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Earthquake, Landslide and Flood Disaster Prevention: the SciNetNatHaz project

Acknowledgments:

The SciNetNatHaz Project is partially funded by the EU and Hellenic National funds within the context of the Black Sea Basin Joint Operational Programme 2007-2013

K. Papatheodorou, TEI of Central Macedonia, Hellas

www.scinetnathaz.net

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Contents

- Problems regarding flood disaster mitigation
- A brief description of the Project
- Outputs
- The SciNetNatHaz proposal for flash flood disaster prevention

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A brief description of the Problems regarding Flood Prevention

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Hazard to …..Disaster!

Vulnerability &
Insufficient Capacity
to Reduce the RISK

- Unforeseen events
- Poorly assessed Hazard location and/or magnitude of events
- No preventive actions taken due to various reasons (economic, etc)
- Lack of public awareness
- ….and more ….

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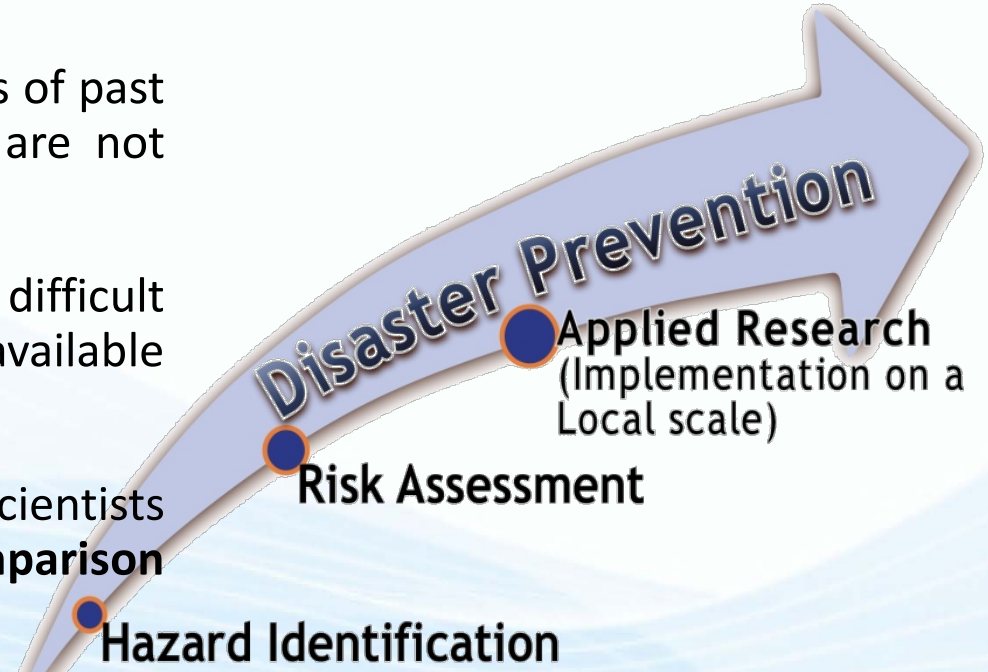
Hazard Assessment in the EU… the Information Gap!

- **Usable Data are still lacking**. Inventories of past landslides and floods do not exist or are not accessible.
- **Metadata** are not supplied so it's very difficult to assess reliability and accuracy of available data (if found).
- **Different methodologies** are used by scientists even in the same country, **making comparison** of results, **impossible.**
- **Hazard identification & Risk assessment on a local scale** (that could provide the essential information for planning preventive measures) **has only been sparsely implemented**.



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Some Flood related issues

- **Serious problems regarding floods in large rivers are being tackled** with **early warning systems**, **preventive measures** and **management plans** developed but…

- All though there is great advance in **cross border flood management issues**, there is still a lot to be done in terms of a **common approach of the flood problem** in neighboring countries.

- **Flash floods,** which are frequent and common in most of the Mediterranean and the Black Sea countries, **are not dealt with**. This fact has already been recognized by the EU and flood management plans are foreseen to be designed during the next period of the Directive 2007/60/EC implementation.

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What needs to be done

CONSENSUS (a pre-requisite!) among the members of the scientific community involved in ELF Disaster mitigation regarding:

- **Harmonization of METHODOLOGIES** used to assess the hazards…in order to create a large network of potential partners working on the same problem, supporting each other, sharing competencies.
- **DATA harmonization** including **METADATA** creation.
- **DATA** collection and **SHARING**
- **Applied Research** to provide support for decision making

...and….

- **A way to overcome the problem of needing….Time and Money!** (for data collection and processing)

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A brief description of the SciNetNatHaz Project

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The Parthership!

TEI OF CENTRAL MACEDONIA SERRES GREECE
Lead Partner

DEMOCRITUS University of THRACE, Greece

Institute of Engineering Seismology & Earthquake Engineering, EPPO

"Assen Zlatarov" University BULGARIA

OVIDIUS University ROMANIA

"Dr. Ghitu" Institute, Acad. of Sciences MOLDOVA

BSB, Environmental Academy of Sciences UKRAINE

Bogazici University-Kandhili Observatory & Earthquake Research Institute, TURKEY

Basic Info:

Black Sea Basin Joint Operational Programme 2007-2013

Duration: 31 months
Total Budget (**ENPI + IPA**): 1.053.000,00
Total Grand (**ENPI + IPA**): 947 700,00
Start - End Dates: **01.05.2013 - 30.04.2015**

Areas of investigation

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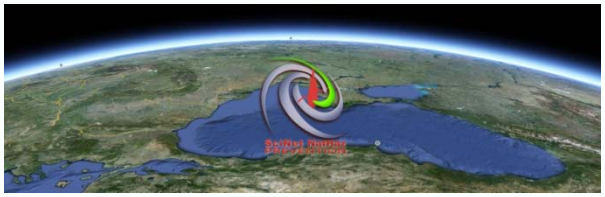
Scope of the SciNetNatHaz Project



A. **To establish a strong regional (BS) cooperation by developing a SCIentific NETwork** for Earthquake, Landslide and Flood (ELF) Hazard **Prevention** that will set the basis for:

B. **Systematic data** acquisition, **harmonization**, management and **sharing** with the scientific community

C. **Harmonization of Methodologies** and **Procedures used to assess ELF hazards**

D. A **systematic Hazard assessment - Pilot implementation in selected areas** so that preventive measures can be proposed

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…some of the results (so far) #1

A. **More than 80 Scientists** are already participating in the Project coming from 12 different Universities, Academies of Sciences and Research Institutes around the Black Sea area. More scientists have expressed their interest in being voluntarily involved in the implementation phase.

B. **Topographic and Thematic maps** in analogue and digital format, **digital and tabular data were collected, processed and Metadata files created** according to the INSPIRE directive (around 1000 files).

- A **Geodatabase** has been developed as part of a WeGIS which hosts both data and Results produced by the Project.
- A **Web GIS platform** has been developed and is already operational. It will provide data and pilot implementation results to stakeholders.
- **Open source software has been adopted** for all applications in order to be freely shared with the stakeholders.
- **Open Seminars** are being scheduled for the next months.

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…some of the results (so far) #2

C. **Harmonized Methodologies** selected/adapted to local conditions are proposed and **are being used for ELF Hazard assessmen**t throughout the implementation area.

D. **Pilot Implementations of Flash Flood Hazard** assessment/Design of Preventive measures, have already been carried out in Greece, in Romania, in Turkey and in Bulgaria (under implementation).

- **More than ten Presentations in International Conferences** and **six Paper Publications in Scientific Journals** have already been supported by the project. Publications are being made in order to communicate the Project Outputs (and funding source & Programme) with the stakeholders –especially the Scientific Community and practitioners-and receive feedback.

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The SciNetNatHaz proposal for flash flood disaster Prevention

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Problems and Solutions

- **Usable Data are still lacking.** Inventories of past landslides and floods do not exist or are not [illegible]
- **M[illegible]** [illegible] to assess reliability and accuracy of available data (if found).
- **Different methodologies** are used by [illegible] even in the same country making co[illegible] of results, **impossible.**
- **Hazard identification & Risk ass[illegible] local scale** (that could provide the essential inf[illegible]) **has only been sparsely implemented.**

1. Develop a methodology with minimal data requirements which can provide accurate and reliable results to support decisions regarding designing PREVENTIVE MEASURES

2. Pilot Implementations on a "Site Specific"/Engineering scale in order to evaluate performance

3. Share competencies/Build Capacity of the Stakeholders to broaden the number of users

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Flash Flood Hazard (FHA) Assessment - Methodology (Model) selection Considerations

Sequential Steps for Model selection:

1. **Problem** definition;
2. Specification of the **objectives**;
3. **Evaluation of the available data**;
4. Determination of the **available** computer/hardware **facilities**;
5. Specification of **economic & social constrains**;
6. Adoption of a particular **class of hydrologic models**;
7. Selection of the particular **type of model** within a selected class;
8. Model **Calibration/Adaptation to local conditions**;
9. **Performance evaluation**;
10. Potential use of the model for prediction purposes;
11. The possibility of embedding the specific model into a more general one.

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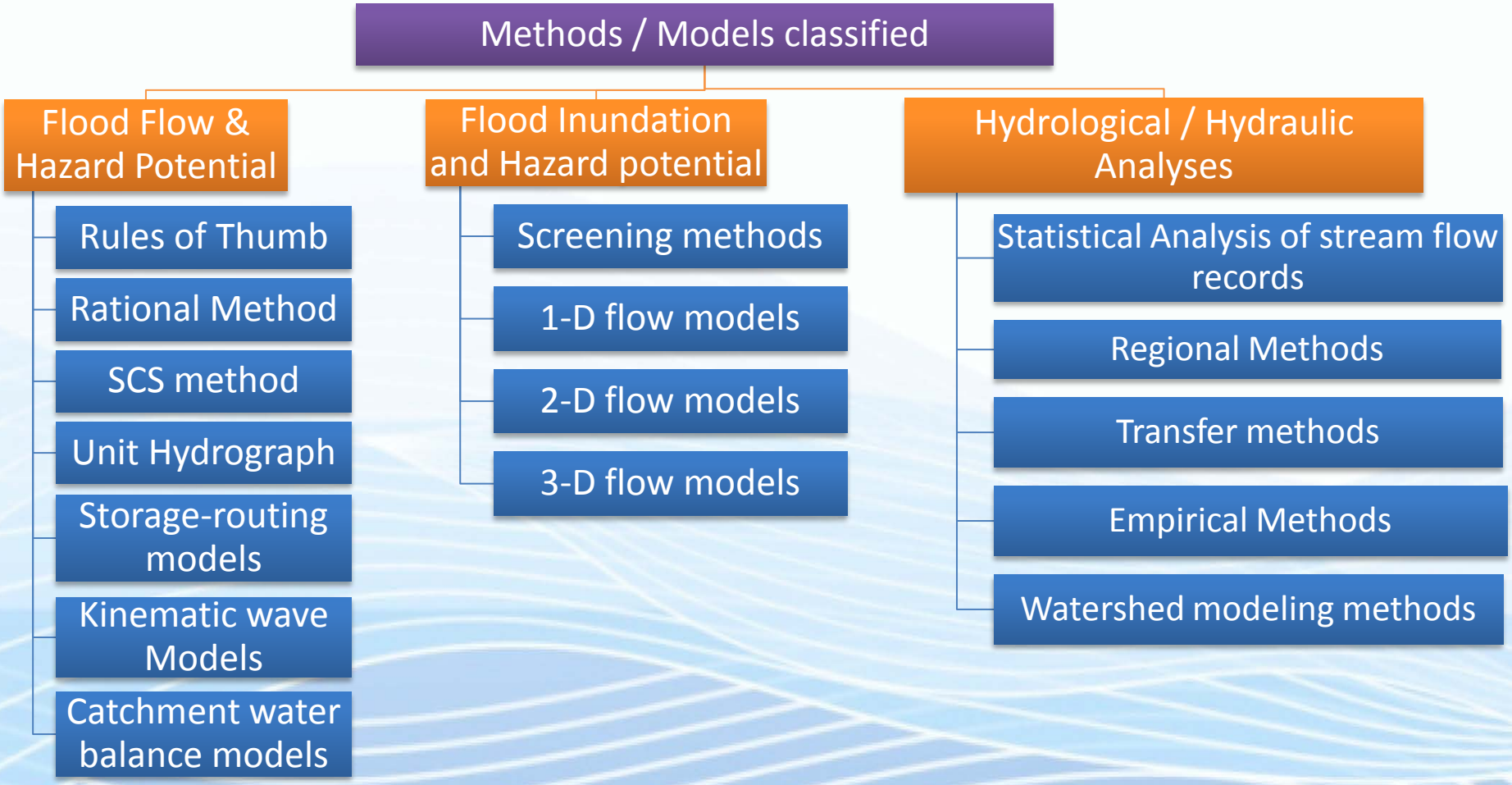
Flood Models, Methods and Techniques considered



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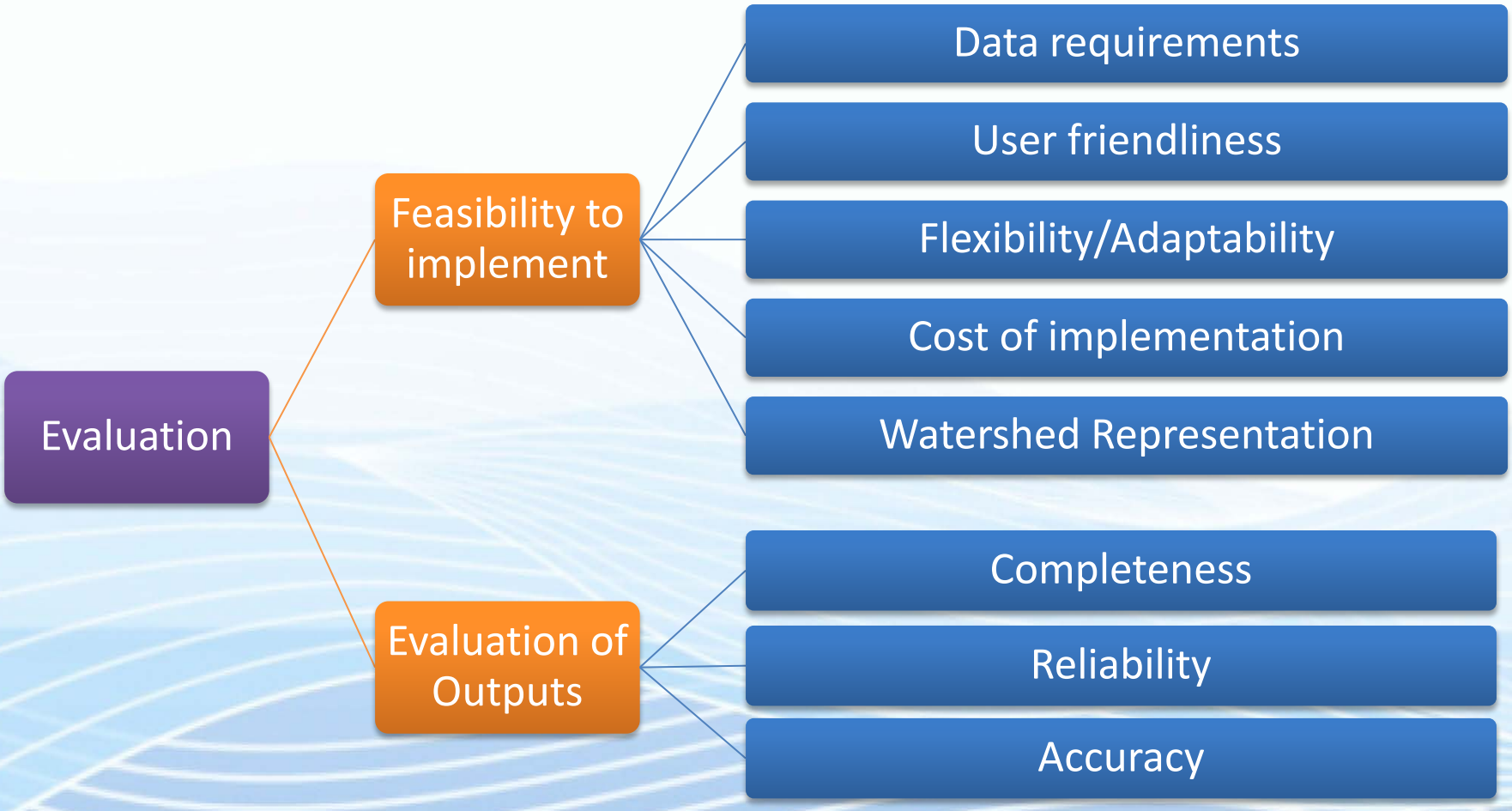
Evaluation criteria (a brief list)



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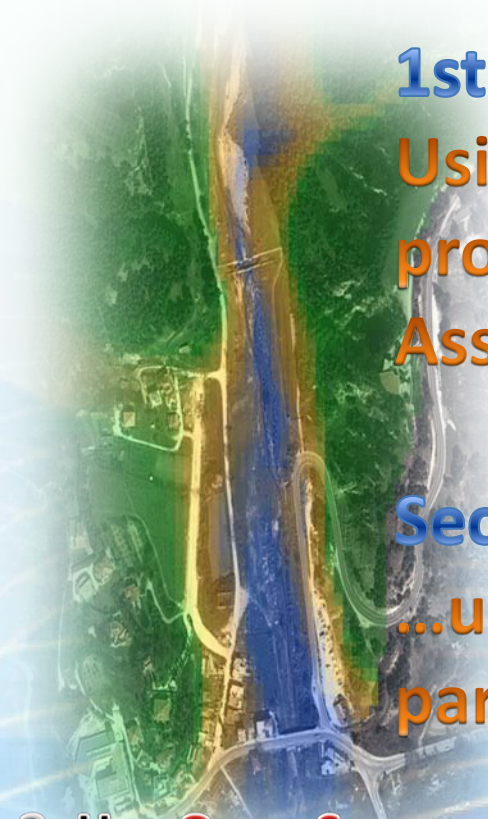
The SciNetNetHaz "two step" proposal



1st Step: SCREENING!

Using Morphometric models to locate Flood prone areas

Assess the potential risks and prioritize research

Second Step: Implementation on a local scale

...using Hydraulic models to assess flooding parameters and design preventive measures

3. Use Open Source Software for the entire process and disseminate to promote adoption by the stakeholders (Public Sector, practitioners, scientists)

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Step 1:

Using Morphometric models and Open Source Software to locate Flood prone areas

A guide to pilot Implementation

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Contents

- Data Requirements
- Procedures
- Outputs
- Evaluation

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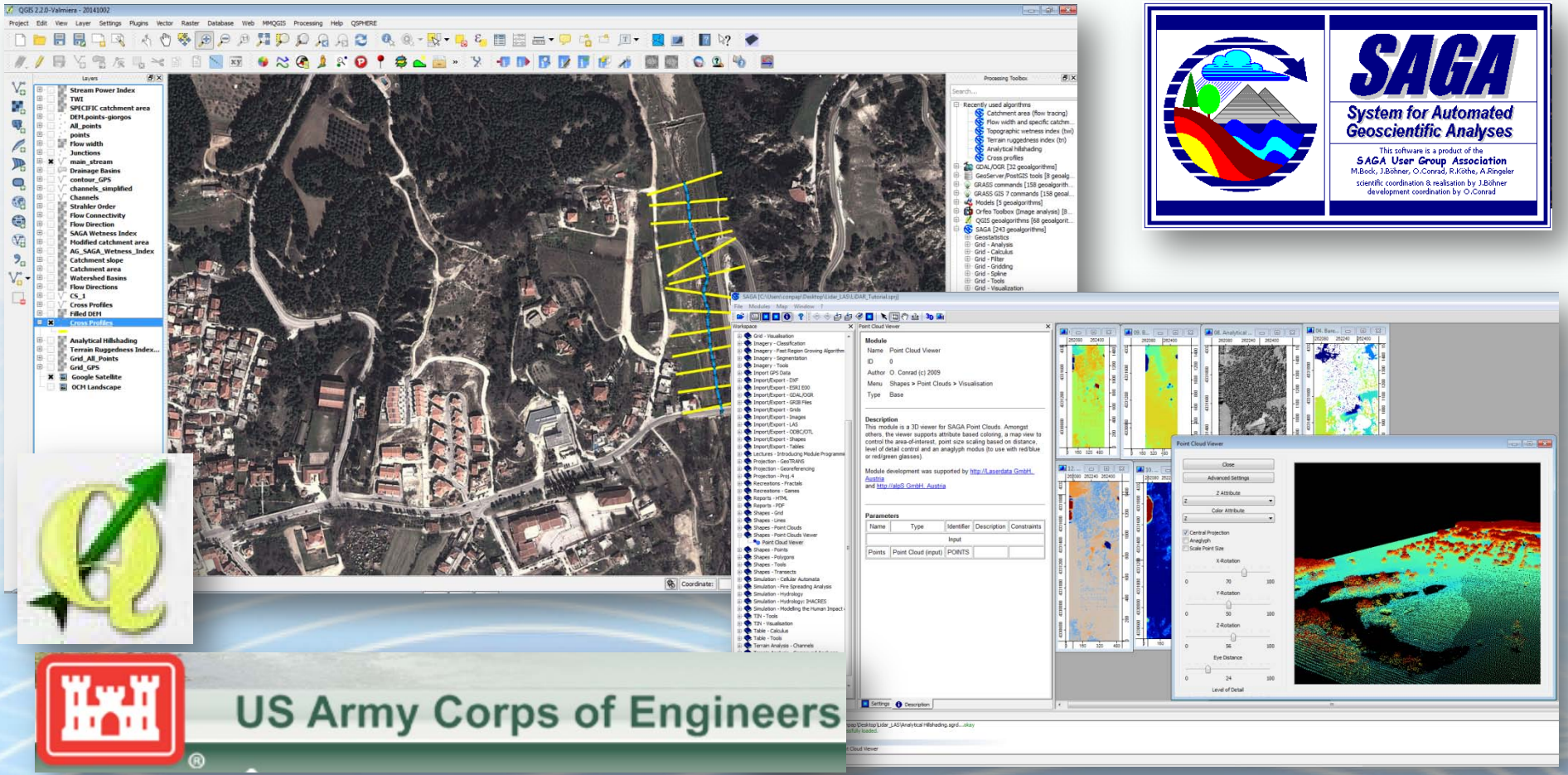
The Tools – Open Source software



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Regional Scale assessment: Required Data

- **Topographic Maps, scale 1:50.000**
- Elevation Points
- Land Use maps (Corine 2000 / 2006)
- Road and Railroad Network

This is compulsory; the rest are optional

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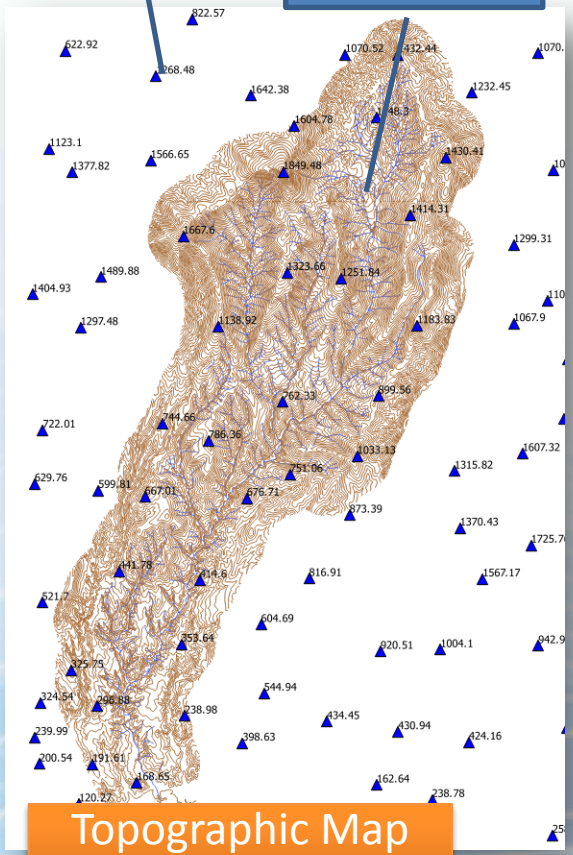
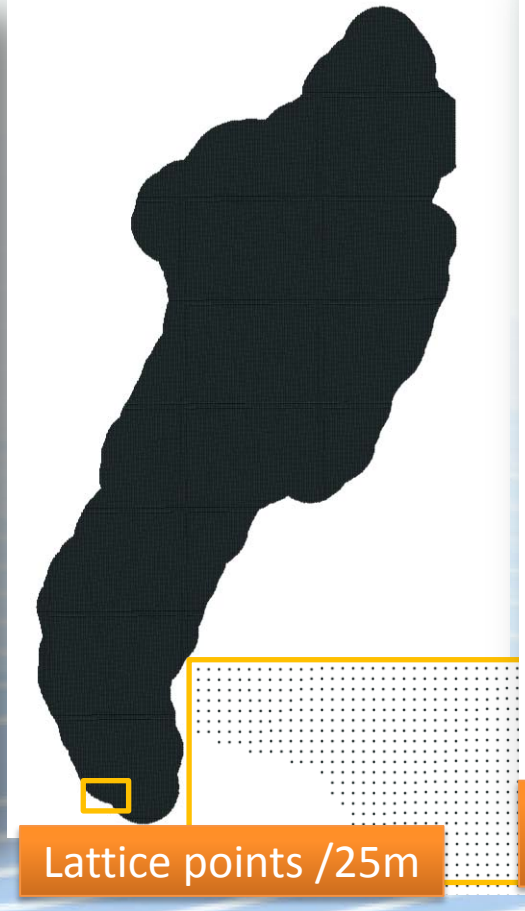
Required Data

Elevation Points

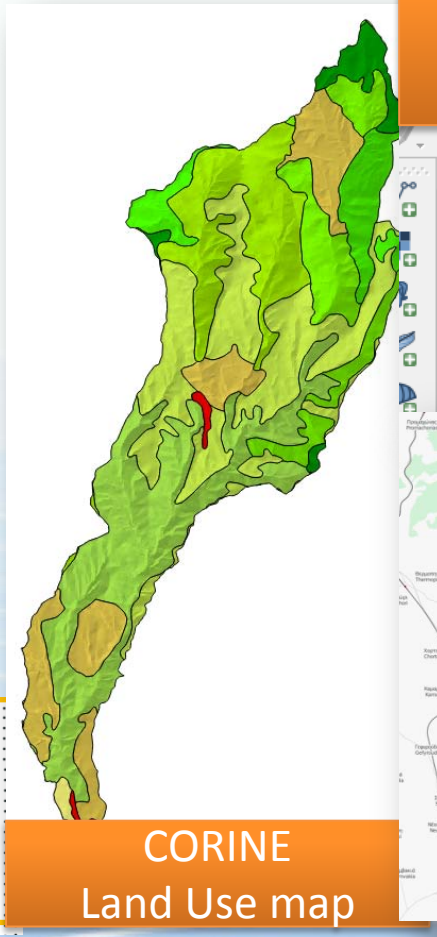
Contours / 20m



Topographic Map 1:50.000

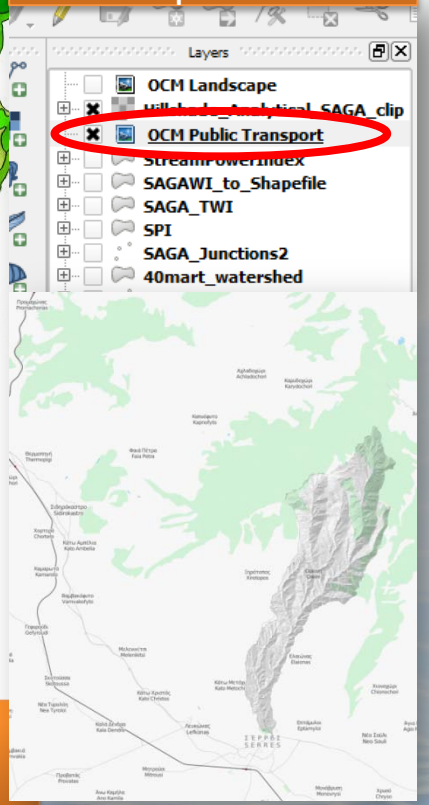


Lattice points /25m



CORINE Land Use map

OpenStreet Maps Public Transportation



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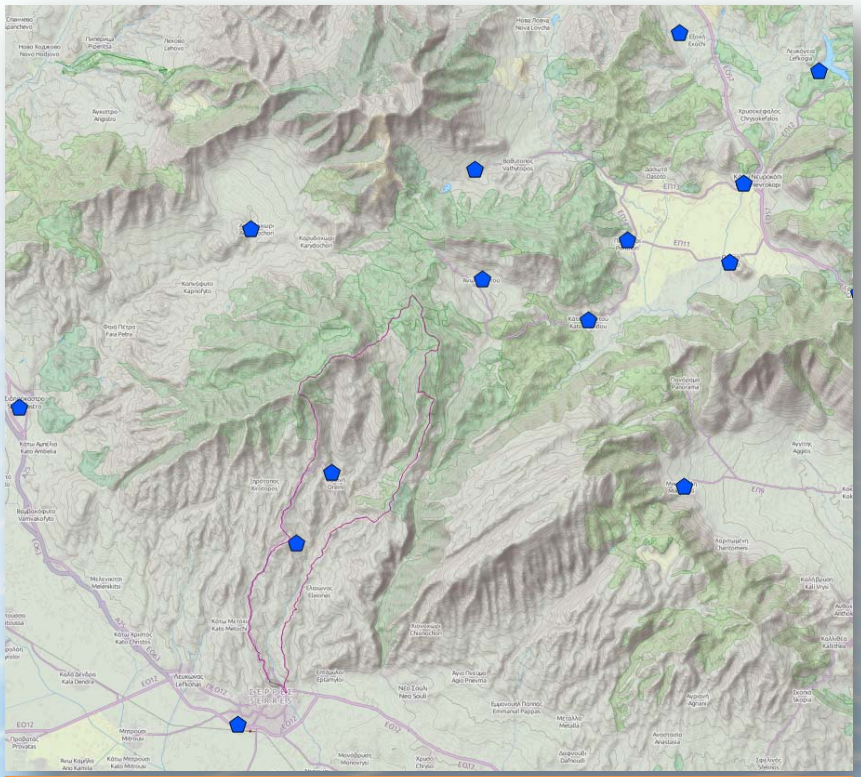
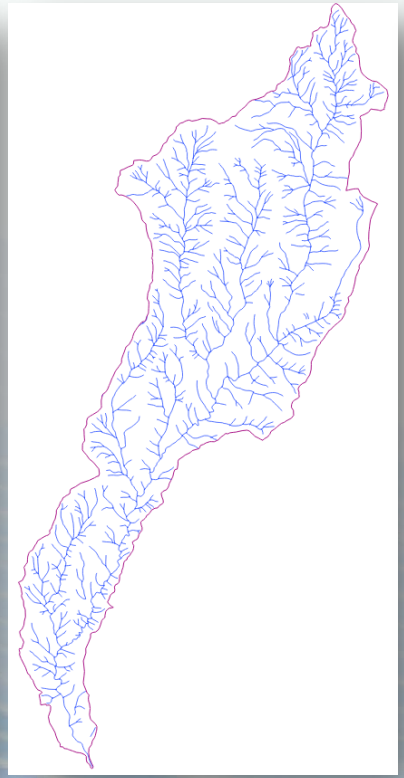
Rainfall & Hydrology

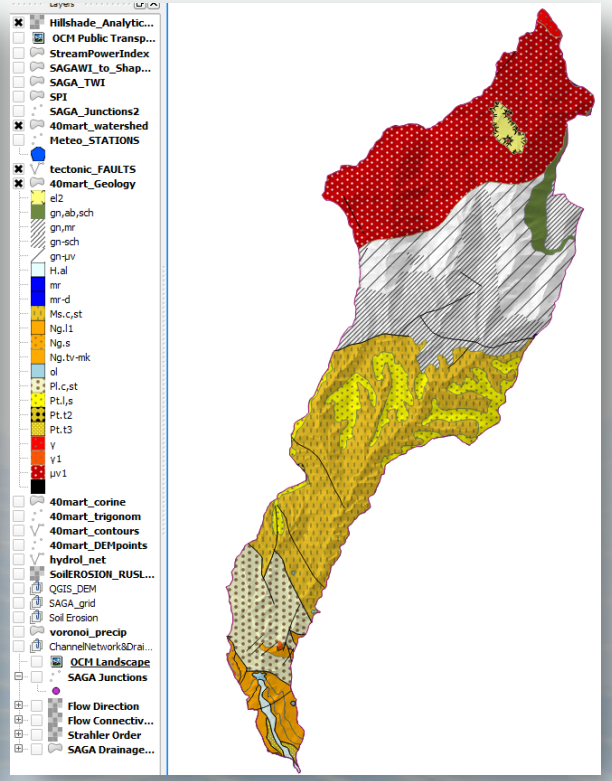
Please Note: Rainfall data are compulsory for the implementation on a local scale



Meteo – Stations on an OpenStreet Map Landscape layer



Hydrology Network (digitized from topo maps)



Geologic map

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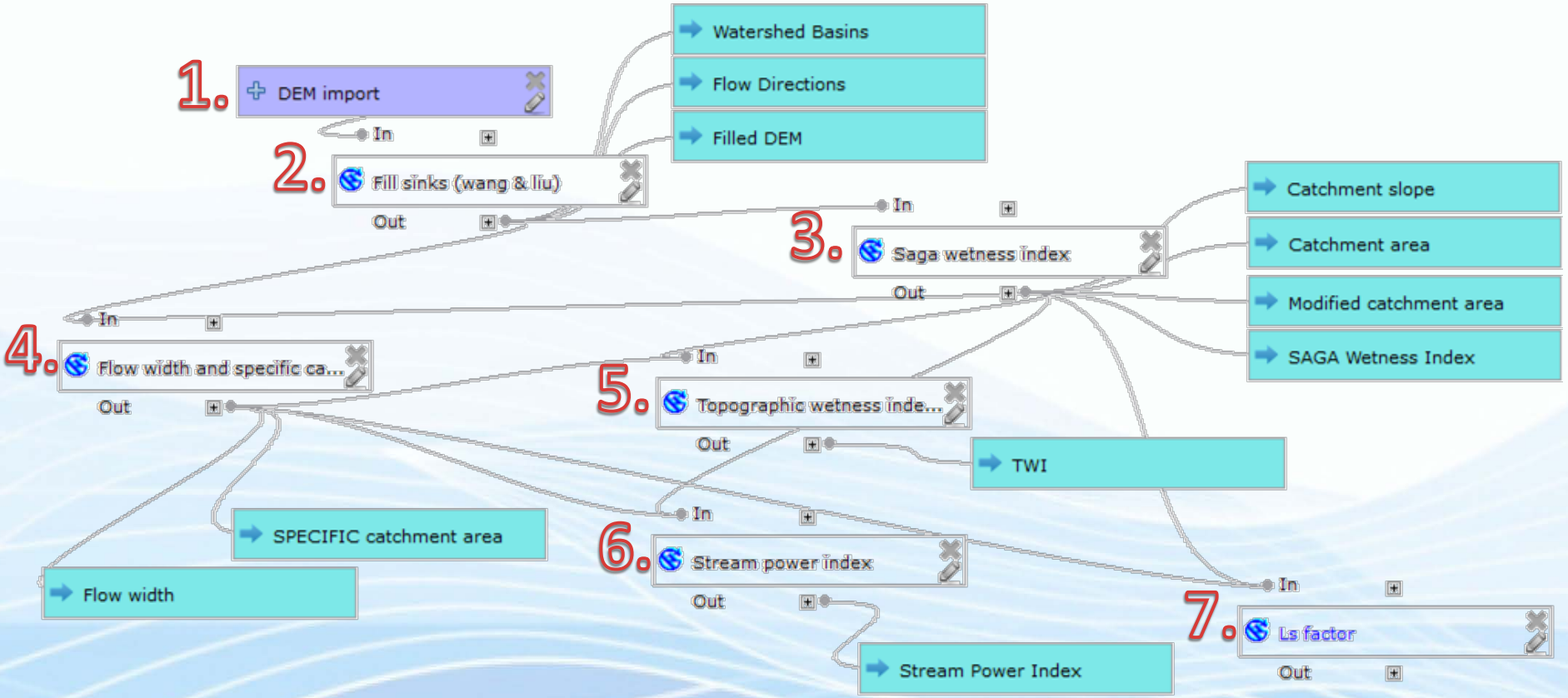
Procedural steps



Build GRID with elevation/topo data → Clip it! (to the watershed) → Fill the SINKS! → Calculate SAGA WI → Calculate TWI → Calculate LS-factor → RUSLE

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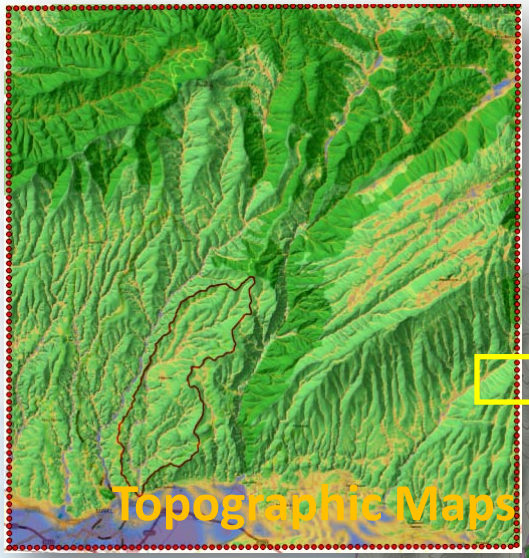
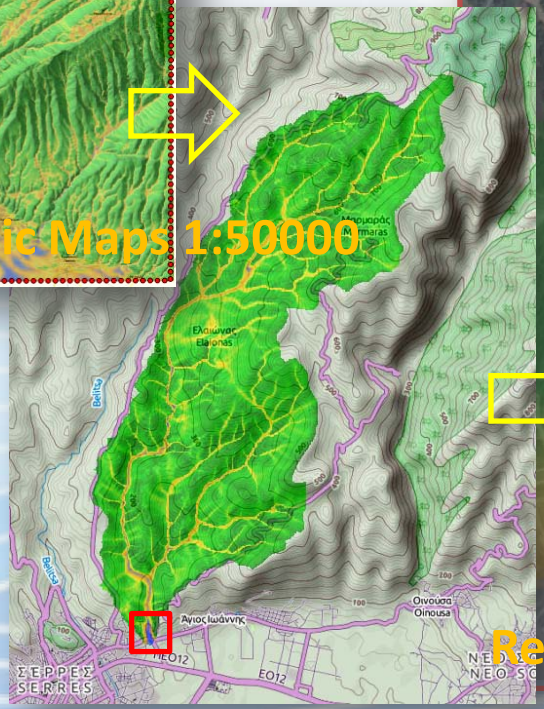
Flood Hazard… Screening from Regional to Local scales



Topographic Maps 1:50000



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

As: Upstream Contributing AREA per contour unit length

β: Slope

Regional Scale assessment of flood prone areas

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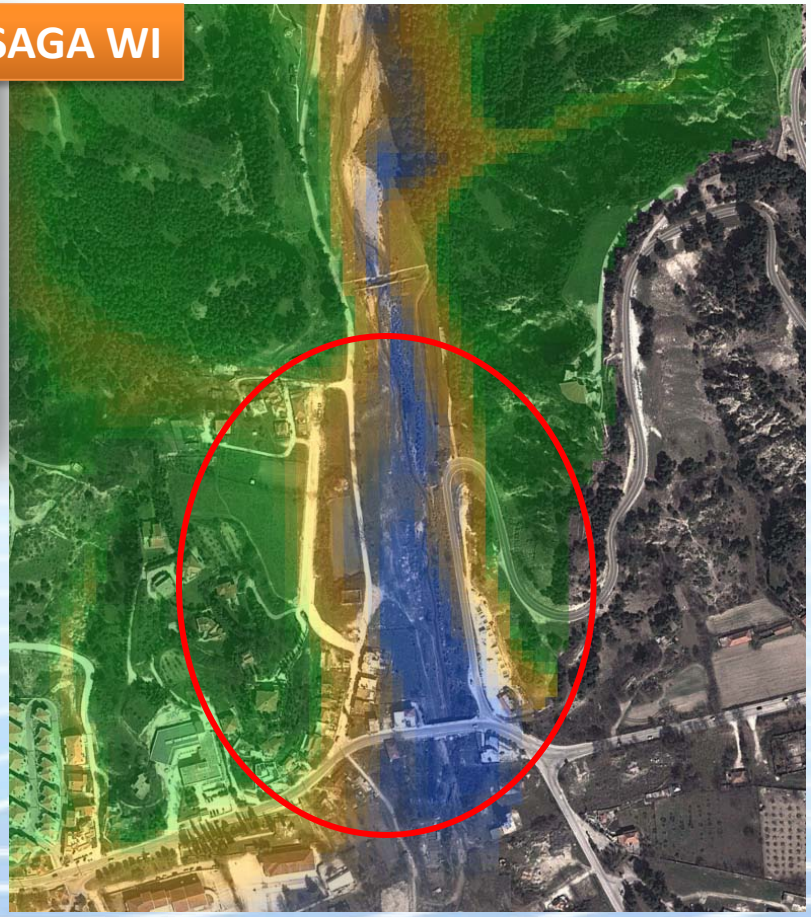
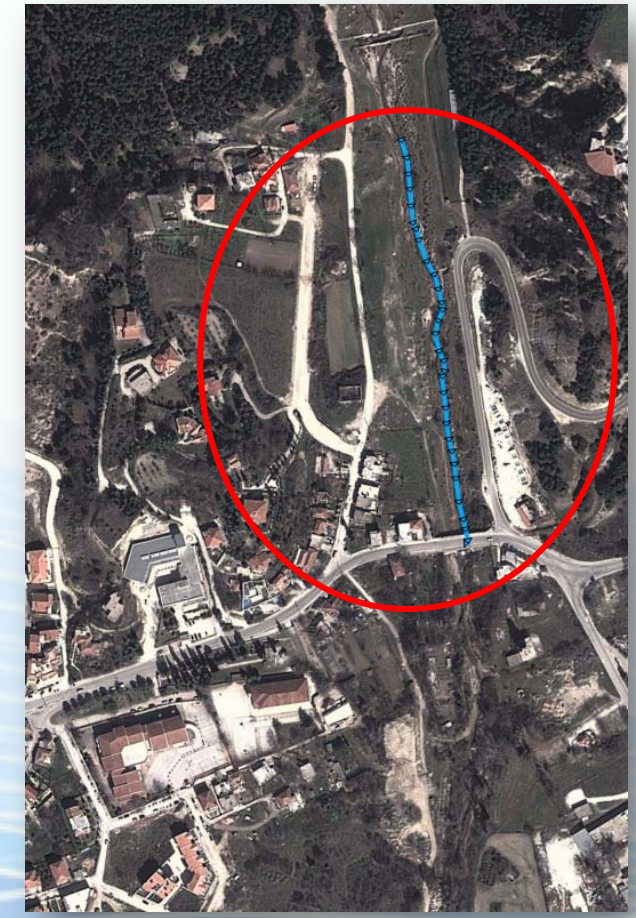
From Regional to Local Scale





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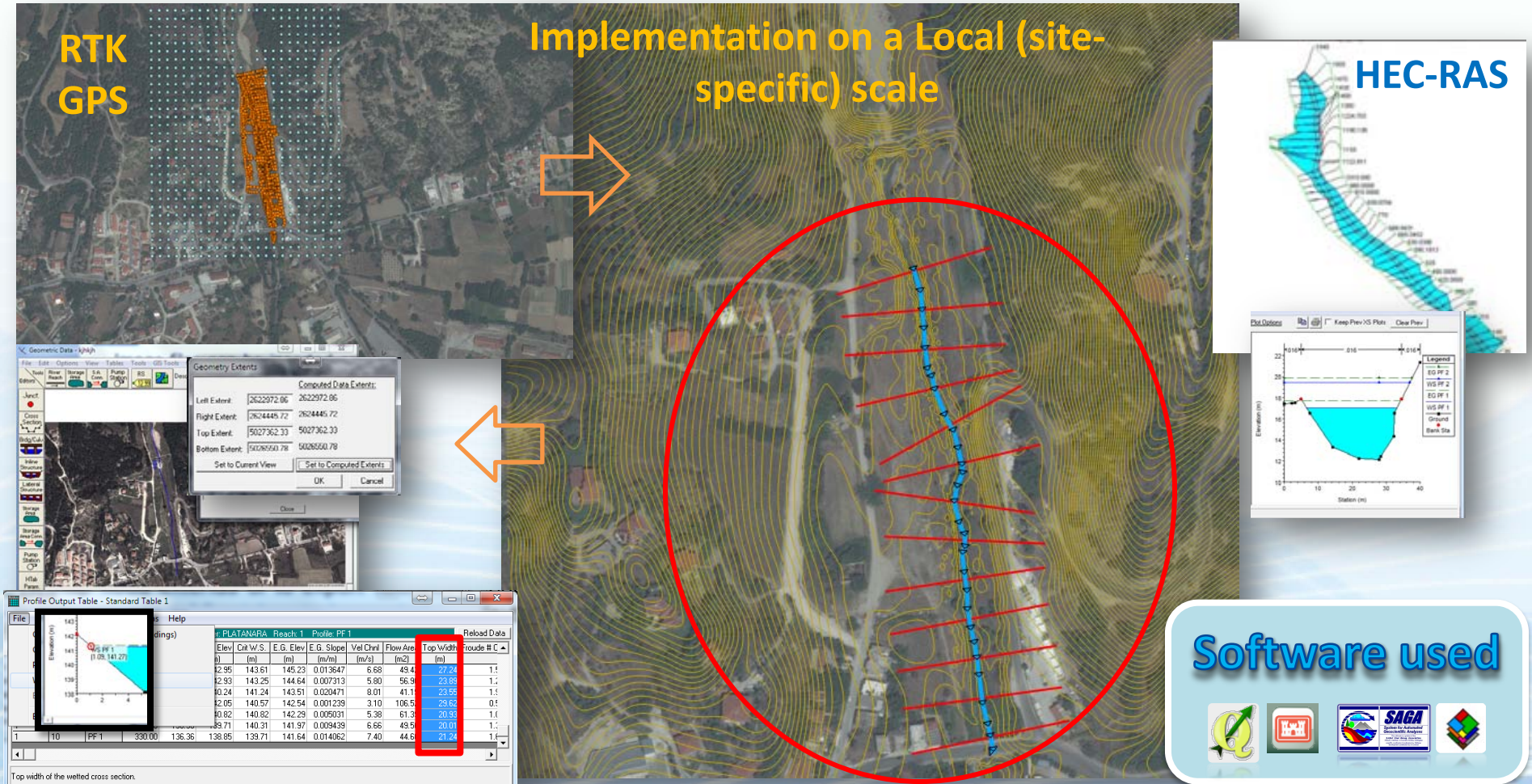
Flood Hazard on Local scales – Hydraulic Models (HEC-RAS)



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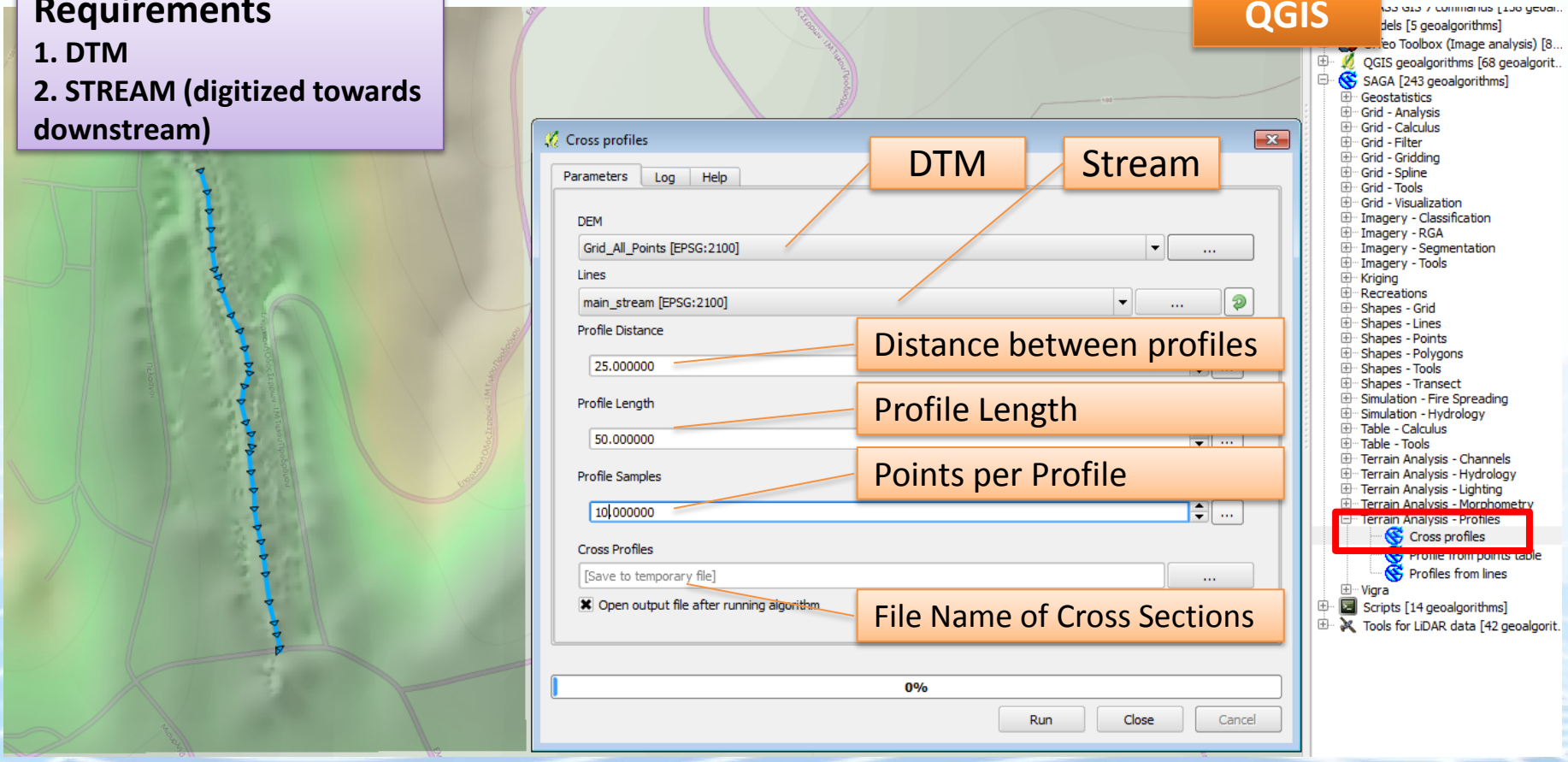
Cross Sections – Output to HECRAS

(local scale implementation)

Requirements
1. DTM
2. STREAM (digitized towards downstream)



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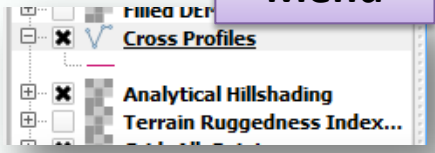
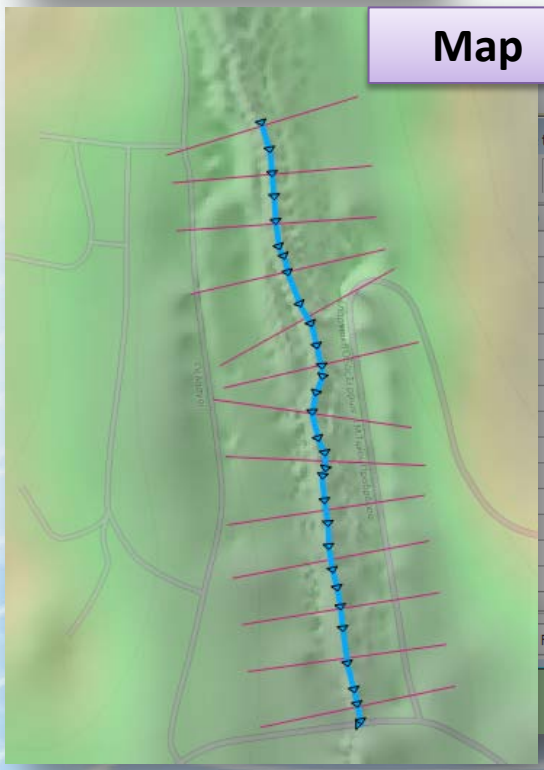
Cross Sections – Output to HECRAS

Menu



Map



Attribute Table (elevation per point)

table - Cross Profiles :: Features total: 13, filtered: 13, selected: 0

	LINE	PART	X000	X001	X002	X003	X004	X005	X006
1	0	0	81.31216345	81.01318737	80.77740383	81.94197267	77.05189802	76.69844410	77.05443992
2	0	0	80.36807859	80.53721828	81.22395998	81.06987561	77.57384116	76.87042625	76.97116680
3	0	0	80.09556574	79.41675102	77.92777418	79.48167429	75.89942276	74.94321184	76.79975725
4	0	0	76.66154973	77.76394551	79.05340228	78.59009320	76.49035852	74.47164445	76.77079476
5	0	0	77.80336311	77.37470877	78.16067886	75.46817292	76.80625927	74.02599430	80.54654084
6	0	0	77.34242100	76.73347127	76.66835280	74.92638915	74.61941307	74.38077634	80.26241746
7	0	0	77.80927850	76.68323782	76.14639791	76.07710368	75.01390560	74.42291312	75.13211237
8	0	0	77.23749681	75.90792673	75.72605607	76.68124969	73.87090896	74.31871114	75.77795388
9	0	0	76.55099047	76.18423905	75.55665144	75.24518147	74.32255786	73.49378710	74.02076655
10	0	0	73.85383254	73.31347786	73.62798108	74.90021990	73.46479715	72.95154047	73.71524203
11	0	0	74.68907417	74.15059204	74.05358555	74.13774337	73.45784859	73.19855870	73.83427092
12	0	0	75.14858686	74.18871763	72.67972298	72.79477218	72.78129420	72.28222858	74.62984865
13	0	0	74.83953867	74.12967483	72.99763645	72.37374664	72.17354573	72.12532994	75.62717616

Features

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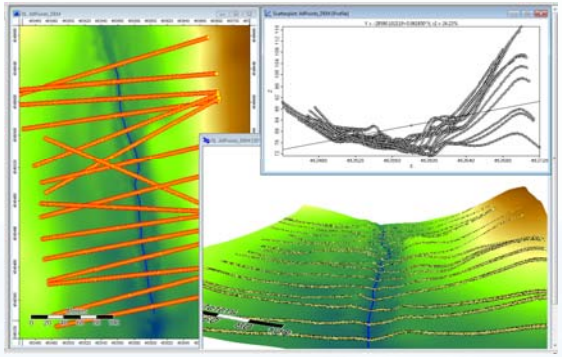
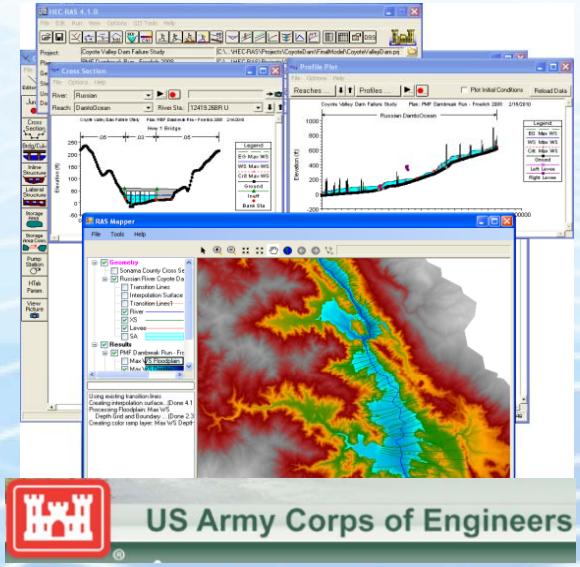
Links to Tutorials



Please click here to see the ”how to” create cross sections tutorial



Please click here to see the ”how to” assess the flooding parameters using the **HEC-RAS** software

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Some Technical Issues follow…

…12 slides showing “how to” locate flood prone areas on a Regional scale …

…. but can be skipped to save time!

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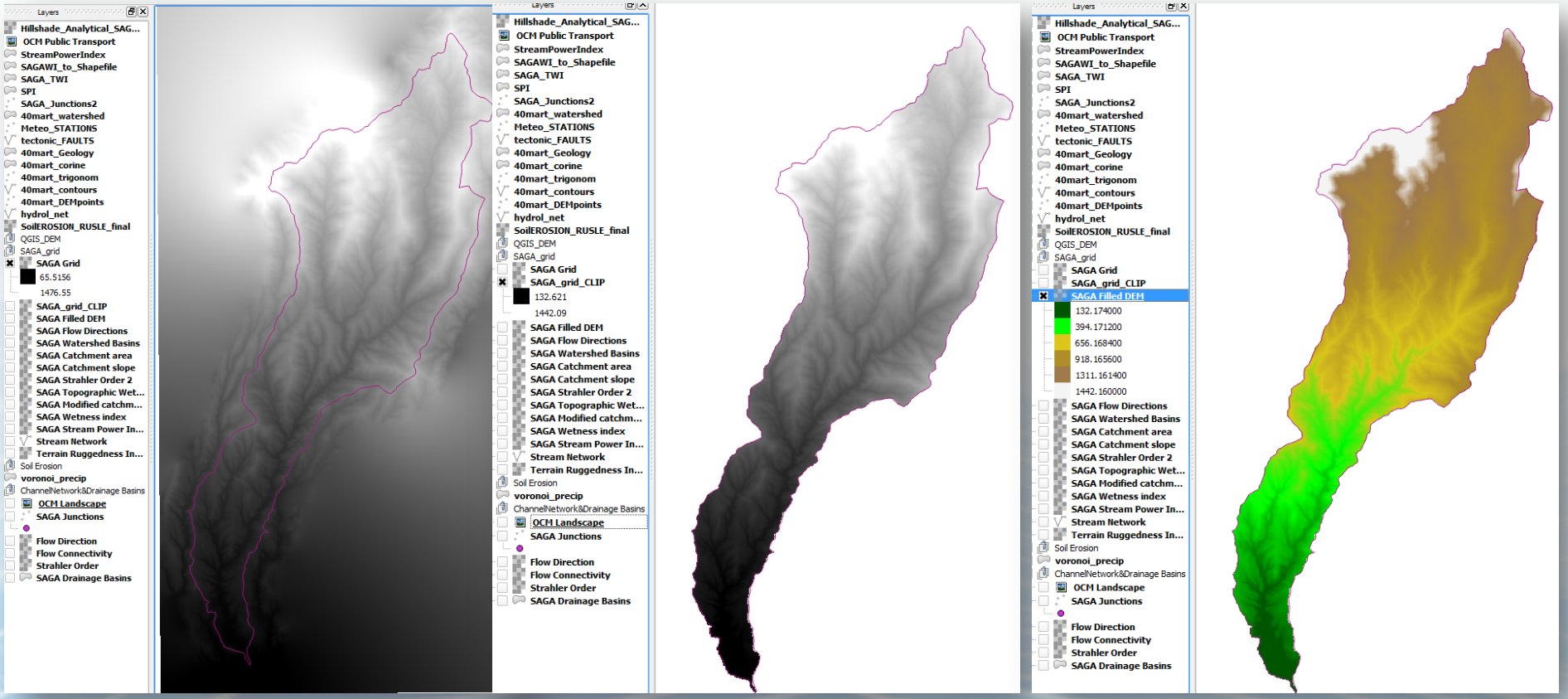
GRID Related Processes



Build GRID with elevation/topo data

Clip it! (to the watershed)

Fill the SINKS!

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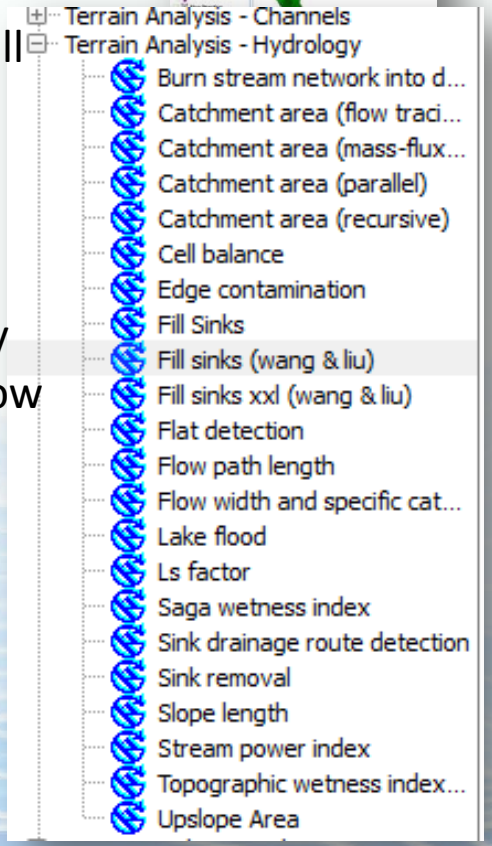
GRID Related Processes – Fill Sinks

- **Description**

This module uses an algorithm (Wang & Liu, 2006) to identify and fill surface depressions in digital elevation models. The method was enhanced to allow the creation of hydrologic sound elevation models, i.e. not only to fill the depression(s) but also to preserve a downward slope along the flow path. This is accomplished by preserving a minimum slope gradient between cells. This is the fully featured version of the module creating a depressionless DEM, a flow path grid and a grid with watershed basins.



- **References**

Wang, L. & H. Liu (2006): An efficient method for identifying and filling surface depressions in digital elevation models for hydrologic analysis and modeling. International Journal of Geographical Information Science, Vol. 20, No. 2: 193-213.

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SAGA Wetness Index

REFERENCES

SAGA Wetness Index

Module

Name	SAGA Wetness Index
ID	15
Author	(c) 2001 by J.Boehner, O.Conrad
Menu	Terrain Analysis > Hydrology > Topographic Indices
Type	Grid

Description

The 'SAGA Wetness Index' is, as the name says, similar to the 'Topographic Wetness Index' (TWI), but it is based on a modified catchment area calculation ('Modified Catchment Area'), which does not think of the flow as very thin film. As result it predicts for cells situated in valley floors with a small vertical distance to a channel a more realistic, higher potential soil moisture compared to the standard TWI calculation.

References

- Boehner, J., Koethe, R. Conrad, O., Gross, J., Ringeler, A., Selige, T. (2002): 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.

Parameters

Name	Type	Identifier	Description	Constraints
Input				
Elevation	Grid (input)	DEM		
Output				
Catchment area	Grid (output)	C		
Catchment slope	Grid (output)	GN		
Modified catchment area	Grid (output)	CS		
Wetness index	Grid (output)	SB		
Options				
t	Floating point	T		Minimum: 0.000000

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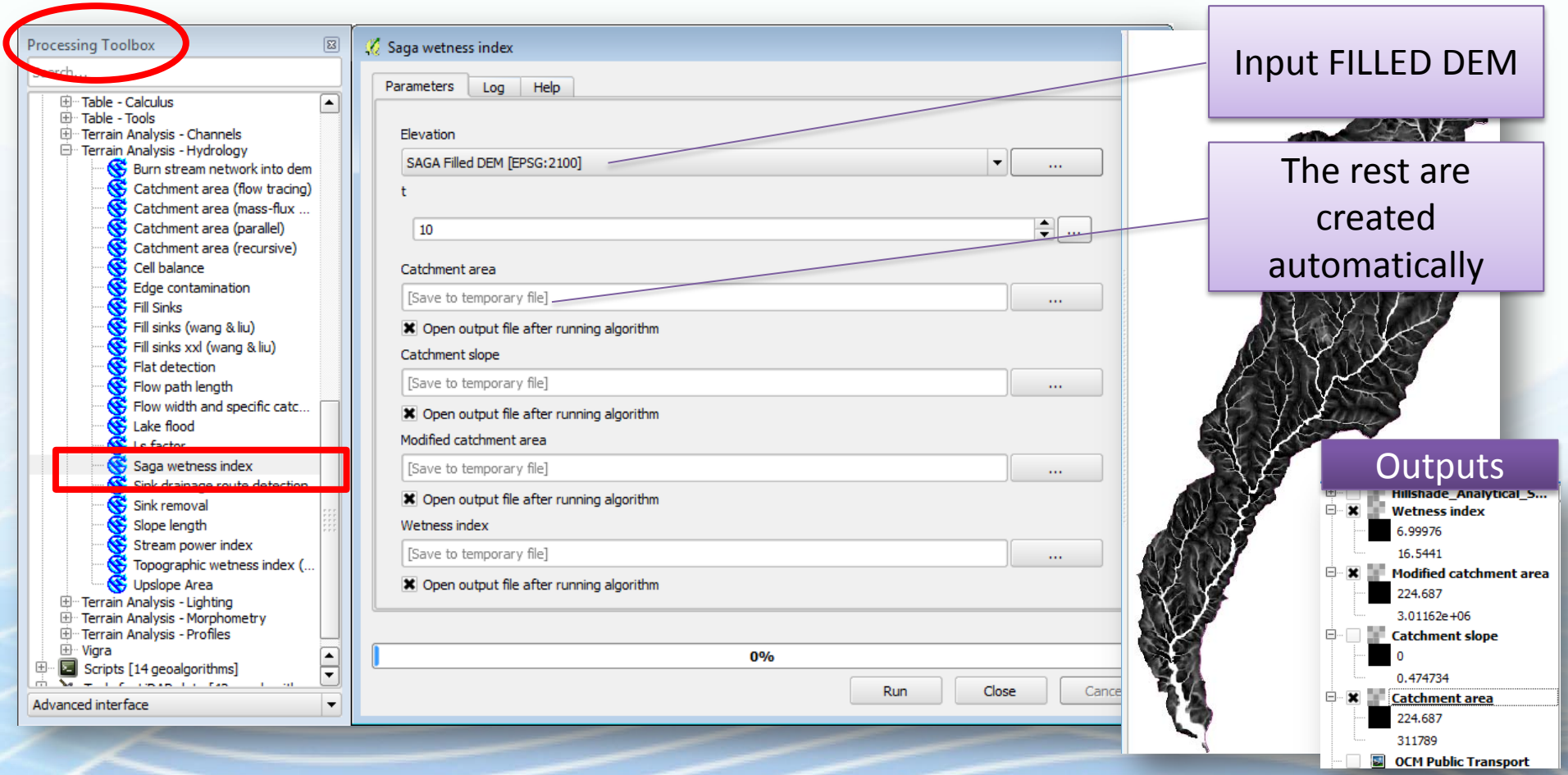
SAGA Wetness Index



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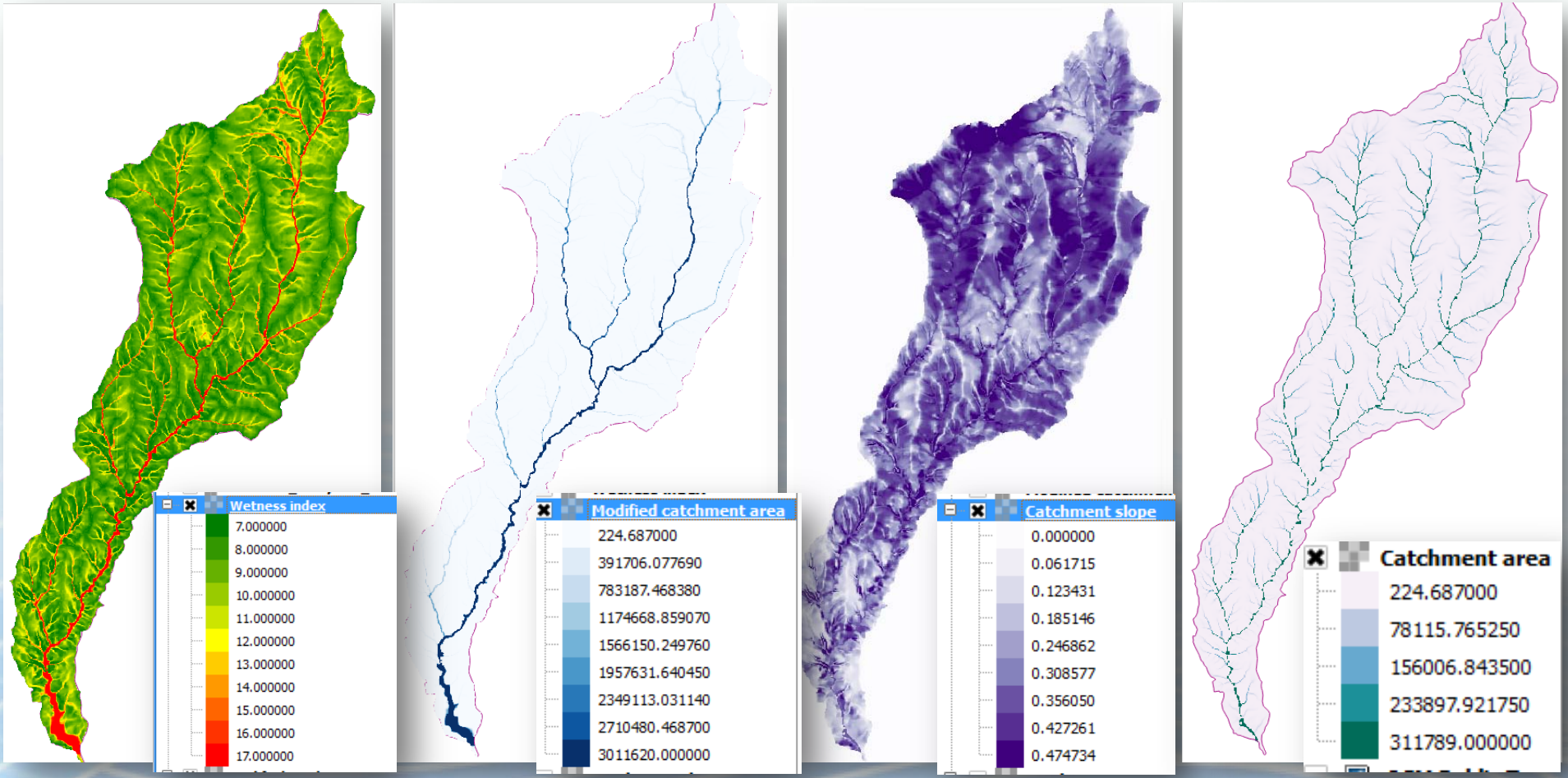
SAGA Wetness Index - Outputs



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Flow Width & Specific Catchment Area

REFERENCES

Flow Width and Specific Catchment Area

Module

Name	Flow Width and Specific Catchment Area
ID	19
Author	O. Conrad (c) 2009
Menu	Terrain Analysis > Hydrology > Catchment Area
Type	Grid

Description
Flow width and specific catchment area (SCA) calculation.

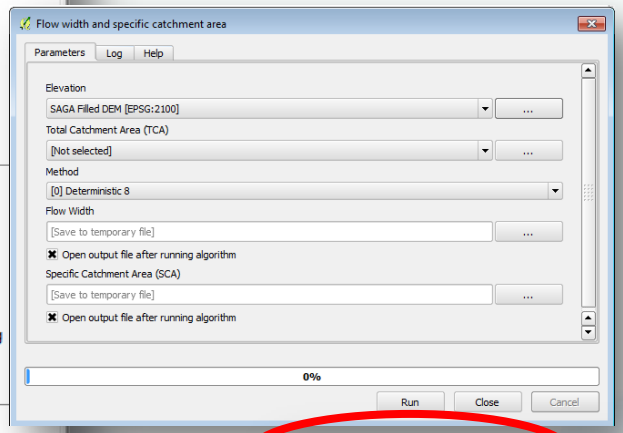
References:
Gruber, S., Peckham, S. (2008): Land-Surface Parameters and Objects in Hydrology. In: Hengl, T. and Reuter, H.I. [Eds.]: Geomorphometry: Concepts, Software, Applications. Developments in Soil Science, Elsevier, 33:293-308.

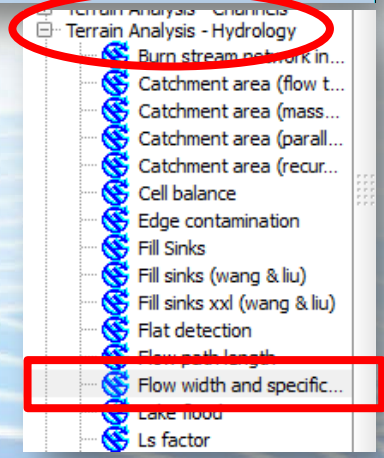
Quinn, P.F., Beven, K.J., Chevallier, P., Planchon, O. (1991): The prediction of hillslope flow paths for distributed hydrological modelling using digital terrain models. Hydrological Processes, 5:59-79

Parameters

Name	Type	Identifier	Description	Constraints
Input				
Elevation	Grid (input)	DEM		
Total Catchment Area (TCA) (*)	Grid (optional input)	TCA		
Output				
Flow Width	Grid (output)	WIDTH		
Specific Catchment Area (SCA) (*)	Grid (optional output)	SCA		
Options				
Method	Choice	METHOD		Available Choices: [0] Deterministic 8 [1] Multiple Flow Direction (Quinn et al. 1991) [2] Aspect

(*) *optional*





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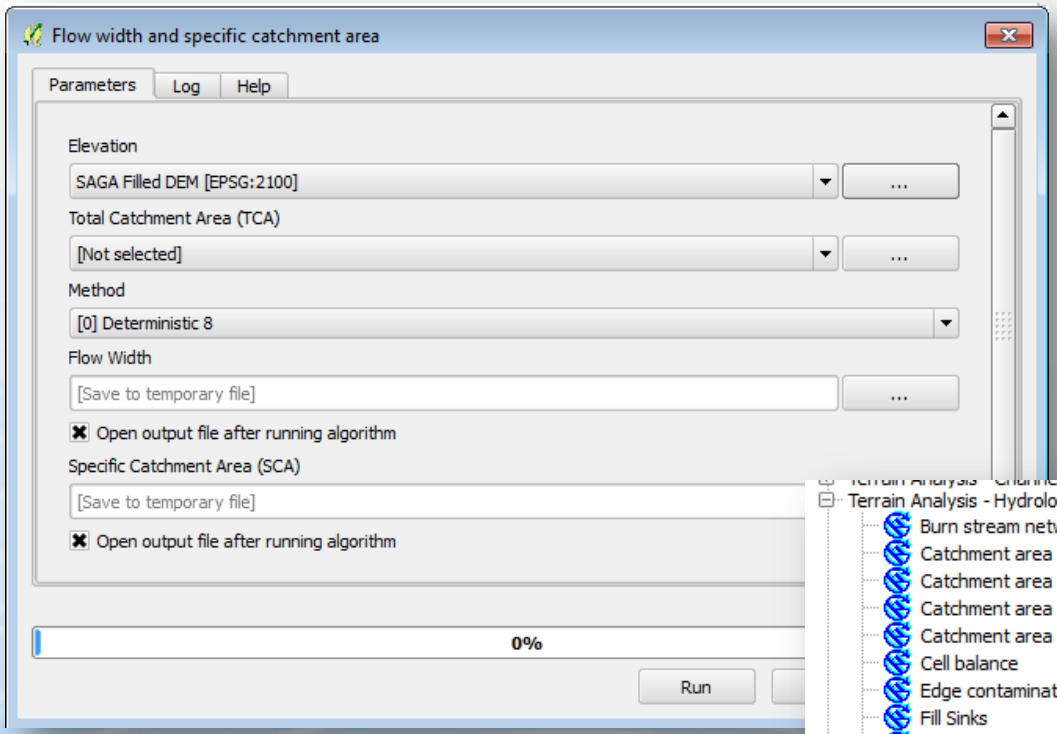
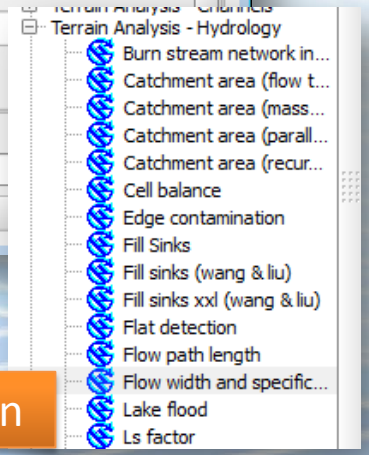
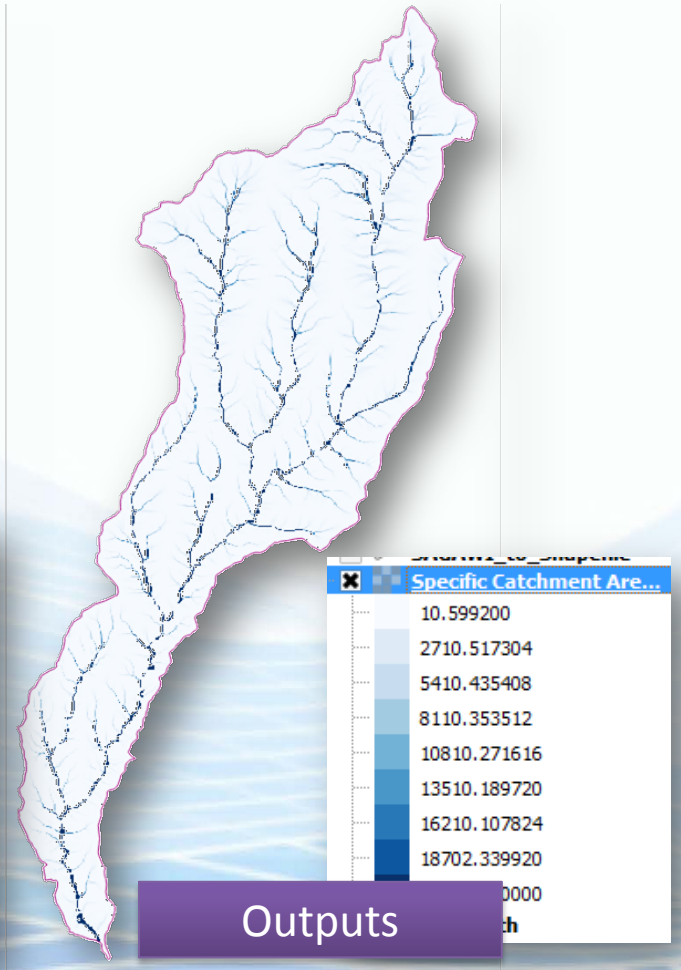
Flow Width & Specific Catchment Area







Menu/Location

Outputs

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Topographic Wetness Index

pographic Wetness Index (TWI)

Module

Name	Topographic Wetness Index (TWI)
ID	20
Author	O.Conrad (c) 2003
Menu	Terrain Analysis > Hydrology > Topographic Indices
Type	Grid

Description

Calculation of the slope and specific catchment area (SCA) based Topographic Wetness Index (TWI)

References:

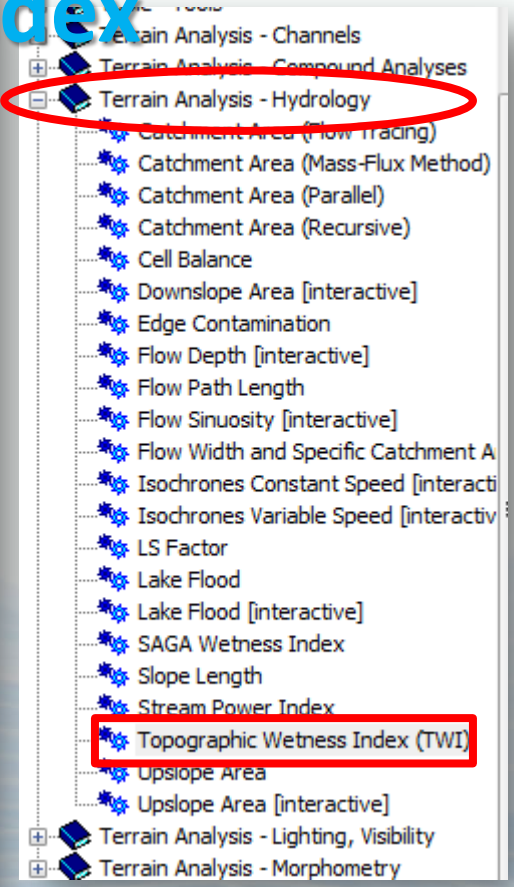
Beven, K.J., Kirkby, M.J. (1979):
A physically-based variable contributing area model of basin hydrology'
Hydrology Science Bulletin 24(1), p.43-69

Boehner, J., Selige, T. (2006):
Spatial Prediction of Soil Attributes Using Terrain Analysis and Climate Regionalisation'
In: Boehner, J., McCloy, K.R., Strobl, J.: 'SAGA – Analysis and Modelling Applications', Goettinger Geographische Abhandlungen, Vol.115, p.13-27

Moore, I.D., Grayson, R.B., Ladson, A.R. (1991):
'Digital terrain modelling: a review of hydrogical, geomorphological, and biological applications'
Hydrological Processes, Vol.5, No.1

Parameters

Name	Type	Identifier	Description	Constraints
Input				
Slope	Grid (input)	SLOPE		
Catchment Area	Grid (input)	AREA		
Transmissivity (*)	Grid (optional input)	TRANS		
Output				
Topographic Wetness Index	Grid (output)	TWI		
Options				
Area Conversion	Choice	CONV		Available Choices: [0] no conversion (areas already given as specific catchment area) [1] 1 / cell size (pseudo specific catchment area)
Method (TWI)	Choice	METHOD		Available Choices: [0] Standard [1] TOPMODEL



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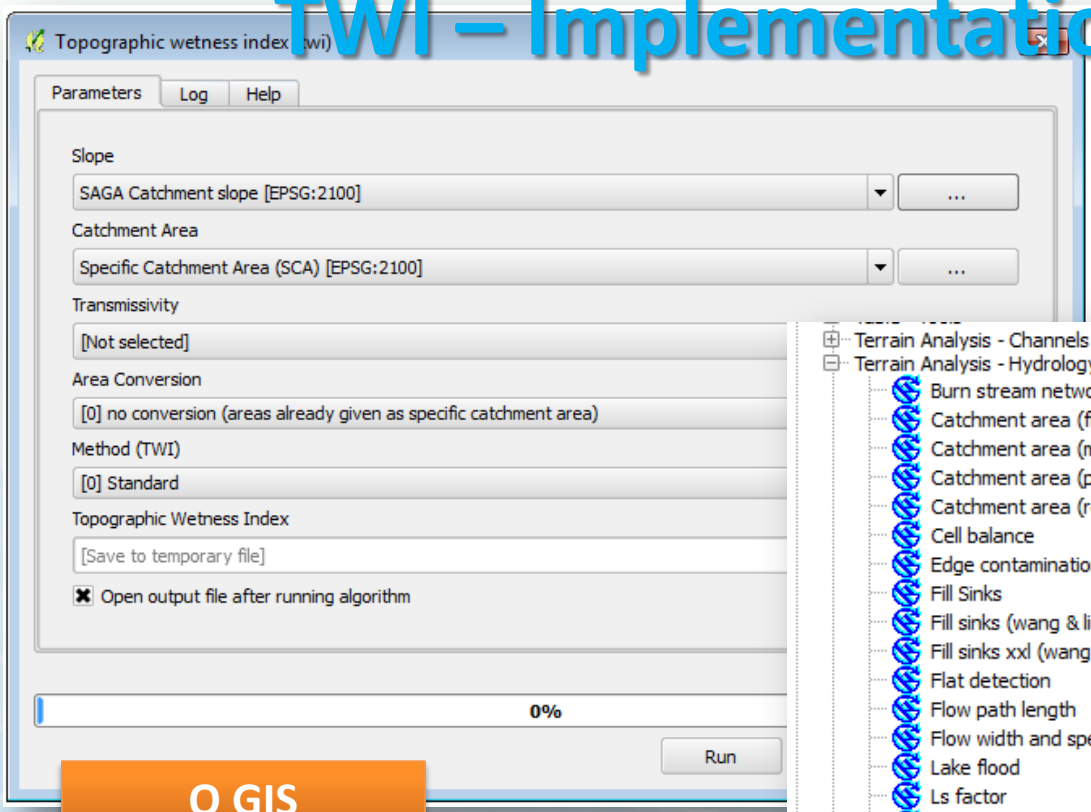
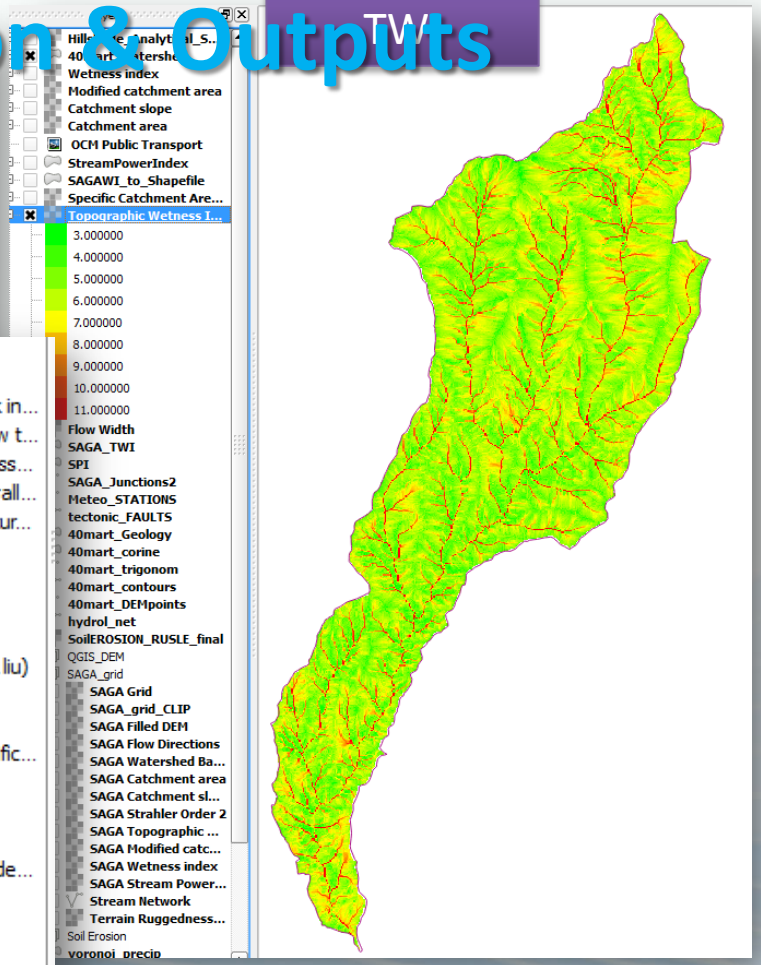
TWI – Implementation & Outputs



Q GIS

Menu/Location



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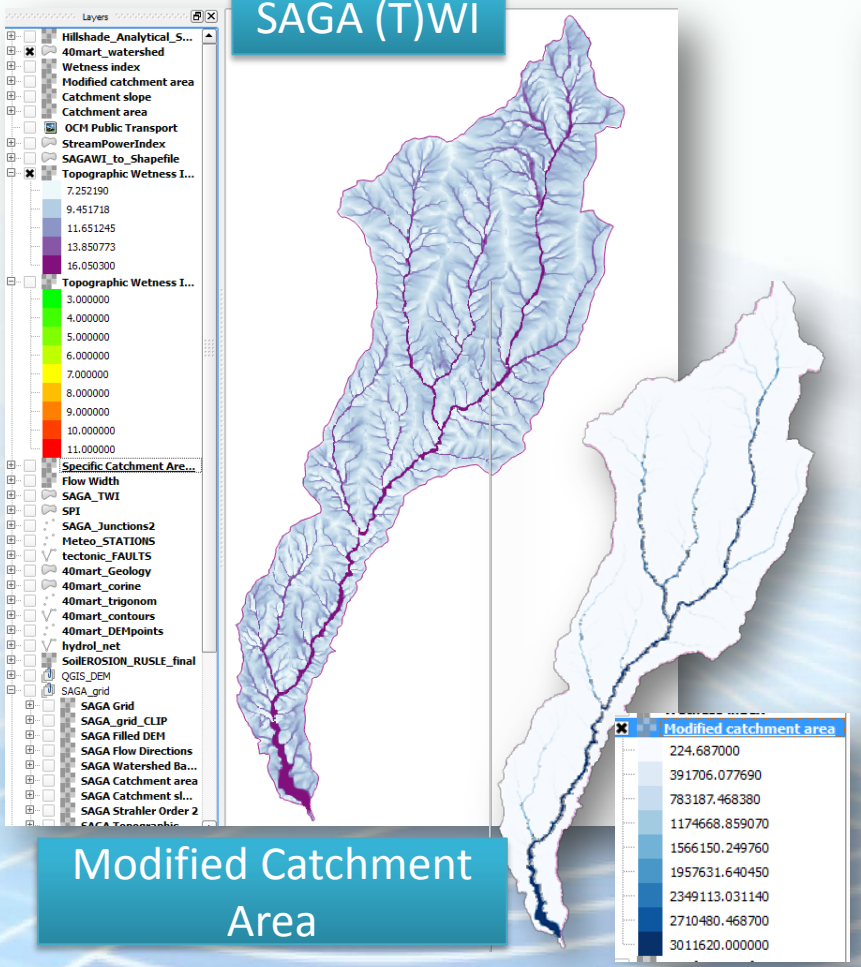
TWI vs SAGA WI

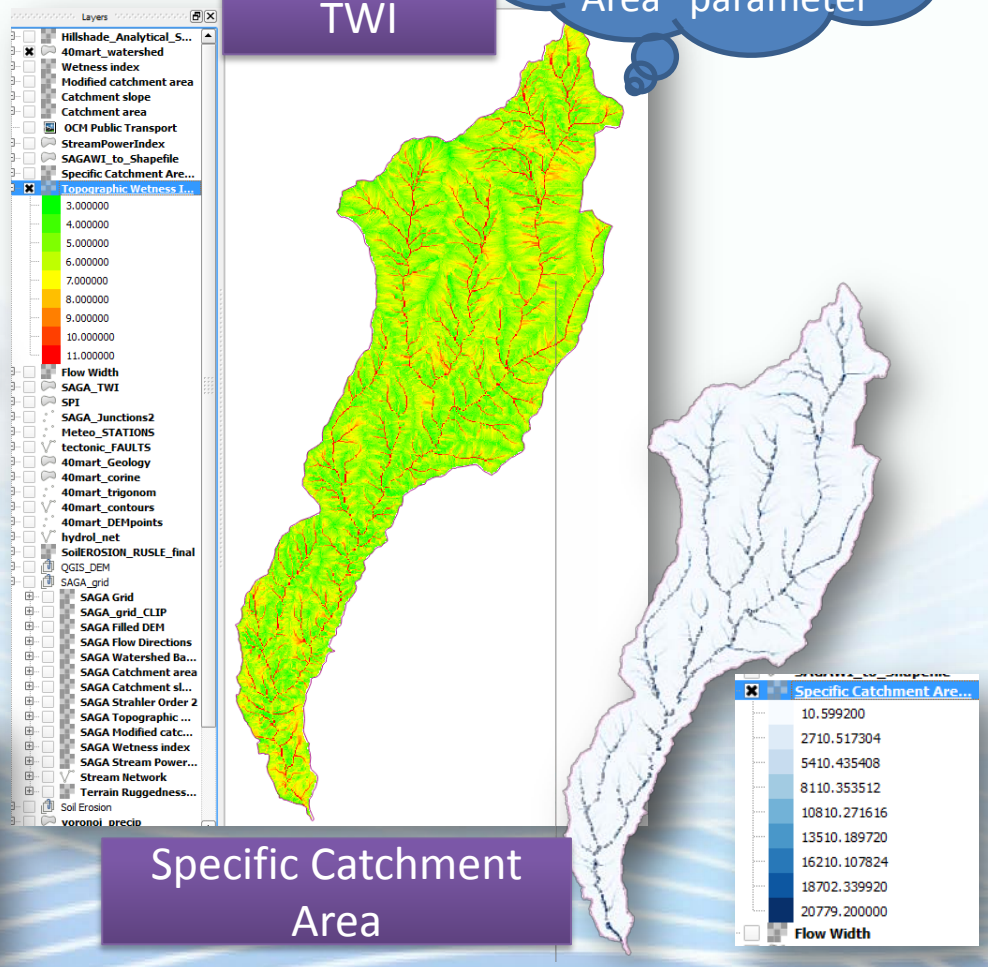
Differences due to the "Catchment Area" parameter

SAGA (T)WI



Modified Catchment Area

TWI



Specific Catchment Area

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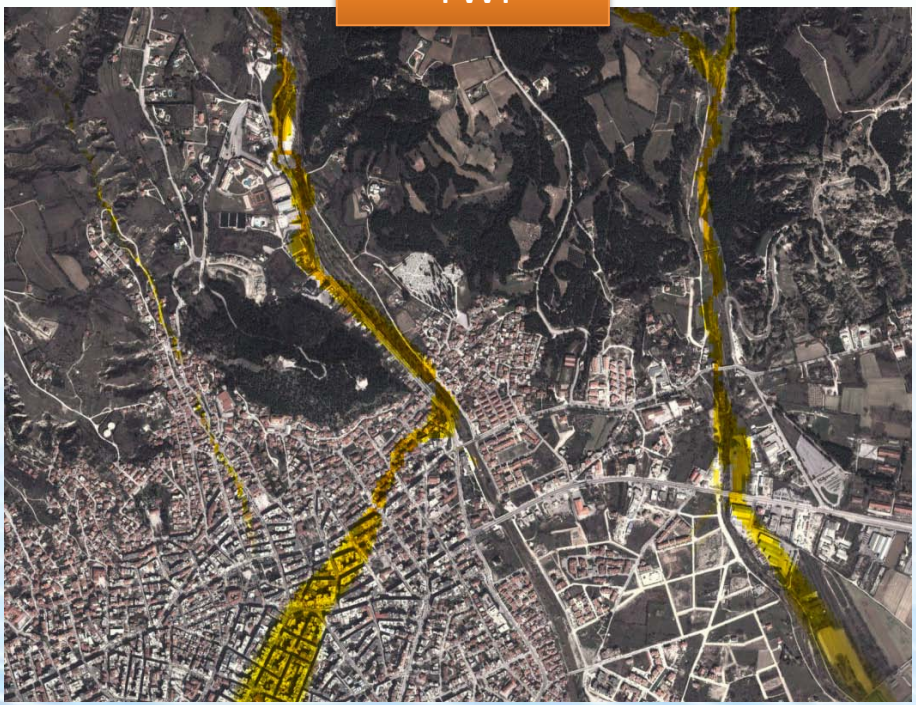
TWI vs SAGA WI

SAGA (T)WI

TWI



This is what has actually happen in Serres, eight years ago

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We can also assess the sediment production areas in order to decide upon the optimal location of sediment retention structures

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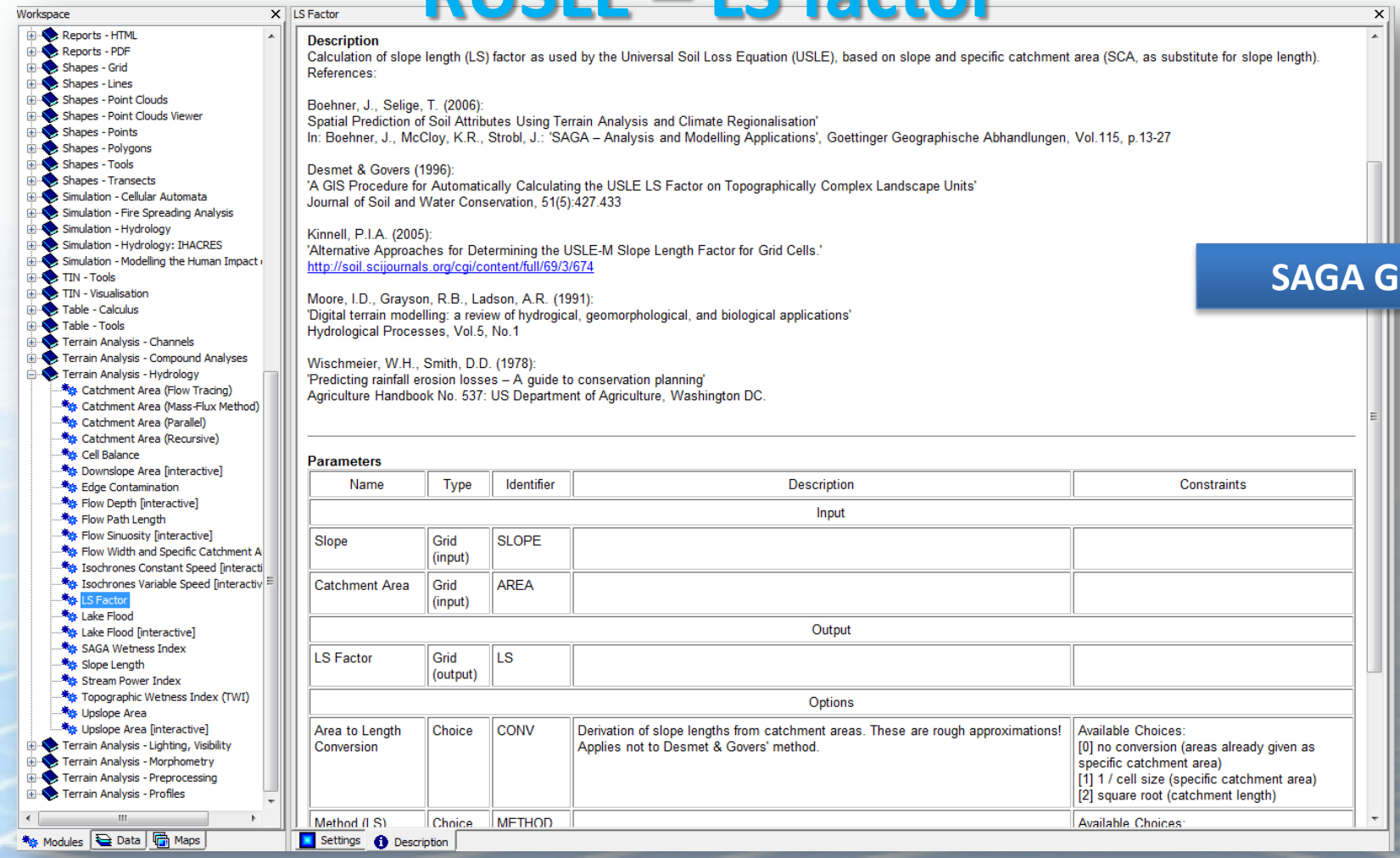
RUSLE – LS factor



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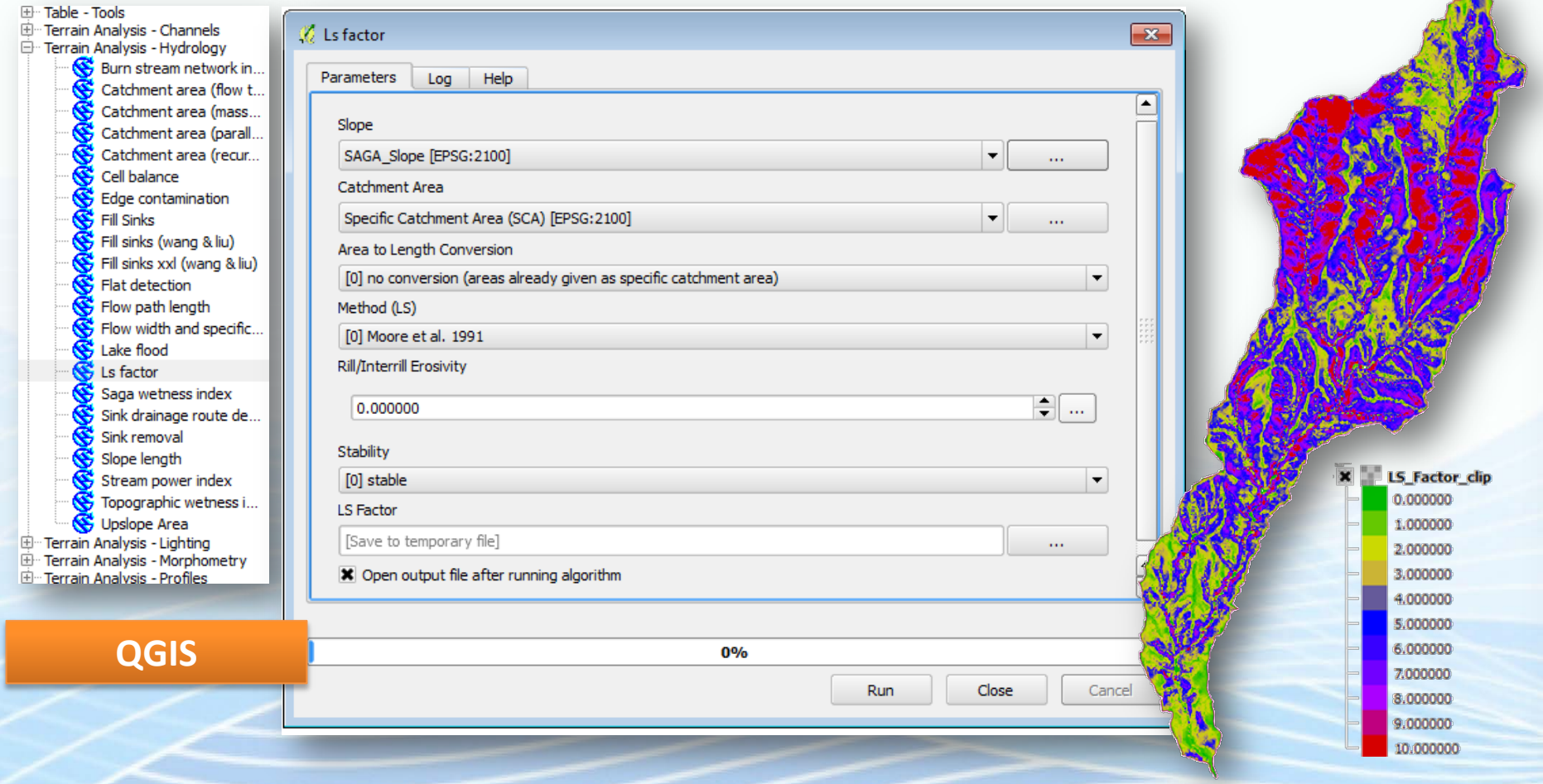
RUSLE – LS factor



QGIS

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RUSLE – Soil Erosion Potential…

QGIS

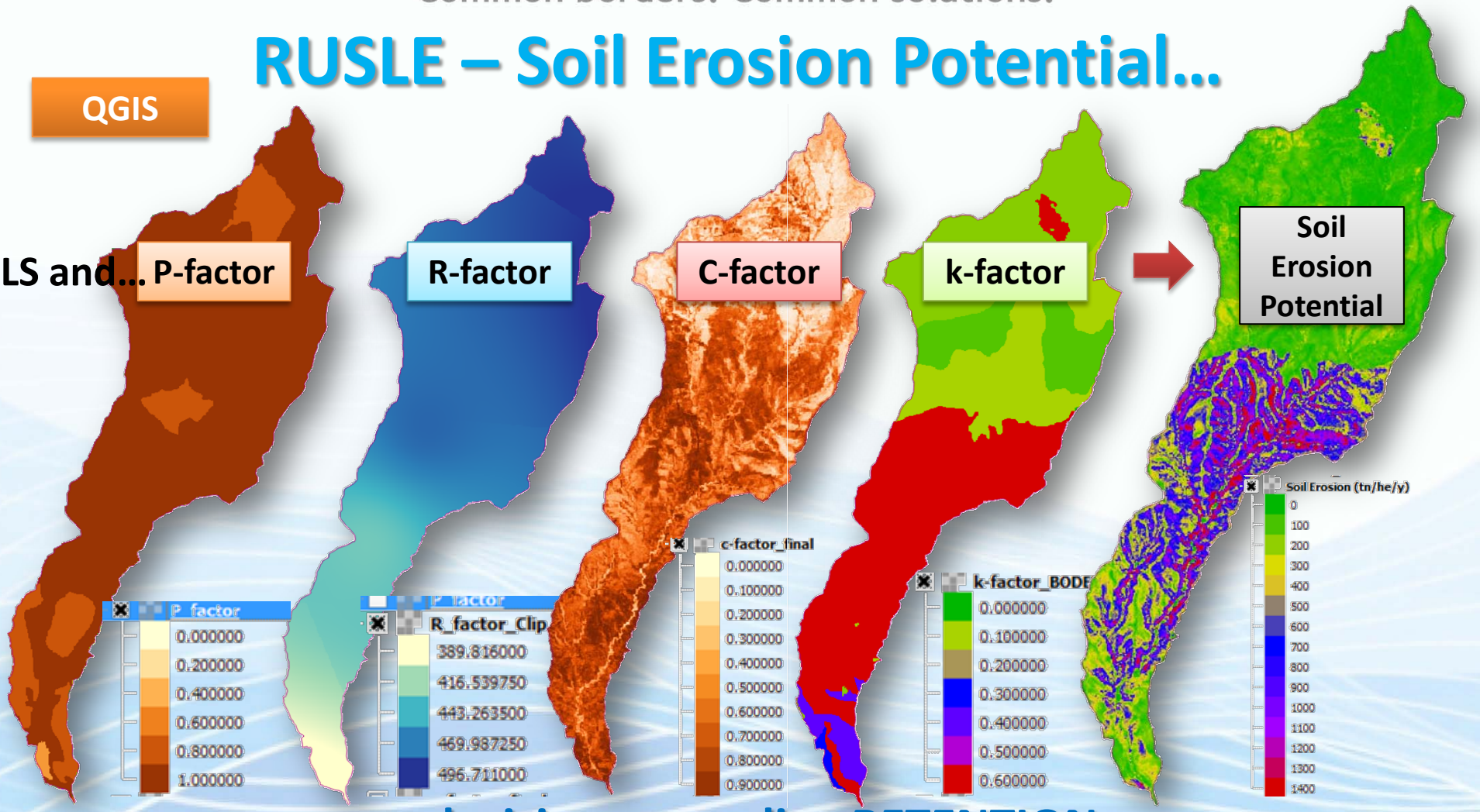
LS and… P-factor

R-factor

C-factor

k-factor

Soil Erosion Potential



…to support decisions regarding RETENTION measures

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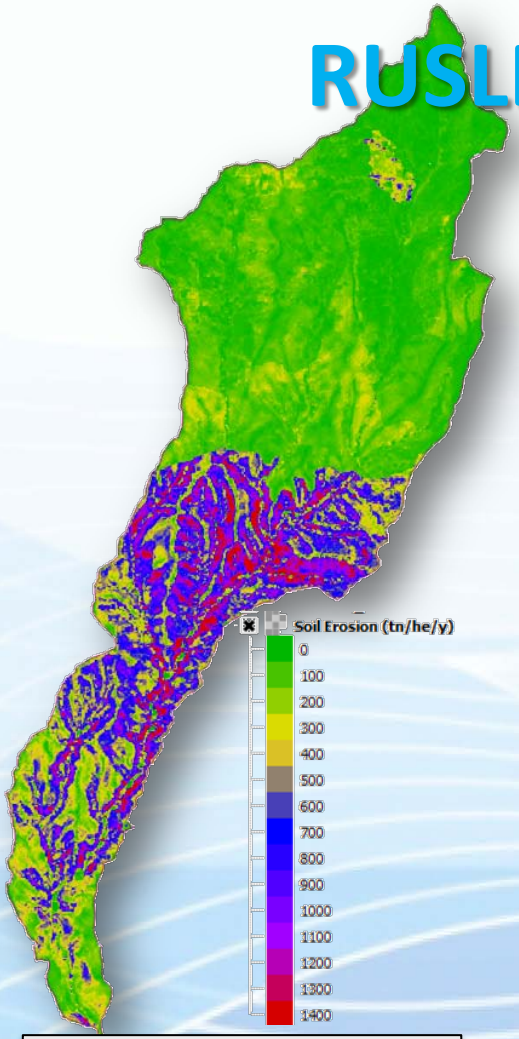
RUSLE – Soil Erosion Potential…



Soil Erosion Potential

…Can be used **to select the optimal location of Sediment Retention structures upstream** in order to effectively **control sediment transport** towards the flood prone area.

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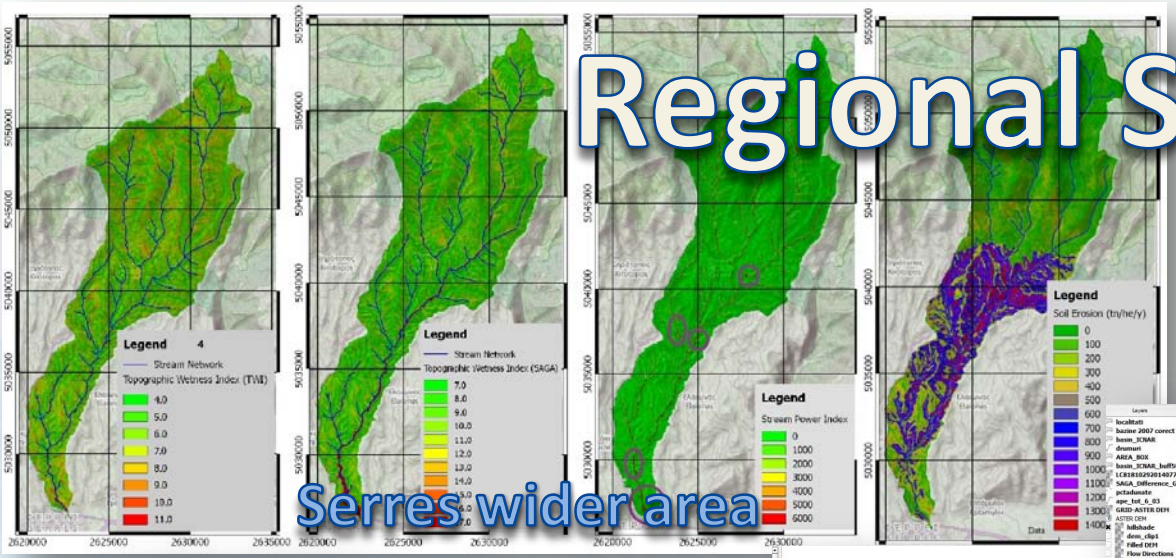
Flood Hazard… on Regional Scales and on Local scales

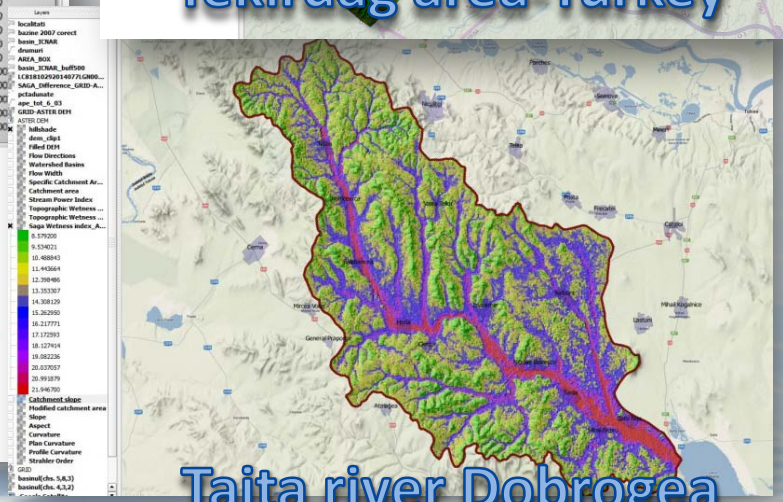
Regional Scale



Serres wider area

Tekirdag area-Turkey

Local Scale



Taita river Dobrogea

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Facebook: https://www.facebook.com/scinetnathaz.scinetnathaz

Follow us on **Twitter**: https://twitter.com/SciNetNatHaz

YouTube Channel: http://www.youtube.com/user/SciNetNatHaz

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A Scientific Network for Hazard Prevention

Thank You All for your Support!

The Project

Acknowledgments:
This project is partially funded by the EU within the context of the Black Sea Basin Joint Operational Programme 2007-2013

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Selected References

(just for the "problems and solutions" part

- ✓ **Clark Ian, European Commission (2012): EU Civil Protection policy Priorities 2011-2013**. European Commission, DG Humanitarian Aid and Civil Protection, ECHO A5, Civil Protection Policy, Prevention and Preparedness
- ✓ **Clark Ian, European Commission (2012): The EU Contribution to the Implementation of the Hyogo Framework in Europe**. European Commission, DG Humanitarian Aid and Civil Protection, ECHO A5, Civil Protection Policy, Prevention and Preparedness
- ✓ **Clark Ian, European Commission (2012): Towards an EU Policy on Disaster Management**. European Commission, DG Humanitarian Aid and Civil Protection, ECHO A5, Civil Protection Policy, Prevention and Preparedness
- ✓ **Council of the European Union (2009):** Council Conclusions on a **Community framework on disaster prevention** within the EU 2979th JUSTICE and HOME AFFAIRS Council meeting, Brussels, 30 November 2009
- ✓ **Commission DG Environment (2008)**: "Assessing the Potential for a Comprehensive Community Strategy for the prevention of Natural and Manmade Disasters". Final Report, March 2008.
- ✓ **Commission of the European Communities (2009):** Communication from the Commission to the Council and the Europeadn Parliament on **EU Strategy for supporting Disaster Risk Reduction** in developing countries, COM (2009) 84 Final, Brussels, 23.2.2009

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Selected References

(just for the "problems and solutions" part

- ✓ **Commission communication [P7_TA(2010)0326] (2010)**: A community approach on the **prevention of natural and man-made disasters**. European Parliament resolution of 21 September 2010 on the Commission communication: A Community approach on the prevention of natural and man-made disasters (2009/2151(INI))
- ✓ **Directorate General for Research (2005):** Extract of the DG RTD Unit I.4. Catalogue of Contracts topic: **Natural hazards Flood Related EU Hazard Research Projects** (Framework Programme 5 (1998 – 2002) "PROGRAMME ENVIRONMENT AND SUSTAINABLE DEVELOPMENT" and Framework Programme 6 (2002 – 2006): "PROGRAMME SUSTAINABLE DEVELOPMENT, GLOBAL CHANGE AND ECOSYSTEMS").
- ✓ **EUROPEAN COMMISSION RESEARCH DIRECTORATE-GENERAL (2003):** Background Information for Press Release: "**Floods: European research for better predictions and management solutions**", Dresden, 13 October 2003.
- ✓ **European Commission: Research and innovation (2006**): Workshop on "RESEARCH: **Floods!: Managing the risks of flooding in Europe**". Conference Minutes.
- ✓ European Commission DG Environment (2008): Member States' **Approaches towards Prevention Policy – a Critical Analysis**. Final Report. March 2008
- ✓ **Miet Van Den Eeckhaut and Javier Hervás (2012): Landslide inventories in Europe and policy recommendations for their interoperability and harmonisation**, A JRC contribution to the EU-FP7 SafeLand project. **JRC Scientific and Policy Reports**.