SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

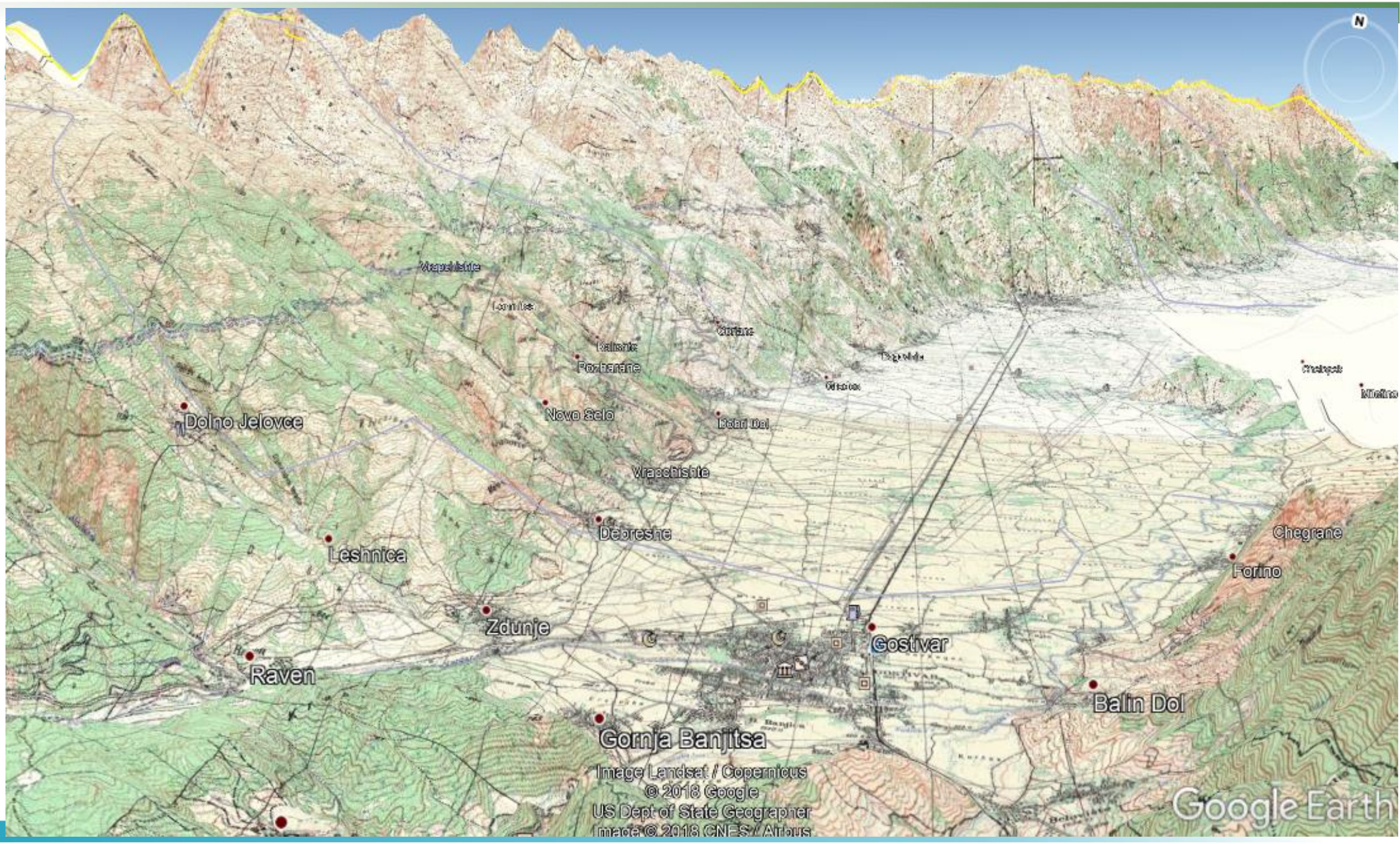
Rapid diagnostic of the catastrophic event happened on 3rd August in the Polog region

Workshop on Bachelor and Master Curriculum Best Practices - North Macedonia

28-29 October 2019, Skopje

Reference Number: 598403-EPP-1-2018-1-RS-EPPKA2-CBHE-JP

Co-funded by the Erasmus+ Programme of the European Union


Dolno Jelovce
Novo Selo
Vrapchishte
Debreshe
Leshnica
Zdunje
Raven
Gostivar
Forino
Chegrane
Balin Dol
Gornja Banjitsa
Image Landsat / Copernicus
© 2018 Google
US Dept of State Geographer
Image © 2018 CNES / Airbus
Google Earth

- Strong winds (especially in Tetovo); - Heavy rainfall on the Shara Mountatin including hail
- Results: High discharge, Pluvial and fluvial erosion, landslides, landfalls, debris flow, flash flooding

Consequences

- 6 dead
- 11 injured
- 24 families evacuated in Šipkovica
- Power cut off in Šipkovica
- Damaged water supply system (Tetovo, Šipkovica….)
- Damaged houses
- 11 damaged bridges, 17 damaged roads
- Damaged hydraulic structures into the torrents bed
- Cost of losses and damages – 25 million Euros

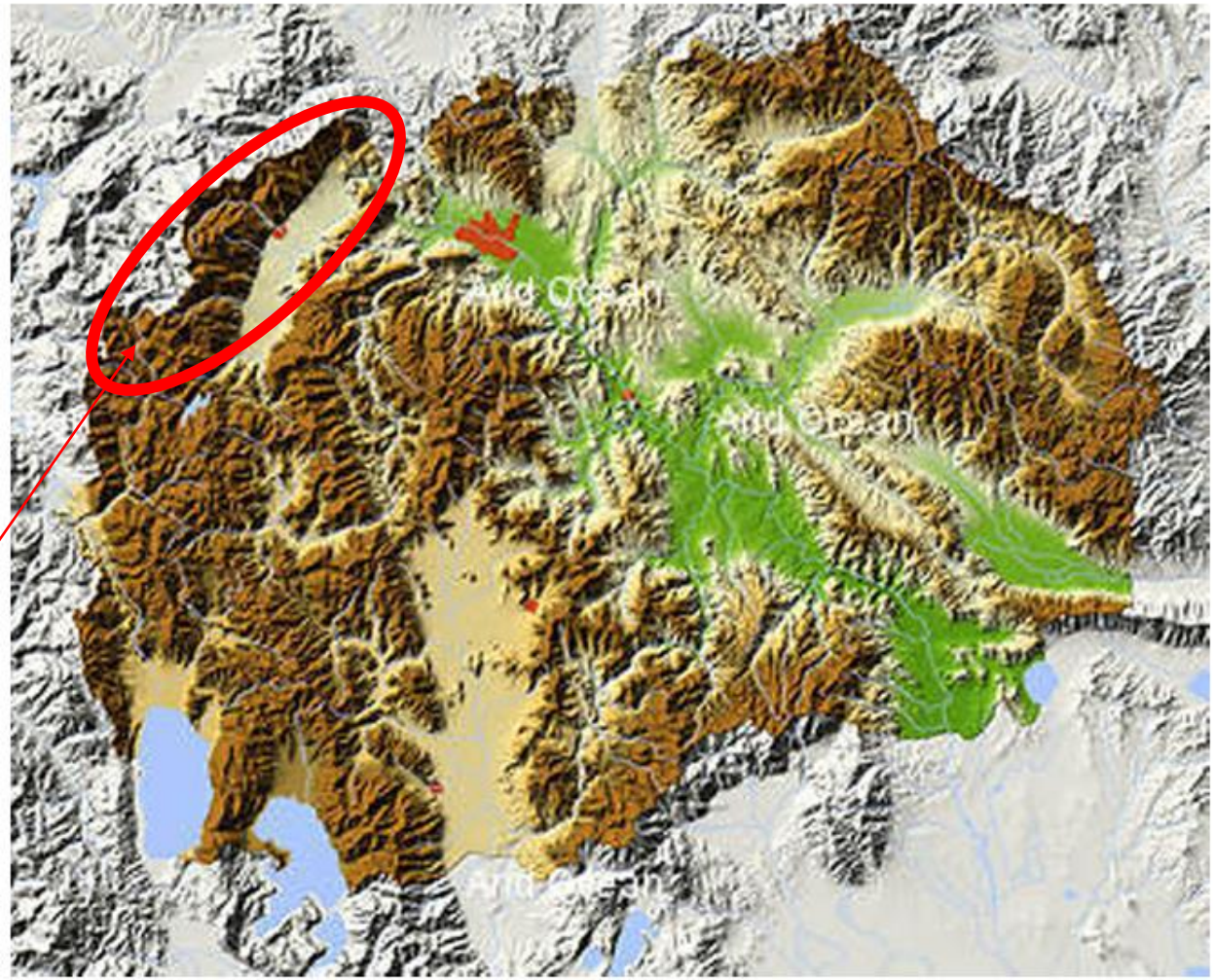
Co-funded by the Erasmus+ Programme of the European Union

WHY
any small and
apparently harmless stream
suddenly become
wild and dangerous
and
cause huge damages?

l by the
ramme
of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Location



SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

AIMS AND OBJECTIVES

The aim of this study was to be done rapid diagnose of the catastrophic event happened on 3rd August 2015 in Tetovo region

The basic questions were:

1- What were the reasons for hazard?

2- What was the reason for huge damages?

3- What type of torrential event happened?

- *Acknowledgment : Preparation of the part of this study that answer the first and the second question was realized and supported by UNDP in the period of 5 august – 2 September 2015 and was presented to represents of the Government , Governmental institutions, embassies, Tetovo municipality and international organizations.*

Co-funded by the Erasmus+ Programme of the European Union

METHODOLOGY

- preliminary desktop analysis: collecting all necessary available maps, collection all necessary data, measuring of the basic parameters of the torrent catchments/
- field work – recognition (villages and catchment) measuring, pictures and clips, interviewees with local people
- analysis of all collected data
- reporting

Aulitzky two-fold classification (1980) for defining torrent type

Co-funded by the Erasmus+ Programme of the European Union

STUDY REGION CHARACTERISTICS

- **Factors causing Erosion**

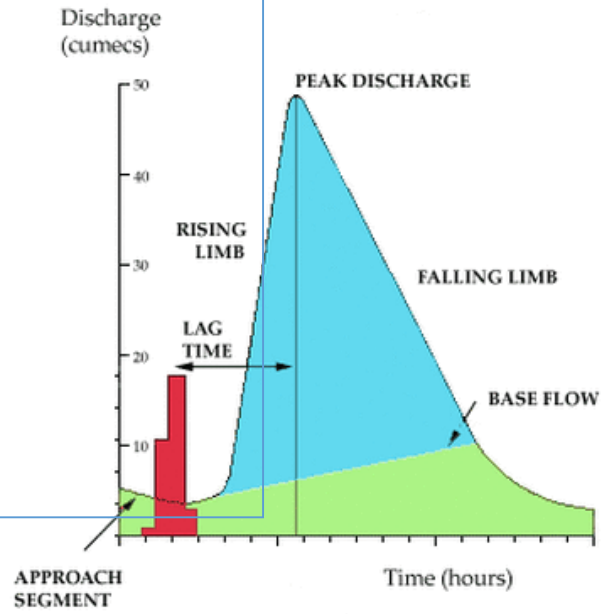
- Climatic factors
- Vegetation
- Soil characteristics
- Relief
- Human activities

- **Factors causing Landslides**

- Climatic factors
- Geological
- Relief conditions
- Morphological
- Human activities

- **Factors affecting a discharge**

- Rocks and soil
- Land use
- Relief
- Rainfalls
- Weather conditions

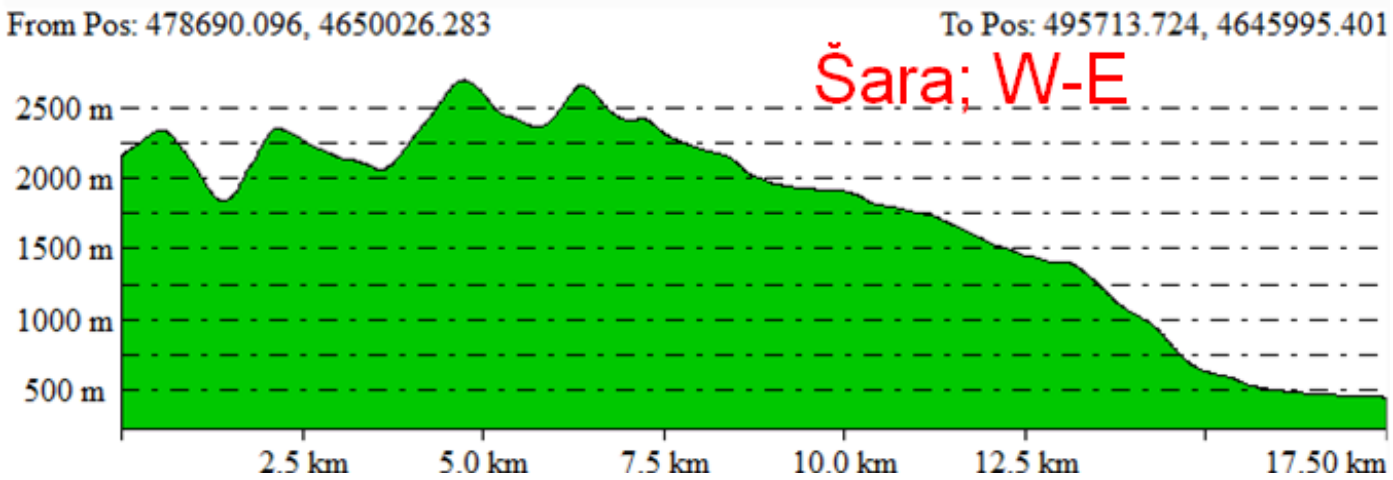


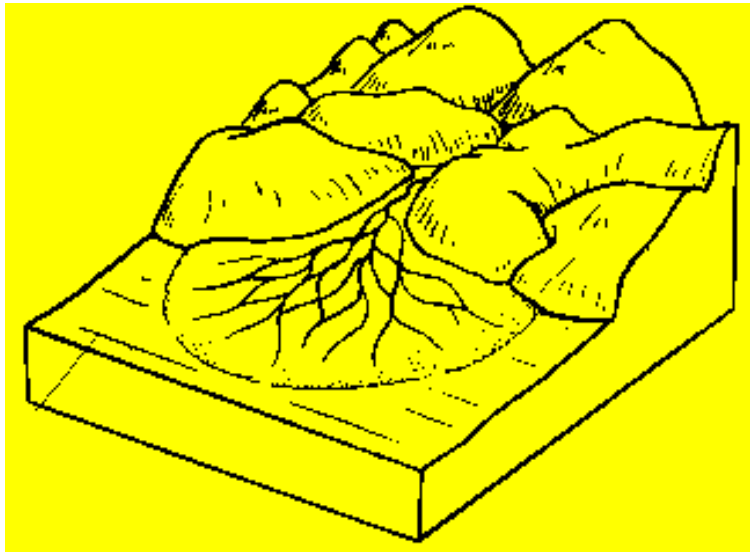
Co-funded by the Erasmus+ Programme of the European Union

West Macedonian Tectonic zone . A part of the Dinarides " Young" mountain .(50 Million years).

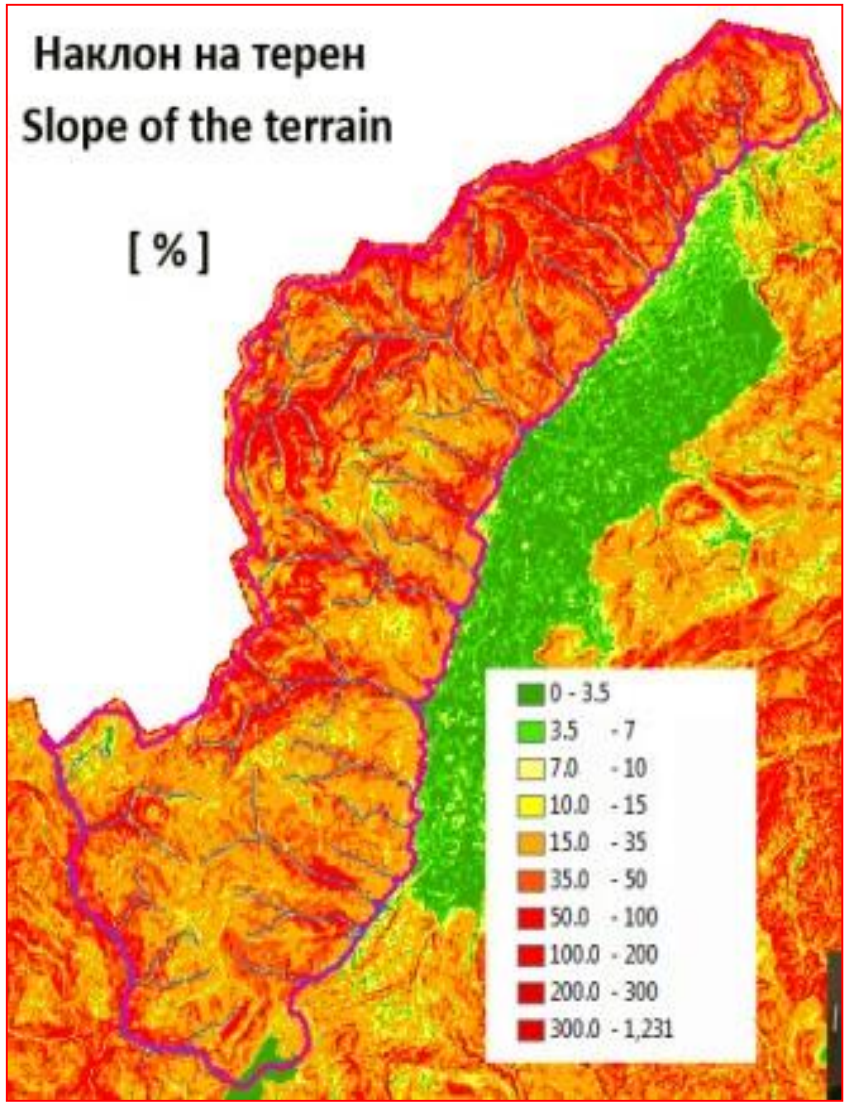
It is one of the highest in the country (top Turcin, 2.748 m)
Relief shape - Variscan and Alpine orogeny, Karst relief; Glacial relief ; Periglacial relief, Fluvial ((a lot of small and a few larger mountain streams dominantly with torrential character).

Co-funded by the Erasmus+ Programme of the European Union

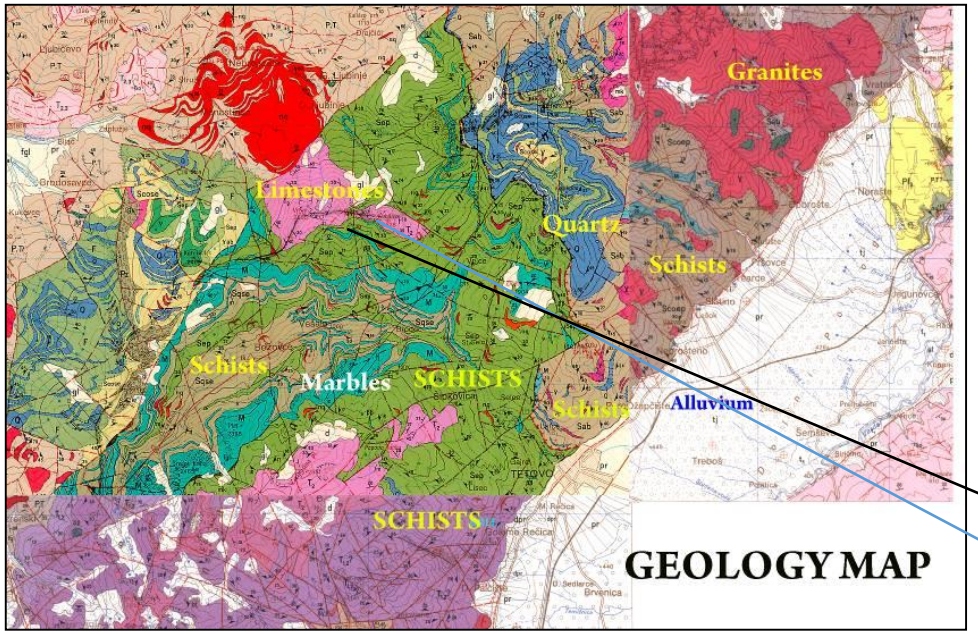


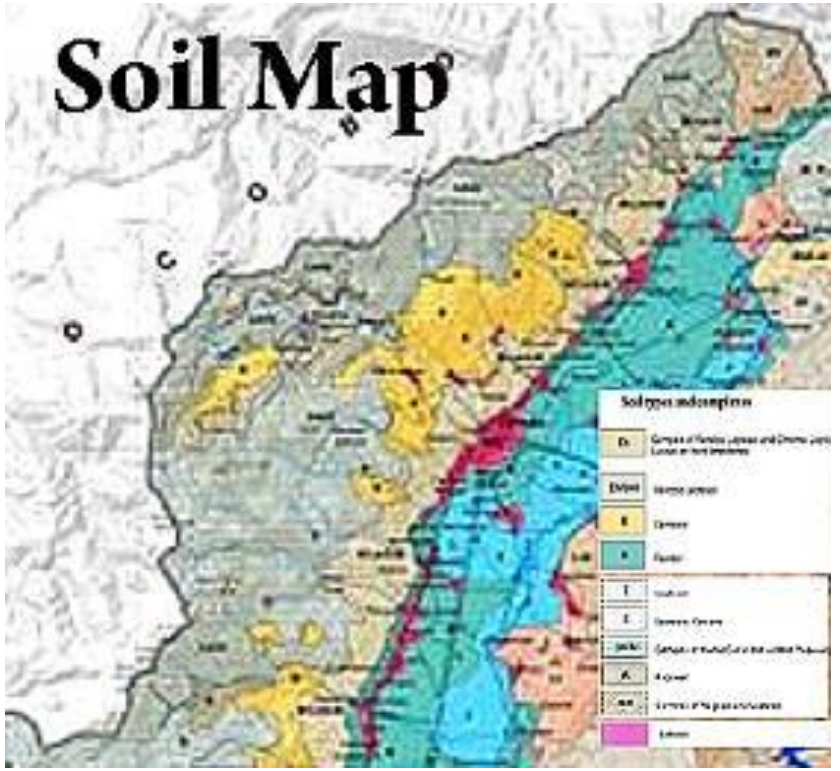


- Slopes of the Stream bed – over 30% in the mountain part,
- Partially over 50% (Poroj – Brza Voda)



Co-funded by the Erasmus+ Programme of the European Union





SCHIST

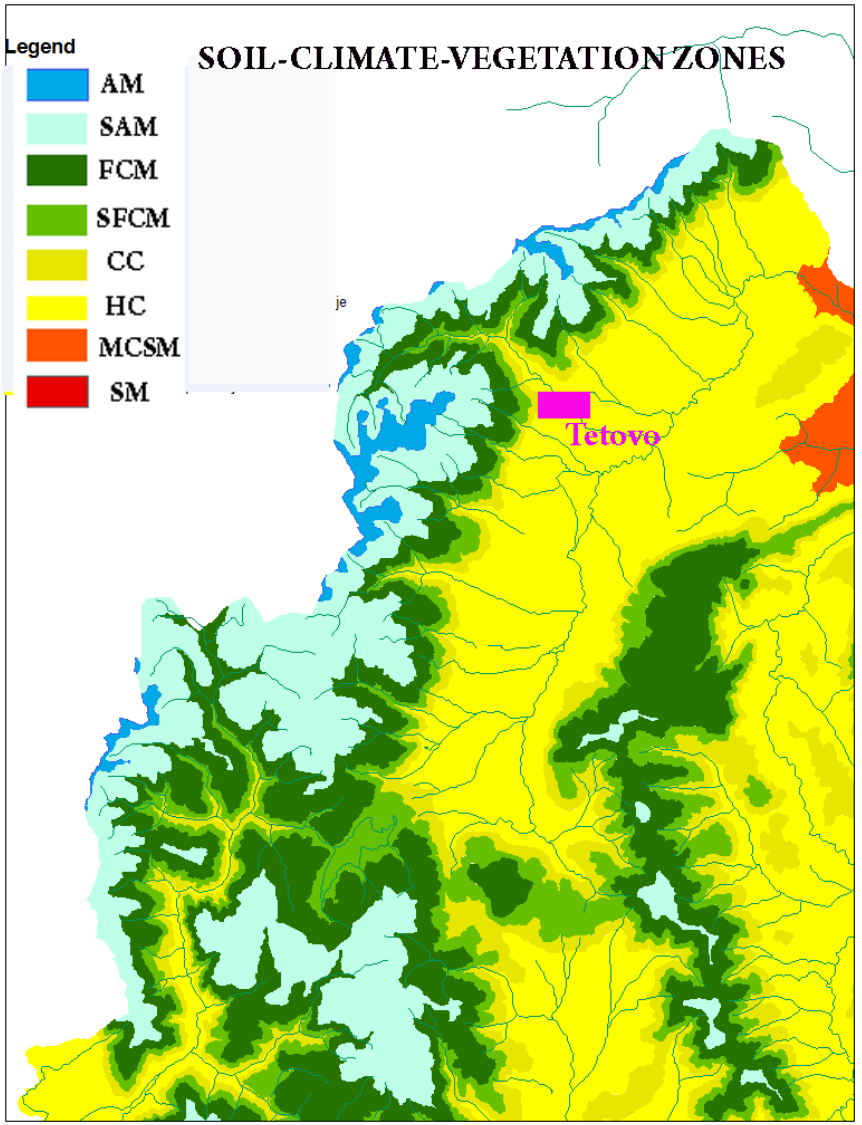
Limestone-marble

- Shallow soil (rankers or calcomelanosols) on the highest altitude over 1650 m.Grasslands. - Alpine mountain and Subalpine mountain zone; Lithosols (leptosols) – shallow soils
- Ccambisols in the forest region (oak and beech forest communities) – (FCM, SFCM, CC)
- Fluvisols (alluvial and colluvial soils) in the valley – Agricultural land - (CC zone)

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Climate in Tetovo is assigned as sub-humid Climate on Popova Shapka is per-humid and the total annual sum of precipitations is slight below 1000 mm. Maximal daily precipitations in Popova Shapka were registered in November 1979 {188 mm) and few-days precipitations caused huge flooding of Tetovo (by river Pena) as well Skopje (by river Vardar).

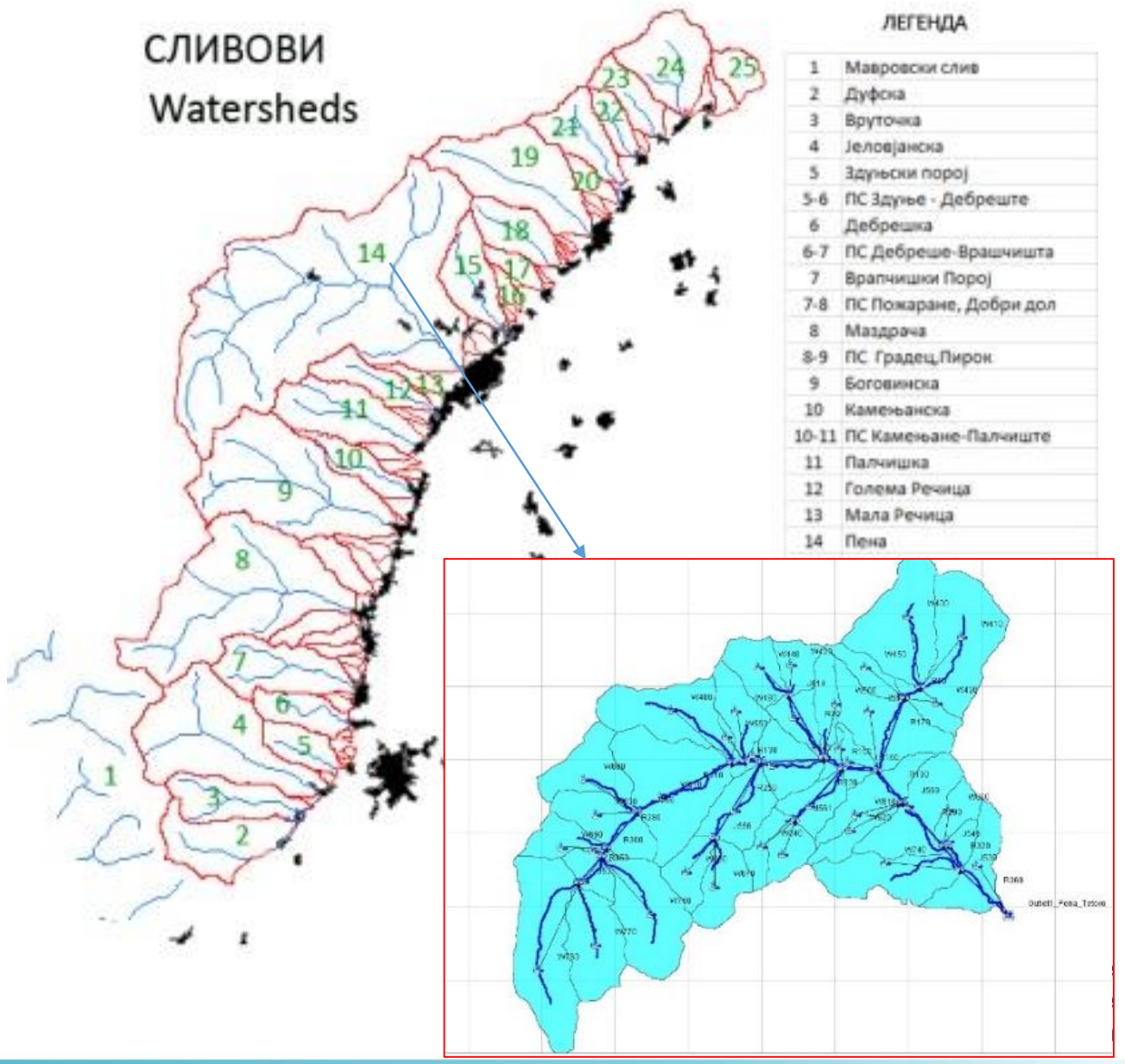
Prob.	element	5`	10`	20`	40`	60`	90`	150`	300`	720`	1440`	24 h
	mm	15.46	22.77	29.63	52.28	63.93	65.35	75.49	73.34	78.31	84.13	142.77
0,1%	mm/min	3.09	2.28	1.48	1.31	1.07	0.73	0.50	0.24	0.11	0.06	0.10
	l/sec.ha	515.17	379.52	246.95	217.82	177.59	121.02	83.88	40.74	18.13	9.74	16.52
	mm	12.01	17.63	23.31	39.05	47.35	48.71	56.52	56.77	61.27	66.34	109.47
1 %	mm/min	2.40	1.76	1.17	0.98	0.79	0.54	0.38	0.19	0.09	0.05	0.08
	l/sec.ha	400.17	293.80	194.25	162.70	131.52	90.20	62.80	31.54	14.18	7.68	12.67
	mm	10.96	16.07	21.13	35.04	42.33	43.67	50.78	51.76	56.12	60.95	99.39
2 %	mm/min	2.19	1.61	1.06	0.88	0.71	0.49	0.34	0.17	0.08	0.04	0.07
	l/sec.ha	365.37	267.87	176.04	146.02	117.58	80.87	56.42	28.76	12.99	7.05	11.50
	mm	9.91	14.50	19.13	31.01	37.27	38.59	44.99	46.71	50.92	55.53	89.28
4 %	mm/min	1.98	1.45	0.96	0.78	0.62	0.43	0.30	0.16	0.07	0.04	0.06
	l/sec.ha	330.33	241.73	159.44	129.21	103.54	71.47	49.99	25.95	11.79	6.43	10.33
	mm	8.49	12.39	16.45	25.58	30.46	31.75	37.19	39.90	43.91	48.22	75.55
10 %	mm/min	1.70	1.24	0.82	0.64	0.51	0.35	0.25	0.13	0.06	0.03	0.05
	l/sec.ha	283.07	206.50	137.07	106.56	84.61	58.80	41.32	22.17	10.16	5.58	8.74
	mm	7.37	10.72	14.32	21.27	25.06	26.34	31.02	34.52	38.38	42.43	64.72
20 %	mm/min	1.47	1.07	0.72	0.53	0.42	0.29	0.21	0.12	0.05	0.03	0.04
	l/sec.ha	245.67	178.62	119.37	88.63	69.62	48.78	34.47	19.18	8.88	4.91	7.49
	mm	5.68	8.19	11.11	14.77	16.92	18.16	21.70	26.38	30.01	33.69	48.36
50 %	mm/min	1.14	0.82	0.56	0.37	0.28	0.20	0.14	0.09	0.04	0.02	0.03
	l/sec.ha	189.17	136.52	92.62	61.56	46.99	33.63	24.11	14.66	6.95	3.90	5.60



Co-funded by the Erasmus+ Programme of the European Union

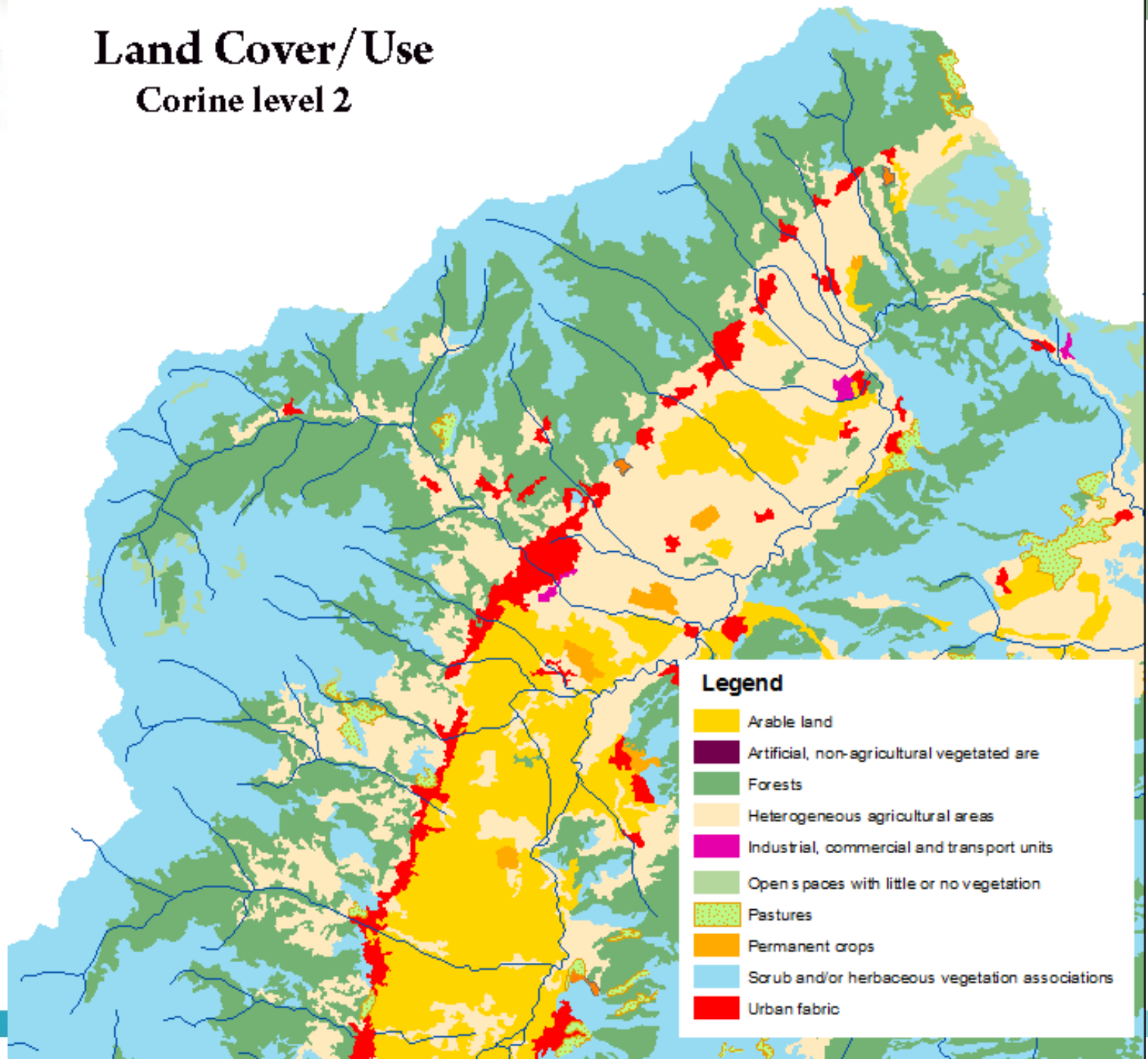
SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

- From Shar Planina to Polog Valley run down over a hundred, minor or major waterways. Springs of the most rivers are on altitude over 2.400 m. In the most upstream part, they are composed of a network of smaller streams.
- All rivers in the Shar Mountains belong to the catchment area of the river Vardar, and most of them are it's direct tributaries. All of them have torrential character.

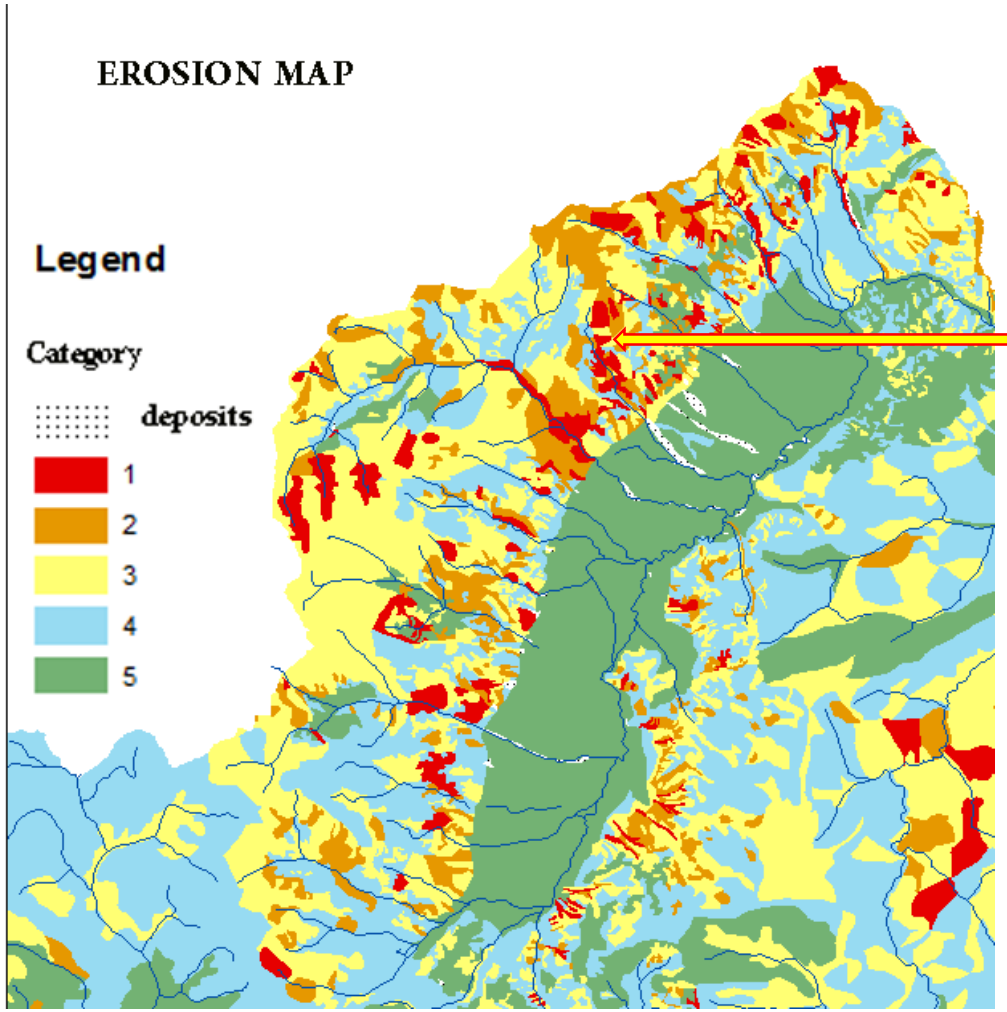


Land Cover/Use

Corine level 2



Co-funded by the
Erasmus+ Programme
of the European Union



- Mean erosion coefficient in the country is Z = 0,31 while in Shara region is Z = 0,54.
- The most erosive catchment in the region is Poroj (Z = 0,75).
- In RM 36,5% of the territory belong to I-III category of erosion, while in the Shara region 77% belong to I-III category of eroson.

Co-funded by the Erasmus+ Programme of the European Union

Description of processes in the torrent beds

- Taking in consideration catchment areas, length and slopes and land cover especially in the upper parts, time for concentration is so short. IN the upper part of the catchments was created the flood wave. Grassland on very shallow soil couldn't retent the water.
- Excluding river Pena, other scenarioc are very similar.
- Huge water discharge formed in the upper part cause strong fluvial erosion processes, deepening of the beds and lateral erosion. This lateral erosion process cause landfalls, landslides, and together with pluvial erosion on the slopes and rock falling was produced huge quantity of solid material into the beds. All this fluid travel downstream, somewhere the biggest boulders stop, but somewhere boulders achieve even the foot of the slopes.

Co-funded by the Erasmus+ Programme of the European Union

Weathering and rockfalls

LANDSLIDE

Co-funded by the
Erasmus+ Programme
of the European Union

DEEP GULLIES

Co-funded by the
Erasmus+ Programme
of the European Union

Fluvial erosion – Pena river

Co-funded by the Erasmus+ Programme of the European Union

All natural factors favorable to appearance of:

- high erosion processes,
- landfalls, rockfalls, landslides,
- Torrential character of the streams
- High peak of discharge in a short time (f.e. Shipkovice 20 minutes)
- Debris flows

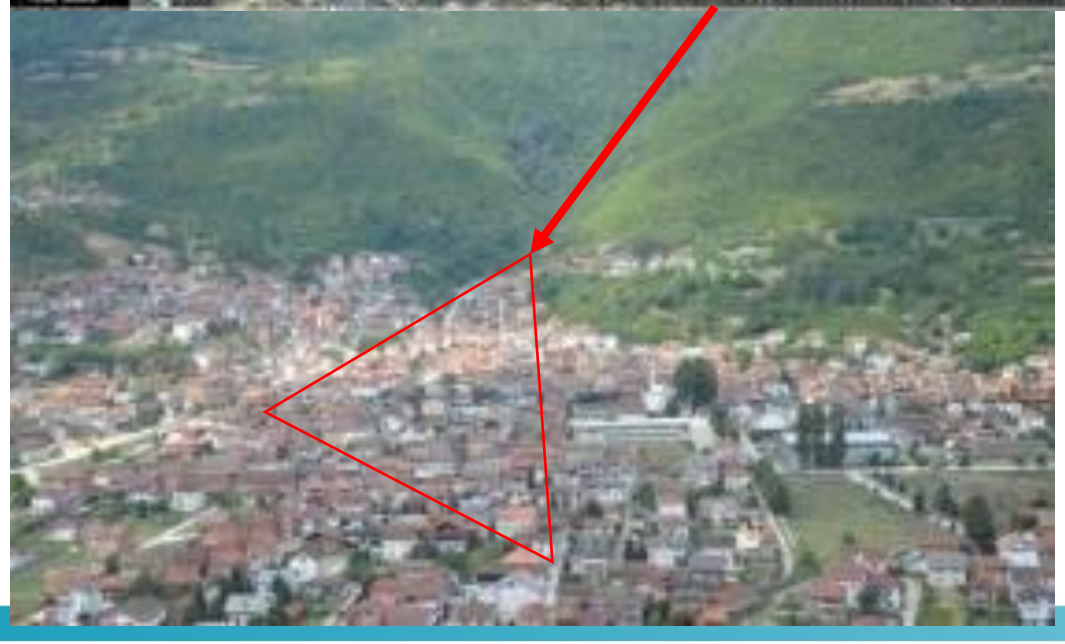
Co-funded by the Erasmus+ Programme of the European Union

Socioeconomic aspects

- Land management activities (insignificant changes)
- Urbanism (location of the settlements)
- Construction activities (bridges??)
- Urban plans, hazard/risk maps
- WASTE (various types of waste into the torrent bed)
- Torrent control works in past

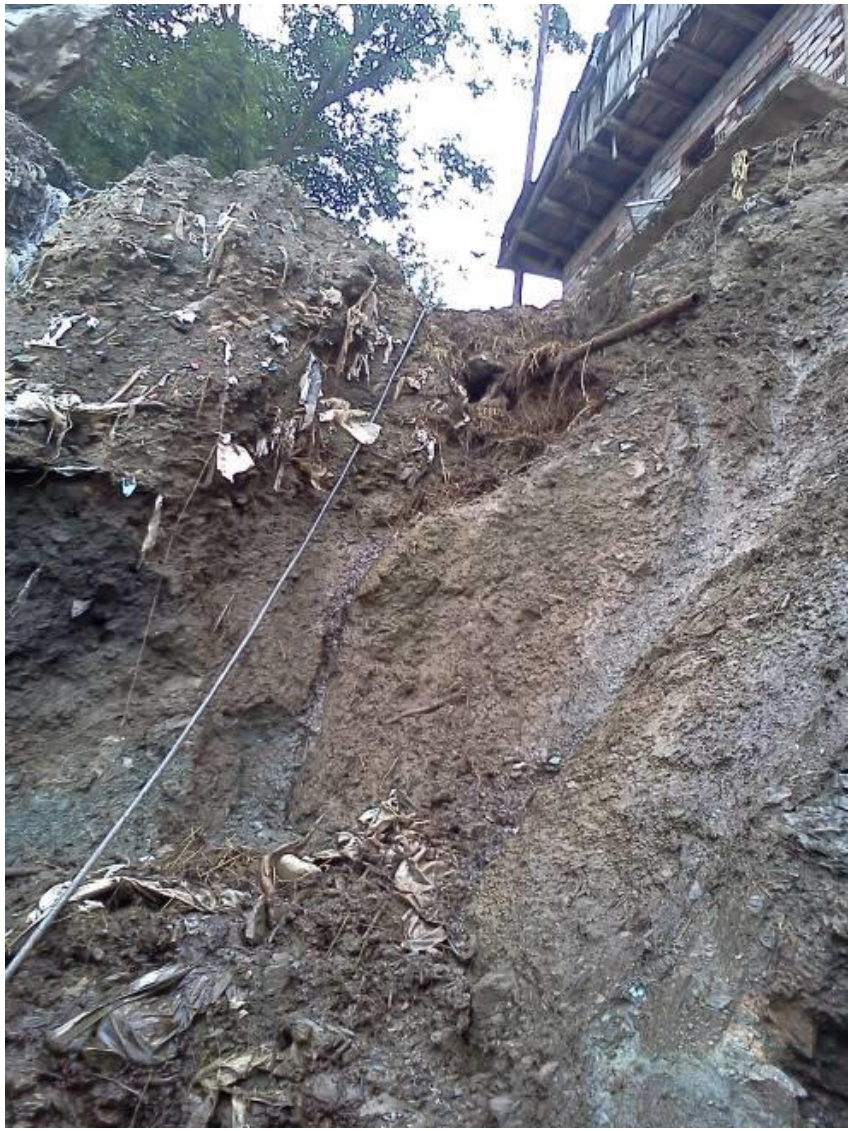
Co-funded by the Erasmus+ Programme of the European Union

Location of settlements (on the alluvial fans)



SETOF
Soil Erosion and TOrrential Flood
Prevention: Curriculum Development at the Universities of Western Balkan Countries

WASTE



Co-funded by the
Erasmus+ Programme
of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

No Urban Plans for villages
Structures close to the bed or into the bed and hazardous area.

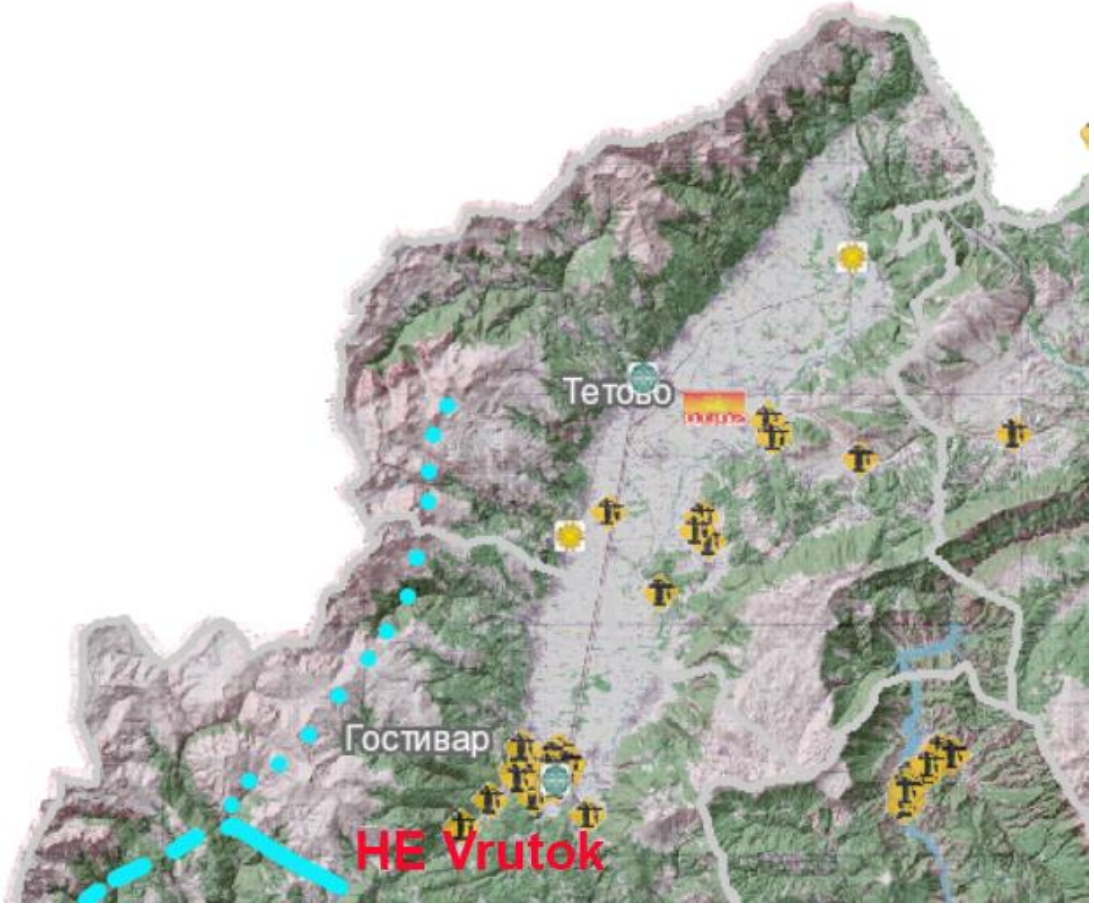
No Hazard map (multy-hazard map is unknown word in the institutions).

Absence of knowledge and No Awareness

BRIDGES

Co-funded by the Erasmus+ Programme of the European Union

Channel (Shraski vodi) for HE



Co-funded by the Erasmus+ Programme of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

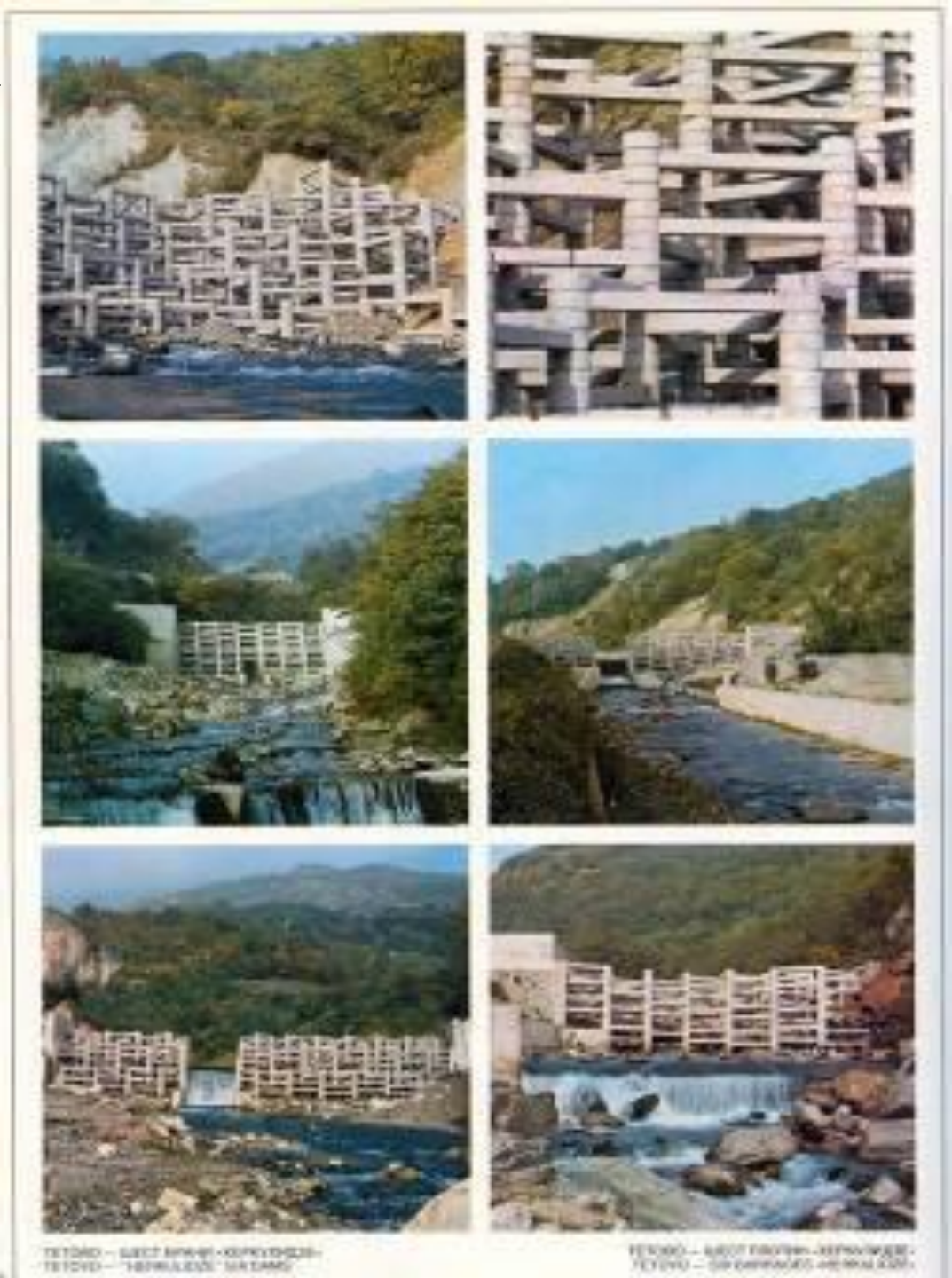
Torrent control works

- The first works started in the 30's after the big flood in river Pena and torrent Poroj. No exact data for other torrents.
- After the big flood in the region in the 1979 when significant part of the previous structures were destroyed, started new torrent control works.
- Irakli Herheuldize (ex USSR – Georgia) visited the region and recommended screw-dams (наносоуловители).
- In the Pena river bed – system of 6 screw-dams
- In the Poroj torrent bed – system of 4 screw-dam (destroyed later)
- In Neproshtenska torrent bed – 1 screw dam
- Screw-dams in Poroj due to construction direct om field (not enough strength of the construction) were fully destroyed in any previous debris flow.
- Screw-dams in Pena were built with concrete parts produced in factory however due to huge force of the fluid were damaged (the I – highest is almost fully destroyed, and nr.3 significantly damaged),

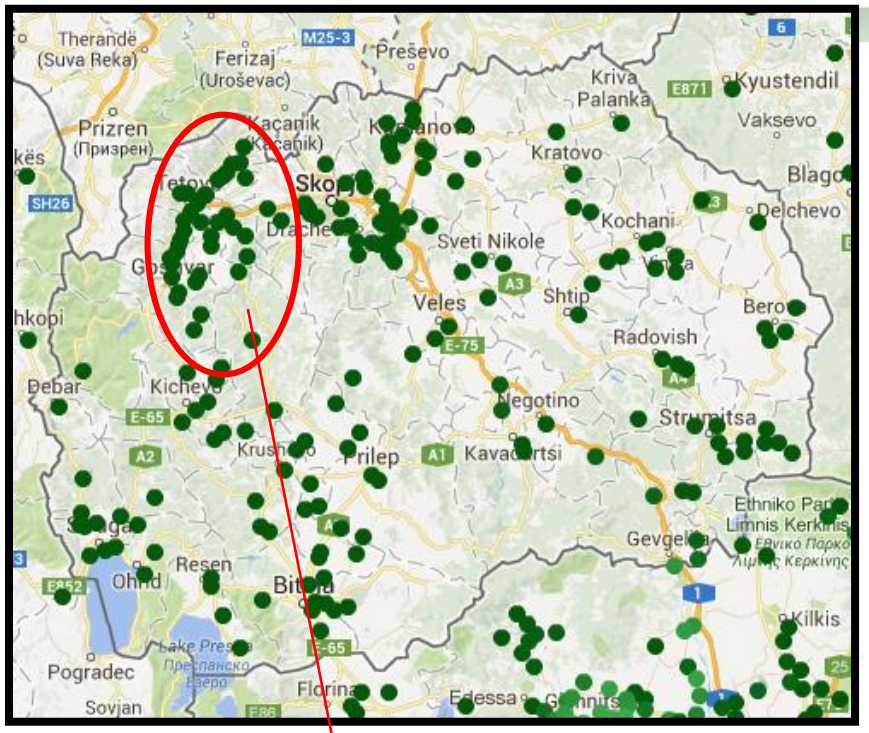
Co-funded by the Erasmus+ Programme of the European Union

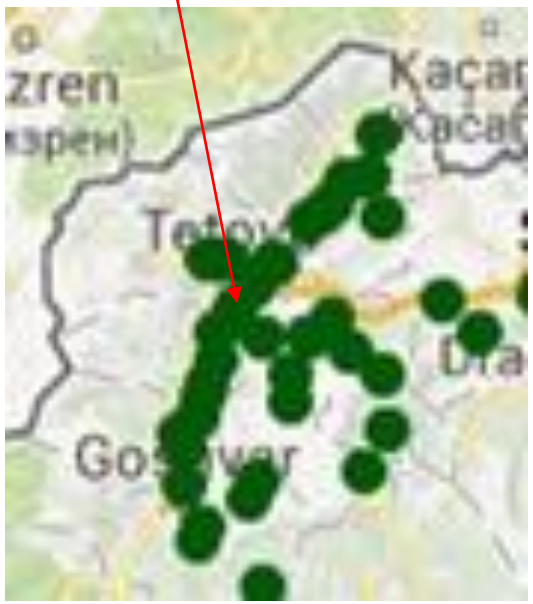
SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Torrent control in the past



Co-funded by the
Erasmus+ Programme
of the European Union





Past floods in the region

- In November 1979 happened floods in the whole country including in this region. City of Tetovo was significantly affected by river Pena.
- In the chronicles is mentioned big flood in the 30' of the XX century.

- "Poroj" – the most significant torrent in the country – big floods 1932?, 1979, . Various floods – 2002, 2003, 2004, 2005, 2006, 2008, 2010, 2015, 2016,2017…..

Personal memories – floods and huge sediments in the 70's and 80's

All region is permanent affected by various type of floods by torrents or by river Vardar.

Flood control is the biggest challenge of the municipality administration.

Co-funded by the
Erasmus+ Programme
of the European Union

Climatologically situation before and during the event

- July 2015 characterize with long dry period without precipitations and very high temperature that in the lower parts achieve over 35°C. This climatic situation influenced the soil structure. Soil was dry, materials that improve soil structures evaporated and soil particles became incoherent. It means that rainfalls easily can displaced soil particles.
- On the critical day 3rd August, happened storm over the highland on the Shara Mountain. Air mass traveled from the Adriatic Sea, cooled and condensed on the mountain and storm event occupied this area.
- Precipitation station in Tetovo in the valley registered only 9 mm. On the other hand station located in Jazince (north from Tetovo) registered 50 mm for 24 hours.
- According to the local people (shepherds) storm duration on the mountain was 2 hours, firstly no intensity rainfalls and then high intensity rainfalls. Probably duration of the high intensity rainfalls was between 60-90 minutes.
- If we accept intensity of 1 mm/min total rainfalls would be between 60-90 mm On the other hand using pluviometric gradient (1mm/30 m) then Jazinnce is located on 900 masl, on the mountatin 2000 masl. Altitude difference is 1100 m or 36 mm. Then 50+36 = 86 mm rainfalls on the mountain.
- Without exact data because Popova Shapka station was out of use as well as the new automatic stations hasn't operate yet, and the radar was shut of (to avoid electric shocks because of storm event) this is only assumption and is uncertain.

Co-funded by the Erasmus+ Programme of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

DESCRIPTION OF THE MOST CATASTROPHIC CASES

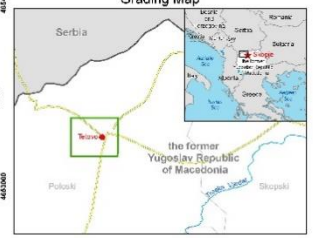
Co-funded by the Erasmus+ Programme of the European Union

COPERNICUS EMS DATA

GLIDE number: N/A

Activation ID: EMSR129
Product N.: 01TETOVO, v1, English

Tetovo - the former Yugoslav Republic of Macedonia
Landslide - 03/08/2015
Grading Map



Cartographic Information

1:13000

Full color ISO A1, high resolution (300 dpi)

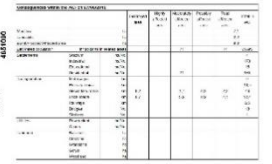
0 0.25 0.5 1 km

N

Grid: WGS 1984 UTM Zone 34N map coordinate system
Tick marks: WGS 84 geographical coordinate system

Legend

Land use - Land Cover



Map information

Heavy rainfall and strong winds in the northwest of the former Yugoslav Republic of Macedonia have caused rivers to overflow, flash floods, landslides and storm damage. The most affected areas are Tetovo city and municipality, and surrounding areas. Many homes were damaged, several were evacuated. At least seven villages in the region lost road access because of mudslides, while the storm also caused bridges to collapse. The event claimed the lives of several people.
The core users of the map are Civil Protection authorities involved in field operations.
The scope of the map production is to support emergency response activities.

Relevant date and time records (UTC)			
Event:	03/08/2015 16:20	Last cloud free image:	07/08/2015 09:23
Activation:	05/08/2015 14:02	Map production:	08/08/2015

Data Sources

Pleiades © CNES (2015), distributed by Airbus DS (acquired on 07/08/2015 09:23 UTC, GSD 0.5 m, approx. 10% cloud coverage), provided under COPERNICUS by the European Union and SIGA, all rights reserved.
Base vector layers based on OpenStreetMap © OpenStreetMap contributors, Waterapp.org. Decision base: approx. 1:10000, extracted on 01-01-2001), refined by ITHACA. Source information is included in vector data.
Elevation data: SRTM (90m posting) and EU-DEM (25 m posting). Height in meters above mean sea level.
Population data: Landscan 2013 © UT-BATTELLE, LLC.
All Data sources are complete and with no gaps.
Index maps based on: Administrative boundaries (JRC 2013, GISCO 2012 © EuroGeographics), Hydrology, Transportation (Natural Earth, 10^2, DCW River 08 © EJ JRC 2007), Settlements (Geonames, 2013).

Dissemination/Publication

Delivery formats are GeoTIFF, GeoPDF, GeoJPEG and vectors (shapefile and KML formats).
Map products available in the Copernicus EMS Portal at the following URL: http://emergency.copernicus.eu/mapping/list-of-components/EMSR129
All products are © of the European Union.

Disclaimer

The products elaborated in the framework of current mapping in rush mode activation are realized to the best of our ability, within a very short time frame during which data using the available data and information. All geographic information has limitations due to scale, resolution, date and interpretation of the original data sources. The products are compliant with Copernicus EMS Rapid Mapping Product Portfolio specifications.

Map Production

The present map shows the the flood and landslide damage grading in the area of Tetovo (the former Yugoslav Republic of Macedonia). The basic topographic features are derived from multi-temporal satellite imagery. The extracted thematic layers, assessing the delineation of the event, have been derived from Pleiades post event image.
All satellite images have been radiometrically enhanced, orthorectified with RPC approach using DEM as reference data).
The estimated geometric accuracy of this product is 5 m CE90 or better, over native positional accuracy of the background satellite image. The estimated thematic accuracy of this product is 85 % or better, as it is based on visual interpretation of geographically dense or very high resolution optical imagery. Only the area enclosed by the Area of Interest has been analysed.

Contact

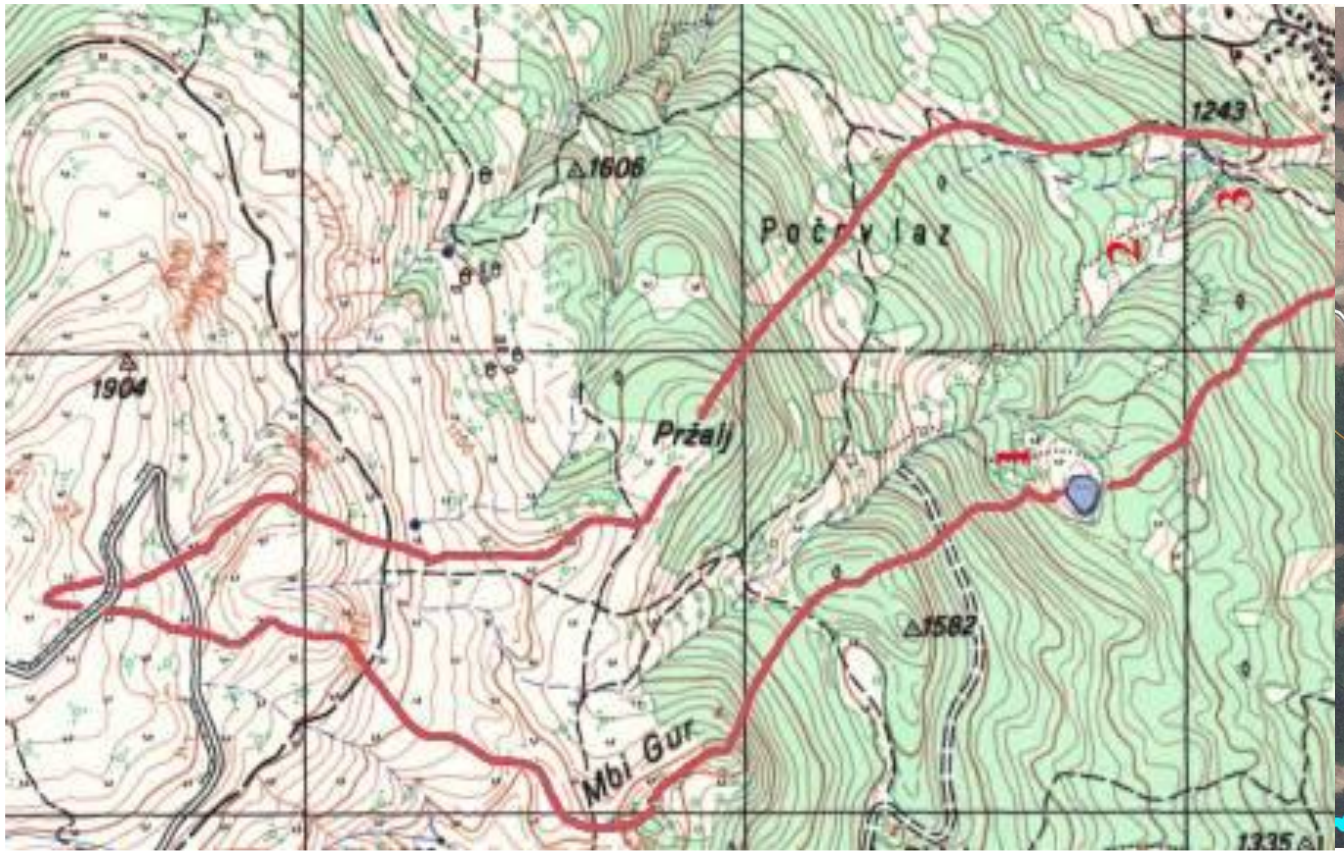
Map produced by SIGS under contract 258/2015 with the European Union
Name of the Release Inspector (quality control): e-GEOS (CGC)
E-mail: rapidmapping@e-geos.it

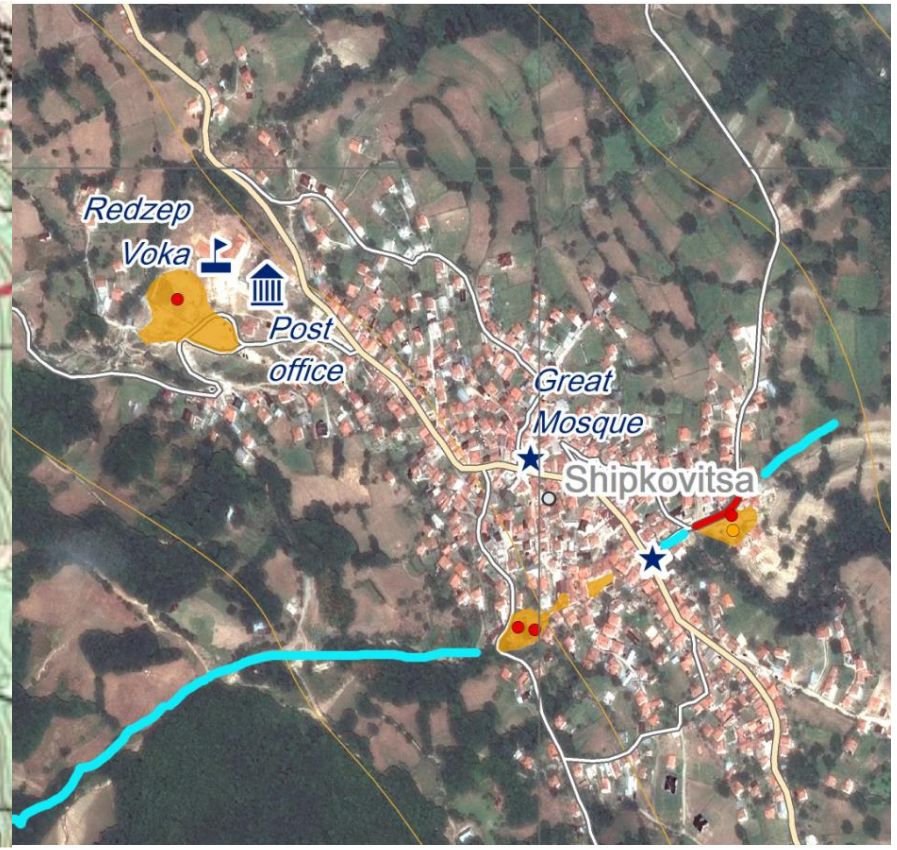
Copernicus
Europe's eyes on Earth

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Shipkovica – 4 fatalities

- Total catchment area – A = 160 ha (1,6 km2)
- Forest cover - 50 % , dense beech forest, other high mountain grasslands
- Forming flood wave on the upper part of the watershed, then intensive fluvial erosion in the main torrent bed





2 - Comparison of land cover - 2002 vs. 2014 - whole region and Shipkovica r

gure 45 - Gully into dense forest

Figure 46 - Gully on the grassland (section 1-2)

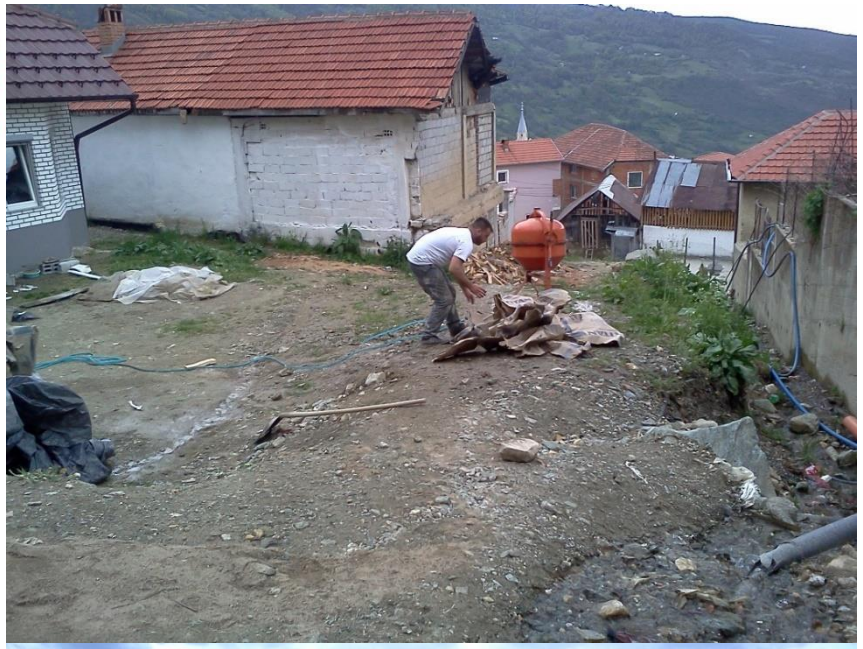
deep gully (cca 300 m upstream of the village) - (3)

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

https://www.youtube.com/watch?v=YB6Ok_VbgRE

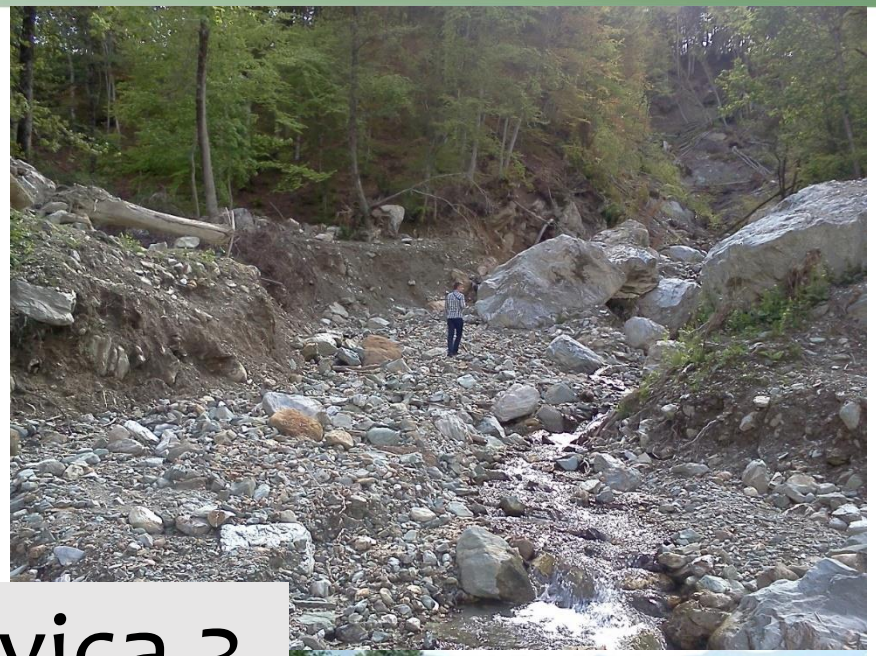
Co-funded by the Erasmus+ Programme of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries



2018

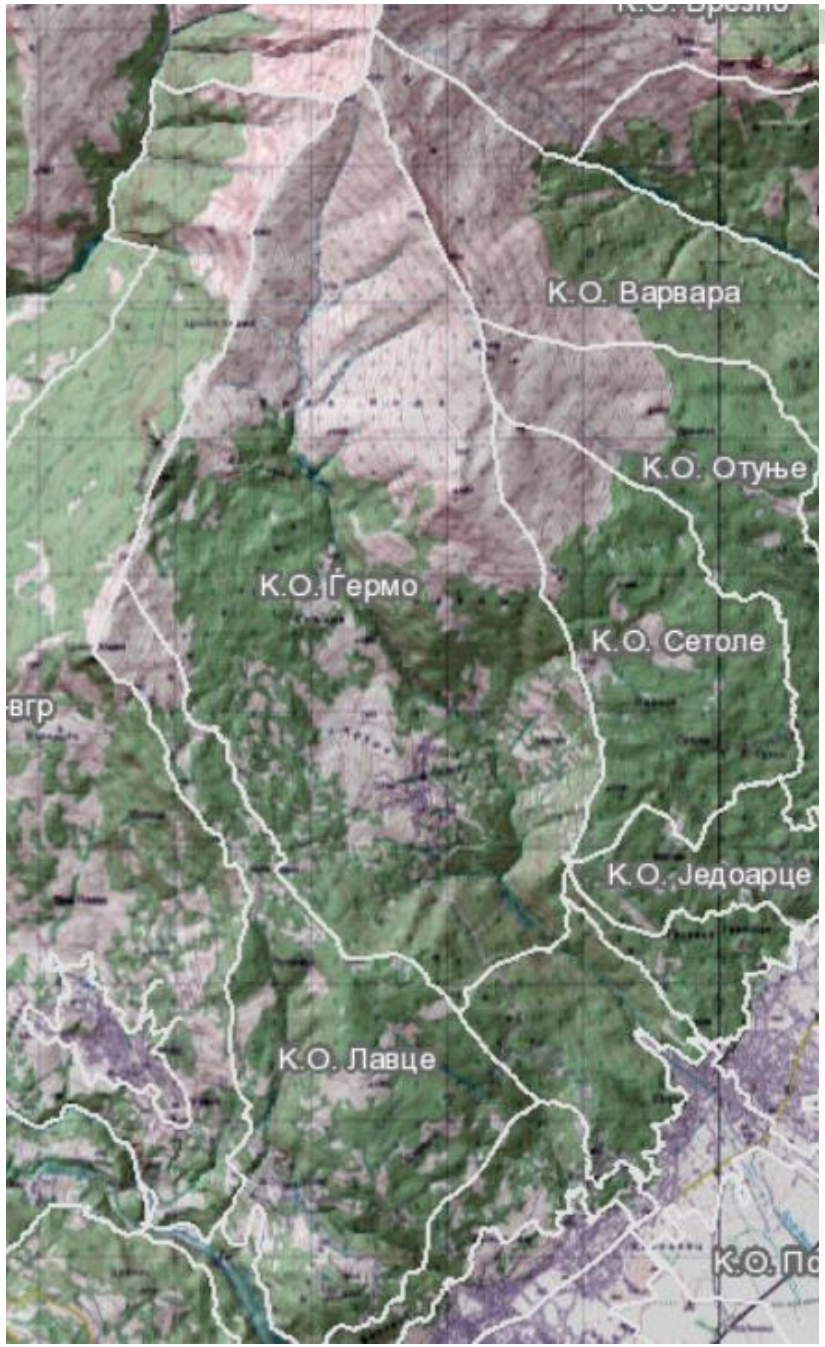
Shipkovica 3



Co-funded by the
Erasmus+ Programme
of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Mala Recica
2 fatalities



Village Poroj

no one house in hazard area

- Catchment area – 1200 ha, Ib >20%, up to 50%
  altitude from 480 – 2375 masl
- 50% forest cover
- High mountain grasslands, meadows, agriculture area
- Floods - 2002, 2004, 2005, 2006, 2008, 2010, 2015,2017

https://www.youtube.com/watch?v=ZZvFwV1msaU

Co-funded by the
Erasmus+ Programme
of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

PENA river

Co-funded by the Erasmus+ Programme of the European Union


Tetovo
Marshal Tito
Marshal Tito
ул. 29 Ноември
Киро Ристоски Дрнц
Илинденска
Илинденска
Видое Смилевски Бато

Pena river

Co-funded by the
Erasmus+ Programme
of the European Union

Type of torrents according to Aulitzky classification

	I criteria – hazard along the cone, fan,				II criteria – Generic classification regarding erosion processes		
Name	Bed Slopes %	Debris/ Sediments	Viscosity	**Final classification**	Surface erosion scour	Surface erosion lateral	Embankment failure
Shipkovica torrents	23	Up to big boulders	Non-Newtonian	**Debris flow torrent**	yes	yes	yes
Poroj	22	Up to big boulders	Non-Newtonian	**Debris flow torrent**	yes	yes	yes
Golema Recica	21	Up to big rocks	various	**Debris flow/ Debris flood torrent**	yes	yes	yes
Mala Recica	22	Up to big rocks	various	**Debris flow/ Debris flood torrent**	yes	yes	yes
Pena (with barrages)	16	Fine clay to rocks	Newtonian viscous mass	**Debris flood/ torrential river**	yes	yes	yes

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

TORRENT INDEX (by Aulytzki)

	Shipkovica	Poroj	Golema Recica	Mala Recica	Pena
Maximum grain volume of recent eroded material	>1 m^3 4 points	>1 m^3 4 points	>1 m^3 4 points	>1 m^3 4 points	0,01-0,2m^3 2 points
Maximal thickness of the debris layer	>1m 4 p.	>1m 4 p.	0.5-1m 3 p.	0.5-1m 3 p.	0.5-1m 3 p.
Inclination of the debris cone domain	>15% 4 p.	>15% 4 p.	2-7% 2 p.	2-7% 2 p.	<2% 1 p.
Present vegetation cover on the basin	Meadows up, birch bellow 2,5 p	Meadows up, birch bellow 2,5 p	Meadows up, birch bellow 2,5 p	Meadows up, birch bellow 2,5 p	Meadows up, birch bellow 2,5 p
Are the erosional features and surface on the debris cone domain	Debris ridges and features with coarse blocks – 4p.	Debris ridges and features with coarse blocks – 4p.	Poorly defined depositional features 3 p.	Poorly defined depositional features 3 p.	Poorly defined depositional features 3 p.
The discharge situation on debris cone is	Blocking structures that inhibit flow - 4p.	With blocking structures that inhibit flow - 4p.	With blocking structures that inhibit flow - 4p.	With blocking structures that inhibit flow – 4p.	With blocking structures that inhibit flow – 4p.
Total points	22,5	22,5	18.5	18.5	15.5
Torrent index	3.75	3.75	3.09	3.09	2.58
Description	Most endangered	Most endangered	Most endangered	Most endangered	Most endangered

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Characterization of the torrent type

	Shipkovica	Poroj	Golema Recica	Mala Recica	Pena
Debris flow and flood have in the past	Caused considerable devastation in the old community – 4p	Caused considerable devastation in the old community – 4p	Cause devastation of newly buildings along the torrent - 2p	Cause devastation of newly buildings along the torrent - 2p	Caused considerable devastation in the old community – 4p
Potential maximum one-day precipitations	100-150 mm 2 p.	100-150 mm 2 p.	100-150 mm 2 p.	100-150 mm 2 p.	100-150 mm 2 p.
Location an potential debris volume in the upper part of the catchment	Large debris source separated by open gorge channel – 3p	Large debris source separated by open gorge channel – 3p	Closes debris source separated by flat torrent reach - 2p.	Closes debris source separated by flat torrent reach - 2p.	Closes debris source separated by flat torrent reach - 2p.
Role of unrooted trees or logs in debris flow/flood	Single trees and swamps reach torrent - 3 p	Single trees and swamps reach torrent - 3 p	Single trees and swamps reach torrent - 3 p	Single trees and swamps reach torrent - 3 p	Only branches can reach torrent bed – 1p
Water storage potential of the bedrock and surficial material	Inclined shale-marl units 2 p.	Inclined shale-marl units 2 p.	Inclined shale-marl units 2 p.	Inclined shale-marl units 2 p.	Inclined shale-marl units 2 p.
Total points	14	14	11	11	11
Torrent index 2	2.8	2.8	2.2	2.2	2.2
Description	Torrent with potential for debris flow	Torrent with potential for debris flow	Potential for bedload transport	Potential for bedload transport	River (Creek) with flood potential

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Recent torrent control works

- Only regulation of the torrent in the urban area in the valley
- No upstream measures nor hydraulic nor biotechnical.

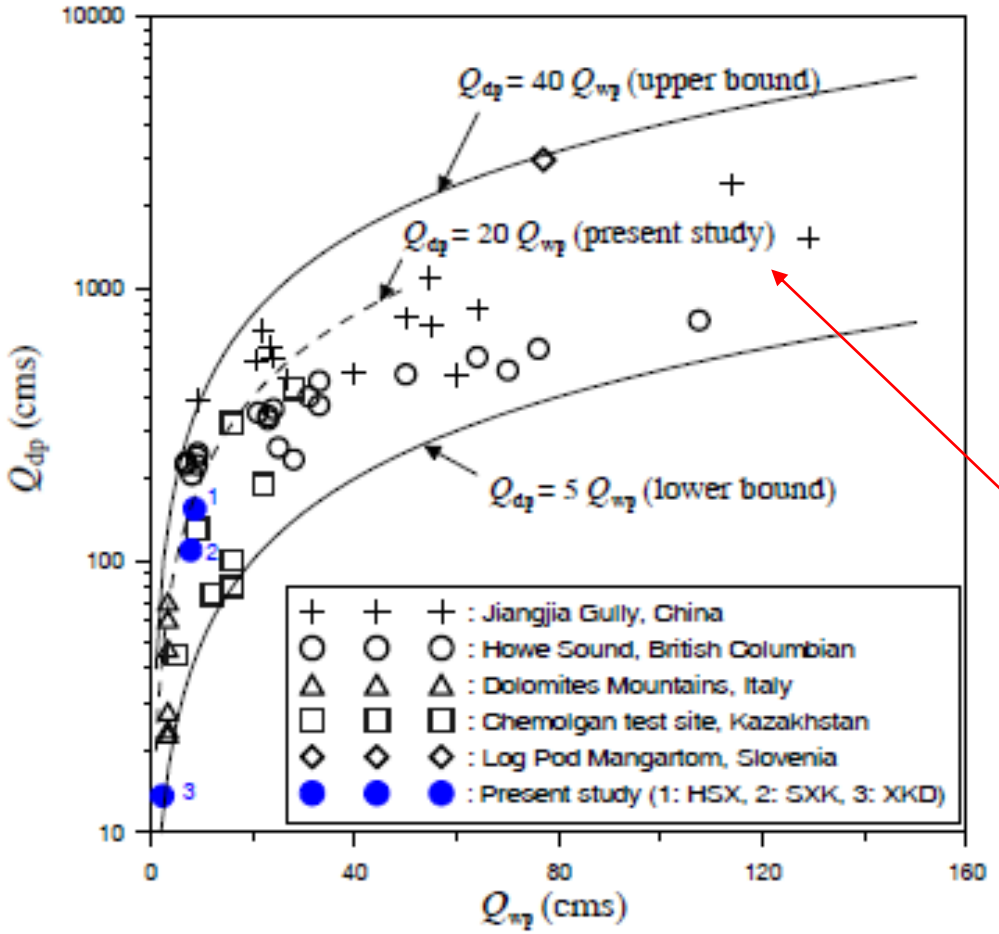
Result

DECEPTION of VOTERS before ELECTIONS

ENGINEERING DOUBT – Absence of knowledge

Debris flow discharge vs Water flow Discharge - Q_{dp} vs Q_{wp}

- Definitely, the debris flow discharge differ from water flow discharge. The debris-flow discharge is an important variable when designing debris-flow mitigation structures such as culverts, flumes, bridges, debris-flow barriers, and check dams.



- It is very complicate to define the debris flow discharge. There are various methods.
- The relationship between Qdp and Qwp was widely used in engineering planning because Qwp,which is related to the return period, can be easily determined by hydrologic analysis. The assumed Qdp is proportional to Qwp and is expressed as Qdp = cbQwp, where cb is the discharge coefficient of the debris flow.

(J.-C. Chen and M.-R. Chuang, 2014)

$$Q_{dp} = (5 - 40)\ Q_{wp}$$

Co-funded by the Erasmus+ Programme of the European Union

CONCLUISONS

- On the critical day huge quantity of precipitations on the mountain and unfavorable natural factors of the area result in huge runoff, high pick of discharge containing a lot of debris results of erosion processes including material form landslides, weathering and non-natural debris. On the transition from mountain to the valley where are located settlements, these torrents deposed sediments and caused flooding of the area.
- Damages were increased because of inappropriate human activities too (illegal ban, throwing garbage in the bed, absence of hazard plans etc.)
- Using Aulitzky classification, these torrents are classified as debris flow or debris flood torrents. Torrent index is high and areas near then are assigned as most endangered. According to the torrent character these torrents except river Pena are assigned as torrents with potential for debris flow/ flood.
- Lack of knowledge especially difference between river and torrent hydrology in the recent period cause designing of not appropriate structures, absence of upstream measures and channel dimensions that cannot accept the flood wave.

Co-funded by the Erasmus+ Programme of the European Union

SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Blagodaram na vnimanieto

Thank you for your attention!

Co-funded by the Erasmus+ Programme of the European Union