Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

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[1], E. Tzanou[1], C. Maftei[2], H. Aksoy[3], O. Kirca[3], M.J. Adler[4]

1. *Civil, Surveying & Geomatics Engineering dept, TEI of Central Macedonia, Greece*
2. *Civil Engineering dept, Ovidius University Constanta, Romania*
3. *Civil Engineering dept, Istanbul Technical University, Turkey*
4. *Romanian Ministry of Environment & Sustainable development*

Information: ***K. Papatheodorou****, Project Coordinator, TEI of Central Macedonia, Hellas, ww.scinetnathaz.net*

Project funded by the EUROPEAN UNION

Common borders. Common solutions.

Some of the problems preventing… Flood disaster prevention

- **Data**
- **Methodologies**
- **LOCAL SCALE implementation**
- **Flash floods**

- ***Most of the above problems have already been recognized by the EU and actions are foreseen to be implemented during the upcoming period (Directive 2007/60/EC implementation).***

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Potential Solutions – The SciNetNatHaz activities

1. Adopt methodologies which: i) can provide **accurate and reliable outputs** to **support decisions** regarding designing PREVENTIVE MEASURES and ii) have minimal data requirements

2. **Pilot Implementations on a "Site Specific"/ Local scale** in order to evaluate performance by comparing outputs to actual facts

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

Disaster Prevention

Applied Research (Implementation on a Local scale)

Risk Assessment

Hazard Identification

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Parameters taken into consideration during the Flood Hazard Assessment models evaluation/selection

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

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.

Common borders. Common solutions.

Evaluation criteria (a brief list)

- Evaluation
  - Feasibility to implement
    - Data requirements
    - User friendliness
    - Flexibility/Adaptability
    - Cost of implementation
    - Watershed Representation
  - Evaluation of Outputs
    - Completeness
    - Reliability
    - Accuracy

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Flood Models, Methods and Techniques considered

Methods / Models classified

- **Flood Flow & Hazard Potential**
  - Rules of Thumb
  - Rational Method
  - SCS method
  - Unit Hydrograph
  - Storage-routing models
  - Kinematic wave Models
  - Catchment water balance models
- **Flood Inundation and Hazard potential**
  - Screening methods
  - 1-D flow models
  - 2-D flow models
  - 3-D flow models
- **Hydrological / Hydraulic Analyses**
  - Statistical Analysis of stream flow records
  - Regional Methods
  - Transfer methods
  - Empirical Methods
  - Watershed modeling methods

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

The SciNetNatHaz proposal for Flash Flood Disaster Prevention

1st Step: SCREENING for strategic planning

i) Using Morphometric models to locate Flood prone areas

ii) Assess the potential risks and prioritize research on a local scale

2nd Step: Implementation on a local scale

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

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

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Step 1:

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

A guide to pilot Implementation

…is included in "SciNetNatHaz_FloodHA_Regional scale.pptx"

Project funded by the EUROPEAN UNION

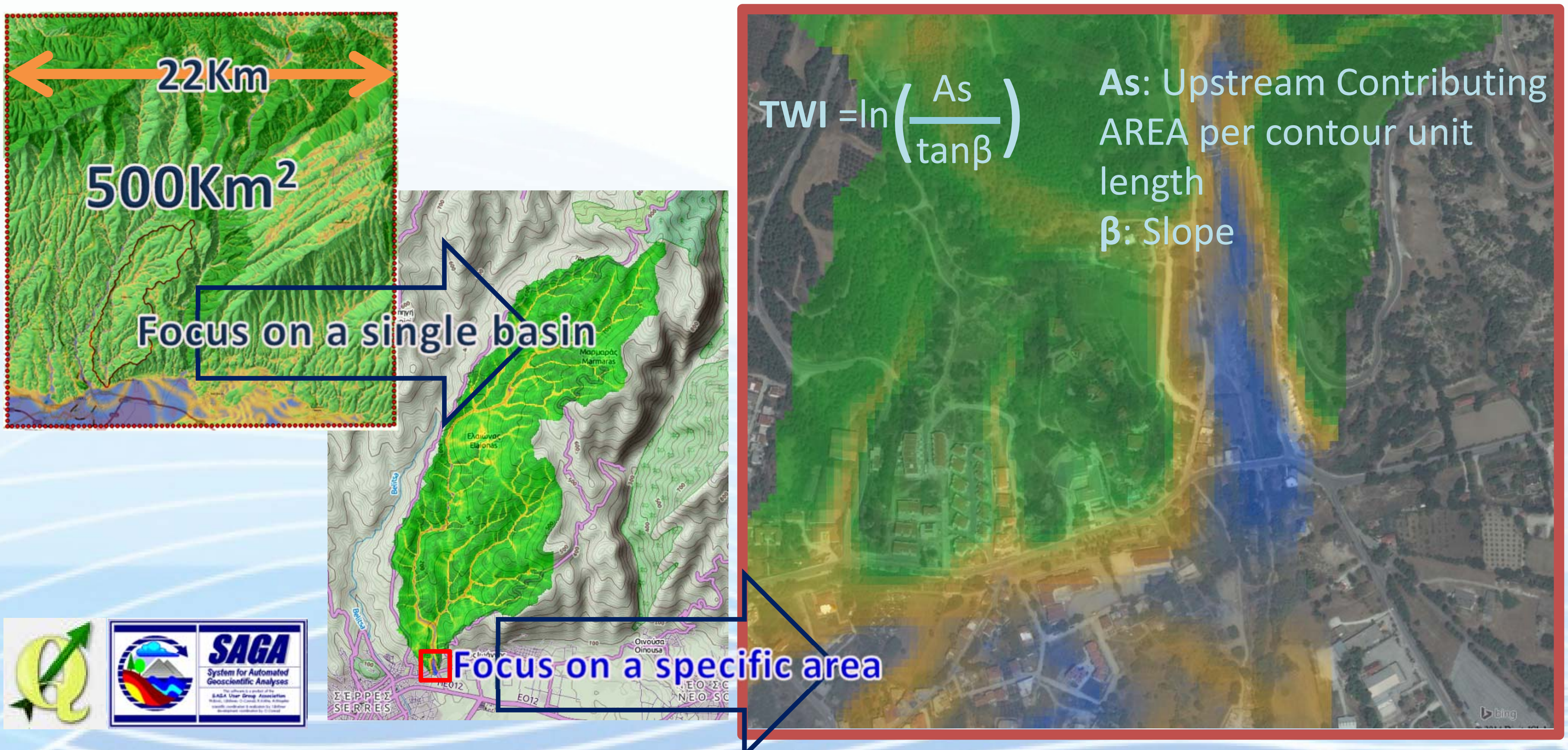
SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

1st step: “Screening” to locate …”where”

Can be applied on a regional scale using only topographic map data or even ASTER DEMs



Project funded by the EUROPEAN UNION

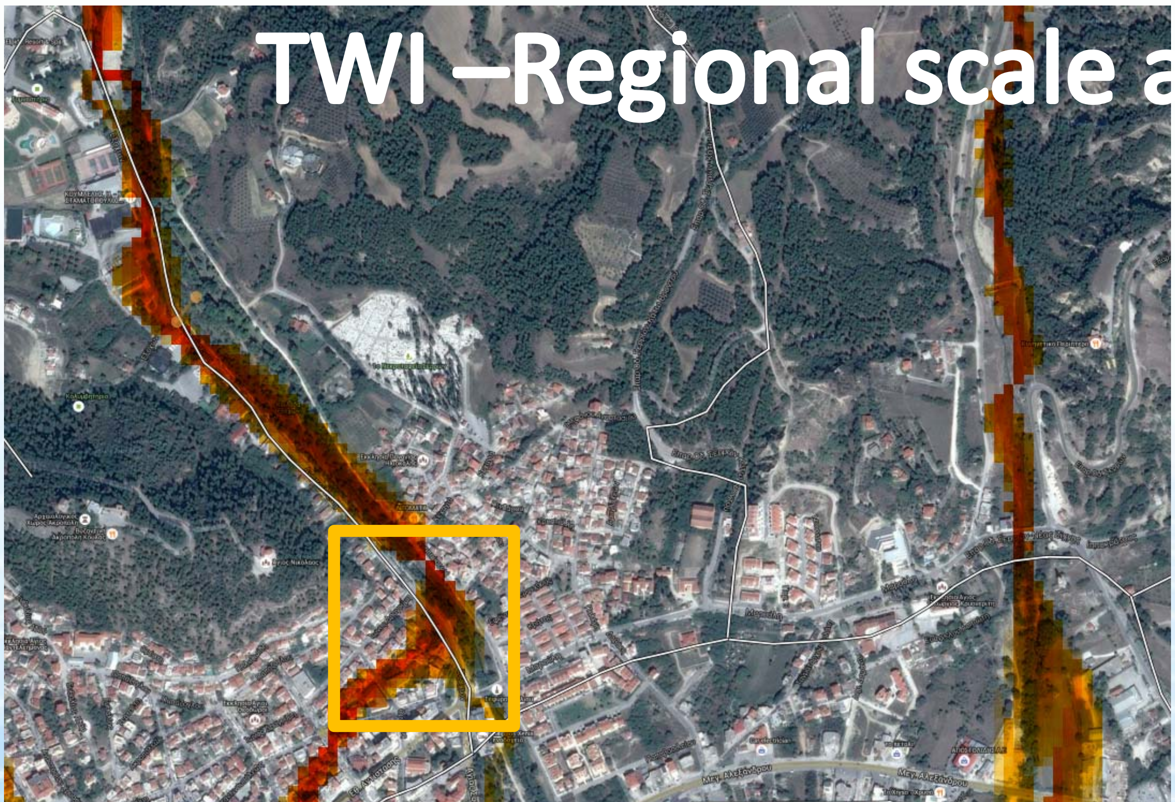
SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

1st step: "Screening" to locate …"what"

TWI –Regional scale assessment



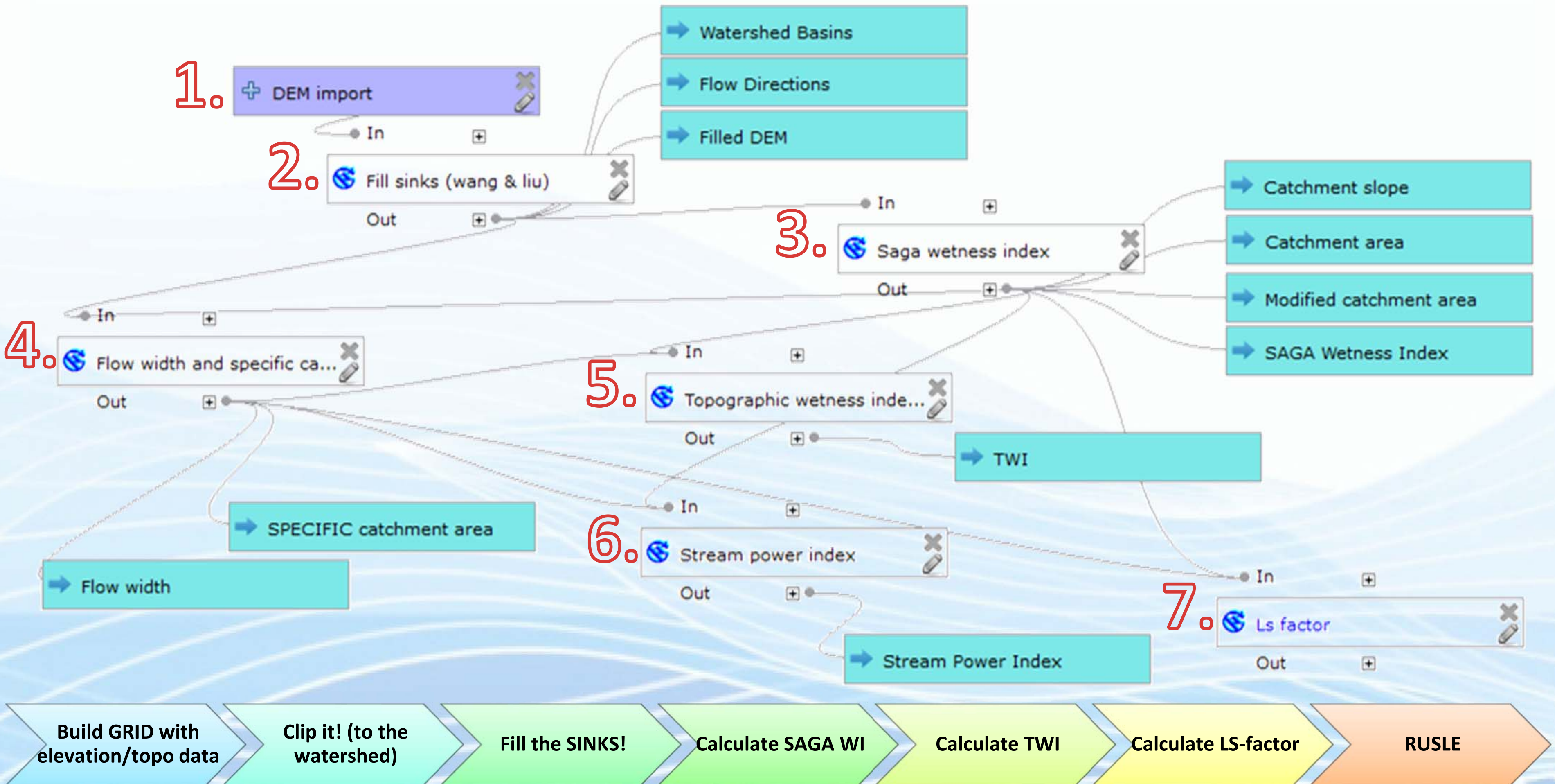
Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Processing (Model) to calculate TWI



Project funded by the
EUROPEAN UNION

SciNet NatHaz
Prevention

Black Sea
CROSS BORDER
COOPERATION

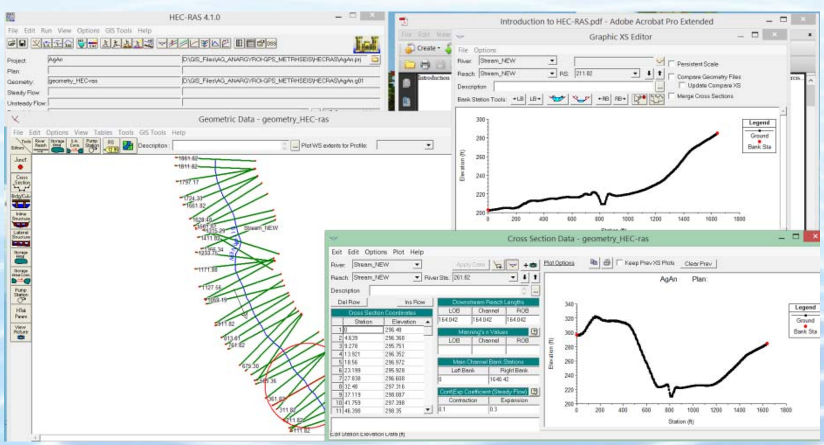
Common borders. Common solutions.

2st step: Calculate Flooding parameters (local scale)

- **HEC-RAS is a one-dimensional steady flow hydraulic model** designed to aid hydraulic engineers in **channel flow analysis** and **floodplain determination**.

US Army Corps
of Engineers
Hydrologic Engineering Center

- The results of the model **can be applied in floodplain management and flood insurance studies**.



$$H = Z + Y + \frac{\alpha V^2}{2g}$$

- which states that the total energy (H) at any given location along the stream, is the sum of potential energy (Z + Y) and kinetic energy ($aV^2/2g$). The change in energy between two cross-sections is called head loss (h_L).

Project funded by the EUROPEAN UNION

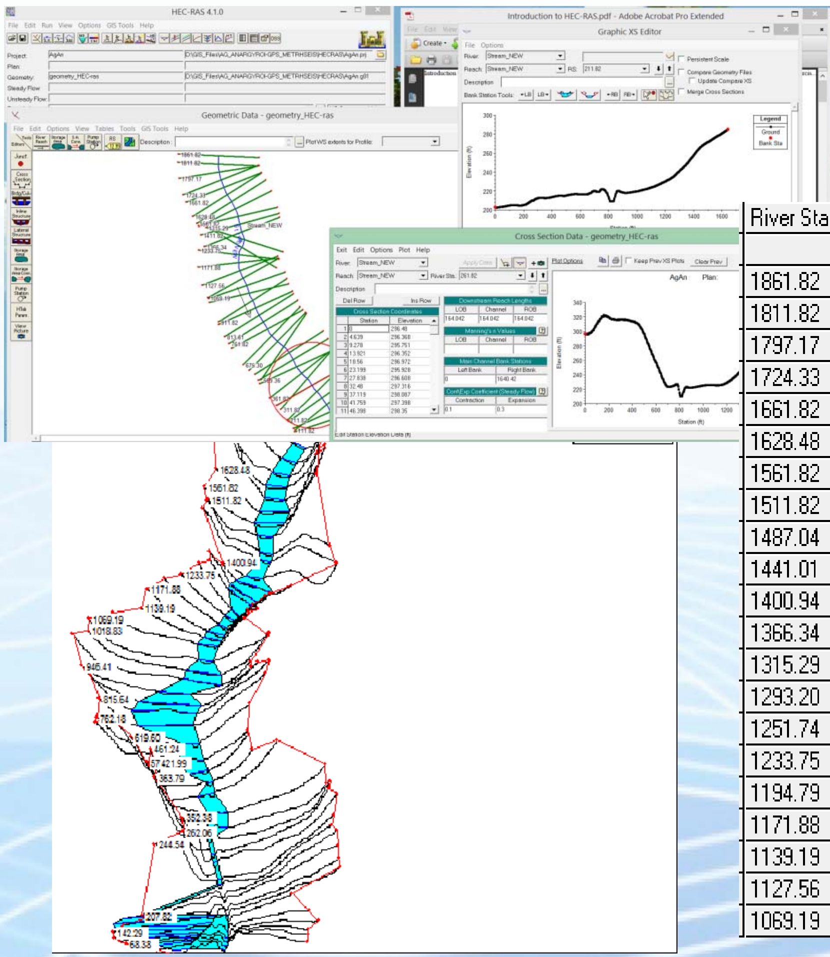
SciNet NatHaz Prevention

US Army Corps of Engineers
Hydrologic Engineering Center

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

2nd step: Calculating Flood parameters



River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1861.82	64.50	95.94	96.97	96.97	97.31	0.01160	2.55	25.33	38.41	1.00
1811.82	64.50	93.63	94.59	94.59	94.89	0.01225	2.42	26.69	45.65	1.01
1797.17	64.50	92.55	93.71		93.81	0.00220	1.40	45.95	48.78	0.46
1724.33	64.50	92.46	93.57		93.66	0.00190	1.28	50.42	55.23	0.43
1661.82	64.50	92.36	93.45		93.53	0.00197	1.31	49.07	53.02	0.44
1628.48	64.50	92.26	93.46		93.49	0.00052	0.74	86.64	81.04	0.23
1561.82	64.50	92.17	93.42		93.45	0.00055	0.77	83.68	77.17	0.24
1511.82	64.50	92.08	93.03	93.03	93.35	0.01196	2.50	25.78	41.09	1.01
1487.04	64.50	89.30	90.39	90.39	90.74	0.01150	2.62	24.58	35.38	1.00
1441.01	64.50	87.94	89.08	89.08	89.44	0.01132	2.66	24.28	33.87	1.00
1400.94	64.50	84.75	85.66	85.66	85.95	0.01208	2.40	26.89	45.98	1.00
1366.34	64.50	83.97	84.86	84.86	85.06	0.01389	1.96	32.97	85.11	1.00
1315.29	64.50	83.66	84.55		84.63	0.00369	1.24	52.08	98.74	0.54
1293.20	64.50	83.63	84.28	84.28	84.48	0.01380	1.99	32.46	81.43	1.00
1251.74	64.50	81.69	82.74	82.74	83.08	0.01166	2.60	24.84	36.68	1.01
1233.75	64.50	81.01	82.19	82.19	82.56	0.01143	2.72	23.75	32.30	1.01
1194.79	64.50	80.38	81.61	81.61	82.00	0.01118	2.79	23.14	29.73	1.01
1171.88	64.50	80.20	81.39		81.53	0.00417	1.69	38.16	49.65	0.62
1139.19	64.50	80.16	81.17		81.36	0.00659	1.95	33.09	48.99	0.76
1127.56	64.50	80.11	81.14		81.28	0.00471	1.67	38.57	55.94	0.64
1069.19	64.50	79.50	80.52	80.52	80.85	0.01179	2.56	25.23	38.48	1.01

Project funded by the EUROPEAN UNION

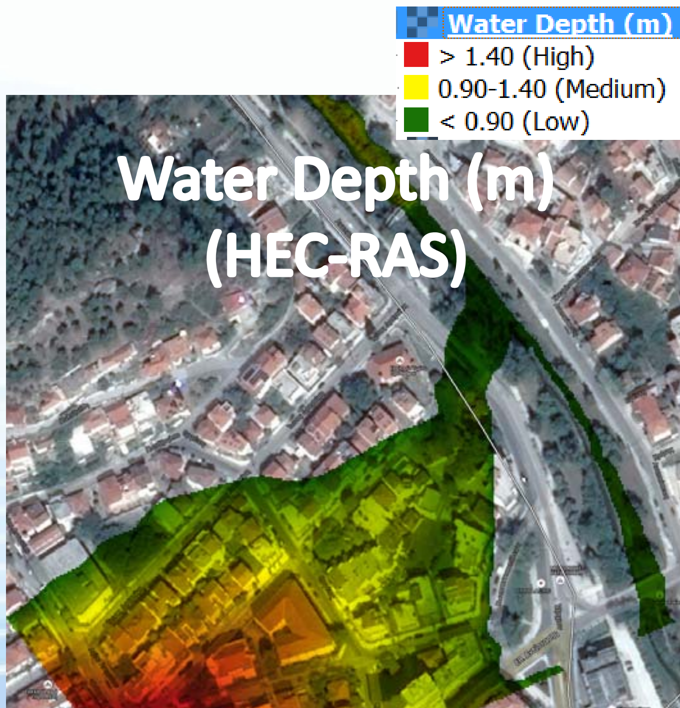
SciNet NatHaz Prevention

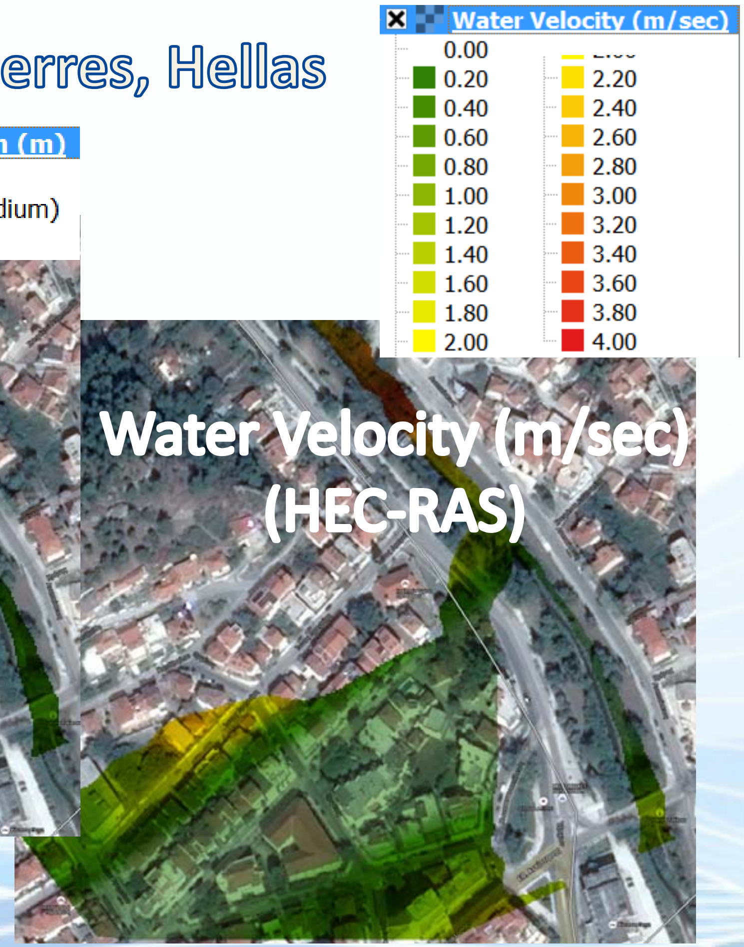
Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Assess Hazard – Calculate flood Parameters

Ag. Anargyri stream, Serres, Hellas





SAGA System for Automated Geoscientific Analyses

US Army Corps of Engineers Hydrologic Engineering Center

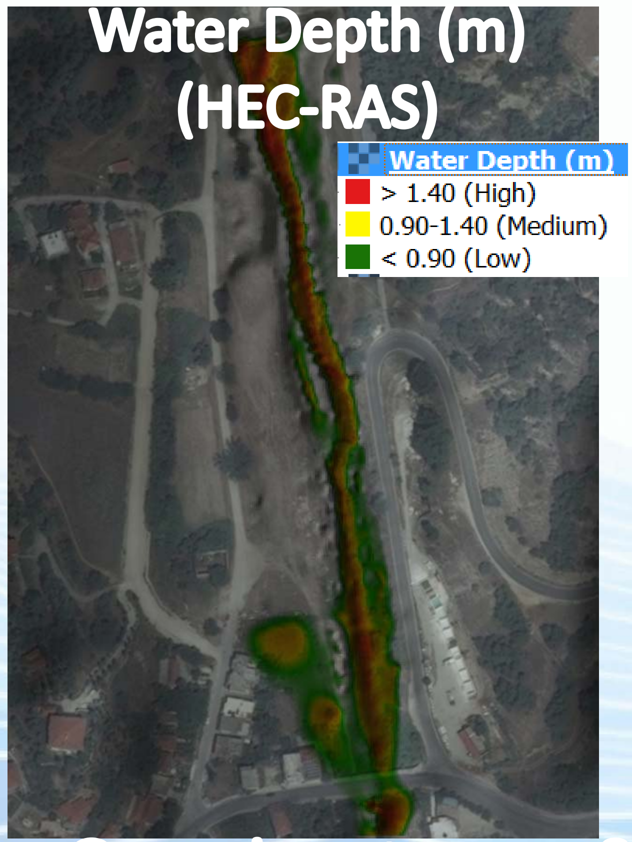
Project funded by the EUROPEAN UNION

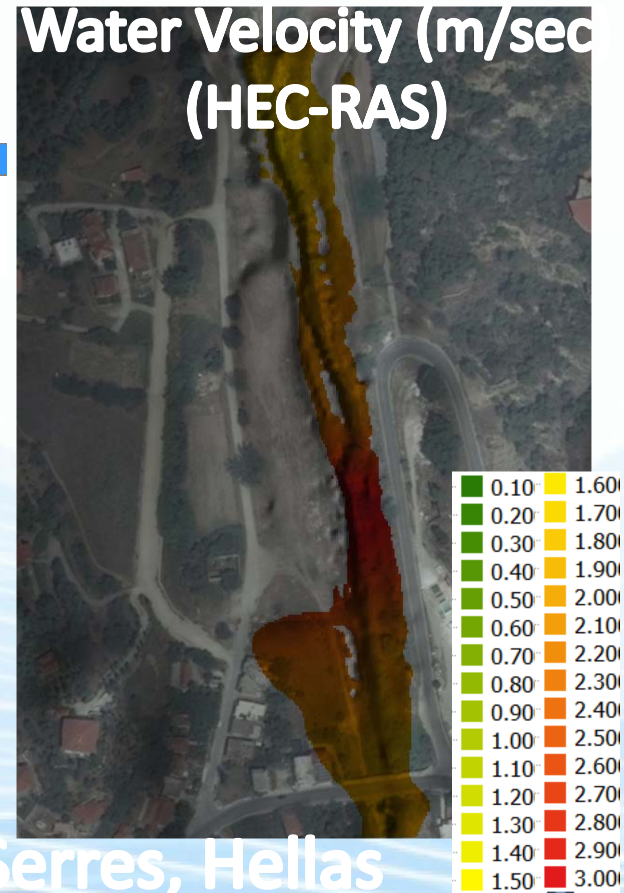
SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Assess Hazard – Calculate flood Parameters





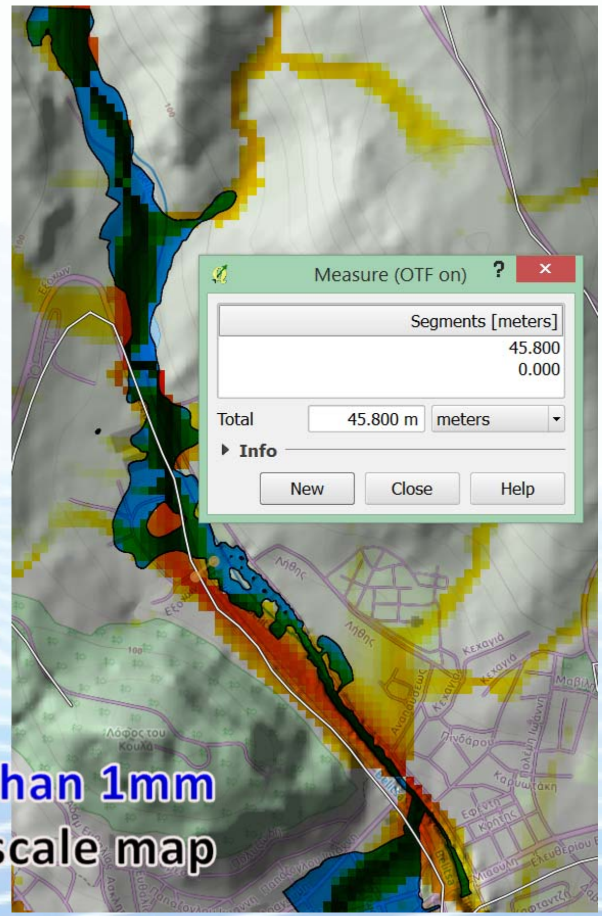
Eleonas - Ayios Georgios stream, Serres, Hellas

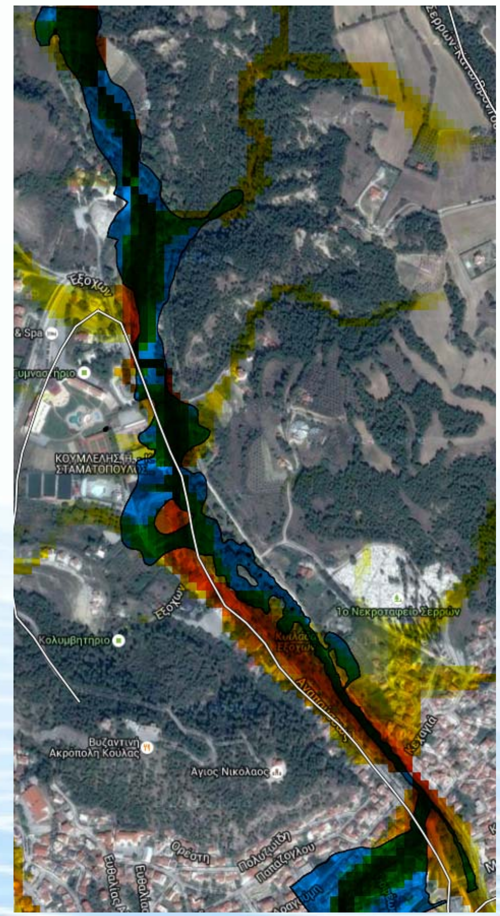
Common borders. Common solutions.

Accuracy & Reliability – Comparing TWI to….HEC-RAS

Data Requirements

- TWI : Topographic maps **1:50.000** ; Elevation points
- HEC-RAS: Topographic Maps **1:500**, Rainfall (time series and peak intensities) …and hydrologic if any

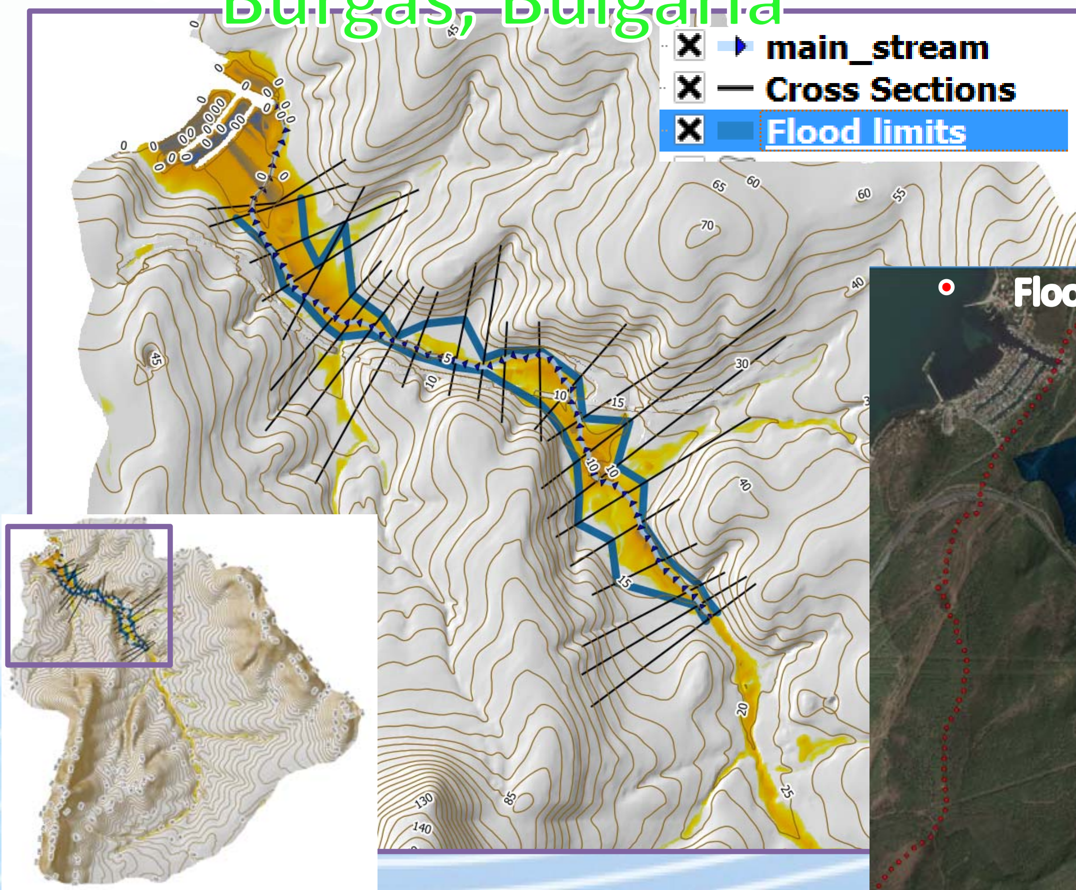


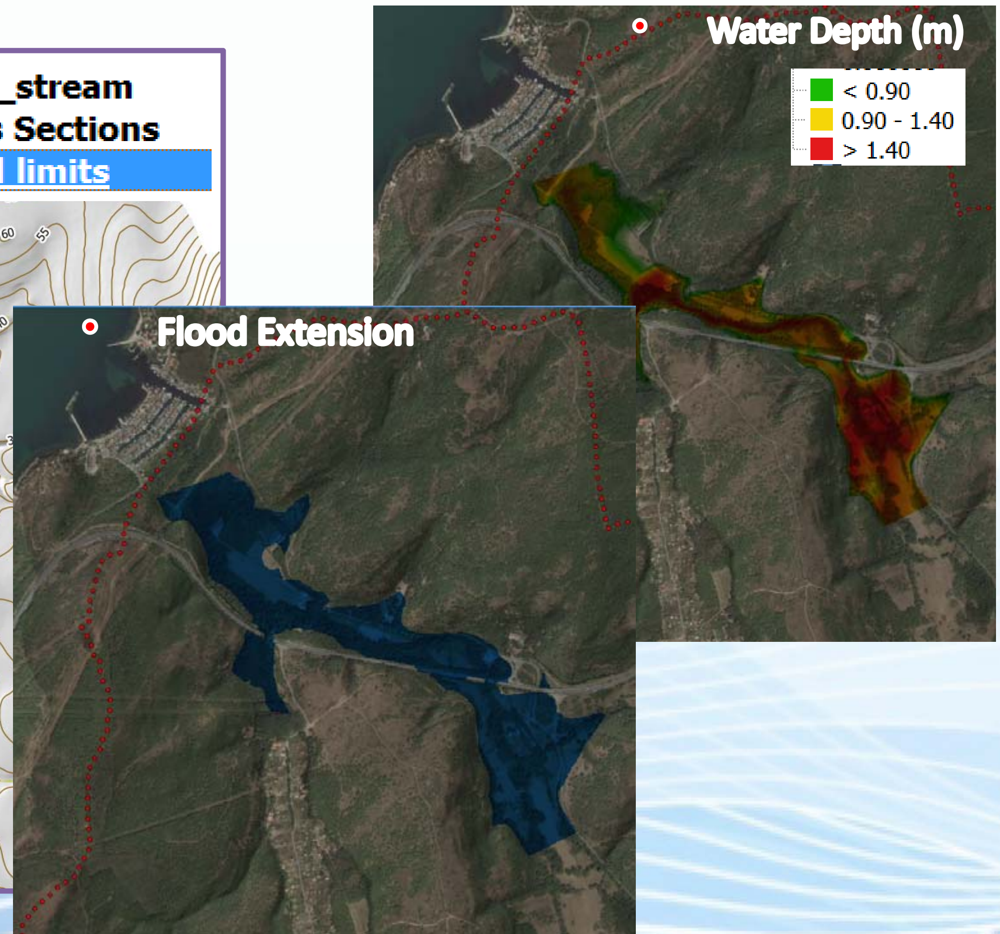


45.800 m are less than 1mm on a 1:50.000 scale map

Output comparison: from Regional to Local scale

- Burgas, Bulgaria





Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Conclusions (1/2)

- The use of TWI on a regional scale, can provide reliable information to **select flood susceptible areas at potential risk**, at which to apply at a second stage, **flood hazard and risk assessment on a local scale**, to **assess flooding parameters** and **design typical preventive measures**.
- Application of HEC-RAS model on a local scale provided flood extension calculations that fit very well to actual facts; so it can be used for calculating the flood parameters and design (at least) typical preventive measures.
- **The proposed methodology has been tested in many cases** including two in Serres Greece, Voinesti and Taita rivers (Dobrogea, Romania), Burgas (Bulgaria). **In all cases, comparison of outputs to actual flood events, indicate a very good performance**.

Common borders. Common solutions.

Conclusions (2/2)

- **F**lood **P**rone **A**reas (FPA) indicated using the TWI model show an impressive convergence with the 50yrs flood inundation area (floodplain) as it results from using the HEC-RAS model, despite the fact that the **FPA is based on 1:50.000 scale** topographic map data whereas the **HEC-RAS implementation is based on 1:250 scale topo-survey data plus hydrologic and rainfall data**.
- From a qualitative point of view (flood susceptibility) the regional scale assessment is very reliable and accurate.
- Special care must be given to topographic data input

Project funded by the EUROPEAN UNION

Common borders. Common solutions.

Bottom Line!

The **SciNetNatHaz** proposed procedure for Flood Disaster Prevention is:

- Adaptable to local conditions so it **can be applied anywhere**
- Has minimal data requirements and is based on Open Source software so there's a **minimal cost in money and time**
- Delivers outputs reliable and accurate enough to **support informed decisions** regarding Flood disaster **Prevention**
- Tackles the **Flash Flood problem** which has not been thoroughly investigated
- **Fully complies and covers all requirements (or even exceeds in certain cases) of the "Flood" Directive (2007/60/EC)**

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

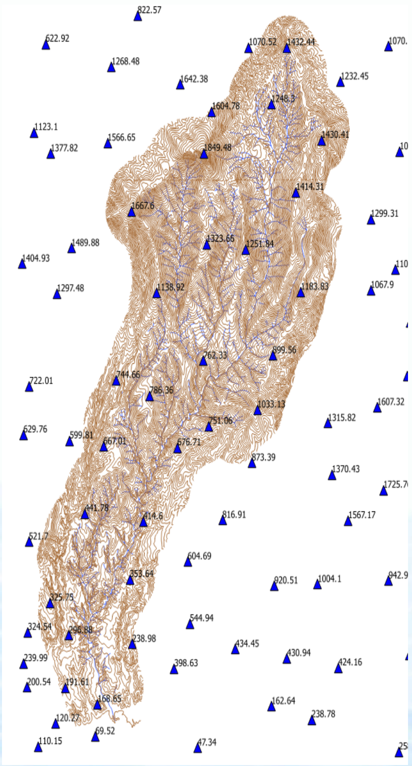
Common borders. Common solutions.

Comments (1/2)

- Topographic maps of **1:50.000** scale combined with a **15x15m DEM pixel size**, provide **reliable and accurate enough outputs**. Note: *Regional Scale Assessment performance is highly dependent on the quality and scale of topographic data.*

- Larger scale maps and relatively smaller DEM pixel sizes greatly improve the accuracy of outputs. Scales between 1:10.000 and 1:5.000 can be considered as optimal

- The use of ASTER DEMs (30x30m pixel size) can provide valuable information at the expense in location accuracy and reliability



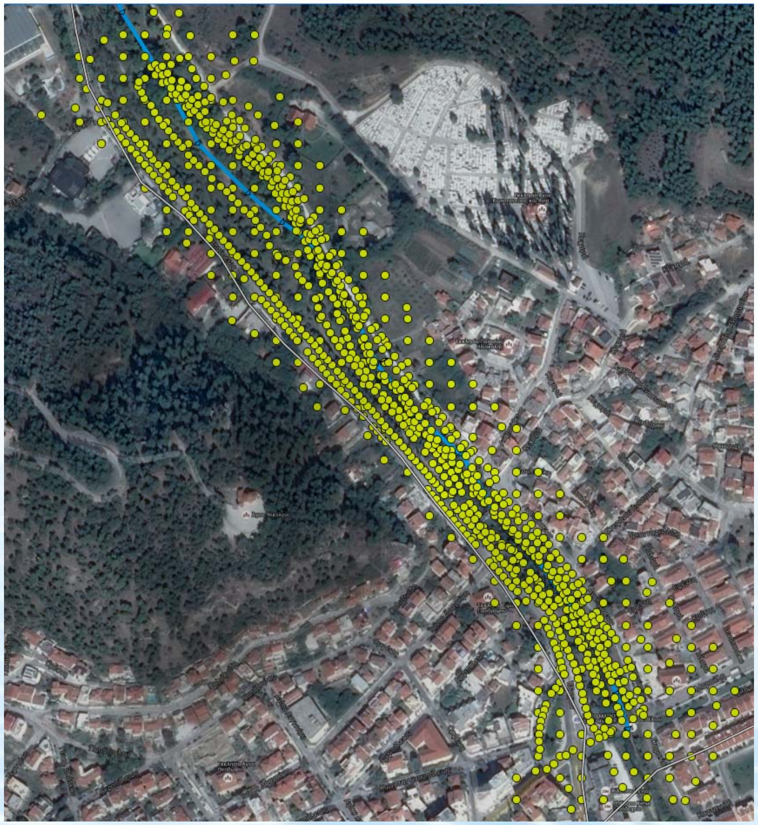
Topographic Map 1:50.000

Comments (2/2)

- Applied Research on a Local Scale **demands** highly accurate topographic data of (scale of 1:2.000 or larger) …

- …a hydrologic analysis including **rainfall time series and peak intensities**…but focuses on the specific area and **provides all the necessary information** to design typical preventive measures

- …and is **absolutely necessary!**



GPS surveying n the Agioi Anargyroi area (Serres, Hellas)

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

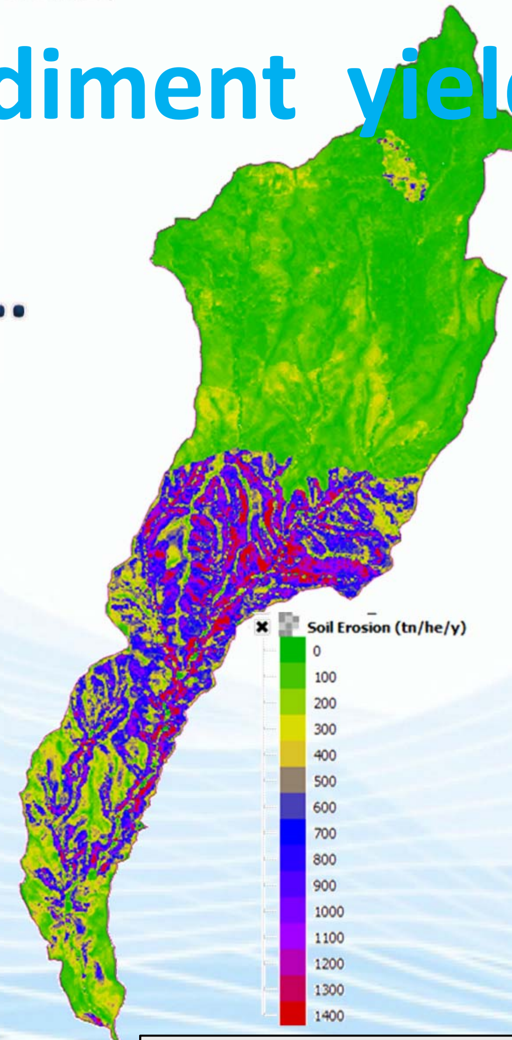
Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Soil Erosion Potential - Sediment yield

RUSLE – 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.



Soil Erosion Potential

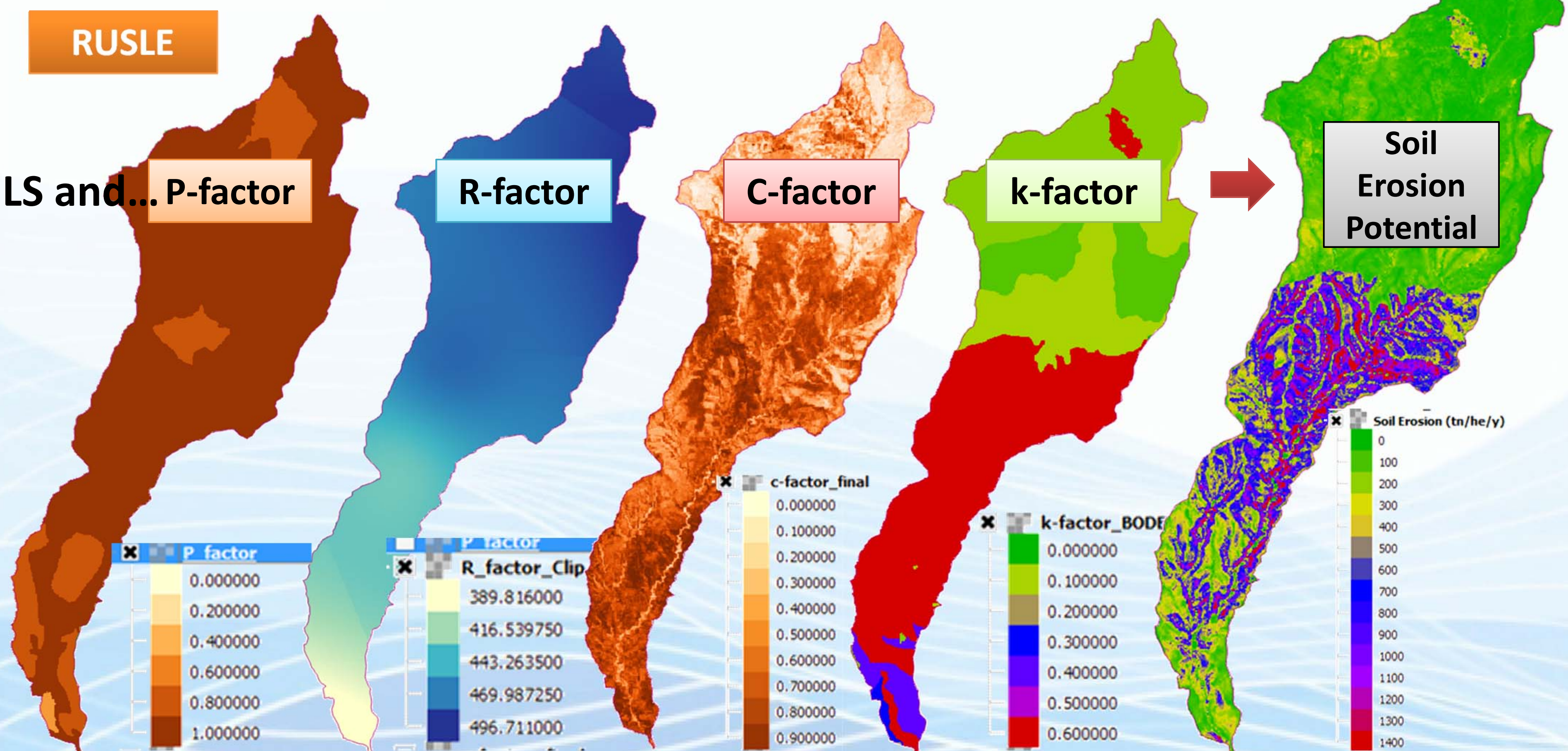
Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Soil Erosion Potential - RUSLE



…to support planning for sediment retention measures

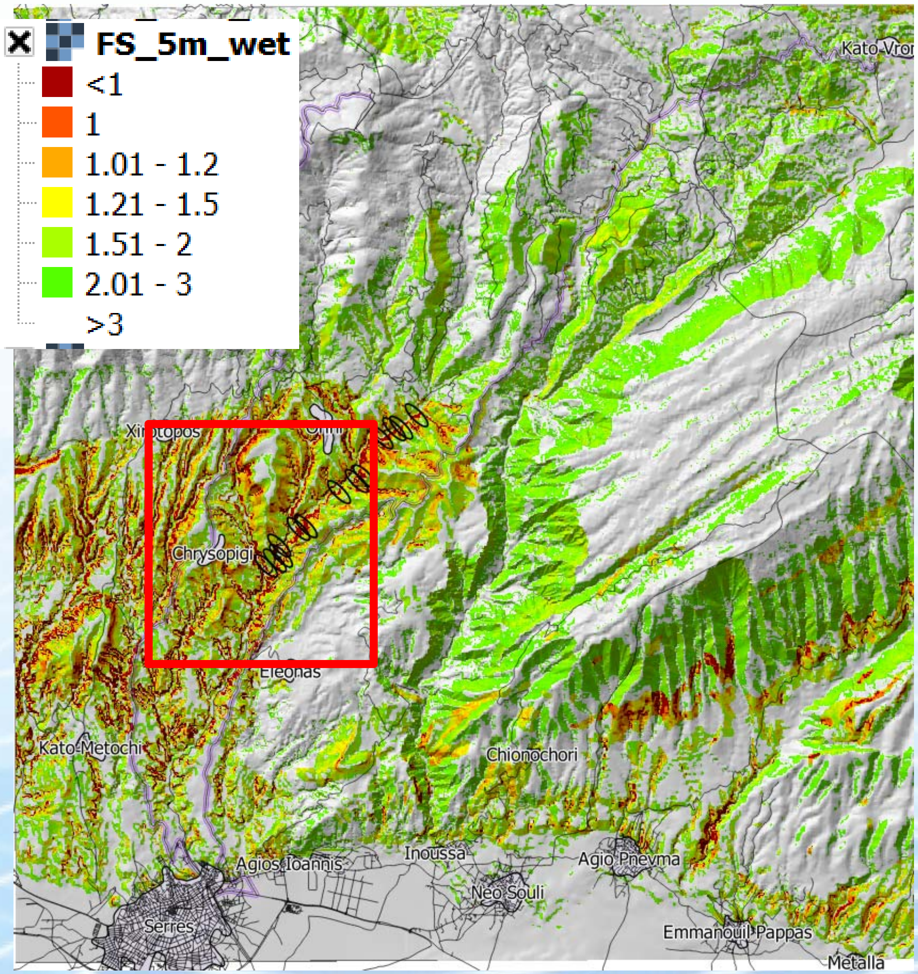
Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Περιοχή υψηλού δυναμικού στερεοπαραγωγής



Project funded by the EUROPEAN UNION

Common borders. Common solutions.

Cost of implementation

And please remember that everything is based on Open Source Software so that YOU can use it!

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Thank You for Supporting the SciNetNatHaz project!

A Scientific Network for Earthquake, Landslide and Flood Hazard Prevention

The Project

Acknowledgments:

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

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Open Invitation!

News & updates @: **http://www.scinetnathaz.net/**

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

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

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

Project funded by the EUROPEAN UNION

SciNet NatHaz Prevention

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Selected References

- **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 of the European Communities (2009):** Communication from the Commission to the Council and the European Parliament on **EU Strategy for supporting Disaster Risk Reduction** in developing countries, COM (2009) 84 Final, Brussels, 23.2.2009
- **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))
- **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
- **C**. **Maftei** and **K. Papatheodorou** (2015): Flash Flood prone area Assessment using Geomorphological and Hydraulic Models. Journal of Environmental Protection and Ecology (JEPE), Vol. 16, No.1 (2015). [41] (http://www.jepe-journal.info/home/vol-16-no-1-2015)
- **Konstantinos A. Papatheodorou**, **Eleni A. Tzanou, Konstantinos D. Ntouros** (2014): Flood Hazard prevention using Morphometric and Hydraulic models. An example implementation. Green Infrastructure and Sustainable Societies (GreInSus) International Conference, May 2014, Izmir,, Turkey.