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Remote Rapid Visual Screening (RRVS)

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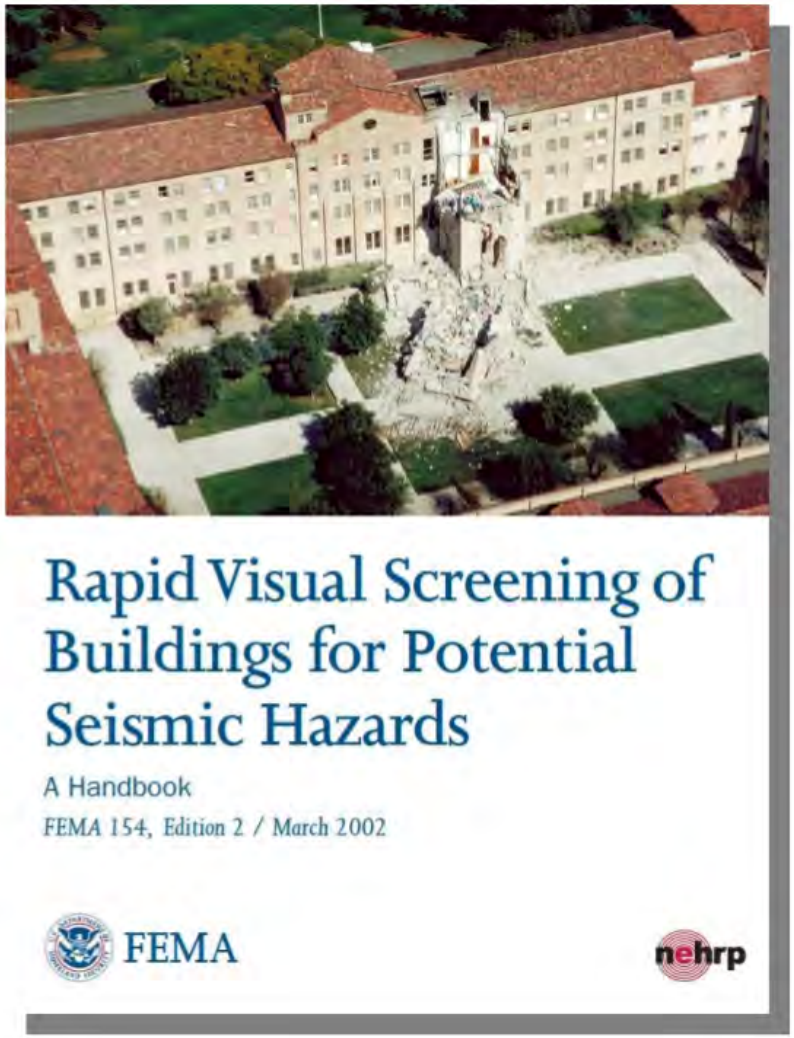
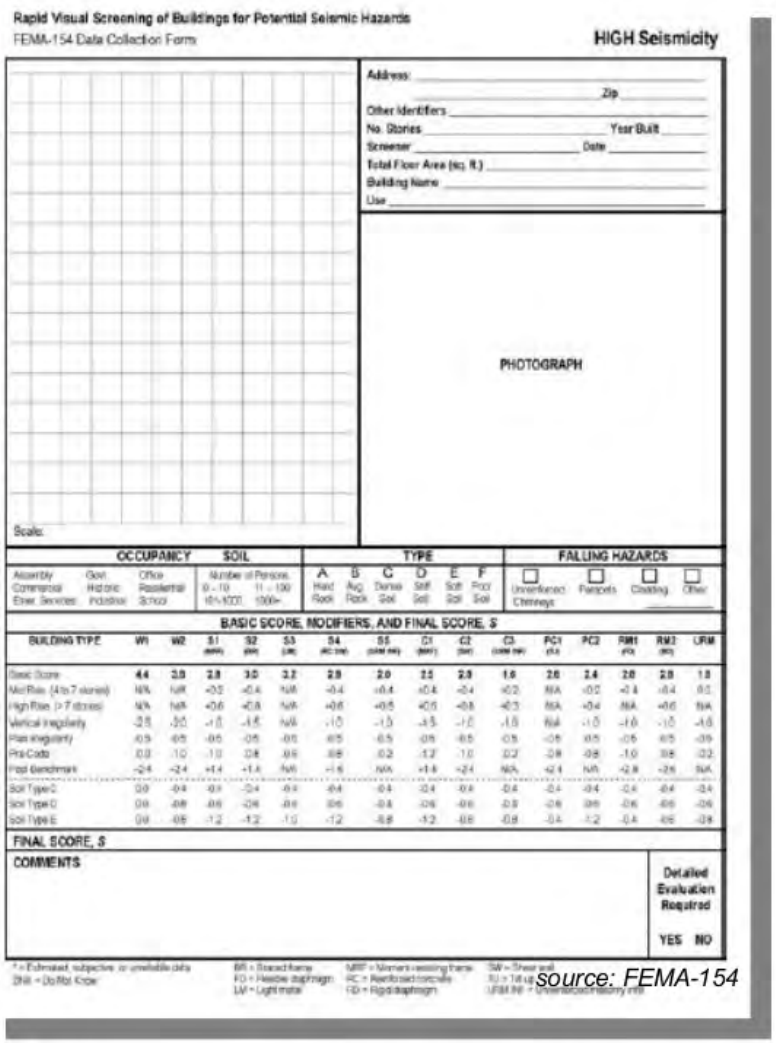
GFZ German Research Centre for Geosciences

L'Aquila, May 30-31 2016

FEMA P-154





Source: FEMA-154

GFZ Helmholtz-Zentrum Potsdam

SIBYL

GNT AEDES

JRC Scientific and Technical Reports

Field Manual for post-earthquake damage and safety assessment and short term countermeasures (AeDES)

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EUR 22868 EN - 2007

JRC EUROPEAN COMMISSION

ipsc Institute for the Protection and Security of the Citizen

Protezione Civile Nazionale

less loss

Horizontal Structures \ Vertical structures	Unknown	Masonry buildings: Irregular layout or bad quality (rubble stones, pebbles...) W/O tie rods or tie beams	Irregular layout or bad quality (rubble stones, pebbles...) With ties rods or tie beams	Regular layout and good quality (Blocks, bricks, squared stone..) W/O tie rods or tie beams	Regular layout and good quality (Blocks, bricks, squared stone..) With tie rods or tie beams	Isolated columns	Mixed	Strengthened
	A	B	C	D	E	F	G	H
1 Not identified	❍	□	□	□	□	SI	□	□
2 Vaults without tie rods	□	□	□	□	□	❍	G1	H1
3 Vaults with tie rods	□	□	□	□	□		□	□
4 Beams with **flexible** slab (wooden beams with a single layer of wooden planks, beams and shallow arch vaults,...)	□	□	□	□	□	NO	G2	H2
5 Beams with **semirigid** slab (wooden beams with a double layer of wooden planks, beams and hollow flat blocks,...)	□	□	□	□	□	❍	□	□
6 Beams with **rigid** slab (r.c. floors, beams well connected to r.c. slabs,...)	□	□	□	□	□		G3	H3

Other structures	
R.c. frames	□
R.c. shear walls	□
Steel frames	□

REGULARITY	Irregular	Regular
	A	B
1 Plan and elevation	❍	❍
2 Infills distribution	❍	❍

Roof

1 ❍ Thrusting heavy
2 ❍ Non thrusting heavy
3 ❍ Thrusting light
4 ❍ Non thrusting light

SECTION 4 Damage to structural elements and existing short term countermeasures

Structural component – Pre-existing damage \ Damage level – extension	DAMAGE (1) D4-D5 Very Heavy > 2/3	D4-D5 Very Heavy 1/3 - 2/3	D4-D5 Very Heavy < 1/3	D2-D3 Medium-Severe > 2/3	D2-D3 Medium-Severe 1/3 - 2/3	D2-D3 Medium-Severe < 1/3	D1 Light > 2/3	D1 Light 1/3 - 2/3	D1 Light < 1/3	Null	EXISTING SHORT TERM COUNTERMEASURES None	Removal	Ties	Repair	Propping	Barriers or passage protection
	A	B	C	D	E	F	G	H	I	L	A	B	C	D	E	F
1 Vertical structures	□	□	□	□	□	□	□	□	□	❍	❍	□	□	□	□	□
2 Floors	□	□	□	□	□	□	□	□	□	❍	❍	□	□	□	□	□
3 Stairs	□	□	□	□	□	□	□	□	□	❍	❍	□	□	□	□	□
4 Roof	□	□	□	□	□	□	□	□	□	❍	❍	□	□	□	□	□
5 Infills and partitions	□	□	□	□	□	□	□	□	□	❍	❍	□		□	□	□
6 Pre-existing damage	□	□	□	□	□	□	□	□	□	❍						

(1) - The damage extension must be filled only if the corresponding damage level is present in the building.

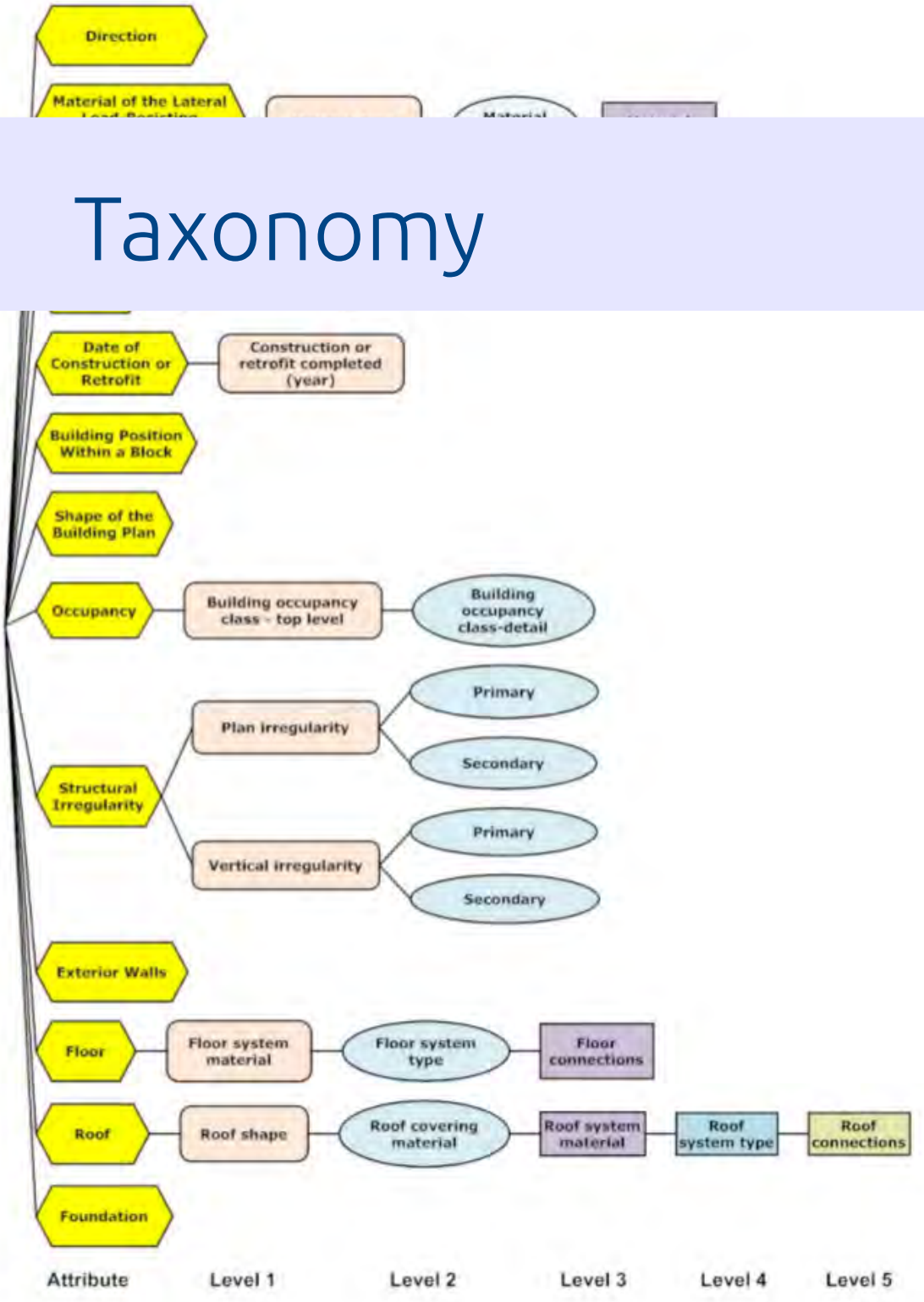
SECTION 5 Damage to non-structural elements and existing short term countermeasures

Damage \	PRESENT	EXISTING SHORT TERM COUNTERMEASURES None	Removal	Propping	Repair	No entry	Barrier or passage protection
	A	B	C	D	E	F	G
1 Falling of plaster, coverings, false-ceilings	❍	❍	□	□	□	□	□
2 Falling of tiles, chimneys...	❍	❍	□	□	□	□	□
3 Falling of eaves, parapets....	❍	❍	□	□	□	□	□
4 Falling of other internal or external objects	❍	❍	□	□	□	□	□
5 Damage to hydraulic or sewage systems	❍	❍			□	□	□
6 Damage to electric or gas systems	❍	❍			□	□	□

SECTION 6 External risk induced by other constructions and existing short term countermeasures

Potential cause \	Risk on: Building	Entry road	Lateral roads	Existing short term countermeasures: No entry	Barriers or passage protection
	A	B	C	D	E
1 Objects falling from adjacent buildings	□	□	□	□	□
2 Failure of distribution systems	□	□	□	□	□

Taxonomy



The GEM Physical Taxonomy

Taxonomy

- **Faceted taxonomy: GEM**

ID	Level 1 (L1)	ID	Level 2 (L2)
	Material type		**Material technology**
MAT99	Unknown material		
C99	Concrete, unknown reinforcement		
CU	Concrete, Unreinforced		
CR	Concrete, Reinforced		
		CT99	Unknown concrete technology
		CIP	Cast-in-place concrete
		PC	Precast concrete
		CIPPS	Cast-in-place prestressed concrete
		PCPS	Precast prestressed concrete

Level 1 detail

Level 2 detail

An example of a **Level 1** detail (CR = concrete, reinforced) and a **Level 2** detail (e.g. CIP = cast-in-place concrete)

Multiple Hazards Extension

NOTE: Experimental extension of REM taxonomy to floods is available

ATC-20 / ATC-38

ATC-20 Rapid Evaluation Safety Assessment Form

Inspection

Inspector ID: _____ Inspection date and time: _____ ☐ AM ☐ PM

Affiliation: _____ Areas inspected: ☐ Exterior only ☐ Exterior and interior

Building Description

Building name: _____

Address: _____

_____

Building contact/phone: _____

Number of stories above ground: _____ below ground: _____

Approx. "Footprint area" (square feet): _____

Number of residential units: _____

Number of residential units not habitable: _____

Type of Construction

☐ Wood frame ☐ Concrete shear wall

☐ Steel frame ☐ Unreinforced masonry

☐ Tilt-up concrete ☐ Reinforced masonry

☐ Concrete frame ☐ Other: _____

Primary Occupancy

☐ Dwelling ☐ Commercial ☐ Government

☐ Other residential ☐ Offices ☐ Historic

☐ Public assembly ☐ Industrial ☐ School

☐ Emergency services ☐ Other: _____

Evaluation

Investigate the building for the conditions below and check the appropriate column.

Observed Conditions:	Minor/None	Moderate	Severe	Estimated Building Damage (excluding contents)
Collapse, partial collapse, or building off foundation	☐	☐	☐	☐ None
Building or story leaning	☐	☐	☐	☐ 0–1%
Racking damage to walls, other structural damage	☐	☐	☐	☐ 1–10%
Chimney, parapet, or other falling hazard	☐	☐	☐	☐ 10–30%
Ground slope movement or cracking	☐	☐	☐	☐ 30–60%
Other (specify) _____	☐	☐	☐	☐ 60–100%
				☐ 100%

Comments: _____

_____

Posting

Choose a posting based on the evaluation and team judgment. *Severe* conditions endangering the overall building are grounds for an Unsafe posting. Localized *Severe* and overall *Moderate* conditions may allow a Restricted Use posting. Post INSPECTED placard at main entrance. Post RESTRICTED USE and UNSAFE placards at all entrances.

☐ **INSPECTED** (Green placard) ☐ **RESTRICTED USE** (Yellow placard) ☐ **UNSAFE** (Red placard)

Record any use and entry restrictions exactly as written on placard: _____

_____

_____

Candidate for Further Study FEMA P-58 (PACT): ☐ FEMA E-74 (Nonstructural): ☐ FEMA P-154 (RVS): ☐ Retrofitted URM: ☐

ATC-38 POSTEARTHQUAKE BUILDING PERFORMANCE ASSESSMENT FORM

Note: DO NOT LEAVE ANY BLANK SPACES! Indicate Unknown (UNK), Not Applicable (NA), or None if necessary.

Building Site Information [1]

Inspector(s):	Date:	Bldg. ID#:	Page 1 of 6
Address:		Building Name:	
Type of Survey: ☐ Exterior Only ☐ Exterior and Interior		Recording Station ID:	
Existing Posting Placard: ☐ Red ☐ Yellow ☐ Green ☐ None		Photo ID#s:	
Building Owner/Manager Contact – Name:		Phone:	
Civil/Structural Engineer for Repair – Name:		Phone:	
General Damage Classification (Structural): ☐ None (N) ☐ Insignificant (I) ☐ Minor (m) ☐ Moderate (M) ☐ Heavy (H) ☐ Collapse (C) General Damage Classification (Nonstructural): ☐ None (N) ☐ Insignificant (I) ☐ Minor (m) ☐ Moderate (M) ☐ Heavy (H) ☐ Collapse (C)			

[Note: For "M" or "H" classification, fill out Detailed Damage Description Section on page 5]

Building Construction Data [2]

Construction Date:	Design Date:	Sloped Site: ☐ Yes ☐ No	
Number of Stories Above Ground:		Number of Basement Levels:	
Number of Living Units:	Foundation Type:	Soil Type:	
Plan Width (ft):	Plan Length (ft):	Approximate Building Area (sq ft.):	
Occupancy Type (see Glossary):	Occupied Prior to Earthquake: ☐ Yes ☐ No ☐ UNK		
Notes:			

Model Building Type [3]

Predominant Model Building Type (see Glossary):	Seismic Retrofit: ☐ Yes ☐ No ☐ UNK
Describe Building if More Than One Model Building Type Present:	
Describe Retrofit if Present:	
Additions? If yes, describe building type, date of construction:	

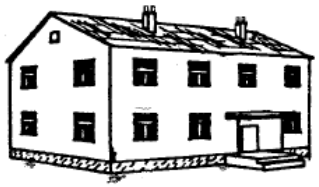
Figure A-1 Postearthquake Building Performance Assessment Form (page 1 of 6).

Consequence Taxonomy

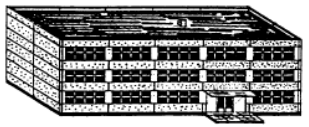
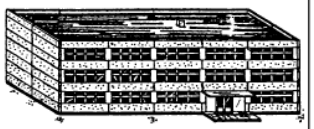
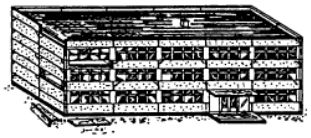
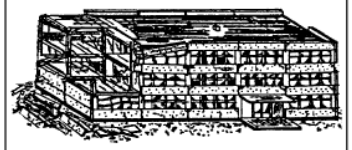
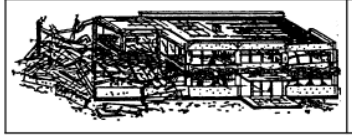
DI_{HRC}	HRC	HAZUS 1999 [17]	VISION 2000 [18]	FEMA 273 [19]	EMS98 [20]	MSK [2]	AIJ [5]	ATC-13 [7]	ATC-21 [21]	EPPO [22]
0	None	No damage limit state								
10	Slight	Slight damage	Fully operational	Immediate occupancy	Grade 1	D1	Light	Slight	Gre Tag	
20	Light							Light		
30			Operational		Grade 2	D2	Minor			
40				Damage control				Moderate		
50	Moderate	Moderate damage			Grade 3	D3			Yellow Tag	Yellow Tag
60			Life safe	Life safe			Moderate			
70								Heavy		
80	Extensive	Extensive damage	Near collapse	Limited safety	Grade 4	D4	Major			
90				Collapse prevention				Major	Red Tag	Red Tag
100	Partial Collapse		Collapse				Partial collapse			
	Collapse	Collapse limit state								

To be discussed

Consequence Taxonomy

Classification of damage to masonry buildings	
	**Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)** Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
	**Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)** Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Serious failure of walls; partial structural failure of roofs and floors.
	**Grade 5: Destruction (very heavy structural damage)** Total or near total collapse.

EMS-98

Classification of damage to buildings of reinforced concrete	
	**Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)** Fine cracks in plaster over frame members or in walls at the base. Fine cracks in partitions and infills.
	**Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)** Cracks in columns and beams of frames and in structural walls. Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels.
	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of conrete cover, buckling of reinforced rods. Large cracks in partition and infill walls, failure of individual infill panels.
	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns. Collapse of a few columns or of a single upper floor.
	**Grade 5: Destruction (very heavy structural damage)** Collapse of ground floor or parts (e. g. wings) of buildings.

MOMA – Mobile Mapping

Navigation system

MOMA mounted On a car

RRVS Remote Rapid Visual Survey

Preliminary screening

Remote Inspection

Selected direct screening

Direct Inspection

RRVS Remote Rapid Visual Survey

Use case: exposure / vulnerability assessment

Use case: post-disaster rapid damage mapping

GEM, FEMA-154

AEDES, ATC-20

MOMA – Mobile Mapping

Omnidirectional (radial or equirectangular) Projection

Perspective (central) Projection

GFZ Helmholtz-Zentrum Potsdam

SIBYL

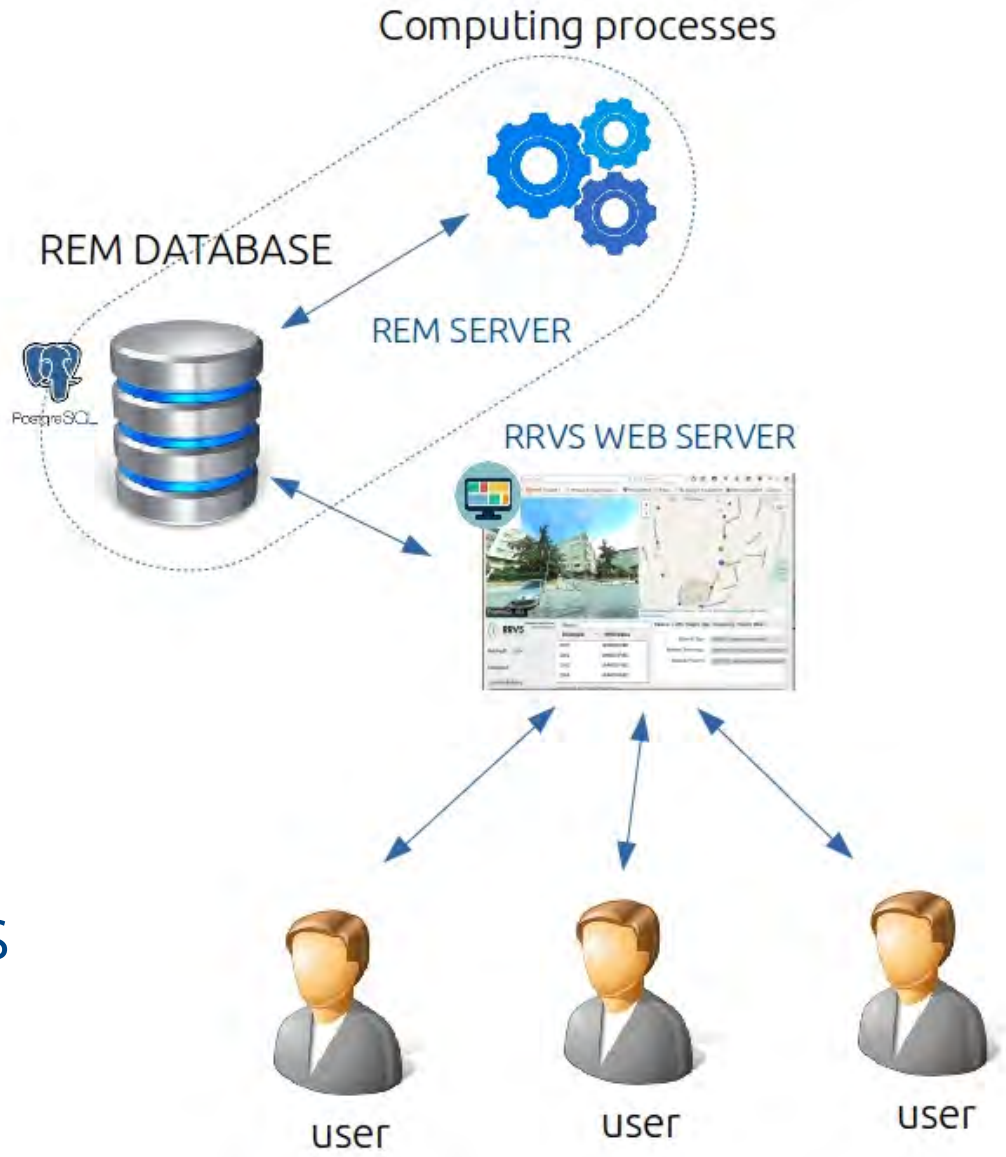
MOMA – Mobile Mapping

Good weather

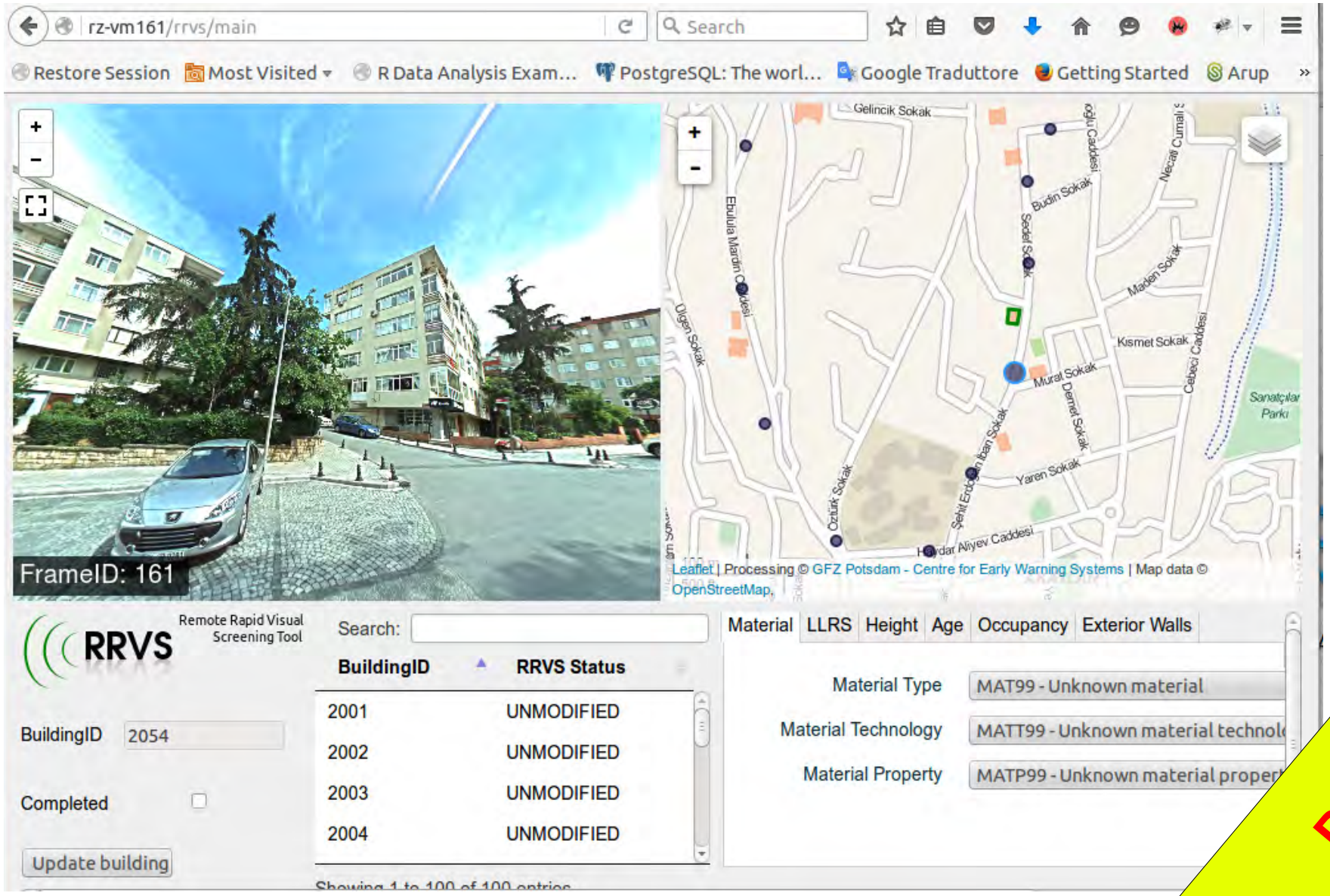
Bad weather

RRVS Remote Rapid Visual Survey

- Multiple, concurrent users
- Multiple tasks (set of sampled buildings)
- Pre-event and post-event surveys
- **Next**: automatic, incremental exposure analysis



RRVS Remote Rapid Visual Survey



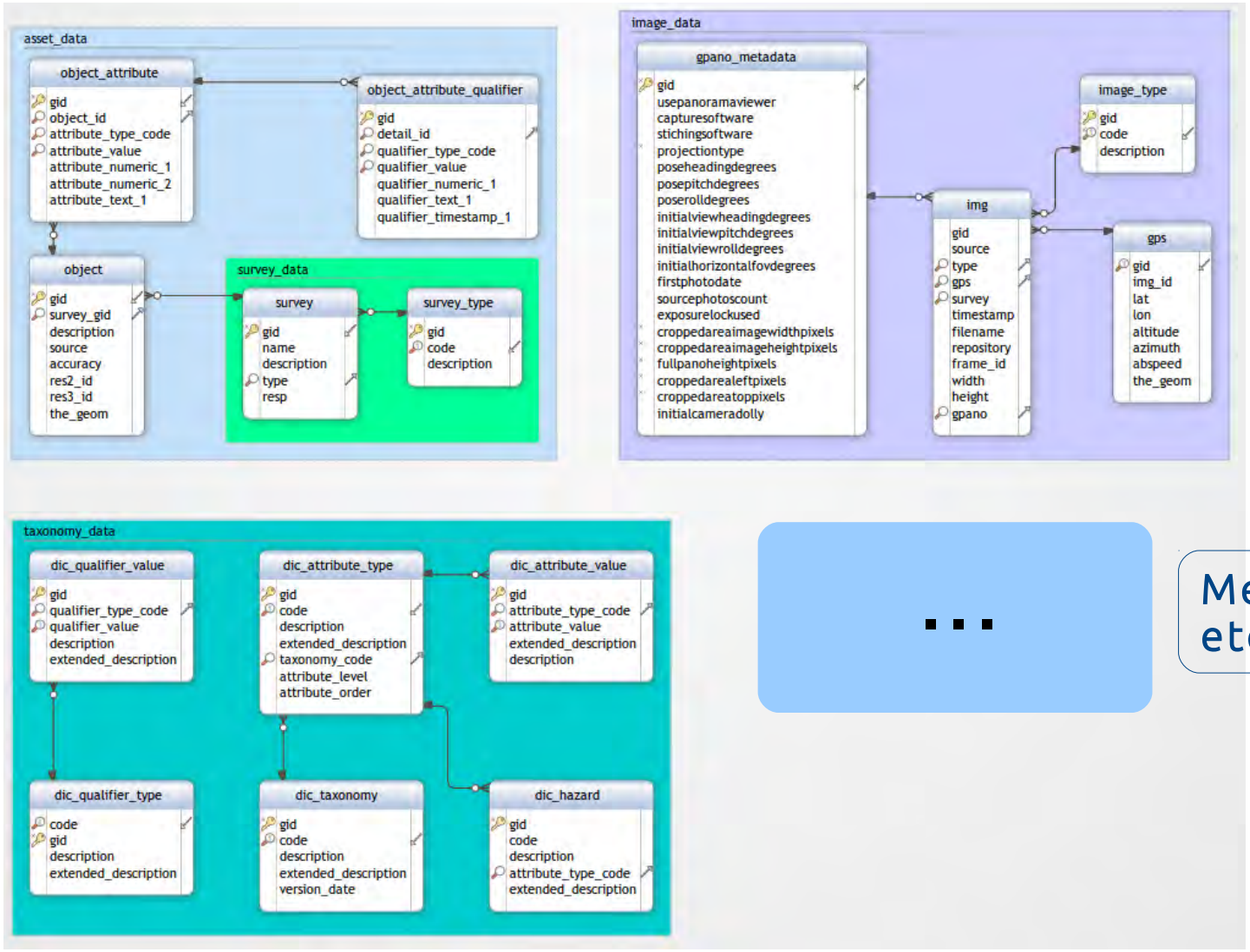
REM Database Schema

Assets

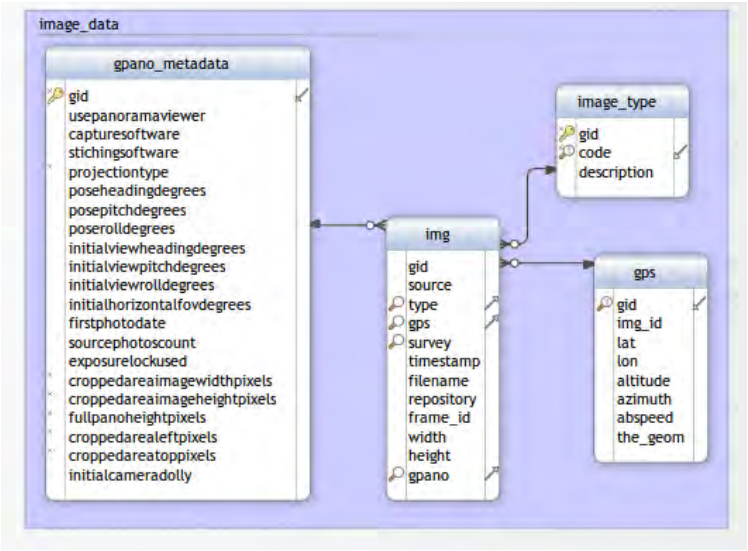
Images

Taxonomy

Measurements etc.



REM Database Schema



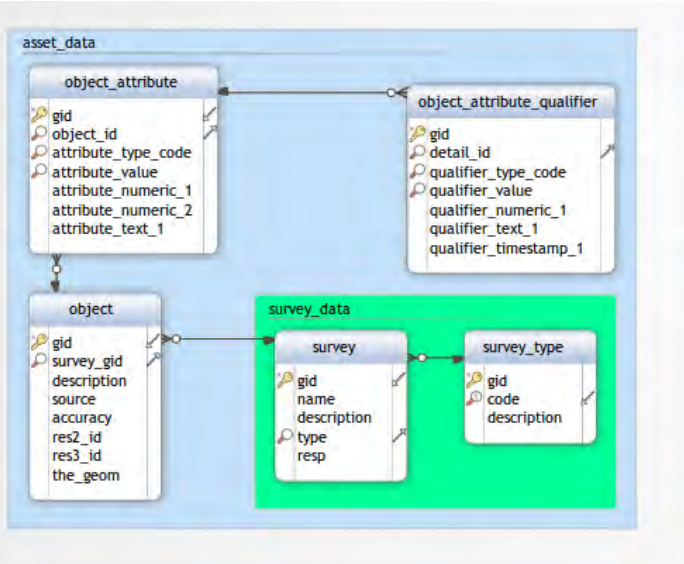
Images

Standard
Panoramic
Omnidirectional

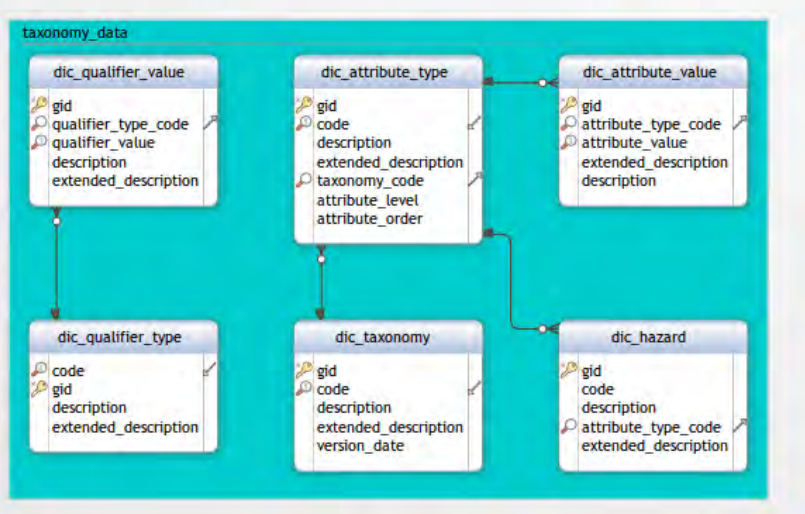
Pre-event / post-event

REM Database Schema

Assets

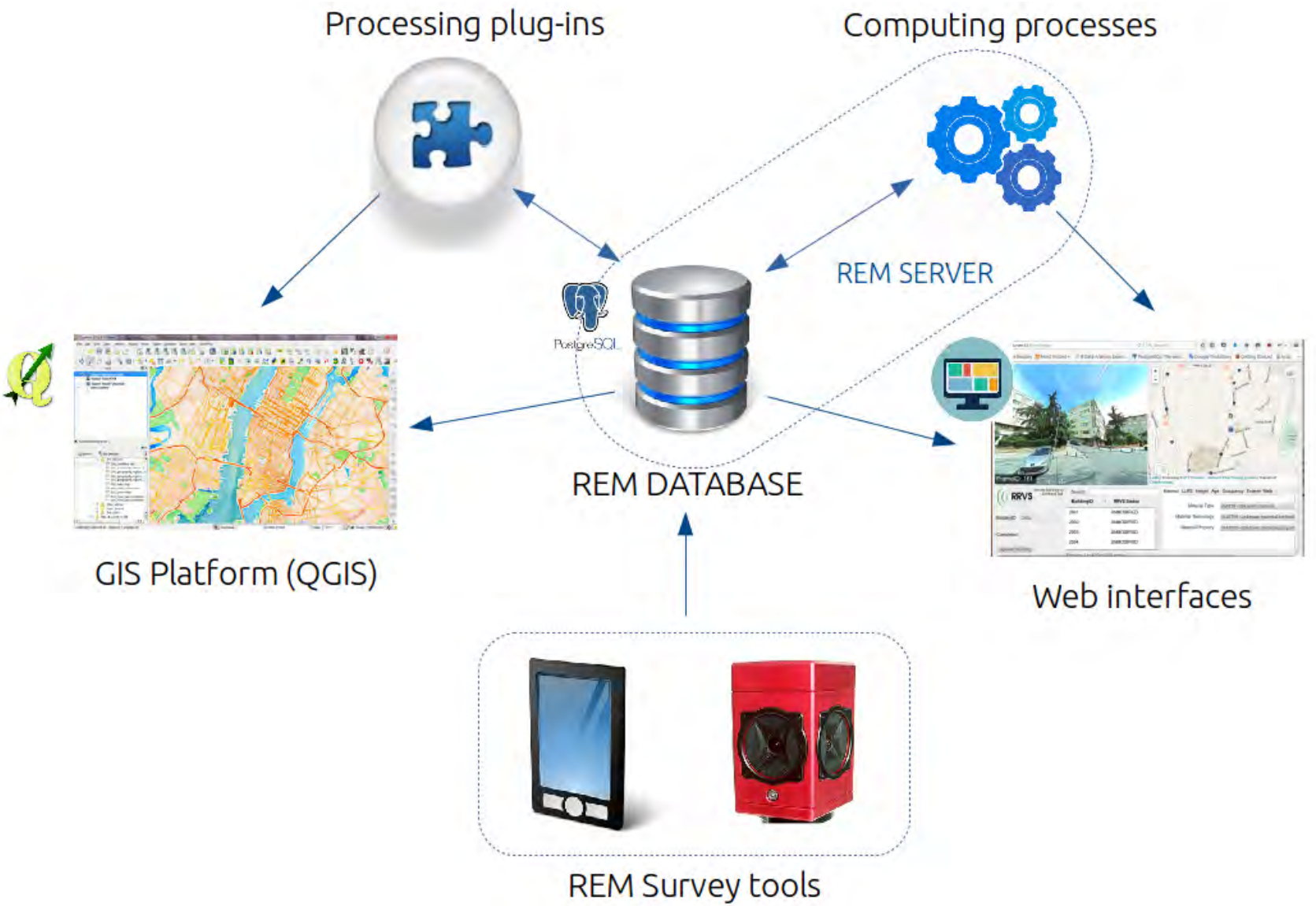


Taxonomy



Objects+
Attributes+
qualifiers

The REM Platform



Outlook and Conclusions

- Software can be cloned from GFZ git-hub repository:

- REM-DB-schema: github.com/GFZ-Centre-for-Early-Warning/REM_DBschema
- REM-SATEX: github.com/GFZ-Centre-for-Early-Warning/REM_satex_plugin
- REM-routing: github.com/GFZ-Centre-for-Early-Warning/REM_optimized_routing
- REM-RRVS: github.com/GFZ-Centre-for-Early-Warning/REM_RRVS

- Current license: BSD3 (to be discussed)

- Participation to development is welcome !

Outlook and Conclusions

- REM provides a useful, efficient platform for information collection, integration and analysis
- The use of modular, extensible taxonomy is geared towards multi-hazard, systemic assessment
- Mobile mapping as part of a multi-stage environmental analysis, to be integrated with direct visual screening and in-depth in-situ analysis
- **Next**: incremental exposure (and vulnerability) modelling
- **Next**: integration with real-time structural monitoring