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MAPPING THE FLASH FLOOD PRONE AREA IN THE TAITA WATERSHED (ROMANIA) USING TOPOGRAPHIC INDEXES AND HYDRAULIC MODEL

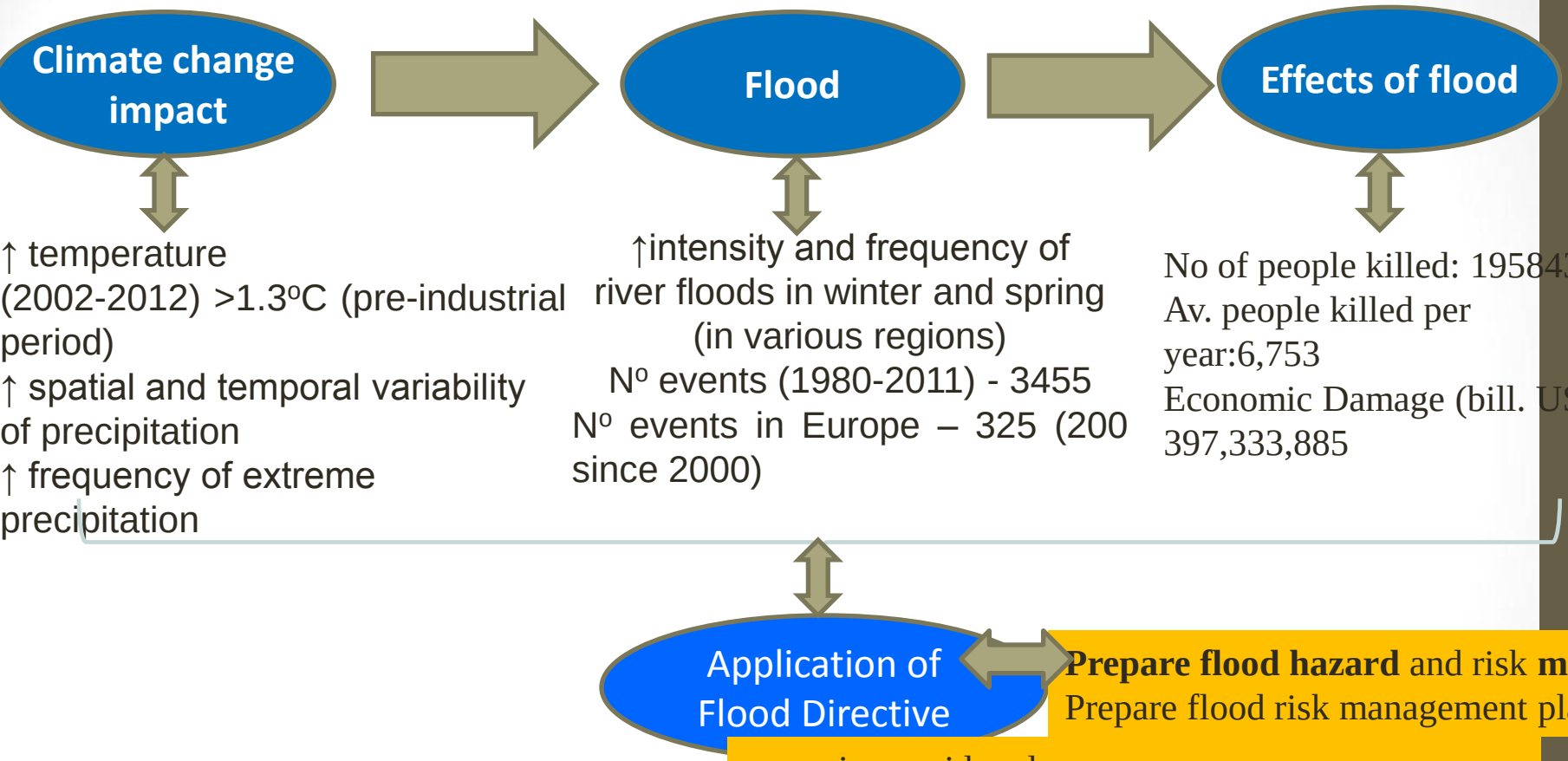
C. Maftei

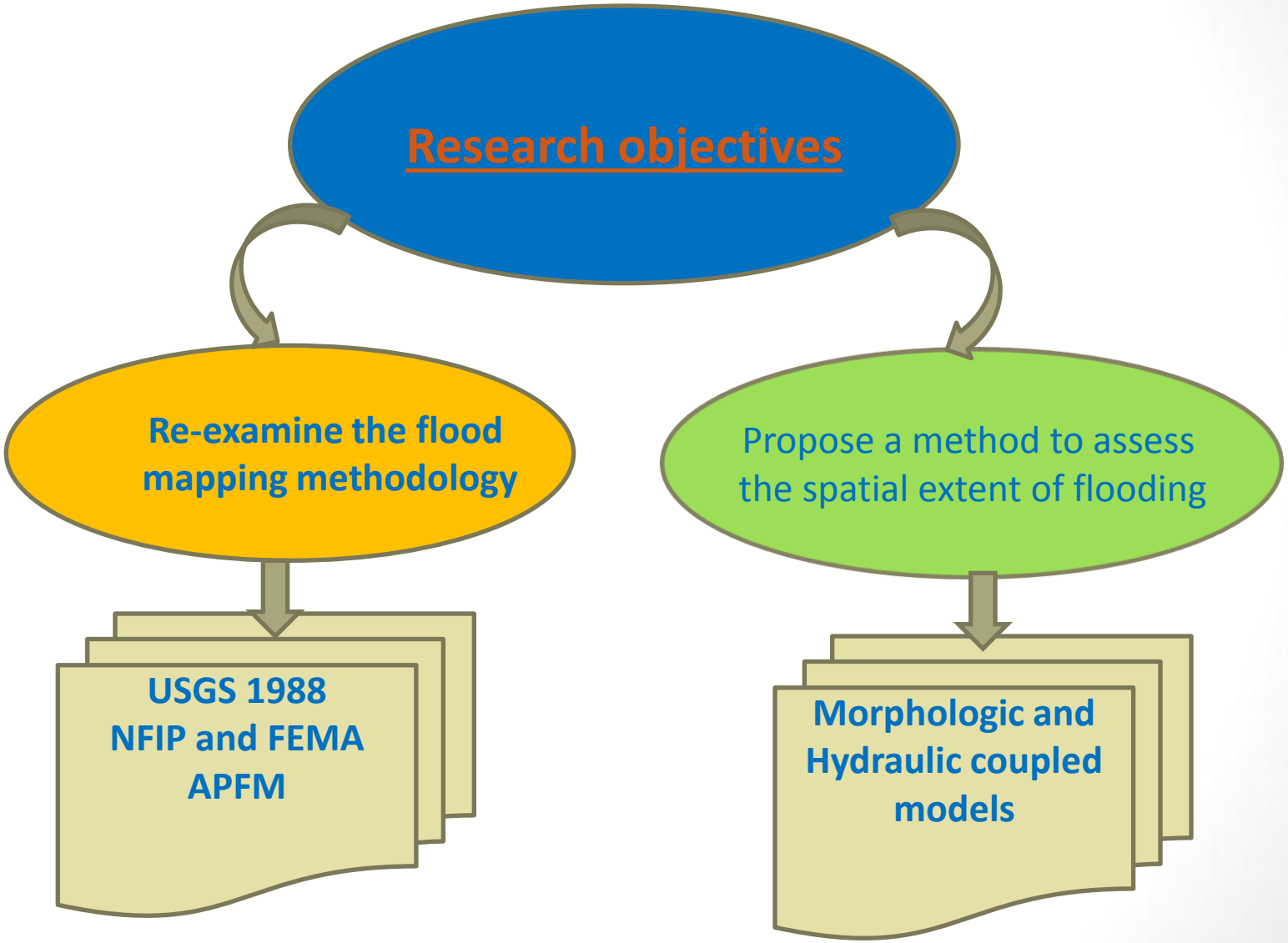
K. Papatheodorou

Outline

- Research context
- Research objective
- Research approach
- Results and discussion

Research context

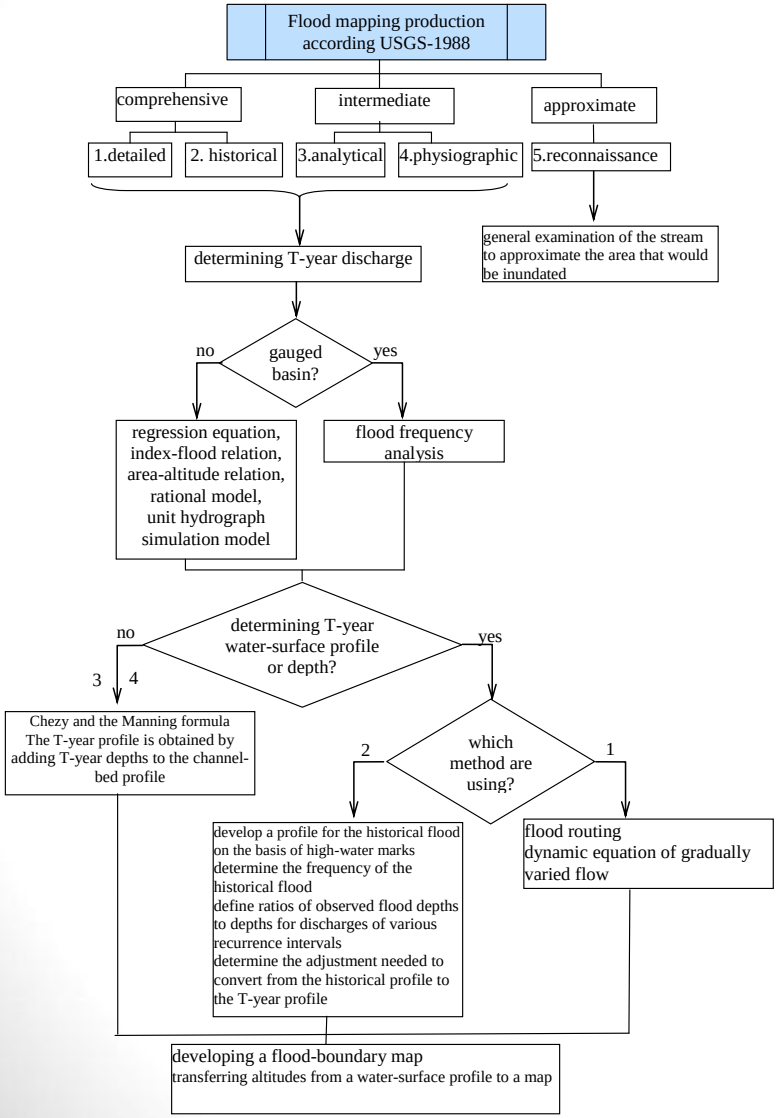


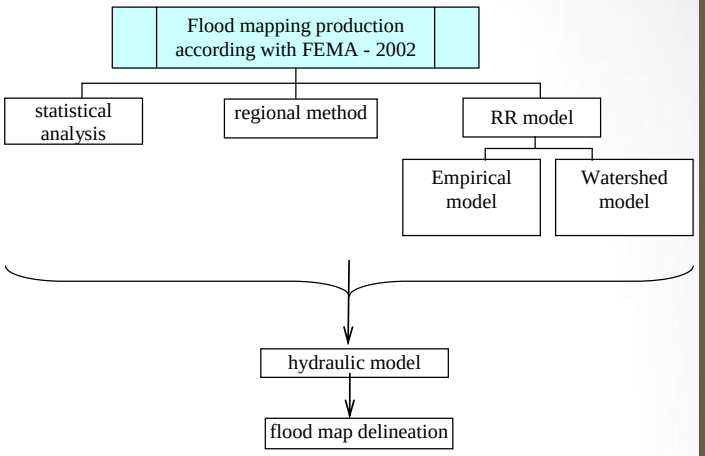

Research objectives
Re-examine the flood mapping methodology
Propose a method to assess the spatial extent of flooding
USGS 1988
NFIP and FEMA
APFM
Morphologic and Hydraulic coupled models

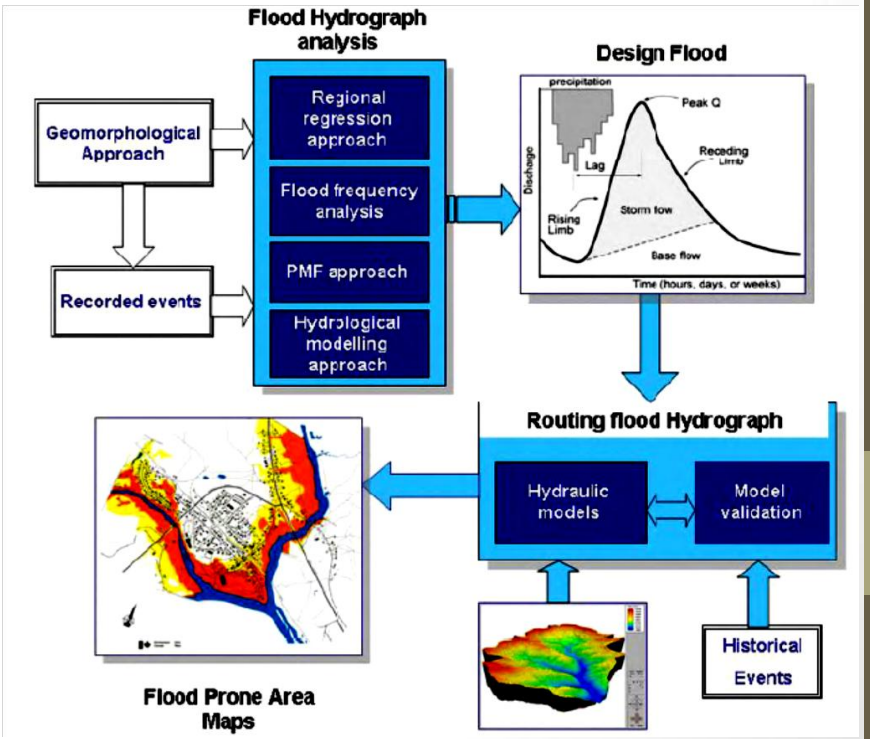
Research approach

- Flood problem in the Dobrogea region
- Status and analysis of observations
- Mapping the flood prone area
- Evaluate results

Flood mapping methodology

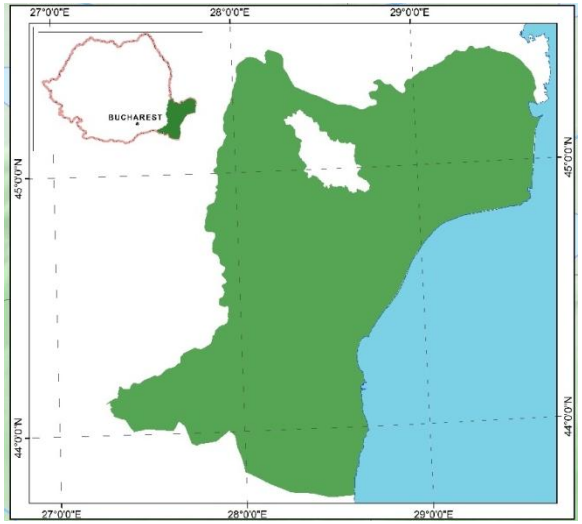


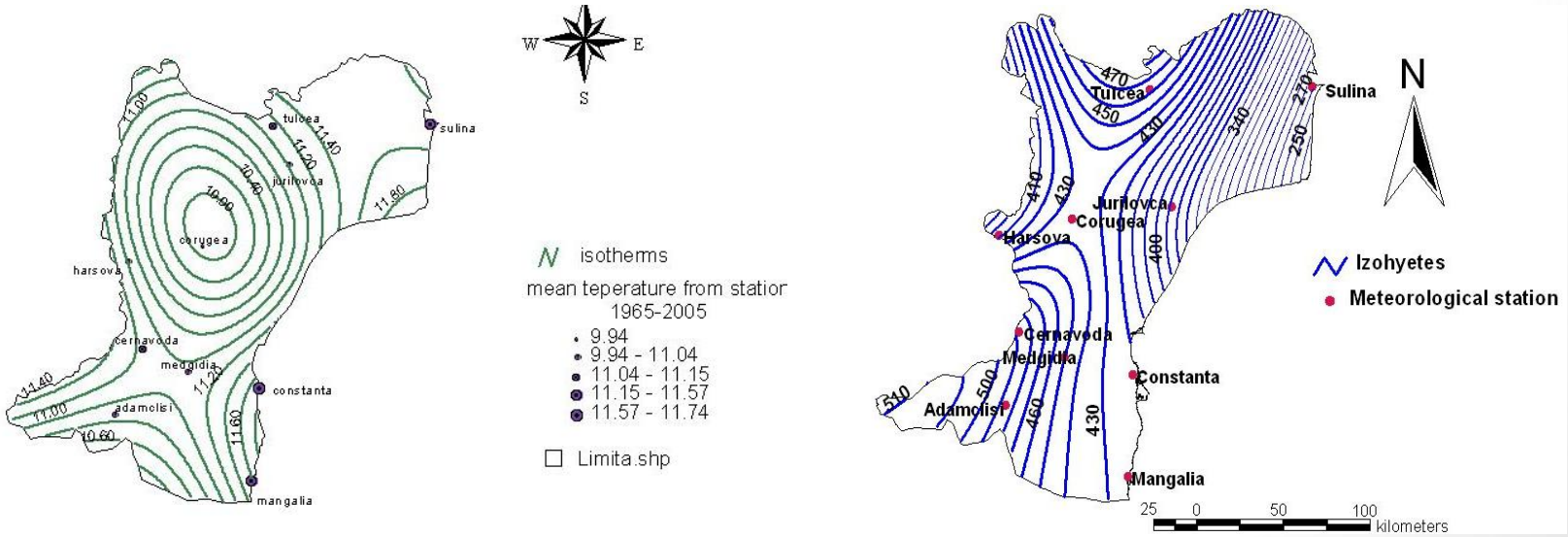




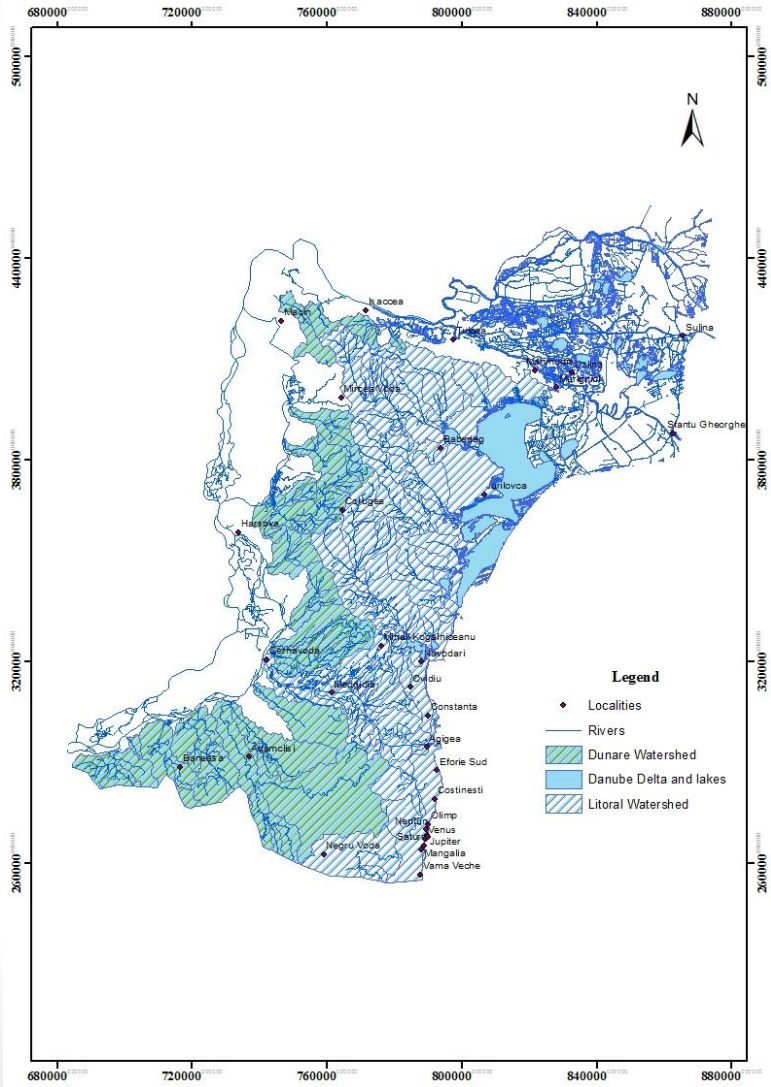
Dobrogea region

- Location
- Geo-morphology
- Climate
- Temperature
- Precipitation
- Hydrology





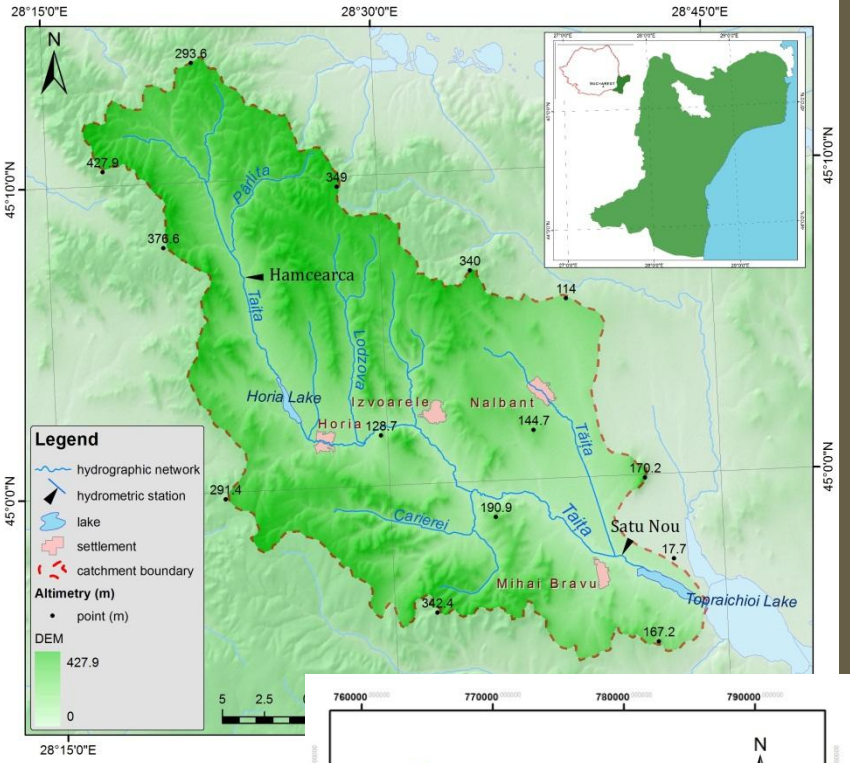
Flood problem in the Dobrogea region

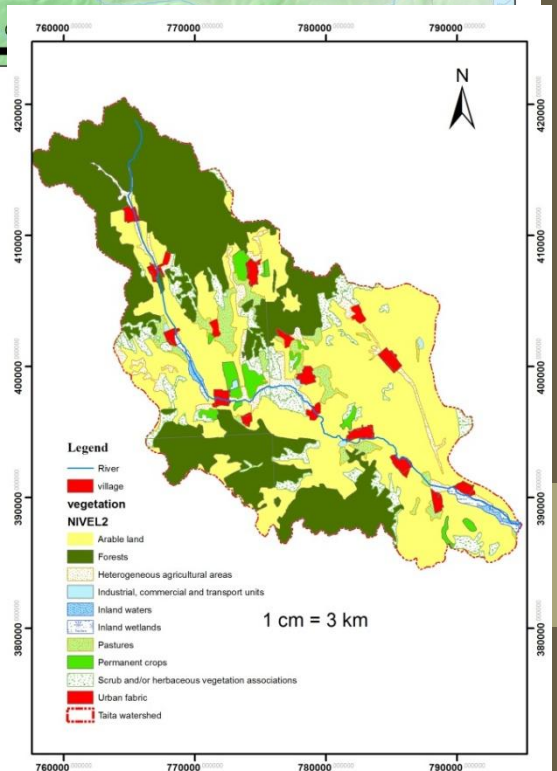


No	Town, village	Date	Characteristics	Damages
1.	Garliţa	1963;1971	-	30 household teared down and animals taken away by the floods
2.	Casian	24.09.1968	442mc/s*	Households and crops destroyed, human lives lost
3.	Lumina	1967	-	Flooded households and destroyed
4.	Runcu	11.06.1985	h apa=1.60 m	Households destroyed and 5 deaths
5.	Baia	16.07.1967	-	Households and gardens flooded
6.	Constanţa	01.07.1992;28 ,29.08.2004	rainfall >200 mm/12 h	Households flooded in the Western area , 3 deaths
7.	Nuntaşi/Nuntasi	01-11.09.1999	32.mc/s (fig.)	Households and gardens flooded, 1 death
8.	Cheia	02.- 04.09.1999	-	Households and gardens flooded, school
9.	Costineşti	22-23.09.2005	Flood coming from upstream, at Biruinta registeredt>300mm/24 h	Damages to the railway, access roads, restaurants, households in Schitu
10.	Casimcea/Casimcea Cheia/Casimcea	30 - 31 V 2002 8 - 9 VIII 2002	398mc/s* 384mc/s*	Households and gardens flooded, access bridge damaged
11	Cuza Voda/Agi Cabul	2 - 4 IX 1999	57,8 *	no
12	Negureni, Valea Marea	2-7 IX 1999	26,8 *	no
13	Albesti	30 - 31 V 2000	153 mc/s*	
14	Sacele, raul Valea Sacele	8 - 9 VIII 2002	45mc/s*	
15	Saraiu, raul Topolog	2 - 20 VII 2005	214 mc/s*	
16	Biruinta,/ Valea Biruinta	20 - 25 IX 2005	131 mc/s*	
17	Urluia/V.Urluia	14-19 VI 1992	10.6mc/s*	
18	Taita/Taita	3.03.1985	56.6mc/s	

Study area and

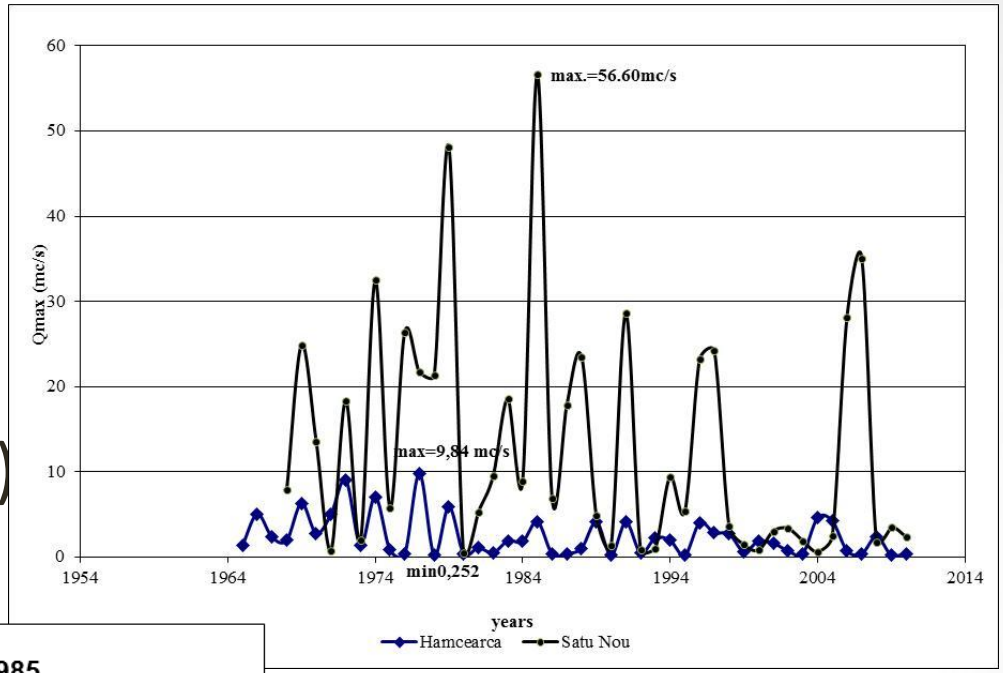
- Taita catchment
  - area 591 km²
  - elevation ranges 261m
  - 10 tributaries
  - part of North Dobrogea Plateau
  - the main source of supply – precipitation 74%
- The hydrometric data are collected in two hydrometric stations:
  - Hamcearca
  - Satu Nou
- Vegetation
  - >33% forest

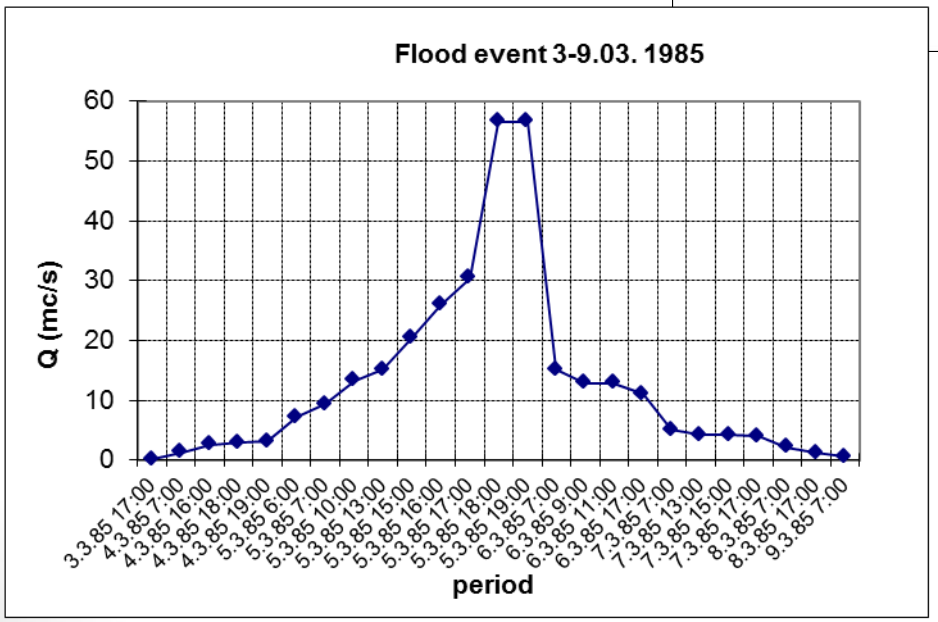




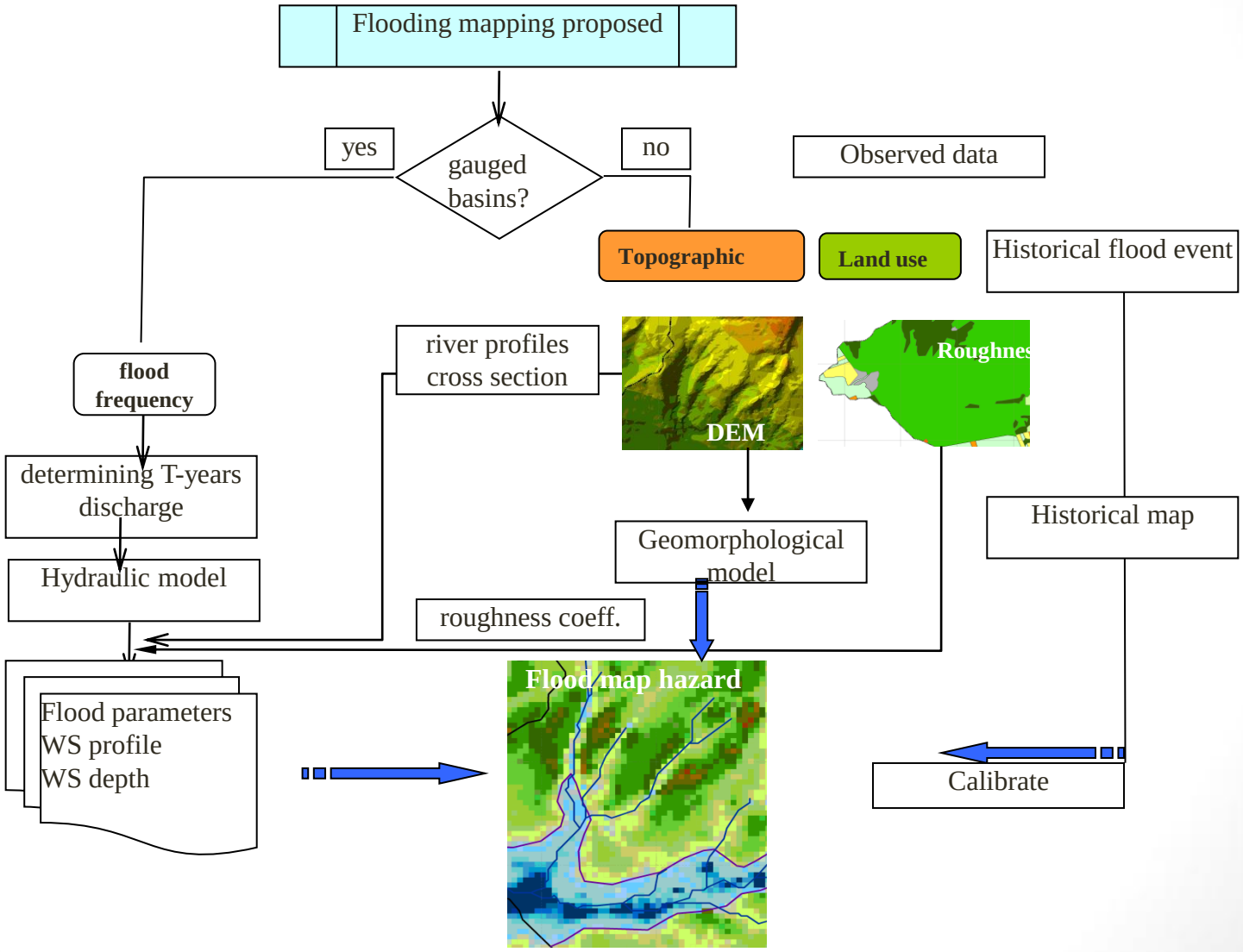
…data base

- In this study the series of annual maximum stream flow, covering the period 1968 (1965) 2010 have been used.





Mapping the flood prone area



Flood frequency:

•frequent event (low probability -10 years)

50 years

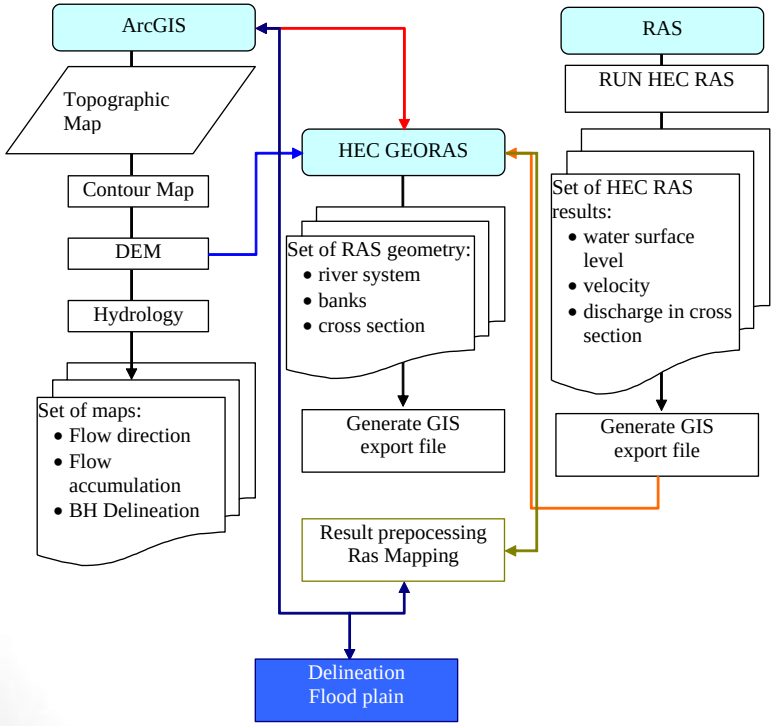
•medium event (medium probability - 100 years)

•extreme event (high probability - 1000 years).

Pearson III distribution

- 30mc/s
- 56mc/s
- 74mc/s
- 192mc/s

Hydraulic model

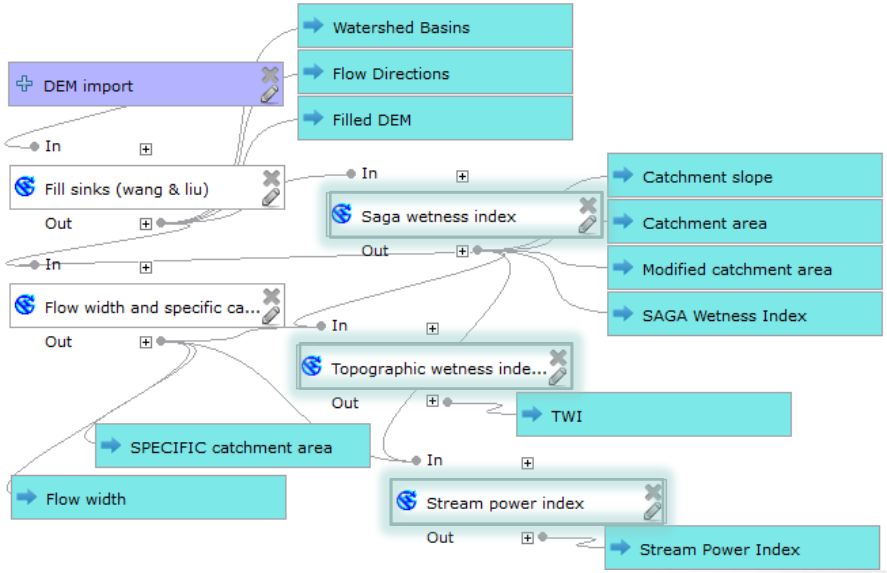


Geomorphological model

Topographic Wetness Index (TWI)

SAGA Wetness Index (SWI)

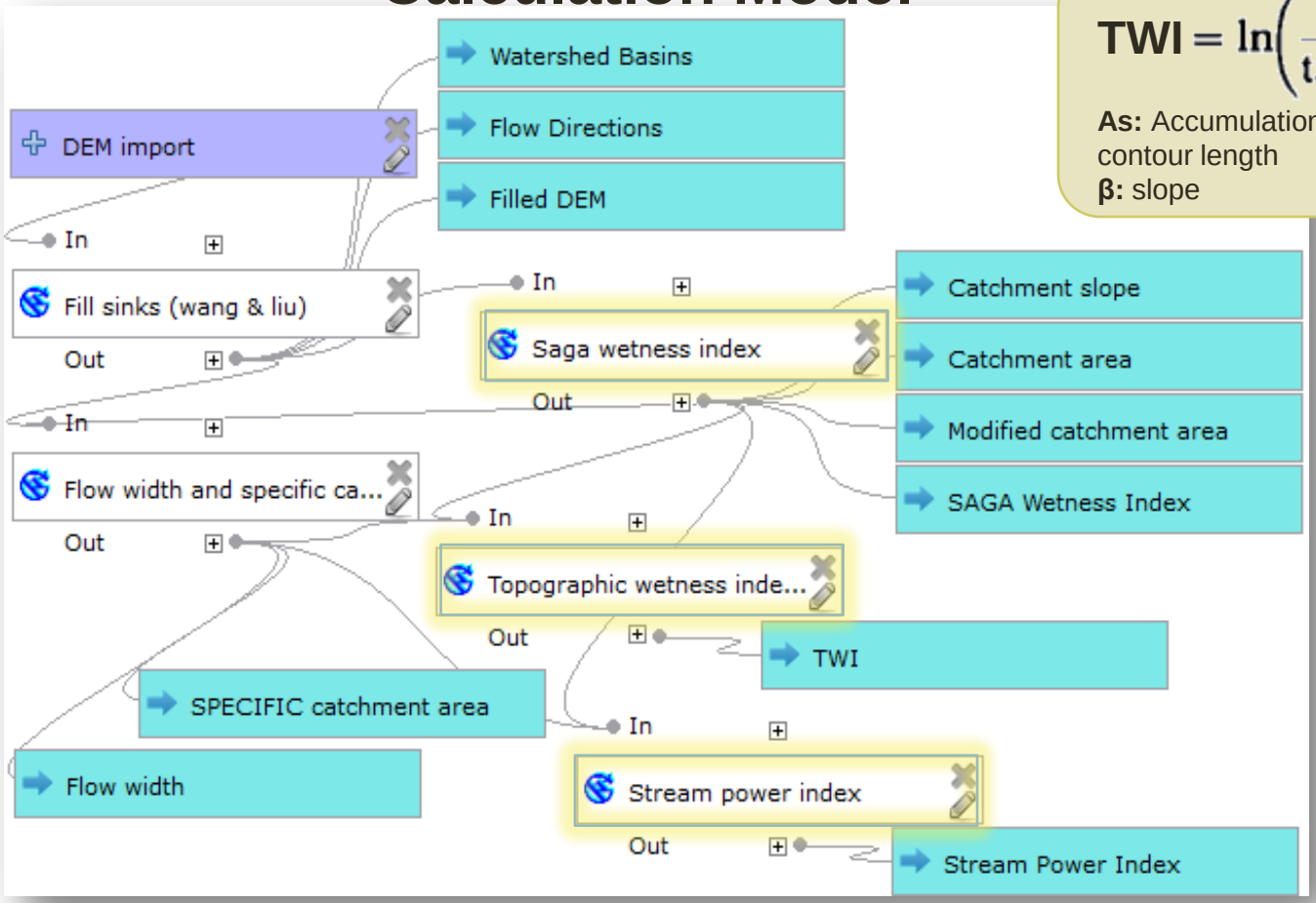
Calculation Models



Geomorphological Model

Topographic Wetness Index (TWI) & SAGA Wetness Index (SWI)

Calculation Model



$$TWI = \ln\left(\frac{A_s}{\tan\beta}\right)$$

As: Accumulation per unit contour length
β: slope

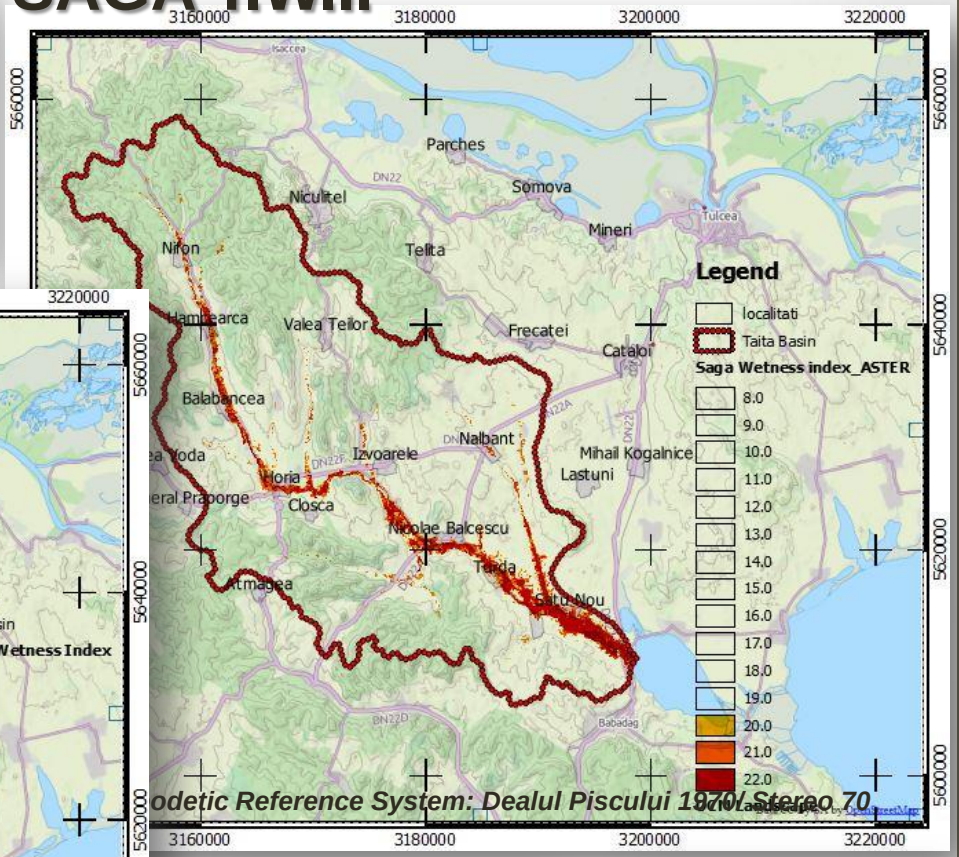
Software Used

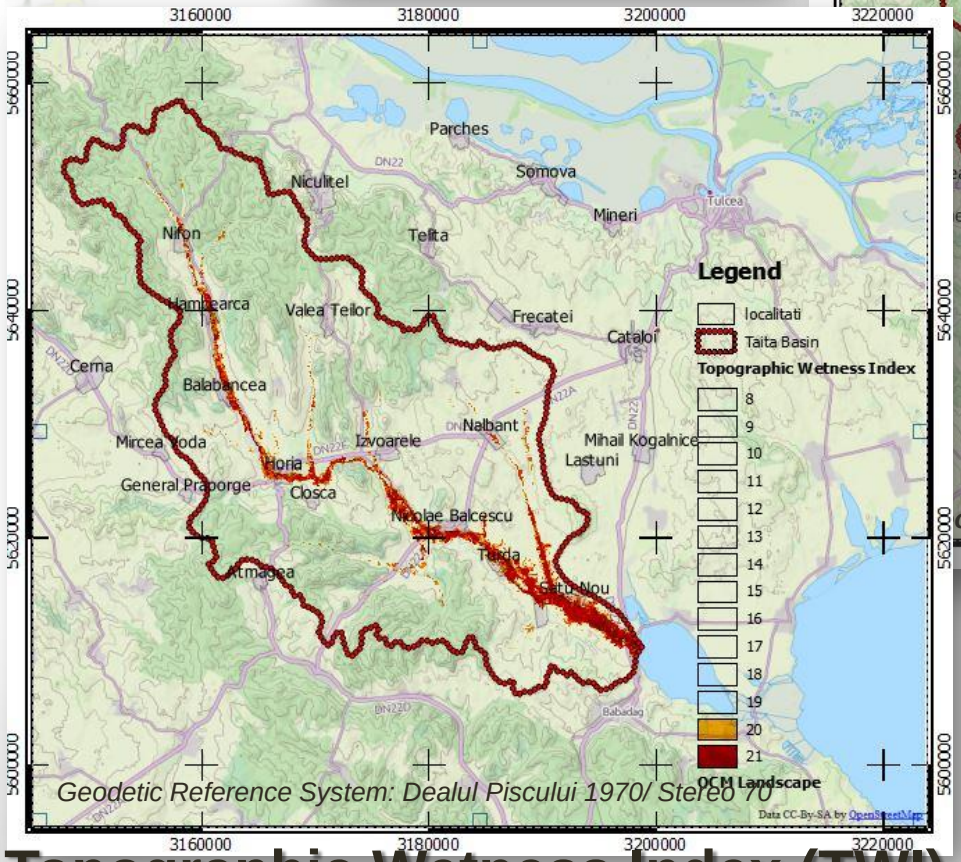
- **Beven, K. and Kirkby, M**. : A physical variable contributing area model of catchment hydology, Hydrolog. Sci. Bull., 24(1), 43– 69, (1979).
- **Moore, I. D., Burch, G. J., and Mackenzie, D. H**.: 'Topographic effects on the distribution of surface soil water and the location of ephemeral gullies', *Trans. Am. Soc. Agr. Engrs.,* 31, 1098- 1107, (1988).
- **Sørensen R., U. Zinko, and J. Seibert**: On the calculation of the topographic wetness index: evaluation of different methods based on field observations. Hydrol. Earth Sys. Sci. Discuss., 2, 1807–1834, European Geosciences Union, (2005).
- **Boehner, J., Koethe, R. Conrad, O., Gross, J., Ringeler, A., Selige, T**.: Soil Regionalisation by Means of Terrain Analysis and Process Parameterisation. In: Micheli, E., Nachtergaele, F., Montanarella, L. [Ed.]: Soil Classification 2001. European Soil Bureau, Research Report No. 7, EUR 20398 EN, Luxembourg. pp.213-222, (2002)

Geomorphological Model - Results

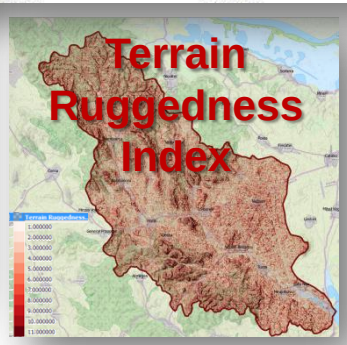
Software Used

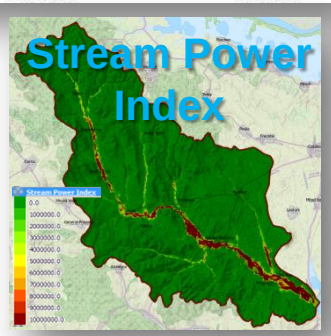
SAGA T.W.I.



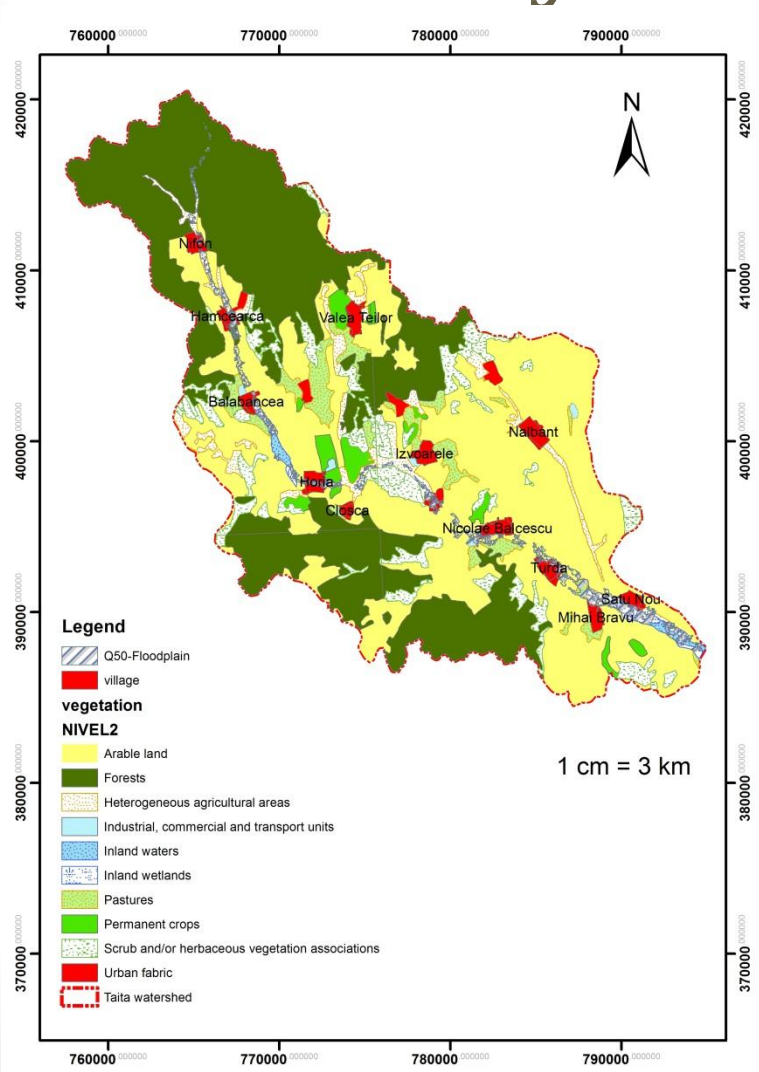


Topographic Wetness Index (TWI)

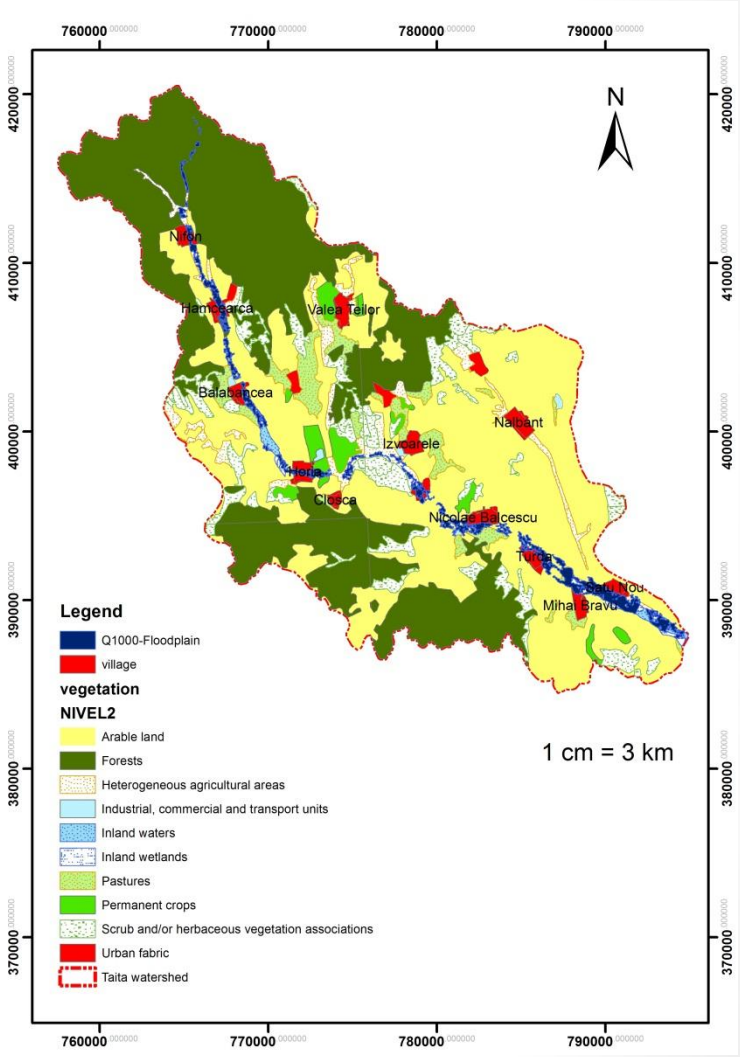




Results hydraulic model

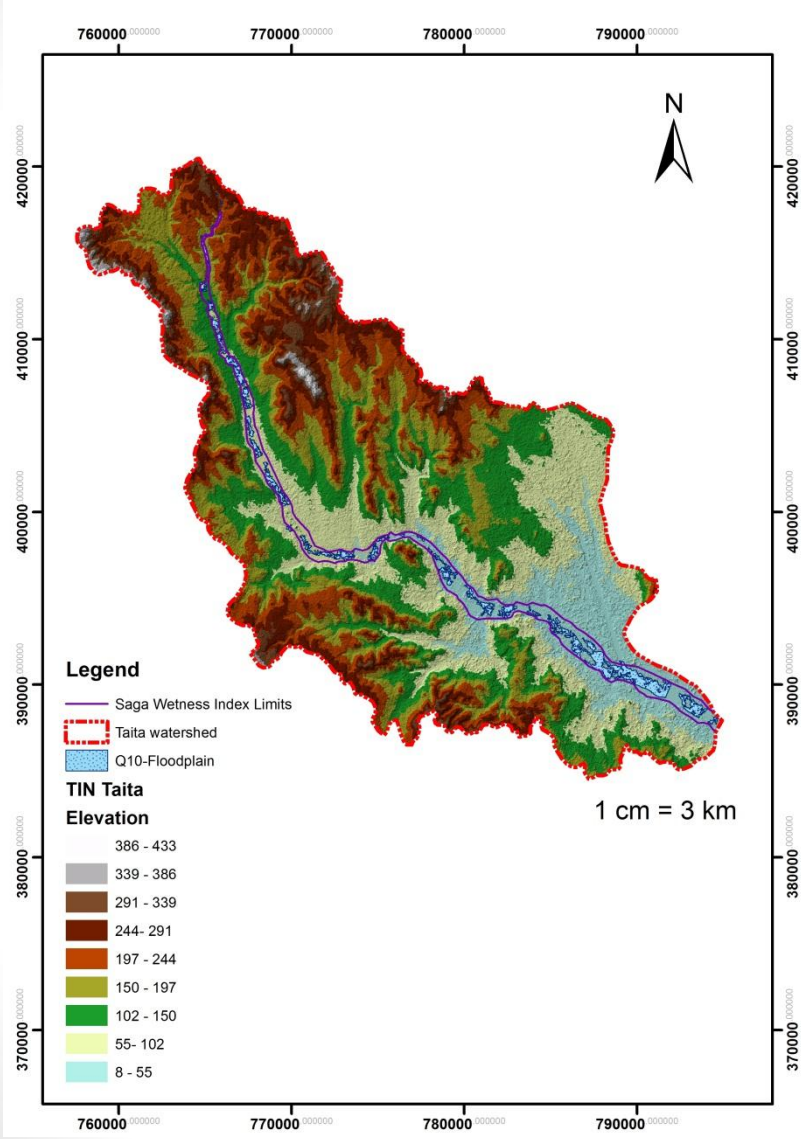


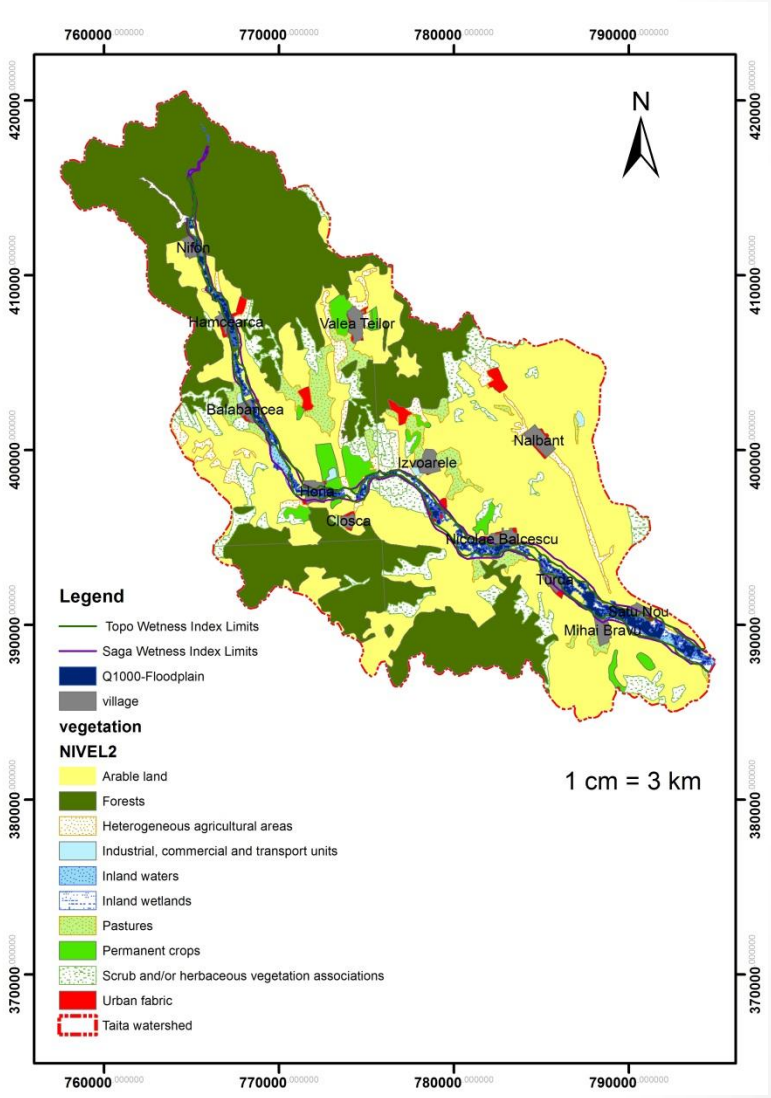
50 years return period



1000 years return period

Comparison of Results





Geodetic Reference System: Dealul Piscului 1970/ Stereo 70

Conclusions (1/3)

- ✓ **Hydrologic and hydraulic modeling was applied to assess flash flood prone areas delineation and flood hazard**, by using widely accepted FFH assessment methodologies.

- ✓ Flash flood prone areas were delineated using the **Topographic Wetness Index** (based on TOPMODEL) and the **SAGA WI geomorphological models**.

- ✓ Inundation areas were also delineated using the **HEC-RAS hydraulic model** by taking into consideration 100 and 1000 years return periods.

Conclusions (2/3)

- ✓ **Comparison of the results** of the different type models used, shows that **there is a remarkable convergence** in the delineation of the inundation (flooded) area despite the fact that these models have very different input data requirements.
- ✓ Taking into consideration that **the geomorfological models** have minimal data requirements as the required data are readily available (ASTER DEMs, topographical data), these models **can be used to** reliably **delineate flood prone areas on a regional scale** in order to proceed with Risk assessment.
- ✓ At a next stage, **hydraulic models can be used** especially **on site-specific (local) scales** in order to accurately estimate the flooding parameters (inunndation area, depth, flood water velocity etc), thus helping make decisions about designing effective preventive measures.

Conclusions (3/3)

- ✓ To demonstrate the broad applicability of the selected methodologies, open source software was used to store, process data and create maps.

- ✓ As resulted, **Quantum GIS (v.2.1), SAGA GIS (v.2.08) and HEC-RAS** can be effectively used to fully apply the proposed methodological approach as they **provide very reliable platforms at no cost**.

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