

SIBYL Component B

Rapid data collection and integration

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Thessaloniki, February 14-15 2016

Data collection overview

Information already available or promptly provided by authorities

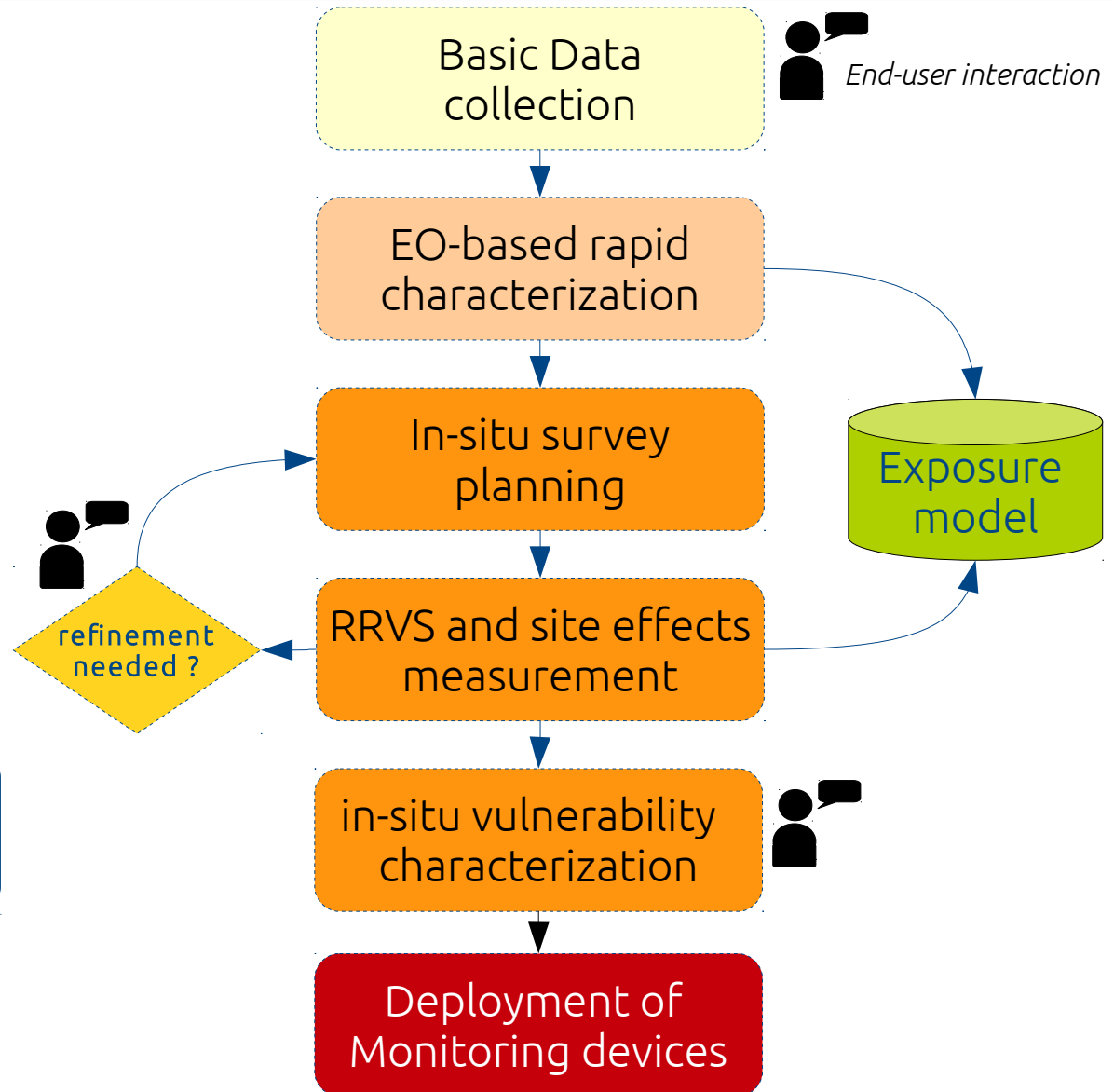
Rapid characterization by medium-res satellite imagery

Optimization based on information distribution and end-user constraint

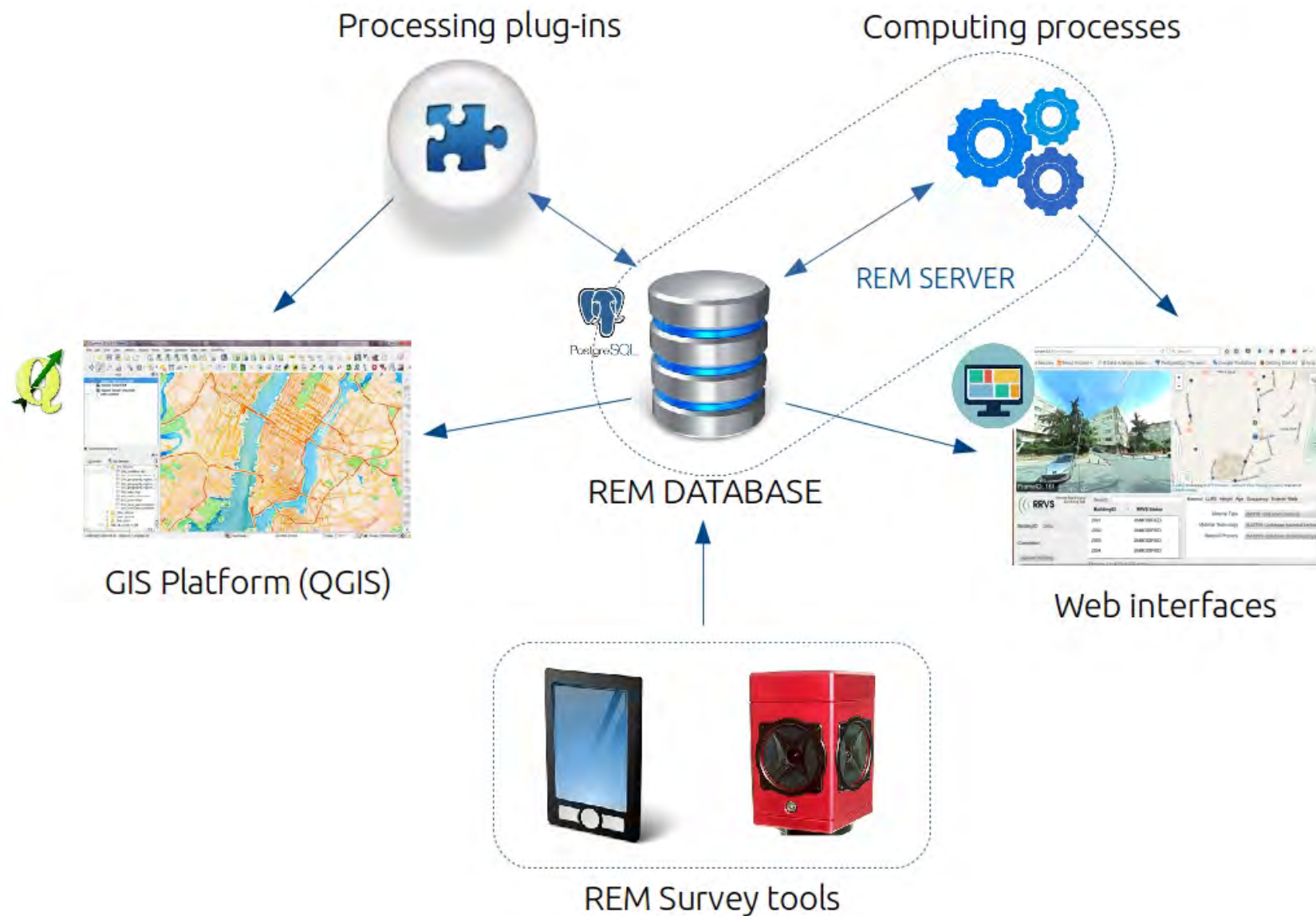
Rapid remote visual screening and first assessment of site effects

selection of representative structures and In-situ structural characterization

Deployment of sensor network and start of real-time monitoring

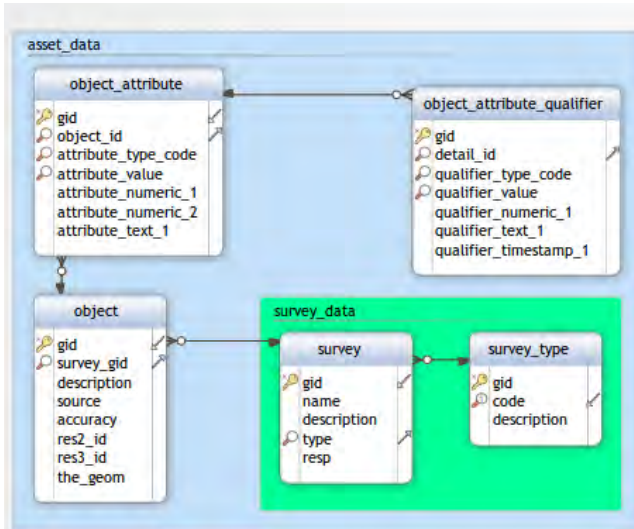


The REM Platform

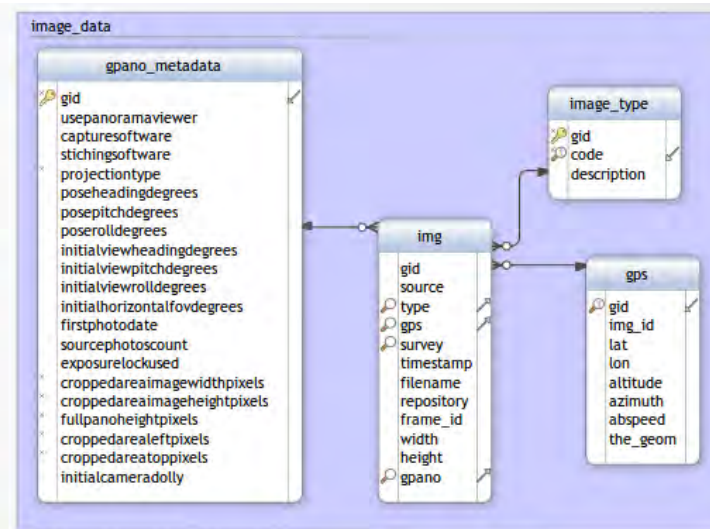


REM Database Schema

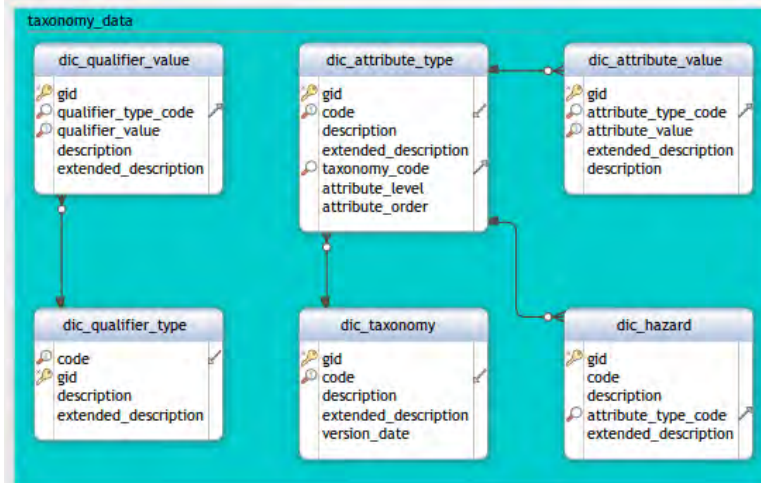
Assets



Images



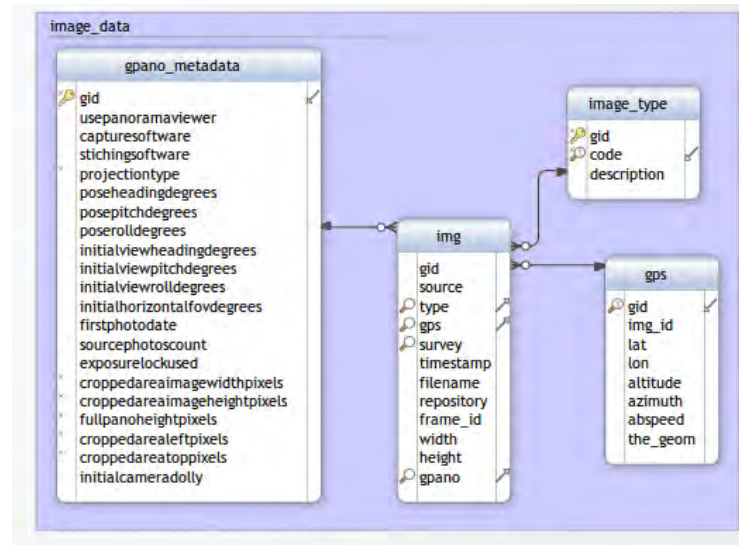
Taxonomy



...

Measurements
etc.

REM Database Schema



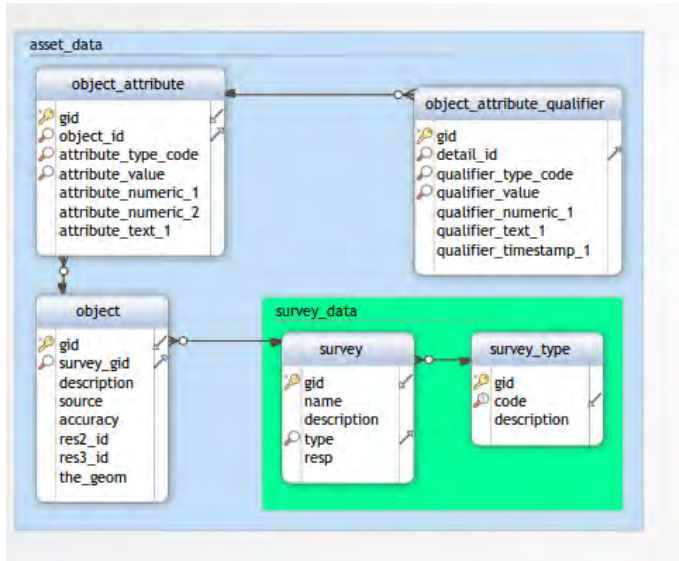
Images



Standard
Panoramic
Omnidirectional
Pre-event / post-event

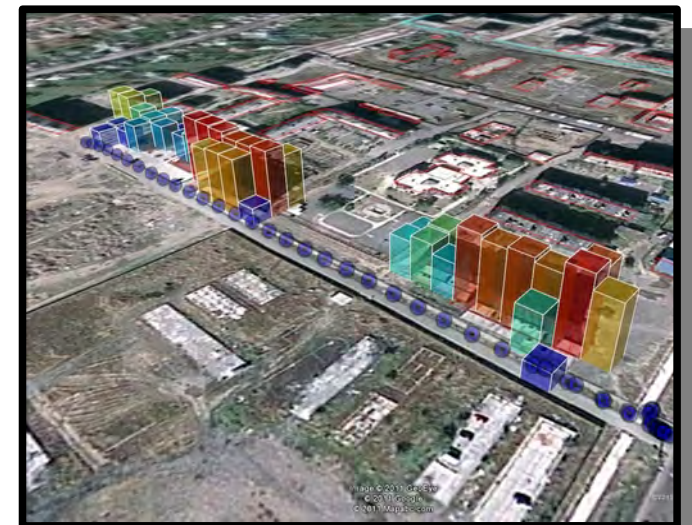
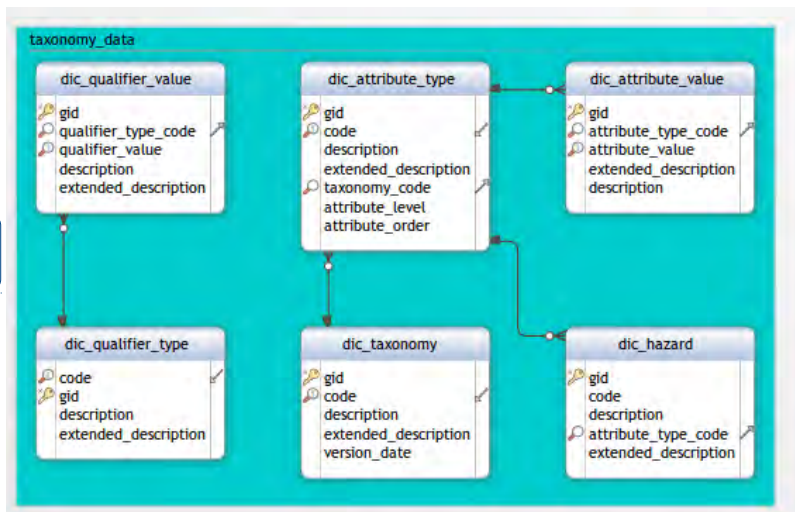
REM Database Schema

Assets

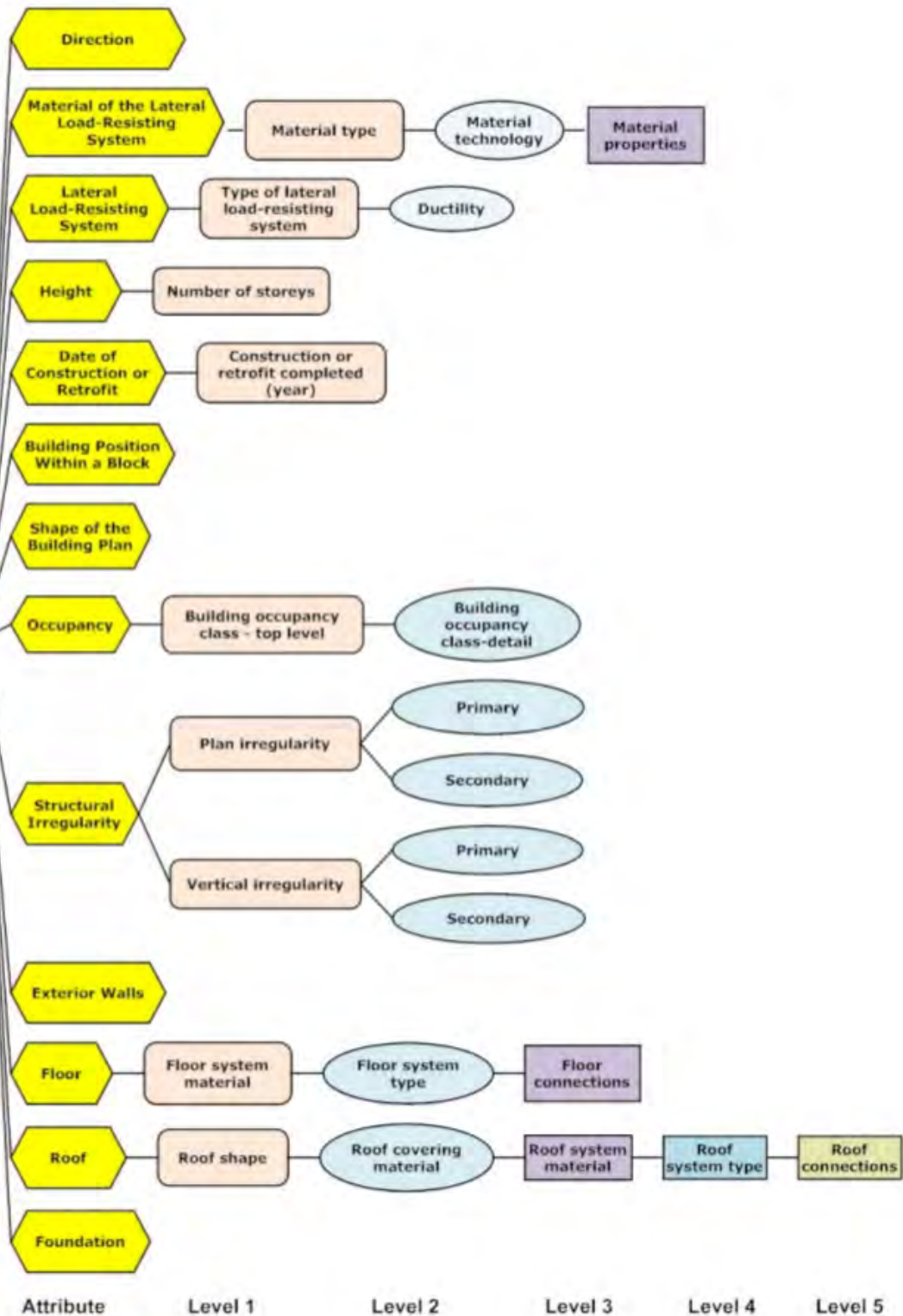


Objects+
Attributes+
qualifiers

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

**STORMS:
chimneys**



**FLOODS:
windows**

**EARTHQUAKE:
walls**

**FLOODS:
openings**

NOTE: Experimental extension of REM taxonomy to floods is available






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	Green Tag	
20	Light		Operational		Damage control	Grade 2		D2		
30				Moderate						
40	Moderate	Moderate damage	Life safe	Life safe	Grade 3	D3	Moderate	Heavy	Yellow Tag	Yellow Tag
50										
60										
70	Extensive	Extensive damage	Near collapse	Limited safety	Grade 4	D4	Major	Major	Red Tag	Red Tag
80				Collapse prevention						
90										
100	Partial Collapse	Collapse	Collapse	Collapse prevention	Grade 4	D4	Major	Major	Red Tag	Red Tag
	Collapse									
	Collapse	Collapse limit state								

To be discussed

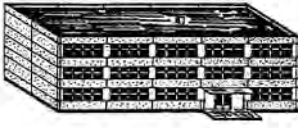
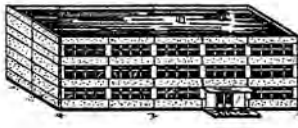



Consequence Taxonomy

Classification of damage to masonry buildings

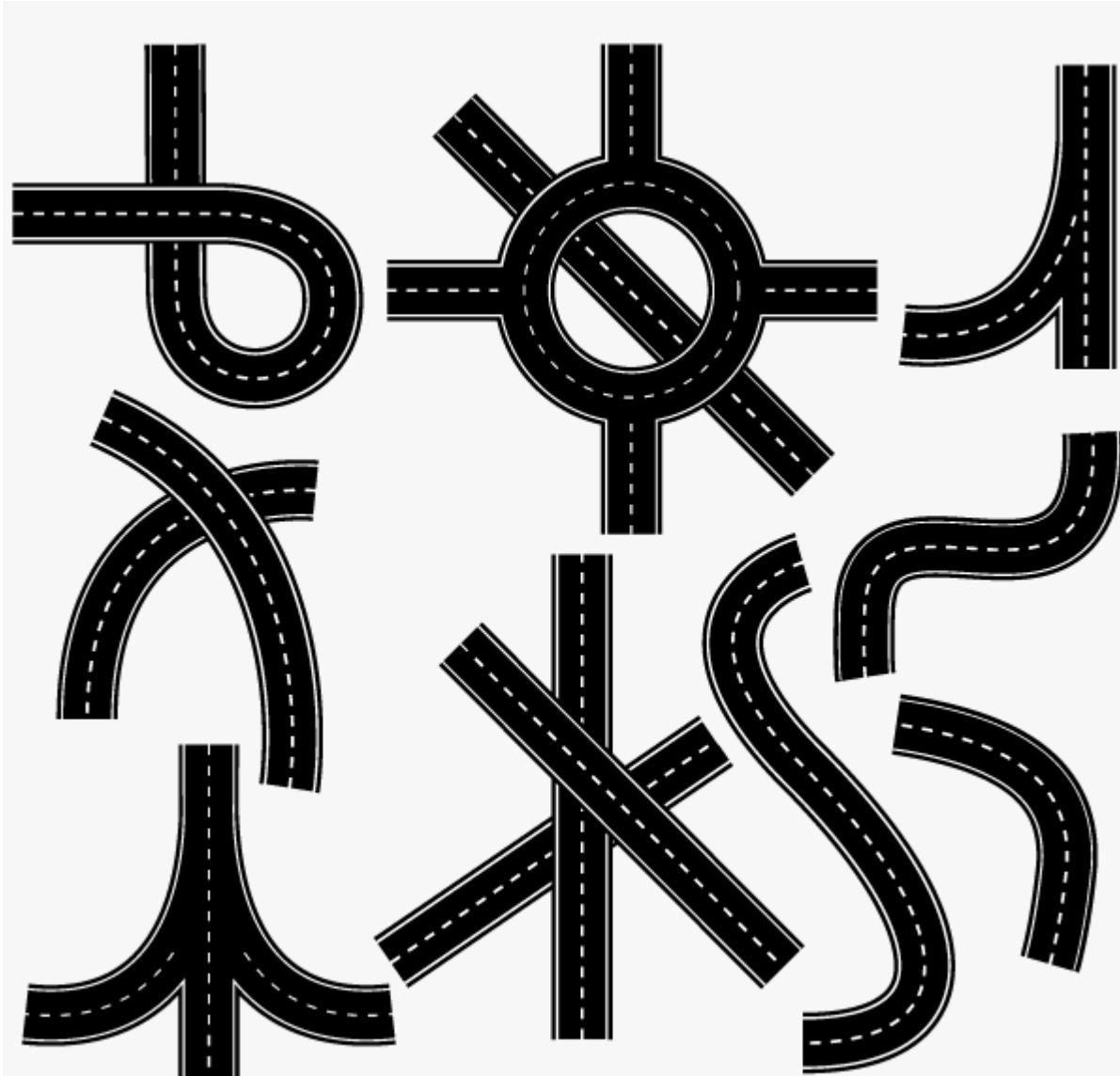
	<p>Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage) Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.</p>
	<p>Grade 2: Moderate damage (slight structural damage, moderate non-structural damage) Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.</p>
	<p>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).</p>
	<p>Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage) Serious failure of walls; partial structural failure of roofs and floors.</p>
	<p>Grade 5: Destruction (very heavy structural damage) Total or near total collapse.</p>

EMS-98

Classification of damage to buildings of reinforced concrete

	<p>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.</p>
	<p>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.</p>
	<p>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 concrete cover, buckling of reinforced rods. Large cracks in partition and infill walls, failure of individual infill panels.</p>
	<p>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.</p>
	<p>Grade 5: Destruction (very heavy structural damage) Collapse of ground floor or parts (e. g. wings) of buildings.</p>

Infrastructure Taxonomy



Syner-G

Hazus

...

To be discussed

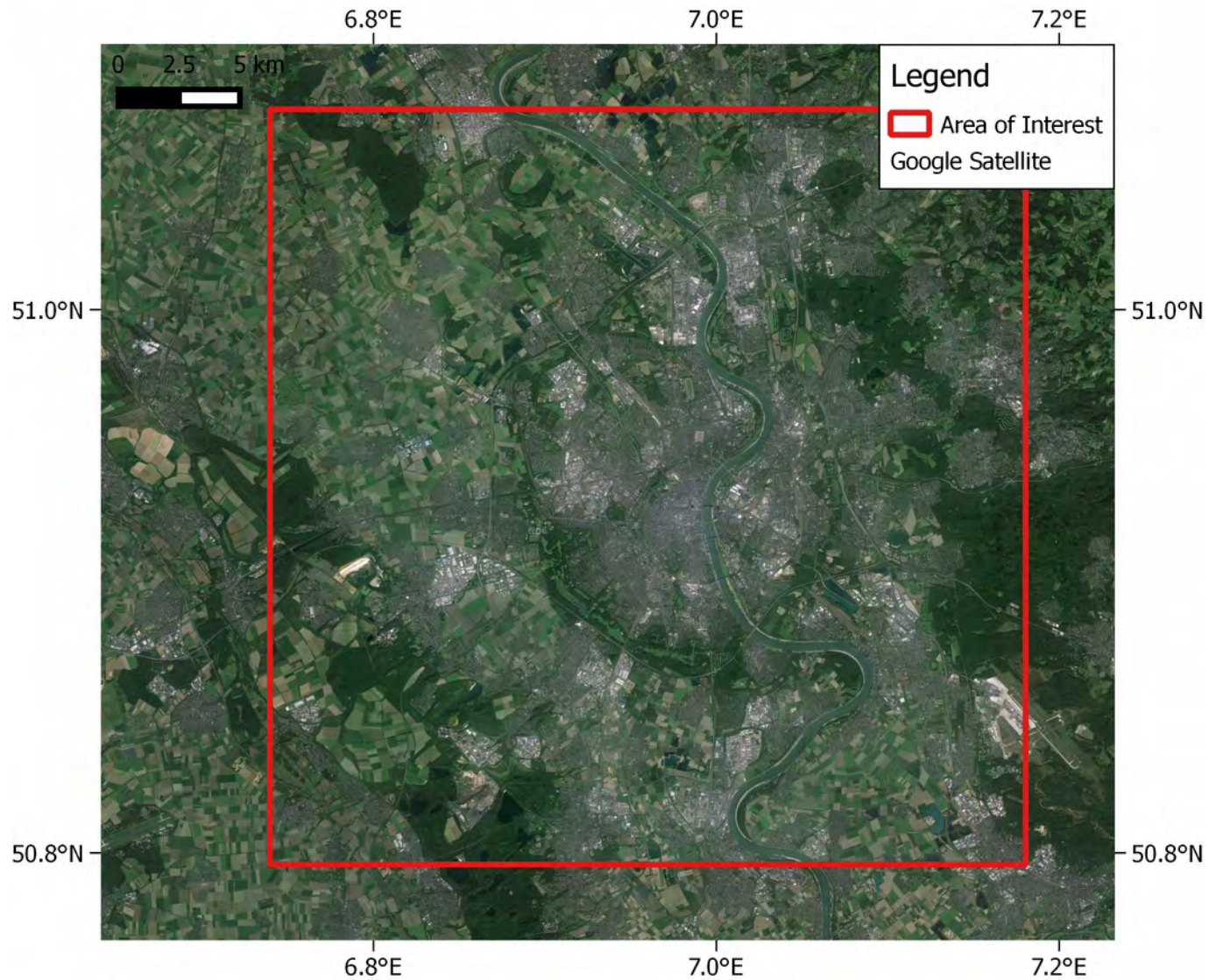
Example: Emergency Limit Condition (CLE)



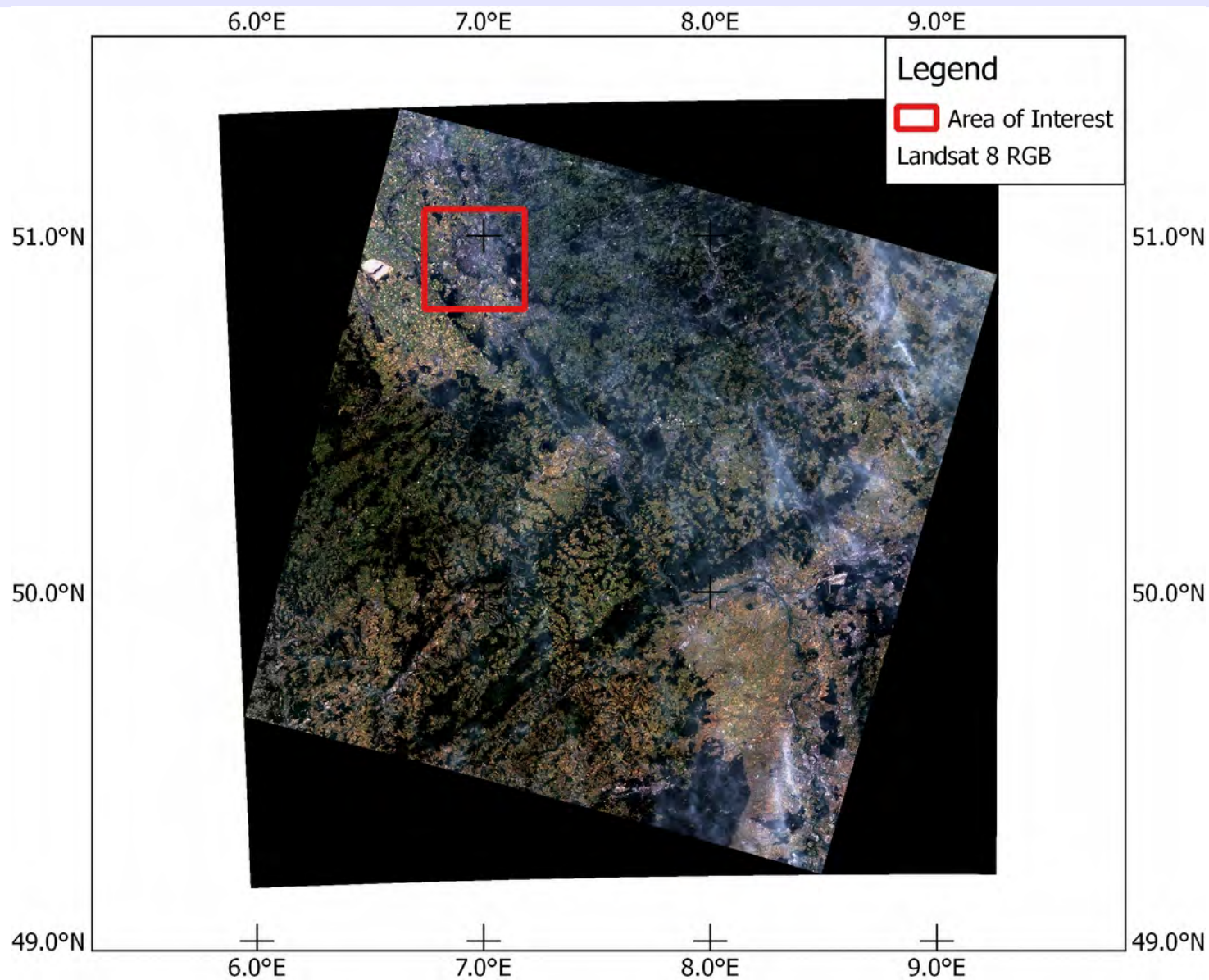
Multi-spectral stratification



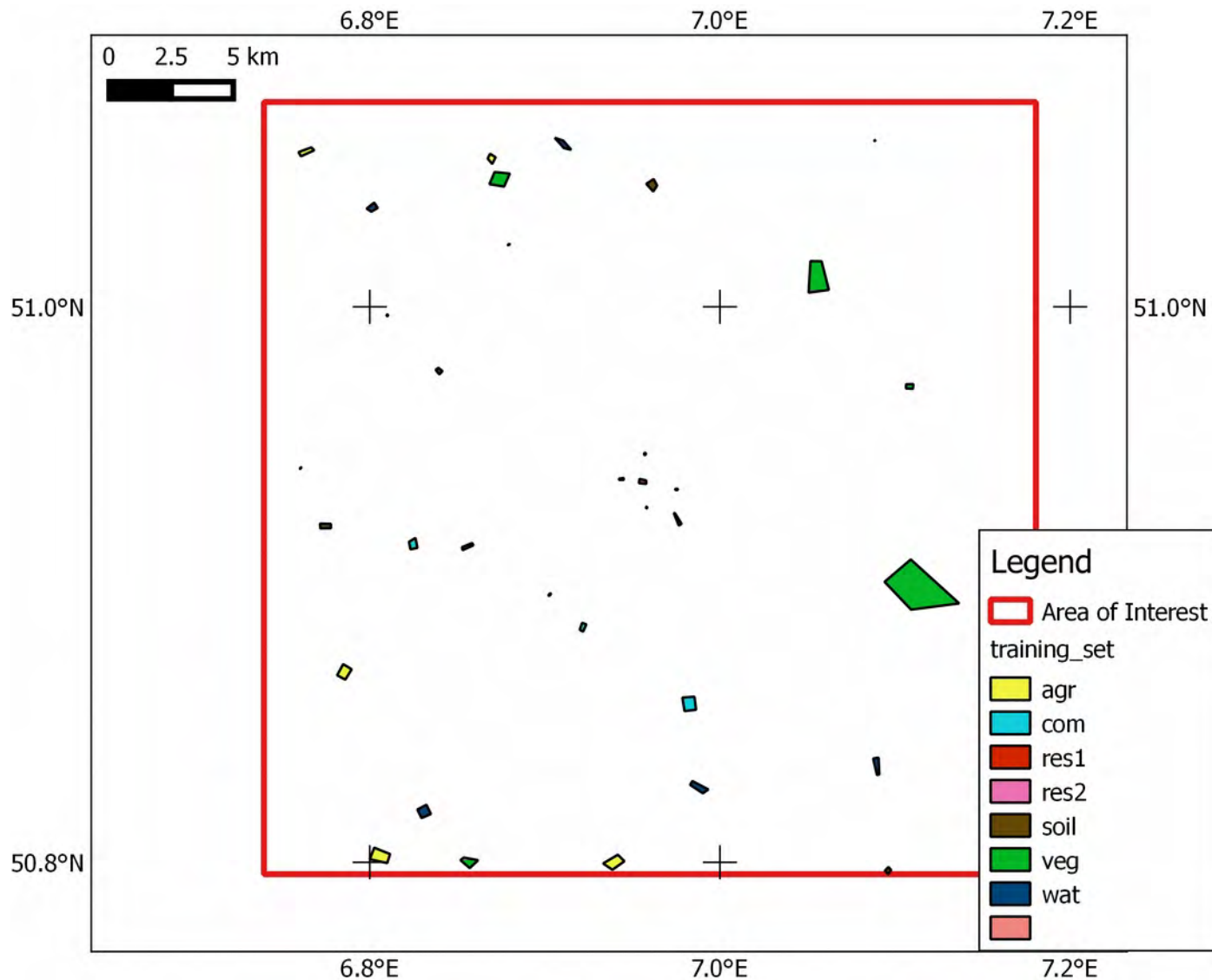
Multi-spectral stratification: SATEX-plugin



Multi-spectral stratification



Multi-spectral stratification



Training

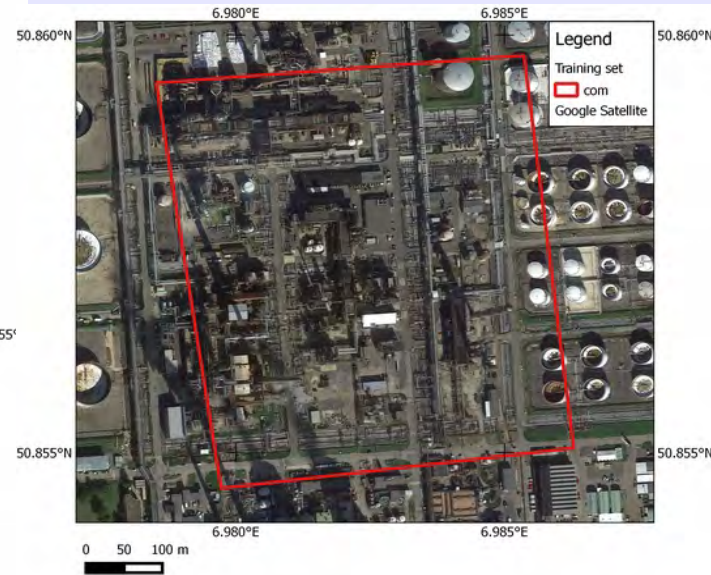
7 classes
5 ex/class

Multi-spectral stratification

Soil



Commercial
Industrial



Vegetation

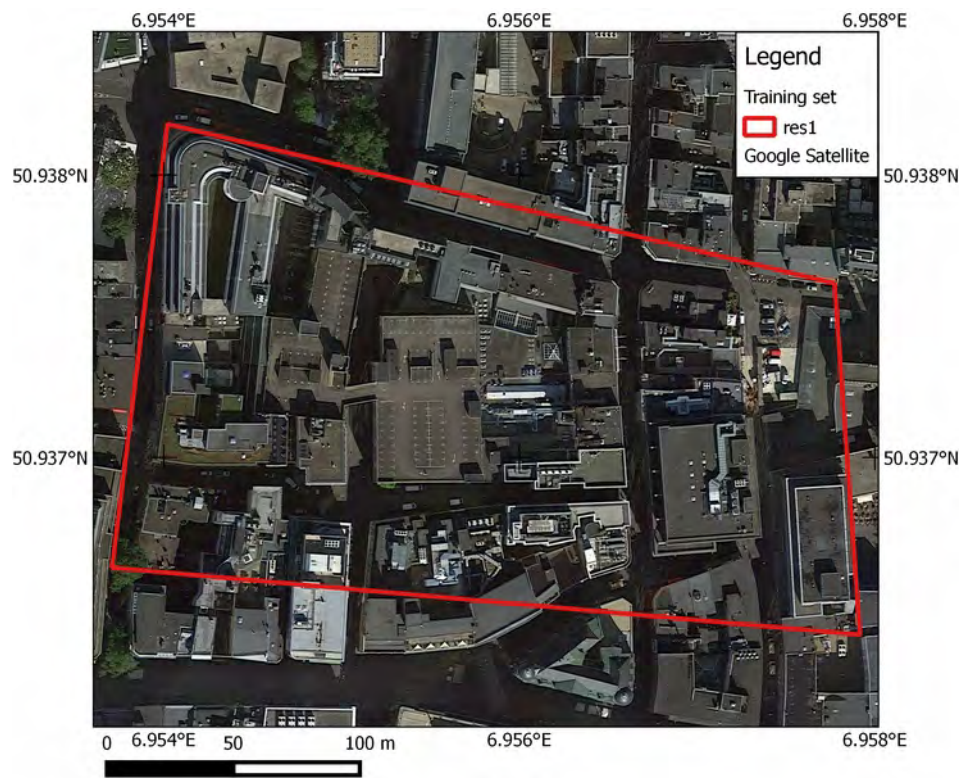


Water



Optical, Very High resolution (Google Maps)

Multi-spectral stratification

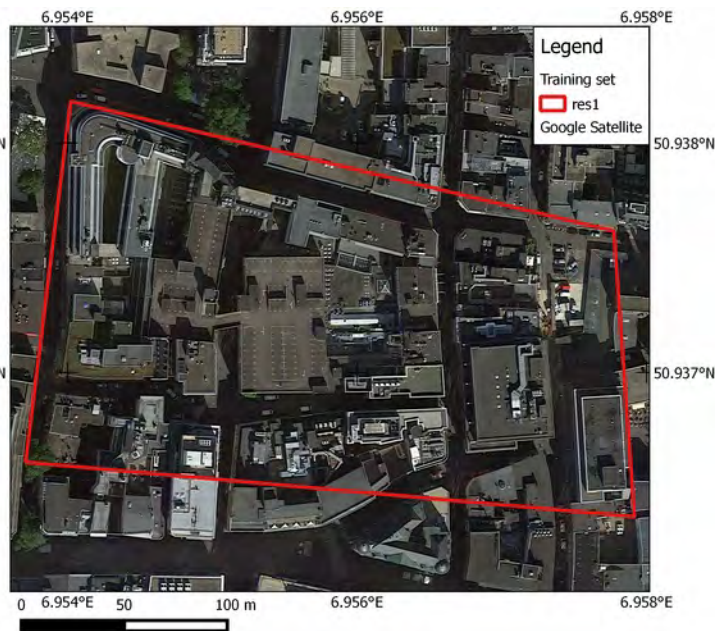


Res1 – high density



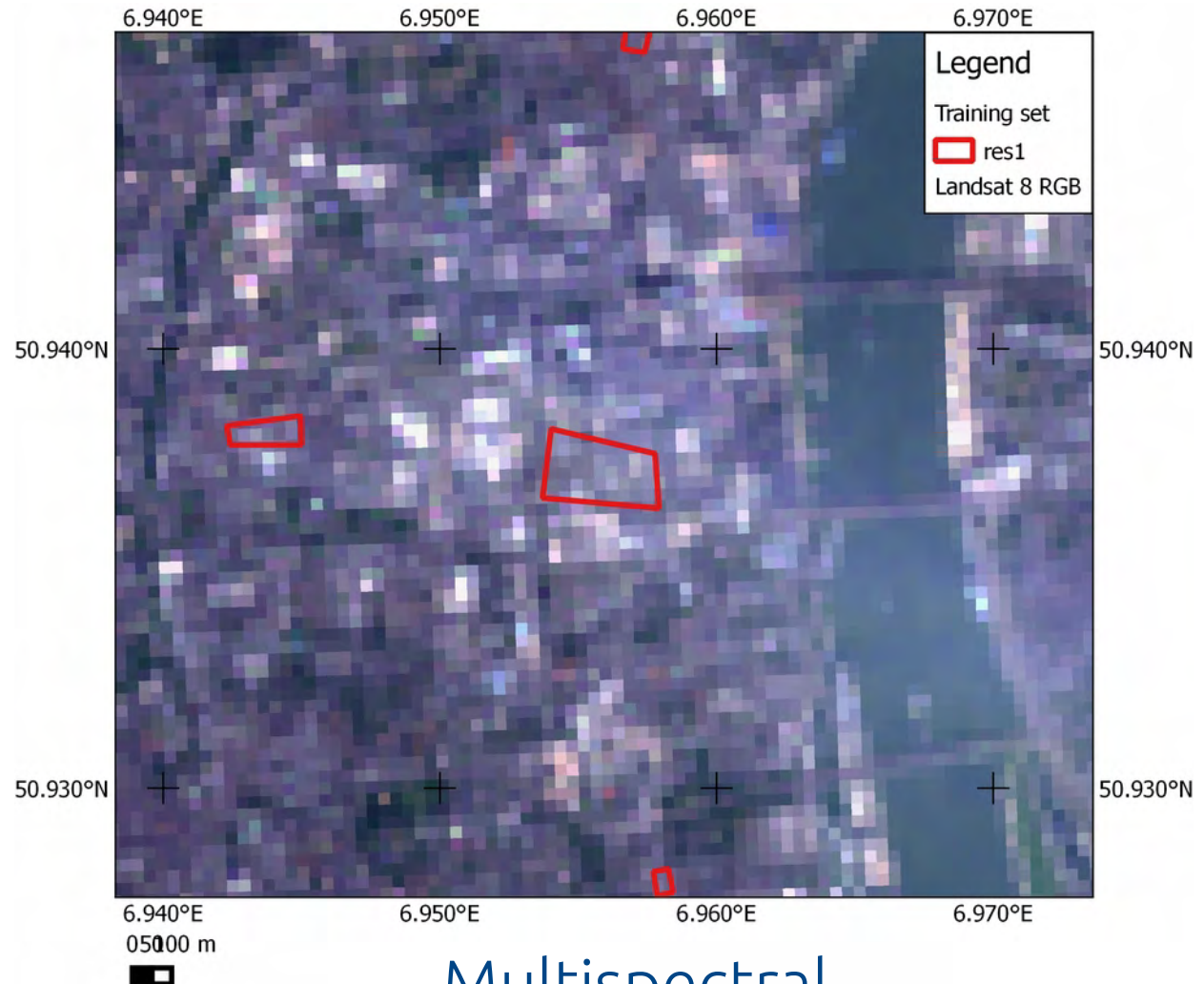
Res1 – low density

Multi-spectral stratification



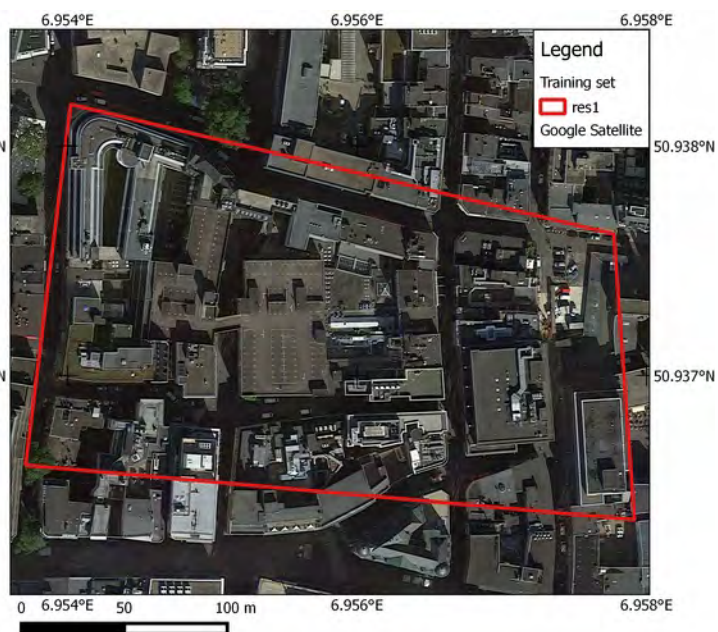
Optical, Very High resolution

Res1 – high density



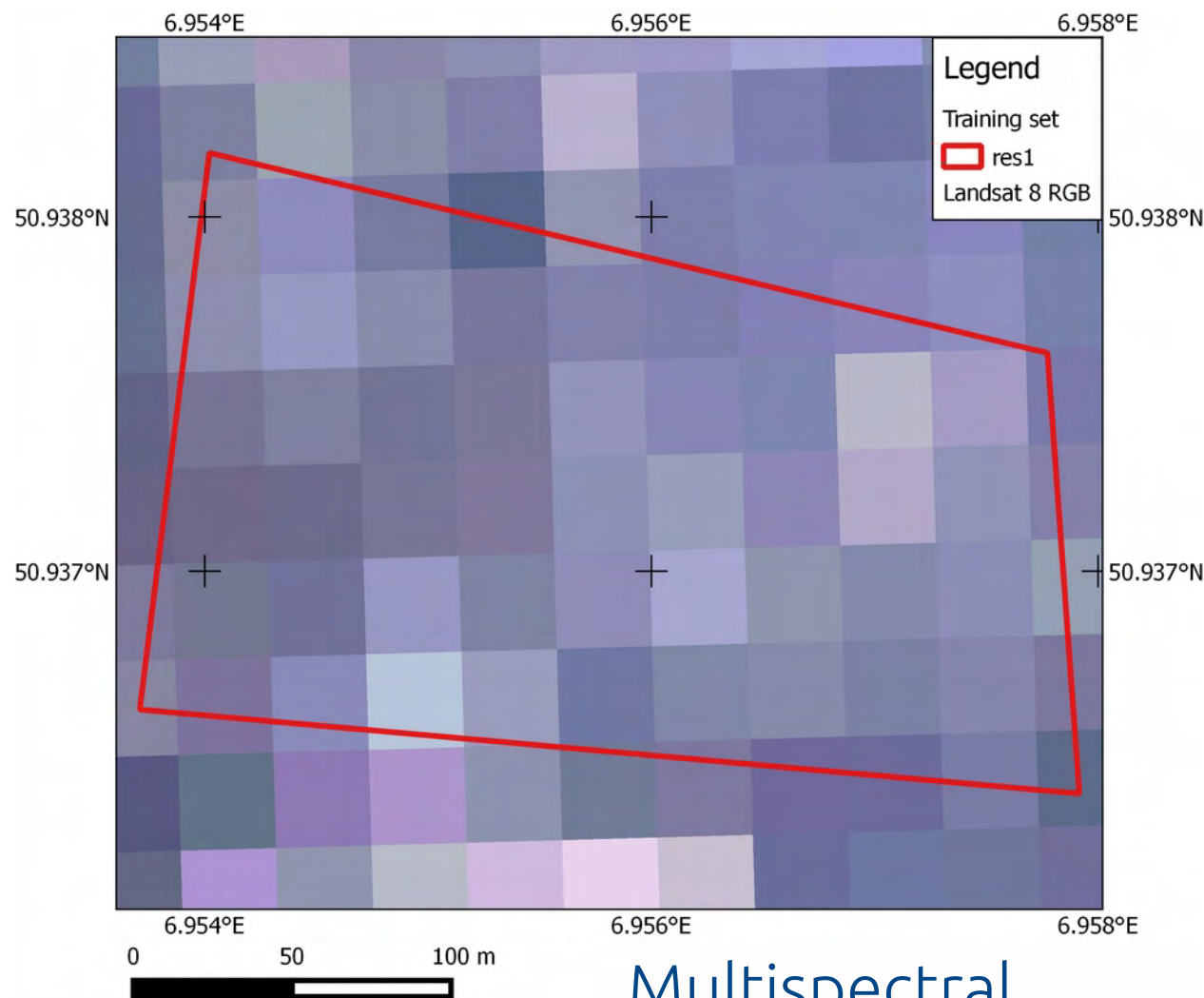
Multispectral, medium-resolution

Multi-spectral stratification



Optical, Very High resolution

Res1 – high density

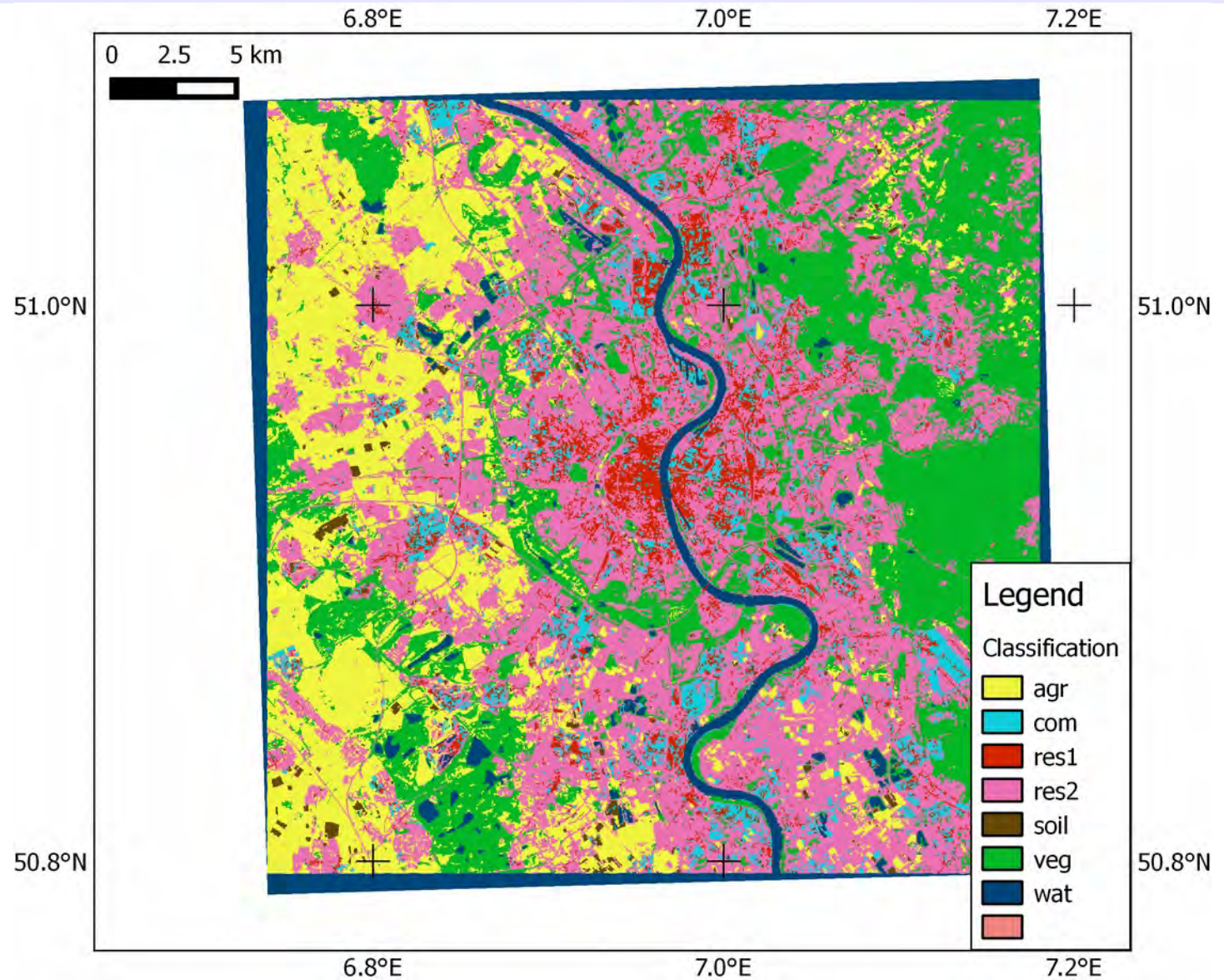


Multispectral, medium-resolution

Multi-spectral stratification

Supervised Classification

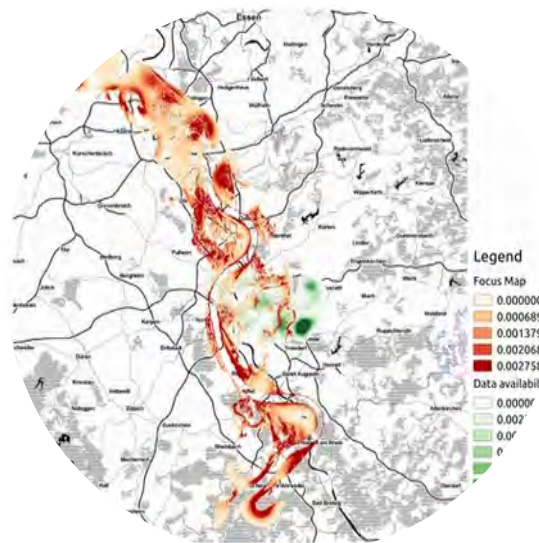
(Support Vector
Machines)



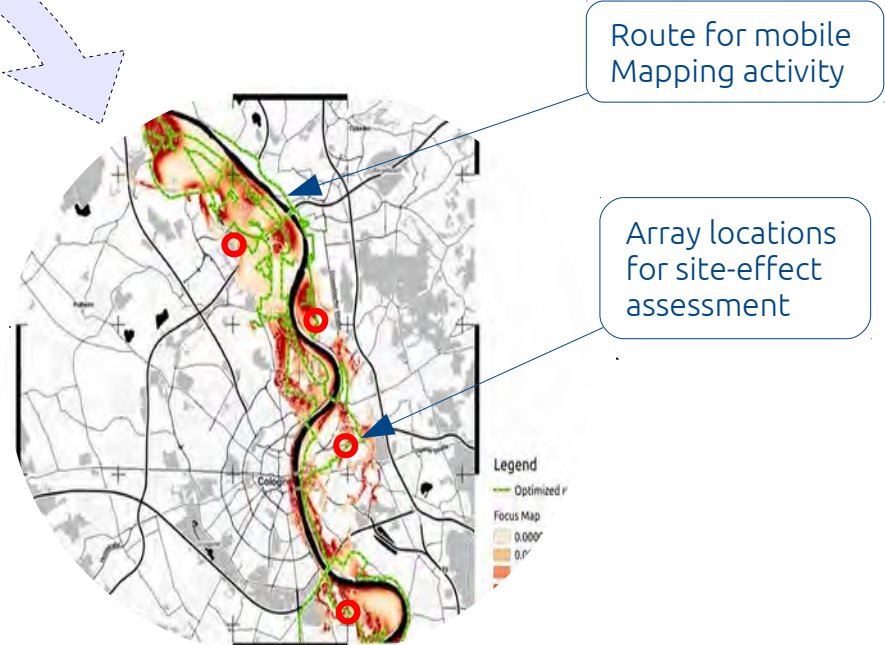
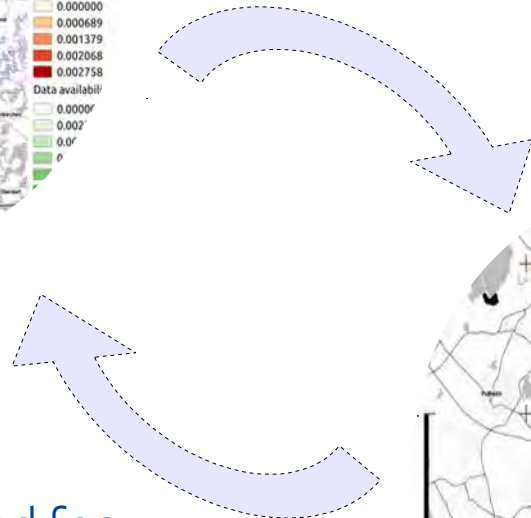
In-situ survey planning



In-situ survey planning



Extent and quality of available information are Combined with application priorities and constraints (also based on end-user consultation) to plan the Optimal arrangement of sampling points and the path for RRVS and field measurements



Route for mobile Mapping activity

Array locations for site-effect assessment

Planning and screening Procedures can be iterated for Incremental refinement of the Exposure / vulnerability model

Sampling and Routing

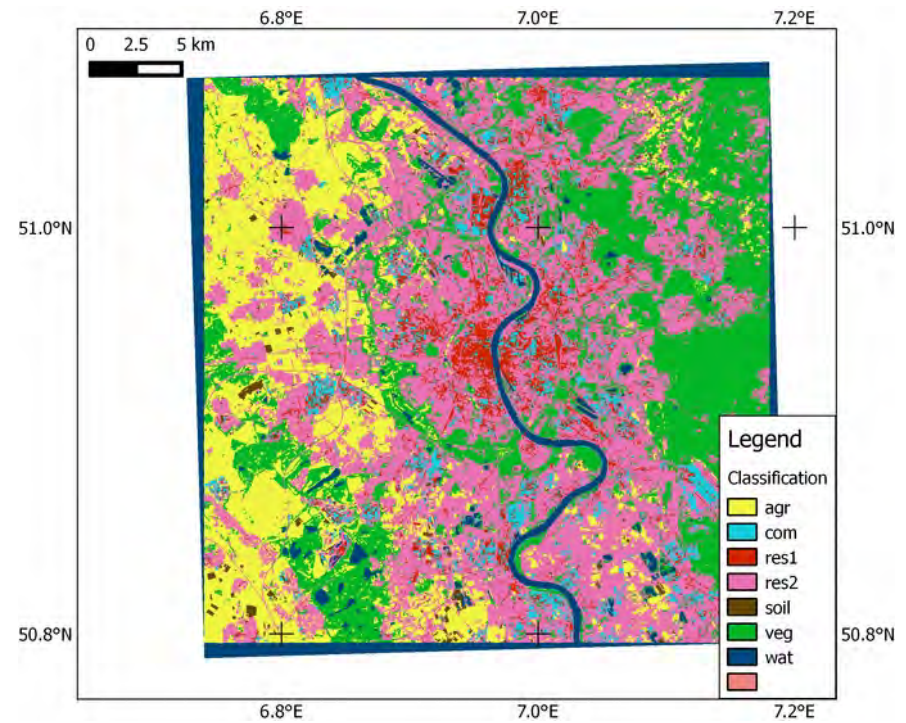
Stratified Sampling

$\theta = \theta(v)$: estimator of v

$$W_s = \frac{N_s}{N}, \quad N = \sum_{s \in S} N_s$$

$$E(\bar{\theta}_{st}) = E\left(\sum_{s \in S} W_s \bar{\theta}_s\right)$$

$$\boxed{Var(\bar{\theta}_{st})} = \sum_{s \in S} W_s^2 \boxed{Var(\bar{\theta}_s)}$$



Sampling and routing - I

The screenshot displays a GIS application window titled "2.8.1-Wien". The interface includes a top toolbar with various navigation and analysis tools, a left sidebar with a "Layers" panel, and a main map area. The "Layers" panel shows a tree view with the following layers:

- sybil_satex_stops
- osm_streets
- marc_cologne_urban
 - com
 - res1
 - res2

A red callout box labeled "Built-up classes" points to the "marc_cologne_urban" layer. The map area is filled with a dense distribution of green circular points, representing a "Sampling Set". A red arrow points from a callout box labeled "Sampling Set" to this distribution. The bottom status bar shows "GPS Information", "Layers", "Coordinate: 331190,5656799", "Scale: 1:222.870", "Rotation: 0.0", and "Render EPSG".

Sampling and routing - II

The screenshot shows the QGIS interface with the following layers in the Layers panel:

- sybil_satex_stops
- osm_streets
- marc_cologne_urban
 - com
 - res1
 - res2

A red arrow points to the roads network on the map, which is labeled "roads network". A red box highlights the sub-layers "com", "res1", and "res2" under "marc_cologne_urban", which are collectively labeled "Built-up classes".

retrieval fin There is a plugin update available Coordinate: 334021,5649310 Scale 1:222.870 Rotation: 0.0 Render EPSG:32632

Sampling and Routing - III

The screenshot displays the QGIS desktop environment. The main map area shows a city map of Cologne with various land use layers. A green line, representing an optimized route, is overlaid on the map. A red arrow points to this line, and a callout box contains the text "Optimized Route".

Layers Panel:

- route_stops_tsp
- route_dijkstramulti
- route_stops
- osm_streets
- sybil_satex_samples
- sybil_satex_samples
- marc_cologne_urban
 - com
 - res1
 - res2

Processing Toolbox:

- Search...
- OrderRouteStops
- GDAL/OGR [45 geoalgorithms]
- GRASS commands [160 geoalgorithms]
- GRASS GIS 7 commands [148 geoalgor...]
- LecoS (Landscape ecology statistics) [...]
- Models [0 geoalgorithms]
- Orfeo Toolbox (Image analysis) [83 ge...]
- QGIS geoalgorithms [103 geoalgorith...]
- R scripts [15 geoalgorithms]
 - [Own Scripts]
 - Raster processing
 - SENSUM
 - dependency installer
 - GenerateDensity
 - GenerateFocusMap
 - GenerateFocusMap 2inputs
 - GenerateRouteNetwork
 - GenerateRouteStops
 - GenerateSamplingPoints PPS
 - GenerateSamplingPoints SRS
 - GenerateSamplingPoints STR
 - OrderRouteStops
 - RasterFlip y
 - RouteDijkstra
 - test
 - Tools
 - Scripts [0 neoalgorithms]

Status Bar:

Coordinate: 341290.5642192 Scale: 1:215.690 Rotation: 0.0

MOMA – Mobile Mapping



GFZ-MOMA : Mobile Mapping



Rapid Visual Screening of Buildings for Potential Seismic Hazards

A Handbook

FEMA 154, Edition 2 / March 2002



Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA-154 Data Collection Form

HIGH Seismicity

	Address: _____		Zip: _____	
	Other Identifiers: _____			
	No. Stories: _____		Year Built: _____	
	Screener: _____		Date: _____	
	Total Floor Area (sq. ft.): _____			
	Building Name: _____			
	Use: _____			
	PHOTOGRAPH			
	Scale: _____			

OCCUPANCY	SOIL					TYPE						FALLING HAZARDS				
	Assembly	Govt	Office	Number of Persons:		A	B	C	D	E	F	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Commercial	Historic	Residential	0 - 10	11 - 100	Hard	Aug.	Disturb.	Soft	Soft	Fill	Rock	Unreinforced	Parapets	Chimneys	Other	
Elsew. Services	Industrial	School	101-1000	1000+	Rock	Rock	Soil	Soil	Soil	Soil	Rock	Clotways				
BASIC SCORE, MODIFIERS, AND FINAL SCORE, S																
BUILDING TYPE	W1	W2	S1	S2	S3	S4	S5	C1	C2	C3	PC1	PC2	RM1	RM2	LFM	
Basic Score	44	3.0	2.0	3.0	3.2	2.0	2.0	2.5	2.0	1.0	2.0	2.4	2.0	2.0	1.0	
Mid Rise (4 to 7 stories)	N/A	N/A	+0.5	-0.4	N/A	-0.4	+0.4	+0.4	-0.4	-0.2	N/A	+0.2	-0.4	-0.4	0.5	
High Rise (> 7 stories)	N/A	N/A	+0.6	-0.8	N/A	+0.6	+0.5	+0.5	-0.8	-0.3	N/A	+0.4	N/A	-0.6	N/A	
Vertical Irregularity	-0.5	-0.0	-1.0	-1.5	N/A	-1.0	-1.0	-1.5	-1.0	-1.0	N/A	-1.0	-1.0	-1.0	-1.0	
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	
Para-Codes	0.0	-1.0	-1.0	-0.8	-0.6	-0.8	-0.2	-1.2	-1.0	-0.2	-0.8	-0.8	-1.0	-0.8	-0.2	
Wood Diaphragms	-0.4	-2.4	+1.4	+1.4	N/A	+1.6	N/A	+1.4	+2.4	N/A	+2.4	N/A	+2.8	-2.8	N/A	
Soil Type C	-0.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	
Soil Type D	-0.0	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	
Soil Type E	-0.0	-0.8	-1.2	-1.2	-1.0	-1.2	-0.8	-1.2	-0.8	-0.8	-0.8	-1.2	-0.8	-0.8	-0.8	
FINAL SCORE, S																
COMMENTS															Detailed Evaluation Required	
															YES NO	

* = Estimated, subjective, or unreliable data
 BR = Braced frame MRF = Moment-resisting frame SW = Shear wall
 DR = Ductile reinforced concrete LV = Light masonry RIG = Rigid diaphragm LFM/RP = Floor slab/beam system

Source: FEMA-154

MOMA – Mobile Mapping



Omnidirectional
Camera

Battery

Acquisition
unit

Navigation
system



MOMA mounted
On a car

MOMA – Mobile Mapping

**Omnidirectional
(radial or equirectangular)
Projection**



**Perspective (central)
Projection**



MOMA – Mobile Mapping



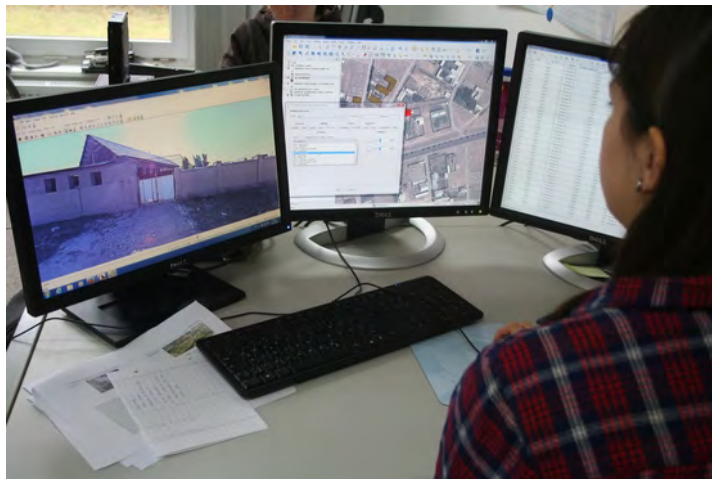
Good weather



Bad weather

RRVS Remote Rapid Visual Survey

Preliminary screening



Remote Inspection

Selected direct screening



Direct Inspection

RRVS Remote Rapid Visual Survey

Use case: exposure /
vulnerability assessment



Ref: FEMA-154

Use case: post-disaster
rapid damage mapping



Ref: ATC-20



RRVS Remote Rapid Visual Survey

rz-vm161/rrvs/main

Restore Session Most Visited R Data Analysis Exam... PostgreSQL: The wor... Google Traduttore Getting Started Arup

FrameID: 161

Leaflet | Processing © GFZ Potsdam - Centre for Early Warning Systems | Map data © OpenStreetMap

Remote Rapid Visual Screening Tool

Search:

BuildingID	RRVS Status
2001	UNMODIFIED
2002	UNMODIFIED
2003	UNMODIFIED
2004	UNMODIFIED

Showing 1 to 100 of 100 entries

Material LLRS Height Age Occupancy Exterior Walls

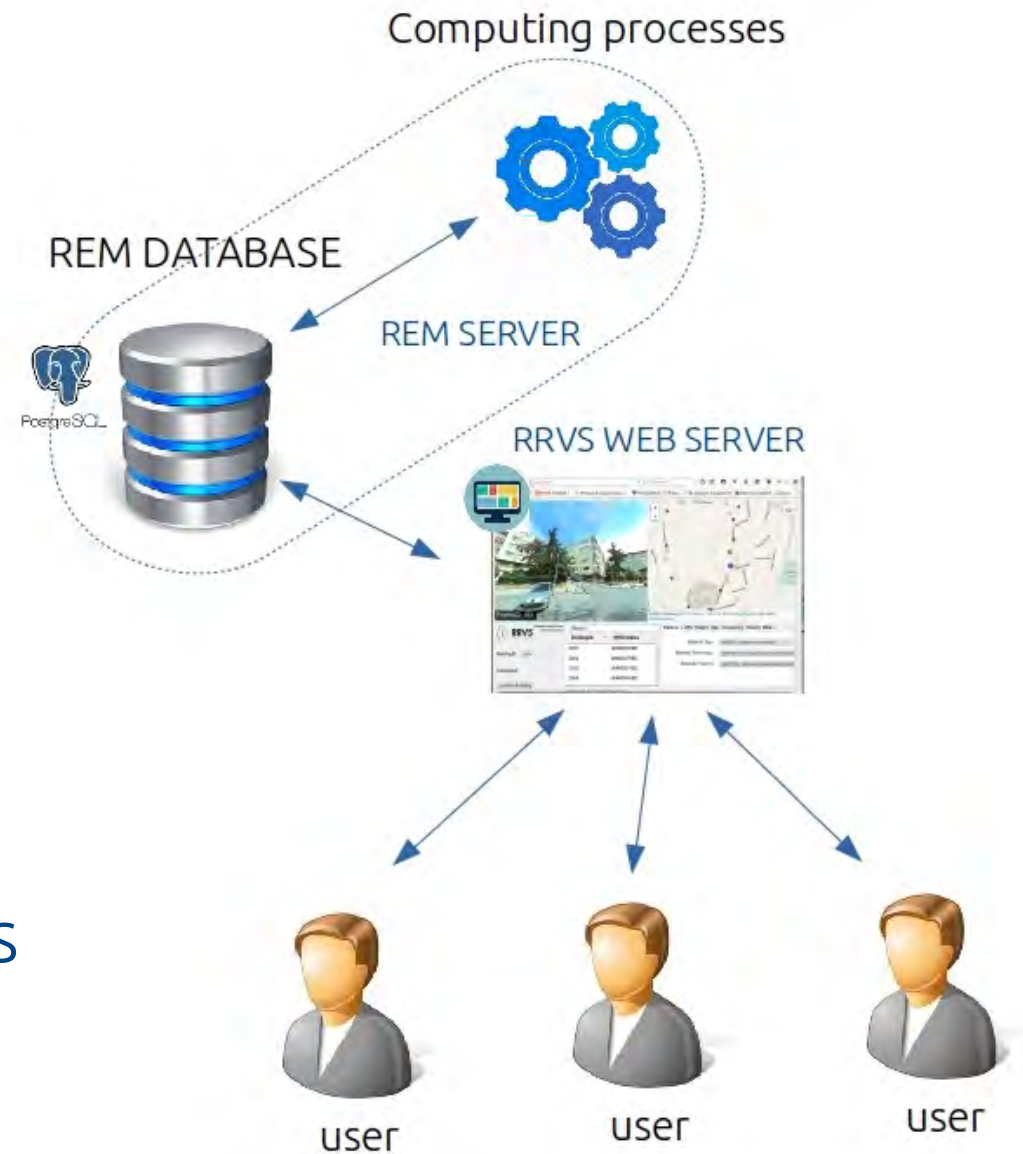
Material Type: MAT99 - Unknown material

Material Technology: MATT99 - Unknown material technolo

Material Property: MATP99 - Unknown material properti

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



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