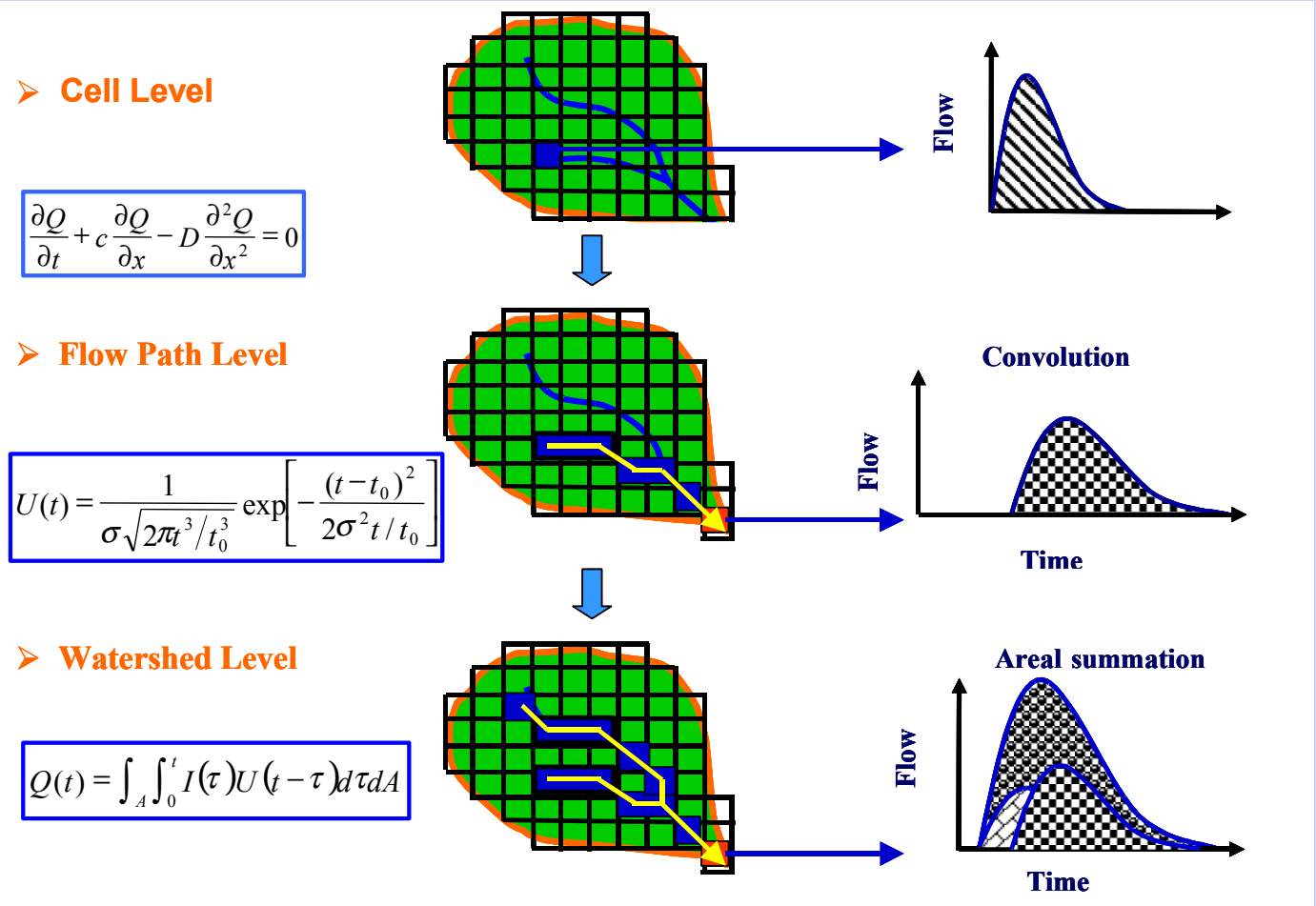
Wetspa Concept

$$Q = Qs + Qi + Qg$$

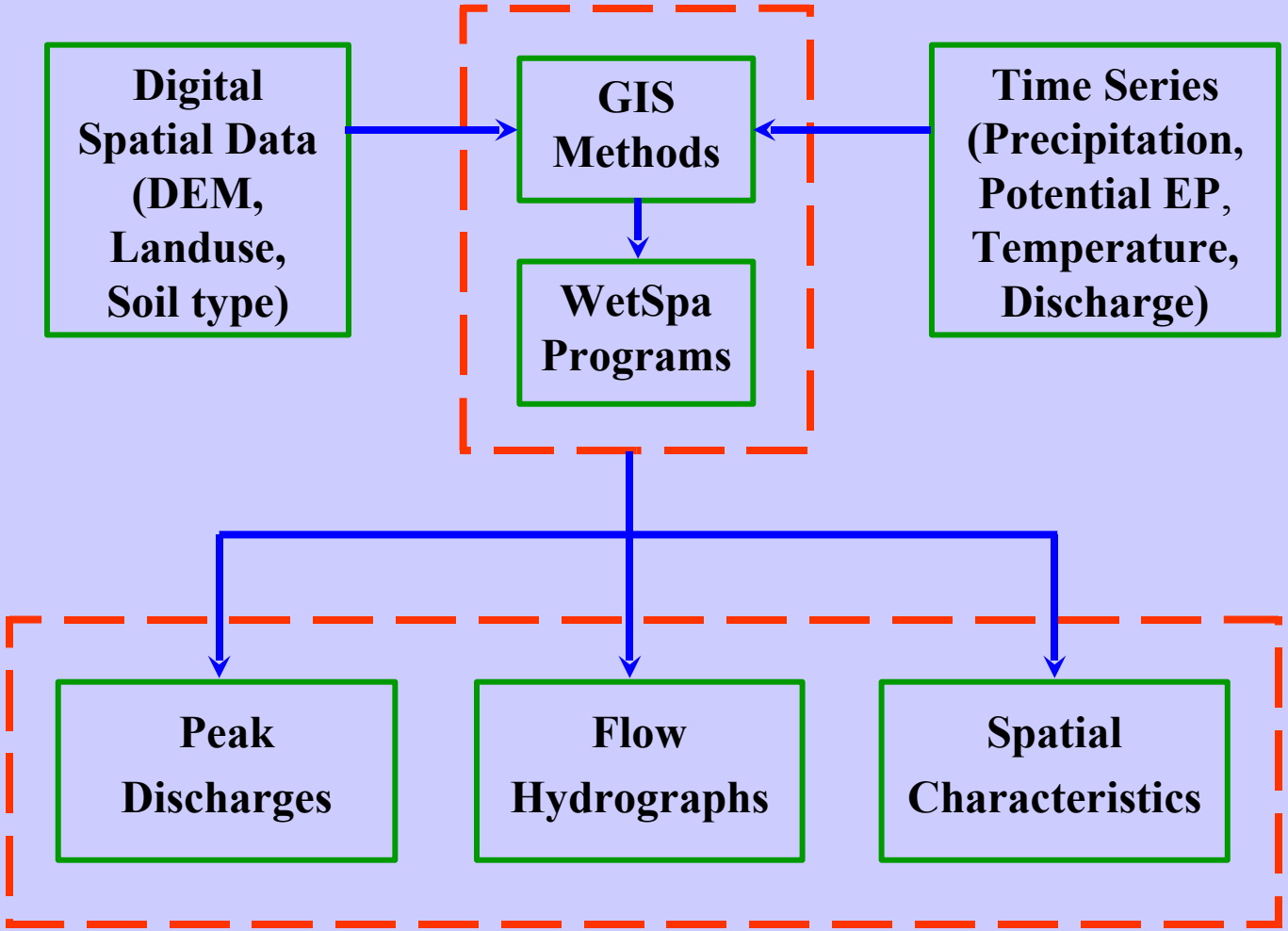




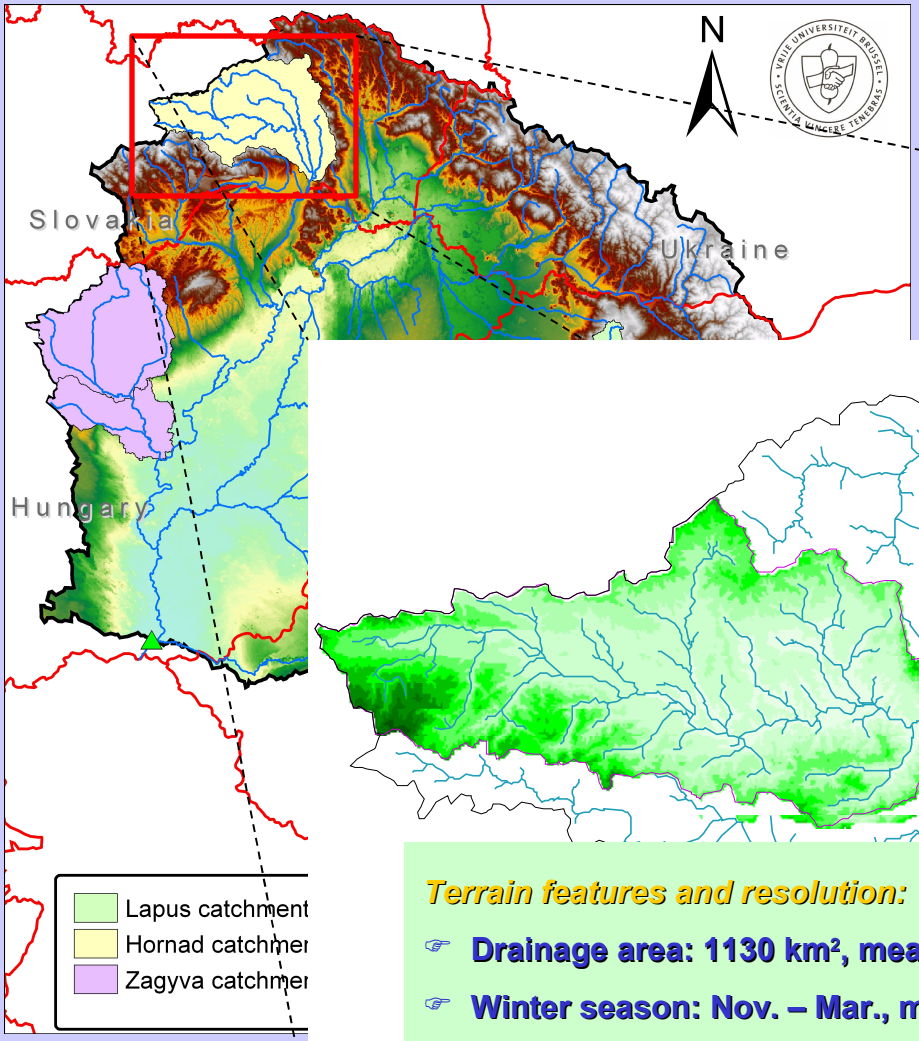
Surface Runoff Routing

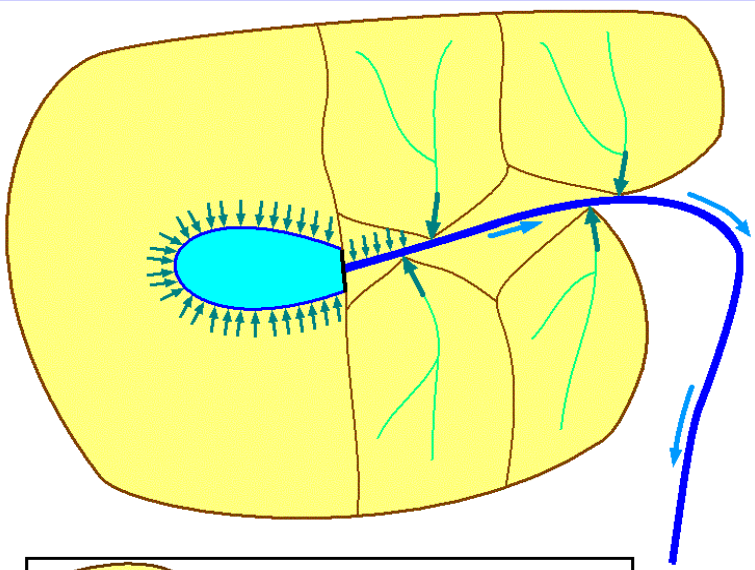


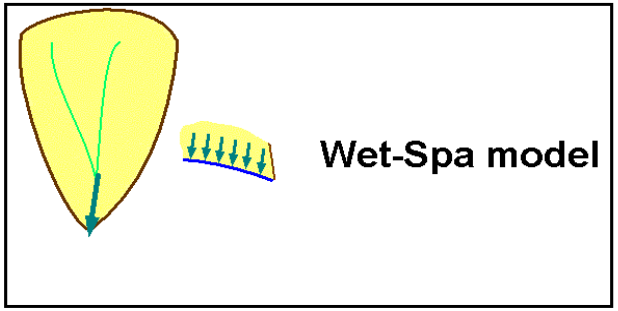
Wetspa Model Input & Output



Wetspa Application 1 Hornad-Margecany (SK)



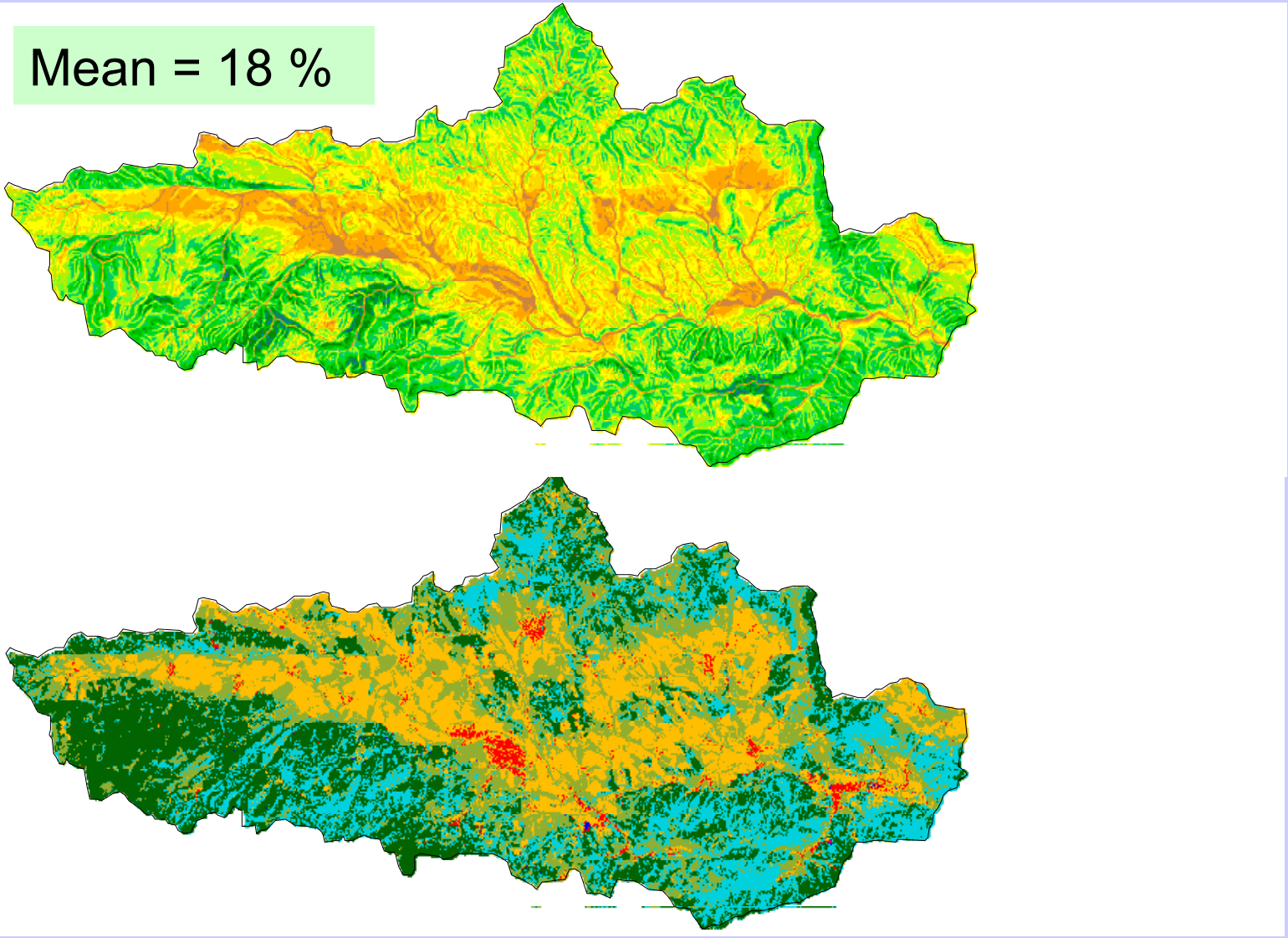




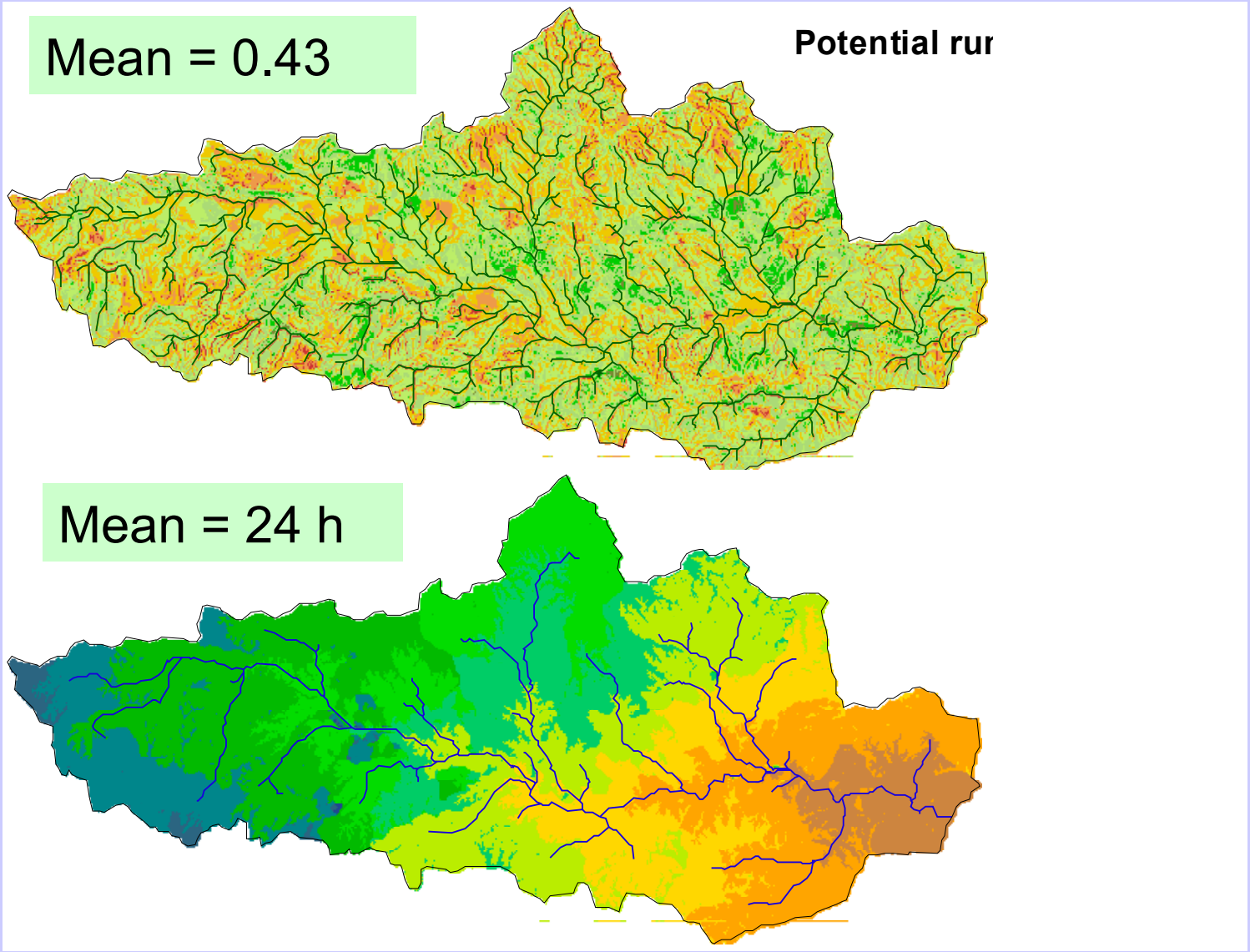
Terrain features and resolution:

- **Drainage area: 1130 km², mean eleva**
- **Winter season: Nov. – Mar., mean ar**
- **Cell size: 100x100m, Time step: 1 day: Data: 1991 - 2000**

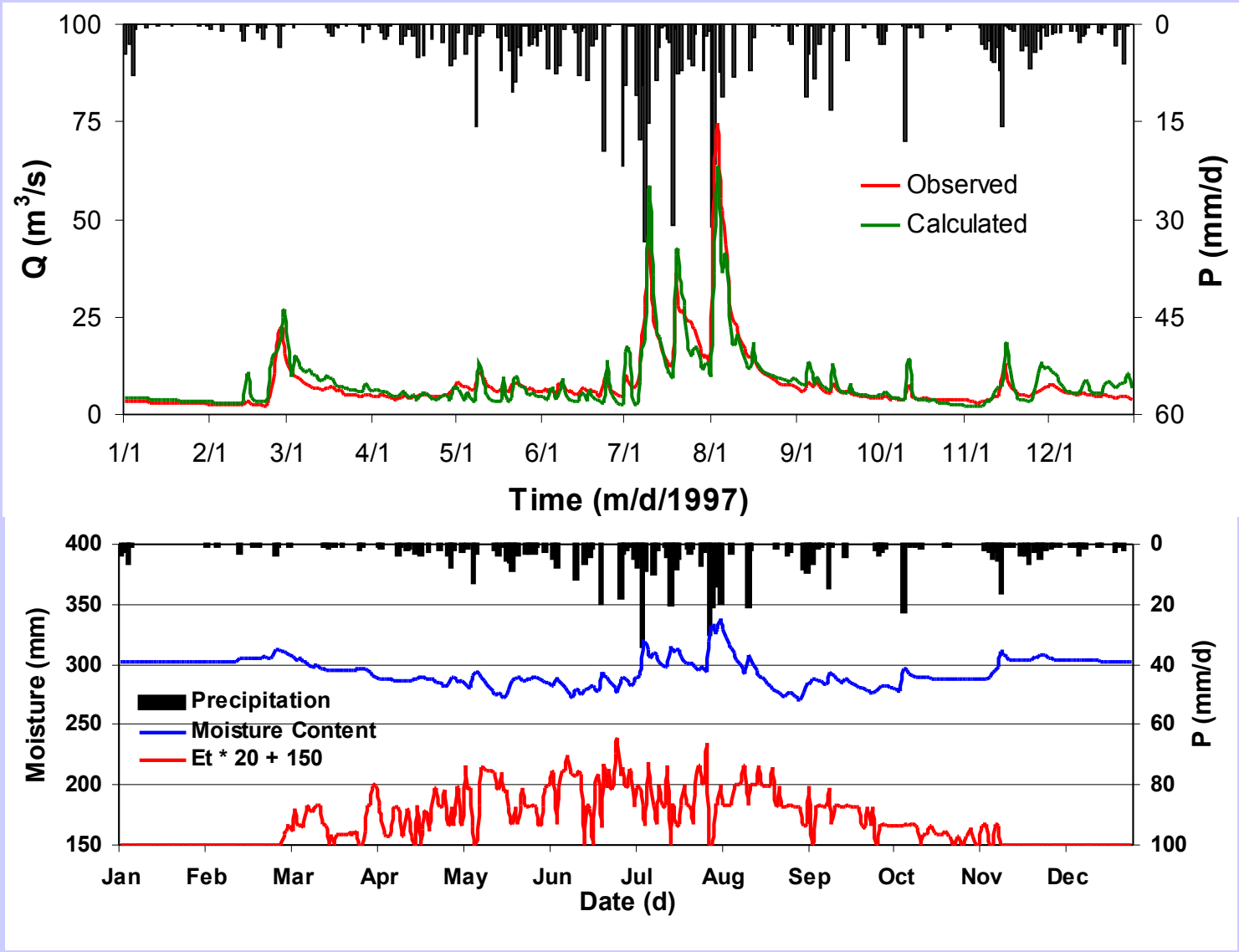
Hornad-Margecany - Input



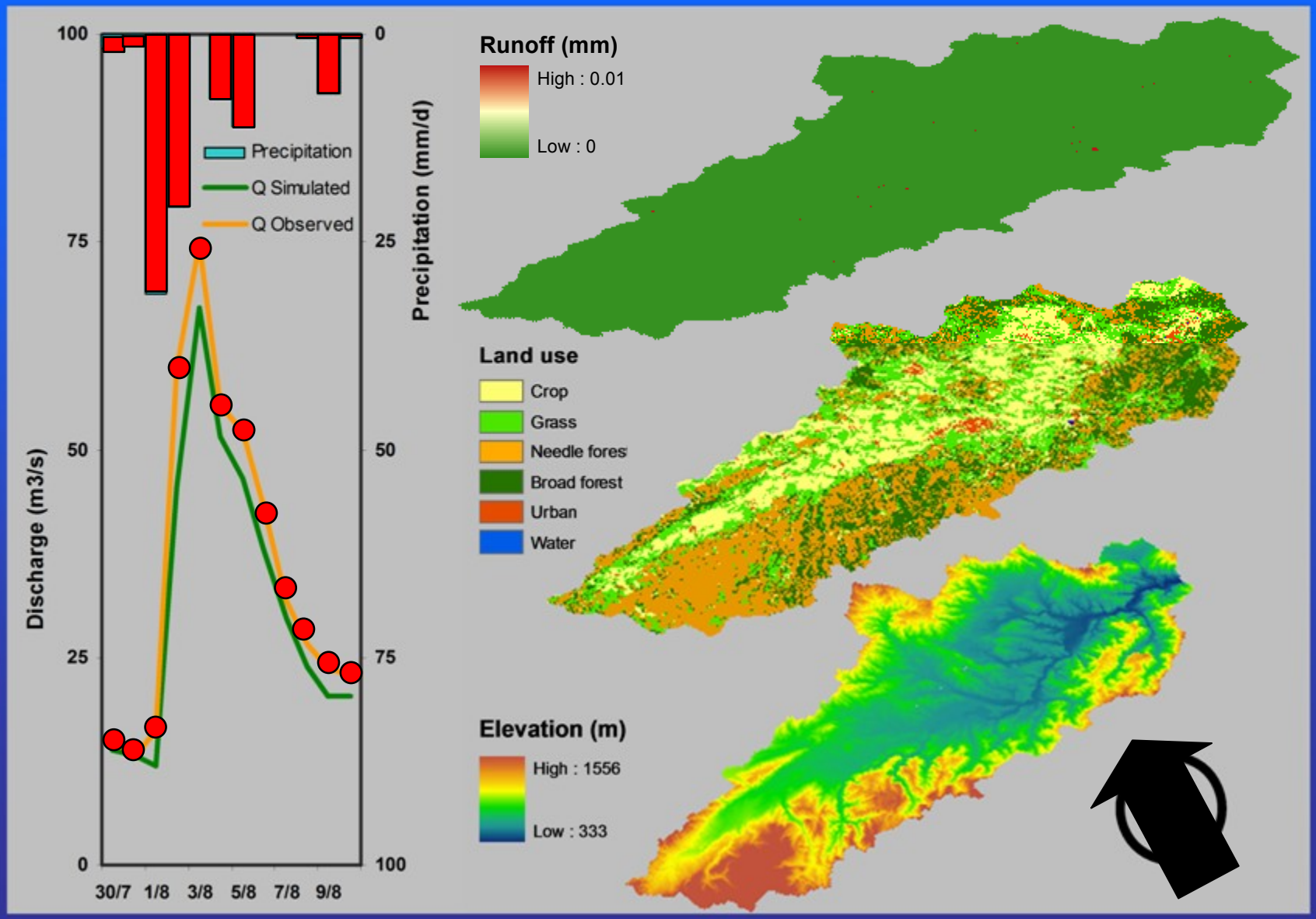
Parameter Derivation Hornad-Margecany



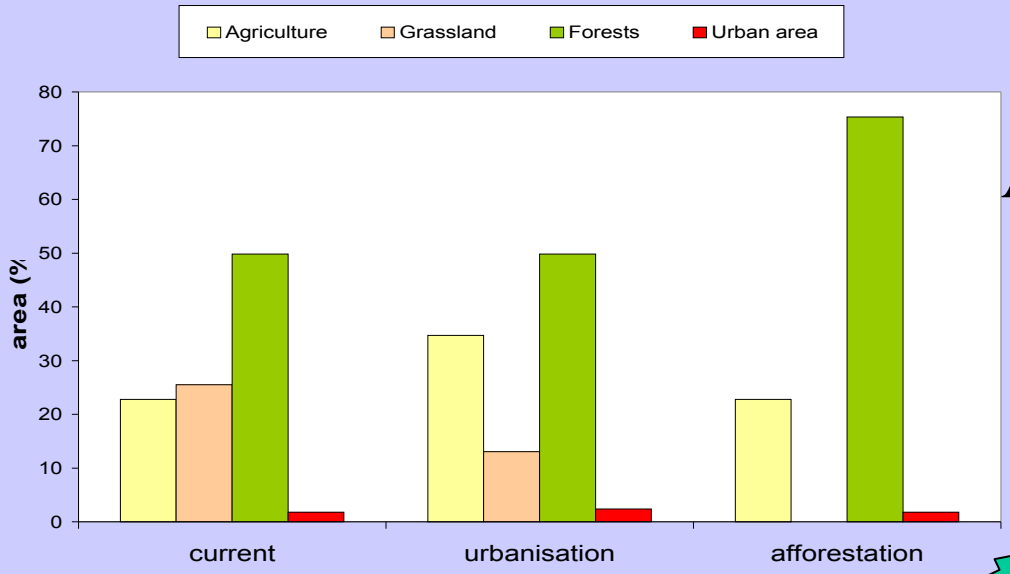
Results – Discharge & Water Balance



Results – Surface Runoff Production



Landuse Scenarios Hornad-Margecany



Current

Landuse	%
Agriculture	22.77
Grassland/Pasture	25.51
Coniferous forest	26.83
Deciduous & mixed forest	23.01
Urban area	1.82
Open water	0.07

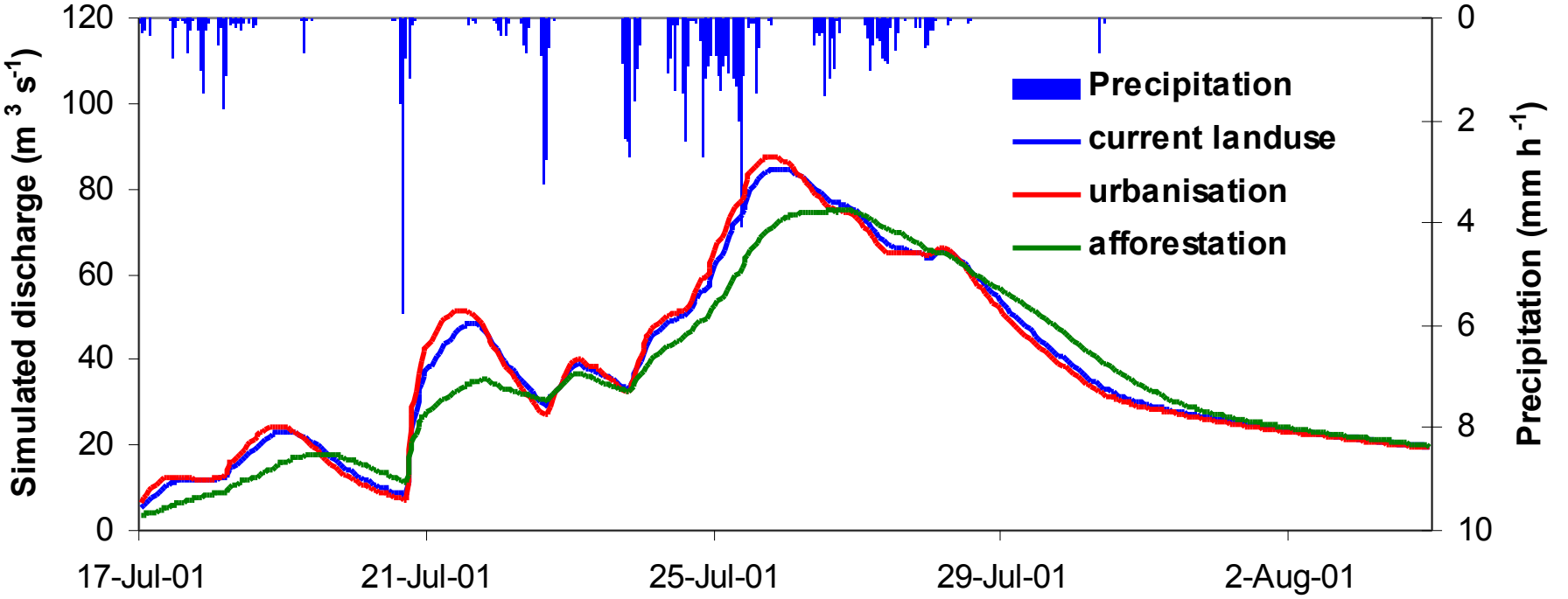
A. 30%Urban,52% Agriculture

Landuse	%
Agriculture	34.69
Grassland/Pasture	13.06
Coniferous forest	26.81
Deciduous & mixed forest	23.01
Urban area	2.37
Open water	0.07

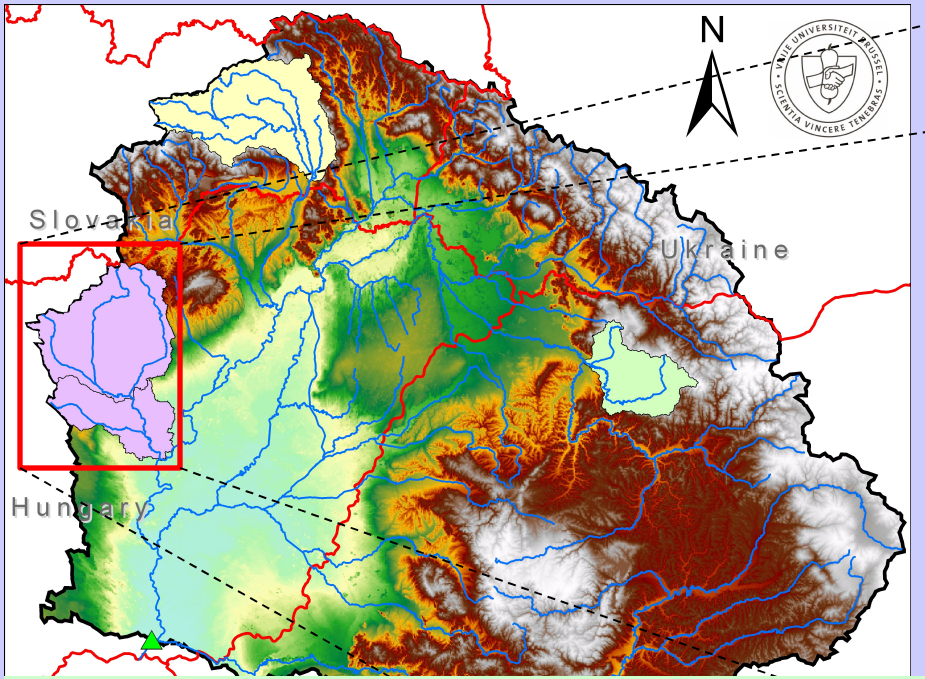
B. 50% Afforestation

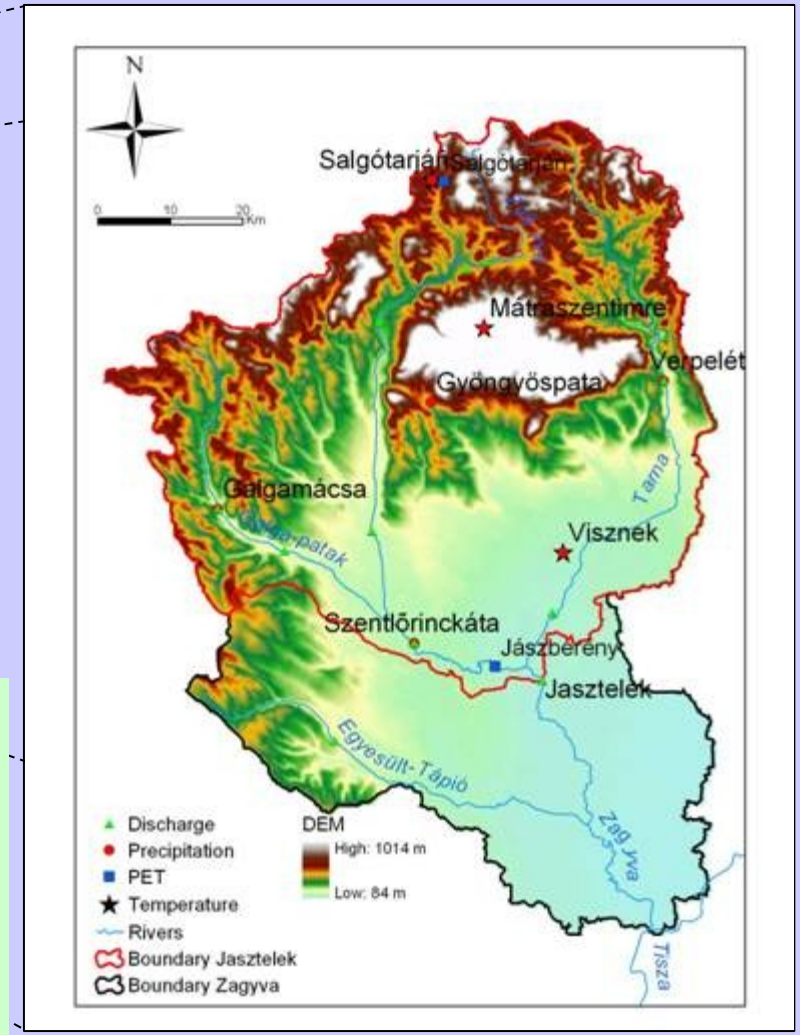
Landuse	%
Agriculture	22.77
Grassland/Pasture	0.00
Coniferous forest	26.83
Deciduous & mixed forest	48.52
Urban area	1.82
Open water	0.07

Landuse Scenarios - Hornad-Margecany



Wetspa Application 2 – Zagyva (HU)

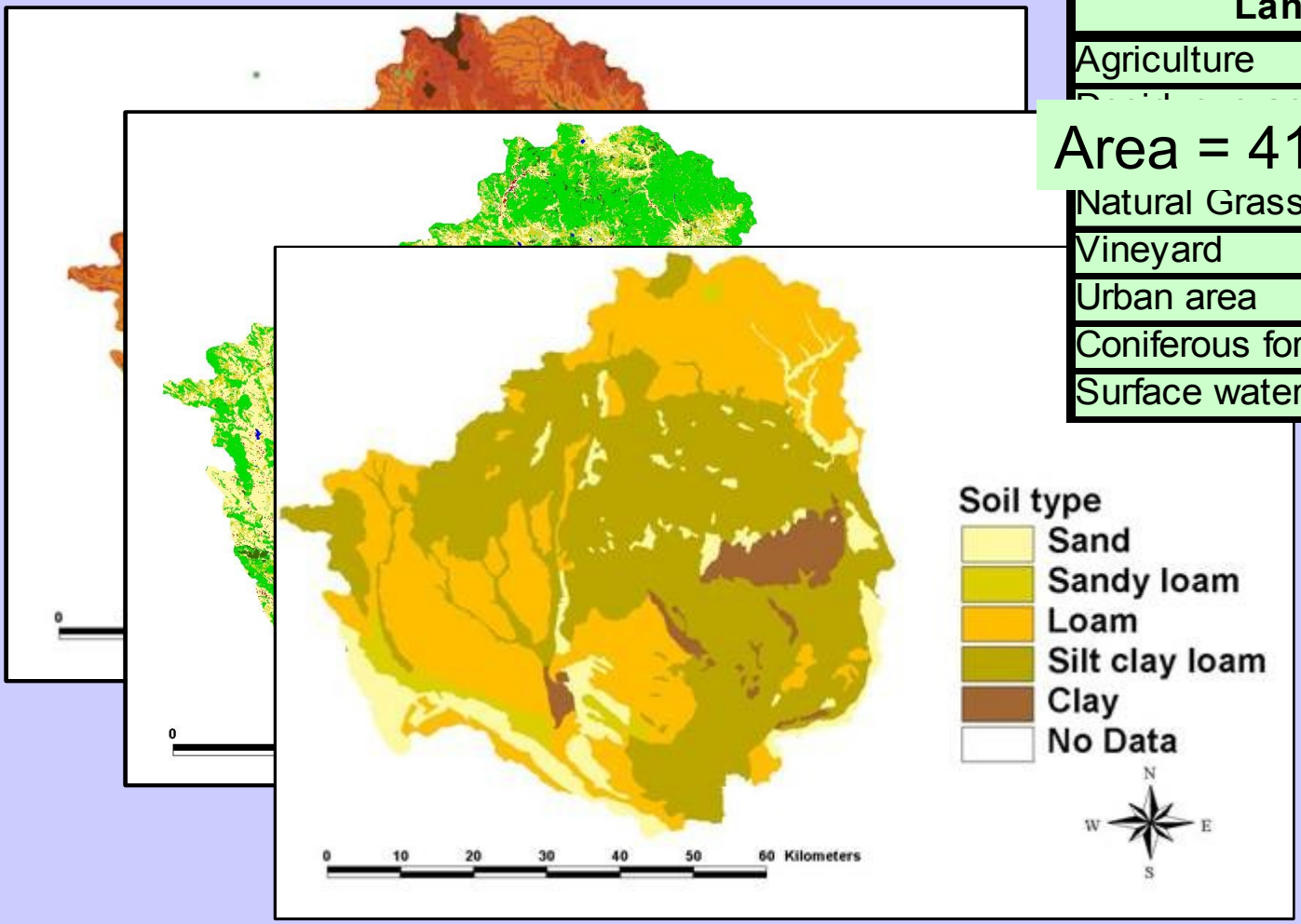




Terrain features and resolution:

- **Drainage area: 4149 km²**
- **Mean elevation: 220 m, mean slope: 5.2 %**
- **Mean annual precipitation: 470 – 700 mm**
- **Mean annual PET: 1141 mm**
- **Cell size: 100x100m, Time step: 1 hour: Data: 3-5/2000**

Zagyva (HU) - Input

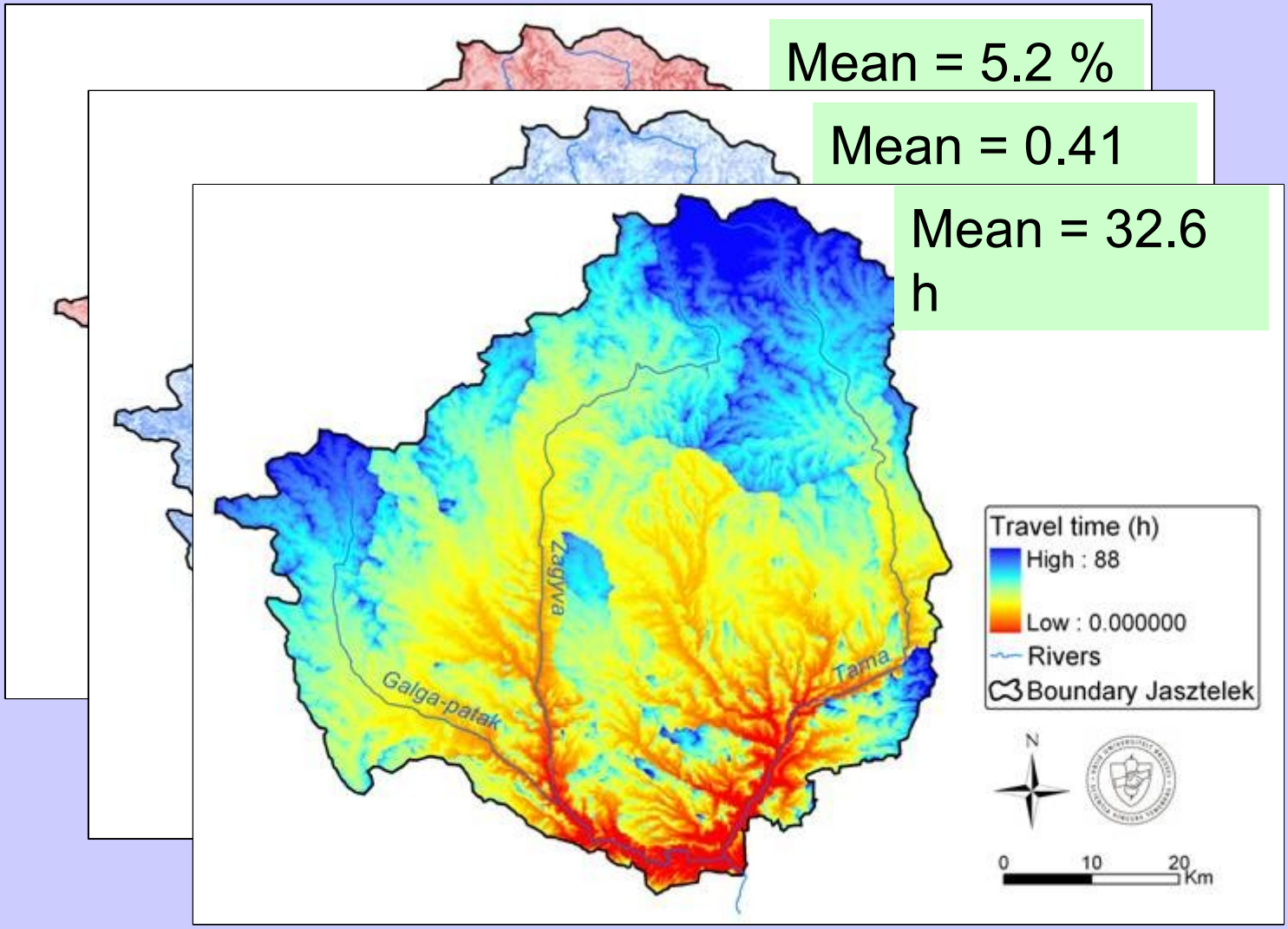


Area = 4149 km²

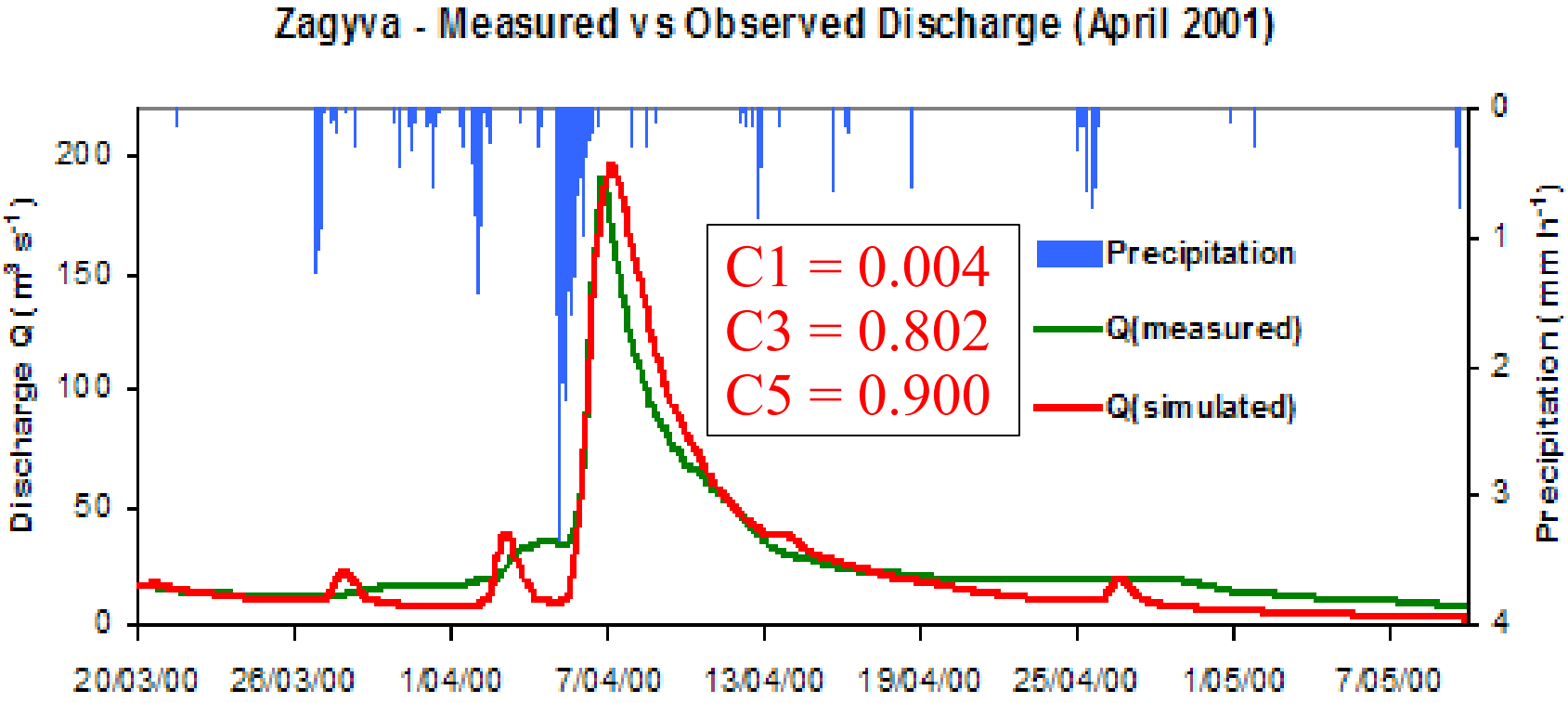
Landuse	area %
Agriculture	50.8
[illegible]	30.0
[illegible]	9.4
Natural Grassland	4.7
Vineyard	1.7
Urban area	1.5
Coniferous forest	1.4
Surface water	0.3

Soil type	area %
Silt clay loam	48.6
Loam	35.1
Sand	9.5
Clay	4.4
Sandy loam	2.3

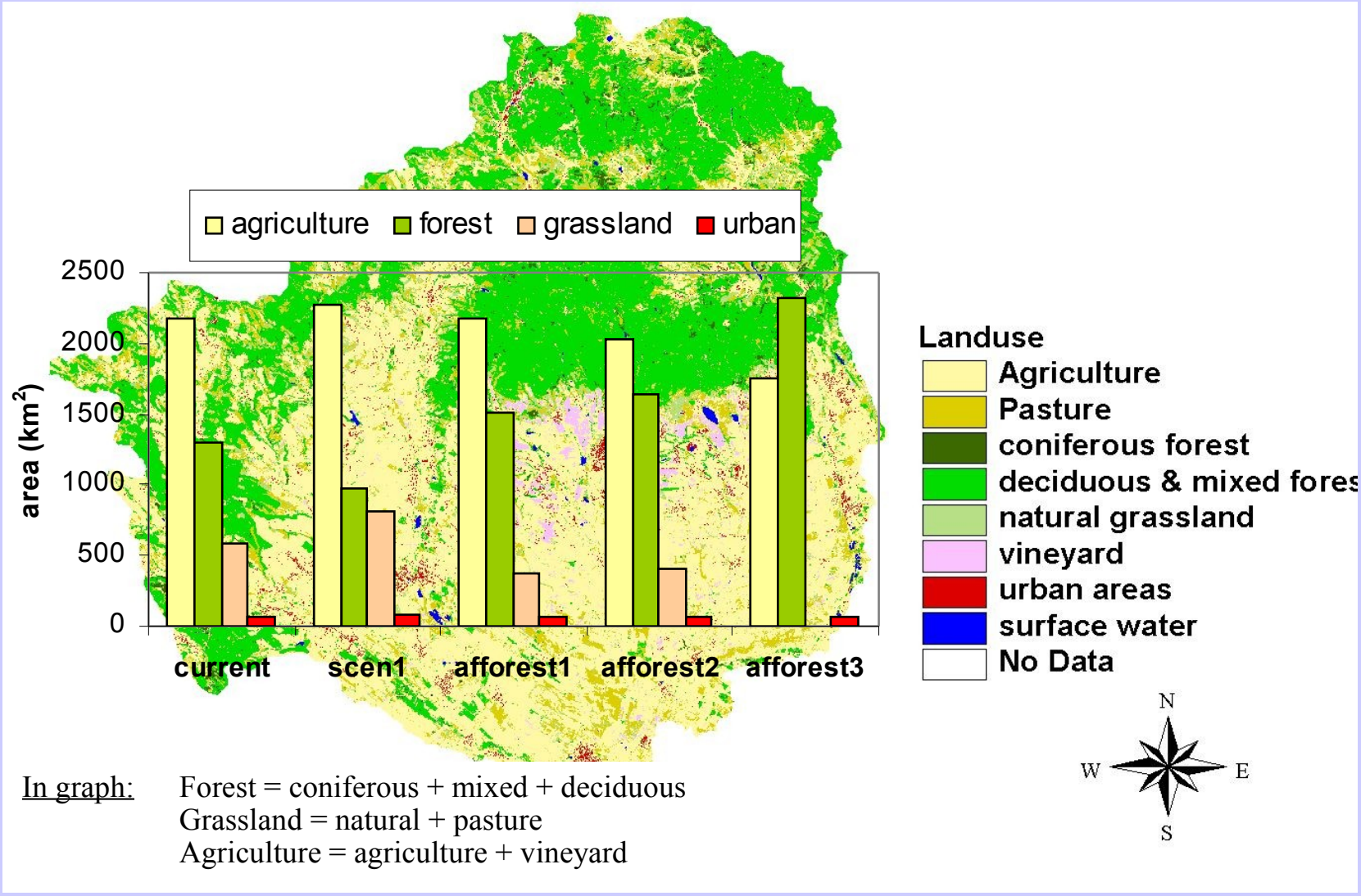
Zagyva – Parameter Derivation



Zagyva - Results

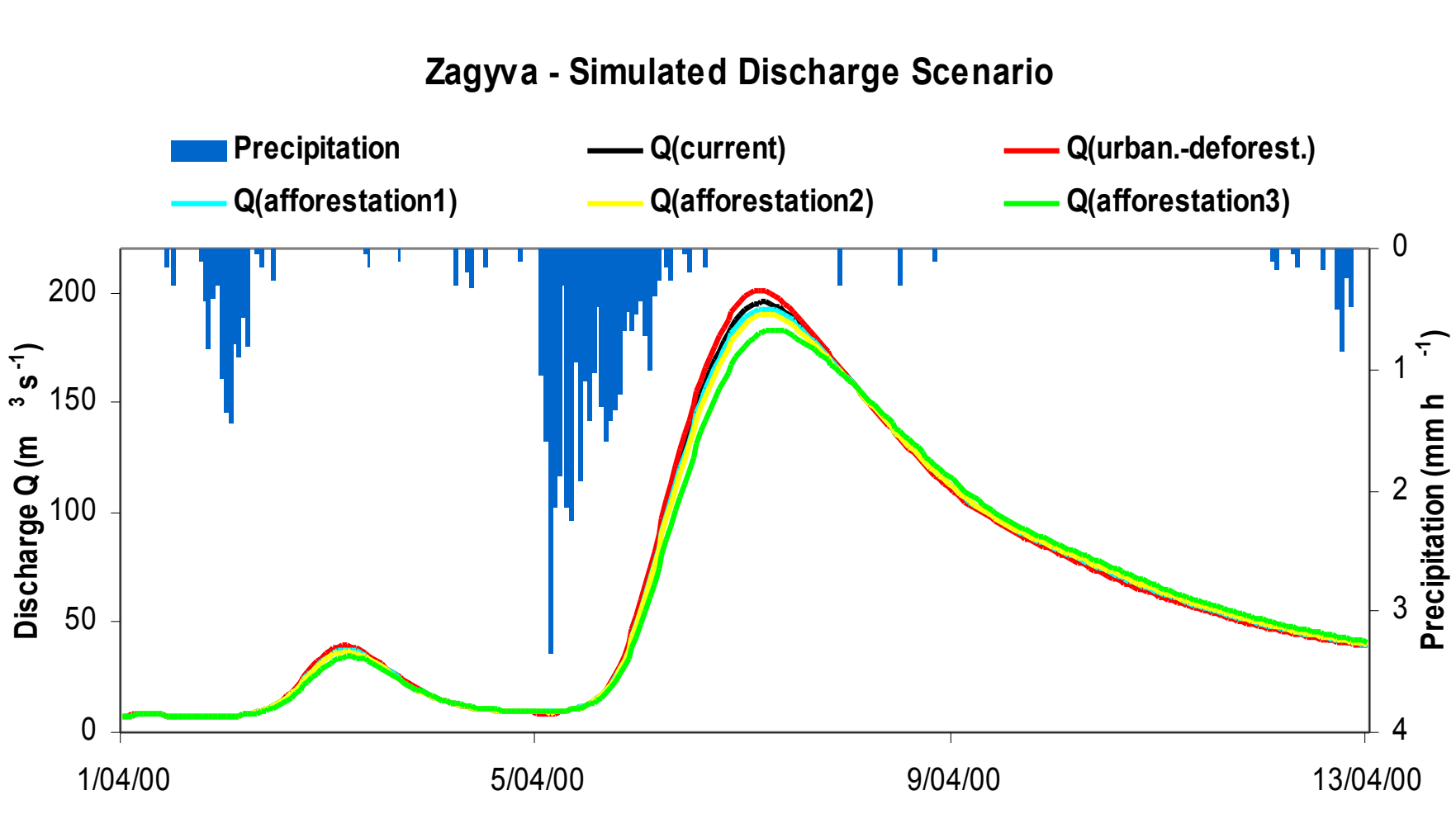


Zagyva – Landuse Scenarios

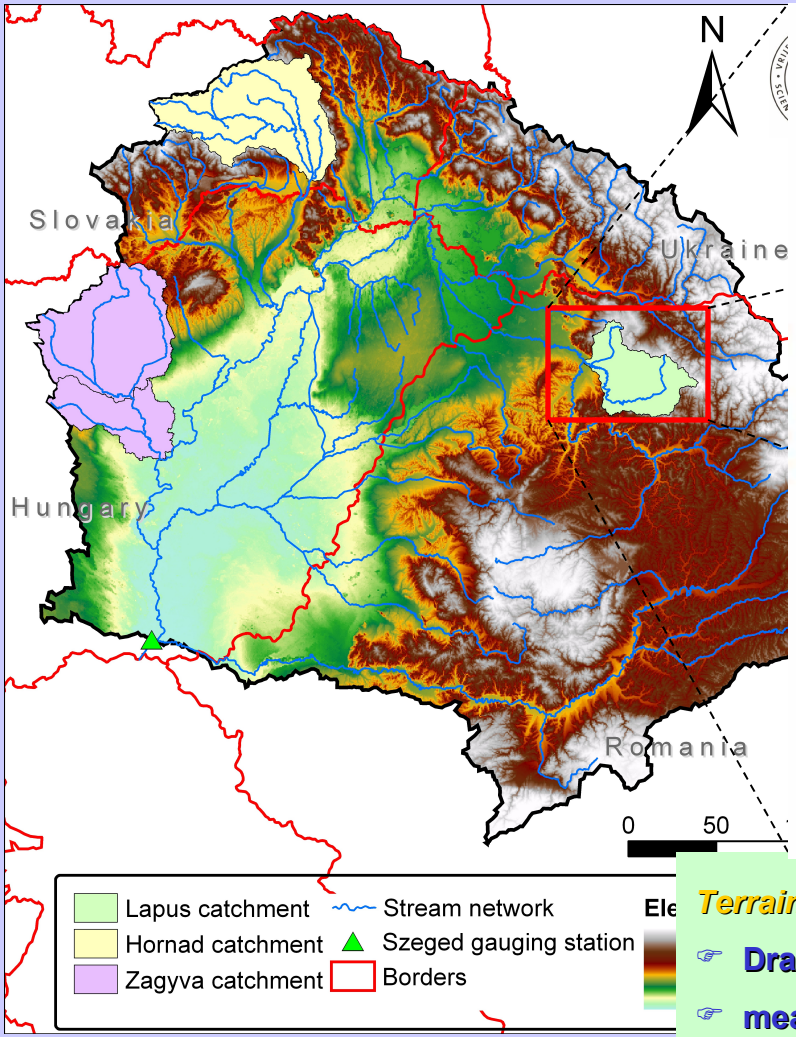


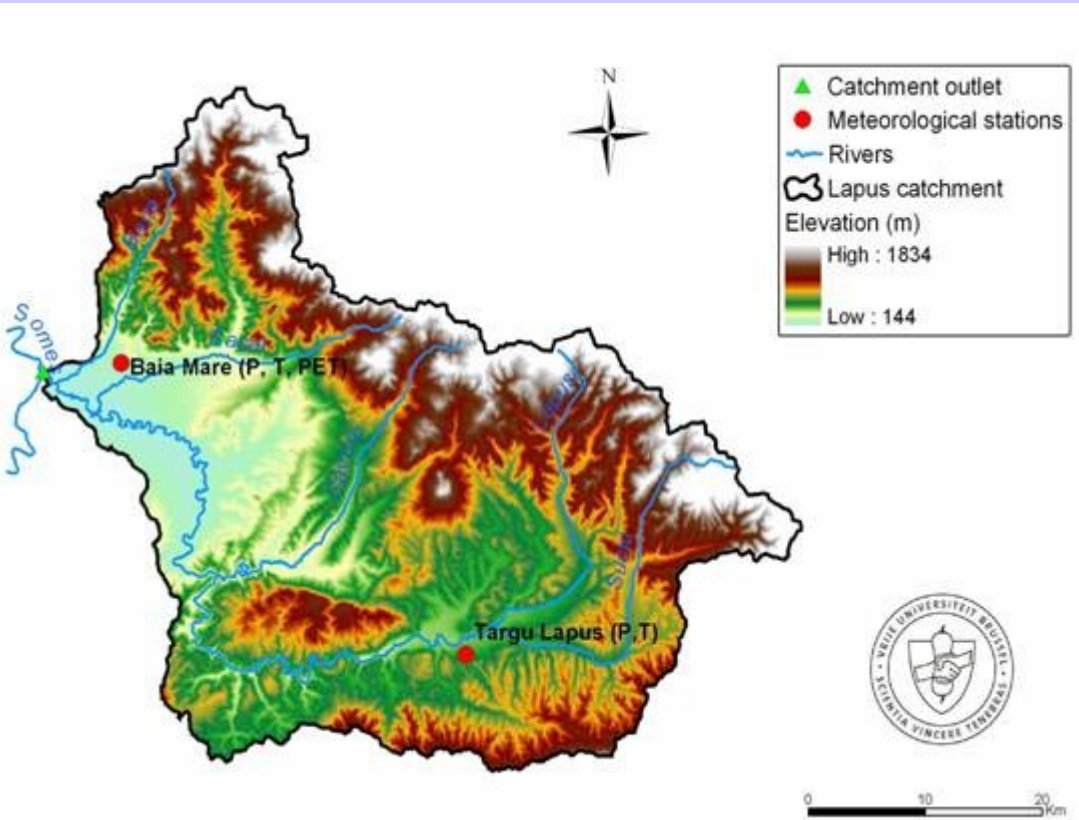
In graph: Forest = coniferous + mixed + deciduous
Grassland = natural + pasture
Agriculture = agriculture + vineyard

Zagyva – Landuse Scenarios (2)



Wetspa Application 3 – Lapus (RO)

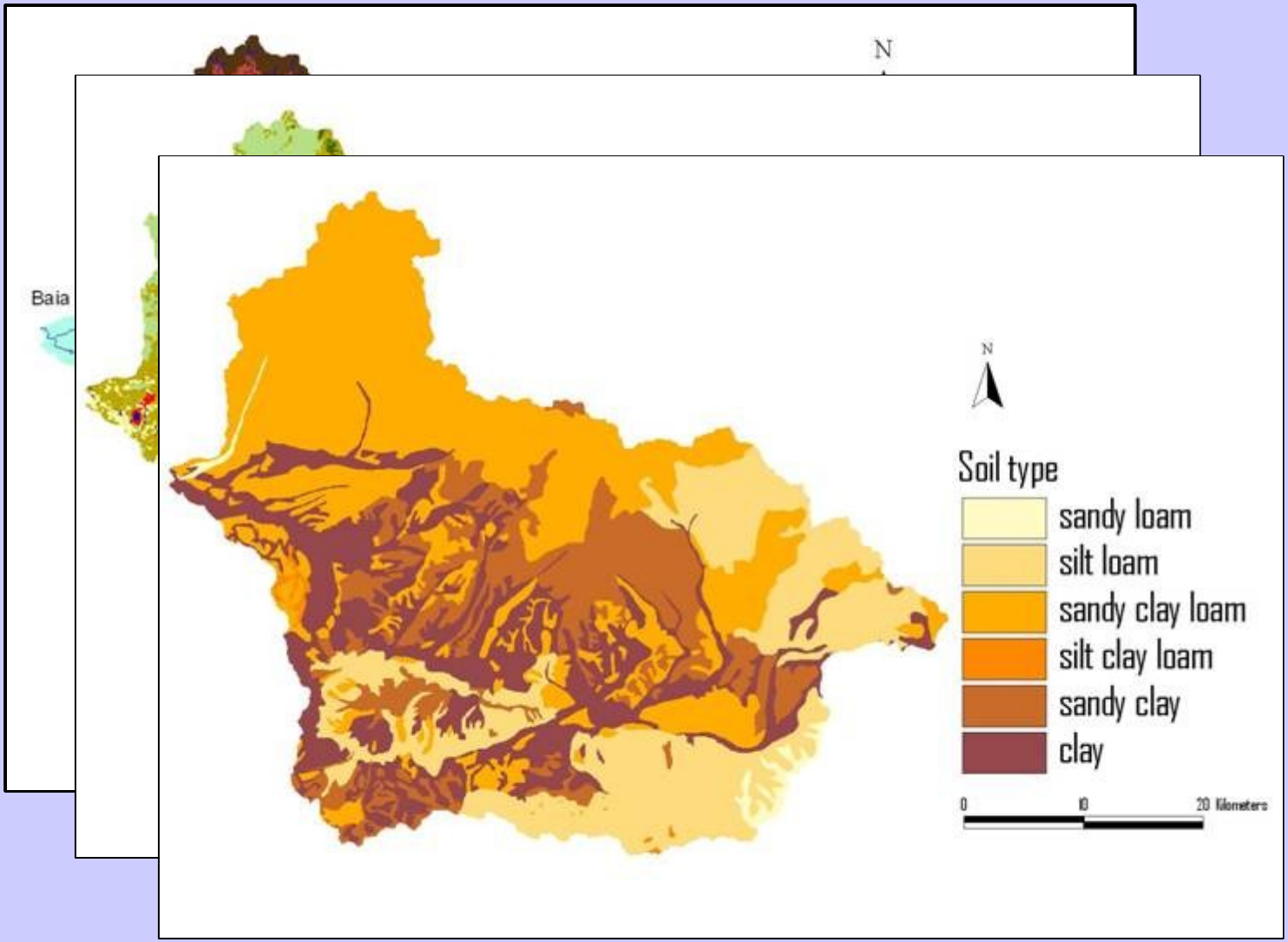




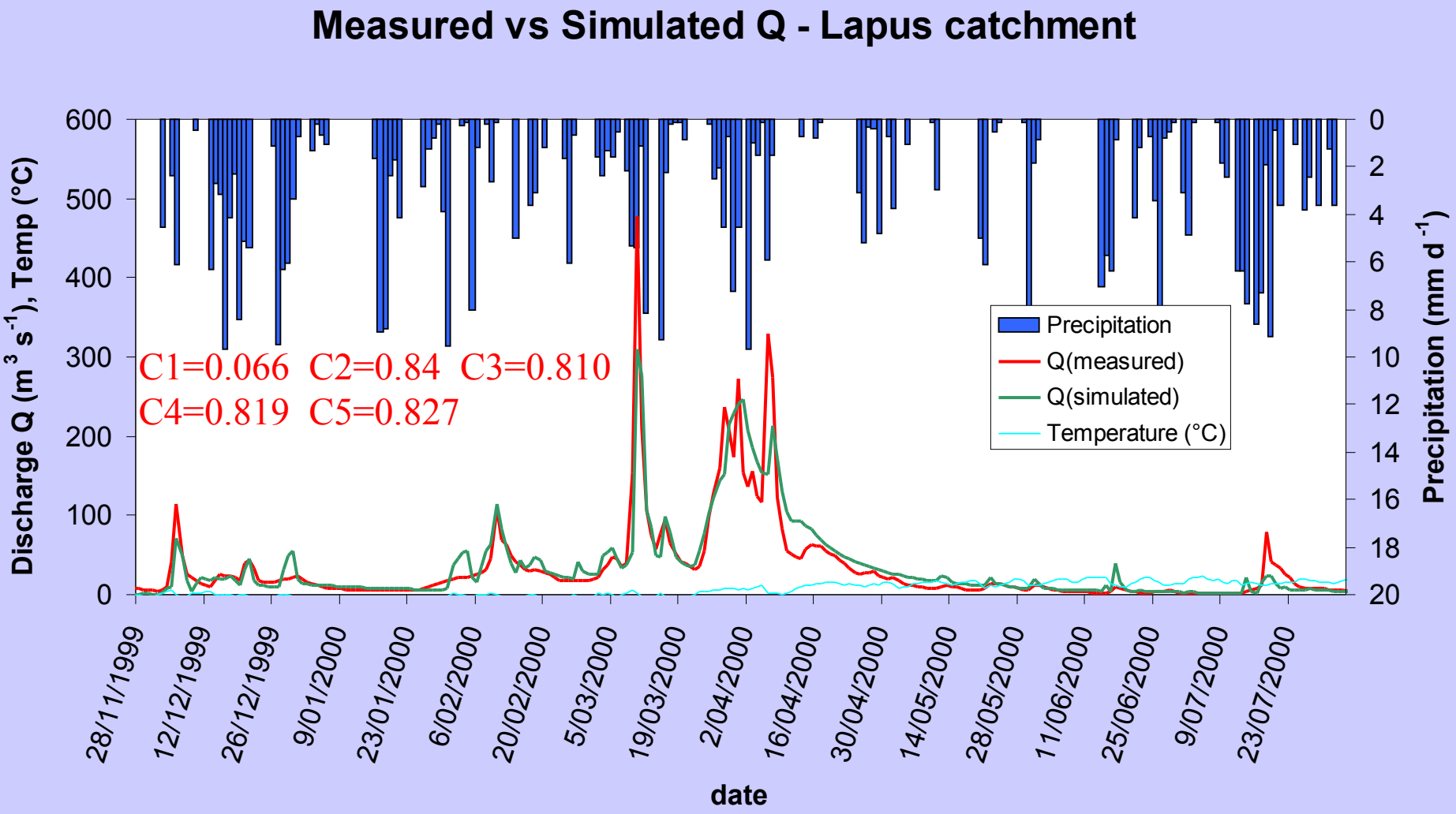
Terrain features and resolution:

- **Drainage area: 1878 km², mean elevation: 541 m, mean slope: 20 %**
- **mean annual precipitation: 700 – 1000 mm**
- **Cell size: 50x50m, Time step: 1 day: Data: 1999 - 2000**

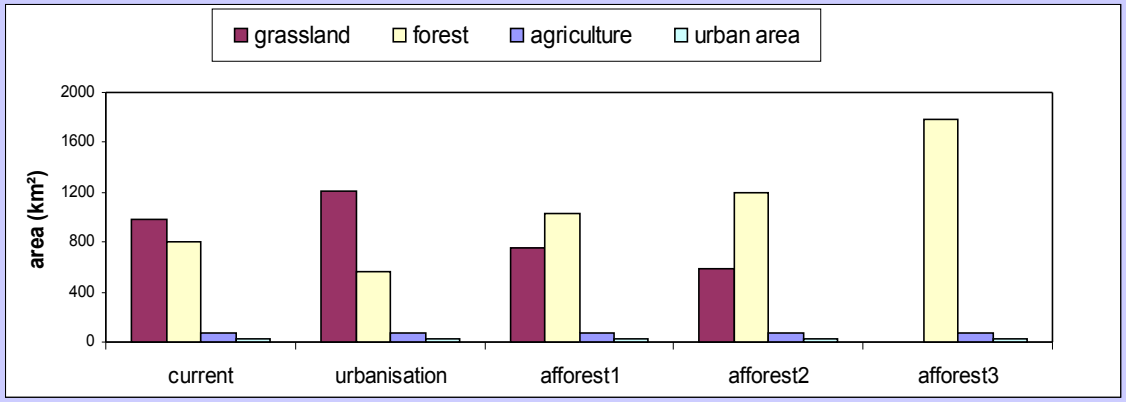
Lapus - Input

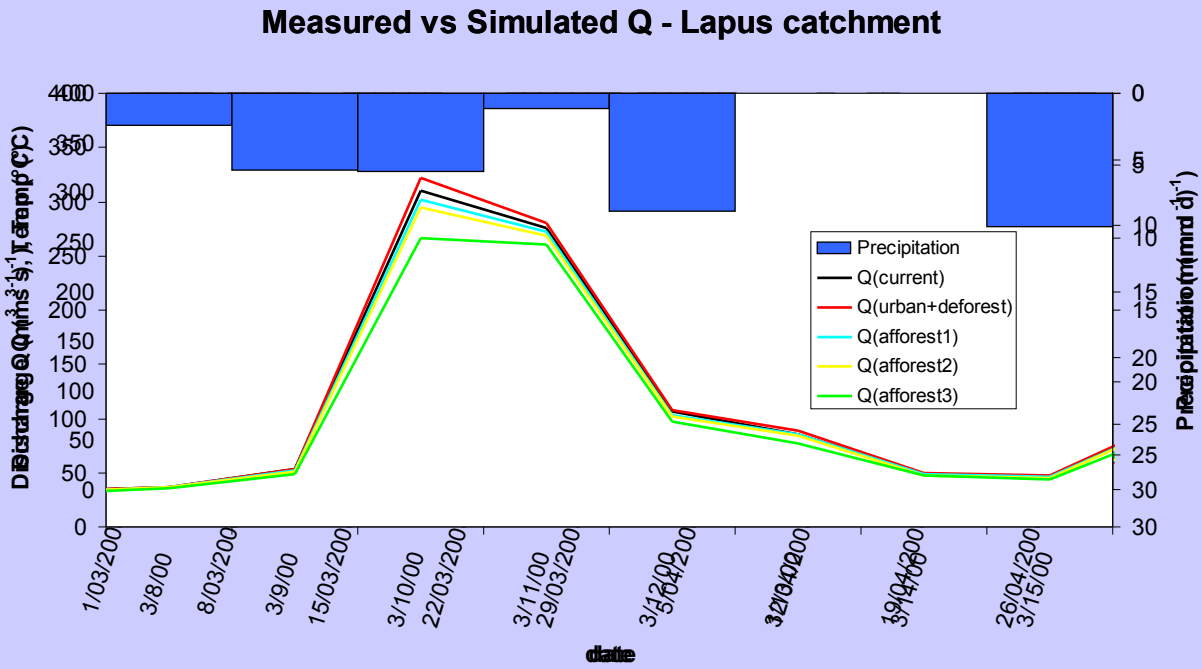

N
Baia
N
Soil type
sandy loam
silt loam
sandy clay loam
silt clay loam
sandy clay
clay
0
10
20 Kilometers

Lapus – Results (daily)



Lapus – Landuse Scenarios





Conclusions

- The model adequately takes into account GIS and remote-sensed data for flood prediction
- Calculations are simplified by making use of GIS tools
- Simulation results and measurements compare favourably
- The model can be used to evaluate the effect of land use changes (and other scenarios) on flood generation
- Land use change only will not suffice as a flood protection measure
- Even drastic land use changes result in moderate peak reduction
- Quality and resolution of time series data greatly influences model efficiency and analysis possibilities

Acknowledgment

This research was carried out in the framework of the EC-5th Framework Project:

"The Tisza River Project"

Real-life scale integrated catchment models for supporting water- and environmental management decisions

(coordinator: Water Resources Research Centre, VITUKI, Hungary)

Thanks for your attention