

Bari , January 24th of 2020

UNIVERSITY OF MONTENEGRO

Faculty of Civil Engeneering



**GEOTECHNICAL RESOURCE AND RESEARCH -
CHARACTERISTICS OF LANDSLIDE AND TYPICAL
REHABILITATION SOLUTION IN MONTENEGRO**

Prof. dr Zvonko Tomanović
University of Montenegro, Faculty of Civil Engeneering,
Podgorica



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UNIVERSITY OF MONTENEGRO
FACULTY OF CIVIL ENGINEERING IN PODGORICA



CONTENT

1 – Montenegro

2 – University of Montenegro

3 – Faculty of Civil Engineering

**4 – Landslide in Montenegro -
Characteristics of Landslide
and Typical Rehabilitation
Solution in Montenegro**





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1 – MONTENEGRO

- Montenegro has an area of 13,812 square kilometers and a population of 620,079 (2011 census).
- Montenegro is small part of the Balkans, yet it is the most biologically diverse country in the Europe.
- Montenegro is a member of a large number of world organizations such as the UN, etc.
- We have no currency of its own. We use EURO as official currency, even though our country is not even a member of EU (from 2002).



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2 – UNIVERSITY OF MONTENEGRO

The our law recognises

Academic degree programs

Applied degree programs

*According to the new education reform of 2017, a system of the **three-cycle system of studies** is in use, system 3+2+3.*



Undergraduate programs- *Basic studies of 180 credits, 3 years*



Postgraduate programs - *Master studies of 120 credits, 2 years*



PhD Degree Programs - *Doctoral studies of 180 credits, 3 years*



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2 – UNIVERSITY OF MONTENEGRO

- ❑ UoM was founded in 1974, under name the University of Titograd
 - ❑ 1975 – 1992, UoM used name the University “Veljko Vlahović”
 - ❑ 1992, changed name into the University of Montenegro
 - ❑ UoM is the oldest higher education institution in Montenegro
 - ❑ UoM has over 20.000 students all levels of study, total number of teachers is 700, and student-teaching ratio is more than 28
- According to the new education reform of 2017, a system of the three-cycle system of studies is in use, system 3+2+3.*



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2 – UNIVERSITY OF MONTENEGRO

First international agreement on cooperation was concluded in 1975 with the University in Florida.

Today, the University has 135 signed agreements with universities from 35 countries,

In the period from 2014 to 2017, UoM have taken part in:

- 250 projects, out of which 5 FP7 projects,*
- 52 COST actions,*
- 10 actions connected with encouraging participation in the programmes Horizon 2020 and COST actions,*
- 3 HORIZON 2020 projects,*
- 11 IPA projects,*
- 8 ERASMUS+ and TEMPUS projects,*
- 13 HERIC projects,*
- 1 HERD project,*
- as well as nearly 120 bilateral research projects.*



2 – UNIVERSITY OF MONTENEGRO

UoM is state university comprised of 19 faculties and 2 institutes of science. Members of UoM are:

- 
1. *Historical Institute*
 2. *Institute of marine Biology*

- 
1. *Biotechnical Faculty*
 2. *Faculty for Sport and Physical Education*
 3. *Faculty of Architecture*
 4. *Faculty of Civil Engineering*
 5. *Faculty of Dramatic Arts*
 6. *Faculty of Economics*
 7. *Faculty of Electrical Engineering*
 8. *Faculty of Fine Arts*
 9. *Faculty of Law*
 10. *Faculty of Mechanical Engineering*
 11. *Faculty of Medicine*
 12. *Faculty of Metallurgy and Technology*
 13. *Faculty of Philology*
 14. *Faculty of Philosophy*
 15. *Faculty of Political Science*
 16. *Faculty of Science and Mathematics*
 17. *Faculty of Tourism and Hospitality*
 18. *Maritime Faculty*
 19. *Music Academy*



3 – FACULTY OF CIVIL ENGINEERING

History of the Faculty

- Faculty of Civil Engineering was founded in 1980
- Its seat is in Podgorica*
- The reasons of founding are the real needs of Montenegro for education of high-degree engineering staff, especially intensified by the destructive earthquake which hit Montenegro in 1979. It will be topic of next speakers*
- Organization of the teaching courses is performed in accordance with the principles of Bologna declaration*
- In 2020/2021 we will be enroll the first postgraduate generation of 2 years studies, system 3+2+3*



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3 – FACULTY OF CIVIL ENGINEERING

□ Teaching courses and research at the Faculty is realized by the staff including:

- ✓ *9 full professors*
- ✓ *7 associate professors*
- ✓ *6 assistant professors*
- ✓ *5 assistants with doctoral degree*
- ✓ *11 teaching assistants*

We engage additional teaching staff consists of:

- Visiting professors from abroad*
- Visiting professors from another UoM units*

□ Nowadays, we have more than 700 active students



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FACULTY OF CIVIL ENGINEERING IN PODGORICA



3 – FACULTY OF CIVIL ENGINEERING

GEOTEHNICS



Dr Zvonko Tomnović
CE full prof.



Dr Branislav Glavatovic
Geofis. asociate prof.



Dr Milan Radulovic
Hidrogeol. asociate prof.



Dr Slobodan Zivaljevic
CE assistant prof.



Borko Miladinovic Msc CE
teaching an rearsch assitant



Miodrag Bujisic Msc CE
teaching an rearsch assitant

3 – FACULTY OF CIVIL ENGINEERING

NATO SfP Project no. 983054



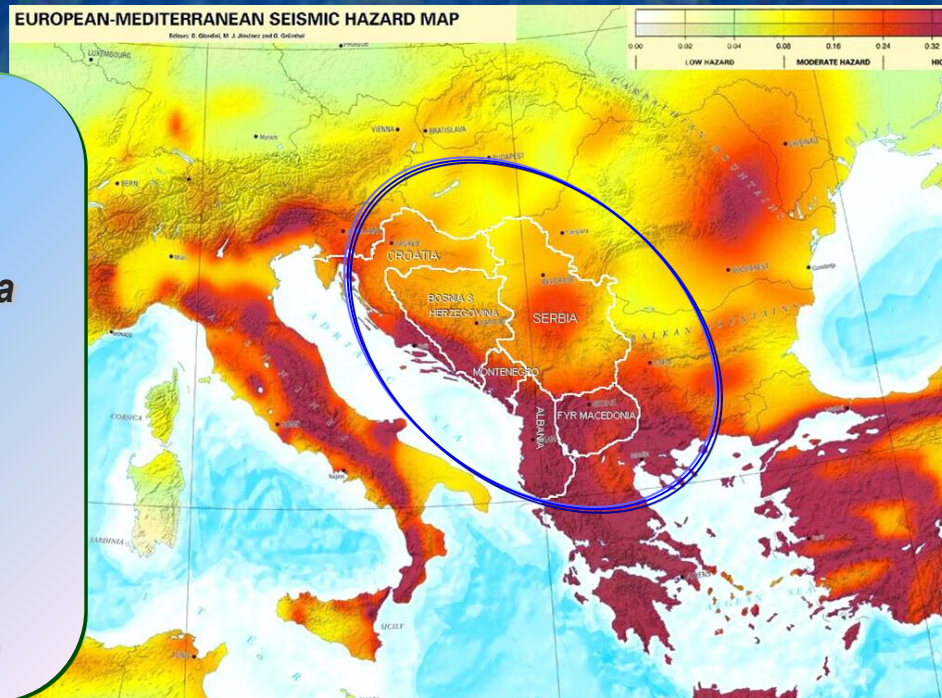
Emerging Security
Challenges Division

“HARMONIZATION OF SEISMIC HAZARD MAPS FOR THE WESTERN BALKAN COUNTRIES” (BSHAP) 2007 – 2011

Participating countries:

- Albania
- Bosnia and Herzegovina
- Croatia
- FYR Macedonia
- Montenegro
- Serbia

- Turkey with NPD
- Slovenia with expertise



Montenegro was the Project leading country

Project was
coordinated by:



Dr Branislav Glavatovic
Geofis. associate prof.
Seismological observatory
of Montenegro

3 – FACULTY OF CIVIL ENGINEERING

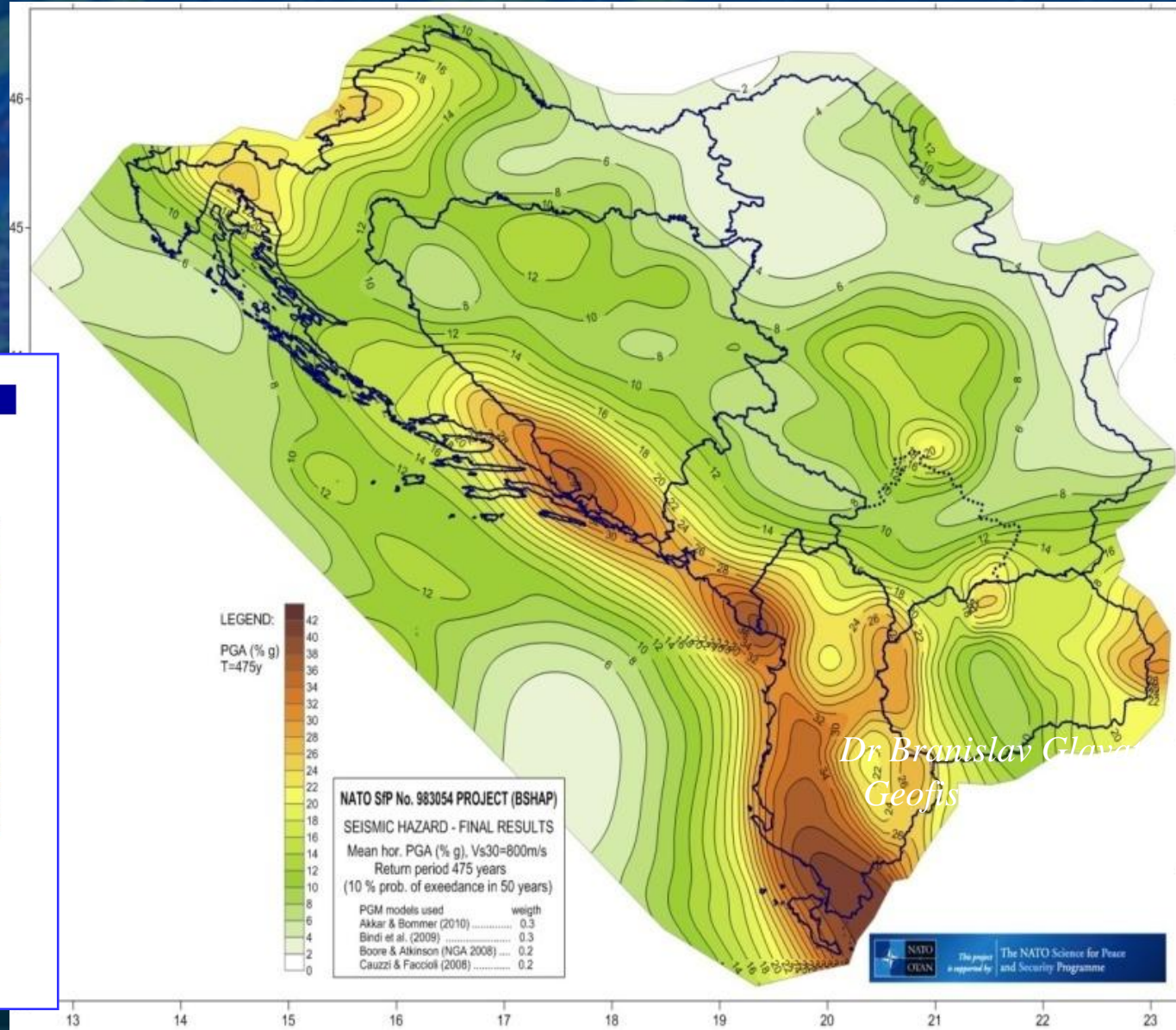
Coordination and cooperation - through WG meetings and workshops

NATO SFP Project No. 983054

HARMONIZATION OF SEISMIC HAZARD MAPS
FOR THE WESTERN BALKAN COUNTRIES
(BSHAP)



October 2011



3 – FACULTY OF CIVIL ENGINEERING

SEISMIC HAZARD MAP

SEISMIC HAZARD MAP CALCULATION WAS REALIZED, BASED ON PROBABILISTIC METHOD AND SPATIALLY SMOOTHED SEISMICITY APPROACH.

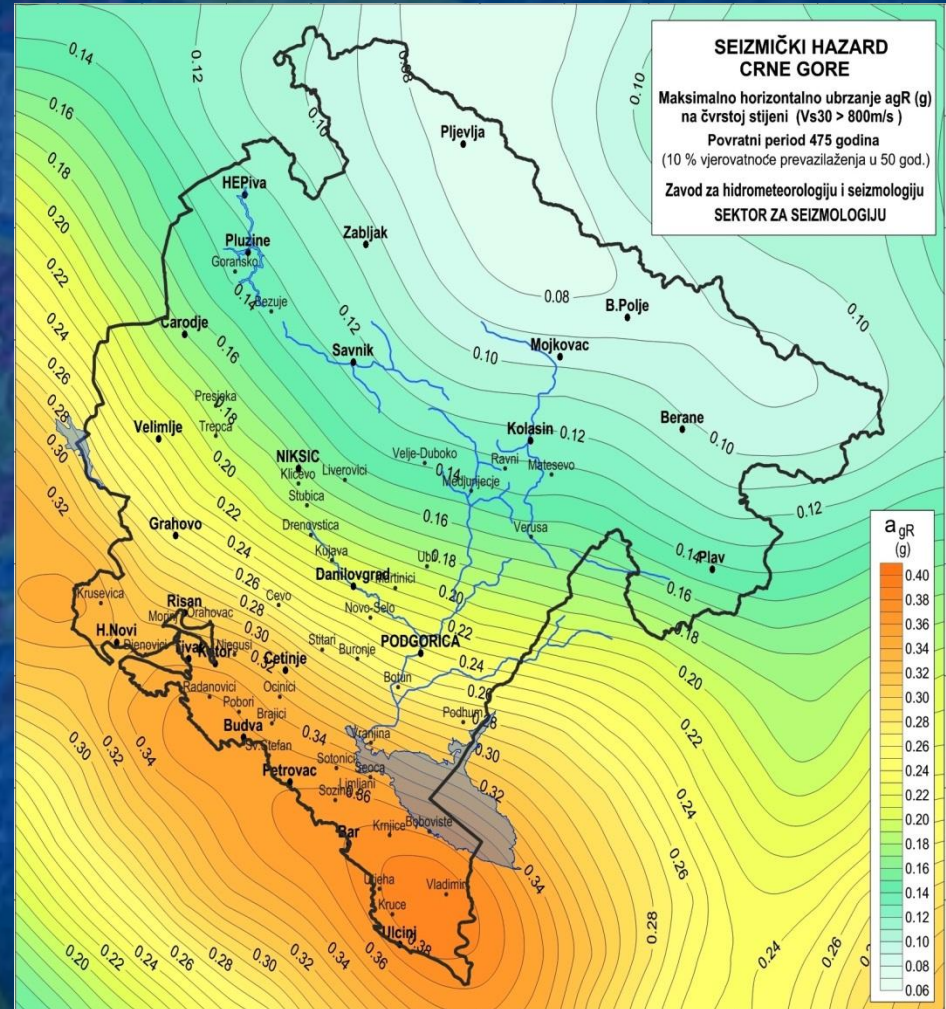
SEVERAL RETURN PERIODS WERE USED: 95, 475 AND 2475 YEARS

SEISMIC HAZARD WAS EXPRESSED AS MAXIMUM PGA VALUES ON THE HARD ROCK ($V_s > 800$ m/s)



Dr Branislav Glavatovic
Geofis. associate prof.

NACIONAL ANEX FOR EC8

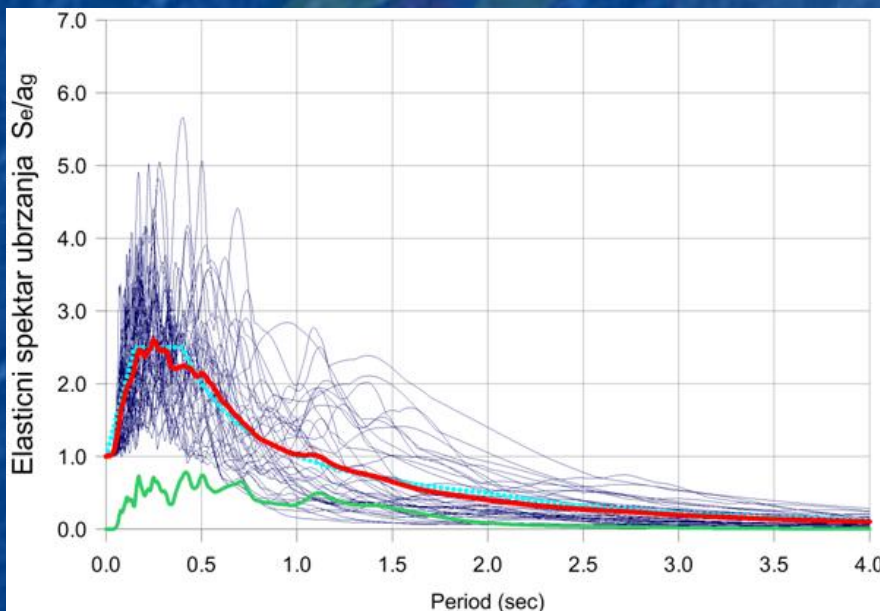


SEISMIC HAZARD MAP 10 % PROBABILITY IN 50 YEARS (475 YEARS RETURN PERIOD) AS A PART OF NATIONAL ANNEX FOR EUROCODE 1998-1 IN MONTENEGRO

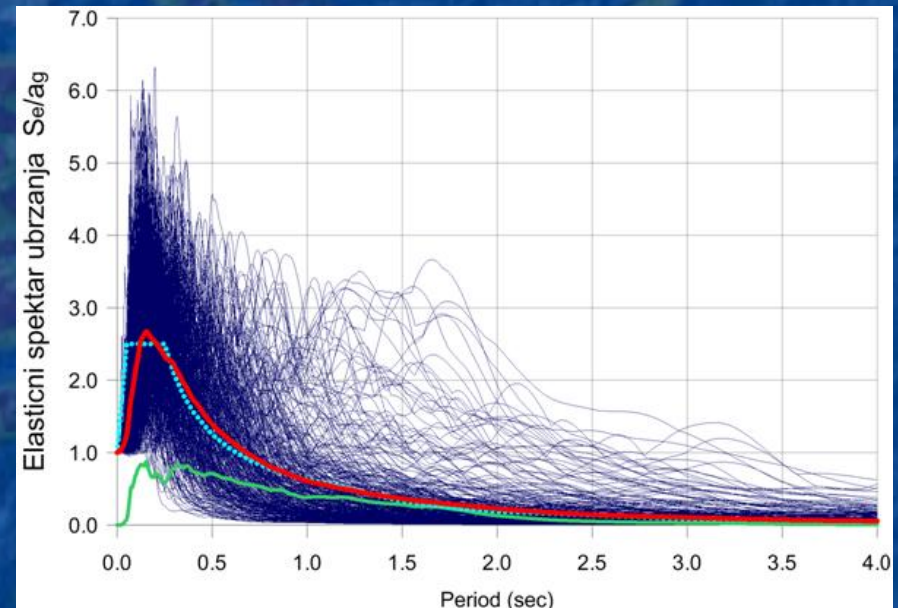
3 – FACULTY OF CIVIL ENGINEERING

HORIZONTAL ELASTIC RESPONSE SPECTRA

- *Response spectra calculation was performed for the complete strong motion data base in Montenegro, for both type of spectra (earthquake type 1 and 2), as well as for horizontal and vertical type of accelerograms*



*Example:
Normalized response spectra for type 1 of earthquakes
($M_s > 5.5$).*



*Example:
Normalized response spectra for type 1 of earthquakes
($M_s > 5.5$).*

Because of the high similarity of all calculated results with the EN98-1 recommended values, those recommended values were adopted in the National Annex for EUROCODE 1998-1 in Montenegro

4 – LANDSLIDE IN MONTENEGRO



Z. Tomanović, S Živaljević
UNIVERSITY OF MONTENEGRO
Faculty Civil Engineering



MITIGATION SOLUTION FOR “MARKOVICI” LANDSLIDE ON THE MAIN ROAD PODGORICA-BUDVA

Bari, 24 January 2020.

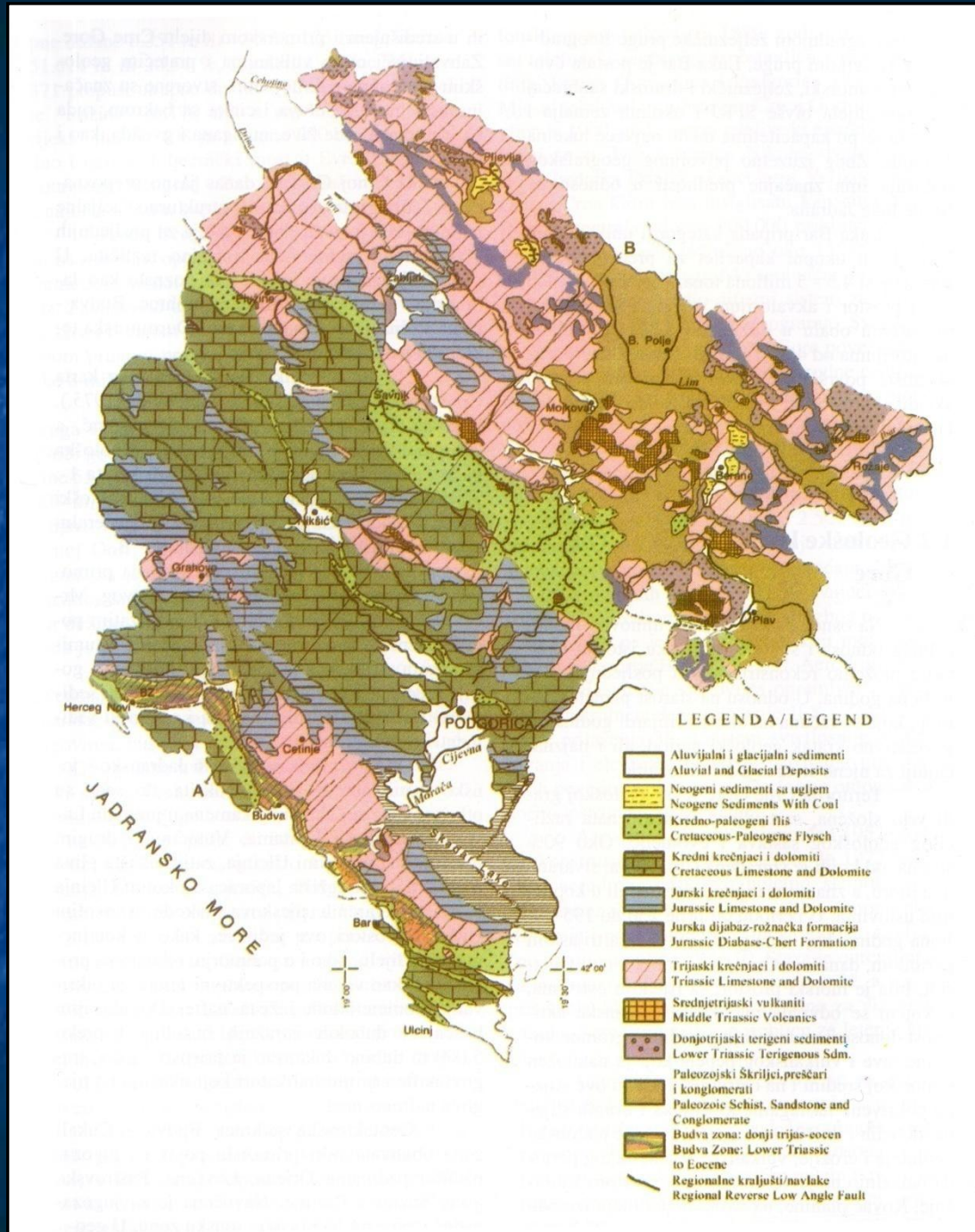


Topics

- **Geological map of Montenegro**
- **Engineering geological map**
- **Map of landslide on costal zone**
- **Landslide “Makovići” on road Budva – Cetinje**
- **Trigger for linslide**
- **Rehabilitation solutin landslide**
- **Conclusion**





Geological map

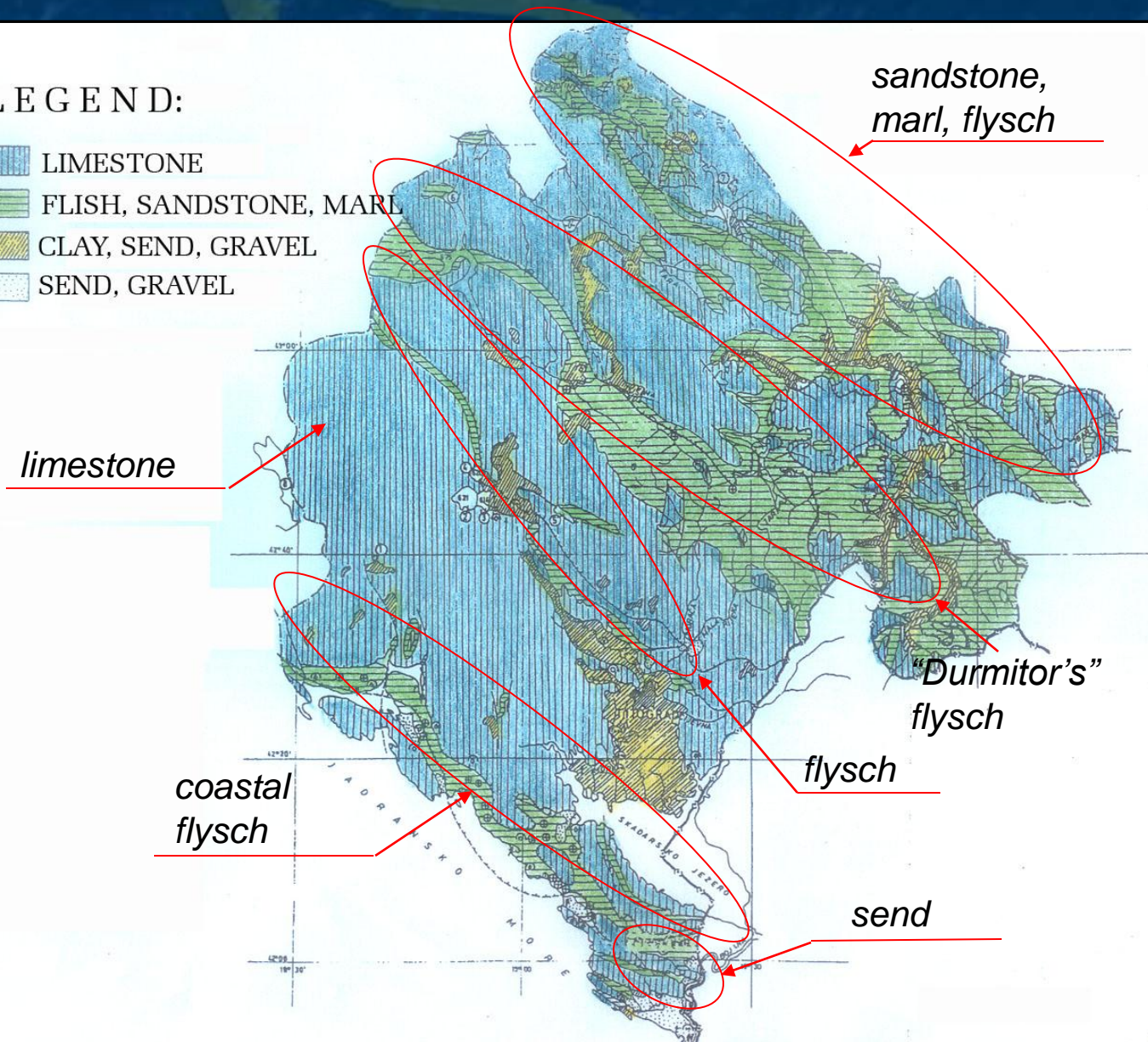
Geological Map
of
Montenegro
is very
complex due
to strong
tectonic
activity in this
area



Engineering geological map

LEGEND:

-  LIMESTONE
-  FLISH, SANDSTONE, MARL
-  CLAY, SEND, GRAVEL
-  SEND, GRAVEL



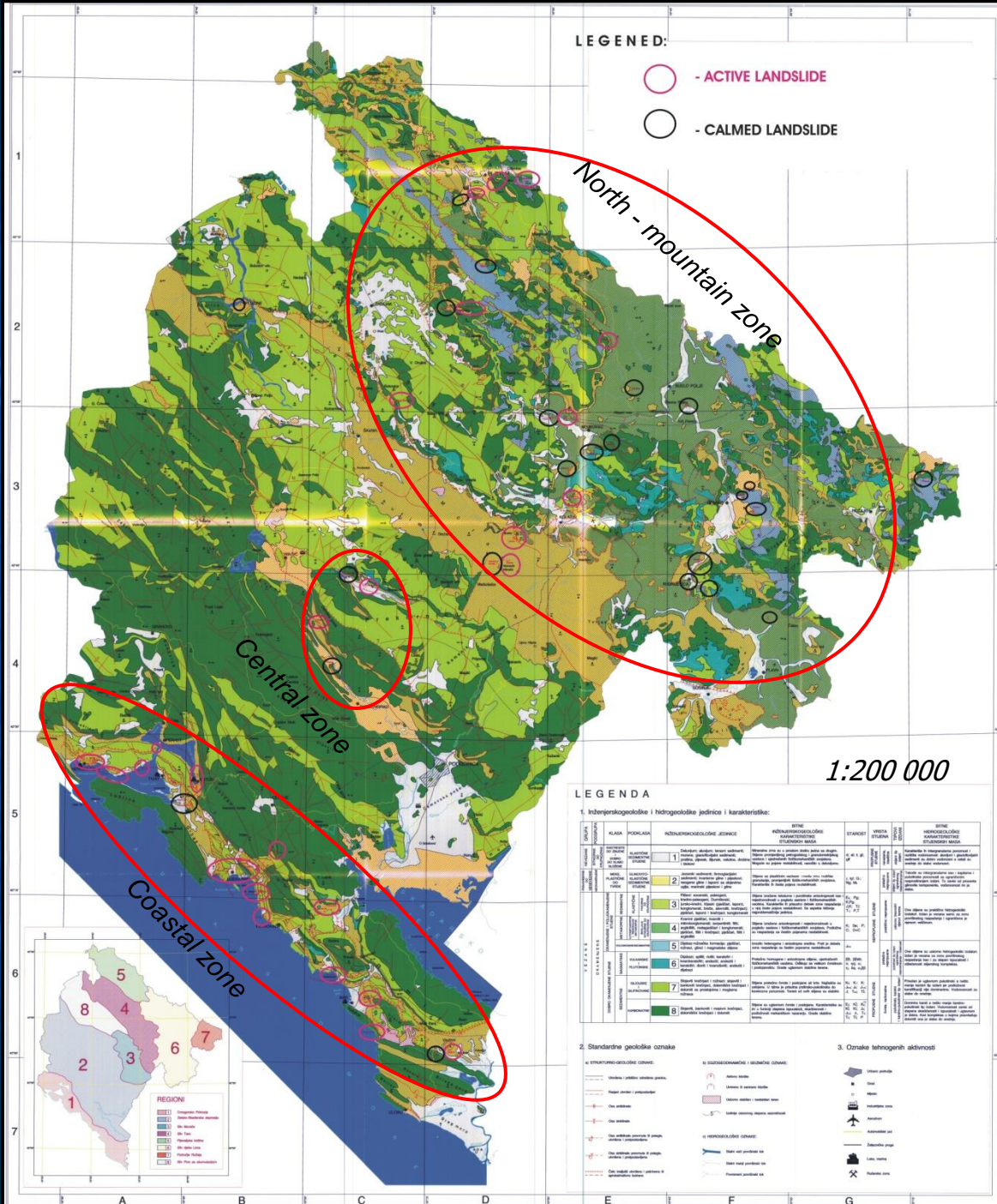
Map of

landslide

- This map was created in 2002 in the Institute of Geological Survey of Montenegro

■ There are three zones of the landslides:

- Coastal zone
- Central zone
- North - mountain zone



LANDSLIDE “MARKOVIĆI”

Trigger for landslide

CETINJE RAINFALL (2015)

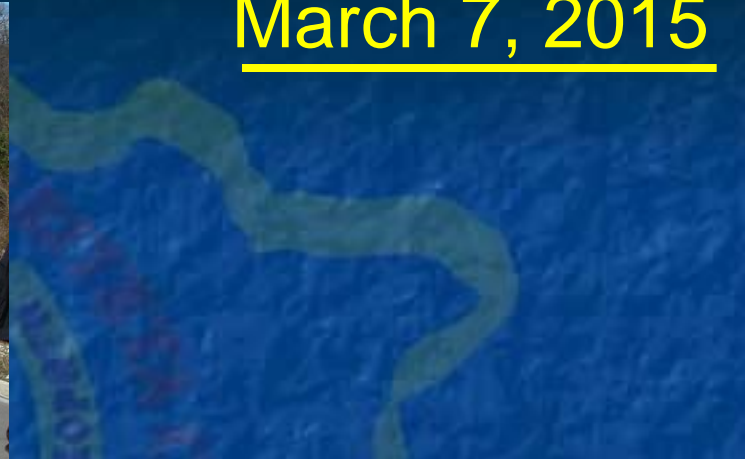
- 5. March 115 l/m²
- 6. March 110 l/m²
- 7. March 181 l/m²

Average rainfall in Cetinje for March is 360l/m², during 5, 6 and 7th March average was in three days 135 l/m²

- **March 6**, at evening the first cracks were observed on the roadway road
- **March 7**, at 7 am the way has already been closed to traffic
- **March 8**, road was already seriously damage
- **March 9**, sliding – displacement was in maximum
- **After March 10** began settling landslides

LANDSLIDE “MARKOVIĆI”

March 7, 2015



LANDSLIDE “MARKOVIĆI”

March 8, 2015



LANDSLIDE “MARKOVIĆI”

March 9, 2015



LANDSLIDE “MARKOVIĆI”

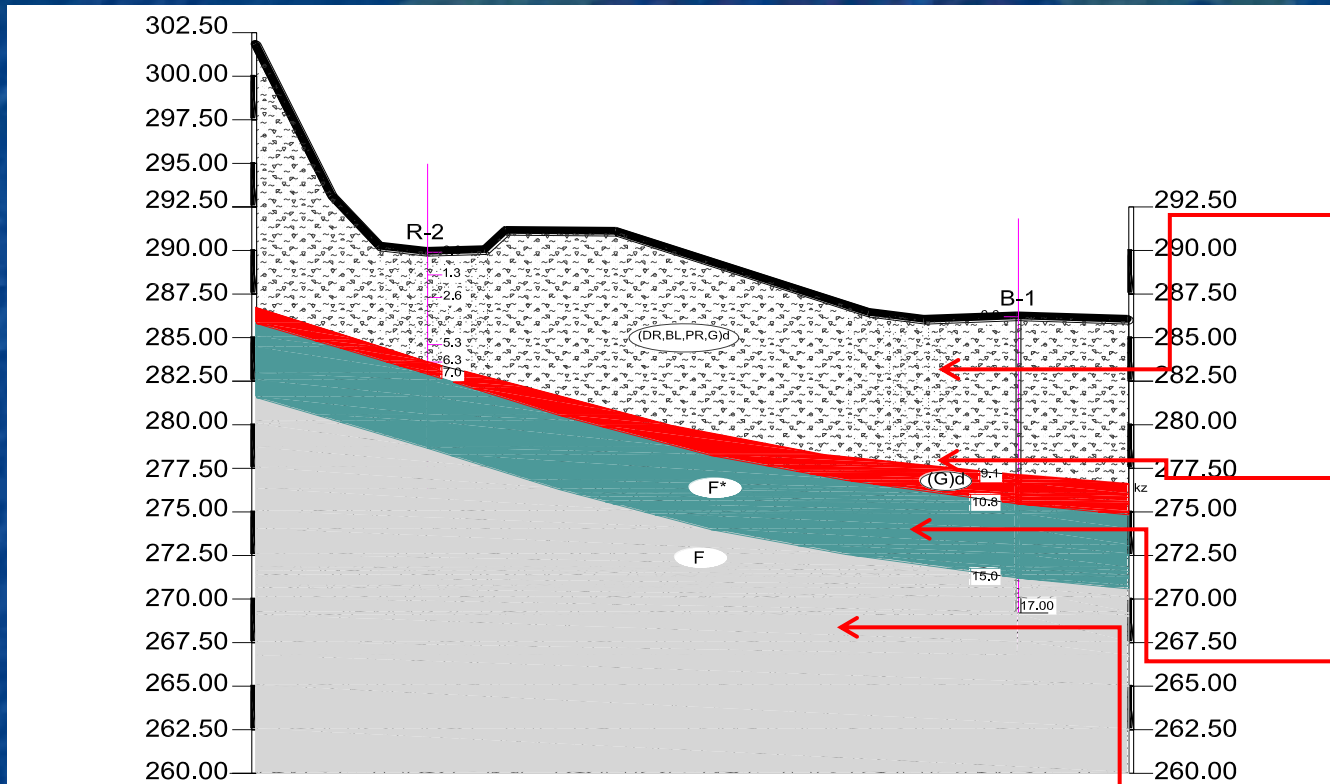
March 9, 2015



VIDEO CLIP

LANDSLIDE "MARKOVIĆI"

GEOLOGICAL CROSS SECTION



Deluvium with limestone blocks

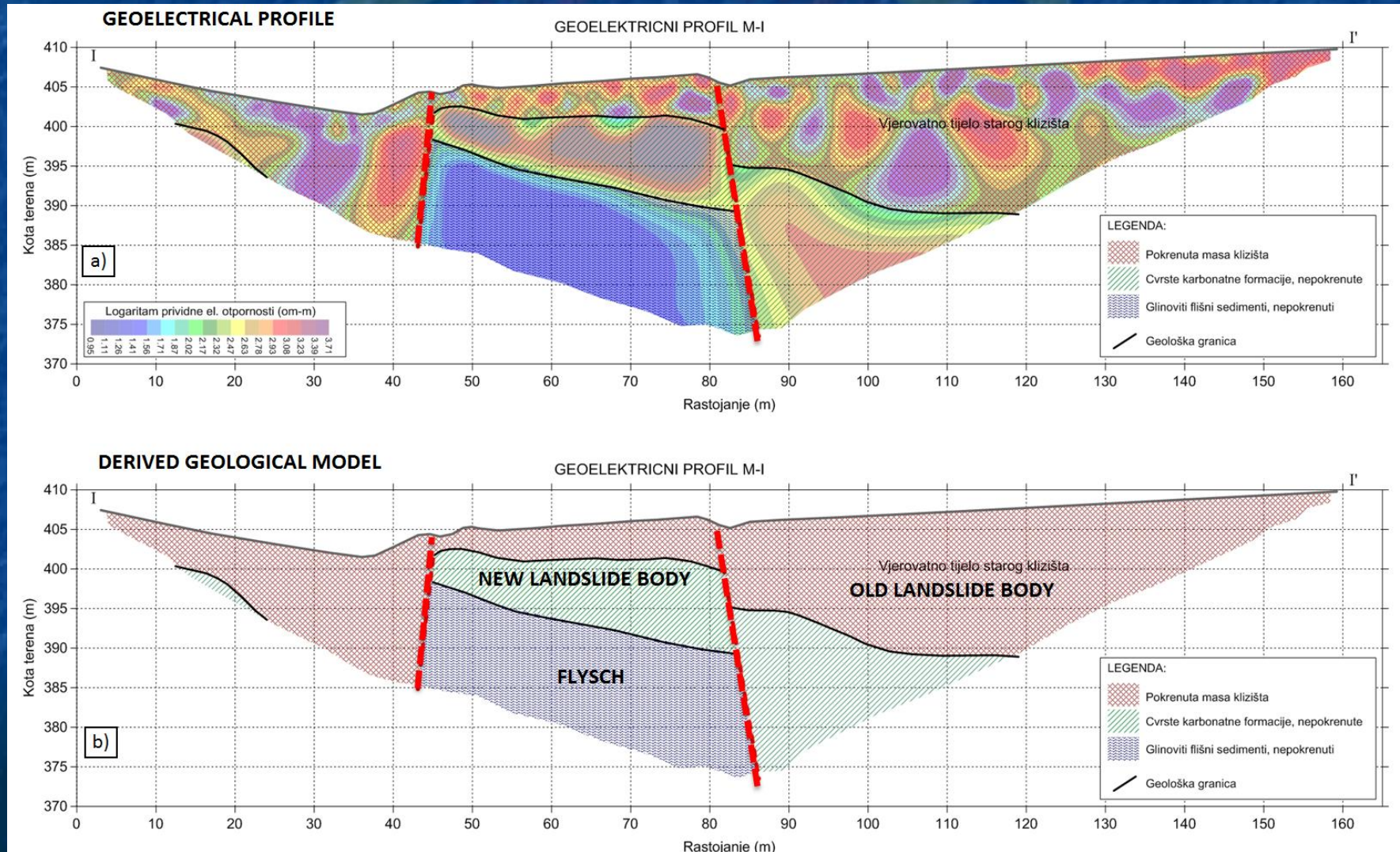
Soft clay

Flisch eluvium

Flisch

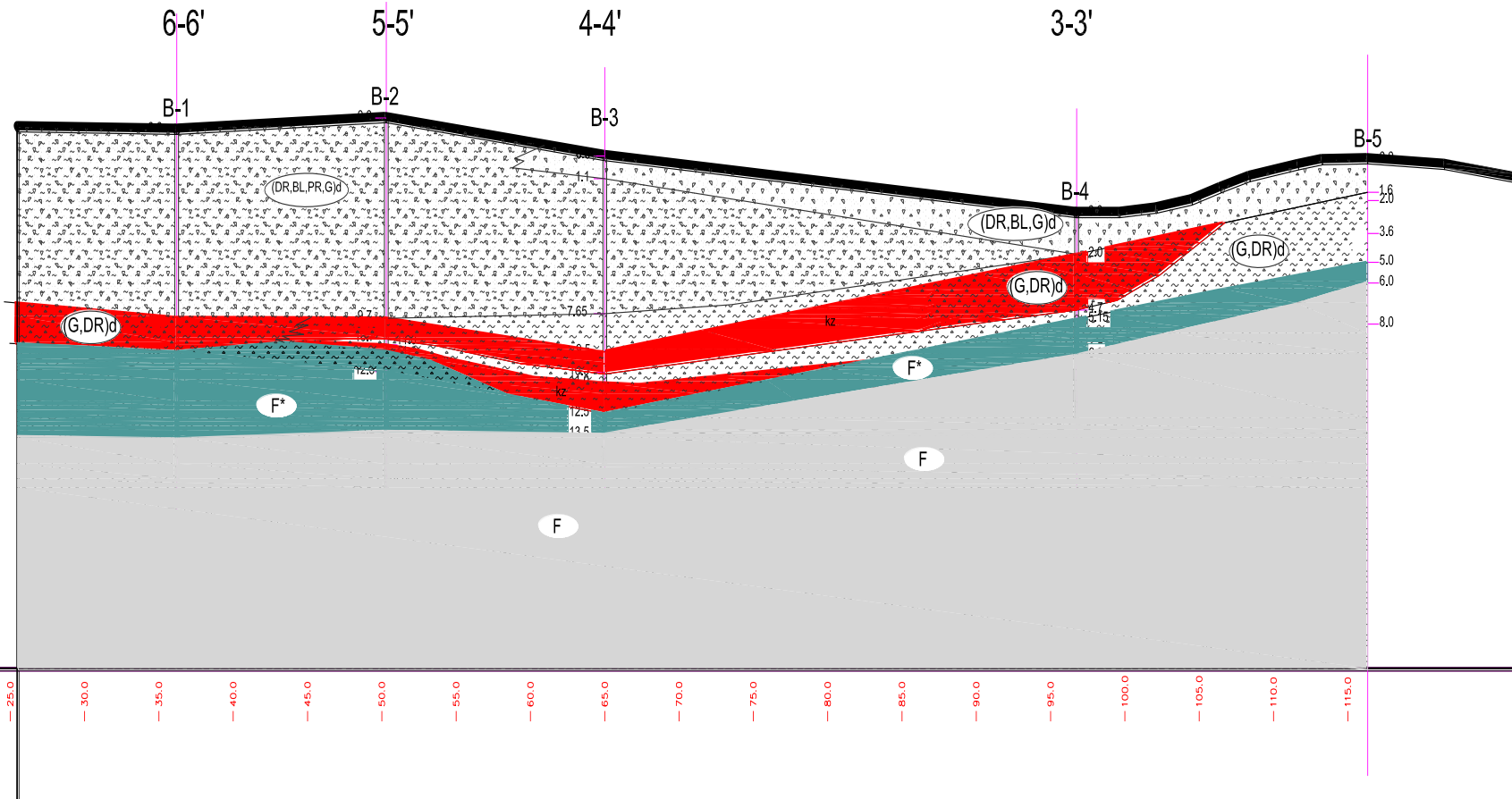
2D Geoelectrical tomography (geoelectrical imaging) was successfully applied as a powerful tool in geotechnical research of many landslides sites in Montenegro

Example of the „Markovici“ landslide near Budva, Montenegro



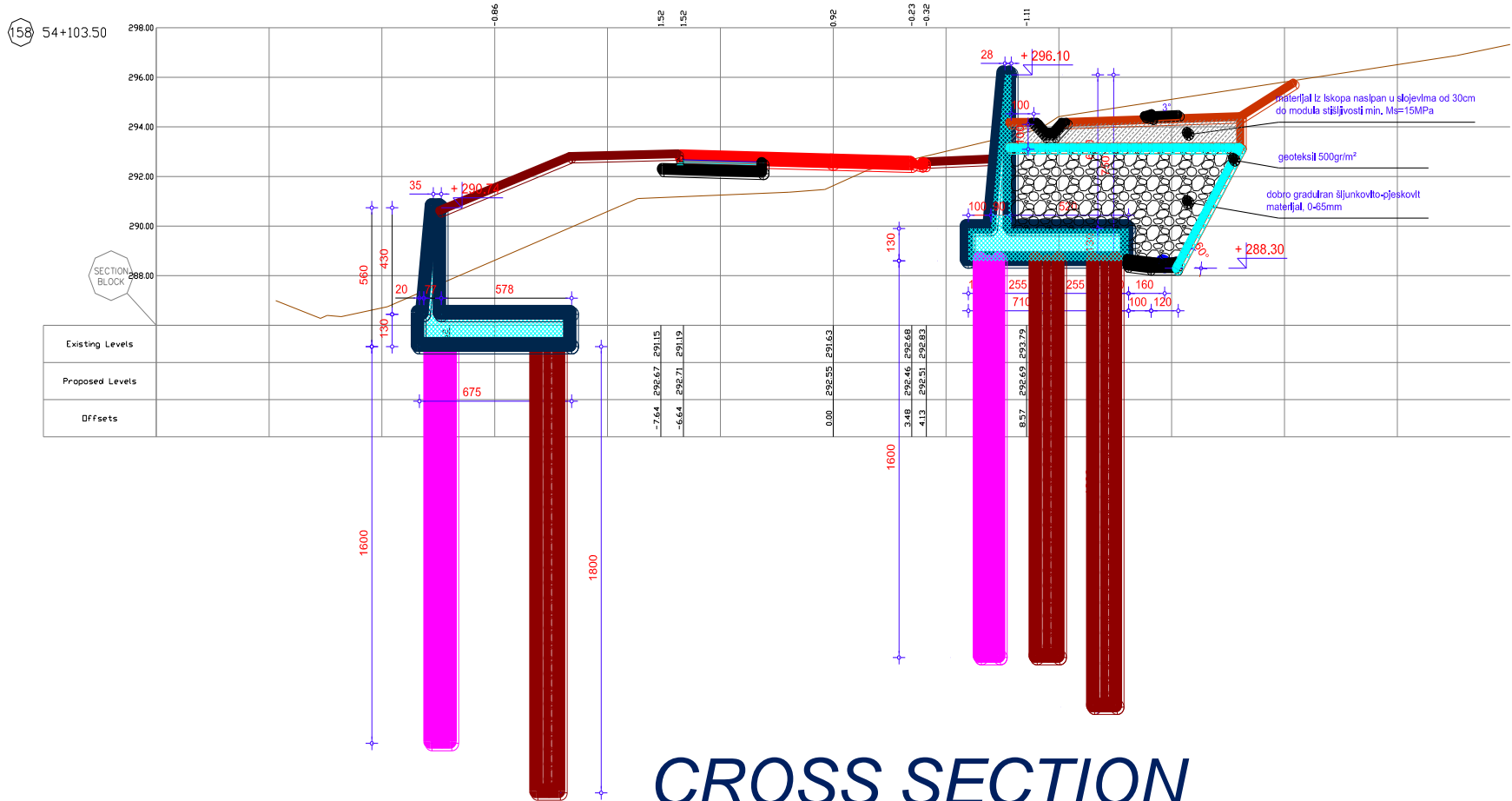
LANDSLIDE "MARKOVIĆI"

GEOLOGICAL LONGITUDINAL PROFILE



LANDSLIDE "MARKOVIĆI"

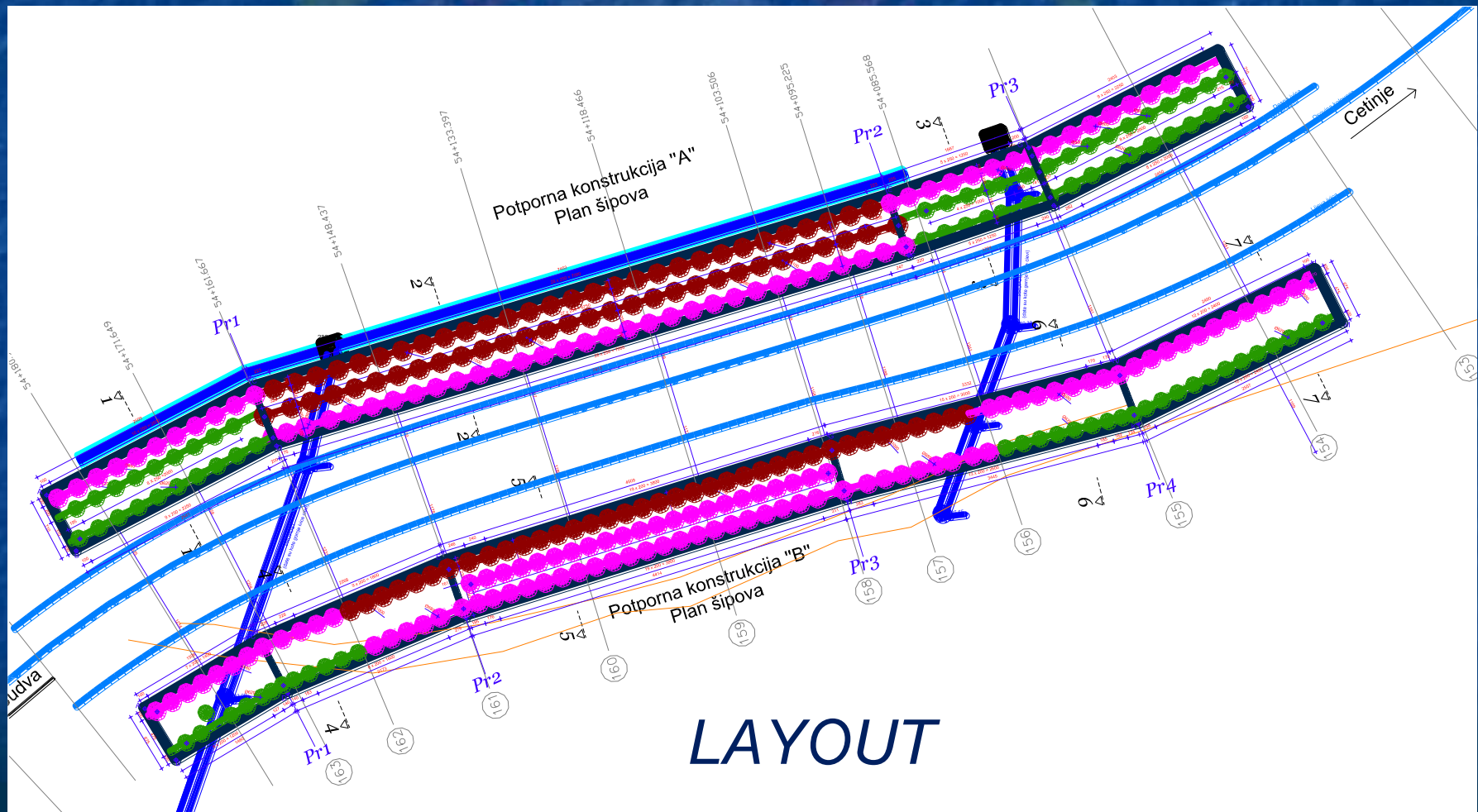
REHABILITATION SOLUTION



CROSS SECTION

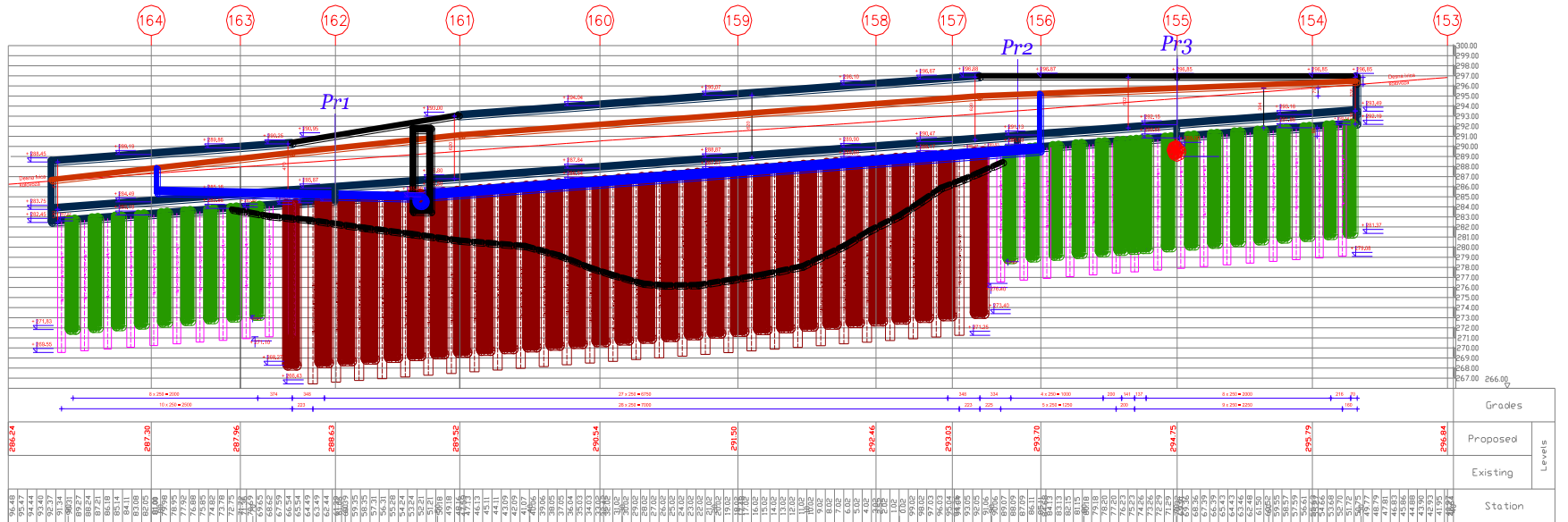
LANDSLIDE "MARKOVIĆI"

REHABILITATION SOLUTION



LANDSLIDE "MARKOVIĆI"

REHABILITATION SOLUTION



The background is a solid blue color with a faint, large watermark of the University of Malaya crest. The crest features a central shield with a lion and a unicorn, topped with a crown and surrounded by a circular border with text.

***Thank you for your
attention !***