



HANS EM  
FACULTY OF FOREST SCIENCES  
LANDSCAPE ARCHITECTURE AND  
ENVIRONMENTAL ENGINEERING



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

# **EROSION AND TORRENT CONTROL SYSTEM "VODNO" – UNIC ENGINEERING ACHIEVMENT**

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**SETOF workshop June 16th-17th, 2022 in Skopje, Republic of North Macedonia**

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"

Co-funded by the  
Erasmus+ Programme  
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# Location



# Vodno Mt. and SKOPJE



# Historical overview of the region

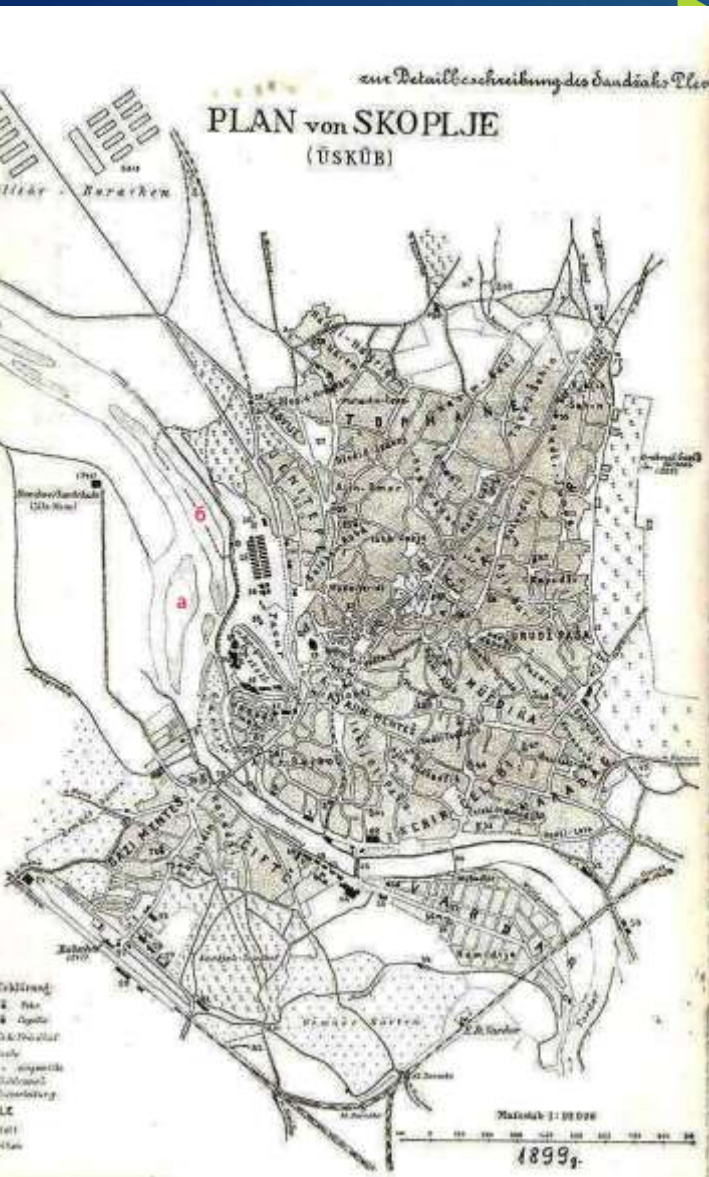
- ▶ Around Vodno Mt. has been existed settlements for millennia. Tomaz A. et al, stated that archeological data acquired during researches from neolith settlements at Govrlevo\_Cerje represent one of the best insight into construction and organization of space within and outside of the houses in the early **6 millenia BC**. [10]. It means that this area is settled at least 8 000 years.
  - ▶ **The territory of Skopje valley has been inhabited since at least 4000 BC[11].**
- ▶ Remains of Neolithic settlements have been found within the old Kale fortress that overlooks the modern city centre. **Originally is a Paeonian (Agrianians – Paeonian tribe) settlement Skupoi.**
- ▶ Later during the Roman empire, in the time of the emperor **Octavian Augustus, from 13 to 11 BC**, Skupi became the camp (castrum) of the two Macedonian legions - the 5th Macedonian and the 4th Scythian legion grew into a city. Later, **in 84 or 85 AC, Emperor Domitian founded the colony of Flavia Scupi**, a city with Roman self-government that was the largest in the area from Thessaloniki in the south to the Danube in the north. At that time Skopje experienced great development.[12]
- ▶ **In 518 AC, catastrophic earthquake destroy the city.**

During much of the early medieval period, the town was contested between the Byzantines mostly but the Bulgarian Empire too, whose capital it was between 972 and 992. From 1282, the town was part of the Serbian Empire, and acted as its capital city from 1346 to 1371. In 1392, Skopje was conquered by the Ottoman Turks, who called it *Üsküb*, with this name also being in use in English for a time. The town stayed under Ottoman control for over 500 years, [13]

According to Turkish traveler-writer E. Celebi, in Skopje In te mid of XVII century. there were 60 000 **inhabitants**. [14] Austro-Hungarian general Piccolomini, shortly conquered Skopje, but because of plague he burned the city in 1689. After that, Skopje was small city and easy growth.

Skopje was a part of Ottoman administrative unit Rummeli. Later, with administrative changes **from 1864, region belong to Kosovo vilayet with Prishtine as capital, and later from 1888 known as Skopje vilayet with Skopje (Uskub) as capital.** Up to the end of Ottoman Empire in this region (1912), Skopje was typical Turkish city. According to the Ottoman census 1833, within the City dominate Muslim population (56,5%) vs Christians (32,35%) while in the Skopje Kaza (region – Skopje +126 villages) dominate Christians (51,63%) vs Muslims (43,71%).[15].





With the construction of the railway and the first railway station in 1873, the city began to spread somewhat shyly at the beginning, on the right side of Vardar river and the first quart was Gazi Mentesh maalo. After the collapse of Ottoman Empire, region was annexed by the [Kingdom of Serbia](#) during the [Balkan Wars](#) (1912-1914). During the First World War the city was seized by the [Kingdom of Bulgaria](#), and, after the war, it became part of the newly formed [Kingdom of Serbs, Croats and Slovenians later \(1929\) Kingdom of Yugoslavia](#) and in [become a](#) capital of new established administrative division [Vardarska Banovina](#) that cover Republic of North Macedonia and parts of Srbija and Kosovo

**Because until the end of the 19th century, Old Skopje was only on the left bank of the Vardar,** there were no direct dangers to people and their buildings except for those who had agricultural property. It means that beside significant flood hazard, exposure to flooding was very low (minimal population, absence of critical objects, no economic structures, factories etc.). After the emigration of Turkish people (starting from collapse of Ottoman Empire) and especially after the I WW, a lot of people from surround villages but also from everywhere arrived in Skopje and settled mainly right side of Vardar river forming new quarts.

- **IN 1963 Skopje was fully ruined by catastrophic earthquake.**

# Flooding of Skopje by Vardar and torrents



# Chronology of important moments in the last 100 years

- ▶ In 1913/14 A special commission from the Kingdom of Serbia inspected the condition of the forests in Sputh Serbija (Vardar banovina) including Vodno), where a catastrophic condition was determined



- ▶ Barelands are visible, deep torrents too and signs of gully erosion. Vodno Mt. was generally with a neglected percent of forest and dominated agricultural land and barelands.
- ▶ In **1922**, the Law on Forests of the Kingdom of SCS was adopted.
- ▶ With Dracevo resolution (**1923 or 1925**) the Association of Engineers and Technicians of Vardarska Banovina, among other things, states that due to the permanent floods from the torrents from Vodno, measures should be taken to protect against flooding.
- ▶ Immediately after that, a **forest nursery was established** on the slopes of Vodno (first at Nerezi village **in 1924**, and then at the location of current Medical Faculty on the slopes of Vodno, where seedlings for afforestation of Vodno were produced, but also in the locality of Jurija in Skopje).
- ▶ The **initial afforestation** of Vodno was carried out in **1928**. Before that there were only some experiments related to afforestation, with different types of seedlings, different soil preparation, different care, different species, different type of planting etc. (1925-6 - eng. V. Shjacki).





1920 - 1925



1940 - 1945



- ▶ **1930** – **Law on torrent control** of the Kingdom of Yugoslavia - there are notice that existed canals on central torrent on Vodno. Knowing that in the In the 30,s started construction of canals into the torrent beds everywhere, probably this canals are from this period .
- ▶ In **1931** A tax has been introduced on goats that have been found to destroy forests, cause erosion and endanger material goods.

# Skopje 1920 vs 2020

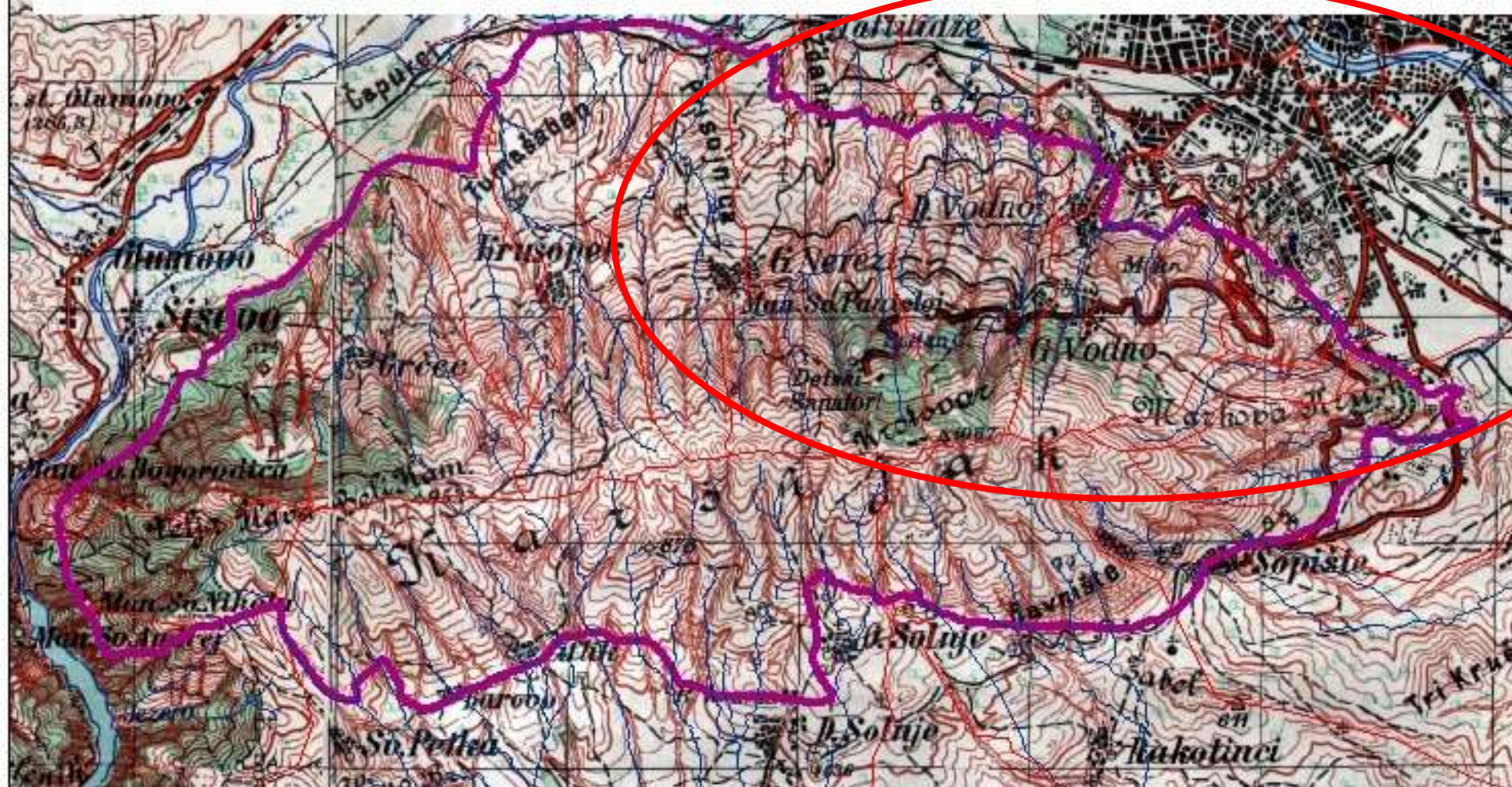


- ▶ After the II World War, there were several administrative divisions, but mostly appeared: district, city, city municipality, municipality. Competent bodies for management of natural resources were district administrations (People board of the district) After the World War II in 1946. and 1948. afforestation continues, and prisoners also took part in afforestation on the most difficult terrains..
- ▶ **After 1945 - establishing of Republic Directorate for torrents** as a part of the Government in the period after the II World War was There is no data when this directorate was abolished and transformed.
- ▶ **13.03.1950 – Establishing of Enterprise for afforestation and torrent control "VODNO"**  
Taking in consideration barelands, high intensity of erosion processes and frequent flooding, Government of the People's Republic of Macedonia made decision No. 885 from March 13, 1950 - and established a **Enterprise for afforestation and torrent control "VODNO"**, probably after the proposal by Republic directorate from torrents. There is no data available, when this enterprise was abolished and transformed.
- ▶ **1950s – Establishing of Water economy "Vardar"**
- ▶ **On 5.01. 1951 – Law on Afforestation** (Official Gazette of the PRM No. 1/51) was adopted.

## On 1.6.1951, happened the last great catastrophic flooding of Skopje from torrents from Vodno Mountain

- ▶ *\*) "The uprooted roses turned red on the yellow mud"*
- ▶ *In the morning, the streets were still covered with stones and water, and the sound of pumps pumping water from the cellars could be heard everywhere. At the same time, trucks and cars loaded with stones poured into the streets. One victim was included in the final balance.*
- ▶
- ▶ The general conclusion then was:
- ▶ "Measures should be taken not to repeat the same, and the measures would be: afforestation, repair of the old ones and construction of new collection canals on Vodno, in order to regulate any eventual torrent that could threaten."
- ▶ *\*) Excerpt from an entry contained in the daily newspaper "Nova Makedonija", number 1998, published on 3-06-1951, on Sunday. Consequences of the breakthrough of a cloud over Vodno, 01-06-1951, 5 o'clock in the afternoon ...*

## Vodno Mt. - situation before 1951

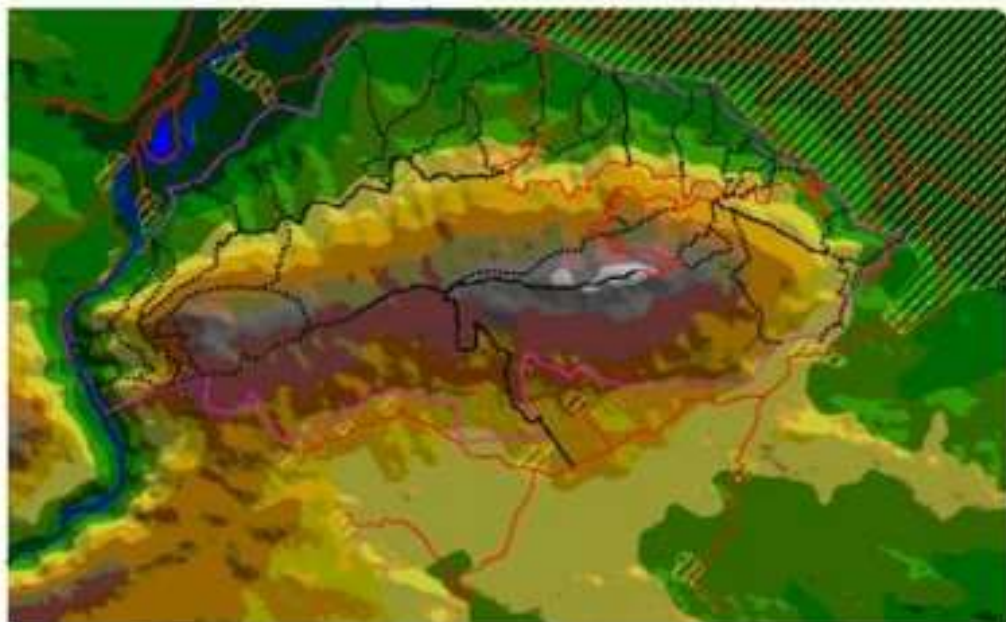


Area –  
4500 ha

Forests –  
451 ha  
10%

- ▶ On **8.03.1954** Executive Council (Government) of the PRM brings a **Decision for determining areas prone to erosion No.1 - Vodno**, (Official Gazette of the PRM 6/54). **Part of Vodno Mt.** (northeastern slopes toward city of Skopje i.e. from villages Sopiste and Pirpor (on east) to G. Nerezi (west), on the crest of Vodno (south) and northern border was in a current part of the Skopje City (Przino, Crnice..). **was proclaimed as erosive area.**
- ▶ **11 09. 1954 - Decision of the Executive Council (Government) for afforestation of 560 ha on the mountain Vodno** on areas prone to erosion (Official Gazette of the PRM no. 28/54).
- ▶
- ▶ **23.04.1957** - (Official Gazette of the PRM no. 11/57). 3 important laws:
- ▶ **Law on protection of steep lands from erosion and torrent control** was adopted. This law was in fact extension of previous law from 1952 that was focused on agricultural land.
- ▶ **Law on forest** - regulate forest management
- ▶ **Law on water** – regulate water management
- ▶ **Guidelines for implementation of measures for protection of steep lands from erosion** (Official Gazette of the PRM No. 29/57)

Park-forest Vodno and neighbourhood - DEM

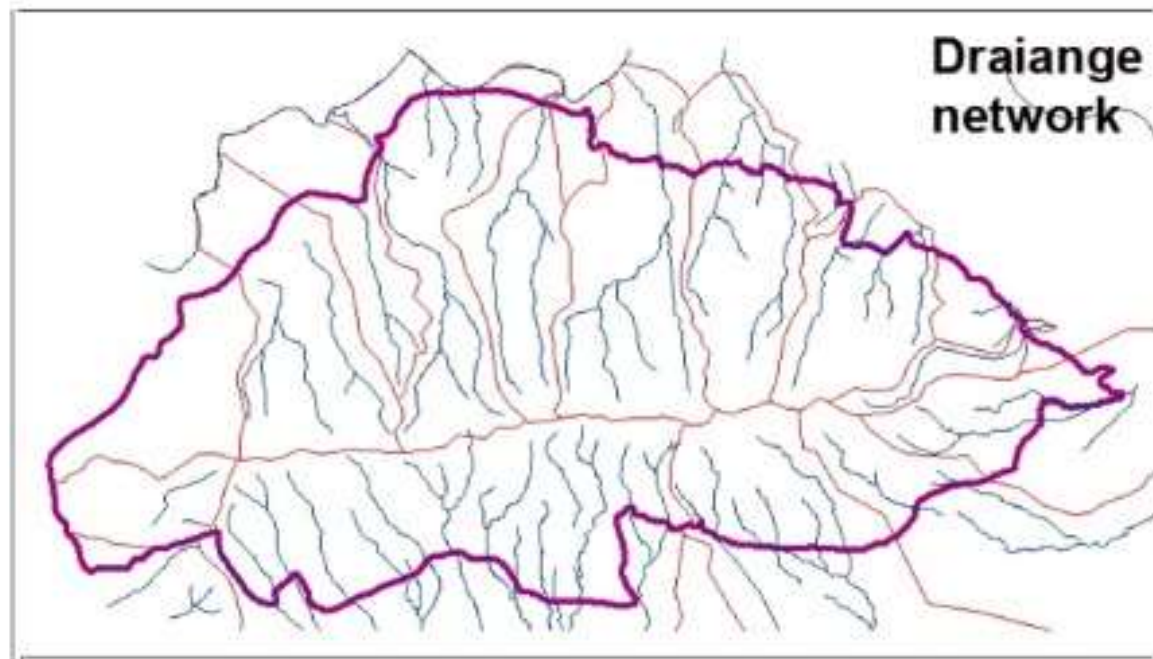


- Asphalt road
- Path
- Macadam road
- Rivers
- Reservoir
- Border of the Park f
- Settled area

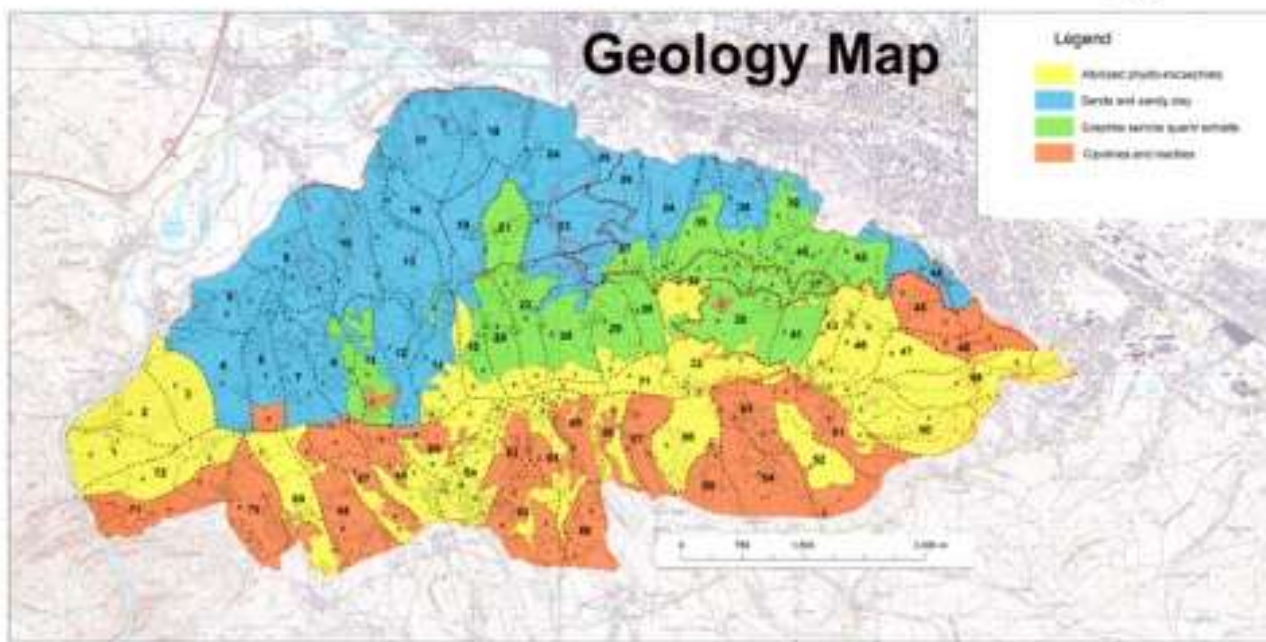
- ALTITUDE
- 200-300m
  - 300-400m
  - 400-500m
  - 500-600m
  - 600-700m
  - 700-800m
  - 800-900m
  - 900-1000m
  - 1000-1060m



Drainage network



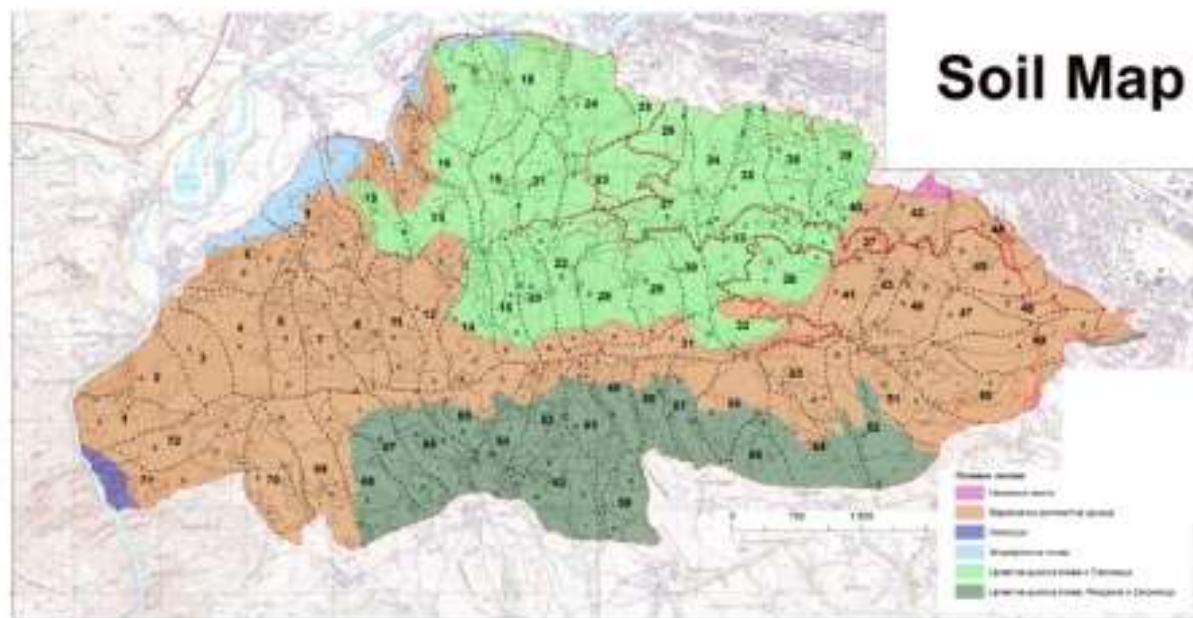
Geology Map



Legend

- Metased. phyllosilicates
- Sands and sandy clay
- Gneiss, mica, quartz schists
- Crystalline amphiboles

Soil Map



- Soil types
- Brown forest
  - Brown forest
  - Brown forest
  - Brown forest
  - Brown forest
  - Brown forest
  - Brown forest

# Erosion and Torrent Control measures

- ▶ After proclaiming of part of Vodno as erosive area (1954), several administrative decisions were adopted.
  - Firstly, citizens (up to 400) of two villages (Dolno and Gorno Vodno ) located within the erosive area were **displaced** and their land was expropriated. They got land on the lowest slopes of Vodno that belong to urban plan of the city of Skopje.
  - In the same time, some **bans in the erosive area** were passed as follow: ban on cultivation of agricultural land, ban on grazing, ban on constructions, ban on wood cutting, ban on collection non wood products.
- ▶ **An obligation for afforestation** of all non-forested land was adopted. Government ordered afforestation of 560 ha and provide finances from the state budget. In the highest location of central part of the urban area, was constructed elite quart where lived people on the highest position in the country including president residence. Beside security officers of this people, additionally was set a police station on the end of the quart near the former village D. Vodno. It enabled safety of the mass young plantations as well as new hydraulic constructions in the neighborhood of this elite quart



# Afforestation

- ▶ As it was mentioned before, the Government in 1954 adopted decision for afforestation of 560 ha of the land proclaimed as erosive land. A terrain is unprecedentedly difficult, dominate calcomelanosol with depth 5 to 23 cm but hole for seedling should be at least 30 cm, while in some places a huge slope (especially in the canyon part of the torrents) was a great barrier.
- ▶ According to the plan, was decided some plantations to be realized in holes, some in mini terraces – cordons, somewhere in furrows. Probably were used any wattles or fascines (personal opinion created knowing the principles in this period) but because of limited durability they don't exist now.
- ▶ In these activities on afforestation participated citizens of Skopje, employees in various institutions and students. Afforestation mostly was done in cordons or in holes.
- ▶ On the most shallow sites, where soil was very shallow and rocks were almost on the surface, was used explosive for opening holes.
- ▶ Soldiers and prisoners worked on the hardest terrains. Afforestation was done somewhere with a high density of seedlings even 6000-10000 seedlings / ha.

**Cordons**

**Cordons**

© 2021 Google  
Image © 2021 Maxar Technologies

Google Earth

Imagery Date: 10/20/2020 41°58'20.02" N 118°25'28.74" E elev: 470 m eye alt: 1.50 km



# Cca 110 domestic and 106 alochtonous species were used

<i>Pinus nigra</i>	<i>Cheilanthes persica</i>	<i>Sesleria juncifolia</i>	<i>Edraianthus kitaibellii</i>
<i>Pinus silvestris</i>	<i>Ephedra major</i>	<i>Lilium martagon</i>	<i>Ashillea holosericea</i>
<i>Pinus brutia</i>	<i>Lilium candidum</i>	<i>Fritillaria tenella</i>	<i>Ashilea aizoon</i>
<i>Cedrus atlantica</i>	<i>Fritillaria graeca</i>	<i>Convallaria majalis</i>	<i>Hieracium pannosum</i>
<i>Cedrus deodara</i>	<i>Ruscus aculeatus</i>	<i>Iris pumilla</i>	<i>Phillitis scolopendrium</i>
<i>Pseudotsuga menziesii</i>	<i>Sternbergia colchiciflora</i>	<i>Iris sintenisii</i>	<i>Juniperus Foetidissima</i>
<i>Cupresus sempervirens</i>	<i>Iris reichenbachii</i>	<i>Orchis tridentata</i>	<i>Achilea frasilii</i>
<i>Cupresus arizonica</i>	<i>Orchis purpureus</i>	<i>Corylus colurna</i>	<i>Physsalis alkekegni</i>
<i>Taxus baccata</i>	<i>Himanthoglossum hircinum</i>	<i>Celtis austarlis</i>	<i>Globularia bellidifolia</i>
<i>Magnolia soulangeana</i>	<i>Aristolochia macedonica</i>	<i>Silene saxifraga</i>	<i>Orobanche purpurea</i>
<i>Mahonia aquifolium</i>	<i>Alyssum scardicum</i>	<i>Cerstium lanigerum</i>	<i>Valetiana dioscoridis</i>
<i>Morus alba</i>	<i>Mathyolla tristis</i>	<i>Dephinium fissum</i>	<i>Campanula thessala</i>
<i>Morus nigra</i>	<i>Sempervivum heufelii</i>	<i>Alissum corymbosum</i>	<i>Inula adchersoniana</i>
<i>Ficus carica</i>	<i>Saxifraga grisebachii</i>	<i>Eryssimum comatum</i>	<i>Achillea serbica</i>
<i>Juglans nigra</i>	<i>Spiraea crenata</i>	<i>Saxifraga aizoon</i>	<i>Paulownia tomentosa</i>
<i>Cercis siliquastrum</i>	<i>Geum rivale</i>	<i>Saxifraga scardica</i>	<i>Catalpa bignoides</i>
<i>Gleditshia triacanthos</i>	<i>Podocytisus caramanicus</i>	<i>Malus florentina</i>	<i>Adoxa moschatallina</i>
<i>Laburnum anagyroides</i>	<i>Genista nysaaana</i>	<i>Potentila taurica</i>	<i>Knautia macedonica</i>
<i>Robinia pseudoacacia</i>	<i>Coronilla cretica</i>	<i>Geum argenteum</i>	
<i>Allanthus glandulosa</i>	<i>Acer marzicum</i>	<i>Cytisanthus trifoliolatus</i>	<i>Calamintha grandiflora</i>
<i>Acer negundo</i>	<i>Daphne oleoides</i>	<i>Kitaibella vitifolia</i>	<i>Stachys scardica</i>
<i>Aesculus hippocastanum</i>	<i>Epilobium dodonaii</i>	<i>Eryngium wiegandii</i>	<i>Lonicera tatarica</i>
<i>Euon japonica</i>	<i>Trnia citaibellii</i>	<i>Trinia glauca</i>	<i>Ramondia nathaliae</i>
<i>Fraxinus americana</i>	<i>Lasperpitium garganicum</i>	<i>Athamantha haynaldi</i>	<i>Micromeria cristata</i>
<i>Forsitia suspensa</i>	<i>Vinca herbacea</i>	<i>Arctostaphilos uva ursi</i>	
<i>Simphoricarpus orbiculatus</i>	<i>Symphytum ottomanum</i>	<i>Cynychum acutum</i>	
<i>Simphoricarpus racemosus</i>	<i>Sideritis scardica</i>	<i>Asperula taurina</i>	

VODNO 1920 - risk for Skopje

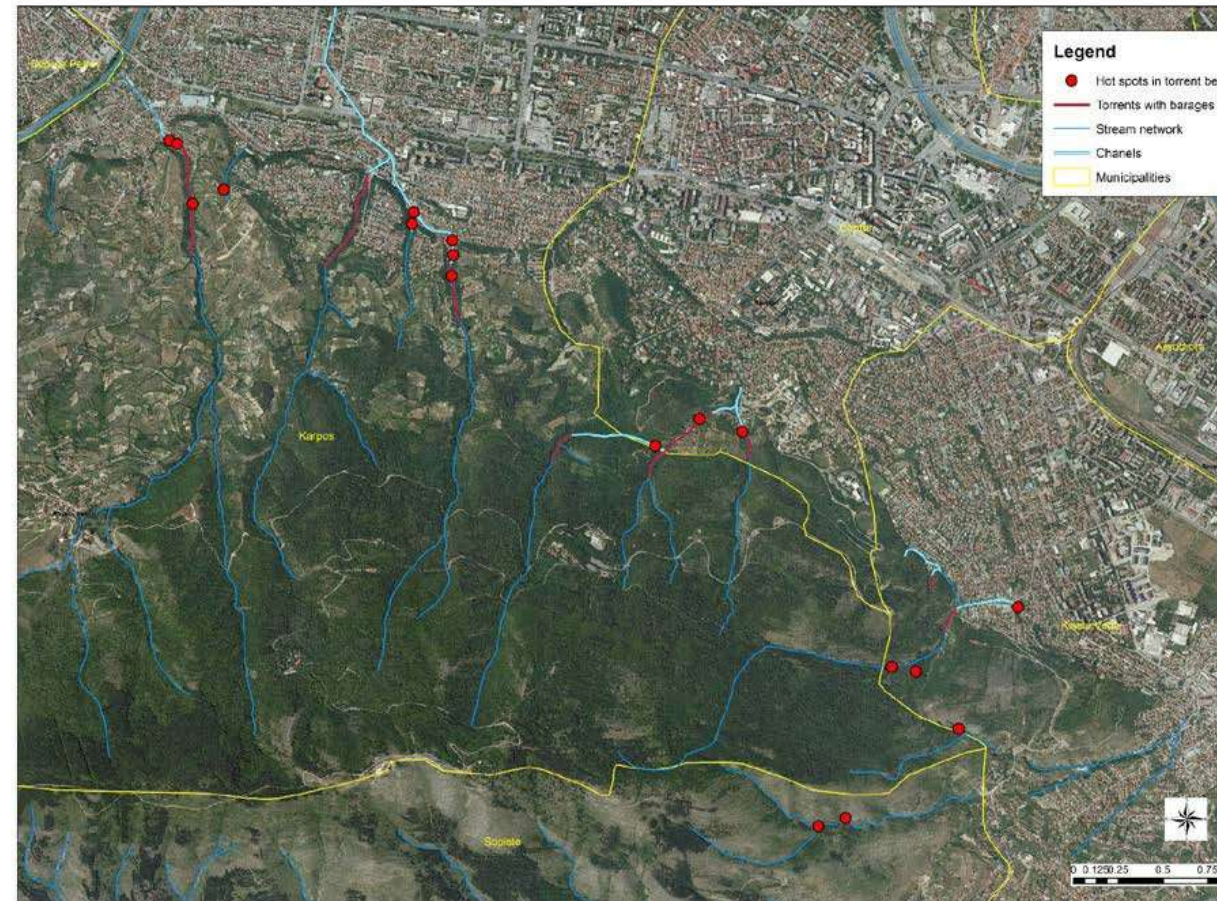
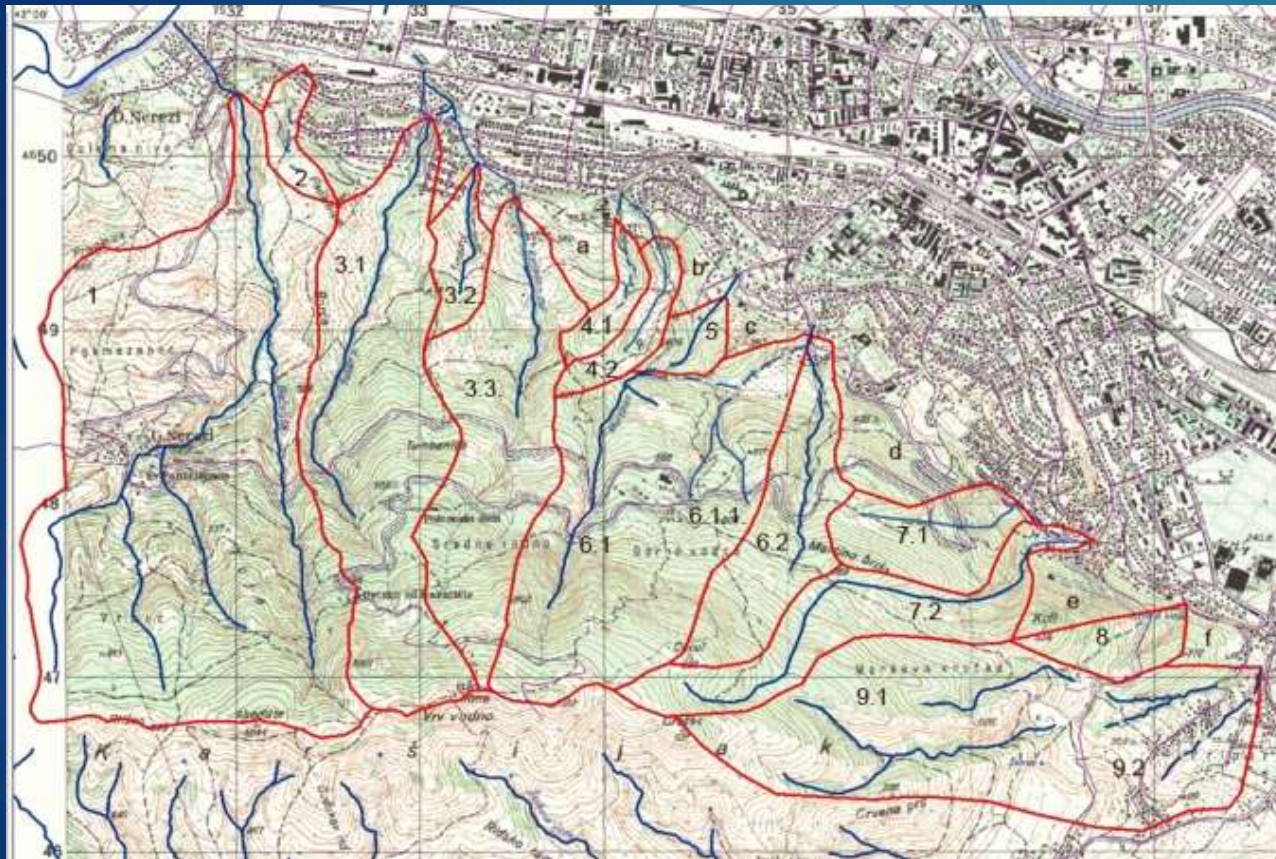


VODNO 2010 - "Lungs" of Skopje



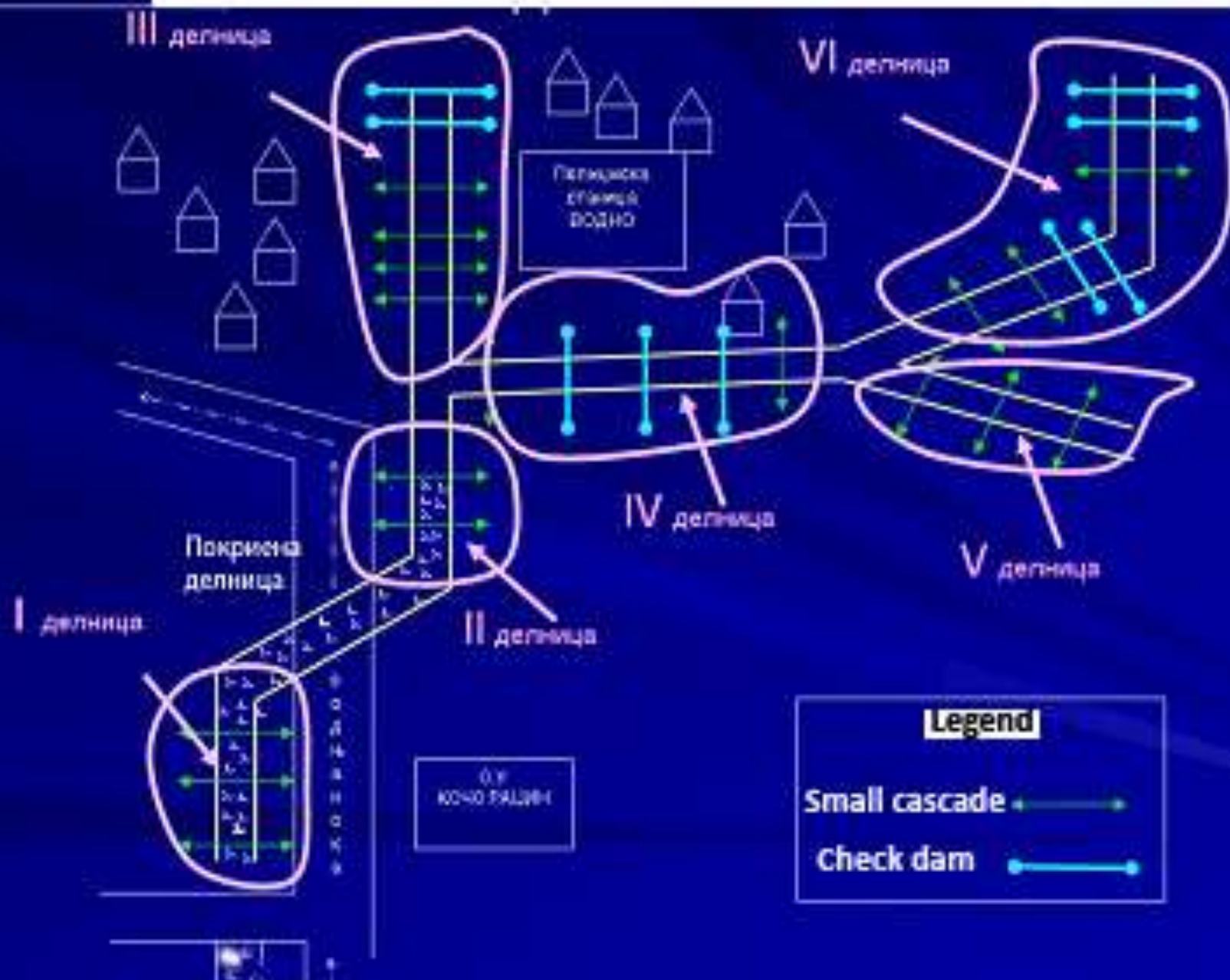
# Hydraulic measures

- ▶ 1 independent torrent
- ▶ 3 systems of coletor canals and drained canal to the Vardar
- ▶ 1 independent torrent (unregulated)





# Scheme of torrent management in Central Vodno series







# Results up to the 1969

- ▶ Afforested – at least 540 ha bare lands
- ▶ Regulated – 10 torrents and tributaries (later additionally 2)



Figure 1 Vodno Mt. – forest cover 1951 and 1971

**21.10.1970 – Law on Republic Fund for Afforestation of barelands** (Official Gazette of the PRM no. 25/70). Additionally cca 500 ha barelands afforsted

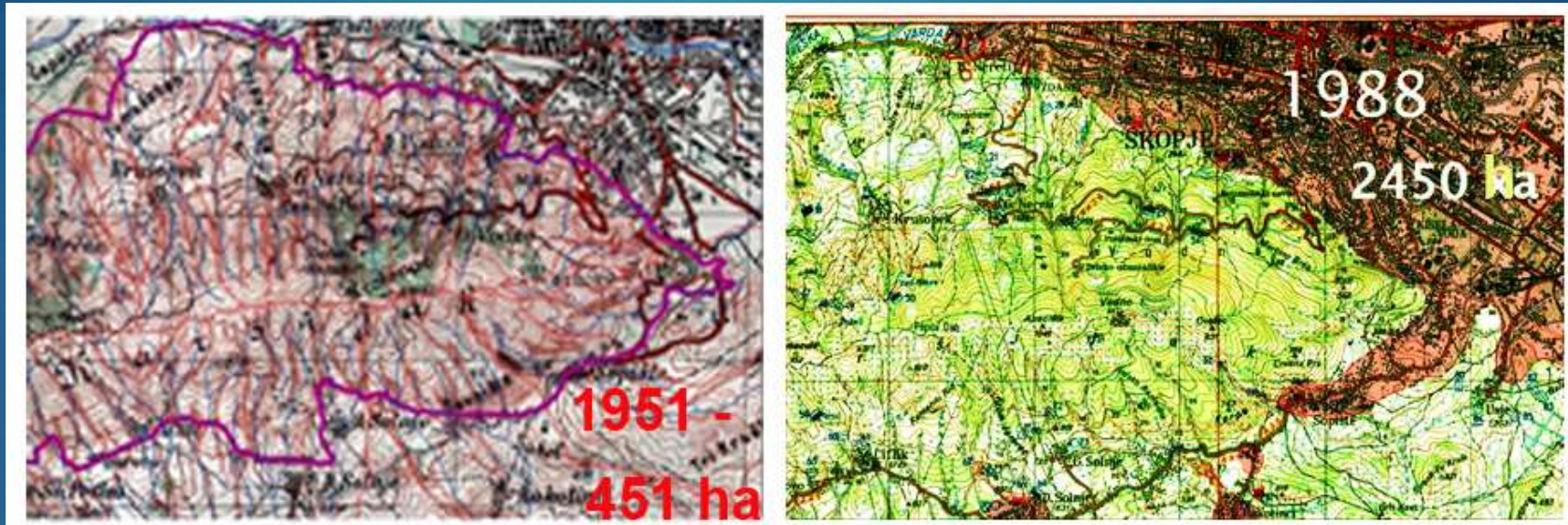
# “Empowering” of protection ??????



- ▶ **1970** - With the decision of Assembly of the City of Skopje in 1970, the previously declared Erosion Area (the Nerezi - Pripor section) has been declared a **Landscape with Special Natural Features** (PPPK) with name CITY PRK FOREST VODNO.
- ▶ It is very strange taking in consideration that human influence was significant in this area (afforestation, arable land, vineyards, orchards..). Perhaps an idea was the area to be protected on any way.
- ▶ According to the land cover classification, 35% of the area is not naturally covered (now is 43%) and is question how this area could be recognized in article 19 where is strictly written that areas should be **created naturally**. Additionally, 50% of the area (now 23%) are natural grasslands. Yes it is natural, but can not been recognized in known definition of park forest. It means that in 1971, 80% (now 77%) can not be recognized within article 19 or in world definition of park forests.
  - ▶ **The real reason is that Vodno is above Skopje and must be protected because of military – security needs**

# Current situation

- ▶ 2579 ha forests (in 1951 – 451 ha).
- ▶ Only 1 torrent remains unregulated and the eastern system hasn't been finished yet.



The first Forest management plan was launched in 1993.  
The City of Skopje is competent body for management of PA VODNO ,  
mainly PE Parks and Greenery but also other city communal enterprises  
responsible for hygiene streets, Water supply and Traffic .

Human stupidity and idiocy, especially  
of those in the highest positions,  
has no limits

- ▶ A lot of “INAPPROPRIATE” structures  
and activities by people but also by the  
institutions

# “KABADAHIJHSTVO”

- ▶ - **SPANISH VILLAGE** - New established quart inside into the Protected area
- ▶ (**instead** of removal of illegal construction, this part was involved in the general urban plan)
- ▶ - **Dumping construction waste in the torrent bed**
- ▶ - **Dumping construction waste, closing the bed and redirection of water**
- ▶ - **Dumping construction waste , setingng pipe and redirection of water**
- ▶ - **Deviation of water to the streets**
- ▶ - **Structures in the torrent bed**

# Various waste in the torrent bed



# Construction waste and closing the canal and redirection of water



# Structures in the bed and redirection of water to the streets



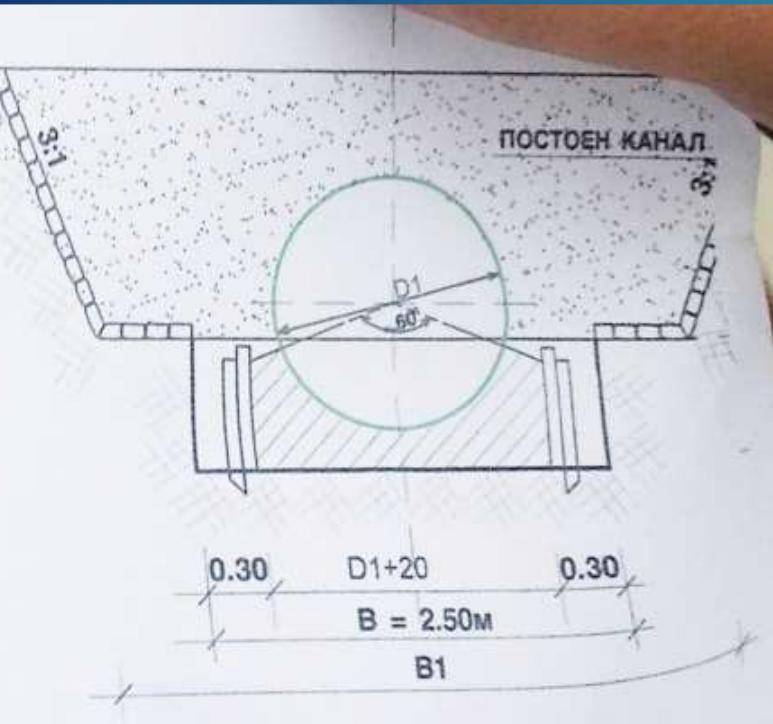


# Strange structures



# ENGINEERING ERRORS

Closing of the canals.  
Wrong hydrological calculations  
Almost all canals in the urban area  
are closed now but but





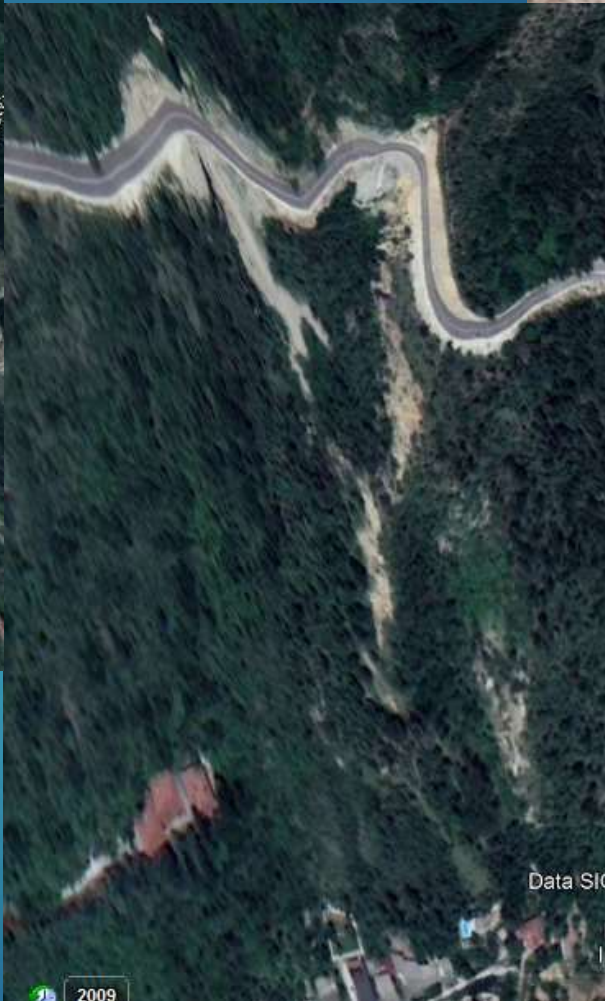
- For this type of errors of civil enengineers - License for designing should be revoked from the designer and reviewer.

# The **TOP** of **IDIOTISM** – KABADAHIJSTVO

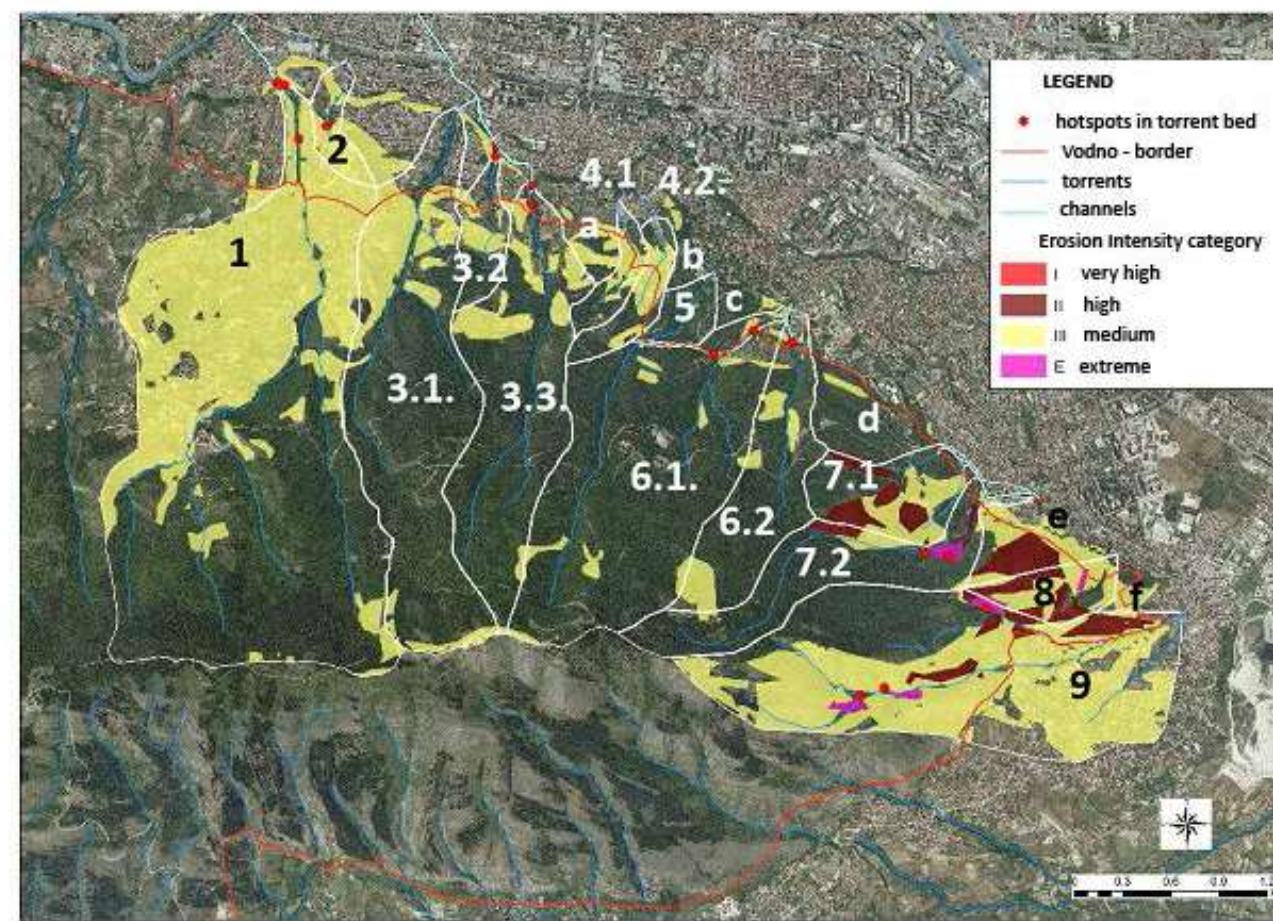
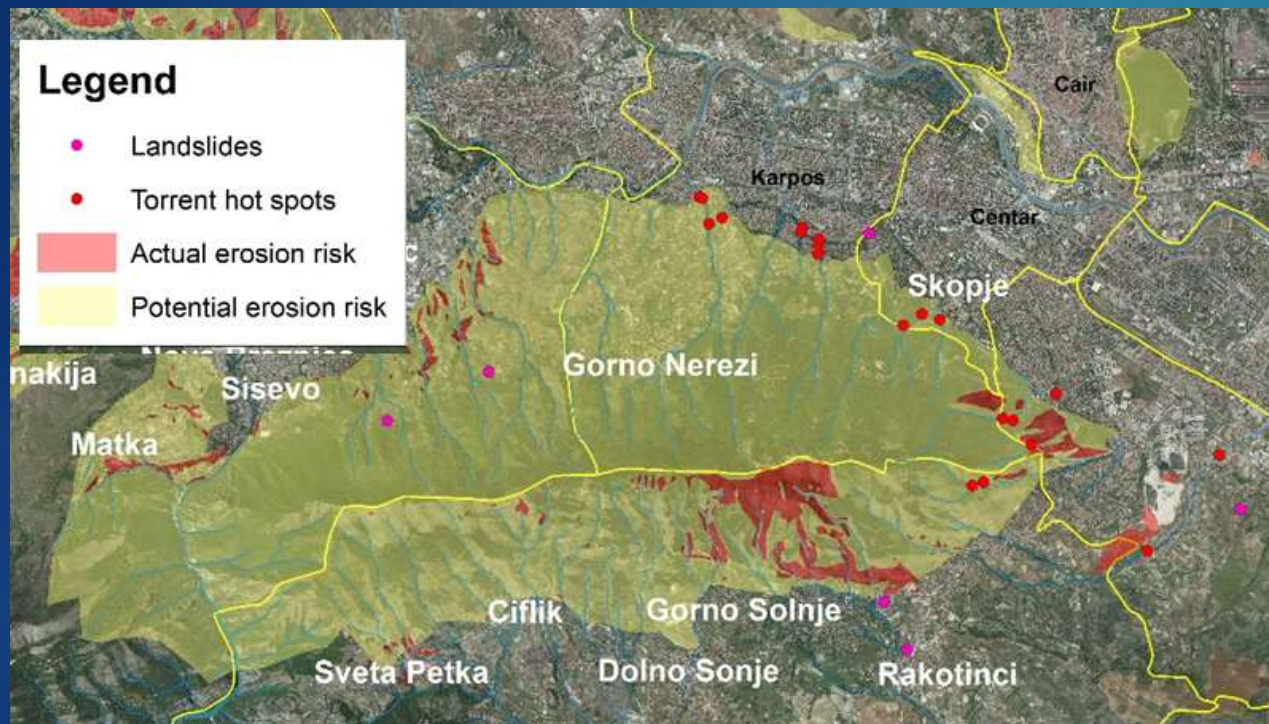
New elite quart “Sun City” and Access road







# Erosion Study and Action plan for the City of Skopje



- Established new category of erosion - **EXTREME** for construction sites
- Erosion intensity could be 100 times higher than on agricultural land. (Brady and Weil, 1999)

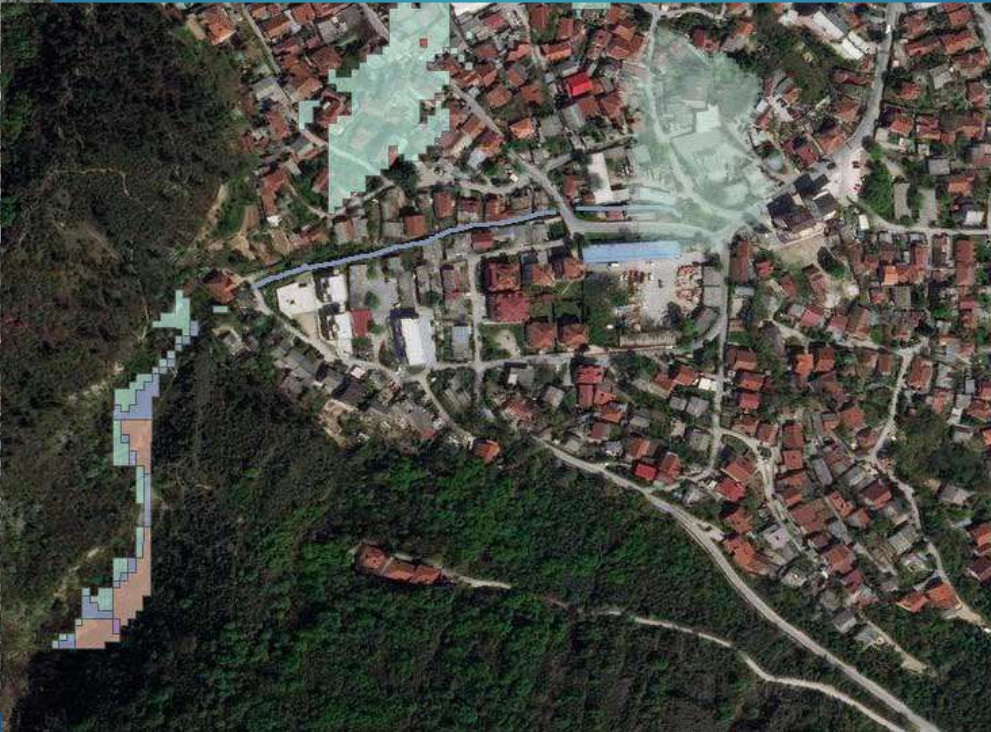
# Identified problems







# Potential flooding 1% probability



# Erodion and torrent Action Plan - 2018

- ▶ General plan for afforestation and reclamation of degraded land by gas pipeline – 2019
- ▶ - Technical documentation for urgent afforestation – 2020
- ▶ Forest management plan - 2016
- ▶ Nothing implemented

# Actual processes

## ▶ **ROLE of VODNO PA**

- ▶ - protection from erosion and torrent flood of the Skopje
- ▶ - recreation
- ▶ - air purifying
- ▶ - cultural heritage (cca 20 items)
- ▶ - natural heritage (40 important locations cca 50 ha)
- ▶ - agricultural
- ▶ - SECURITY

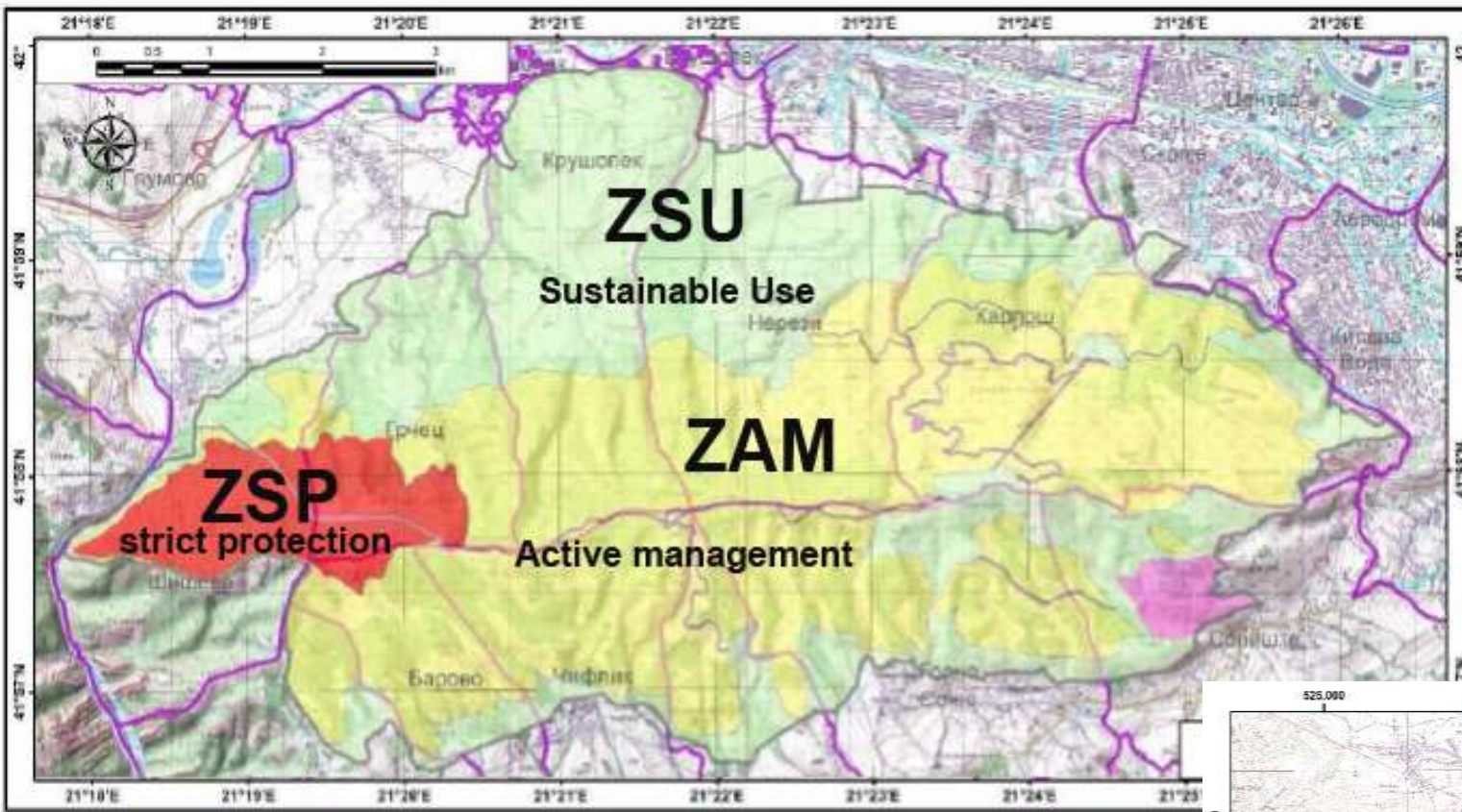
## ▶ **DECISION of THE GOVERNMENT VODNO to be Re-proclaimed AS Protected Landscape according to the Law on NATURE !!!!!**

### ▶ Collision with all other legislation

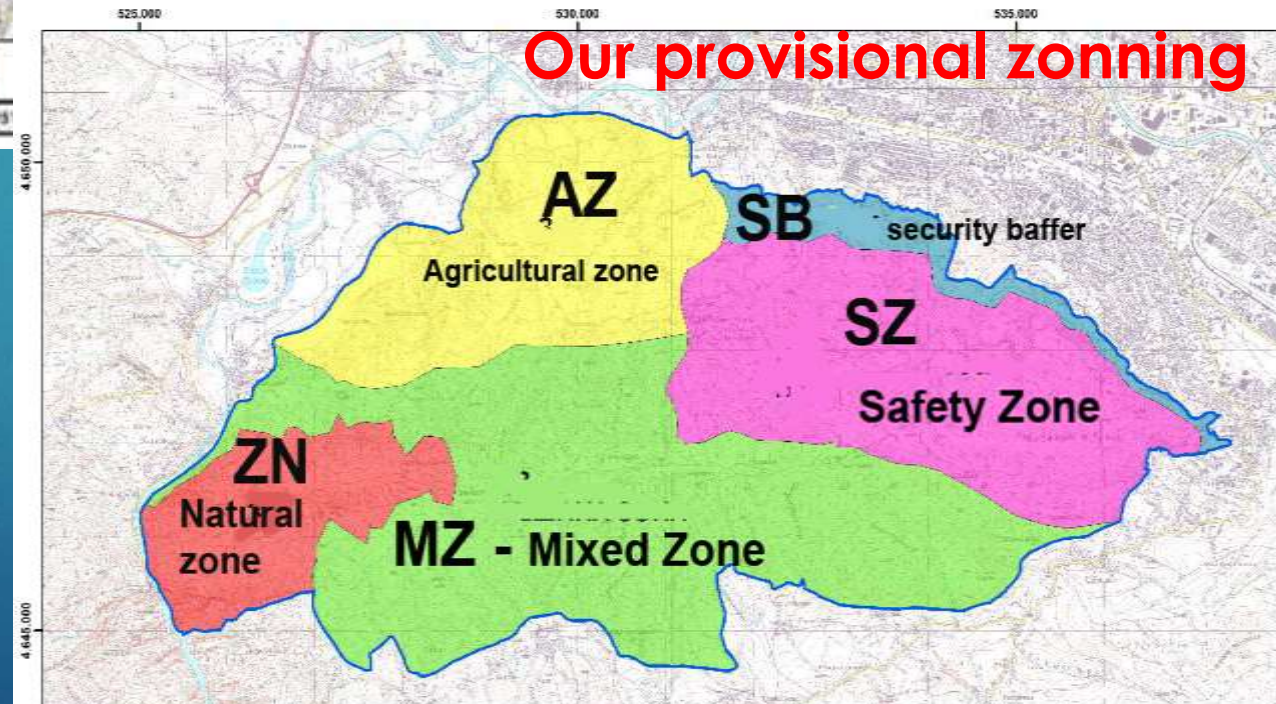
- ▶ - Law on crises management; Law on water (part Harmful impact of water)
- ▶ Law on Forests (protection of forest, fires, silviculture); Law on protection and rescue

Zones according to  
the Law of nature

NGO "GO SAKAM VODNO"  
(I love Vodno)



Our provisional zoning



► Limited knowledge of people  
who prepared Study for  
valorization of natural values  
Or "dirty things" -  
deal with "Urban mafia"???



**NGO “GO SAKAM VODNO” (I love Vodno) + 40 other NGOs + various experts/institutions (Forestry, water management, crises management, spatial planning,**

**Numerous press conferences. Various medias, written reactions meetings with city mayor. Other stakeholders Meeting with the Prime Minister and Min. of Environment**



**Temporary BAN on all construction on VODNO –  
Preparation of Spatial Plan >>>>**



**Last Slide**

*It's not over...*

**“Law on Vodno” >>>**

**- Integral management plan to unify:**  
Erosion Action plan, Study for valorisation of natural values, Forest management plan, Study for flooding of Skopje, Plan for cultural heritage, Recreational plan..

## Оплакување на Христа (Lamentation of Christ)

St. Panteleymon Church  
unknown painter 1164,  
Skopje



Scrovegni (Arena) Chapel, Padua  
Giotto do Bondone 1305

