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Hydrology and Hydraulic Modeling for Flash Floods Risk Assessment and Mapping

A Methodology Proposal

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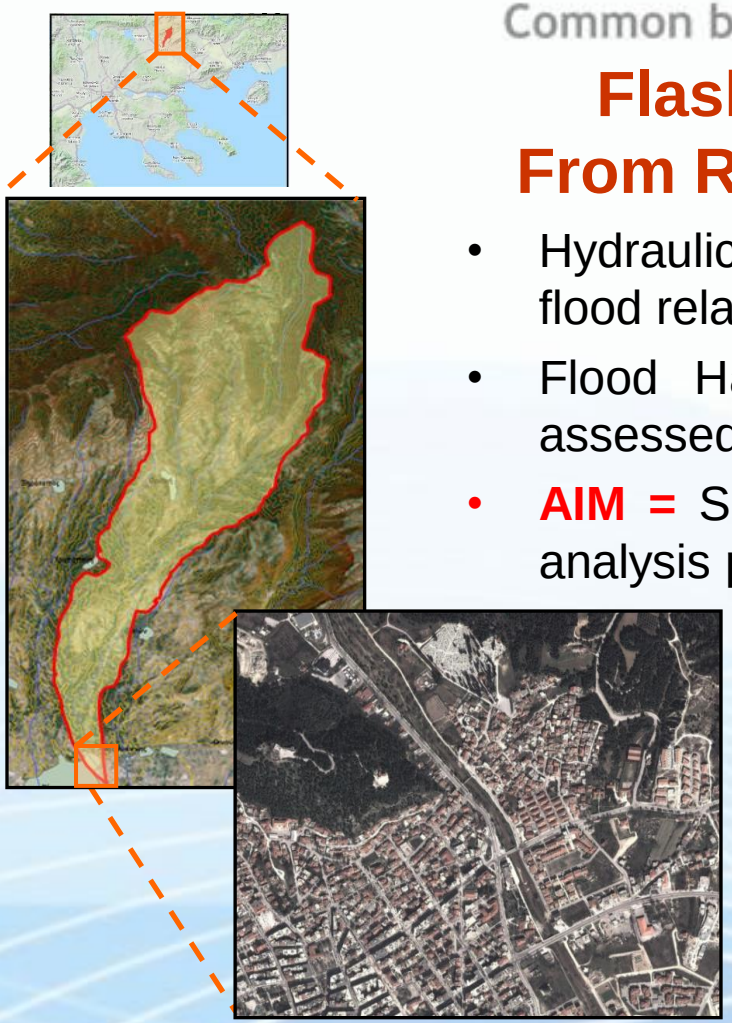
Flash Flood Assessment From Regional to Local Scale

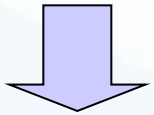


- Hydraulic models are used to calculate on a local scale, all flood related parameters
- Flood Hazard and Disaster Risk may be “accurately” assessed-as possible
- **AIM =** Spot Problematic areas according to the hydraulic analysis performed

The procedure has been implemented in the area of Serres (Kentriki Makedonia)

Methodological Framework for Flash Flood Hazard (FFH)

- Methodology for FFH is structured (among others) on basic principles of **hydrology** and **hydraulics**
- Standardized methodology for flood map production (step by step)
- Use of **Open Source Software**



- Geo-morphological and hydrological features of the river basin
- Calculation of hydrographs for different return periods
- Simulation of the river system-Detailed hydraulic analysis
- Estimation and Mapping of floodplain Inundation

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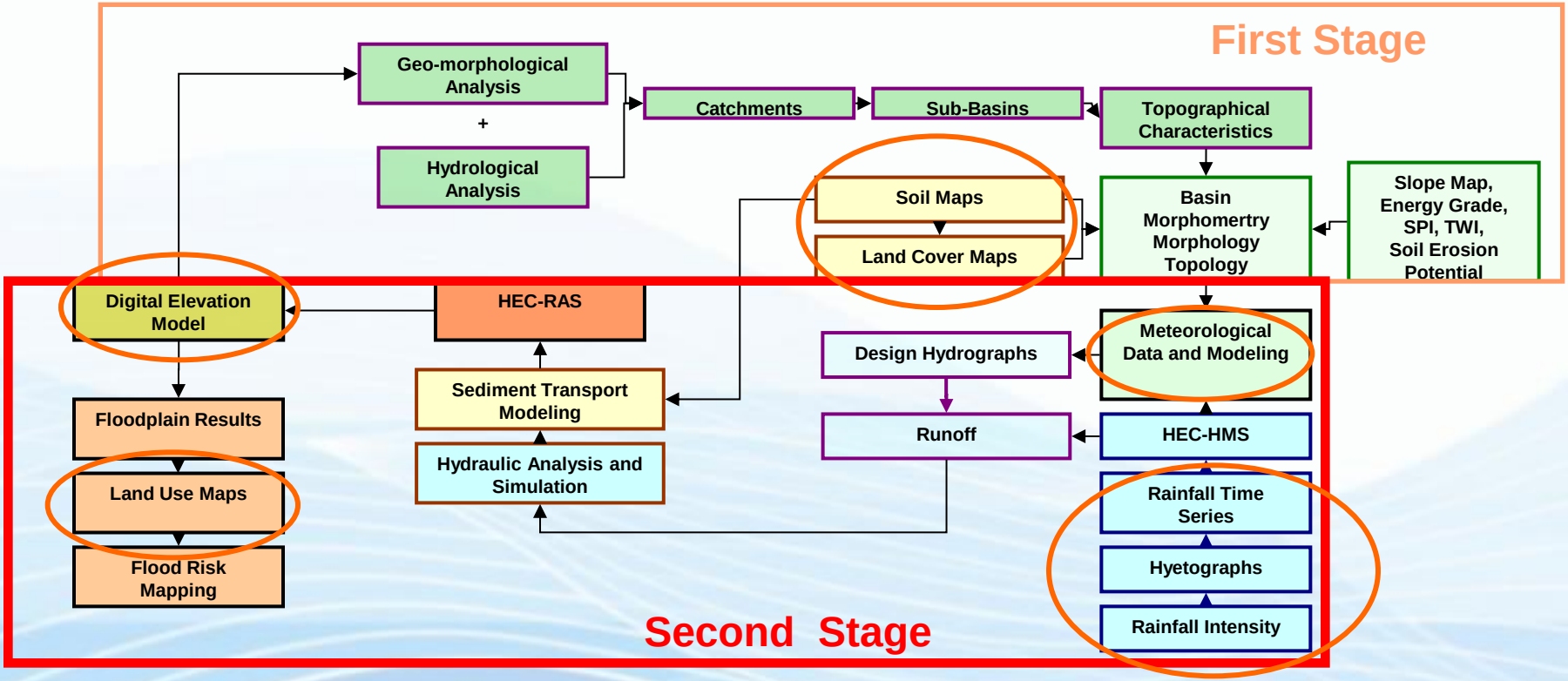
Methodology Flowchart



Hydrologic Analysis

- Hydrology analysis aims to determine the design hydrograph for different return periods
- **Hydrology Modeling System**
- Simulation of the precipitation-runoff processes of dendritic watershed systems.
- **Hydrographs** produced are used for studies of water availability, urban drainage, flow forecasting, future urbanization impact, reservoir spillway design, **flood damage reduction, floodplain regulation**, and systems operation.

Our proposal …..HEC-HMS

- Designed by the Hydrologic Engineering Centre, U.S. Army Corps of Engineers
- HEC-HMS 3.5 for Windows, Solaris or Linux

Contains:

- Watershed Physical Description
- Meteorology Description
- Hydrologic Simulation
- Parameter Estimation
- Analyzing Simulations
- GIS Connection

- Use depends on the available data in each case, historical precipitation, time series etc.
- User can determine the mathematical model for analysis

Provide Design Hydrograph and Max Discharge Flow Needed

This software is free, widely used and scientifically accepted.
Large documentation on its use and technical background

Data production for local scale implementation

- **Max Discharge data**: Precipitation data, meteorological stations, past event data…but….not always available
- **DEM data**: **As accurate as possible ground geometry**
  1. Digitizing of available Maps of proper scale…..**1:500, 1:200**
  2. Satellite data-elevation data
  3. Surveying data in detail containing all structures in stream and surrounding area
- Land use & land cover data, city (urban) plans, places of interest, special structures
- Public network data (sewerage network and its discharge capabitity)
- Socio-economic data for the area of interest

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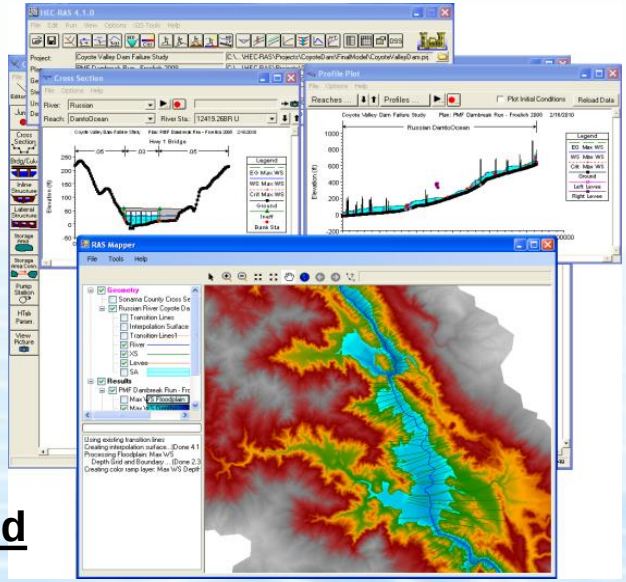
Hydraulic Analysis….HEC-RAS

- The main objective of this methodological approach is the determination of the exact characteristics of a possible flood event for **different flood scenarios**.
- Assess the flooding parameters, with **HEC-RAS** software(River Analysis System, US Army Corps of Engineers - Hydrologic Engineering Center)
- **HEC-RAS** performs hydraulic calculations for a full network of natural and constructed channels

Capabilities of **HEC-RAS**:

- Hydraulic Analysis
- Data Storage and Management
- Graphics and Reporting
- RAS Mapper
- HEC-RAS 4.1(among others…new Mapper and Sediment Transport Model)



This software is free, widely used and scientifically accepted
Large documentation on its use and technical background

Implementation…..so far

Application steps:

1. Preparation, evaluation and synthesis of digital data
2. Field work
3. Hydrologic analysis through HEC-HMS
4. Hydraulic analysis through HEC-RAS
5. Flash Flood scenarios and Flood Risk maps

Digital Data produced:

- Contour lines and hydrographic network of 1:5.000 scale maps (HGMS-Hellenic Geographic Military Service),
- Corine Land Cover 2000 data updated by in situ research
- Precipitation data for a period of about 27years (HNMS Hellenic National Meteorological Service) -2 meteorological stations in the area.
- Surveying data of the stream bed and the surrounding area (stream geometry, cross sections, long sections-profile1:200 scale)
- Street and city plan of 1:1000 scale maps.

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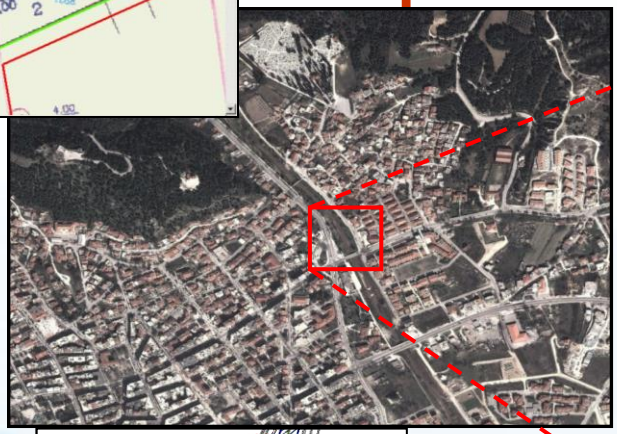
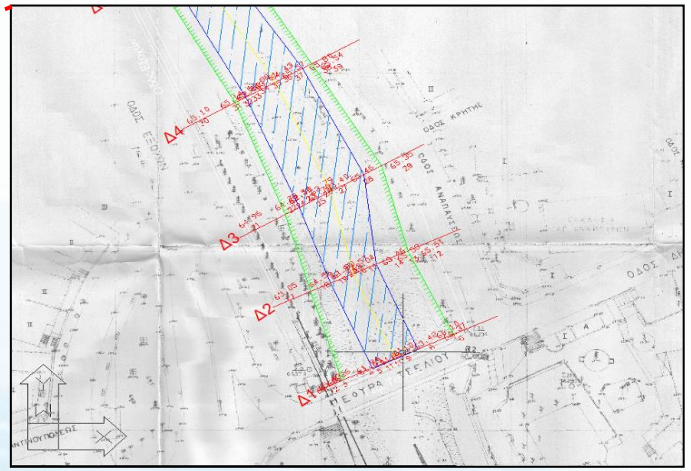
Data on Local Scale for Input Geometry in HEC-RAS

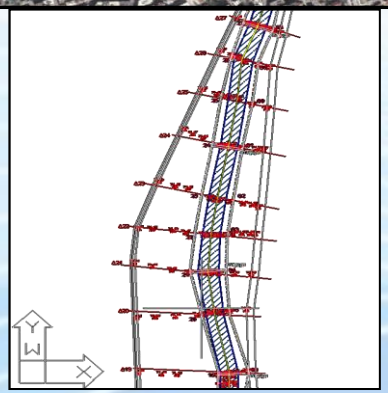


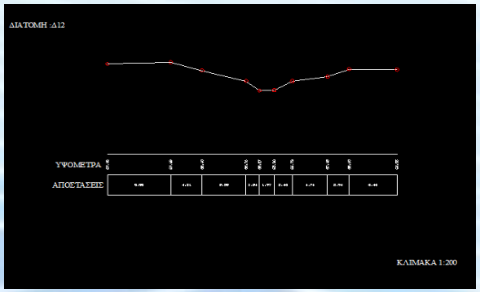


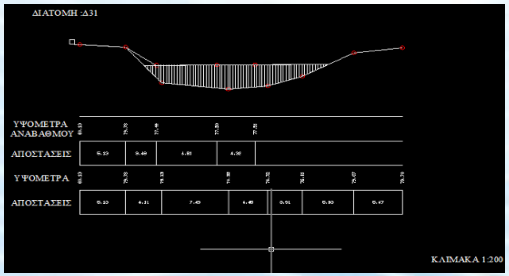
City map digitizing

Cross sections

Surveying Data







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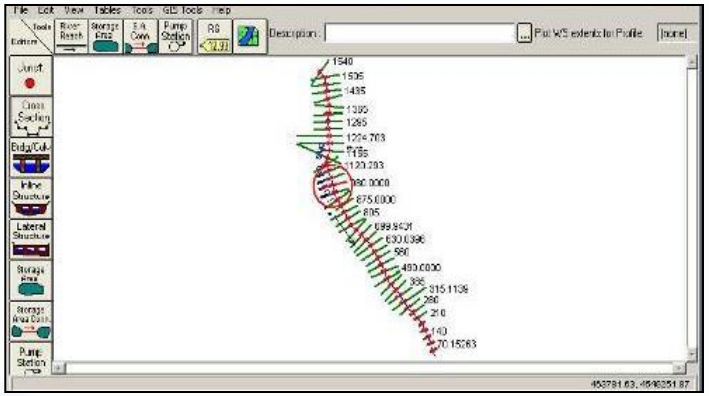
Implementation…..so far

Hydrologic Analysis led to the basin discharge computation (flow and sediment).

	10y	50y	100y
Flow Discharge (m^3/s)	64.50	117.46	**240.85**
Sediment Discharge(m^3/s)	14.15	25.77	**52.84**

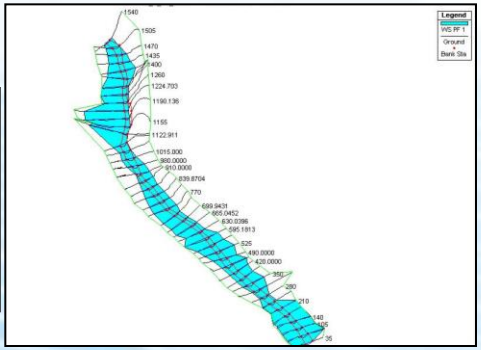
Geometry input

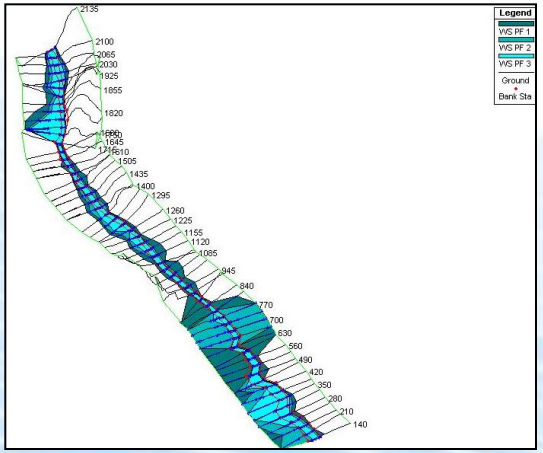


Hydraulic Analysis in HEC-RAS used the flow and sediment discharge

Results

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)
1	18	PF 1	330.00	142.24	145.08		145.60	0.001906	3.18	103.76
1	17	PF 1	330.00	141.62	144.26	144.26	145.47	0.005135	4.88	67.62
1	16	PF 1	330.00	141.00	143.61	143.61	144.83	0.005194	4.88	67.60
1	15	PF 1	330.00	140.10	143.25	143.25	144.57	0.005031	5.10	64.65
1	14	PF 1	330.00	138.22	141.91		142.69	0.002448	3.91	84.44
1	13	PF 1	330.00	137.54	142.05		142.54	0.001239	3.10	106.52
1	12	PF 1	330.00	136.92	140.82	140.82	142.29	0.005031	5.38	61.39
1	11	PF 1	330.00	136.58	140.30	140.30	141.75	0.005049	5.33	61.88
1	10	PF 1	330.00	136.36	140.12		141.14	0.003284	4.47	73.86





"3-D" flood model

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Flood Risk Mapping….so far

10 (a), 50(b) and 100(c) year return flood period

a

b

c

Suggestive Bibliography

- Alexander, D., 1993. Natural disasters, New York, Chapman & Hall
- Balica, S.F., Douben, N., Wright, N.G., 2009. Flood Vulnerability Indices at Varying Spatial Scales, Water Science and Technology Journal, 60 (10), 2571-2580
- Balica, S.F., Wright N.G., 2010. Reducing the complexity of Flood Vulnerability Index, Environmental Hazard Journal, 9 (4), 321 - 339.
- Barredo, J.I., de Roo, A., Lavalle, C., 2007. Flood risk mapping at European scale. Water Science and Technology, 56 (4), 11-17
- Hansson, K., Danielson, M., Ekenberg, L., 2008. A framework for evaluation of flood management strategies, Journal of Environmental Management 86, (3), 465–480
- Schanze, J., 2006. Flood risk management – a basic framework, Flood Risk Management:
- Hazards, Vulnerability and Mitigation Measures NATO Science Series: IV: Earth and Environmental Sciences, 2006, 67, Part 1, 1-20
- Bedient P. B., and W. C. Huber (2002). Hydrology and Floodplain Analysis. Third edition. Prentice Hall. 763 p.
- Floodplain Mapping Program, North Carolina Division of Emergency Management. NC Floodplain Mapping: Watauga River Basin; LiDAR Bare Earth Mass Points, Feb-Apr and Dec 2003; EarthData International of North Carolina: High Point, NC, USA, 2004.
- US Army Corps of Engineers. HEC-RAS River Analysis System, User's Manual; U.S. Army Corps of Engineers, Hydrologic Engineering Center, Institute for Water Resources: Davis, CA, USA, 2010.
- Johnson, L.E. 9: GIS for Floodplain Management. In Geographic Information Systems in Water Resource Engineering; Taylor and Francis, LLC: Boca Raton, FL, USA, 2009; pp. 187–206.
- Hicks F. E. and Peacock, T. (2005), Suitability of HEC-RAS for Flood Forecast-ing, Canadian Water Resources Journal Vol. 30(2): 159–174
- MHL (2006), Review and Assessment of Hydrologic/Hydraulic Flood Models, Department of Natural Resources, New South Wales, ISBN 0 7347 5854 5, pp. 47-69.

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Thank you!

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