



City of Ljubljana

Aspects of Earthquake Risk Management in Slovenia

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the City of Ljubljana

12th International Crisis Management Conference
Ljubljana, June 8th 2017

Based on the national research project

„Earthquake risk in Slovenia“

and municipal research project

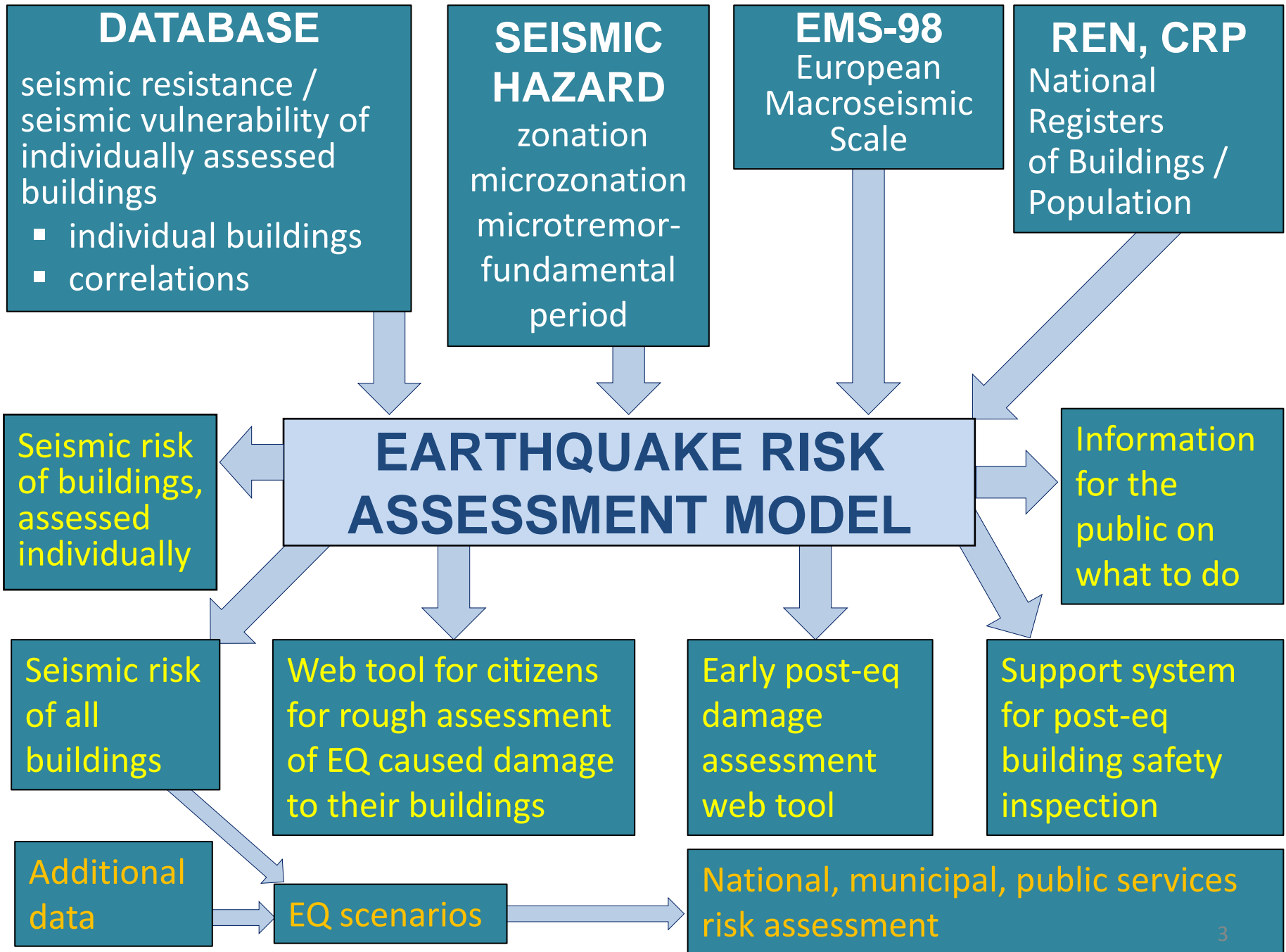
„Seismic Risk in Ljubljana“

financed by: Administration of RS for Civil Protection and Disaster Relief
City of Ljubljana

performed by: Slovenian National Building and Civil Engineering Institute
Slovenian Environment Agency
Water Science Institute

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presented by: Julij JERAJ



DATABASE

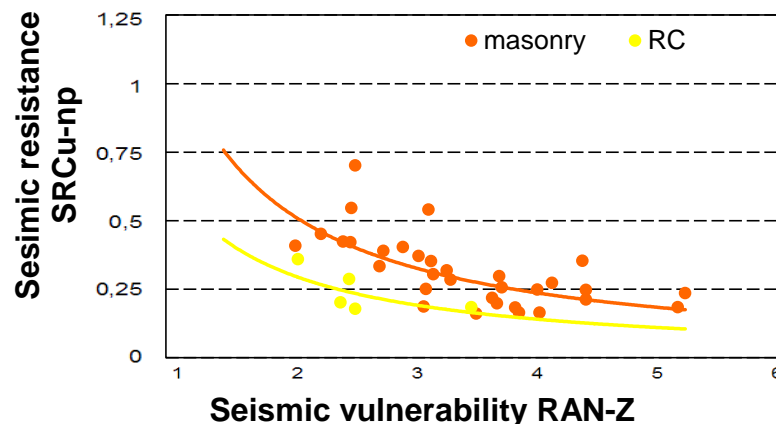
seismic resistance /
seismic vulnerability of
individually assessed
buildings

- individual buildings
- correlations

Seismic Vulnerability and Seismic Resistance Assessment

Methodologies in Slovenia

- **seismic VULNERABILITY of masonry buildings RAN-Z (1995)**
parameters: amount of walls, masonry type, confinement, distribution of walls in layout, height of building
output: numerical value 0 - 10
- **seismic RESISTANCE of masonry buildings PO-ZID (2001)**
based on data and results of analytic push-over method
output: coefficient of seismic resistance SRCu-np
- **seismic RESISTANCE of RC buildings PO-AB (2002)**



RAN-Z vulnerability grade:

up to 3.5 low vulnerability

3.5- 6.5 medium vulnerability

above 6.5 high vulnerability

Database of 1500 Individually Assessed Buildings in Slovenia

City of Ljubljana

Buildings of historical nucleus of Ljubljana (1985)

Health centres (1998) and hospitals (2012)

Fire stations (2000)

School buildings (2001, 2004, 2007)

Some groups of residential buildings (2004, 2007, 2010, 2011)

Buildings of MOL Administration and Public services (2004 to 2007)

Industrial buildings in the City of Ljubljana (2001-2008)

Public buildings of the State

State Administration buildings (2007 to 2009)

Social Institutions and Residential buildings for students (2004 – 2010)

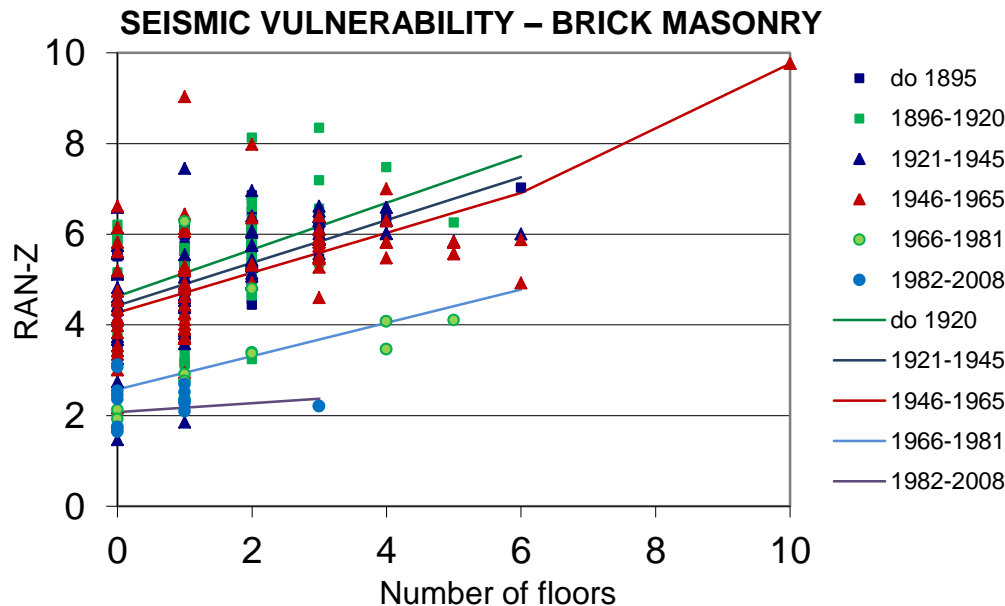
Houses of Posočje region after 1998 and 2004 earthquakes

POTROG (155 buildings) and CHERPLAN - Idrija (2011-2013)

Analysis of the Database

Correlations between seismic vulnerability and some basic data, available in the National register of buildings (REN):

- **Building material** (stone masonry, brick masonry, concrete, r.c., combination, other)
- **Number of floors** (0, 1, 2, ...)
- **Period of construction** (up to 1895, 1896–1920, 1921–1945, 1946–1965, 1966–1981, 1982–2008, 2009 ->)



DATABASE

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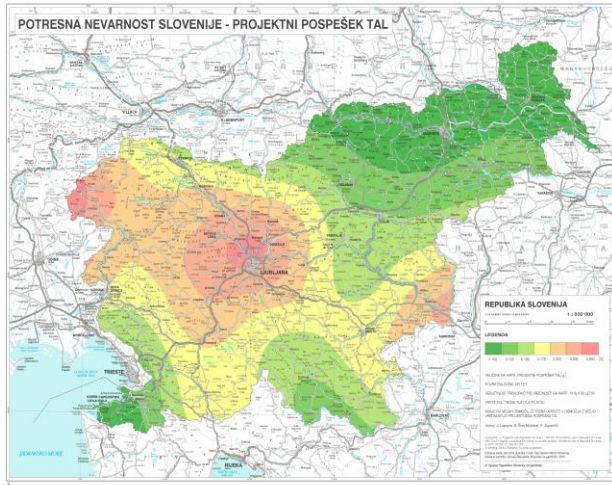
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SEISMIC HAZARD

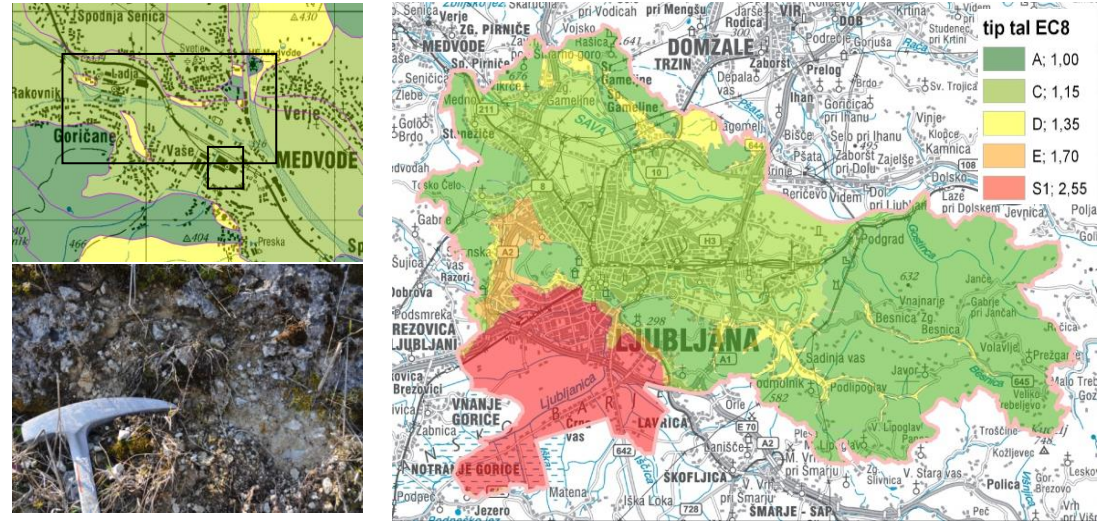
zonation
microzonation
microtremor-
fundamental
period

Seismic hazard of Slovenia

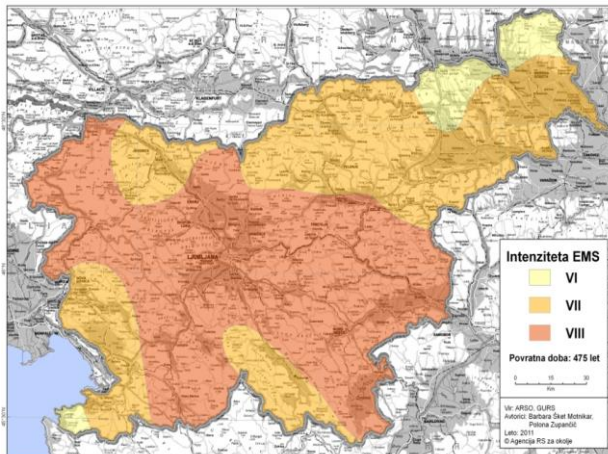
Design ground acceleration (a_g) (Evrokod 8)



Microzonation of MOL – Ground types (A, B, C, D, E, S1, S2)

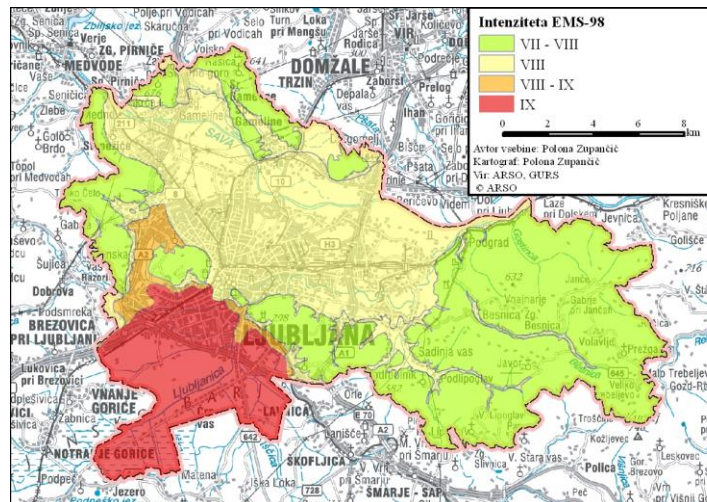


Seismic intensity - Project EMS-98



Return period 475 years

Microzonation of MOL – Intensity EMS-98



Soil type	Intensity	Part
A	VII-VIII	45%
B, C, D	VIII	37%
E	VIII-IX	3%
S ₁	IX	15%

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SEISMIC HAZARD

zonation
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EMS-98

European
Macroseismic
Scale



European Macroseismic Scale EMS

Vulnerability types of buildings:

A, B, C, D, E and F

Classification of damage of buildings:

0: no damage	1: negligible to slight	2: moderate	3: substantial to heavy	4: very heavy	5: destruction
HABITABLE		LIMITED USE		NOT SAFE	

Intensity EMS: I – XII

Damage to buildings: V-XII EMS



European Macroseismic scale EMS

Damage caused by an earthquake of intensity VIII EMS

Building's vulnerability type	Damage degree (extent of damage)					
	0	1	2	3	4	5
A	0	0	25	35	30	10
B	0	25	35	30	10	
C	25	35	30	10		
D	60	30	10			
E	100					
F	100					

DATABASE

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SEISMIC HAZARD

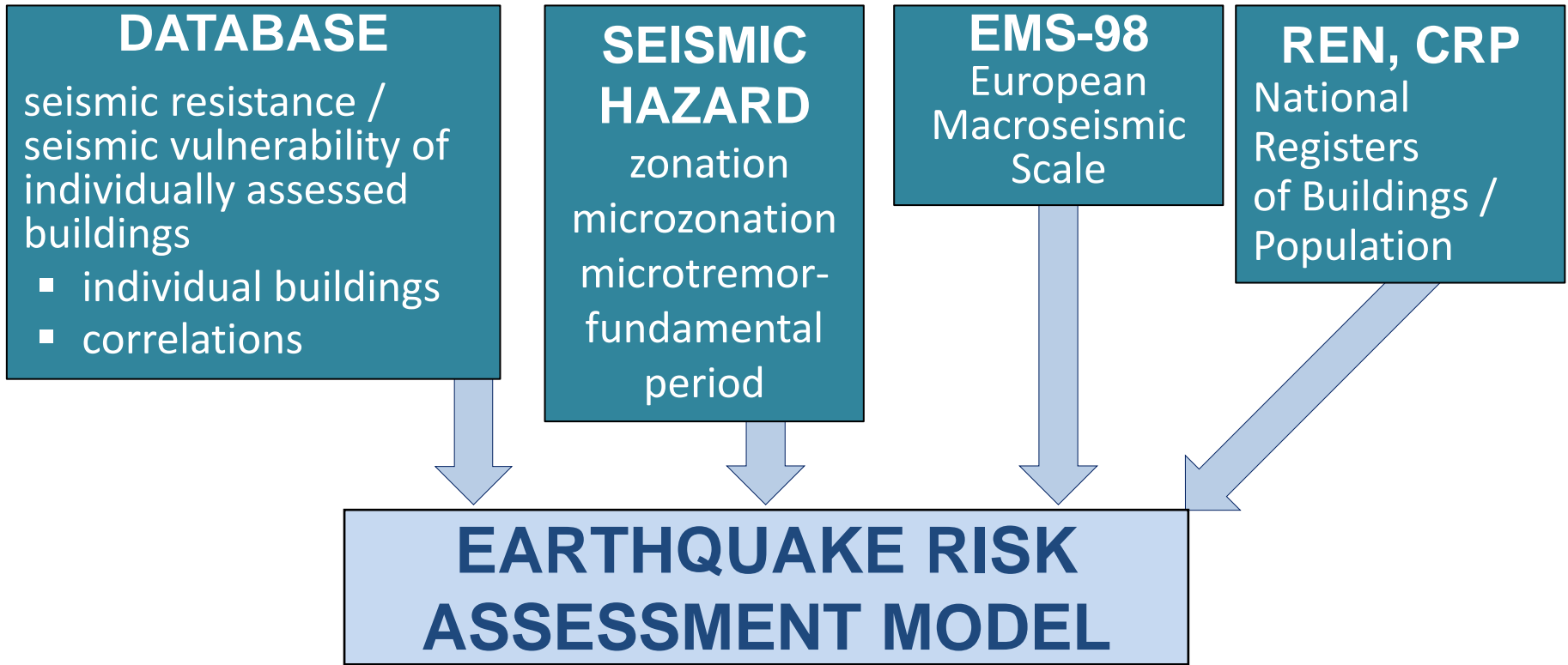
zonation
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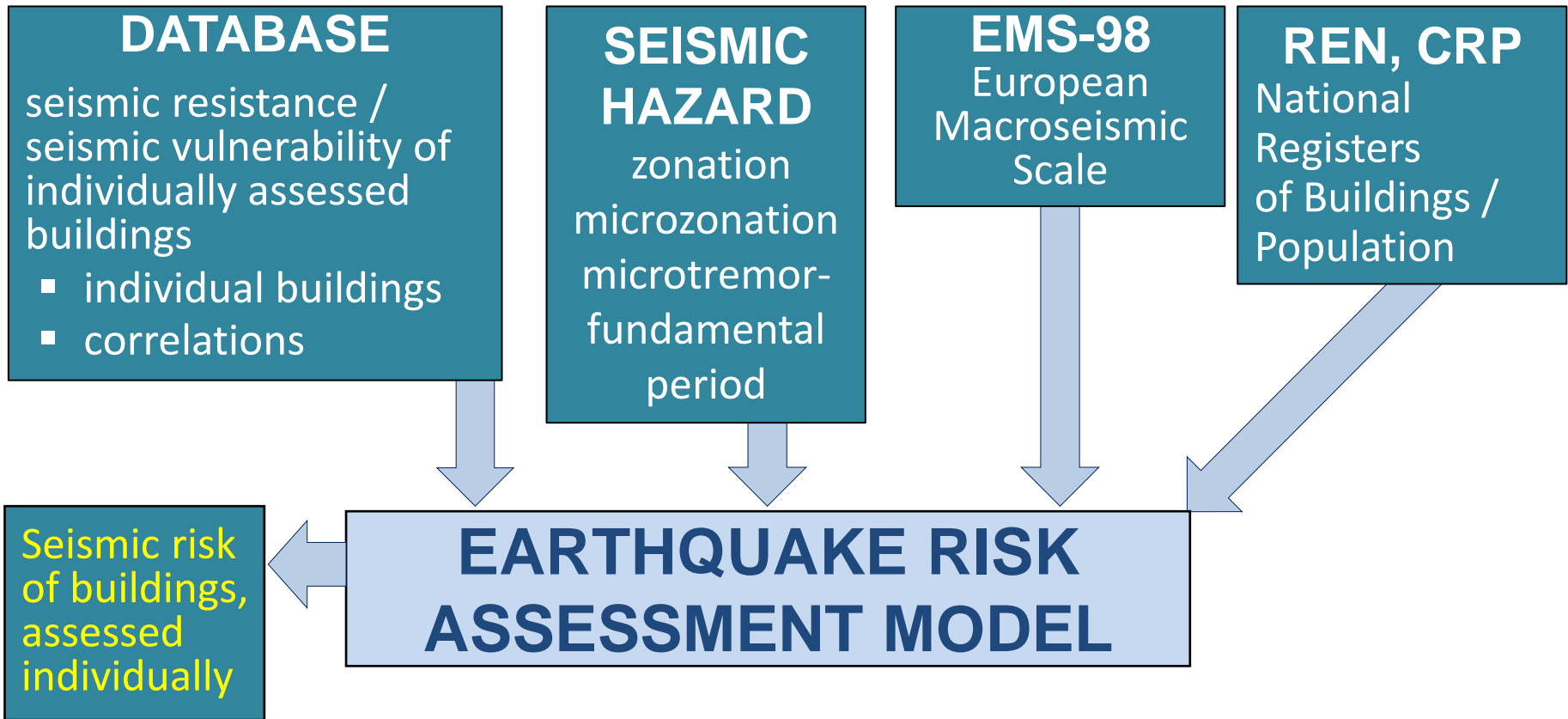
EMS-98

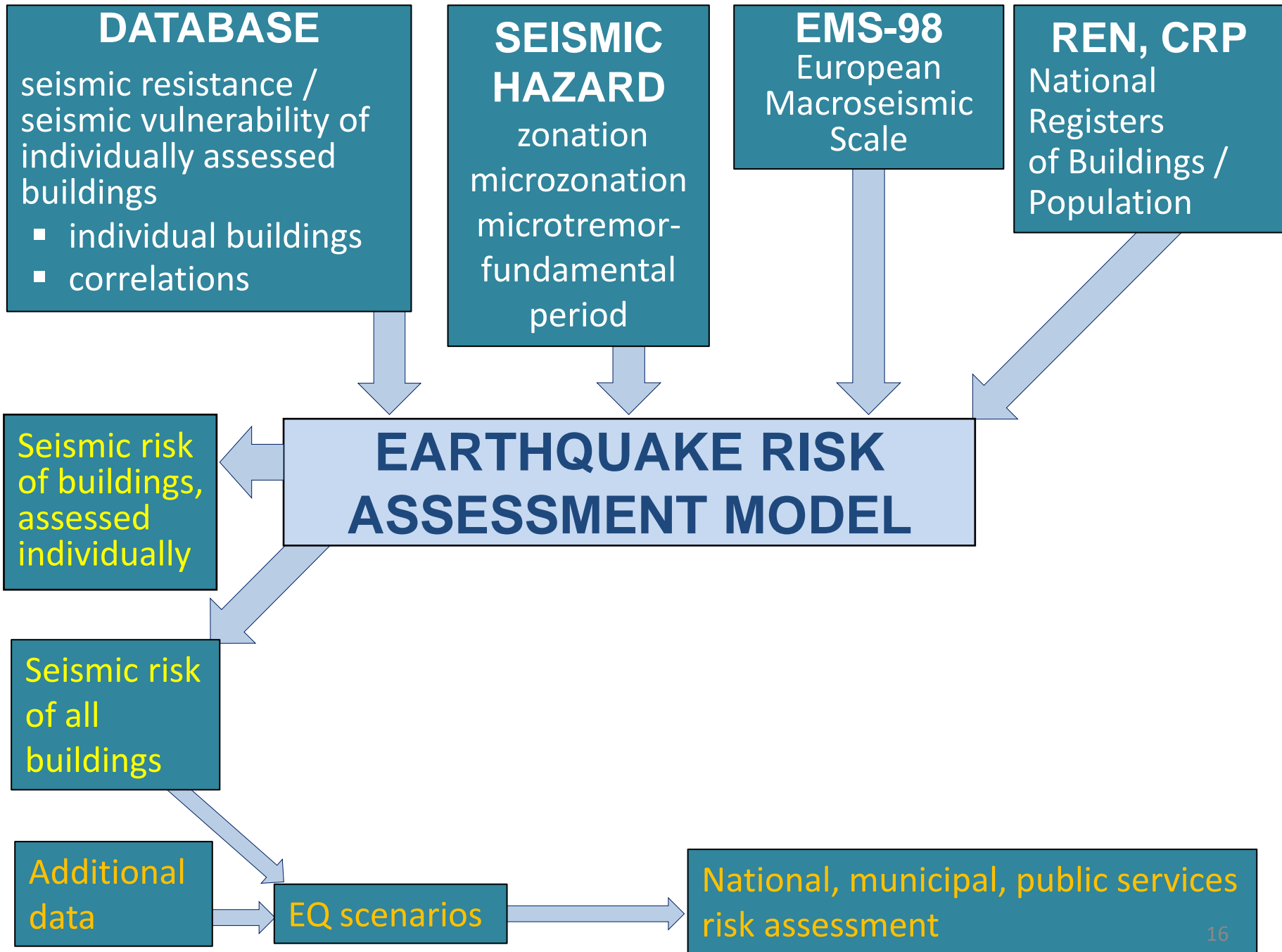
European
Macroseismic
Scale

REN, CRP

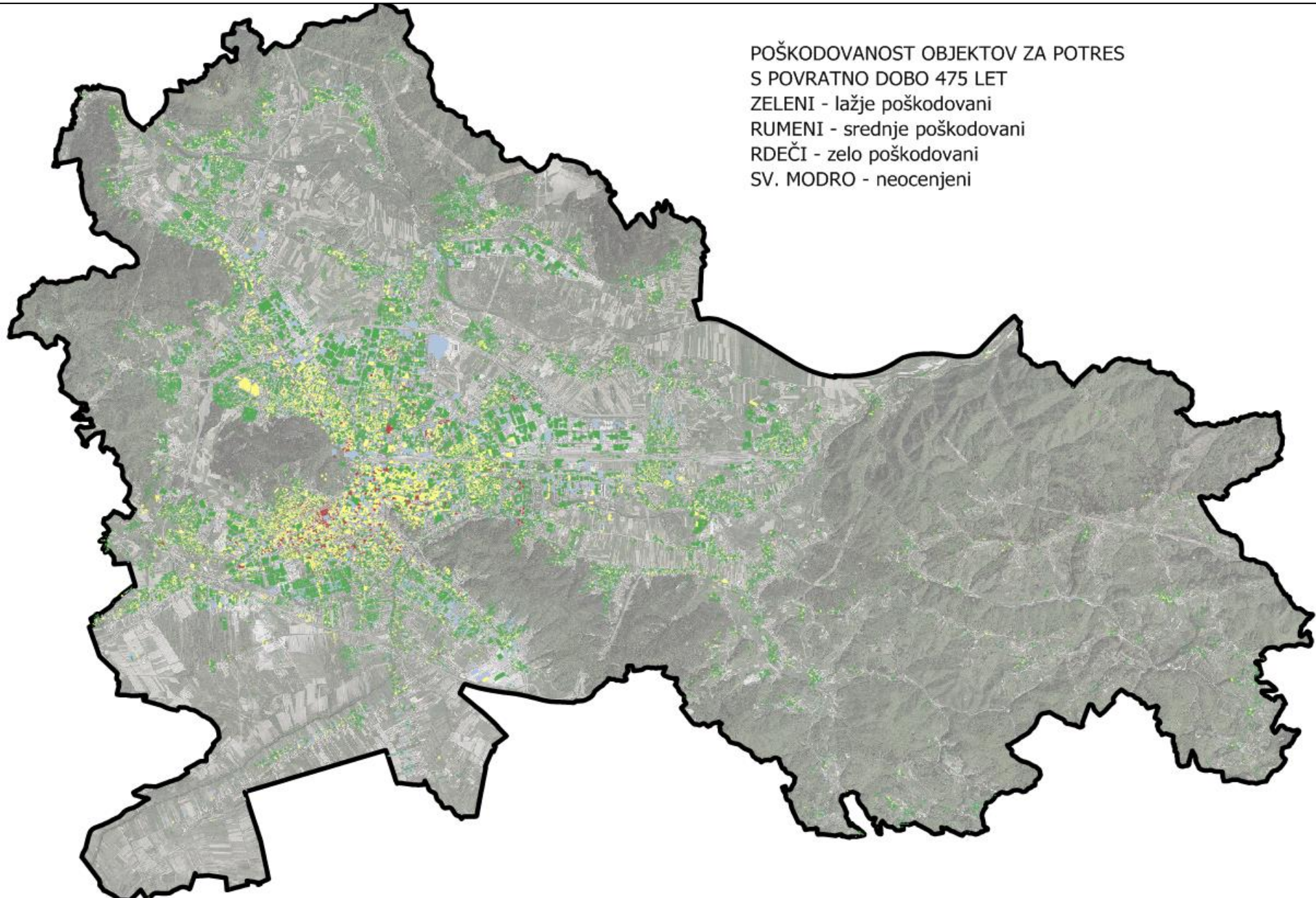
National
Registers
of Buildings /
Population





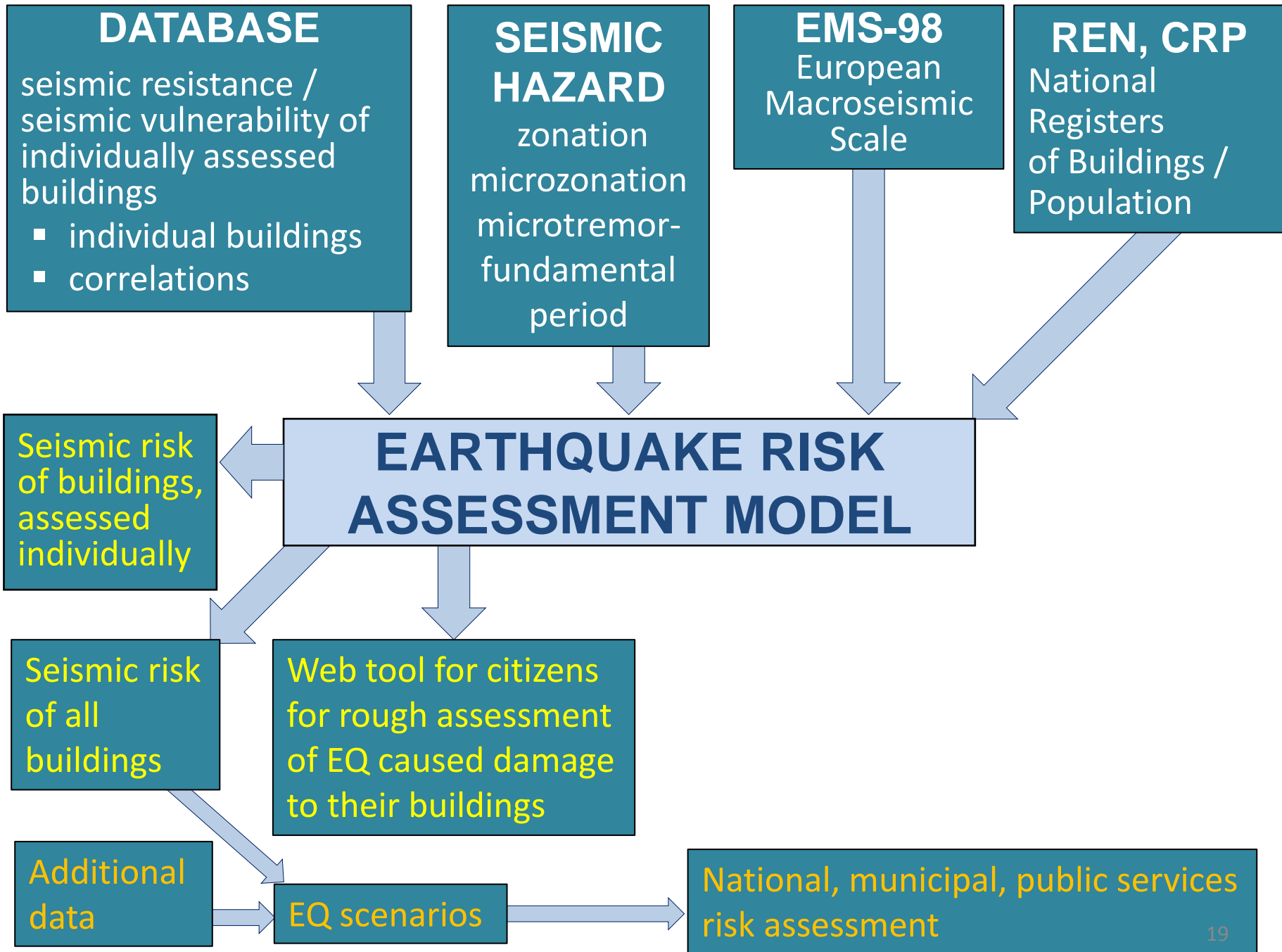


POŠKODOVANOST OBJEKTOV ZA POTRES
S POVRATNO DOBO 475 LET
ZELENI - lažje poškodovani
RUMENI - srednje poškodovani
RDEČI - zelo poškodovani
SV. MODRO - neocenjeni



Scenario for the earthquake of the VII – IX EMS intensity with the epicenter in the middle of the City of Ljubljana

Damage degree	unknown	0	1	2	3	4	5 destruction
Buildings	12,551	25,074	19,026	9,136	4,953	1,339	107
Permanently registered citizens	58,683	38,626	74,055	40,867	54,538	25,293	6,912
						Urban search and rescue	
						Medical assistance	
						Dead	
				Temporary sheltering		Temporary sheltering	
				Mid to long term temporary housing		Rebuilding	
Rescue personnel		49%	19%	20%	10%	2%	0%
Cultural heritage buildings	385	342	218	202	332	73	6



Questionnaire for the estimation of expected damage

[Nazaj](#) [Naprej](#)

Podatki o stavbi

Korak 1 / 9

Leto zgraditve stavbe

1956

Število kletnih etaž:

0

Kletne etaže so tiste, ki so vsaj deloma vkopane.



Število etaž nad pritličjem:

P + 4

Pritličje je prva etaža, ki je v celoti nad nivojem zemljišča.

Mansarda se šteje za nadstropje, če je nad njo pohodna stropna konstrukcija, sicer ne. Upoštevajte tudi nadstropja, ki pokrivajo le del tlorisa.



[Nazaj](#) [Naprej](#)

[Nazaj](#) [Ponovna ocena](#)

Rezultati

Korak 9 / 9

Rezultati so prikazani za naslednjo stavbo:

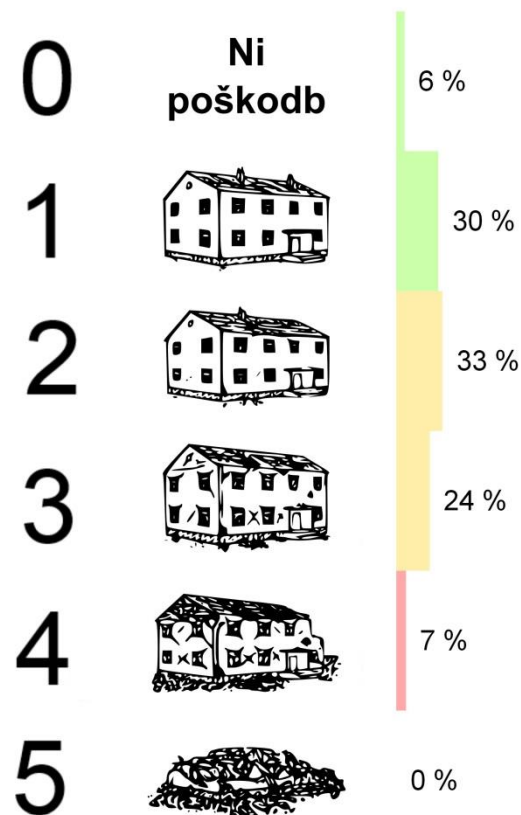
letno izgradnje: 1956

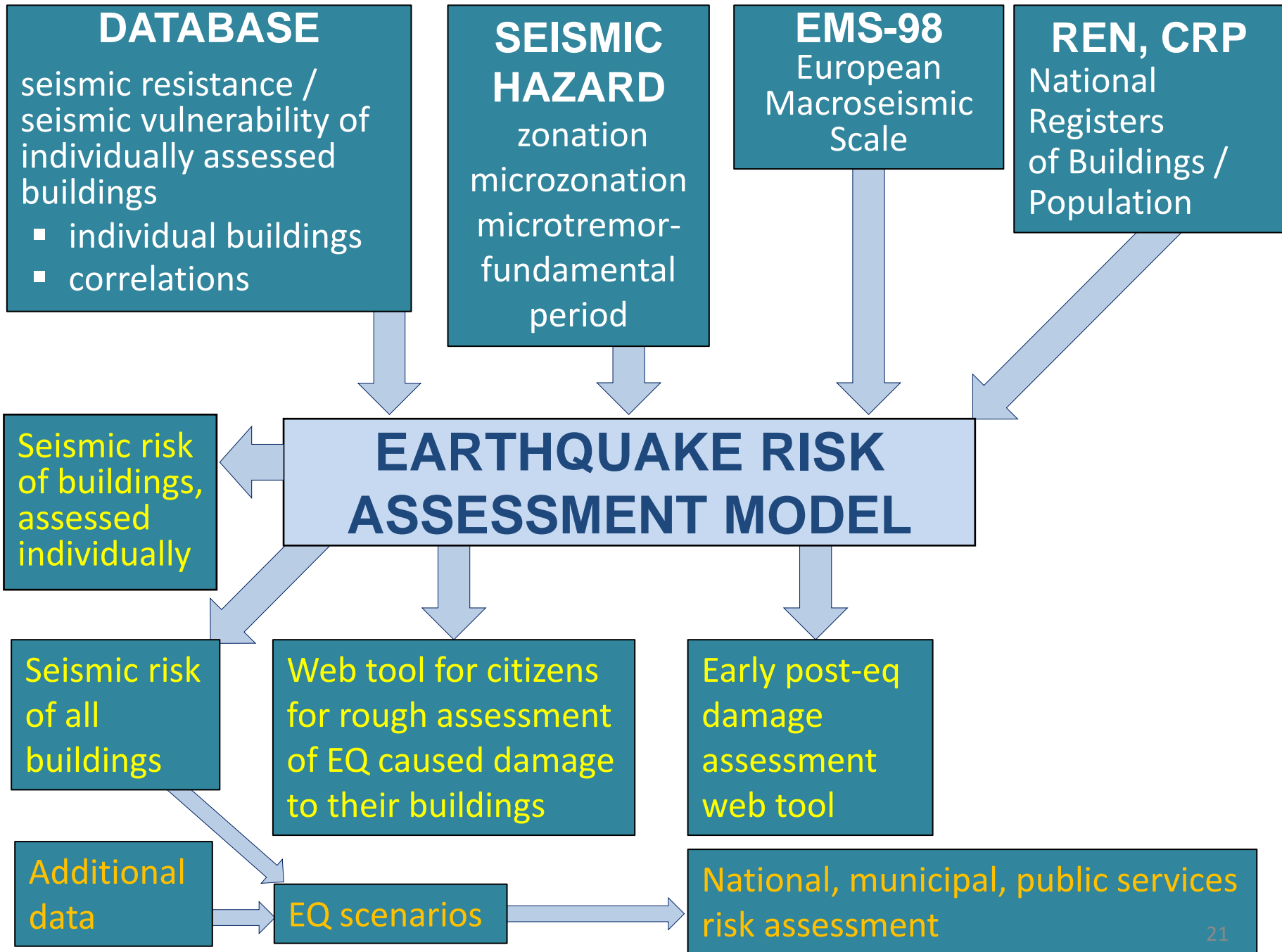
konstrukcija: OPEKA

št. etaž: P + 4

dejanska intenziteta: VIII

Kategorija poškodovanosti





Rapid Damage Assessment System

Analiza za potres: 30.06.2014 ob 04:09 5 km J od Ljubljane, intenziteta 8

VIII (močne poškodbe)

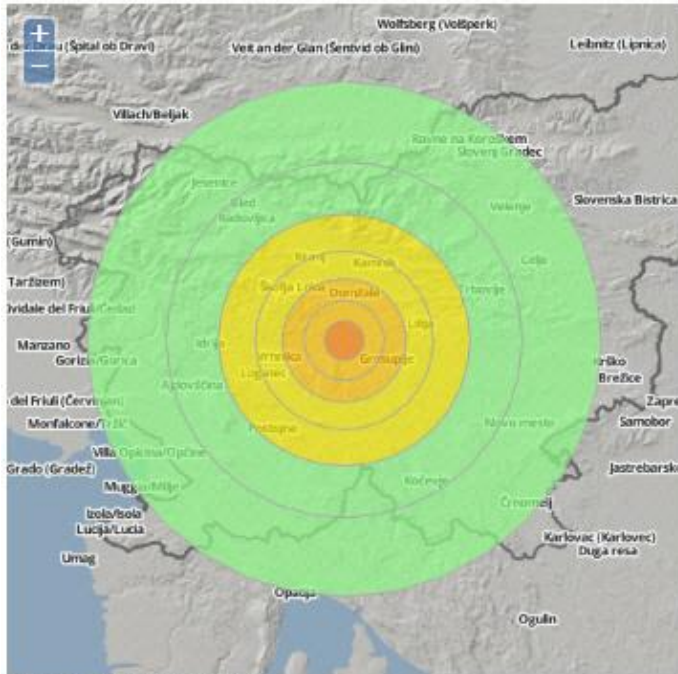


Ocena obsega

Ocena obsega drugega potresa

Ocenjeno padanje intenzitete izbranega potresa.

Prikazana so območja, v katerih so možne poškodbe stavb.



Legenda intenzitete (EMS):

Tresenje	brez	šibko	zmerno	močno	močnejše	zelo močno	nasilno	ekstremno
Poškodbe	brez	brez	manjše	manjše	zmerne	močne	rušine	rušine
Intenziteta	I	II-IV	V	VI	VII	VIII	IX	X

Analiza obsega (vključene so le stavbe Republike Slovenije)

Ocena ogroženih stavb in prebivalcev.

Vsote

Po občinah (RDEČE)

Po občinah (RUMENO)

Ali si čutil

Analiza za območje celotne Slovenije

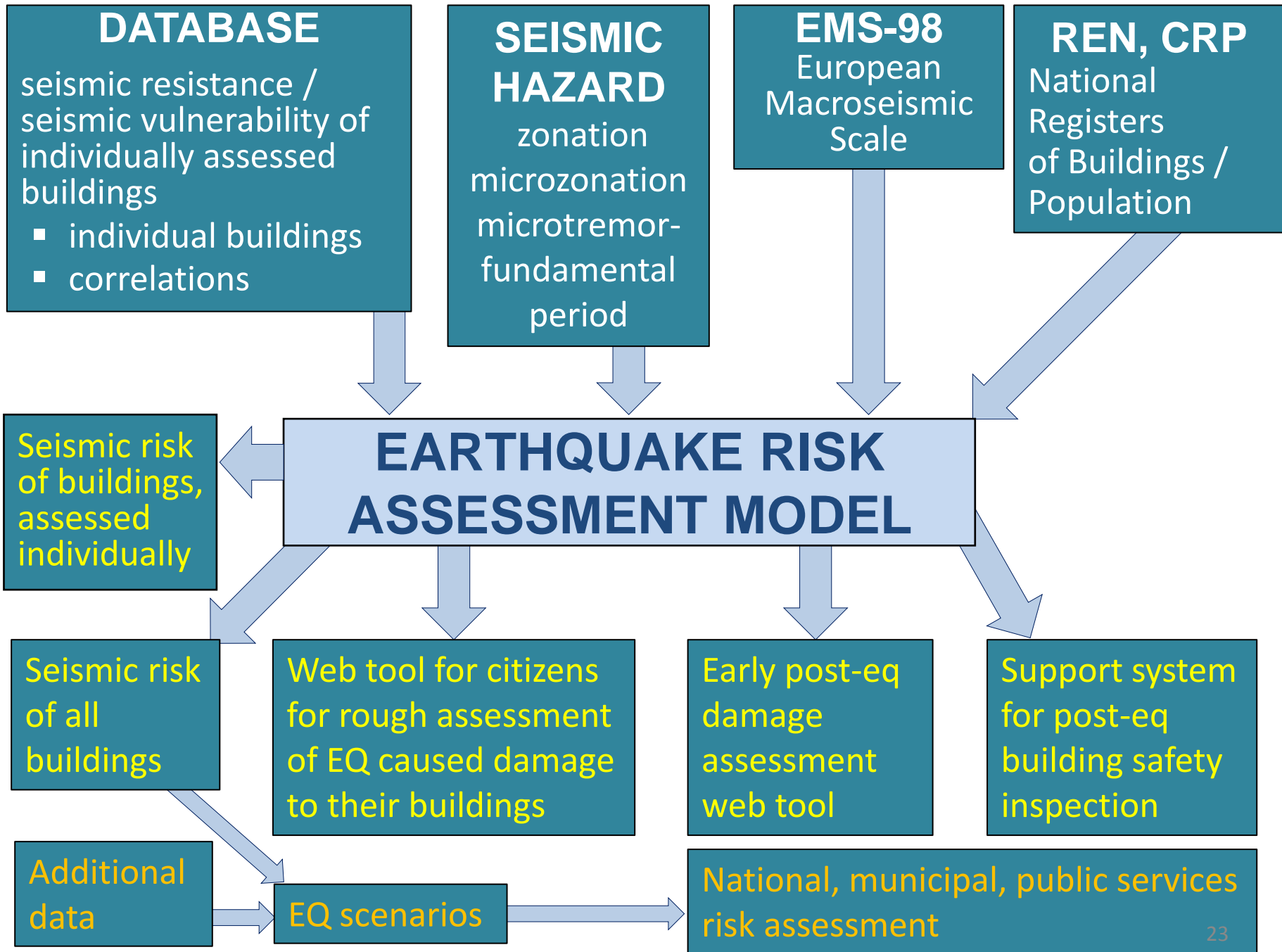
	Ogrožene stavbe	Ogroženi prebivalci (nočni scenarij)
Potrebna stalna namestitvev	127 (0%)	5552 (0%)
Potrebna začasna namestitvev	8627 (2%)	68784 (11%)
Bivanje v stavbi je možno	246254 (83%)	448914 (73%)
Neocenjene stavbe	39890 (13%)	89943 (14%)
Skupaj	294898 (100%)	613193 (100%)

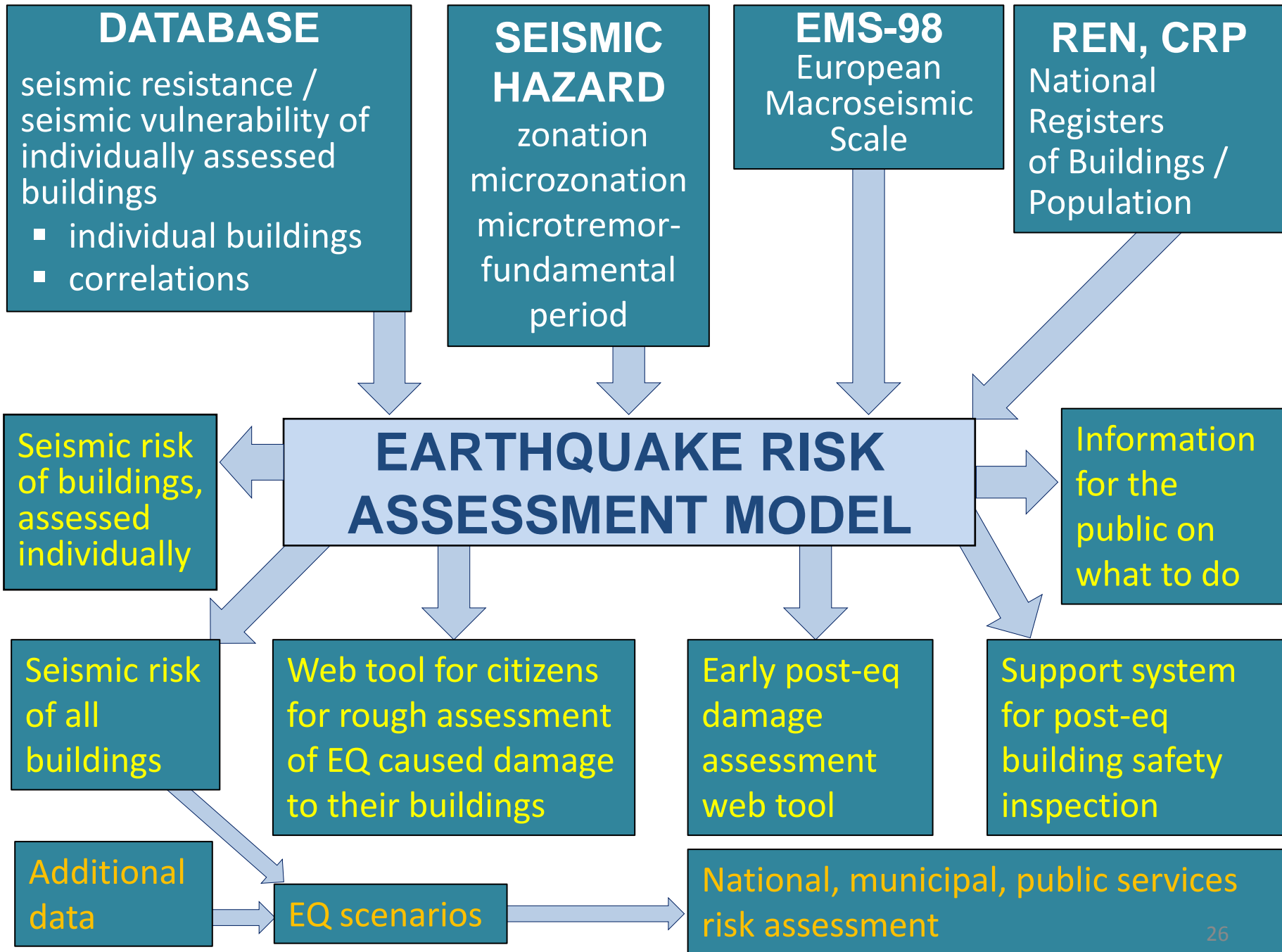
Analiza po občinah

Zanesljivost ocene pri občinah označene z * je bistveno manjša od ostalih.

Občina	Stavbe (RD)	Stavbe (RU)	Stavbe (ZE)	Stavbe (N/A)	Preb (RD)	Preb (RU)	Preb (ZE)	Preb (N/A)
BOROVNICA	0	6	1917	374	0	110	2961	614
BREZOVICA	1	432	5321	861	8	677	8861	1356
IG	2	415	3645	682	9	676	4636	1036
KRANJ	0	105	14799	1141	0	3525	41682	2949
LITIJA *	0	33	7443	983	0	579	11133	1564
LJUBLJANA	124	6271	53240	12551	5535	55476	115312	40597
LOG-DRAGOMER	0	57	1517	177	0	73	3210	269
LOGATEC	0	36	5792	832	0	283	9948	2398
MEDVODE	0	28	6683	1068	0	285	12842	1612
VODICE	0	5	2264	310	0	10	4132	435
VRHNIKA	0	38	6767	985	0	392	12062	1607







Informing the public

- **Research report 1:** http://www.sos112.si/slo/tdocs/naloga_99.pdf
- **Research report 2:** http://www.sos112.si/slo/tdocs/naloga_102.pdf
- **Brochure/adults:** http://www.sos112.si/slo/tdocs/brosura_odrasli_potres_2012.pdf
- **Brochure/kids:** http://www.sos112.si/slo/tdocs/brosura_otroci_potres_2012.pdf
- **Web tool** Questionnaire for the estimation of expected damage <http://potrog2.vokas.si/>
- **Web tool** Rapid Damage Assessment System
<http://potrog2.vokas.si/>
- **Meetings** with representatives of ministries, municipal departments, building maintaining companies
- **Publishing** scientific papers

Potres!

Kako ravnati

Kako sami ukrepate pred potresom

Poučite se

Slovenija leži na potresno nevarnem območju, zato so potresi pri nas pogosti. Večina je zelo šibkih in jih ne zaznamo, le zelo redki so tako močni, da povzročijo škodo.

Na karti potresne intenzitete preverite, kakšne učinke potresov lahko pričakujete na območju, na katerem živite.

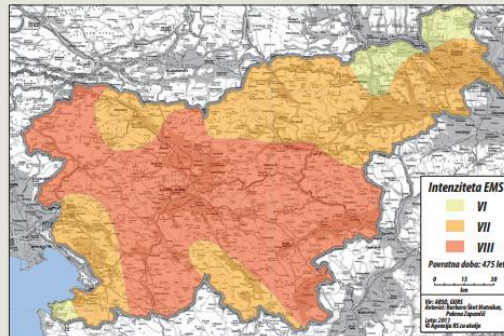
Ob močnejšem potresu se lahko zgodi, da:

- ne bo zagotovljena preskrba z elektriko in zemeljskim plinom;
- bo motena oskrba z vodo oziroma voda ne bo pitna;
- bo poškodovan in zaradi tega neuporaben kanalizacijski sistem;
- sistem ogrevanja, ki ga običajno uporabljate, ne bo deloval ali ne bo varen za uporabo;
- stacionarni in mobilni telefoni ter internet ne bodo delovali ...

... zato si pripravite:

- zadostno zalogo vode – preskrbite si vodo v plastenkah, dodatno lahko pripravite tudi sredstva za razkuževanje vode;

Karta potresne intenzitete Slovenije za povratno dobo 475 let *



Evropska potresna lestvica (EMS) ima 12 stopenj. Vir: ARSO.

VI EMS – potres z manjšimi poškodbami: mnogi se prestrašijo in zbežijo na prsto. Nekateri predmeti padajo na tla. Na številnih stavbah nastanejo manjše nekonstruktivne poškodbe (lasaste razpoke, odpadejo manjši kosi ometa);

VII EMS – potres z zmernimi poškodbami: večina ljudi se prestraši in zbeži na prsto. Stabilno pohištvo se premakne iz svoje lege in predmeti padajo s polic. Številne dobro grajene stavbe so zmerno poškodovane, nastanejo majhne razpoke v stenah, odpadejo deli ometa ali dimnikov. Na starejših stavbah se lahko pojavijo velike razpoke v stenah, lahko se porušijo predelne stene;

VIII EMS – potres z močnimi poškodbami: ljudje se težavo lovijo ravnotežje. Pojavijo se velike razpoke na stenah številnih stavb. Pri posameznih dobro grajenih stavbah se porušijo stene, slabo grajene stavbe se lahko porušijo v celoti.

* Učinki potresa se lahko dodatno povečajo na tleh s slabšimi geološkimi razmerami, na strmeh pobočjih in območjih visoke podtalnice.



sov ne moremo napovedati
niti jih ne moremo preprečiti, lahko pa se nanje
skupaj s starši in učitelji že vnaprej pripravite.



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HARMONIZED DATASETS FOR INTEGRATED DISASTER MANAGEMENT SUPPORT

Conference Paper · September 2015



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Your questions are most welcome

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**Thank you
for your kind
attention!**

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