



SETOF

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

Rapid diagnostic of the catastrophic event happened on 6th August 2016 in the Skopje 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

"This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein"

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

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Dept. of Land and Water
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TORRENT FLOOD SKOPJE 2016

Ivan BLINKOV



SETOF Workshop
October 28-29 , 2019, Skopje, North Macedonia

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INTRODUCTION

- Torrent floods bring enormous harm to people and nature, but also can make long-term consequences and usually return development a few years back.
- These natural hazards origin from the mountainous regions but their consequences are usually felt in downstream sections, particularly in our case, consequences from flood event were felt in the settlements in Skopje region.
- Level of destruction of the natural disasters damages depend on the natural but also depend on socio-economic conditions.

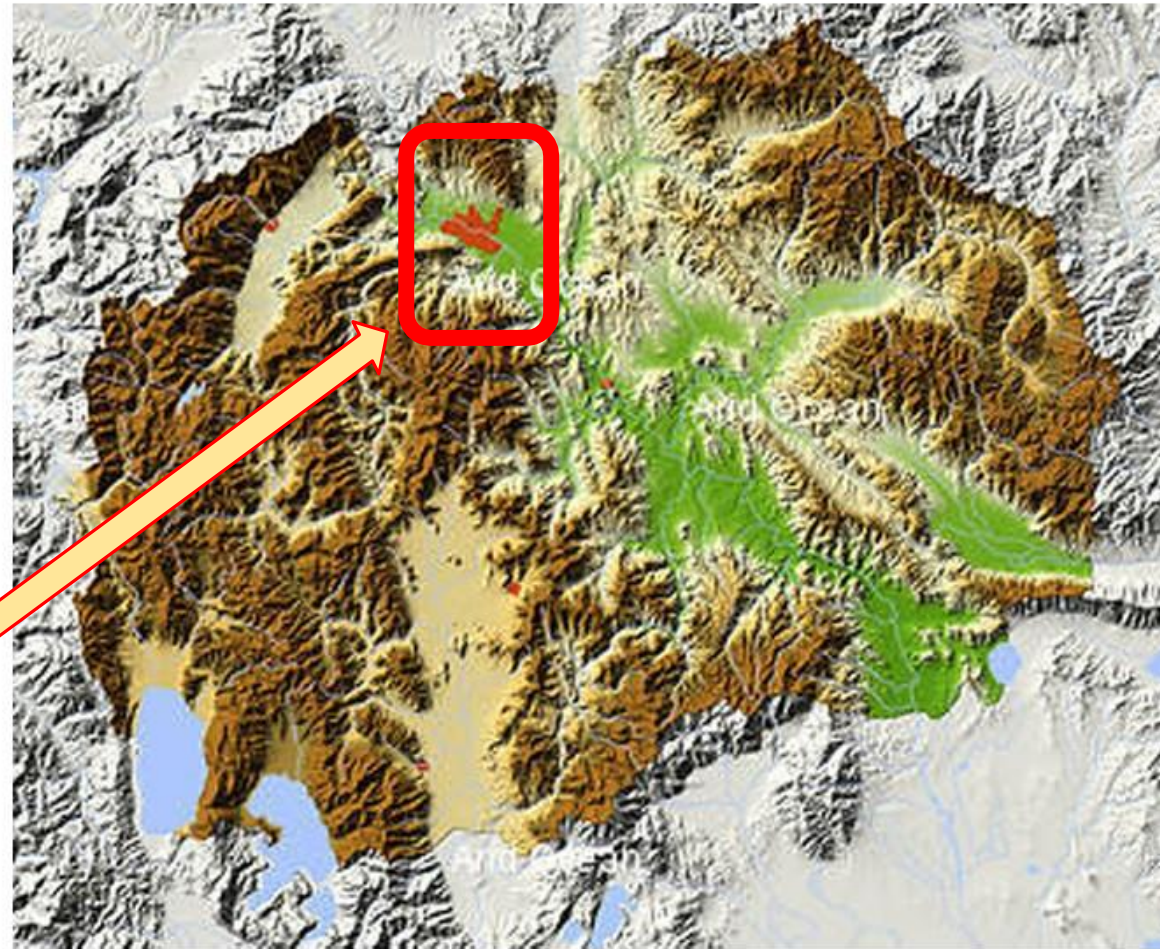




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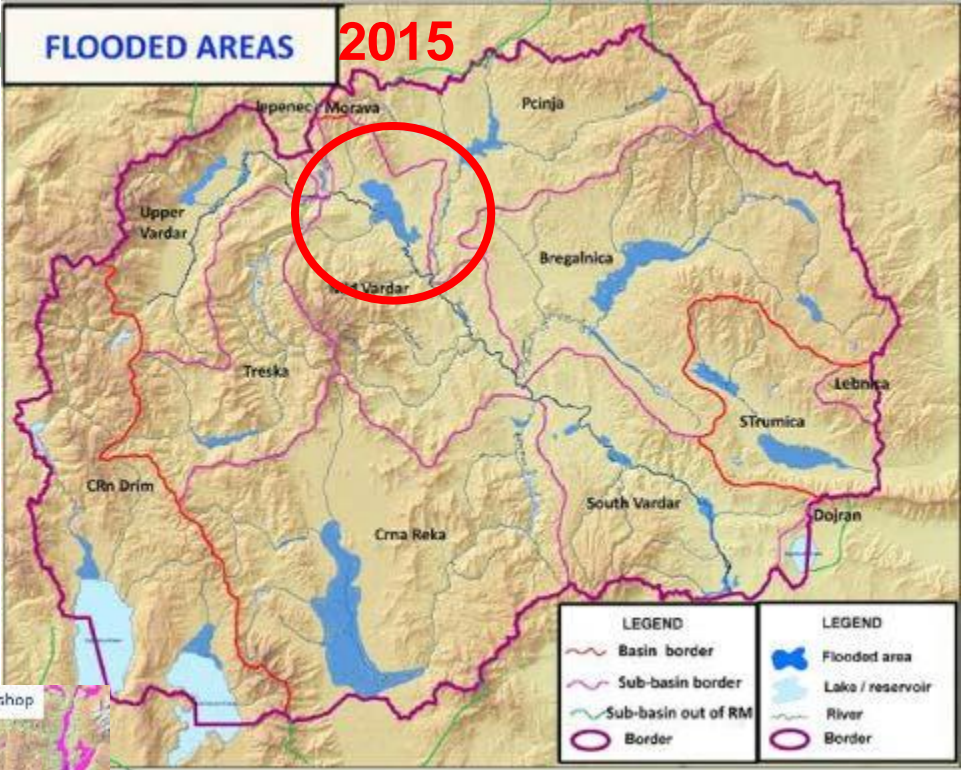
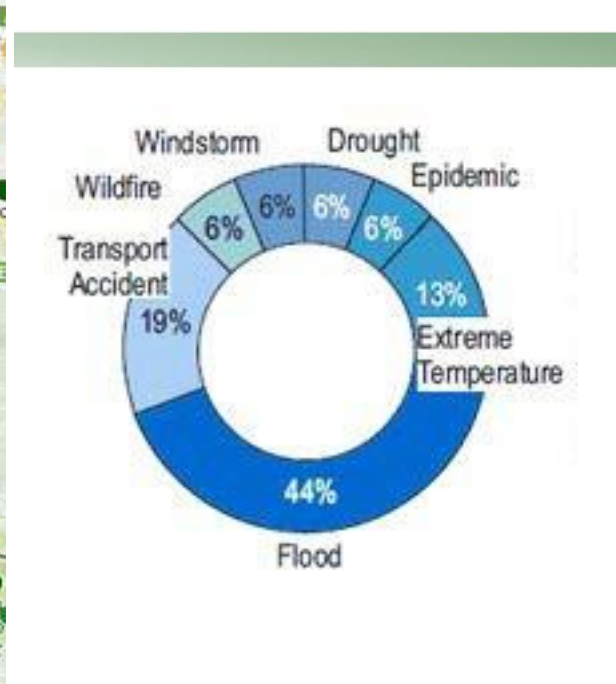
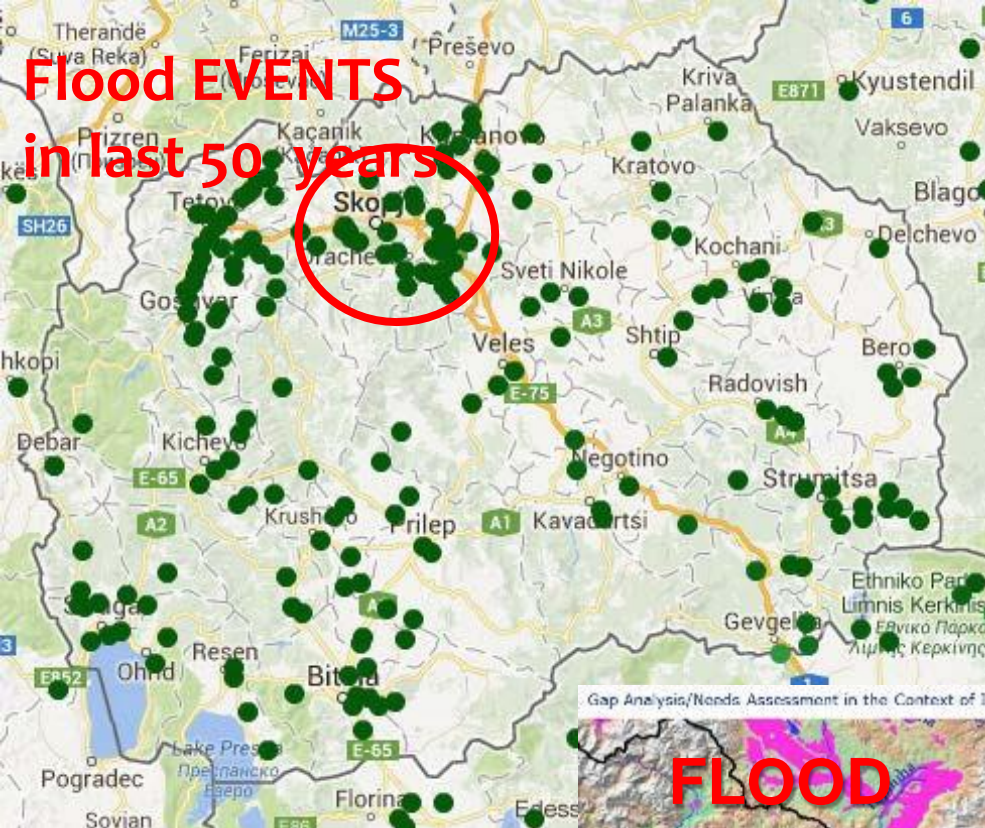
LOCATION

SKOPJE REGION – REPUBLIC OF MACEDONIA

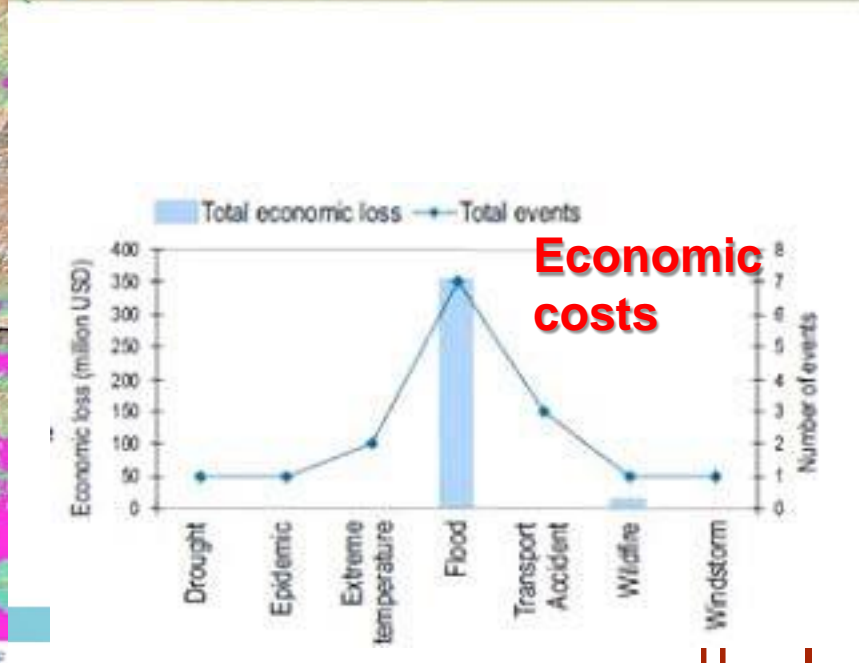
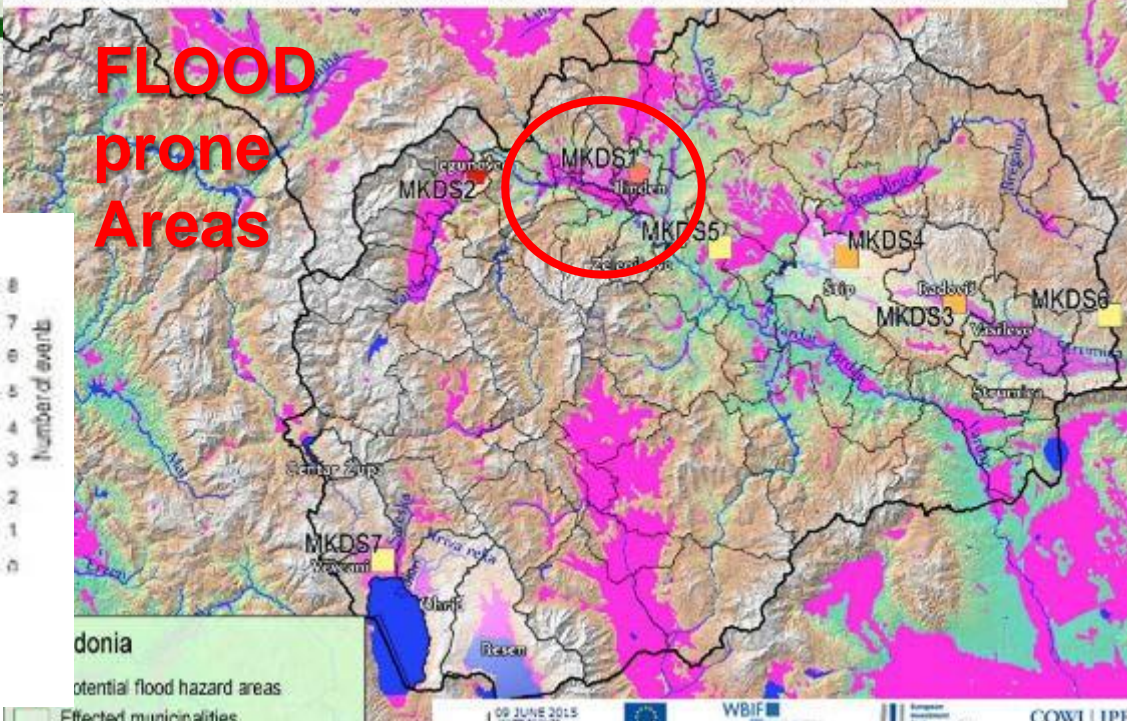


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Gap Analysis/Needs Assessment in the Context of Implementing EU Floods Directive in the Western Balkans - Stakeholders' workshop

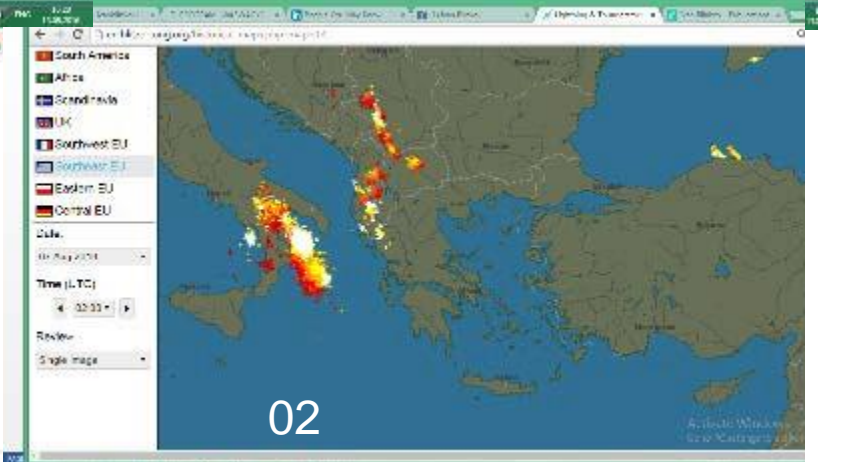
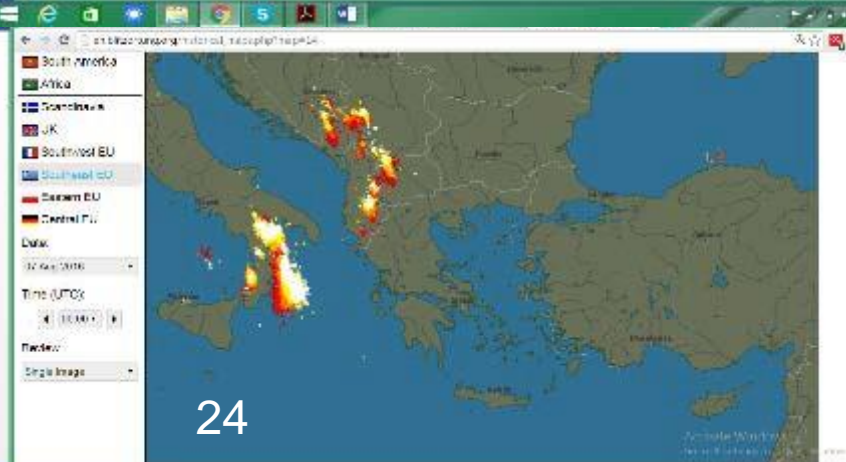
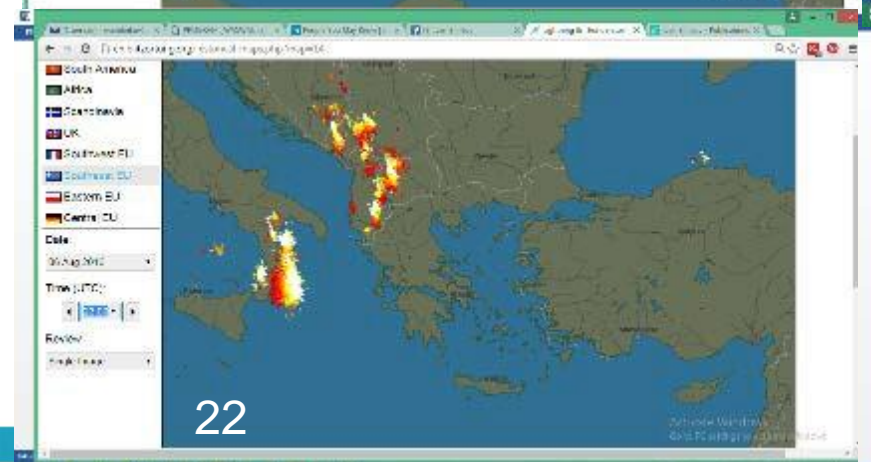
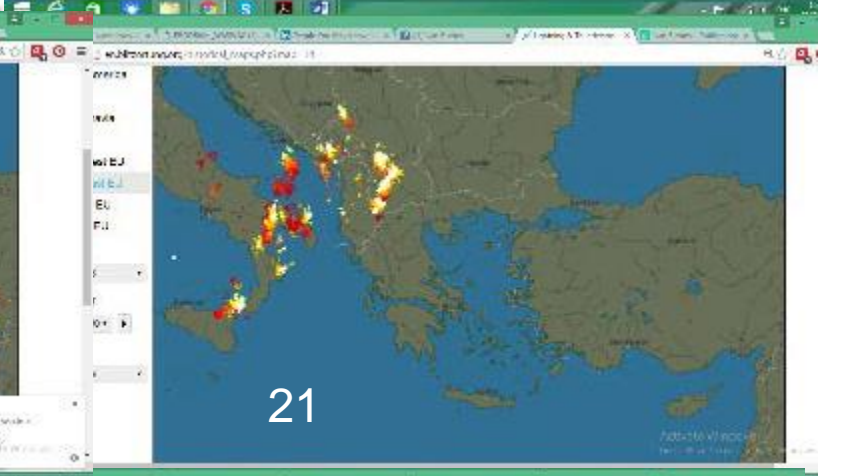
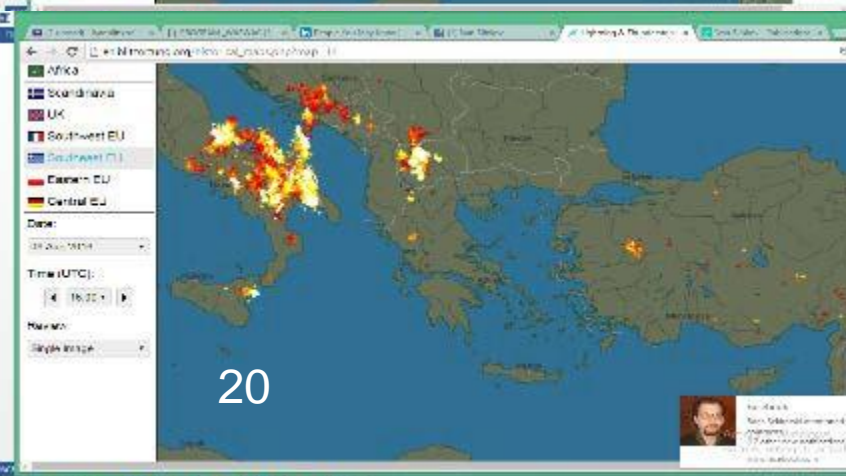
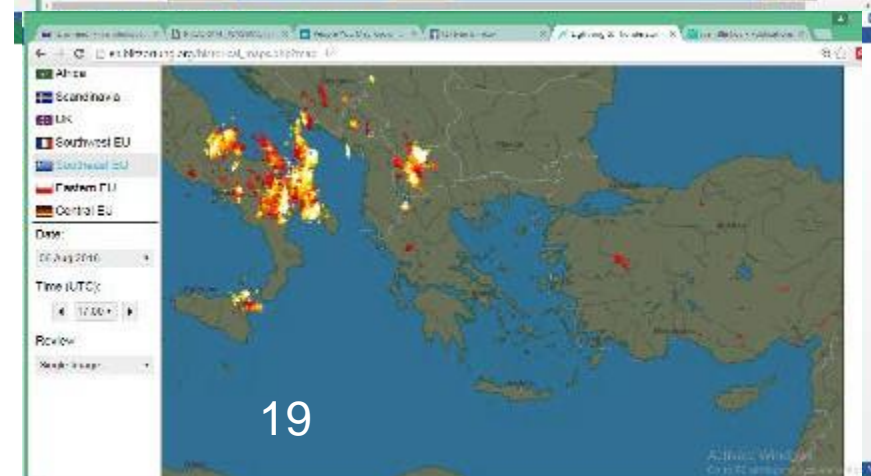
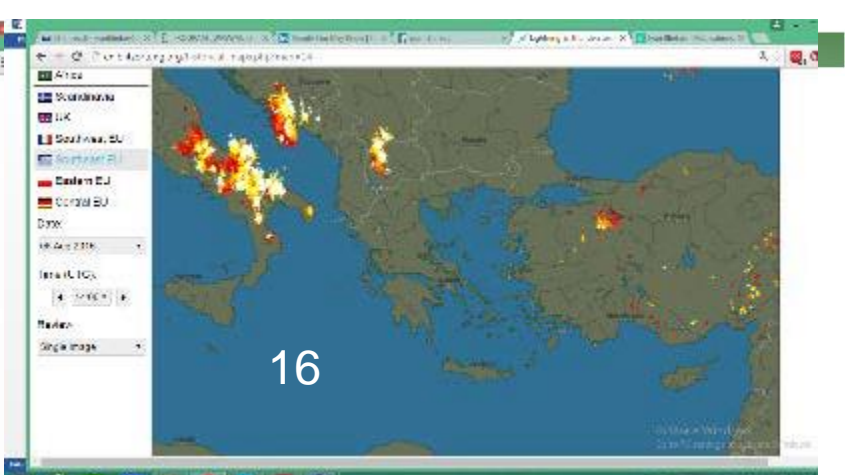
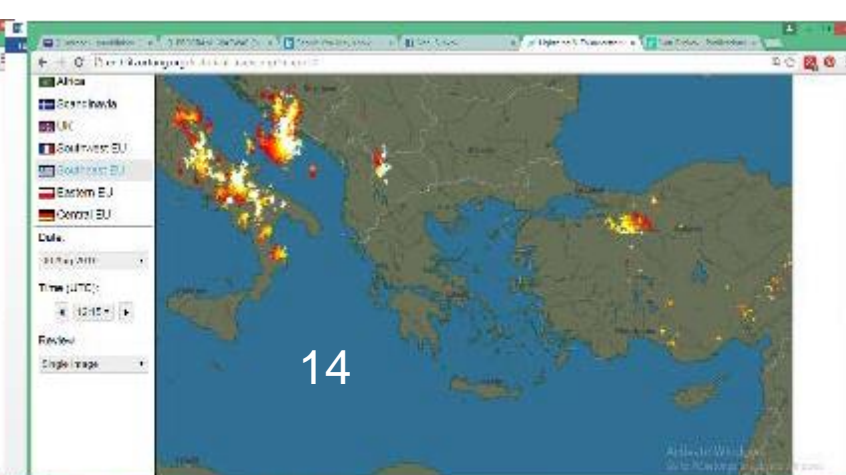
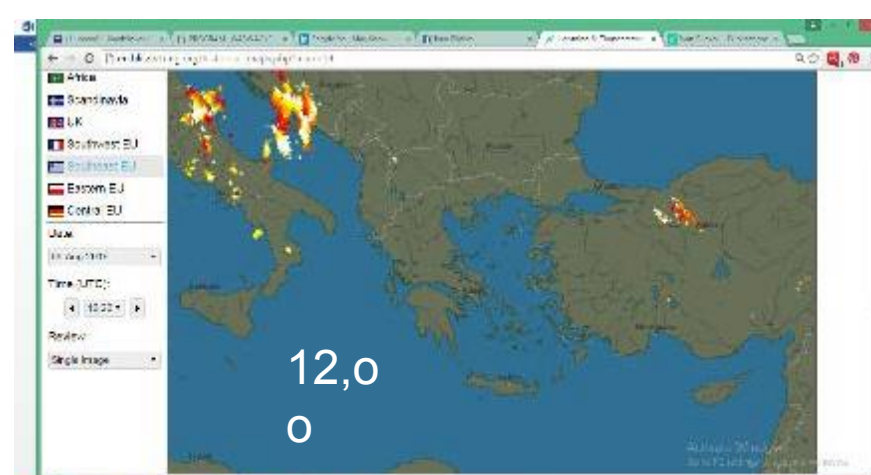




STORM EVENT ON 6 AUGUST 2016

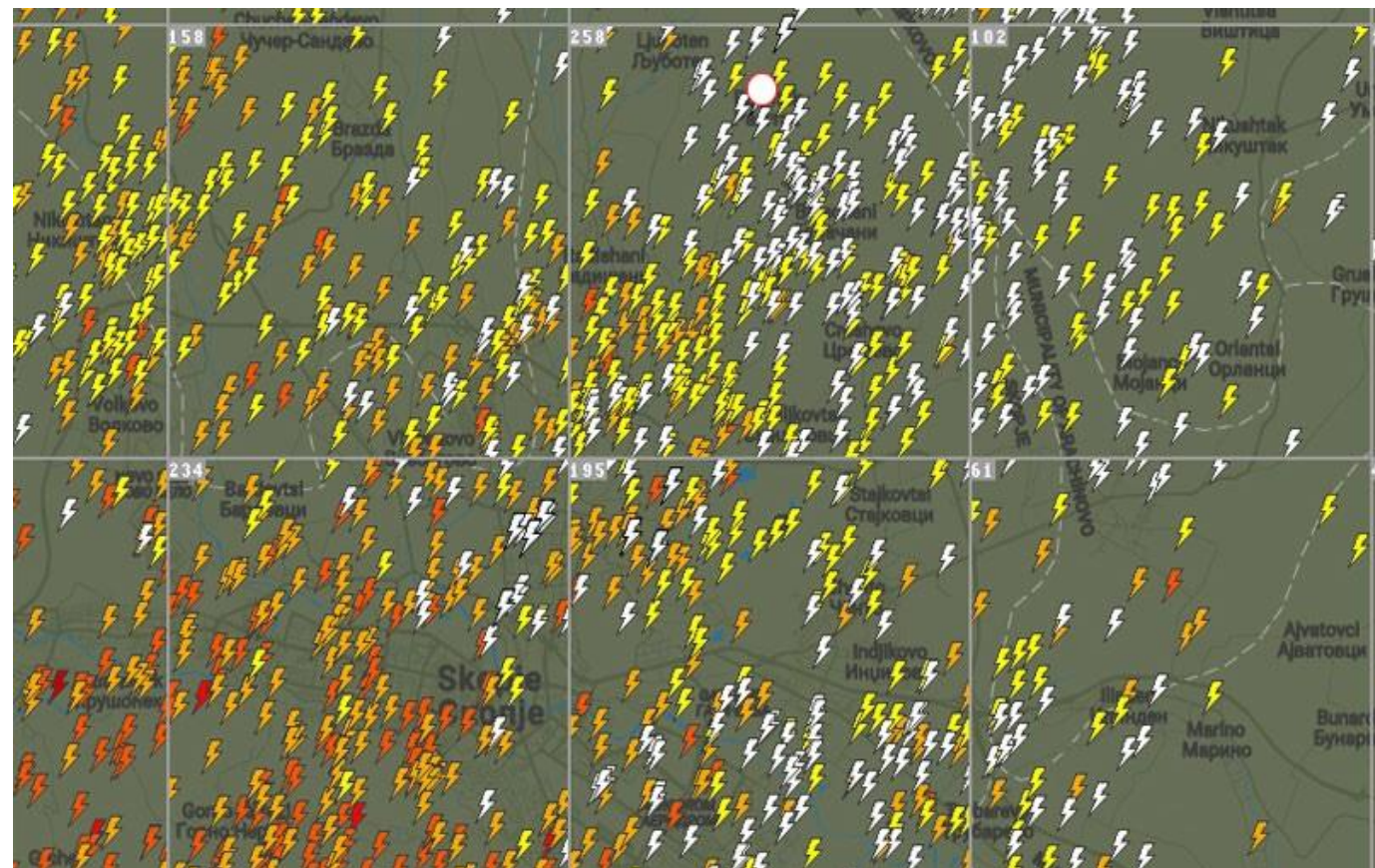
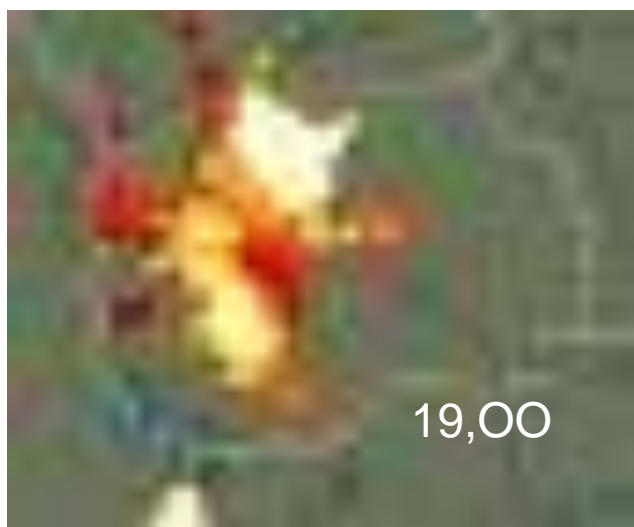
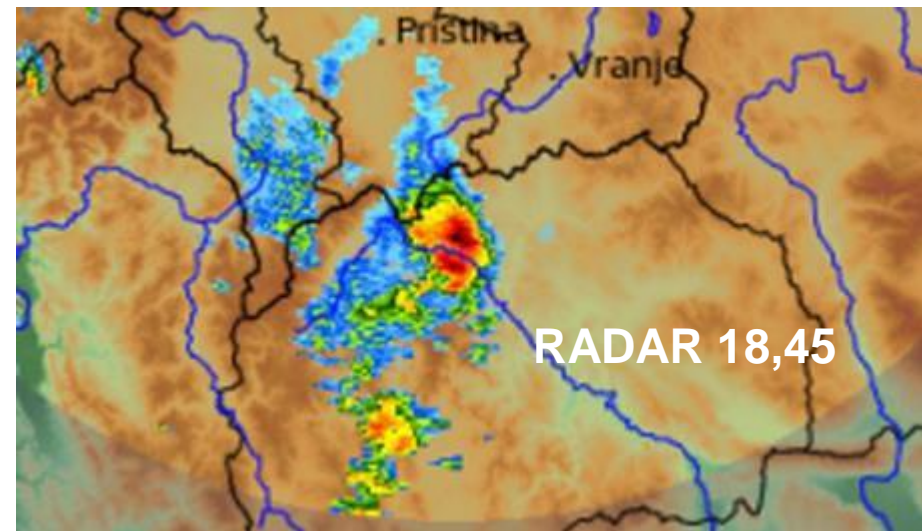
- Cyclone activity arrive from west from Mediterranean , passed Albania, enter in Macedonia over the Shara Mountatin,
- and formed giant cumulonimbus system whose top achieve up to 13 km in height.
- Local circumstances in the Skopje region contribute to the storm
- Lightening and thundering –
- Two—three weeks before precipitations
- All this week 1-6August – no precipitation but high temperature over 300
- Heavy rainfall on the Shara region and Skopje region







BETWEEN 17,20 AND 19,20 - > 1000 LIGHTNINGS



More than 1000 lightnings in Skopje region





A VIEW ON THE STORM IN PART OF SKOPJE, 8 JULY 2016



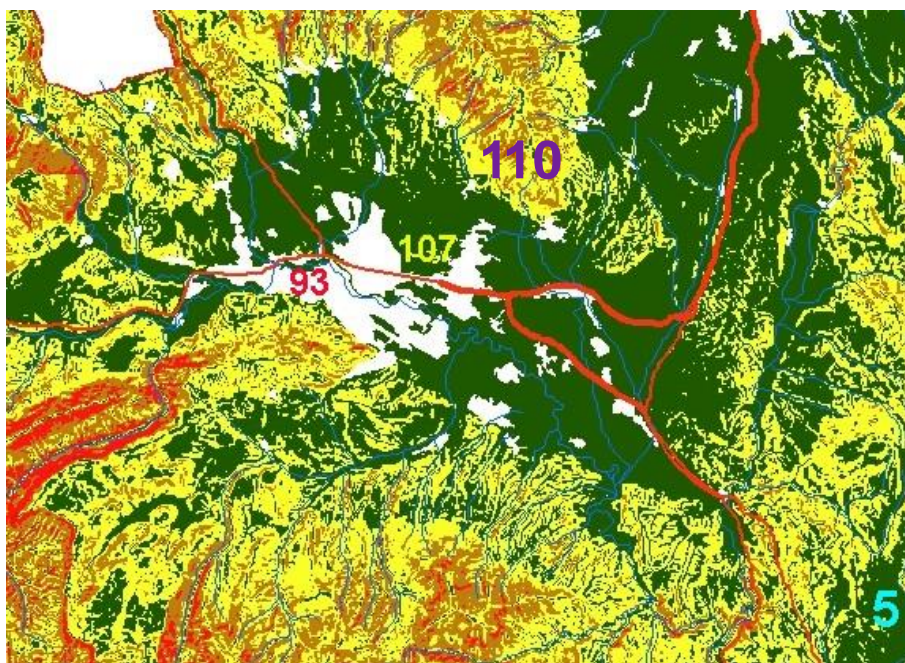
- WITNESSES who lived on the opposite mountain Vodno said it was similar but much wider area.

“Rain bomb phenomenon” (Ristevski P - climatologist) ????????



PRECIPITATIONS

- SHMS - 92,9 for 24 hours, (Maximum recorded in Skopje 11.1979 – 110 mm/24 h)
- 83,4 for 5 hours (300')
- Gazi Baba Rain gauge – 107,4 /24h on the mountain probably 110 mm???
- On the airport – 20 km from SHMS – 5 mm



p [%]	50	20	10	4	2	1	0,1
T [YEARS]	2	5	10	25	50	100	1000
t [MINUTES]	h [mm]						
5	6,622	9,466	11,350	13,729	15,495	17,247	23,037
10	10,198	15,217	18,539	22,737	25,852	28,943	39,158
20	14,309	21,049	25,512	31,151	35,334	39,486	53,207
40	17,490	25,730	31,185	38,078	43,191	48,267	65,038
60	19,005	27,759	33,555	40,879	46,312	51,705	69,525
90	20,237	29,139	35,033	42,480	48,005	53,489	71,609
150	22,774	31,856	37,869	45,467	51,104	56,698	75,186
300	25,465	35,620	42,344	50,839	57,142	53,398	84,069
720	30,004	43,825	52,976	64,538	73,116	81,630	109,763
1.440	74,792	50,457	60,828	73,933	83,654	93,304	125,190





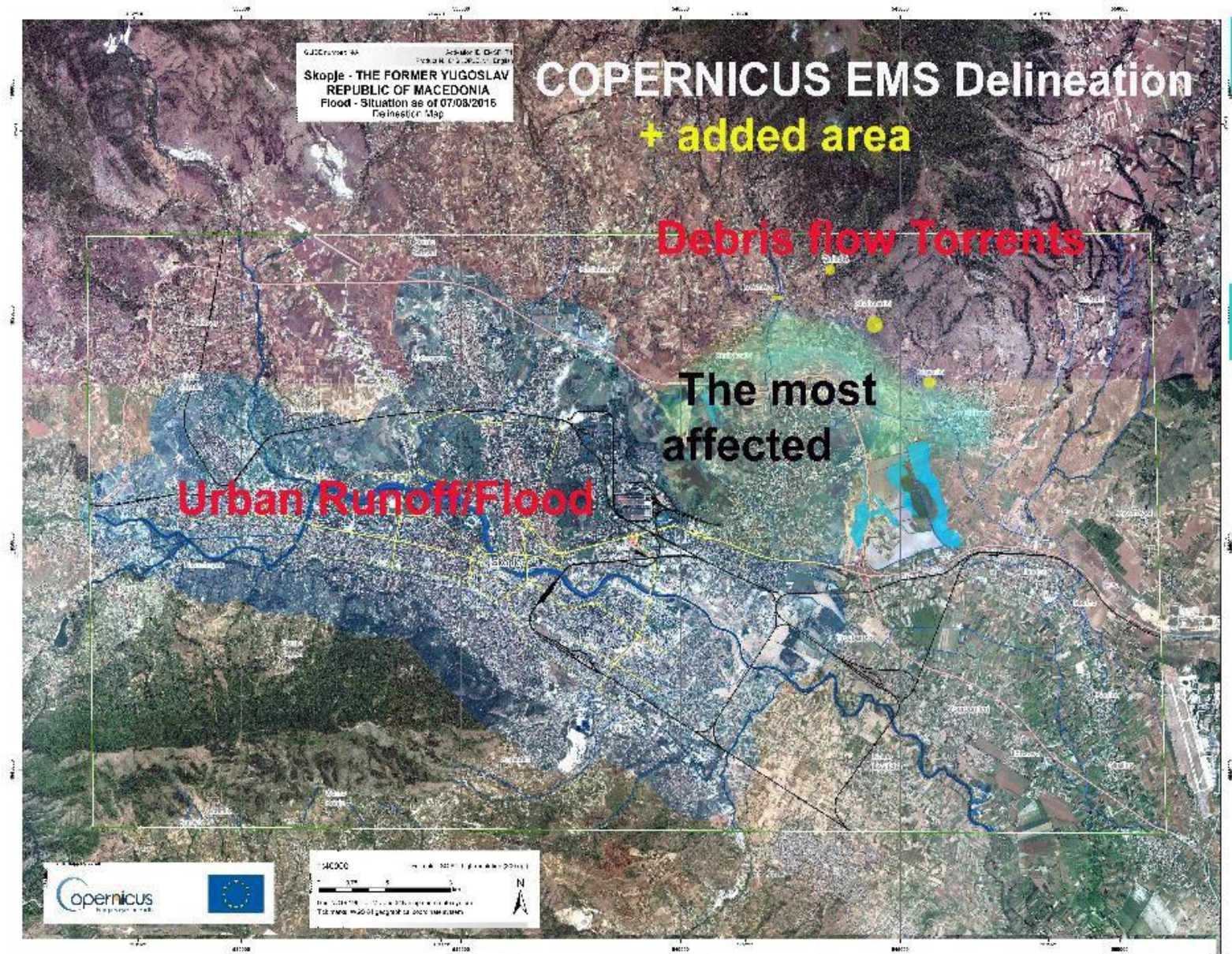
CONSEQUANCES of the **STORM**

- Cca >5 000 000 m³ rainfalls fall on the area (SHMS)
- Huge runoff on the slopes
- High discharge,
- Pluvial and fluvial erosion,
- Debris flow, flash flooding...
- Human activities significantly contributed to the discharge and damages





- Affected almost all Skopje city and part of surrounding
- Area - 170 km²
- Cca 450 000 citizens
- Various flood types
 - Urban runoff/flood
 - Mudflow / flood
 - Overflowing





UNDERPASS



URBAN FLOOD





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Damages in various quart of the city



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URBAN FLOOD IS NEGLECTED COMPARED TO THE DISASTER HAPPENED IN THE SUBURBAN AREA

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SET



Skopska Crna Gora

The MOST AFFECTED
quarts and villages

HUGE RUNOFF, HIGH DISCHARGE IN THE TORRENTS THAT ORIGIN FROM THE MOUNTAIN SKOPSKA CRNA GORA TOGETHER WITH OTHER CIRCUMSTANCES CAUSE DISASTER.

Skopje

Image © 2016 CNES/Astrium
Image Landsat

Image © 2016 DigitalGlobe

Google earth





VILLAGES ON THE SLOPE

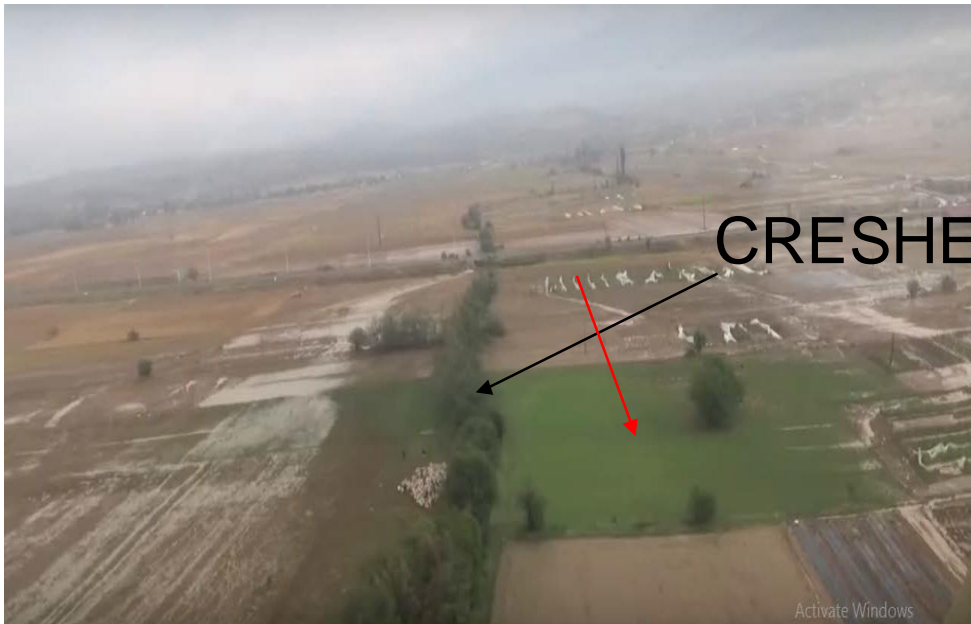


FLOODED AGRICULTURAL LAND in the VALEY





RINGROAD



CRESHEVSKA REKA



Activate Windows

Activate Windows
Go to PC settings to activate Windows





RING ROAD

1/3-1/2 out of died on the Ring road





VILLAGES IN THE VALEY



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S





HUMAN TRAUMA



of the European Union





CONSEQUENCES ONLY IN THE MOST AFFECTED AREA

- At least 22 dead, 6 still missing???, injured???
- ????? families evacuated
- Cca 5000 houses damaged
- Cca 20 000 citizens affected
- Settlements on the slopes on the mountain – damages in 5 villages
- Settlements in the valey - Total destroyed village od Stajkovci, great part of village Singelik, part of village Smilkovci, part of urban quart Chento part of villages Ingjikovo and Aracinovo
- Damaged various infrastructure, including the ringroad
- damaged agricultural land: more then 1000 ha





Questions that need answers

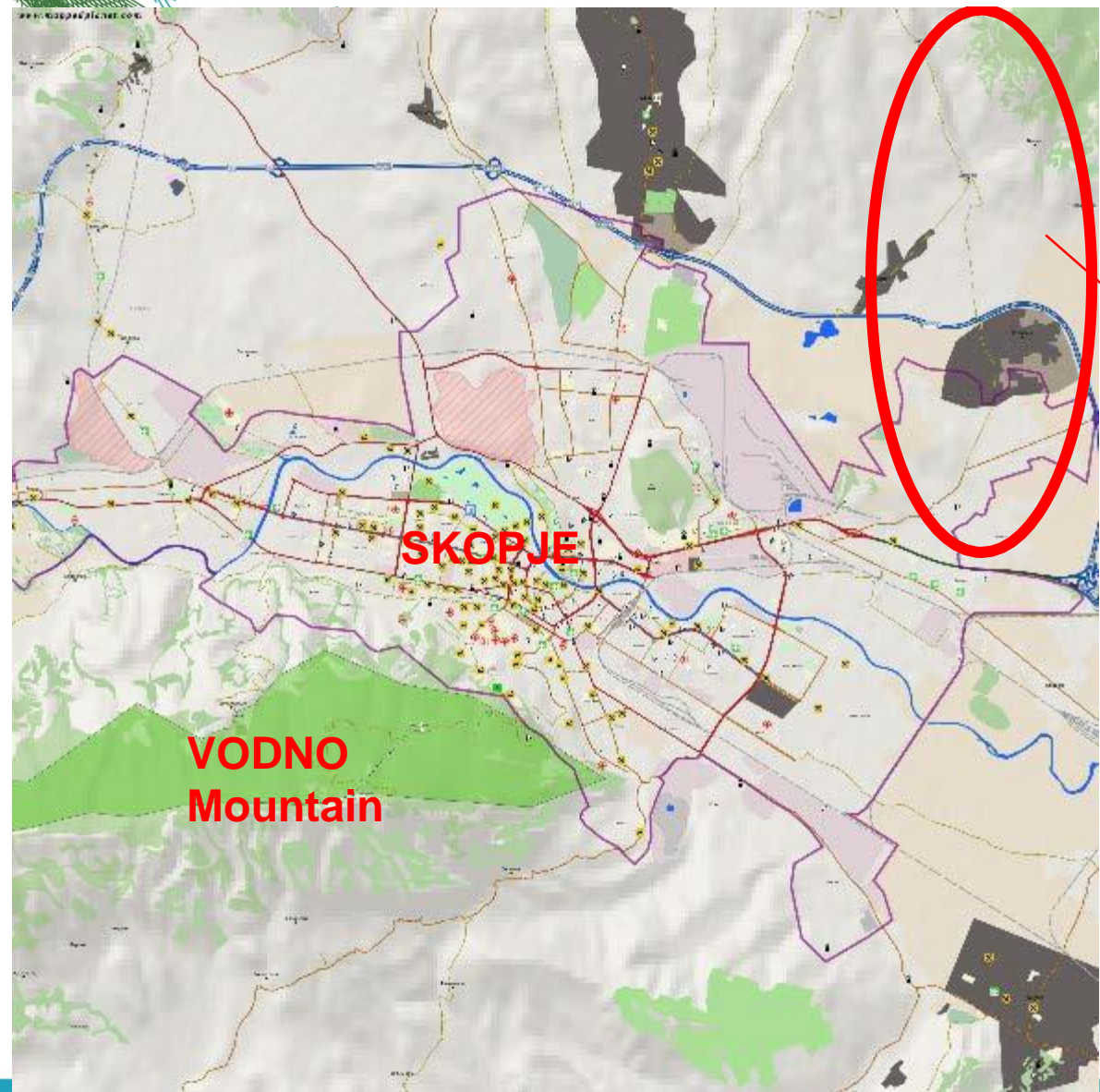
- HAZARD – Does Hazard could be decreased or prevent
- RISK - What causes major damages and why damages in Skopje region were so high ???

To Much WHY, WHY, WHY

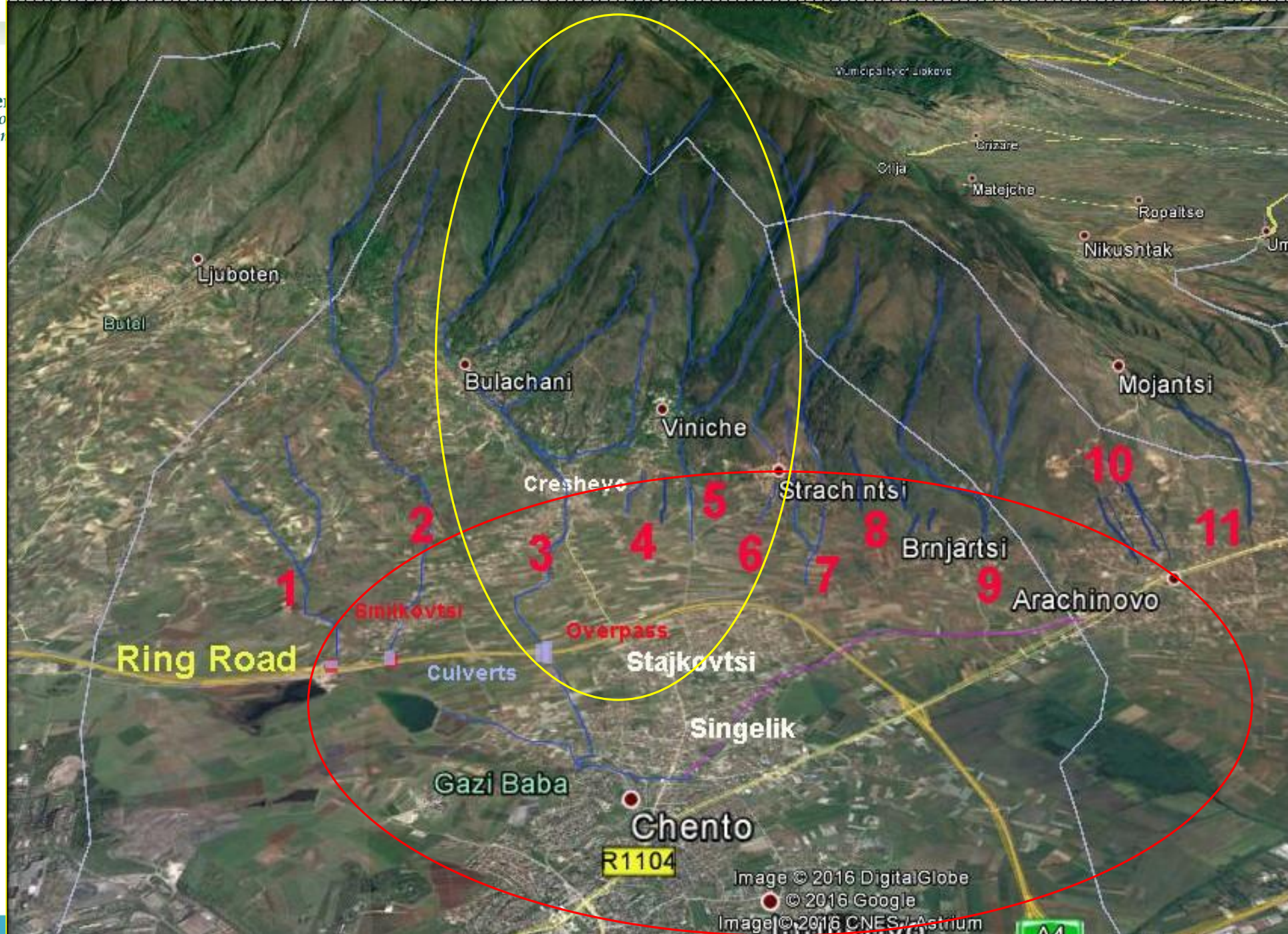




AN ANALYZE ONLY FOR THE MOST AFFECTED REGION

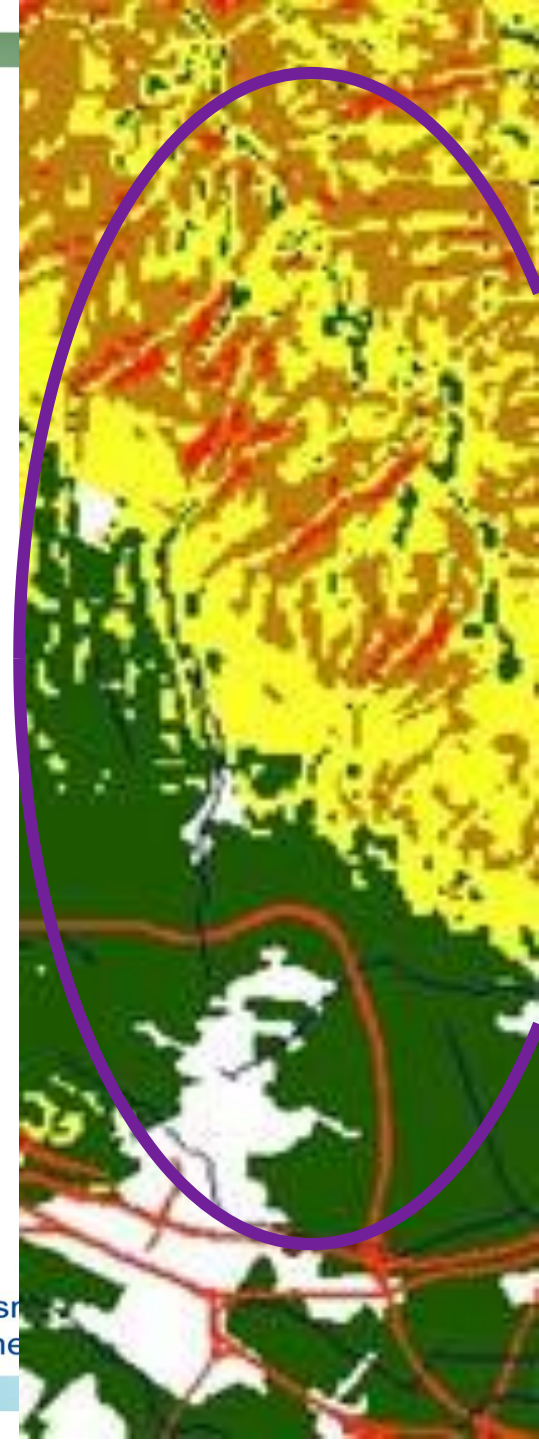
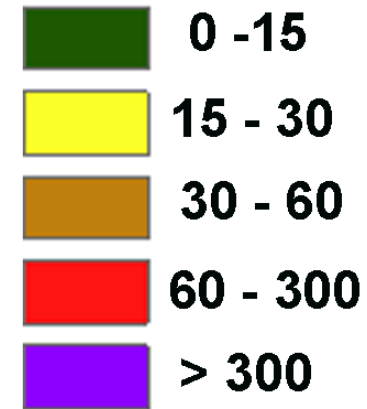


- 1- Smilikovski poroj
- 2- Rashtanska Reka
- 3- Creshevska Reka
- 4- 2 no name torrents
- 5- Vinichka Reka
- 6- Stracinski poroj
- 7- Strachinska Drezga
- 8- 2 no name torrents
- 9- Brnjarska Reka
- 10- 3 no name





Slope [%]

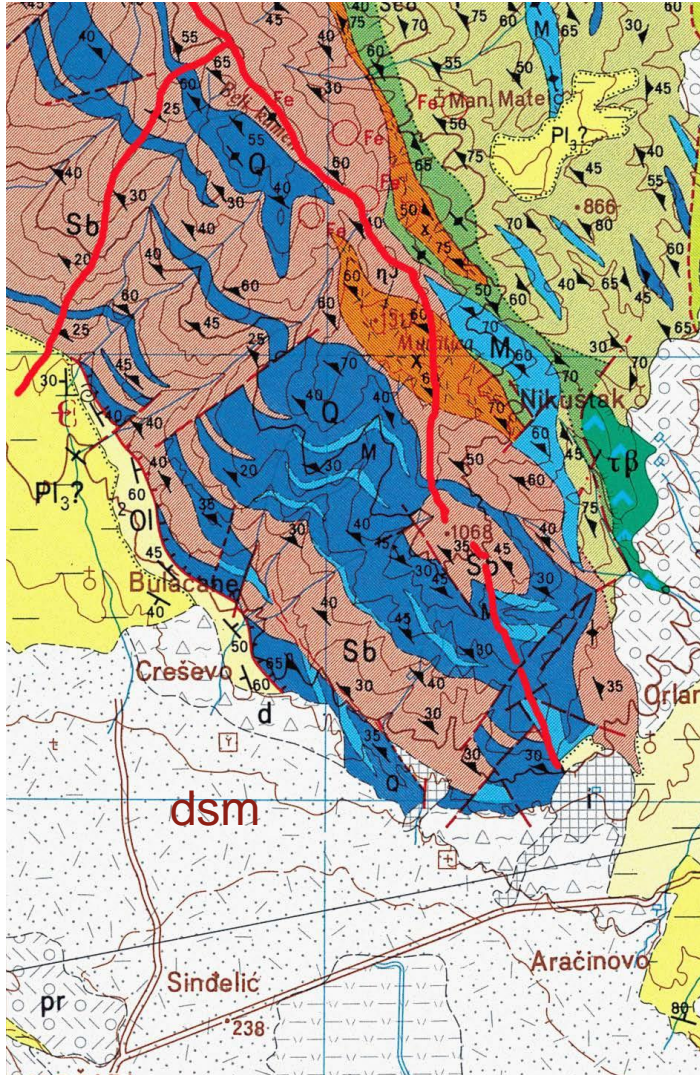


Mountain Skopska Crna Gora belong to unstable Vardar Tectonic zone. It occurred with fault lines.

It is very distinctive from other tectonic units, including fragments of Precambrian crust, a Paleozoic volcanic-sedimentary complex, and Mesozoic structural complexes. Intensive volcanic activity ended in the early Quaternary. The highest peak 1651 m. It is composed of crystalline schists and eruptive rocks, through which Mesozoic rocks and Tertiary



GEOLOGY MAP AND SOILS



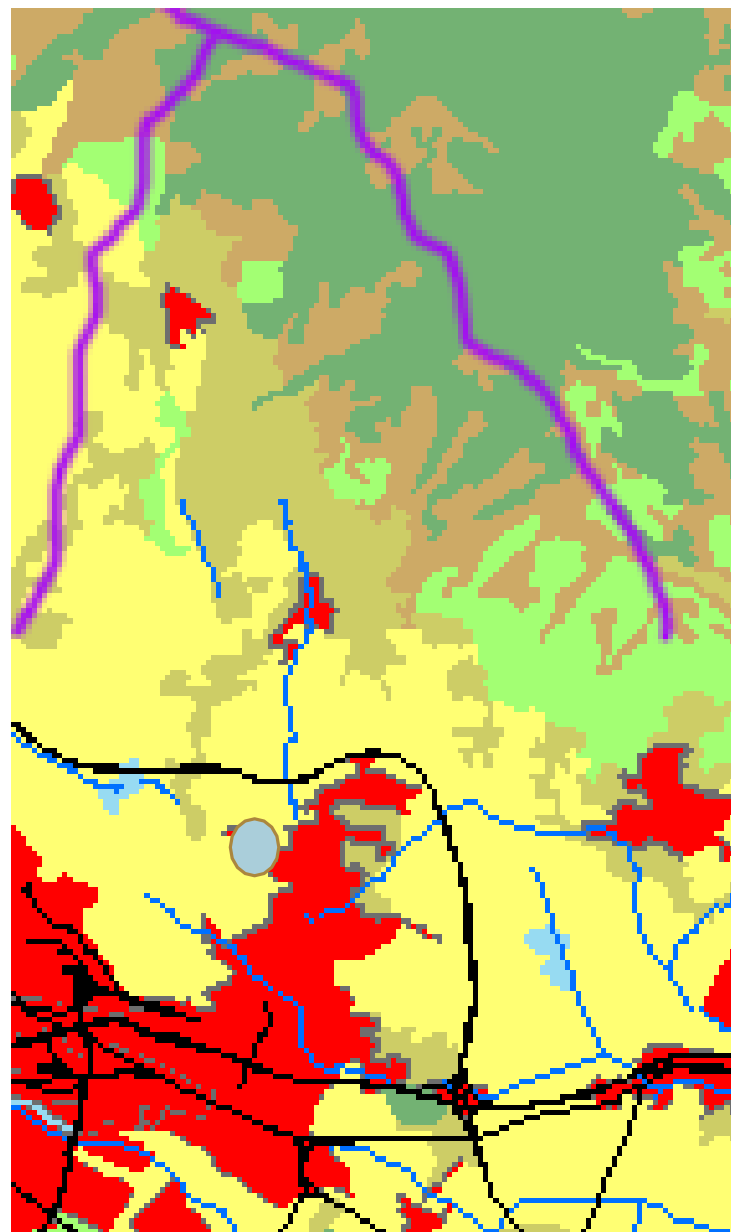
- Q - Quartzite
- Sb – Albite biotite schist
- M – Marbles
- X – metamorphosed rhyolite
- Ol - sandstones
- Pl3? – sand, clay, sandstone, limestone
- d – diluvial sediments
- pr – proluvial sediments
- b – organic swamp sediments
- i – sediments around
- Generally on the higher part of the mountain are eutric and district cambisols
- Below them is complex of chromic cambisols, colluvium and vertisols
- In the lowest part are fluvisols





LAND COVER

-  Bare land
-  Crops and Orchards
-  Heterogeneous agricultural areas
-  Scrub and/or herbaceous vegetation
-  Pastures
-  Forests
-  Settlements, artificial land
-  Inland waters, wetlands
-  Roads
-  Streams and Channels



LAND COVER



A VIEW on THE MOUNTAIN SKOPSKA CRNA GORA – 9.8.2016



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BARE LANDS everywhere





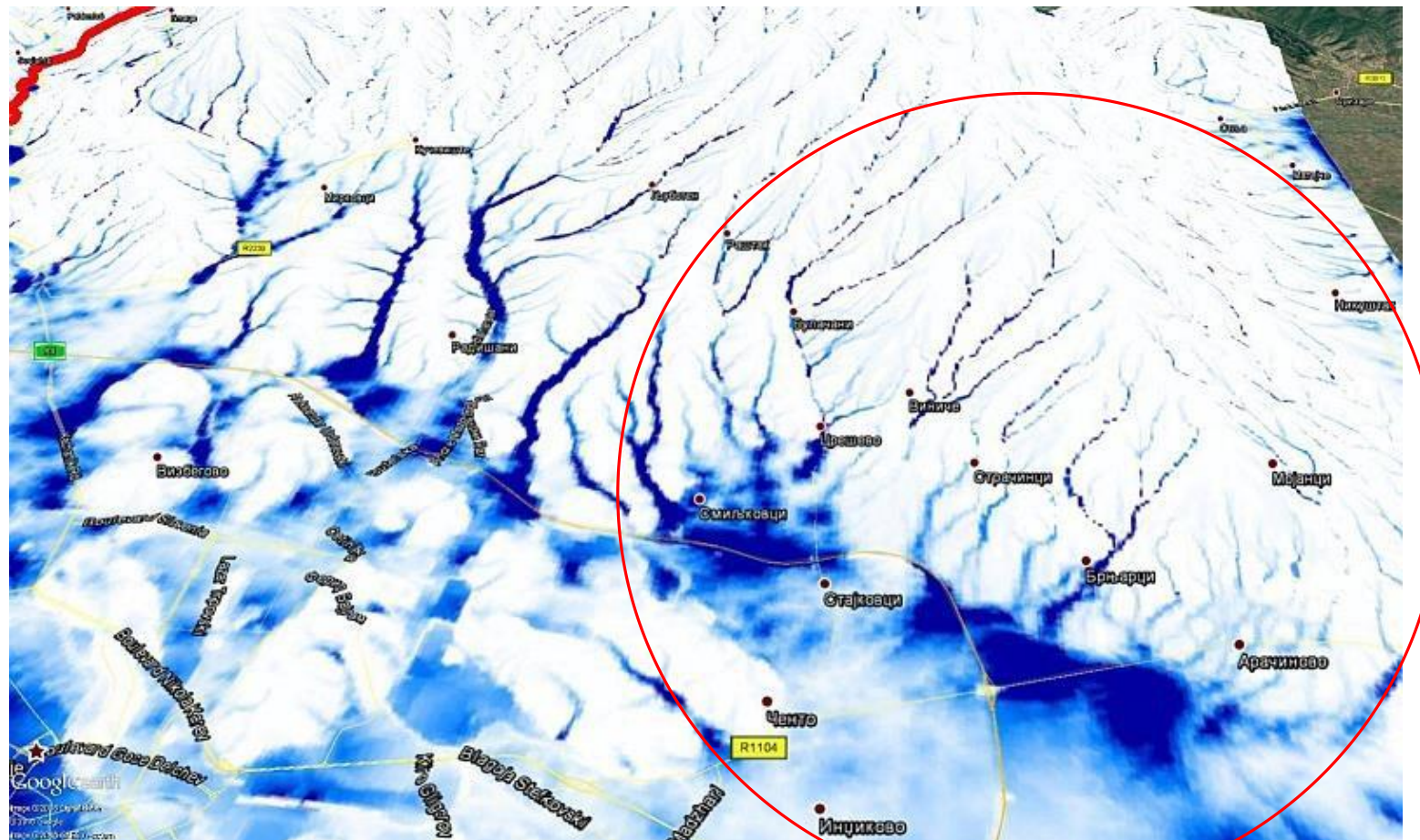
All natural factors favorable to appearance of:

- high rain erosion processes,
- High deep and lateral erosion
- Torrential character of the streams
- High peak of discharge in a short time (f.e. Stracinski poroj 30')
- Debris/ flows
- Sedimentation - rocks in the villages in the slope, mud in the valley

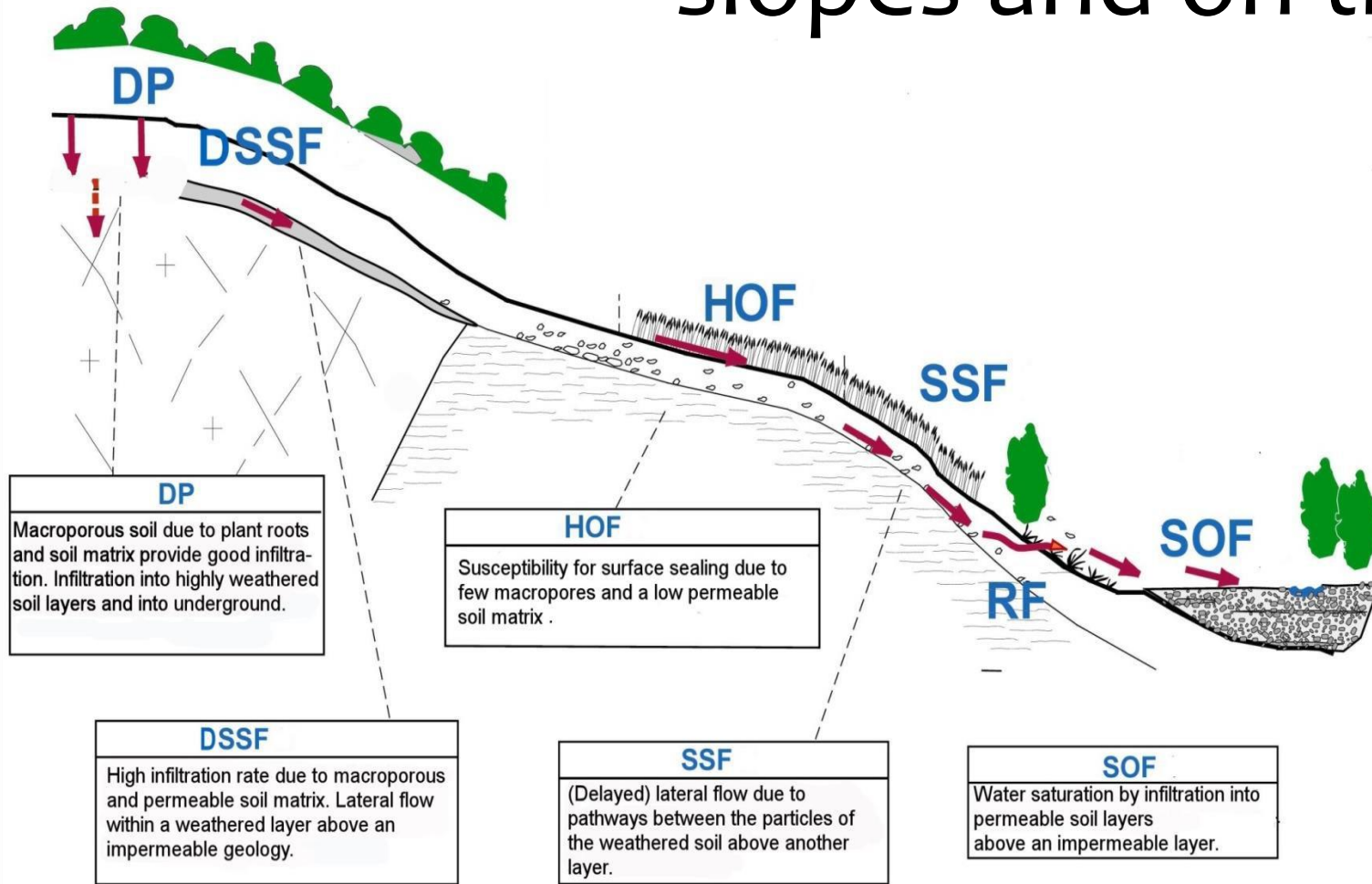




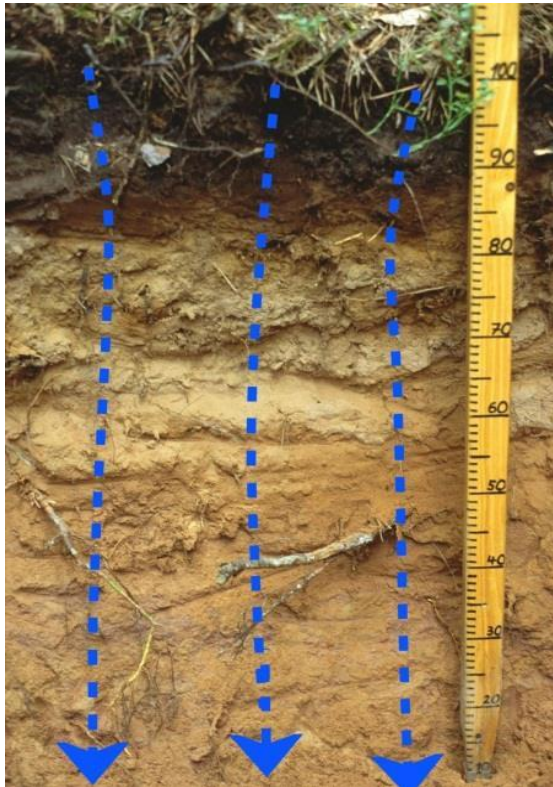
DRAINAGE SIMULATION(MILEVSKI I.)



Type of Runoff process on the slopes and on the forest roads



Site dependent Runoff

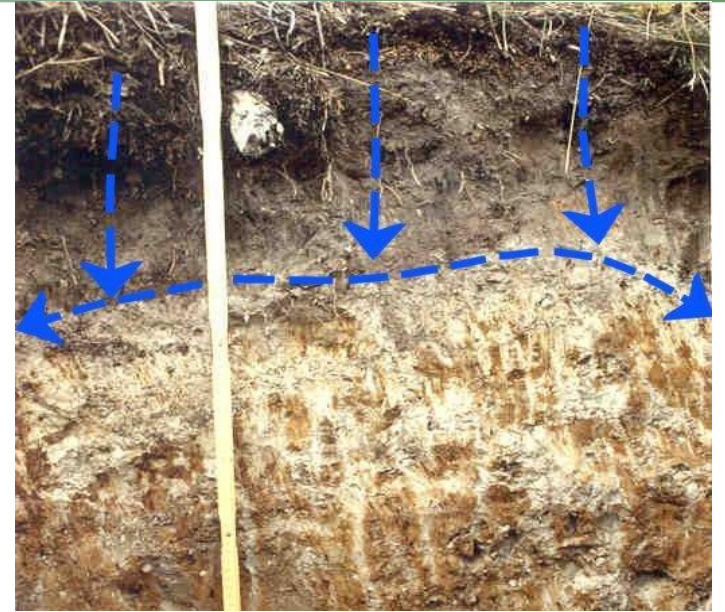


**Deep Percolation
DP**

**Saturated Overland Flow
SOF**



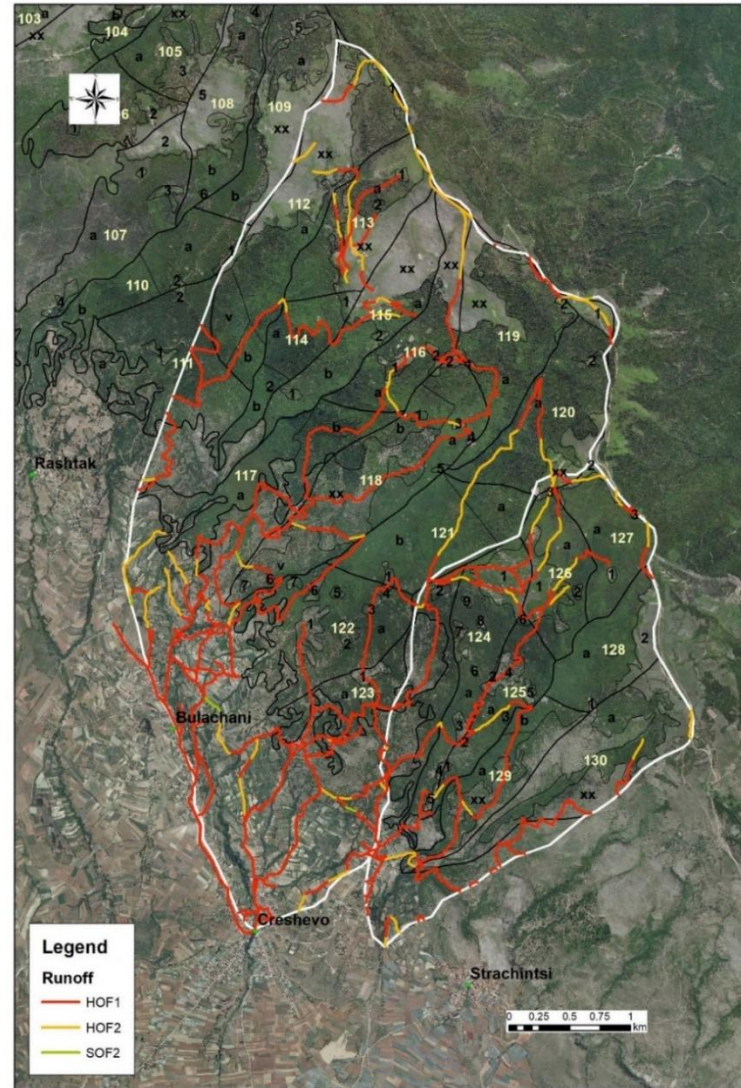
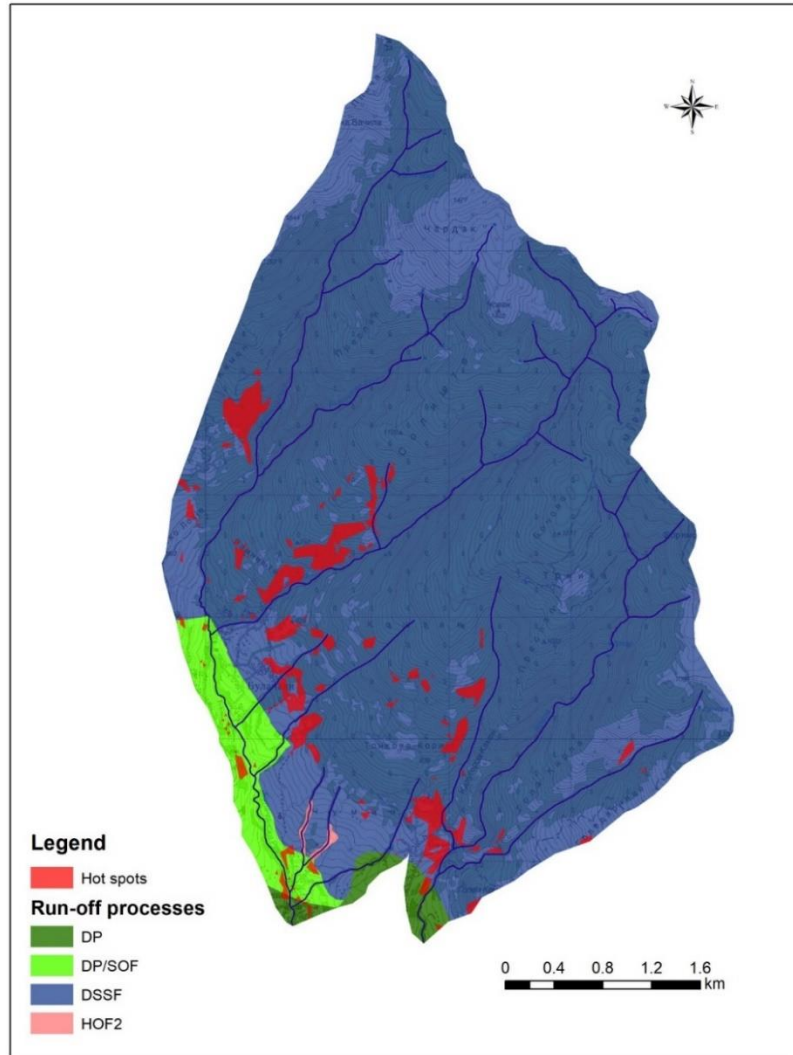
**Sub-Surface Flow
SSF
Interflow**



**Hortonian Overland Flow
HOF**



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



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PEAK OF DISCHARGE DURING THE EVENT – GAVRILOVIC CALCULATION DONE FOR PART OF THE CATCHMENTS ON THE PROFILES

NAME	F	L	S	D	A	S ₁	S ₂	W	(2gDF) ^{0,5}	Qmax	Qmax_s p
	km ²	km	km	m						m ³ /s	m ³ /s.km ²
Rastanski poroj	9,52	10,17	24,57	540,71	0,30	0,71	0,69	1,184	317,7	55,95	5,88
Bulachanska reka	15,47	8,48	23,67	686,44	0,33	0,70	0,54	1,193	456,5	67,61	4,37
Vrela Viniche	6,09	5,25	12,99	520,82	0,31	0,70	0,50	1,211	249,4	32,29	5,31
Strachinski poroj	0,80	2,06	4,71	155,71	0,29	0,64	0,78	1,237	49,4	8,96	11,23
Strachinski poroj 1	1,63	3,28	6,78	361,10	0,28	0,68	0,64	1,226	107,6	16,16	9,90
Brnjarska reka	2,79	3,77	7,85	358,21	0,28	0,69	0,67	1,222	140,0	22,30	8,00
Arachinovski poroj 1	3,64	6,50	14,81	356,25	0,29	0,71	0,72	1,204	159,5	28,90	7,94
Arachinovski poroj 2	0,71	2,50	5,73	147,00	0,30	0,65	0,93	1,233	45,4	10,06	14,10
Arachinovski poroj 3	1,85	2,23	6,11	170,45	0,32	0,74	0,86	1,235	78,6	19,90	10,76
Arachinovski poroj											



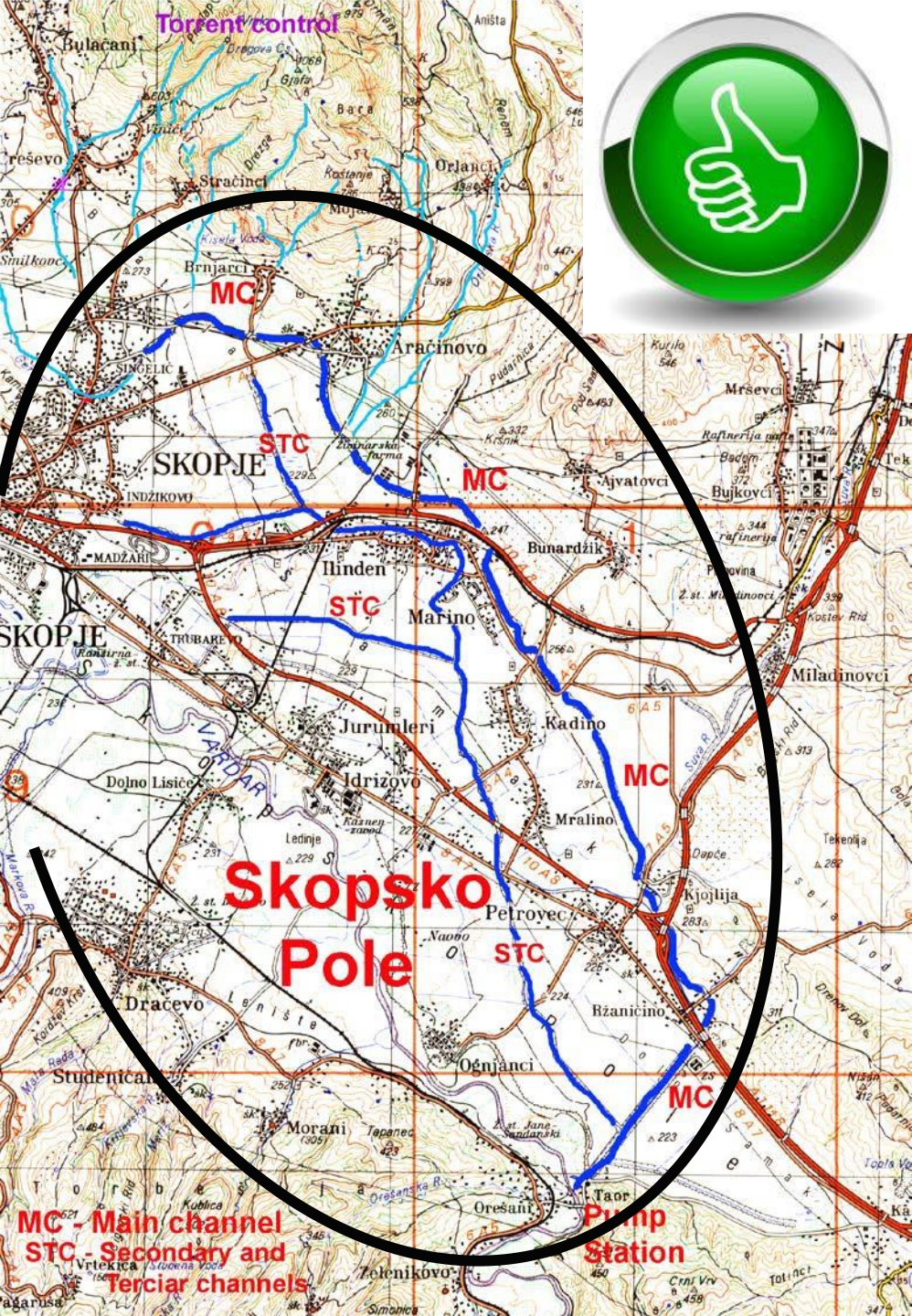


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HUMAN ACTIVITIES THAT INFLUENCE HAZARD

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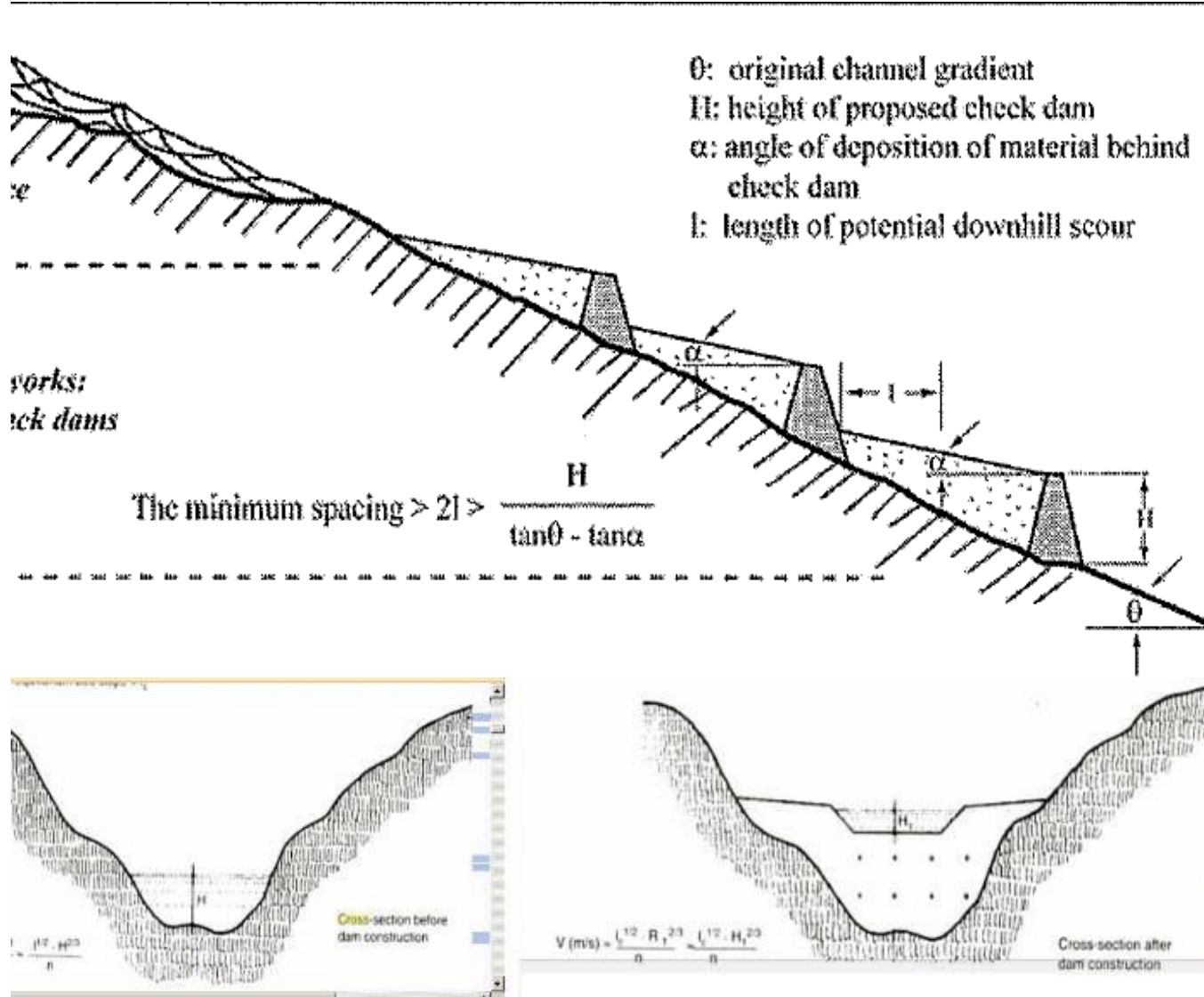




DRAINAGE WORKS AND TORRENT CONTROL

- Drainage of Skopsko Pole (wet area) started in 20's while main activities were in the 60's of the XX century
- Total drained area > 6000 ha.
- Surface water – main channel (collector) secondary and tertiary channels
- Ground water – main collector and additional network
- Almost all torrents regulated in the gorge parts with systems of barrages.
- Part of torrents regulated after the villages,

SYSTEM OF CHECKDAMS - CLASSICAL



- Material – Stone in cement mortar/ later concrete
- Maximal height – 4 m
- Built following all regulations in the 60's
- Role of Checkdam System
- Sediment retain
- Slope and Velocity decrease
- Protection of bed from scour and lateral erosion



CRESHEVSKA REKA



Stracinski Poroj I DREZGA



BRNJARSKA REKA





LAND COVER!

CHANGES OF FOREST COVE

QUESTION THAT NEED DEEP ANALYZE

CHANGES – HOW MUCH?

ILLEGAL CUT??

PLANNED INAPPROPRIATE





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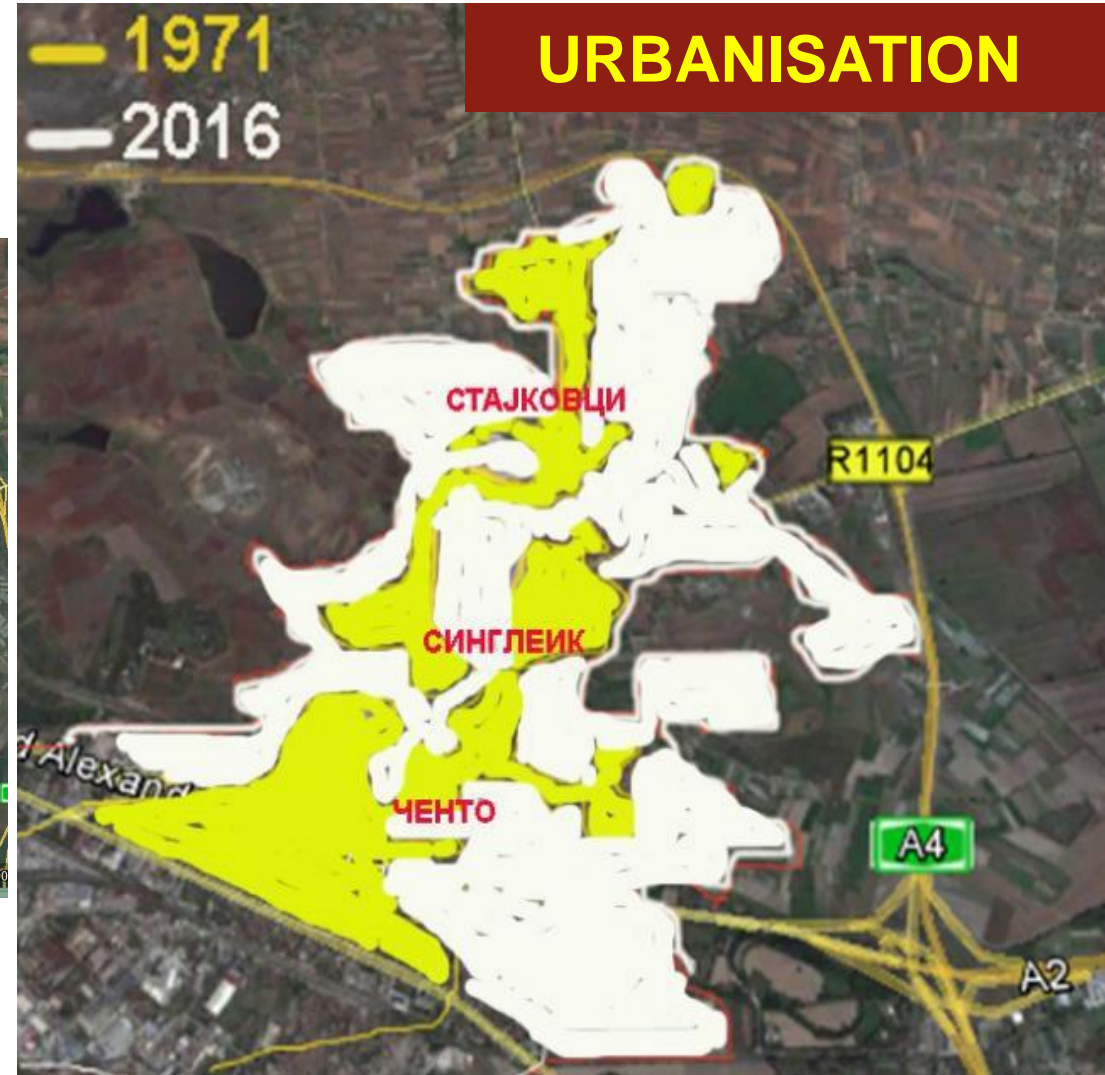
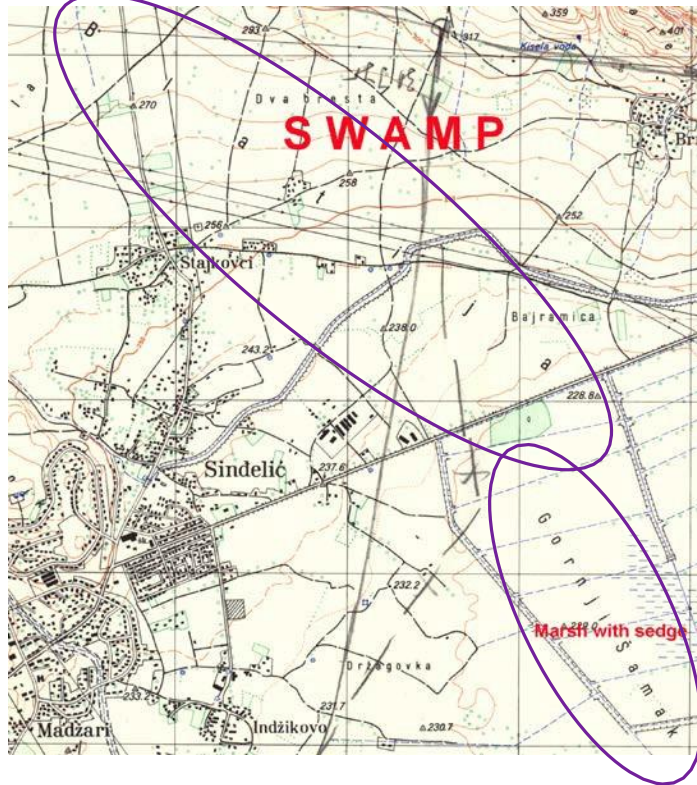
HUMAN INFLUENCE THAT INCREASE EXPOSURE AND VULNERABILITY

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UNPLANNED URBANIZATION IN APPROPRIATE AREA LATER LEGALIZED ILLEGAL BAN





HUMAN NONSENSSES – PEOPLE FROM THE AFFECTED AREA

- The usurpation of the stream bed and conversion in arable land
- Throwing garbage/waste into the bed!!!!
- Some objects (garages , shed, other auxiliary room, even extension of houses close or in the bed)!!!!
- No atmospheric drainage!!!!
- More then 1000 gutters for rain water from the houses ILLEGALY connected to the sewage network!
- Making “wild”crossing of the torrent without culvert !!!!
- NO AWARENESS





SPREADING OF WATER AND MUD IN THE VALLEY



Outflowing on the Curve



Not regulated bed in the valley





RING ROAD

- Located transverse to the torrent direction in the valley
- In this case has a role as a small “DAM” but significant length
- Water retention behind the Ringroad and creation of lake
- Ditches along the road designed for water from the road + water from the valley
- Culverts – several portal culverts (sus dimensions after the culvert again suspicious number and reading of water)





Road Stajkovtsi -
Cresevo

RINGROAD

OVERPASS



v. Stajkovtsi – the most
affected

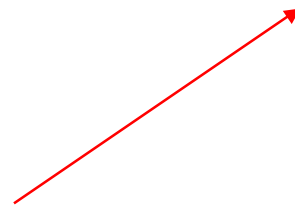


DITCHES – double function – receiving water from the road, collecting spread water from the valley





VERTICAL CONCAVE CURVE ON THE RINGROAD FORM BOTH SIDES TO THE OVERPASS – LENGTH ????





3 TORRENTS

A = 22 km²

**+ DIRECT RAINFALLS ON THE
VALLEY DESTROY VILLAGE
OF STAJKIOVTSI**

How MUCH WATER?

Torrent catchment 2,2 mil m³

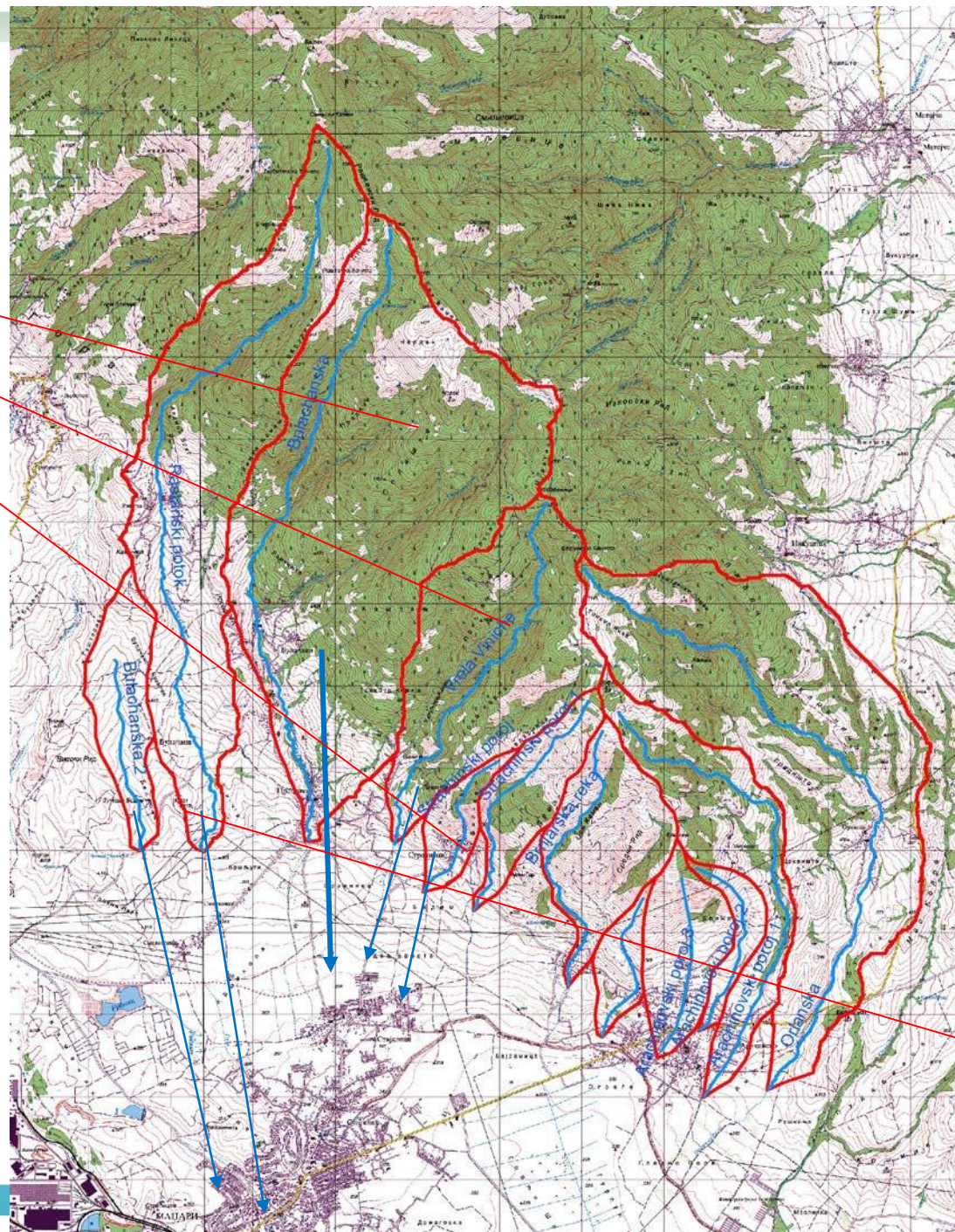
q=0,65

V =1,4 million m³

In the valley and village

7 km² – 0,7 million m³

TOTAL= 2,1 million



After passing village of Stajkovci part of the water was accepted in the main channel collector but significant part continue out and damaged village of Singelik and other settlements. Water from Smilkovski Torrent and Rastanski Torrent contribute to this.



SE

Culverts

Cresevska Reka

Vinicka Reka

Water retention behind the Ring Road

behind the Ring Road

Road slope Erosion

Overflow

Spreading

STAJKOVTSI

Alija Avdovikj

24
22

Stajkovski pat



ONLY WATER ??? What about SEDIMENTS





ENGINEERING FLAWS?????

- Road is designed very well according to the standards for driving but no for water issues.
- Revisor suggested to be prepared separate designs for torrent control in the valey. (statement of prof. Veljanaoski – one of revisers 15 years ago..).
- There is statement that there is general plan for evacuation of these water prepared 8 years ago????? (tbc)

Personnel opinion:

- Usually engineers use software with hydrology method that are not applicable for Macedonia and result in lower values and dimension are lower. Perhaps it is a case for dimensions of ditches.
- According to the law, forest engineers specialist for erosion and torrent control can not got license for designing torrent management designs??? (only civil engineers)





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**DOES ANYBODY
HAS AN IDEA
WHAT IS THIS?**

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RISK/HAZARD MANAGEMENT RIVER AND TORRENT FLOOD

- FUNDAMENTS OF RISK MANAGEMENT

- HOW TO AVOID RISK
- HOW TO TRANSFER RISK
- HOW TO MITIGATE RISK
- WHAT'S THE ACCEPTABLE LEVEL OF RISK

- **PRE-EVENT MEASURES**

- (STRUCTURAL AND NON- STRUCTUIRAL;
• FOR PREVENTION, FOR PROTECTION)

- **MEASURES DURING AND IMMEDIATE
AFTER THE EVNET**

- (RESCUE AND SHELETERING)

- **MEASURES AFTER THE EVENT**





PERSONEL EVALUATION OF LUNCHED MEASURES IN THIS CASE

0 – NOTHING (ZERO ACTIVITIES),

1 –BAD,

2 – POOR

3- MODERATE,

4- GOOD ,

5– EXCELLENT

*** NOTE**





Classification of countermeasures	Functionality of the countermeasures	Type of countermeasures	Protection	Prevention
Intensive structural countermeasures	Transversal protections, against bed erosion	Channel stabilisation works, weirs, dikes	X	3
	Longitudinal protections containing flooding	Levees, flood walls, embankments	X	1
	Stabilization of riverbanks, against lateral erosion	Rock, concrete, composite revetments, gabions or geotextiles revetments, ripraps, groins.	X	1
	Maintenance of bed river profile as and conveyance	Sediment excavation, artificial aggradations, river training (straightening, widening deepening, hard-lining), removal of structural operas with negative impacts / are incompatible / show to be anomalous with the flood management plan		1 X
	Diverge or reduce flood discharge	Sluices and flood control channels, detention ponds, dams,	X	-1
	Reducing the flood peaks	Reservoirs, retention polders, creation of temporary storage areas.		2 X





Classification of countermeasures	Functionality of the countermeasures	Type of countermeasures	Protect-ion	Preven-tion
Extensive structural countermeasures	Interventions aiming at influencing the flood formation mechanics	Renaturation		X
		Maintaining or increasing the total areas of the natural flooding areas	1	X
		Reforestation of hill slopes, soil use to reduce the total runoffs or increasing the duration of the rainfalls runoffs processes, increasing the infiltration and retention capacity of the soils, river rehabilitation;	-1	X
Non structural countermeasures	Real time flood prevision and communication	Evacuation of the total number of people at risk; roads and bridges closure,	X 0	X
	Regulation of soil use	Regulation, laws and acts, Flood Hazard Zoning, building regulations on constructions, technical layout of installations; regulations on timely evacuation.	0**	X
	Flood surveillance,	Real time control of the functionality of the defence system, including levees	0	X
	Ordinary maintenance		2	X

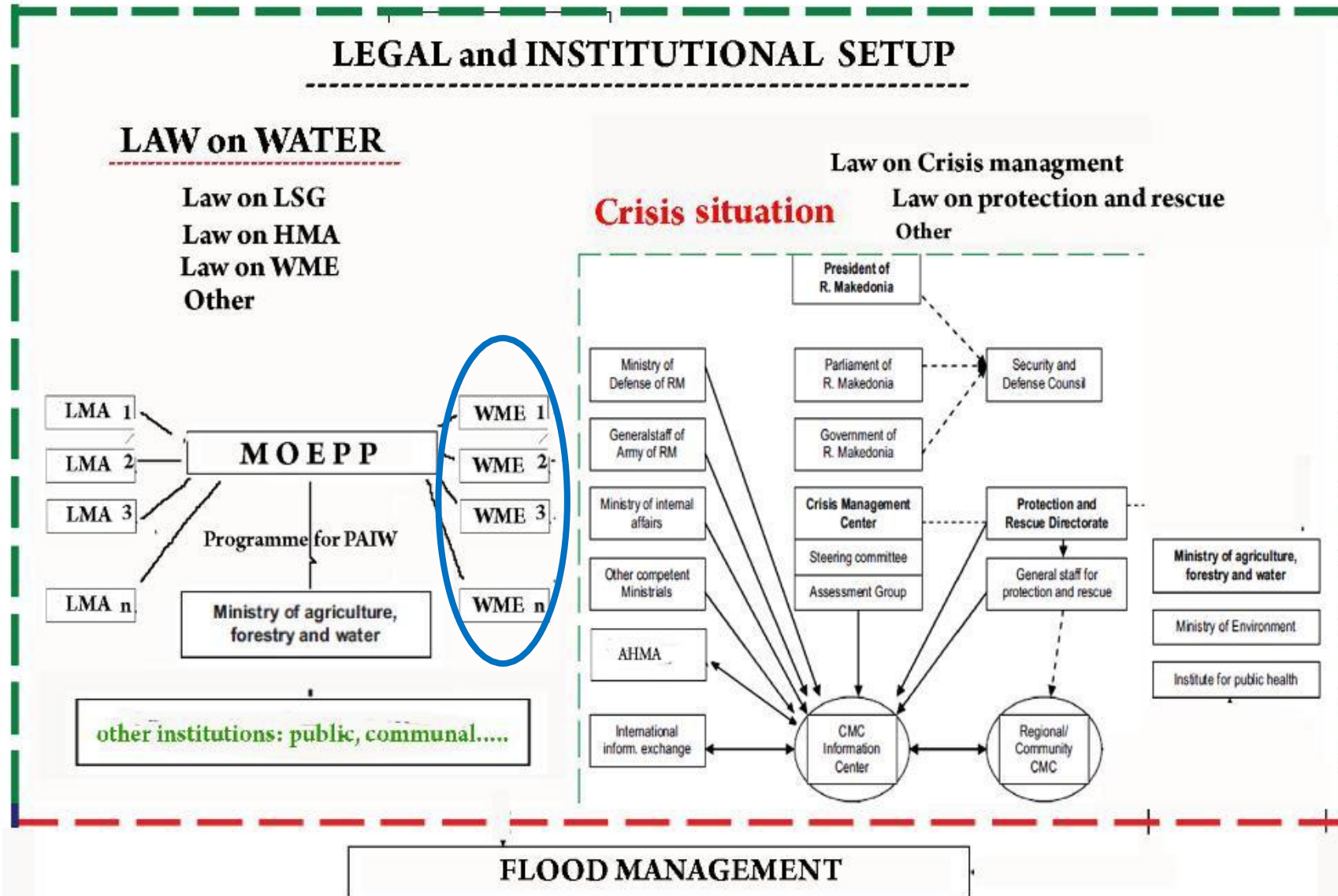




	Transposition	Implementation
Setting up of administrative arrangements – identification of the competent authority (Art. 3)	✓	✓
Description of floods which have occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity (Art. 4)	x	x
Assessment of potential adverse consequences of future floods for human health, the environment, cultural heritage and economic activity (Art. 4)	✓	x
Preparation of flood hazard maps and flood risk maps (Art. 5)	✓	x
Establishing appropriate objectives for the management of flood risks (Art. 7)	✓	x
Establishing measures for achieving appropriate objectives for the management of flood risks (Art. 7)	✓	x
Establishing appropriate steps for coordinating application of Directive 2007/60/EC and Directive 2000/60/EG (Art. 9)	✓	x
Publishing preliminary risk assessment, flood hazard maps and flood risk maps, flood risk management plans, making them available to the public	✓	x
LEVEL OF TRANSPOSITION OF EU FLOOD DIRECTIVE – 14% (ECRAN		



LEGAL AND INSTITUTIONAL SETUP





Law on WATER - Article 123 - Responsibilities for protection from adverse effects of waters

- (1) The municipalities, City of Skopje and municipalities in the City of Skopje authorities shall be responsible for flood protection and for protection from other adverse effects of waters within the urban areas under their competence.
- (2) The legal entities managing water management enterprises from article 191 of this law shall be responsible for protection and defence from floods and protection from other adverse effects of waters including flow regulation and maintenance of the shores and beds within the territory under their competence.
- (3) The state administrative body competent for environment shall ensure the coordination of the activities from paragraph (1) and (2) of this law undertaken by the municipalities, City of Skopje and municipalities in the City of Skopje.
- (4) The state administrative body competent for environment shall ensure the coordination of the activities from paragraph (2) of this law undertaken by the water management enterprises.
- (5) The state administrative body competent for environment, aiming at flood protection and for protection from other adverse effects of waters for the whole territory of the Republic of Macedonia, except for protection from adverse effects referred in paragraph (1) and paragraph
- (2) of this article, shall assign water management enterprises to be responsible for protection and defence from floods for protection from other adverse effects of waters





Article 124

Programme of protection from adverse effects of waters

- (1) For the purpose of protection against adverse effects of waters, the state administrative body competent for environment in agreement with the state administrative body competent for agriculture shall adopt a Programme for protection from adverse effects of waters as part of the river basin management plans.
- (2) The state administrative body competent for environment shall elaborate parts of the programme from paragraph (1) of this article referring to the territory under jurisdiction of the municipality, the City of Skopje and the municipalities within City of Skopje, on a basis of the programme of the municipality, the City of Skopje and the municipalities within City of Skopje.
- (3) The state administrative body competent for environment shall adopt parts of the programme from paragraph (1) of this article referring to the territory under jurisdiction of the water management enterprises, on a basis of the programme of the water management enterprises. The parts of the programme of the water management enterprises referring to the urban areas of the municipality, of the City of Skopje or of the municipalities within the City of Skopje, shall be adopted with cooperation between the municipality, of the City of Skopje or of the municipalities within the City of Skopje, and the water management enterprises.
- (4) The Programme from paragraph (1) of this article shall envisage preventive measures, construction of protection structures and facilities and measures to be carried out, as well as protection works implemented (construction of embankment, accumulations, regulation of rivers, regulation of torrents, protection of land against erosion, reforestation, etc).





POLICY - NATIONAL LEVEL – MINISTRY OF ENVIRONMENT AND PHYSICAL PLANNING

- No department, no unit , no person responsible for flood management.
- Water sector within the Ministry of Environmentpay more attention to water quality issues (more of the staff are chemists, technologist...) and perhaps they have no sense for flood management
- NO preliminary flood risk assessment, no flood hazard and risk maps, no good management plan
- NO Programmes for protection against adverse impact od water in the country
- Prepared “Proposal for establishing of Flood management system in the country





LAW ON LOCAL-SELF GOVERNMENT ARTICLE 22 – LIST OF COMPETENCES OF LSG

- 13 paragraphs out of them : 1- Urbanism , 2- Environmnet, 4 – Communal activities (utilities) – between other
- River training, maintenance and use of river beds in the urban area
- NO DIFFERENCE BETWEEN RIVER AND TORRENTS
- Training of torrents only with constructions of channels in the urban area without biological and hydrotechnical measures in the upstream areas for sediment retaining for streambank erosion control etc. IT is no correct!





WATER MANAGEMENT ENTERPRISE – NEW FORMED STOCK-SHARING ENTERPRISE IN STATE OWNERSHIP “ “WATER ECONOMY” (AD VODOSTOPANSTVO)

- LAW on WATERECONOMY – Off. Gazz. 51/2015
- Chapter II – Article 5 – Competences: supply of water for: drinking, irrigation, industry, drainage and River training
- New company – new emploment
- Department for catchment area control and river training
- employed people without capacity





INSTITUTIONS FOR EMERGENCY

- Everybody try to avoid responsibility
- State Hydro-meteorological Service state that this event couldn't be forecast (special case , old equipment)
- It was weekend (Saturday), evening and vacancy period – “reason” for “slow” reaction of the competent institutions in emergency????
- It should be analyzed later with aim to be avoid this type of disasters in future





SPECIALIZED EXPERT- SCIENTIFIC INSTITUTIONS

- In the period 1945 – 1990 existed special institution for design of torrent control (POROJ – PROEKT) – they prepared almost 300 erosion and torrent control designs
- In the period 1952 – 2005 Water Development Institute, beside designing worked on various studies for hydrotechnical structure conditions, over 1000 various design in the field, erosion torrent control, river training etc.
- No one specialized institution for this purpose in the country.
- Leaved to private companies for civil engineering.





RESUME

- High intensity rainfalls – Flooded cca 170 km², affected almost all city of Skopje
- In the most affected area *(northeast suburban part) 5 000 houses, 20 000 citizens
- At least 22 died, missing ????
- Catastrophic human activities contribute to the disaster
- no awareness of the people, illegal ban, low infrastructure, garbage in the channels
- Engineering mistakes on the ringroad,
- Channels (not cleaned)
- Slow reaction of institutions for emergency????
- FLOOD especially TORRENT FLOOD ARE NEGLECTED in the country





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

Благодарам на вниманието



Thank you for
your attention!

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

