



*This project  
is supported by:*

The NATO Science for Peace  
and Security Programme

# CO-DIRECTORS MEETING OF THE SFP 983054 PROJECT (BSHAP)

**29 October, 2010**

**Tirana, Albania**



РЕПУБЛИКА СРБИЈА

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ПИБ: 102328899 МБ: 7032617 ШД: 75110

# Budget for Serbia

## (A) Equipment

INITIAL BUDGET BREAKDOWN	INITIALLY FORESEEN EXPENDITURES (EUR)	REVISED BUDGET BREAKDOWN	REVISED EXPENDITURES (EUR)
(A1) Seven (7) strong-motion accelerograph stations for the national strong motion network improvement (to be placed on different local soil conditions).	43,000	(A1) 10 strong motion instruments, model ETNA (+2 free of charge-1 damaged in flood) Additional instrumentation: 1 strong motion instrument, model ETNA  3 Surface Triaxial Force Balance Accelerometers	43,000  5,417  6,654
(A2) Accelerograph installation, site preparation, instrument testing and connection to the national strong-motion network.	7,000	(A2) Geophysical investigations of geodynamic characteristics at the instrument sites	4,900

## (B) Computers and software

INITIAL BUDGET BREAKDOWN	INITIALLY FORESEEN EXPENDITURES (EUR)	REVISED BUDGET BREAKDOWN	REVISED EXPENDITURES (EUR)
(B1) One data storage unit for archiving digital acceleration data base available on internet for public use	1,000	(B1) Computer, PC C2QUAD	859
(B2) Software for creating and managing accelerometer data base	1,000	ETNA instrument support software and manual (not charged)	
(B3) Upgrade for ArcView 8.1 software	4,500	(B2) GIS Software MapInfo Profesional+Vertical Mapper	4,633
(B4) EZ FRISK license with two years extension	2,500		

# (C) Training

<b>INITIAL BUDGET BREAKDOWN</b>	<b>INITIALLY FORESEEN EXPENDITURES (EUR)</b>	<b>REVISED BUDGET BREAKDOWN</b>	<b>REVISED EXPENDITURES (EUR)</b>
(C1) Training of tree younger researches "Seismology and Seismic Hazard Assessment" GFZ Potsdam	9,000	(C1) Training of researchers in a next 6 month period	4,500

# (D) Books, journals

<b>INITIAL BUDGET BREAKDOWN</b>	<b>INITIALY FORESEEN EXPENDITURES (EUR)</b>	<b>REVISED BUDGET BREAKDOWN</b>	<b>REVISED EXPENDITURES (EUR)</b>
(D1) Books, journals	3,000	(D1) Books, journals	965

# (F) Travel

INITIAL BUDGET BREAKDOWN	INITIALLY FORESEEN EXPENDITURES (EUR)	REVISED BUDGET BREAKDOWN	REVISED EXPENDITURES( EUR)
(F1) Meetings	9,000	(F1) Meetings (until September 2010): Podgorica, 2007 Ljubljana, 2007 Skoplje, 2007 Budva, 2007 Banja Luka, 2009 Divcibare, 2009 Sarajevo, 2010 Ohrid, 2010	3,865
(F2) Conferences	3,500	(F2) Conferences: Divcibare, 2010 Montpellier, 2010 Ohrid, 2010	6,728

## (H) Other costs

<b>INITIAL BUDGET BREAKDOWN</b>	<b>INITIALLY FORESEEN EXPENDITURES (EUR)</b>	<b>REVISED BUDGET BREAKDOWN</b>	<b>REVISED EXPENDITURES (EUR)</b>
(H1) Miscellaneous	3,500	(H1) Miscellaneous	2,400

# (I) Stipends for young researchers

INITIAL BUDGET BREAKDOWN	INITIALLY FORESEEN EXPENDITURES (EUR)	REVISED BUDGET BREAKDOWN	REVISED EXPENDITURES (EUR)
(I) Stipends for young researcher	9,000	(I) Stipends for young researchers Stipendiaries: Ms. Dragana Petrovic : 16 stipends Ms. Natasa Kotur : 17 stipends Mr. Srdjan Kostic: 13 stipends	6,900

# Equipment purchase and deployment

No	Location	CODE	Lat, N	Lon, E	Alt., m	Instrument	Inv. label
1	Šabac	SABA	44.7581	19.6919	80	ETNA <b>6433</b>	0689
2	Žagubica	ZAGA	44.2409	21.8068	368	ETNA <b>6434</b>	0687
3	Jagodina	JAGA	43.9710	21.2600	121	ETNA <b>6435</b>	0691
4	Lazići	LAZA	43.9646	19.4105	871	ETNA <b>6436</b>	0692
5	Ban. Dvor	BDVA	45.5377	20.4744	73	ETNA <b>6437</b>	0686
6	Zaječar	ZAJA	43.8126	22.2330	205	ETNA <b>6438</b>	0683
7	Radoinja	RADA	43.5205	19.7424	815	ETNA <b>6439</b>	0684
8	Valjevo	VALA	44.2726	19.8831	188	ETNA <b>6441</b>	0681
9	Novi Pazar	NPAA	43.1363	20.513	513	ETNA <b>6442</b>	0688
10	Svilajnac	SVIA	44.2655	21.2152	123	ETNA <b>6443</b>	0685
11	Gruža	GRUA	43.8886	20.7153	279	ETNA <b>6444</b>	0682

# Strong motion instruments type ETNA deployed in Serbia



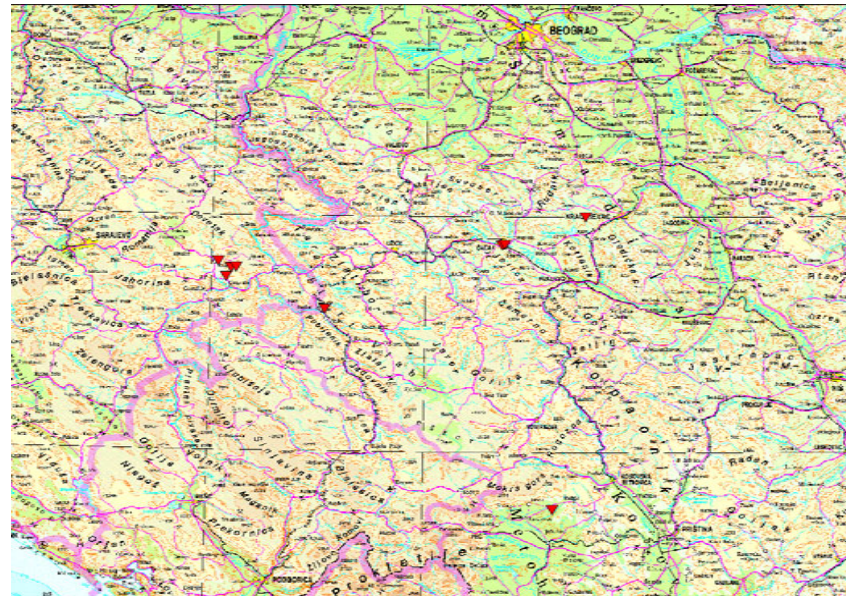
Ongoing activity is investigation of geophysical characteristics of the soils and rocks at instrument sites

The expected results are geodynamical models at sites. Accelerometer stations and records will be complete according to existing engineering seismological standards. The task is performed in cooperation with assigned geophysical institution with whom the contract has been signed.

Young researchers collected all available data concerning geological characteristics at instrument sites.

No.	Earthquake	ML	Number of acc. stations with record
1	Čačak, 2008 15.02.	4.5	3
2	Čačak, 2008. 21.02	3.4	3
3	Priboj, 2008.19.09.	3.5	1
4	Istok, 2010.10.03.	4.7	8
5	Rogatica, 2010.18.03.	3.4	3
6	Rogatica, 2010.18.03.	2.5	2
7	Rogatica, 2010.18.03.	3.0	2
8	Rogatica,2010.24.03.	3.5	2
9	Gruža, 2010.31.03.	2.3	1
10	Rogatica, 2010 13.04.	3.5	2

Recorded accelerations



- Date: 2010-03-10
- Time: 13:38:04,8 GMT
- Region : Serbia, K&M, Pec - Istok
- Latitude: 42.739 N
- Longitude: 20.588 E
- Depth: 12 km
- ML: 4.7
- Focal mechanism: strike slip

**Novi Pazar, distance = 47 km**

Accelerations recorded at stations:

1. **Novi Pazar**
2. Celije
3. **Radojnja**
4. **Sabac**
5. Nis
6. Barje
7. **Svilajnac**
8. Vrutci

Component	Max acceleration
N - S	9.324 cm/sec <sup>2</sup>
E - W	7.123 cm/sec <sup>2</sup>
Z	2.627 cm/sec <sup>2</sup>

# Preparation and compilation of earthquake catalogue data

- all historical earthquakes, up to 1900 and for the period 1901-1970 with intensities  $\geq 5$  have been examined and their parameters reassessed. New equations for ML as a function of  $r_5$  and for intensity attenuation are defined and applied:

$$ML = \log(p \times (r_5)^2) \times 1,056 + 1,208$$

$$I_i = 1,3786 \times M - 3,243 \times \log(d^2 + h^2) + 3.4$$

- catalogue completeness for different time periods analyzed
- catalogue de-clustering performed
- earthquake magnitudes rescaled by conversion  $M_s$  to  $M_w$ ; new equation for magnitude conversion  $M_b$  to  $M_s$  defined and applied:

$$M_s = 1.263(\pm 0.054)m_b - 1.505(\pm 0.244), \text{ for } 3.5 \leq m_b \leq 6.1$$

# Historical macro seismic data used for re assessment of earthquakes

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Редни број	Датум	ВРЕМЕ (средно-европско) с. м. сек.	СЕЙЗМИЧКА ПОЈАВА						ПРИМАНА ПЛОШТА (погреш)	НАПОМЕНЕ
			Тутњала пре потреса		ПОТРЕС		Тутњала после потреса			
			јак.	трај.	јак.	трај.	јак.	трај.		
3543.	17 1893г.	10 <sup>h</sup> 30 <sup>m</sup>			IV				месито 0-3 Хула Коцарска	
3544.	27 1893г.	9 <sup>h</sup> 25 <sup>m</sup>			V	II	III		Хитица Хитица Винарница Винарница <i>Хитица: велика јакост и трајање Кол. и поздрављена изградња Винарница: велика јакост и трајање</i>	
3545	7 1893г.	15 <sup>h</sup>			IV				Са. Винова Са. Гасова	
3546	8 1893г.	2 <sup>h</sup>			IV				Кренивац Кренивац Батањаци Батањаци <i>Кренивац: велика трајање Батањаци: велика трајање</i>	
3547.	8 1893г.	6 <sup>h</sup> 20 <sup>m</sup>	II	III	V				Рурин Рурин	
3548.	8 1893г.	8 <sup>h</sup> 20 <sup>m</sup>			III				Брџани Крижевца	
3549.	8 1893г.	9 <sup>h</sup> 50 <sup>m</sup>			IV				Гасовина Гасовина Креница Мицајивац Ридаре Кренивац Гасовац	

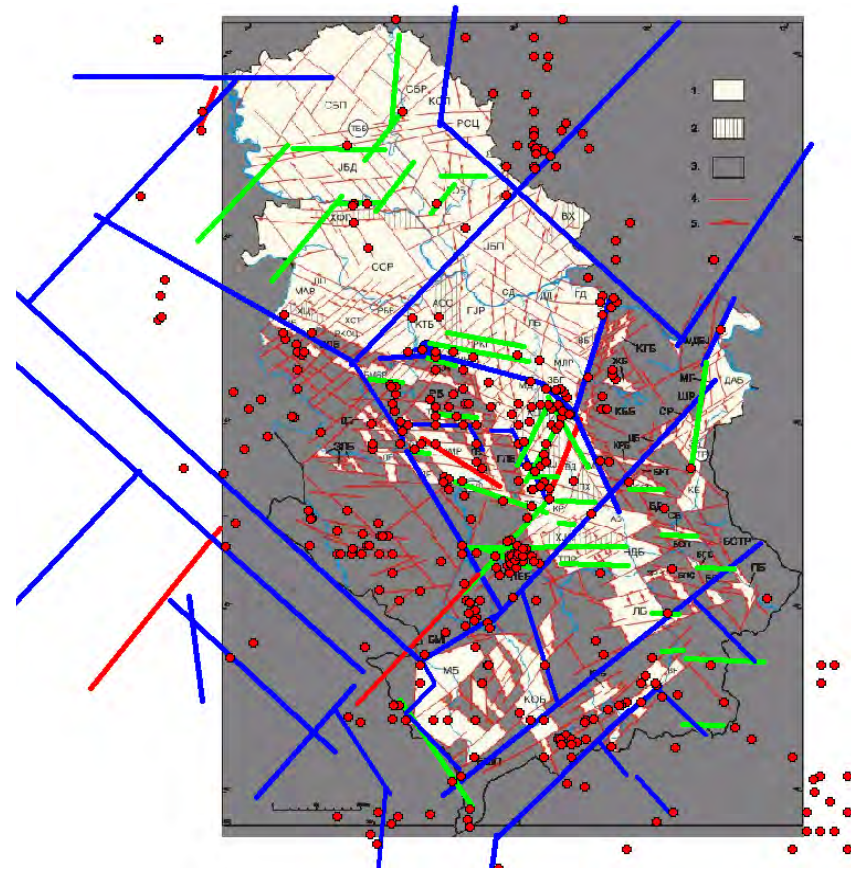
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Редни број	Датум	ВРЕМЕ (средно-европско) с. м. сек.	СЕЙЗМИЧКА ПОЈАВА						ПРИМАНА ПЛОШТА (погреш)	НАПОМЕНЕ
			Тутњала пре потреса		ПОТРЕС		Тутњала после потреса			
			јак.	трај.	јак.	трај.	јак.	трај.		
3550.	8 1893г.	14 <sup>h</sup> 49 <sup>m</sup>			IV				Медвџа Гасовина А. Кренивац Креница Винова Винарница Винарница Креница Креница Гасова А. Кренивац Гасовина	
3551.	8 1893г.	14 <sup>h</sup> 40 <sup>m</sup>			IV				Мавашница Рака Џурковац Рака Жабаци Рака (м)	
3552.	8 1893г.	14 <sup>h</sup> 30 <sup>m</sup>			IV				Мавашница Рака Џурковац Жабаци	
3553.	8 1893г.	14 <sup>h</sup> 47 <sup>m</sup>			IV	III	III		443 213 4414 2112 Винарница 4412 2118 Винова Винарница 4410 2120 Креница Винарница 4411 2122 Креница Винарница 4410 2116 Креница Винарница 4409 2121 Медвџа Кренивац 4420 2119 Жабаци Жабаци 4414 2112 Креница 4421 2113 Креница 4426 2116 Медвџа 4402 2110 Креница 4423 2113 Креница	

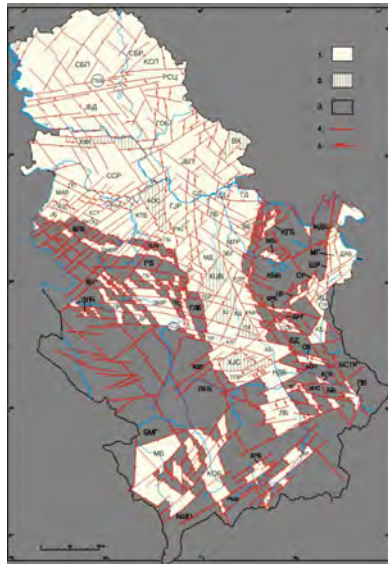
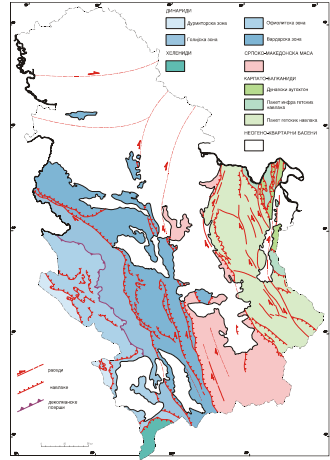
ИЗДАНА ПОТРЕС ПО СКАЛИ I-XII. ЈАЧИНА ТУТЊАВЕ ПО СКАЛИ I-V. — ТУТЊАВЕ (ДАТУМ) А — КИЛ. КОРТАЖА.  
 В — КИЛ. ГРАДИНА. С — КИЛ. ТУРНА. Д — КИЛ. ПУСТА. Е — КИЛ. КЛАНИНА. Ж — КИЛ. ВРХ. ТОРНА ИЛИ ПУСТА.  
 Г — КИЛ. КУПЧУЛА ЈАЧКА.

# Seismic source investigation and determination

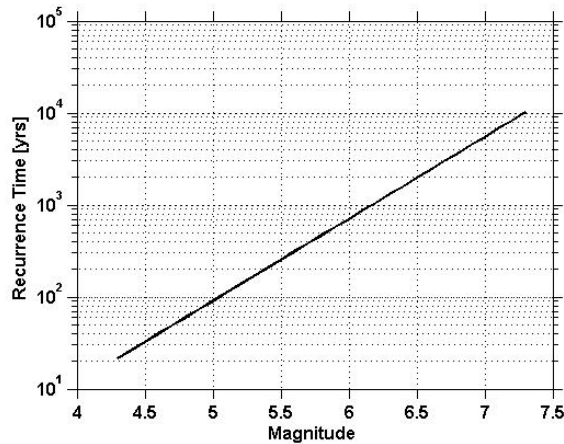
Karta rupturnog sklopa Republike Srbije



# Preparation of GIS background and thematic maps



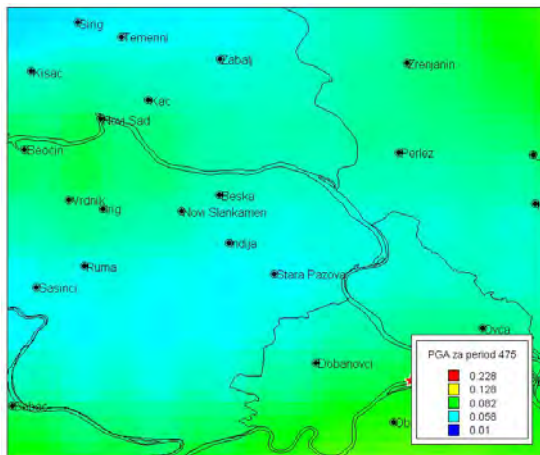
# Seismic hazard assessment



Recurrence of earthquakes inside the identified seismic source zones have been defined, e.g. recurrence of earthquakes for the Vojvodina seismic source zones.

Available GMP models have been tested: Sabetta, 1996; Ambraseys et al., 1996; vertical acceleration Ambraseys and Douglas, 2000. It was found that Sabetta relation is more realistic.

Seismic hazard for the tested area have been calculated using OHAZ 6 software

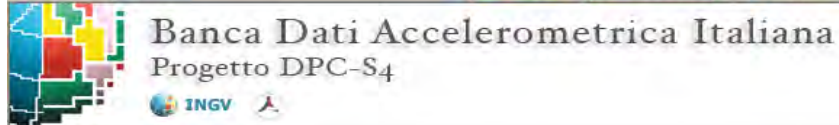


# Determination of ground-motion prediction (GMP) model

## Suggestion

- to collect all available accelerations measured in the Western Balkan region
- to form acceleration data base
- to compare those data with available GMP equations and adopt most realistic model or combination of models
- one reference site dealing with GMP equations is:

[http://esse4.mi.ingv.it/index.php?option=com\\_content&task=view&id=13&Itemid](http://esse4.mi.ingv.it/index.php?option=com_content&task=view&id=13&Itemid)



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- Utilities



Workshop on Ground Motion Prediction Equations  
Milano, June 26 2009

## Workshop on Ground Motion Prediction Equations

Milano, June 26 2009

### [Programme of the workshop](#)

### [5-Projects and Ground Motion Prediction Equations \(GMPEs\)](#) *Pacor, F.*

### [S1 project: Maximum Observable Shaking \(MOS\) maps of Italy &](#) *Zonno G., Musacchio G., Meroni F., Basili R., Imperatori., and P. Martin Mai*

### [S2 Project and GMPEs](#) *Cauzzi C and E. Faccioli*

### [S3 Project: Shakemaps and GMPEs](#) *Michelini A.*

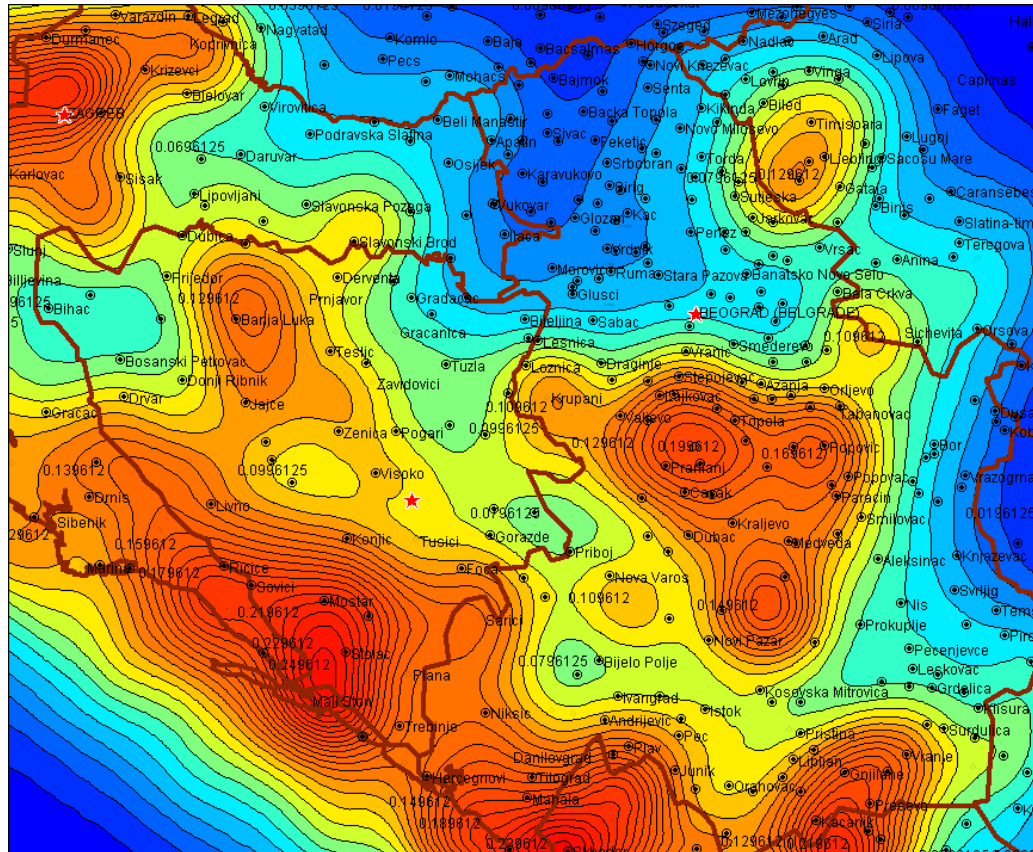
### [S4 Project and the ITA08 GMPE](#) *Massa M. and ITACA working group*

### [S4 Project: GMPE using site classification based on site predominant period](#) *Di Alessandro C. and Rovelli A.*

### [Recent Italian and European GMPEs and validation with recorded data from Parma earthquake \(2008, December\) and L'Aquila earthquake \(2009, April\)](#) *Sabetta F.*

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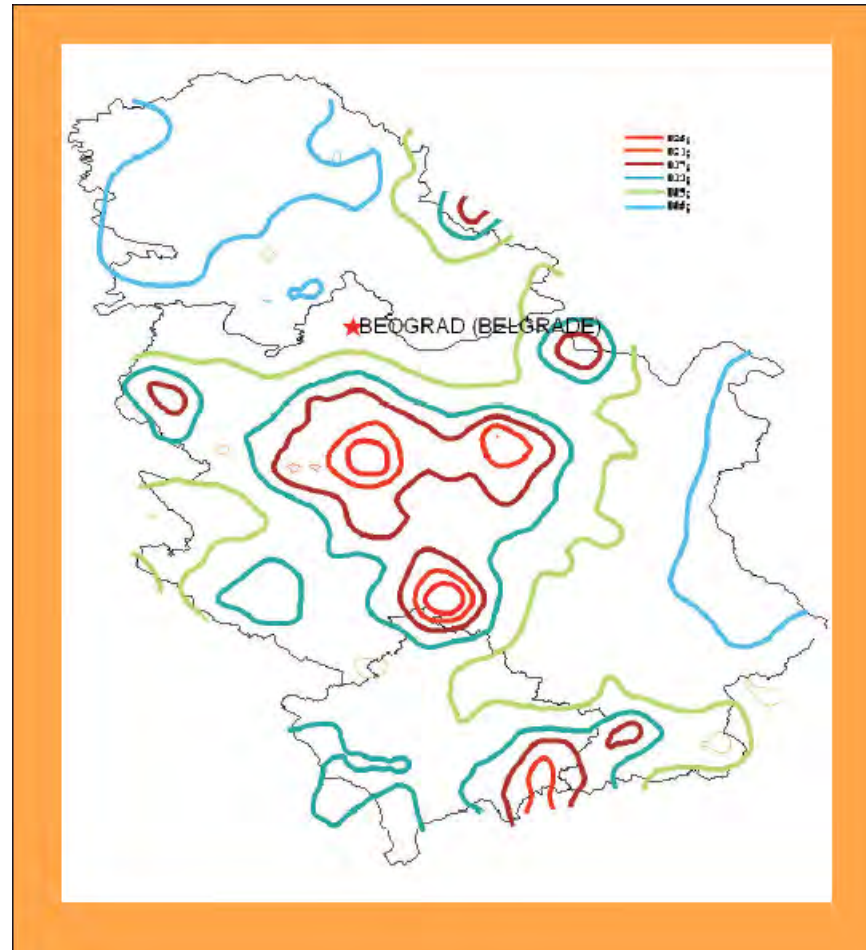
# Seismic hazard assessment



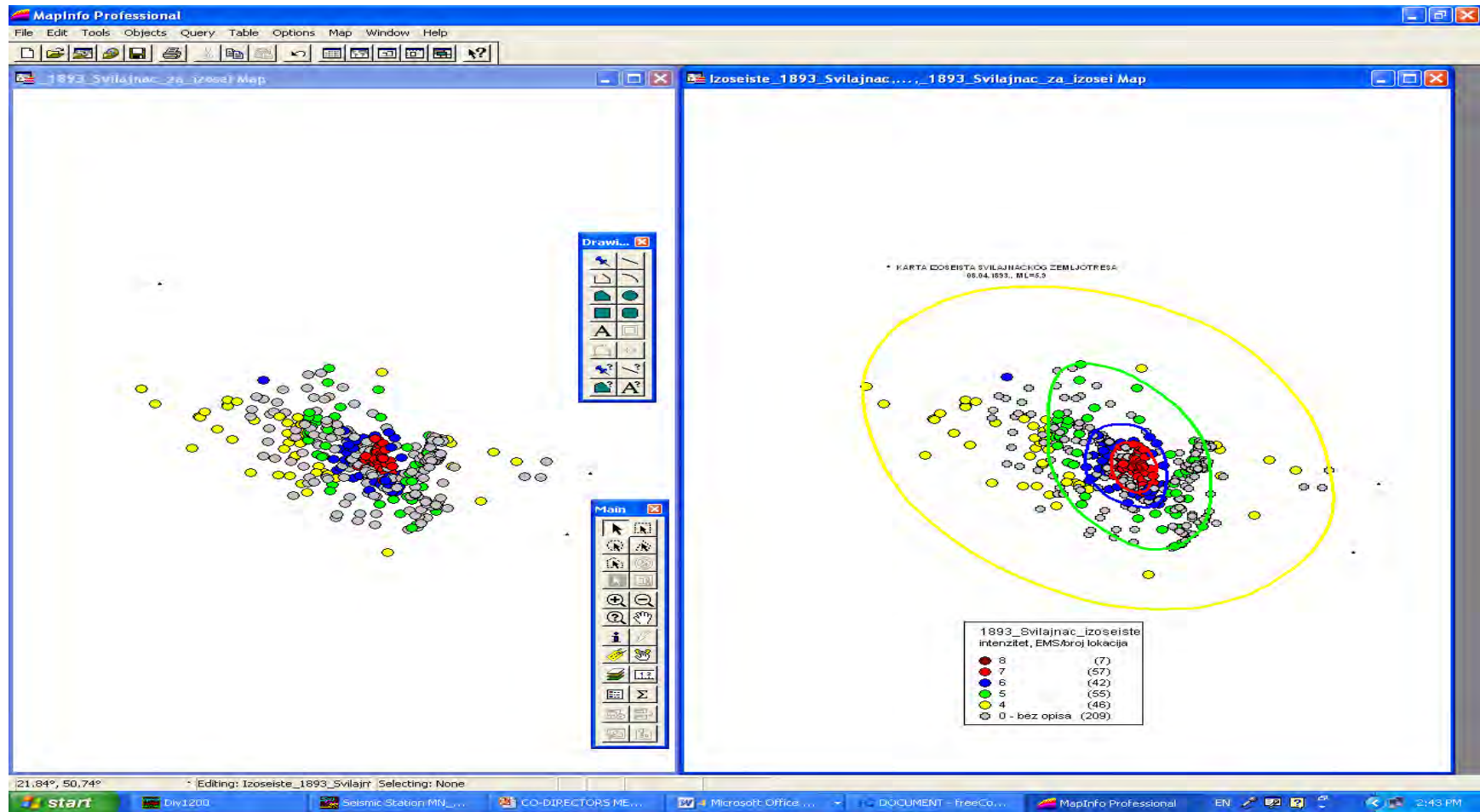
Preliminary calculation of seismic hazard has been tested, based on available data

Seismic Hazard Map of the Serbia and surroundings; isolines and colors represent peak horizontal ground accelerations in g units

# Preliminary hazard map for 475 years return period



# Software purchase



# Training of young scientists

- Training for 18 researchers (3 participants from 6 countries), with engagement of 4 experts from Greece, Czech Republic, Germany Turkey and Albania. Participants would bear the cost of travel only.
- Training should last 5 days and the area of scientific interest should be closely connected to the Project tasks and with future detailed researches.
- Proposed subjects for the training:
  - 1) Inversion of broad band signal in order to define moment tensors with the installation of free of charge software and instruction for its use;
  - 2) SeisComp3 Seismogram Analysis
  - 3) Strong motion Data Analysis
  - 4) Instruction on use of final version of Seismic Hazard Software
- 4 experts in related scientific fields invited for 5 days training. The goal is, as recommended in NATO Project handbook, “to facilitate the transfer of knowledge from advanced research centers to members of the project team.”
- Suggestions regarding the proposed training are welcome.

# Training at Divcibare, April 21-23, 2009

