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SciNetNatHaz Project Progress Meeting - 23-26 Oct 2014, Burgas, Bulgaria

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

A pilot Implementation

Konstantinos Papatheodorou
Helena Tzanou

TEI of Kentriki Makedonia, LP/ENPI Beneficiary

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Contents

- Data Requirements
- Procedures
- Outputs
- Evaluation

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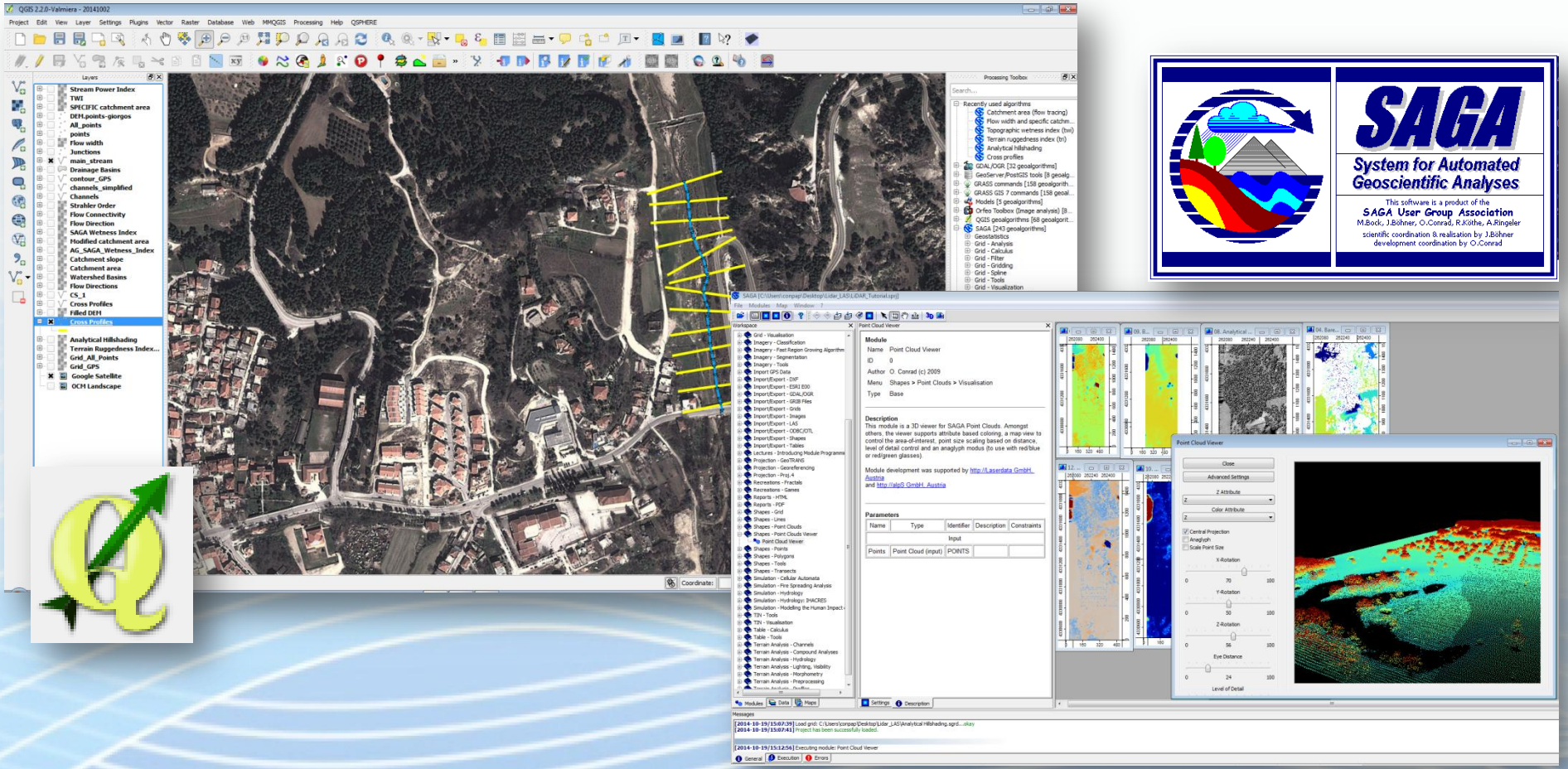
The Tools



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Data: Morphology

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

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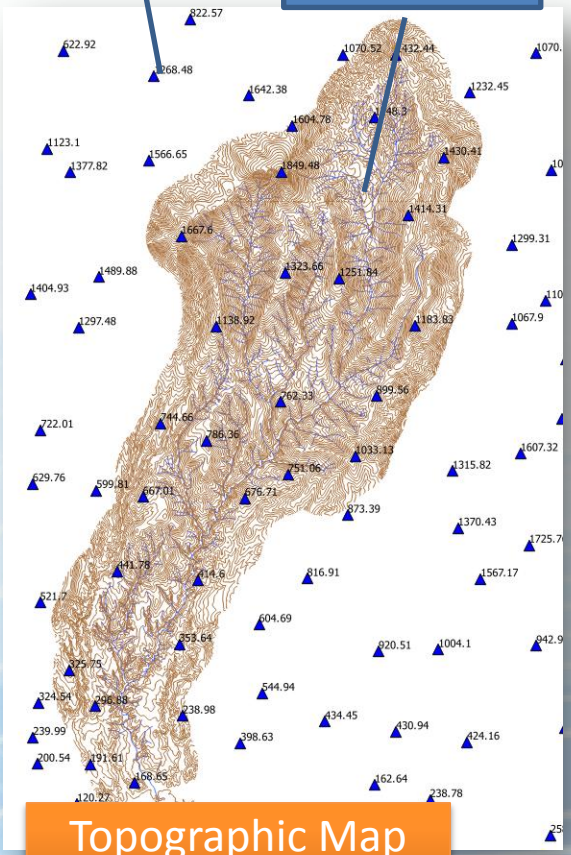
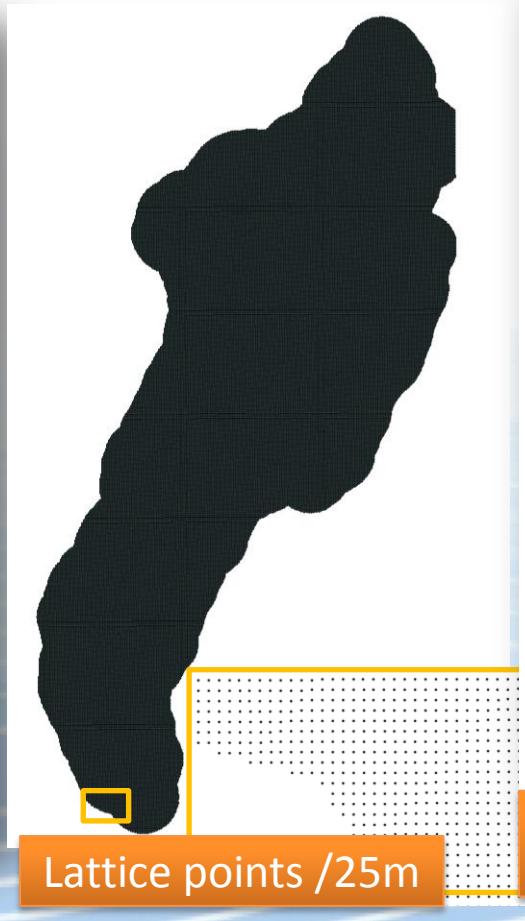
Data: Morphology

Elevation Points

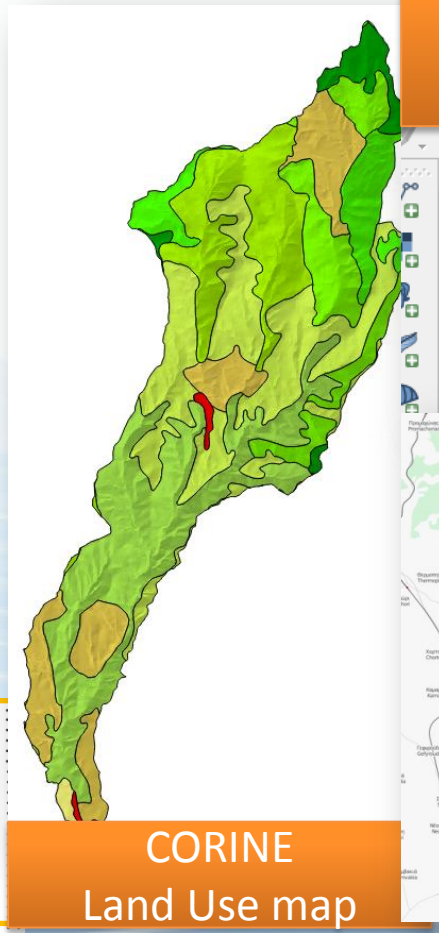
Contours / 20m



Topographic Map 1:50.000

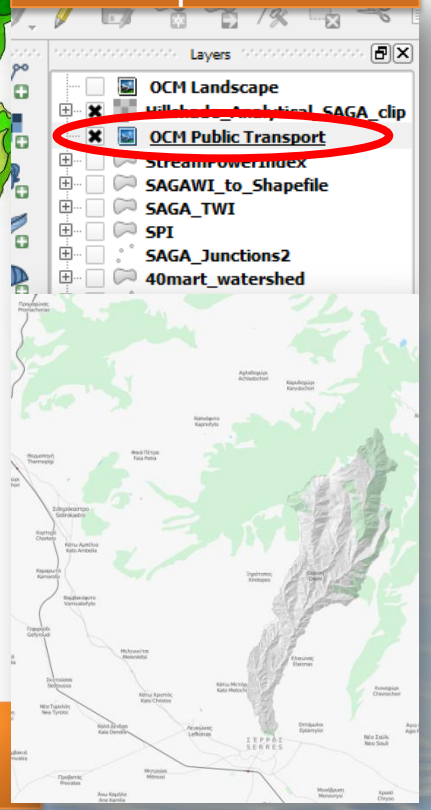


Lattice points /25m



CORINE Land Use map

OpenStreet Maps Public Transportation



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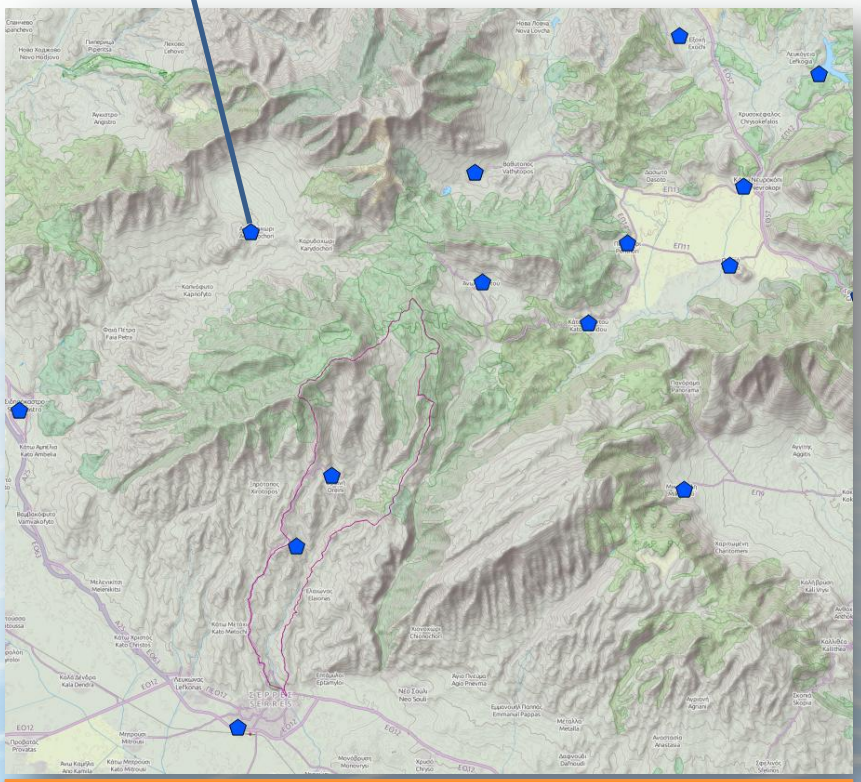
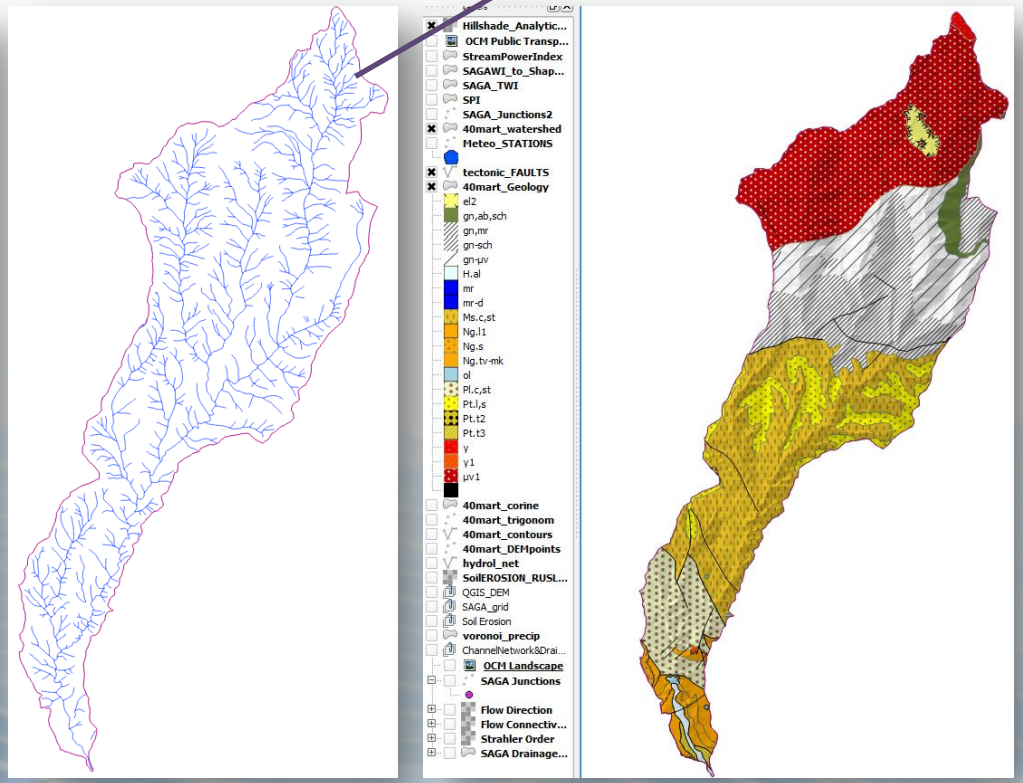
Data: Rainfall & Hydrology

Meteorological Stations

Watershed





Meteo – Stations on an OpenStreet Map Landscape layer

Hydrology Network (digitized from topo maps)

Geologic map

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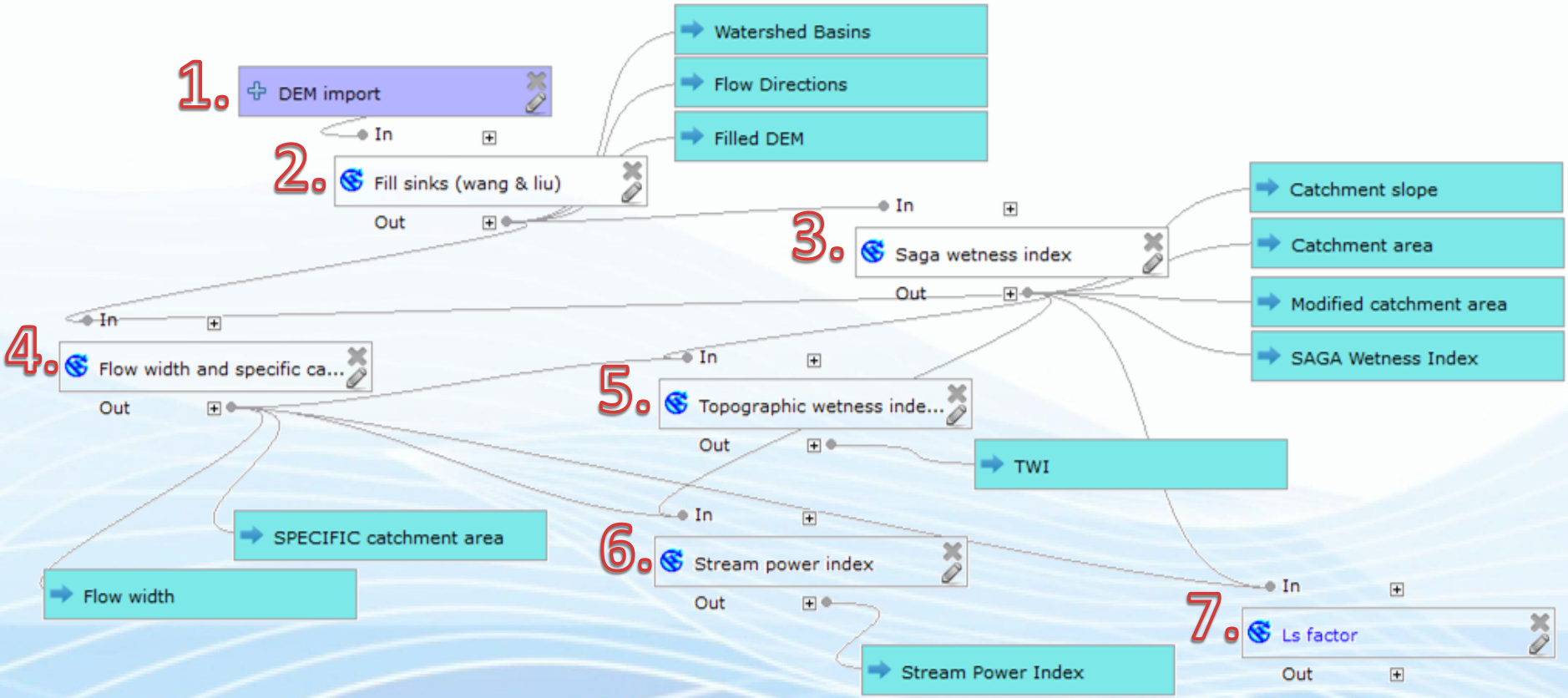
Procedural steps



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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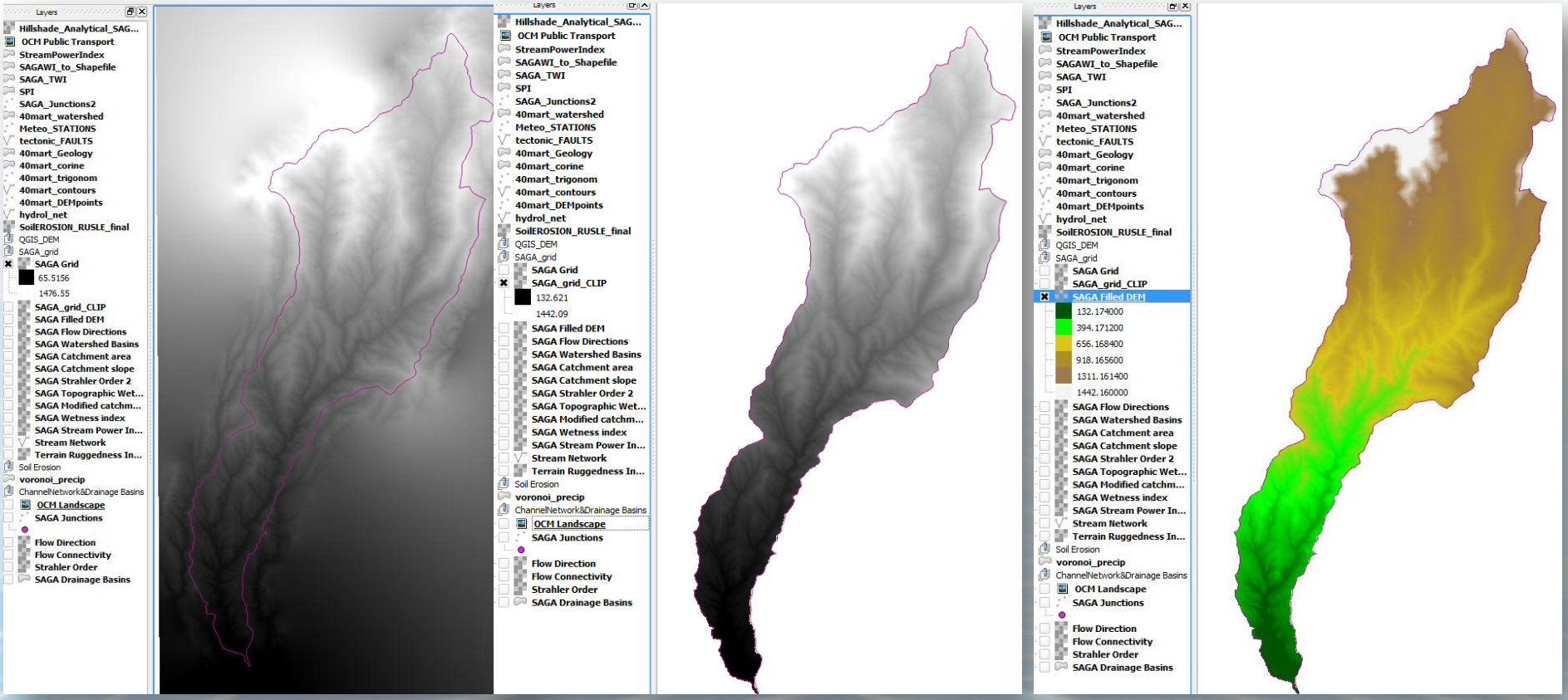
GRID Related Processes



Build GRID with elevation/topo data

Clip it! (to the watershed)

Fill the SINKS!

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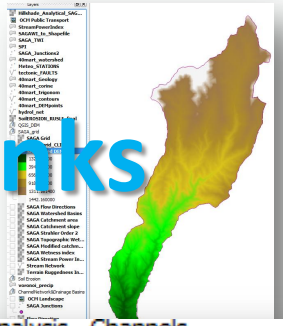
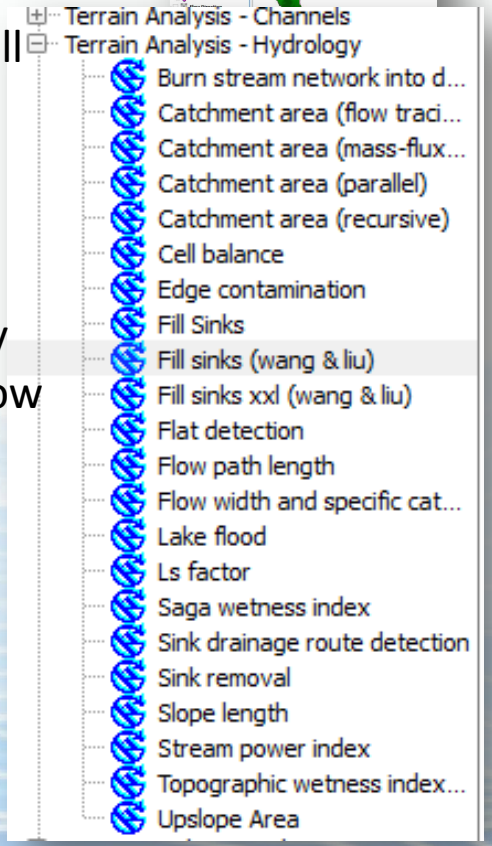
GRID Related Processes – Fill Sinks



- **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

SAGA GIS

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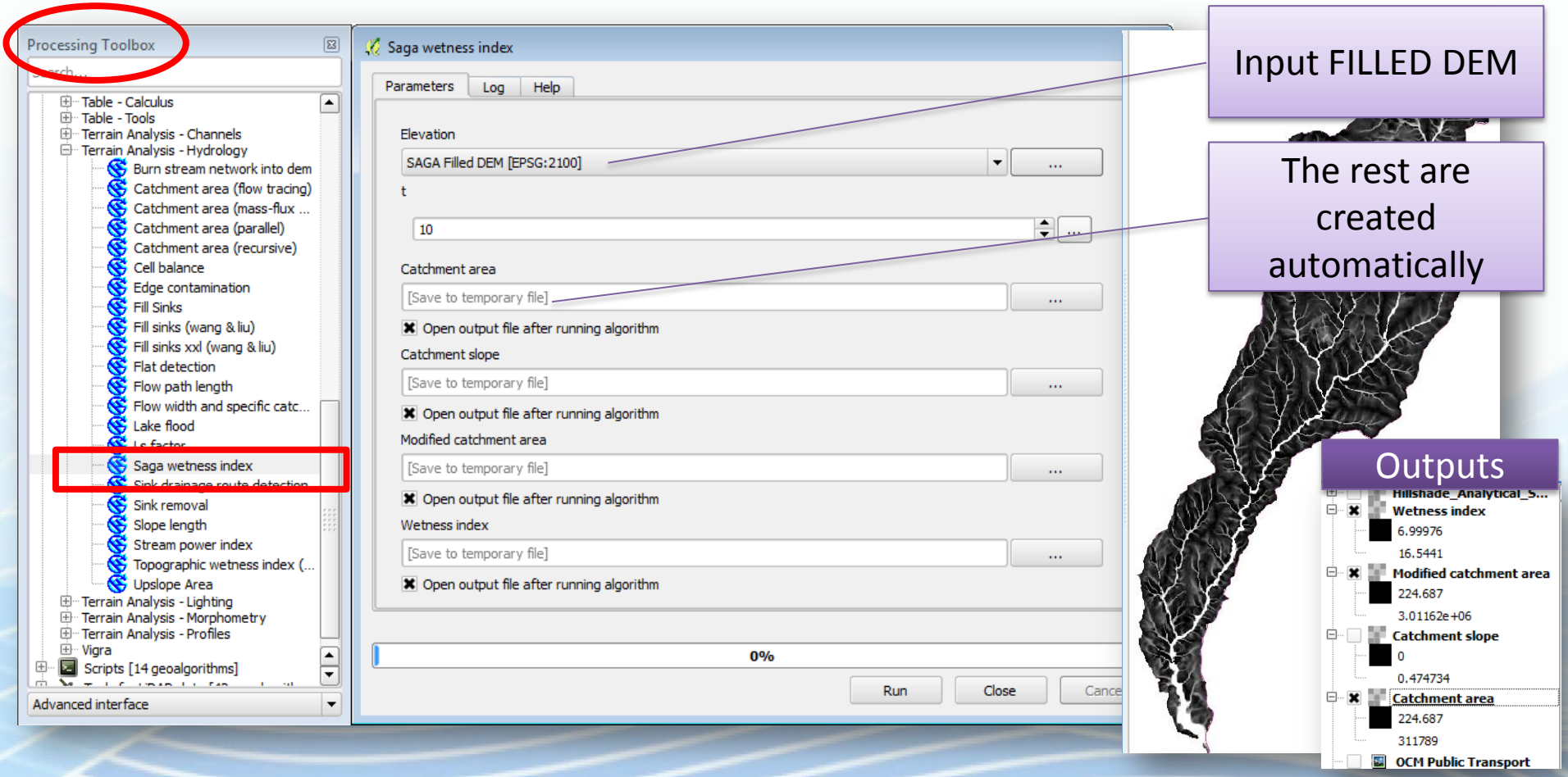
SAGA Wetness Index



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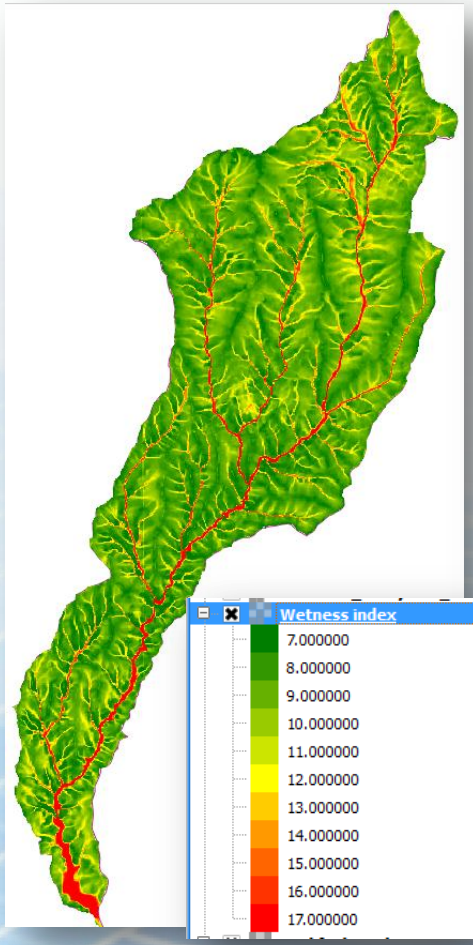
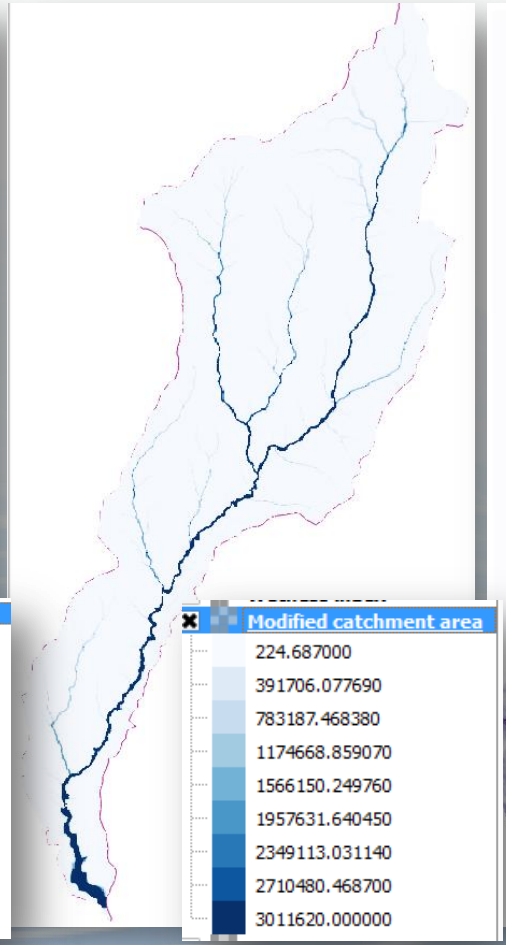
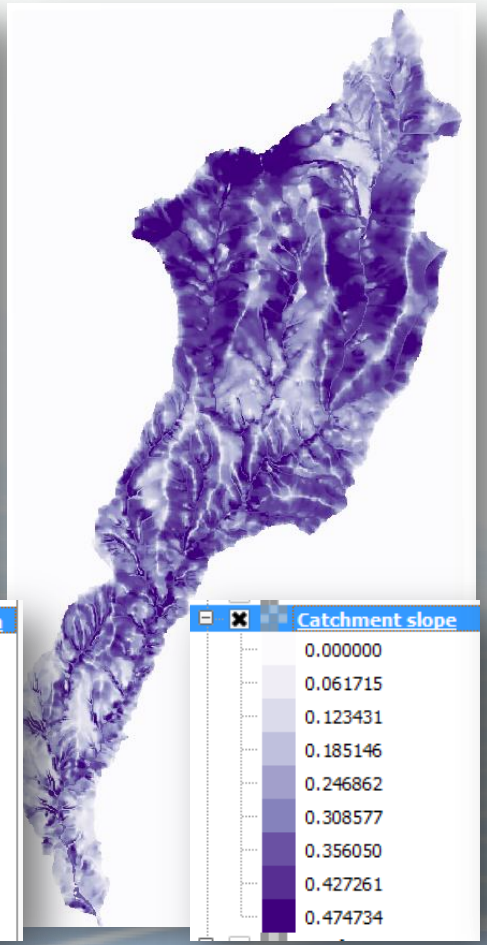
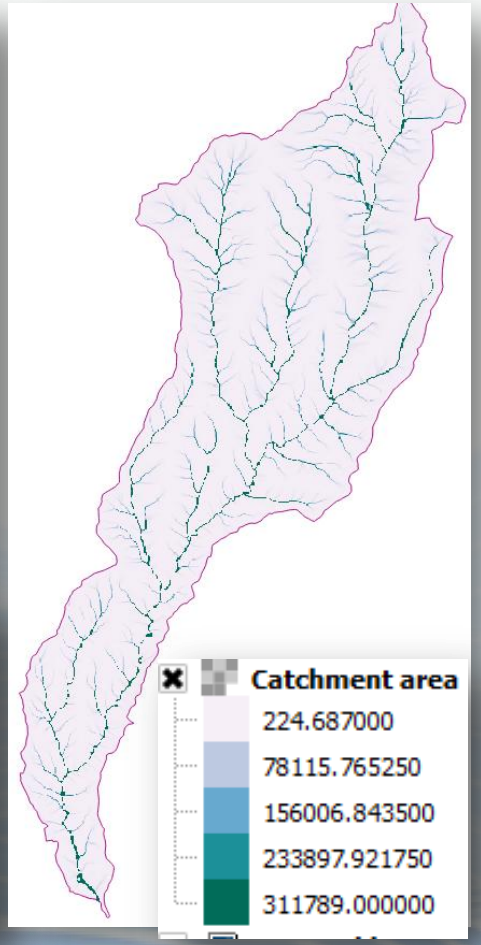
SAGA Wetness Index - Outputs









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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.

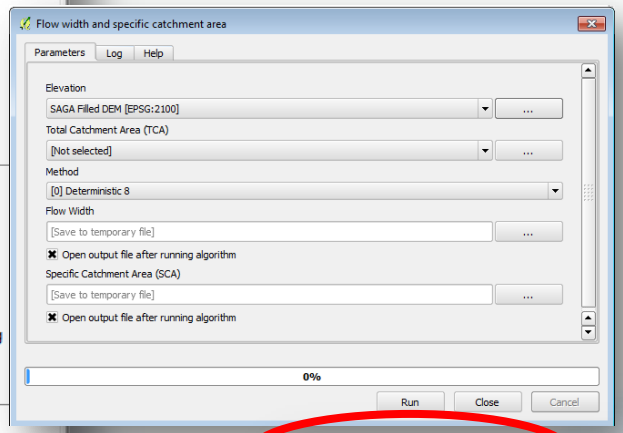
References:
Gruber, S., Peckham, S. (2008): Land-Surface Parameters and Objects in Hydrology. In: Hengl, T. and Reuter, H.I. [Eds.]: Geomorphometry: Concepts, Software, Applications. Developments in Soil Science, Elsevier, 33:293-308.

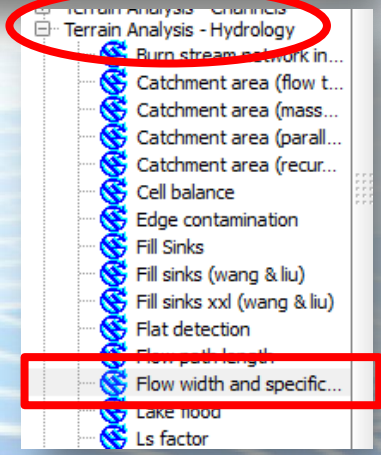
Quinn, P.F., Beven, K.J., Chevallier, P., Planchon, O. (1991): The prediction of hillslope flow paths for distributed hydrological modelling using digital terrain models. Hydrological Processes, 5:59-79

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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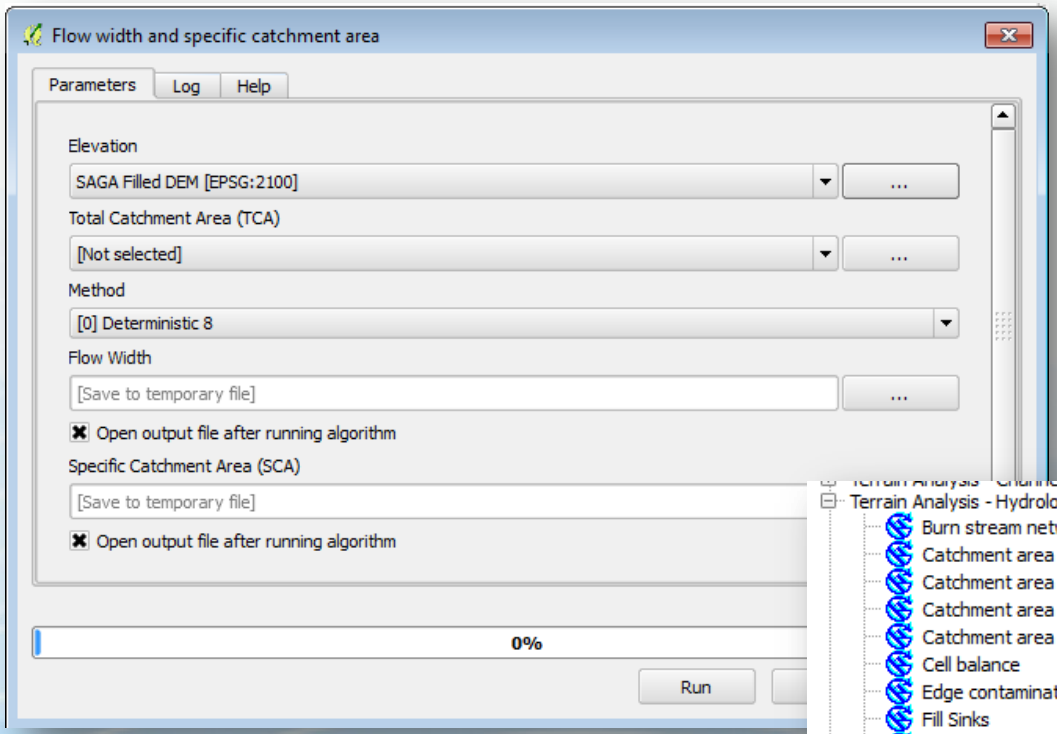
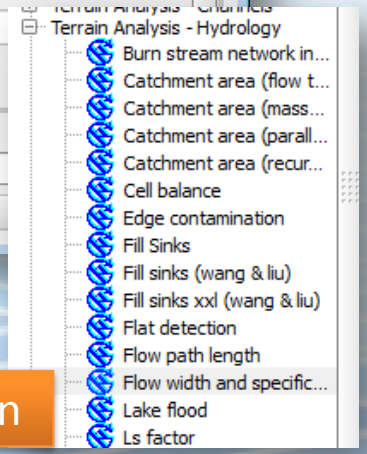
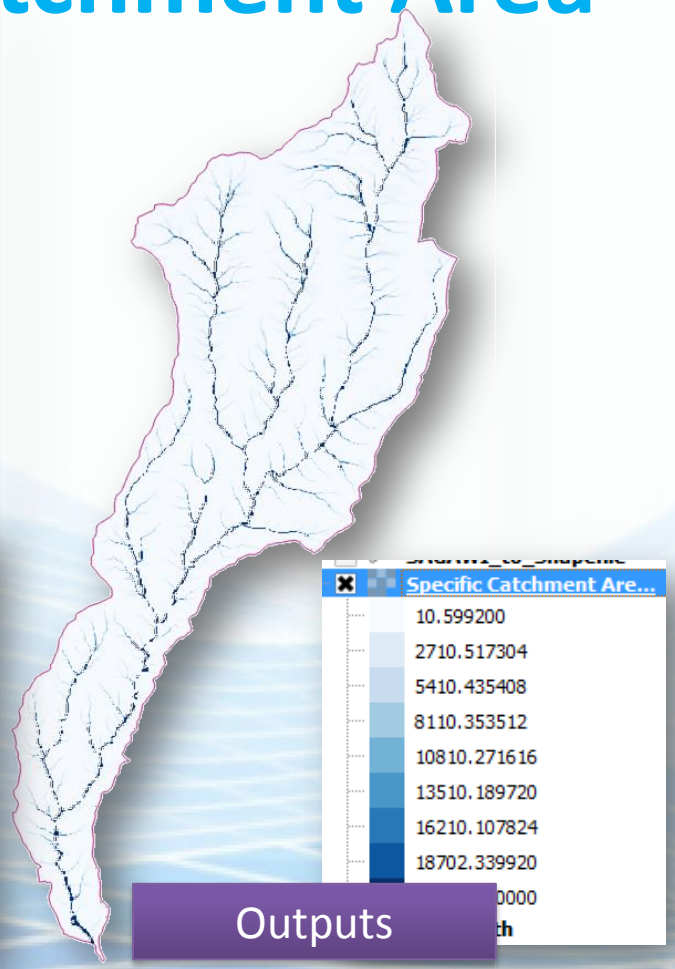
Flow Width & Specific Catchment Area







Menu/Location

Outputs

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Topographic Wetness Index

opographic 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:

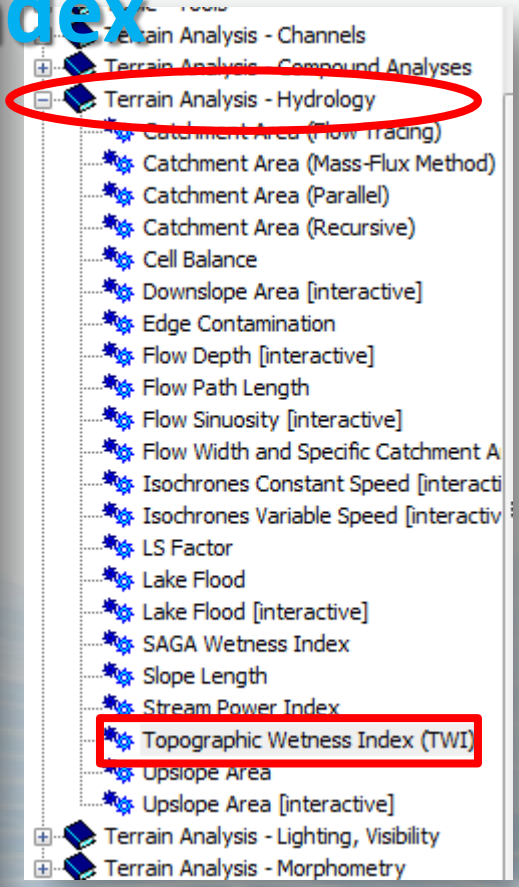
Beven, K.J., Kirkby, M.J. (1979):
A physically-based variable contributing area model of basin hydrology'
Hydrology Science Bulletin 24(1), p.43-69

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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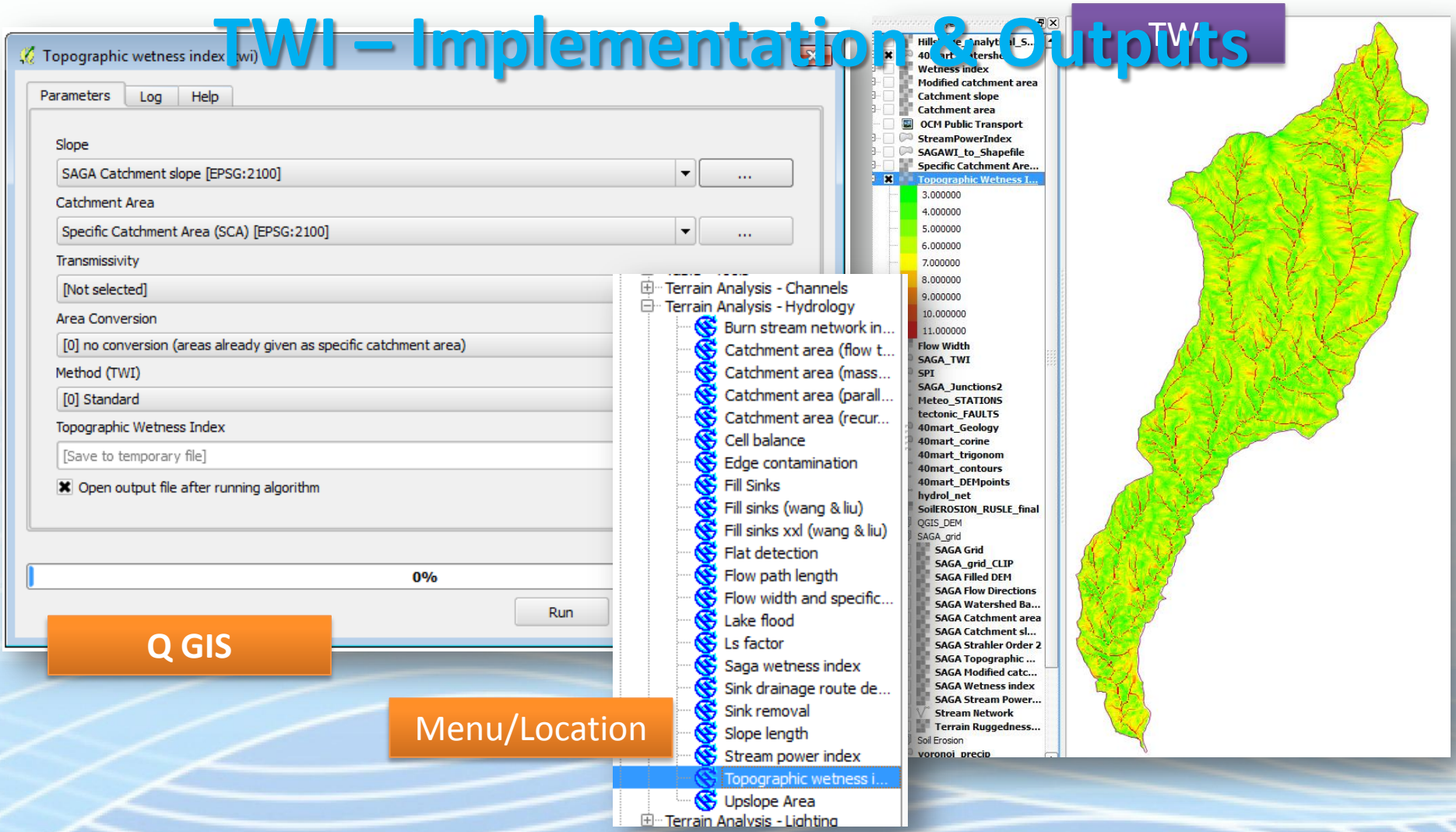
TWI – Implementation & Outputs



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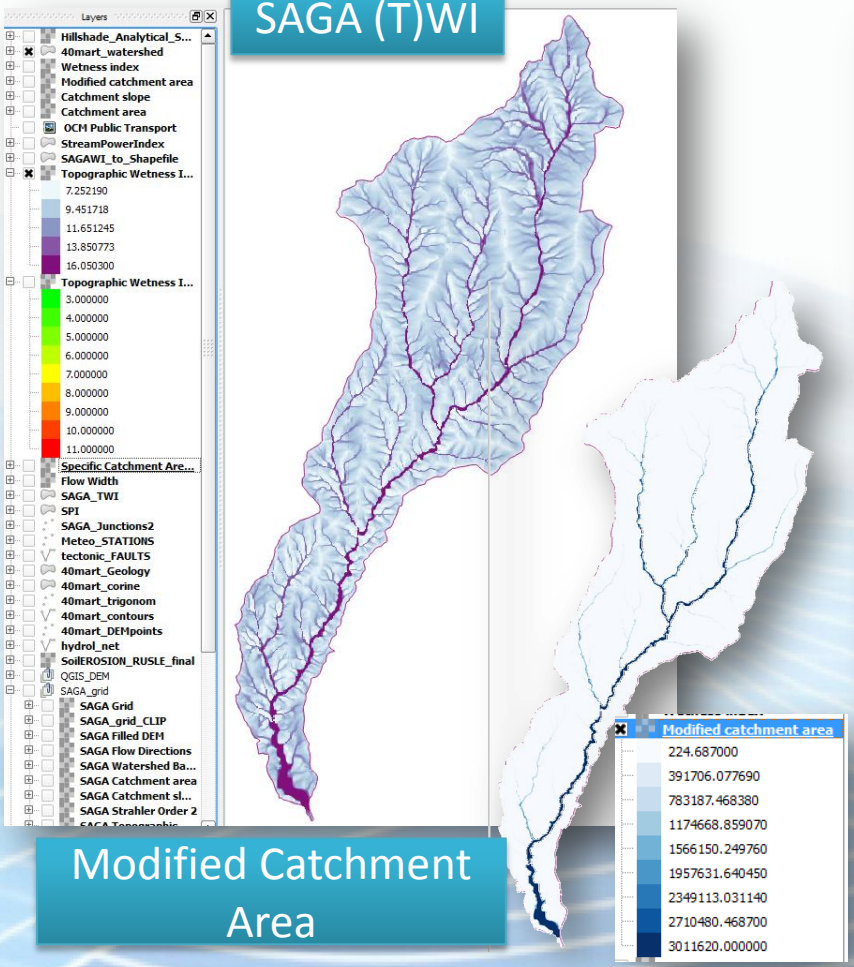
TWI vs SAGA WI

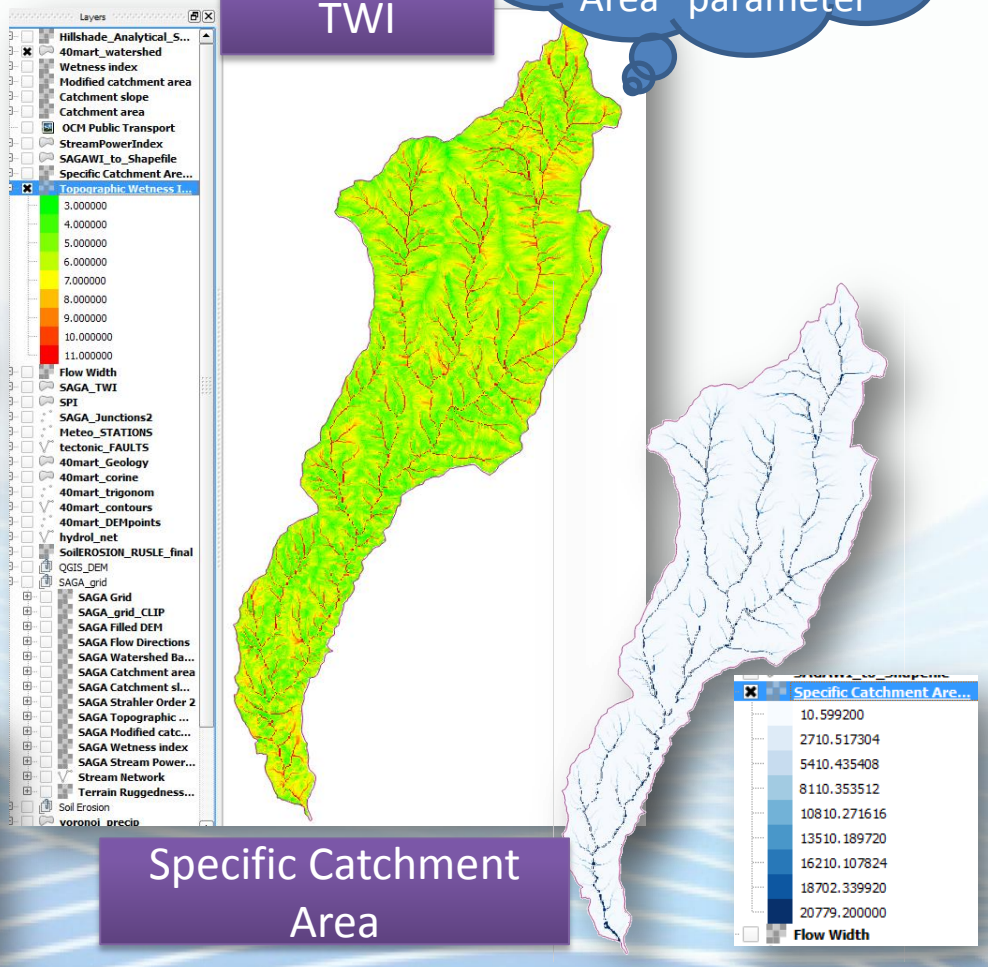
Differences due to the "Catchment Area" parameter

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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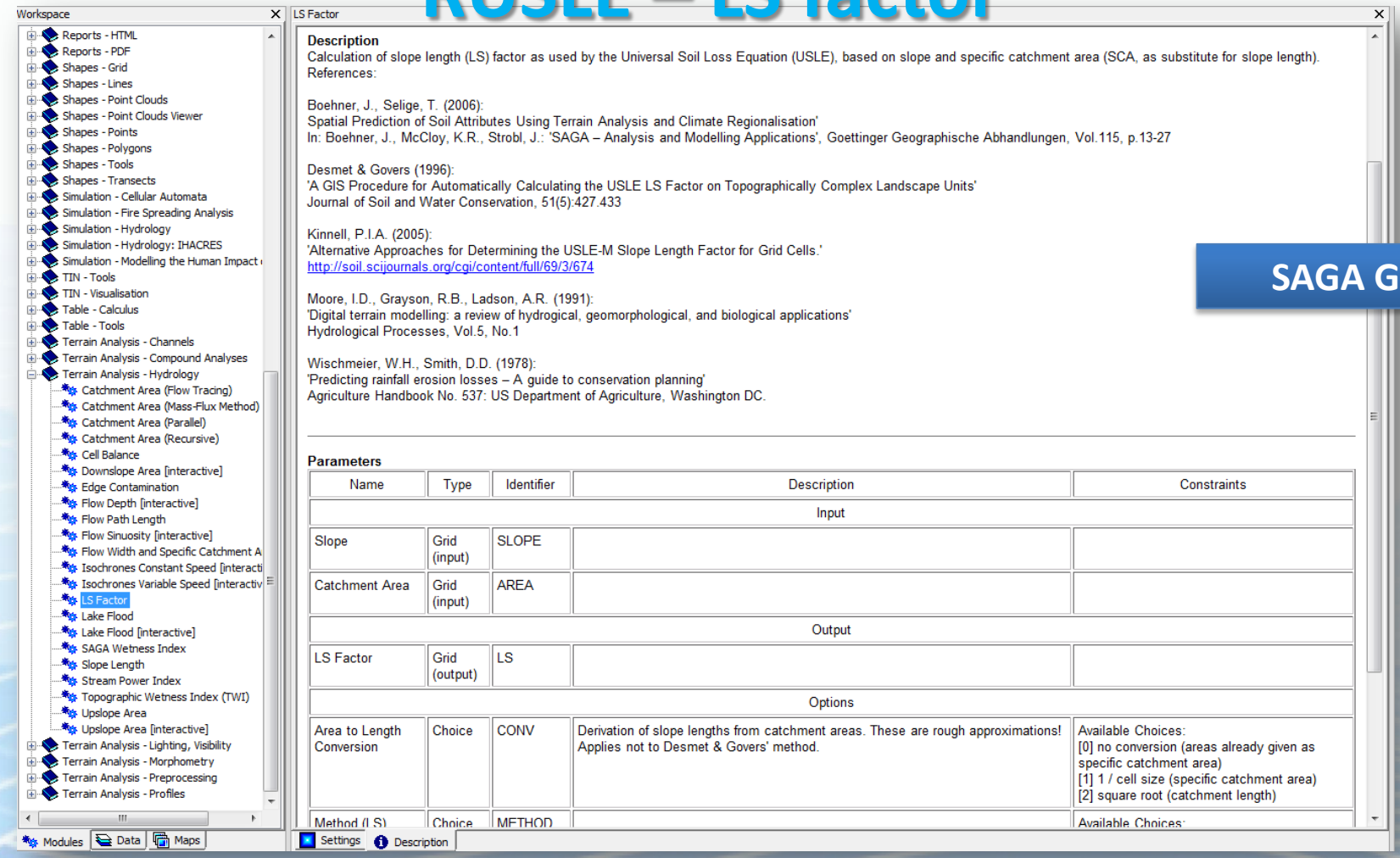
RUSLE – LS factor



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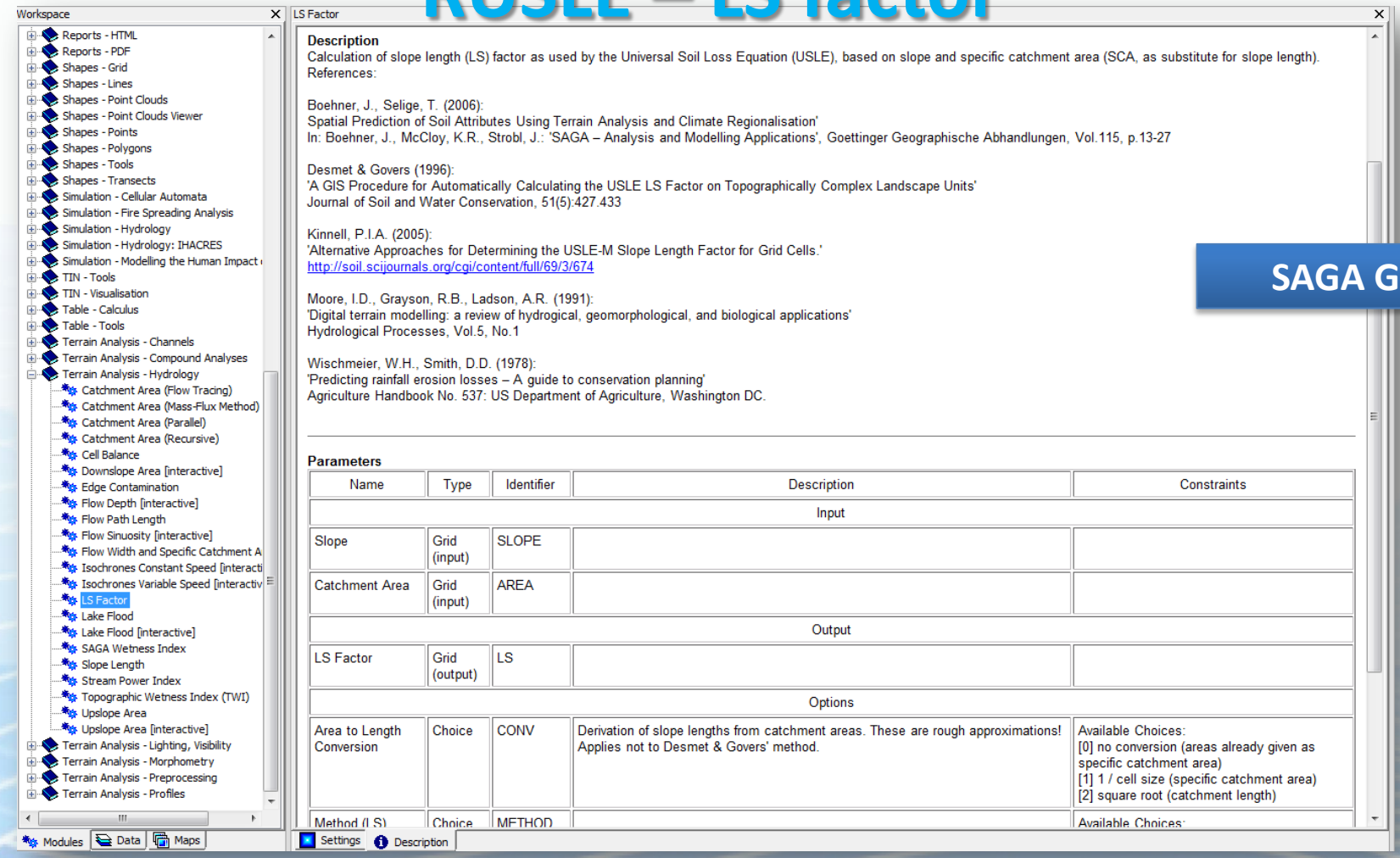
RUSLE – LS factor



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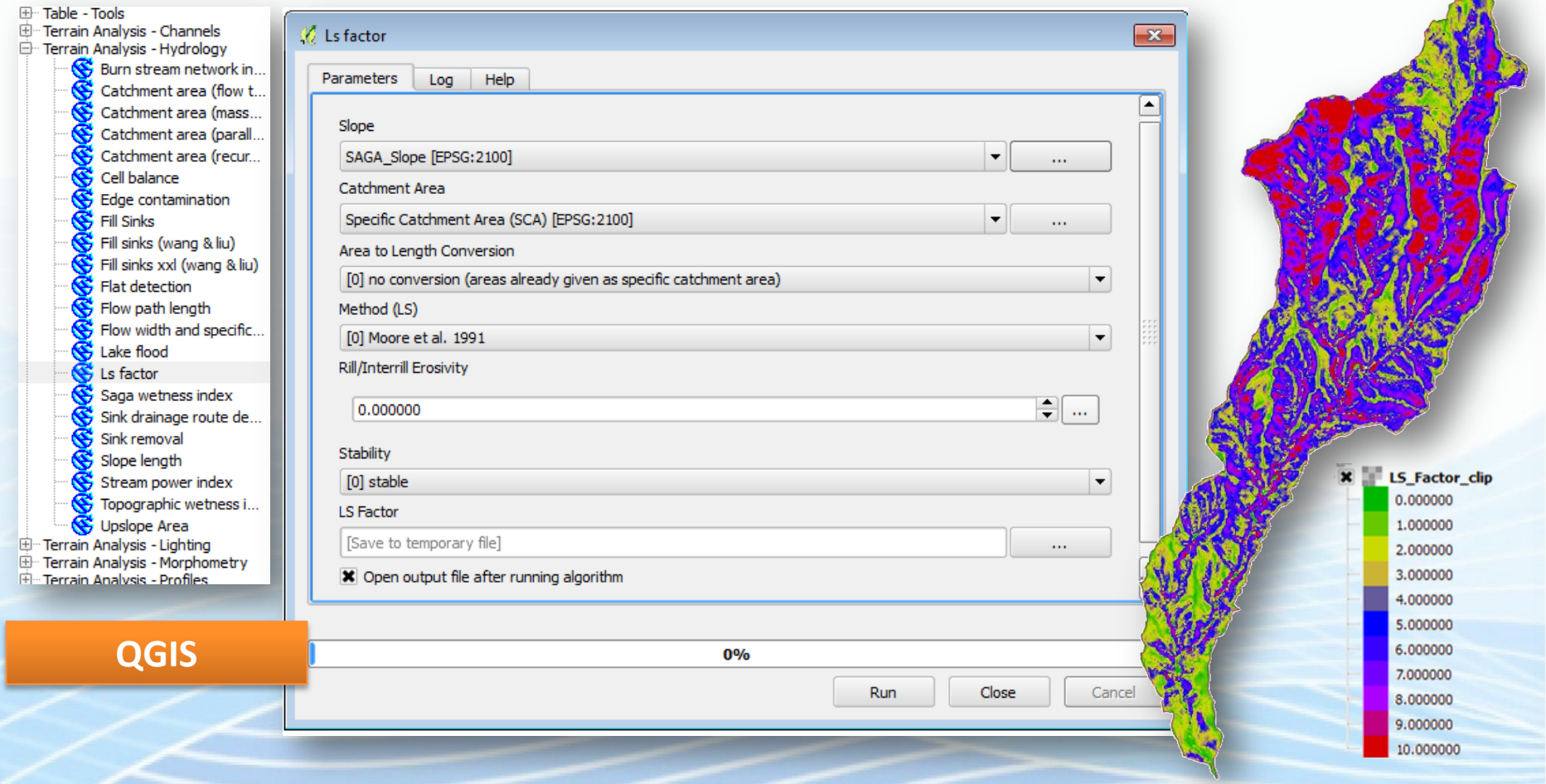
RUSLE – LS factor



QGIS

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RUSLE – Soil Erosion Potential…

QGIS

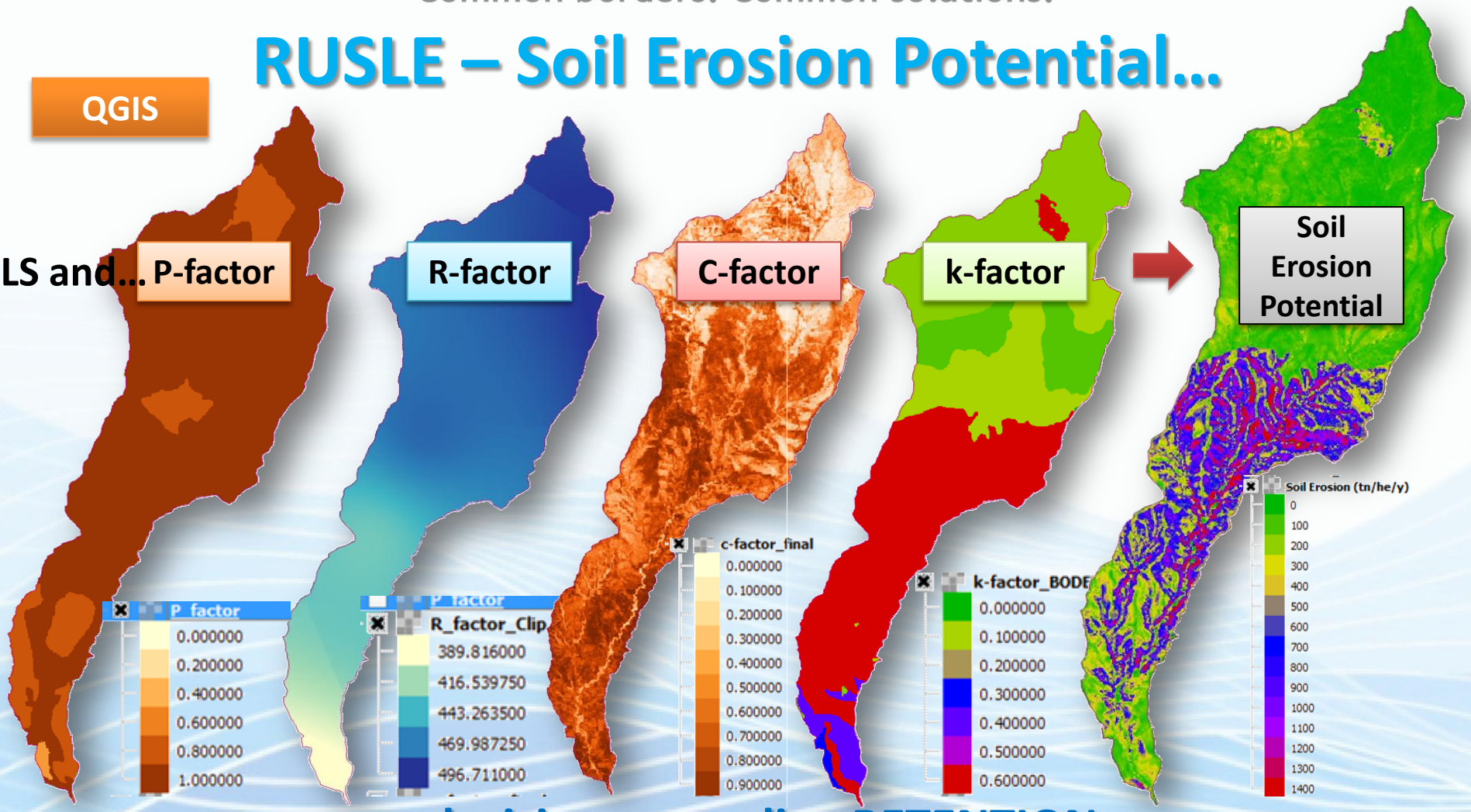
LS and… P-factor

R-factor

C-factor

k-factor

Soil Erosion Potential



…to support decisions regarding RETENTION measures

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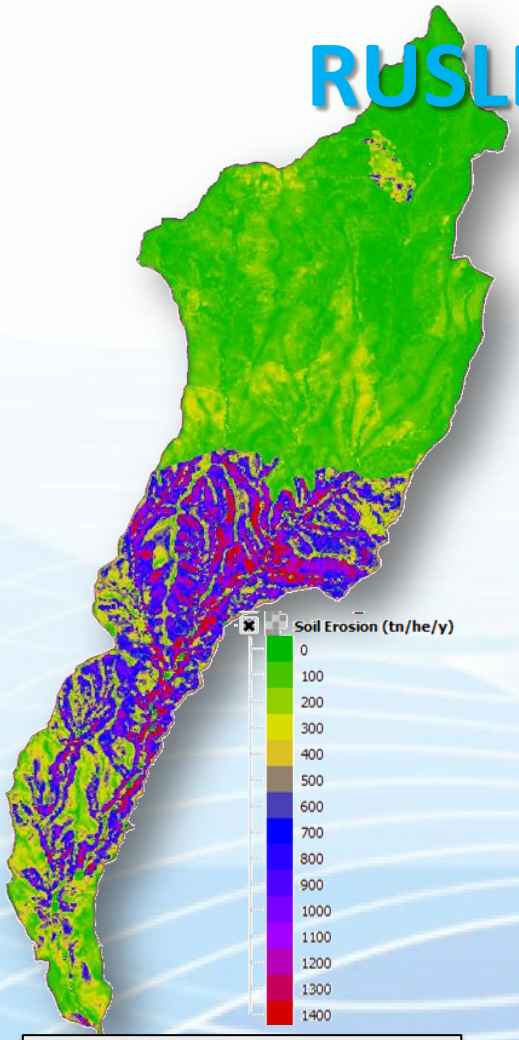
RUSLE – Soil Erosion Potential…



Soil Erosion Potential

…Can be used **to plan Sediment Retention structures (assess location) upstream** in order to effectively **control sediment transport** towards the flood prone area.

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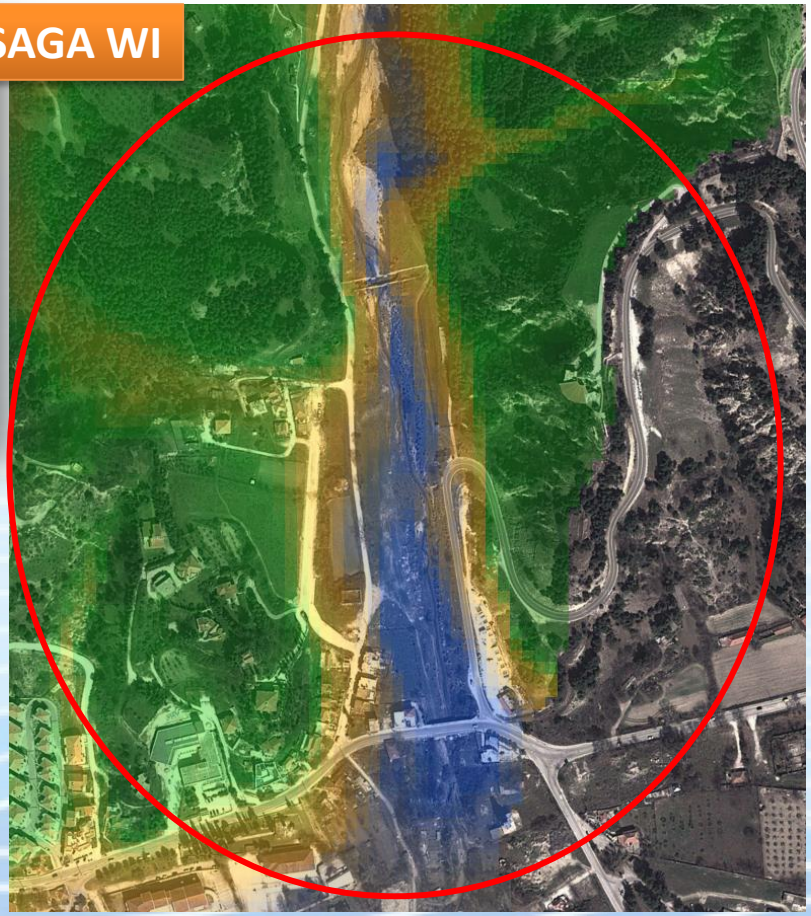
From Regional to Local Scale



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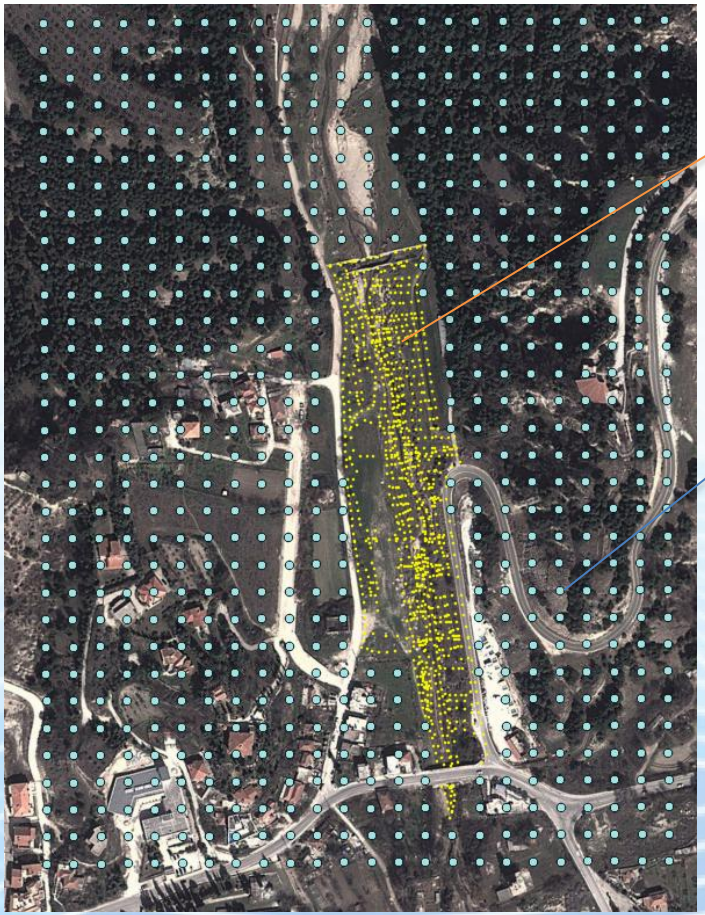
Detailed Topographic Data



Measured in situ with GPS
(differential GPS & RTK)

Lattice /25m
or Produced by topographic maps
1:2.000 - 1 : 5.000

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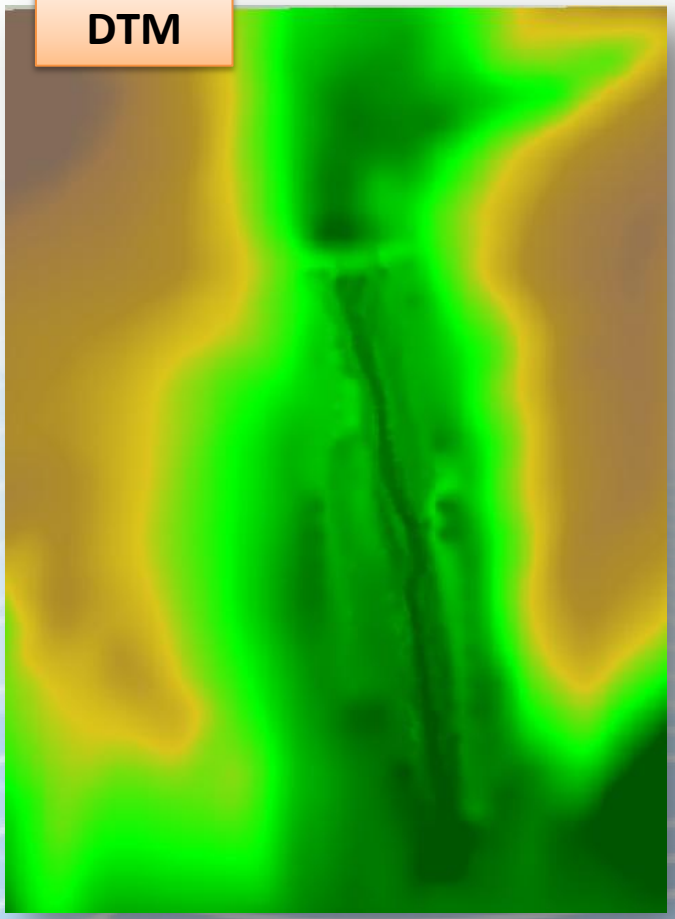
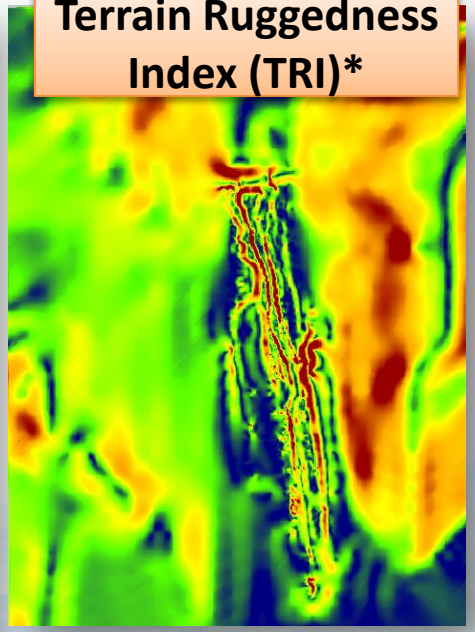
DTM & Products – additional parameters

DTM



Hillshade

Terrain Ruggedness Index (TRI)*



*Riley, S.J., De Gloria, S.D., Elliot, R. (1999)

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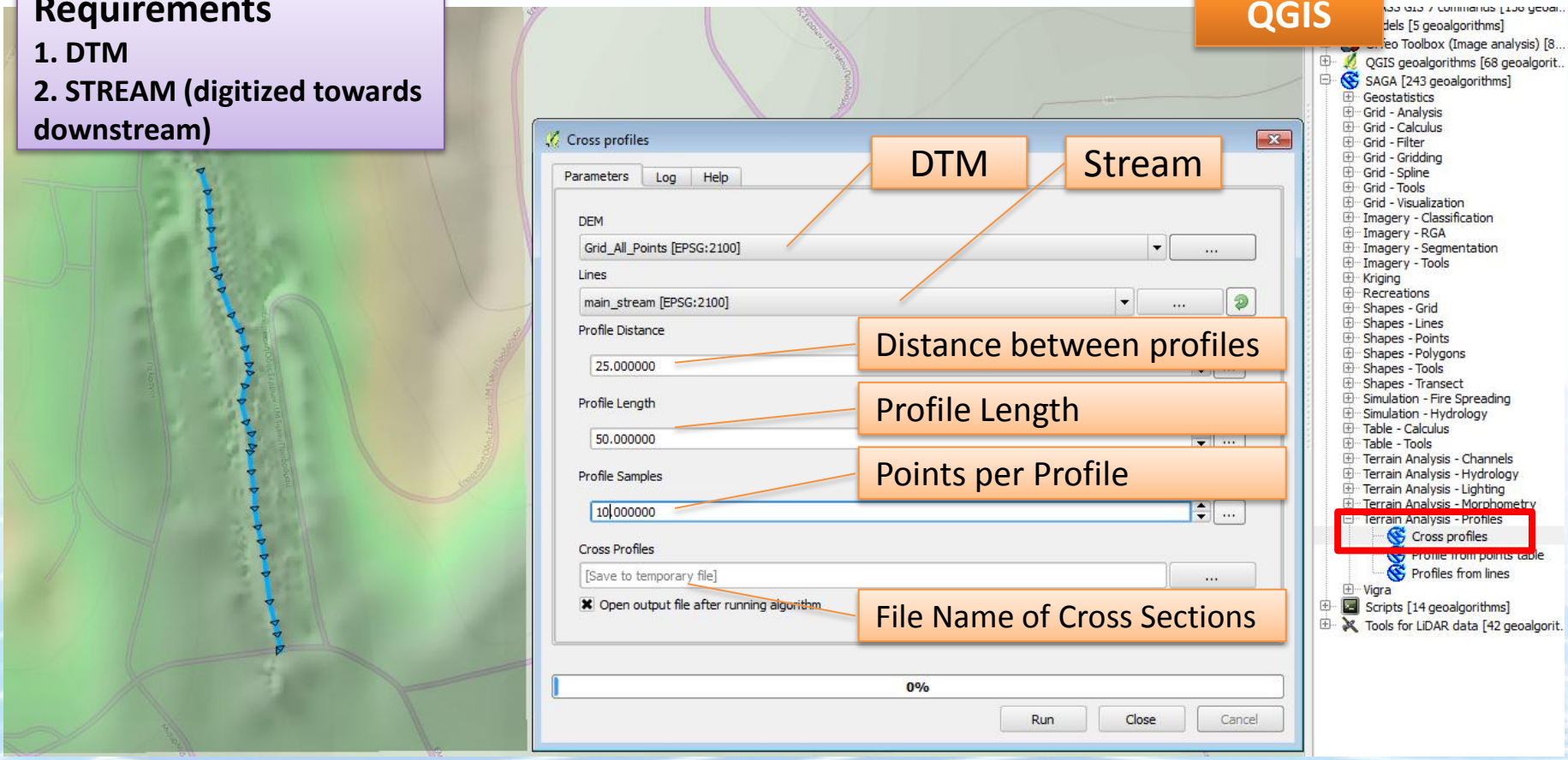
Cross Sections

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

QGIS



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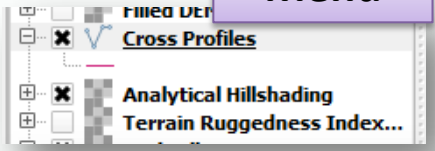
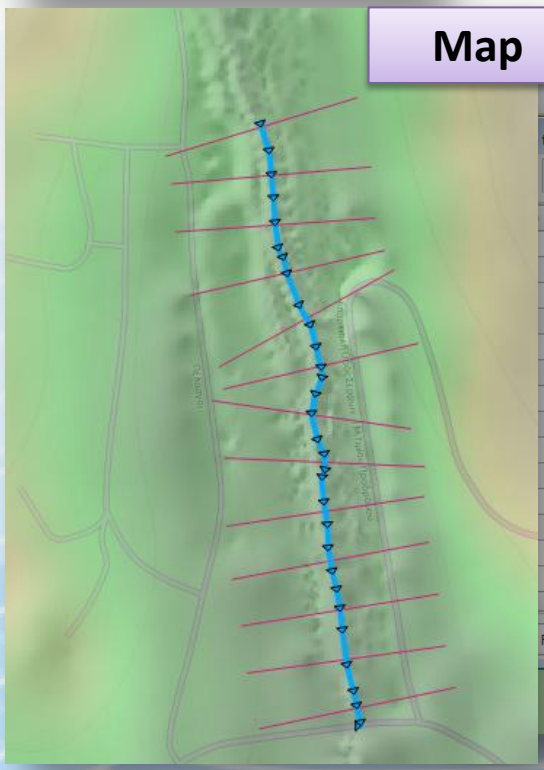
Cross Sections

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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SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Cross Sections to ….HEC-RAS

Attribute Table (elevation per point)

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

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

Show All Features

…

and we copy those data and paste them into HEC-RAS cross section creation module

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SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

SciNetNatHaz Project Progress Meeting - 23-26 Oct 2014, Burgas, Bulgaria

Thank you!

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

A pilot Implementation

Konstantinos Papatheodorou
Helena Tzanou

TEI of Kentriki Makedonia, LP/ENPI Beneficiary