A Software to Assess Liquefaction-induced Damage to Critical Infrastructures

Main Outcomes from LIQUEFACT Project

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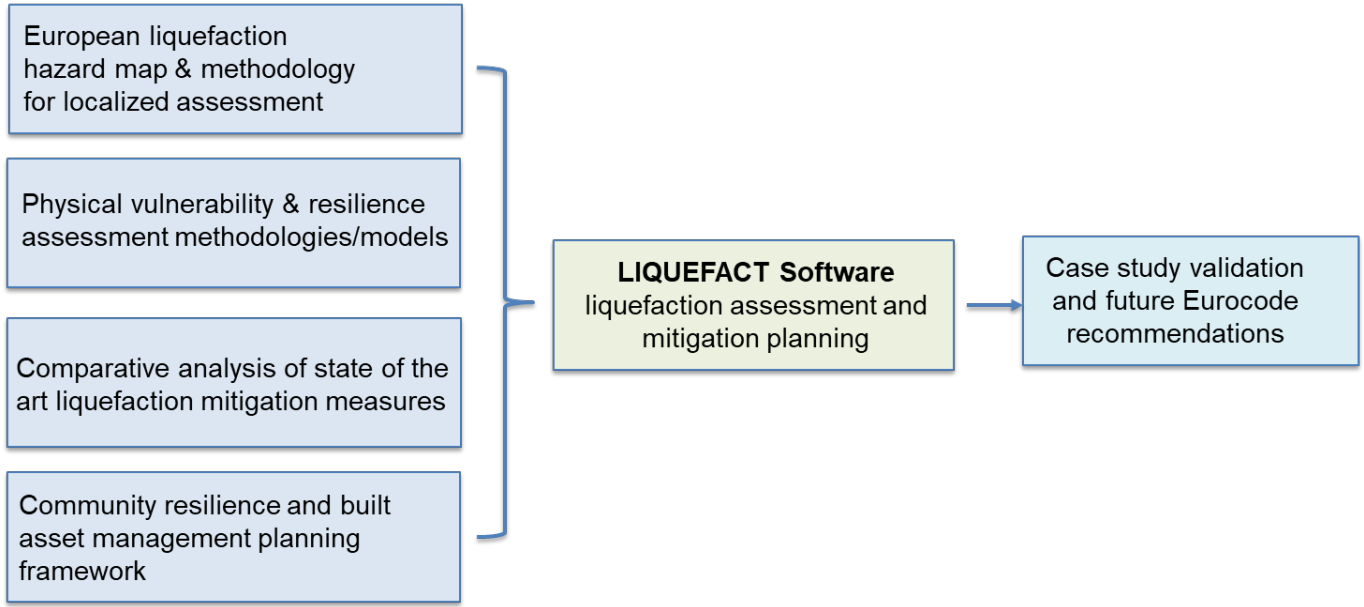
LIQUEFACT Software

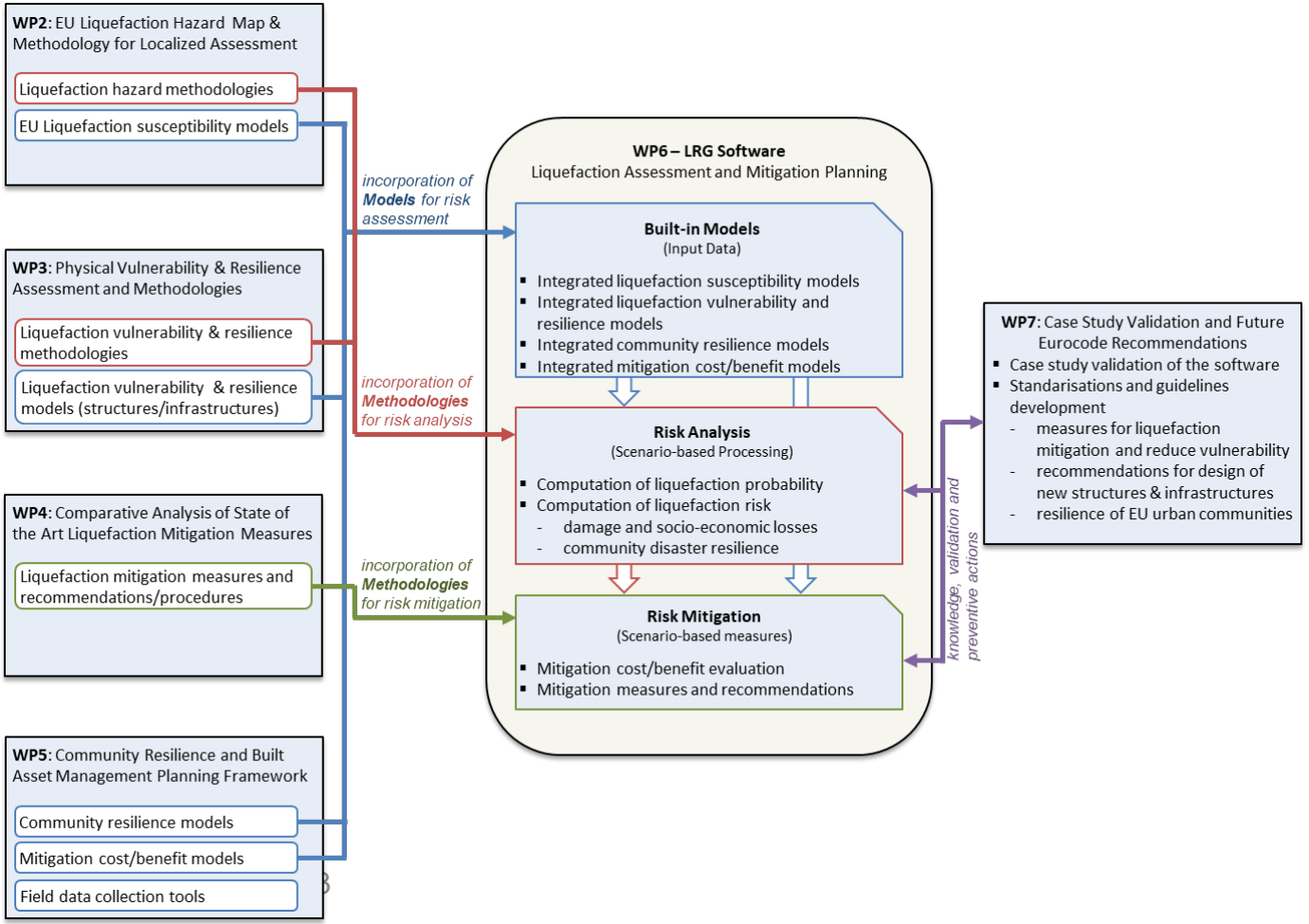
One of the key outputs from the project is the LIQUEFACT software, under development at NORSAR

The basic for the development of the LIQUEFACT software consists in integrating the knowledge (methodologies, procedures and models) from WP2, WP3, WP4 and WP5



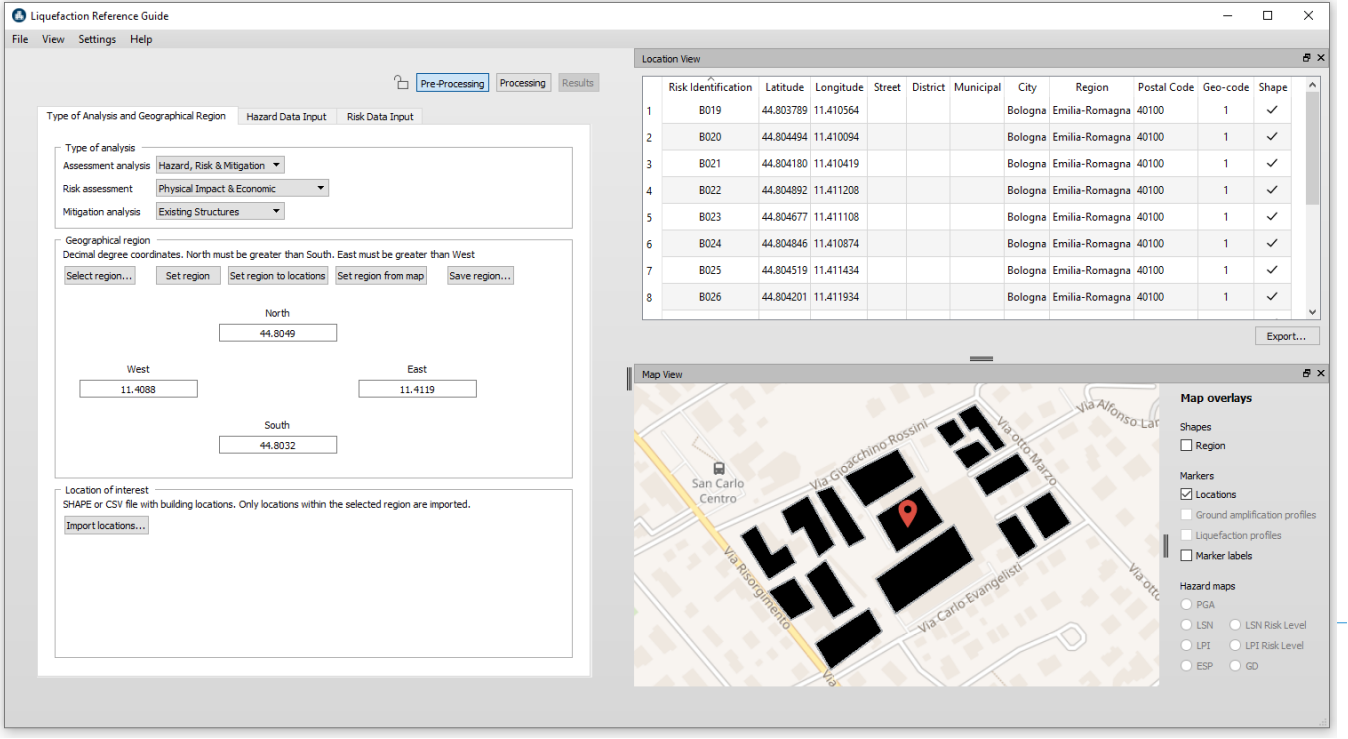
By using LIQUEFACT software, civil engineers and relevant stakeholders involved in the design and implementation can be guided to assess the feasibility and cost-benefit of certain liquefaction mitigation techniques or compute the socio-economic impacts of risk reduction and resilience improvement strategies.

LIQUEFACT Software

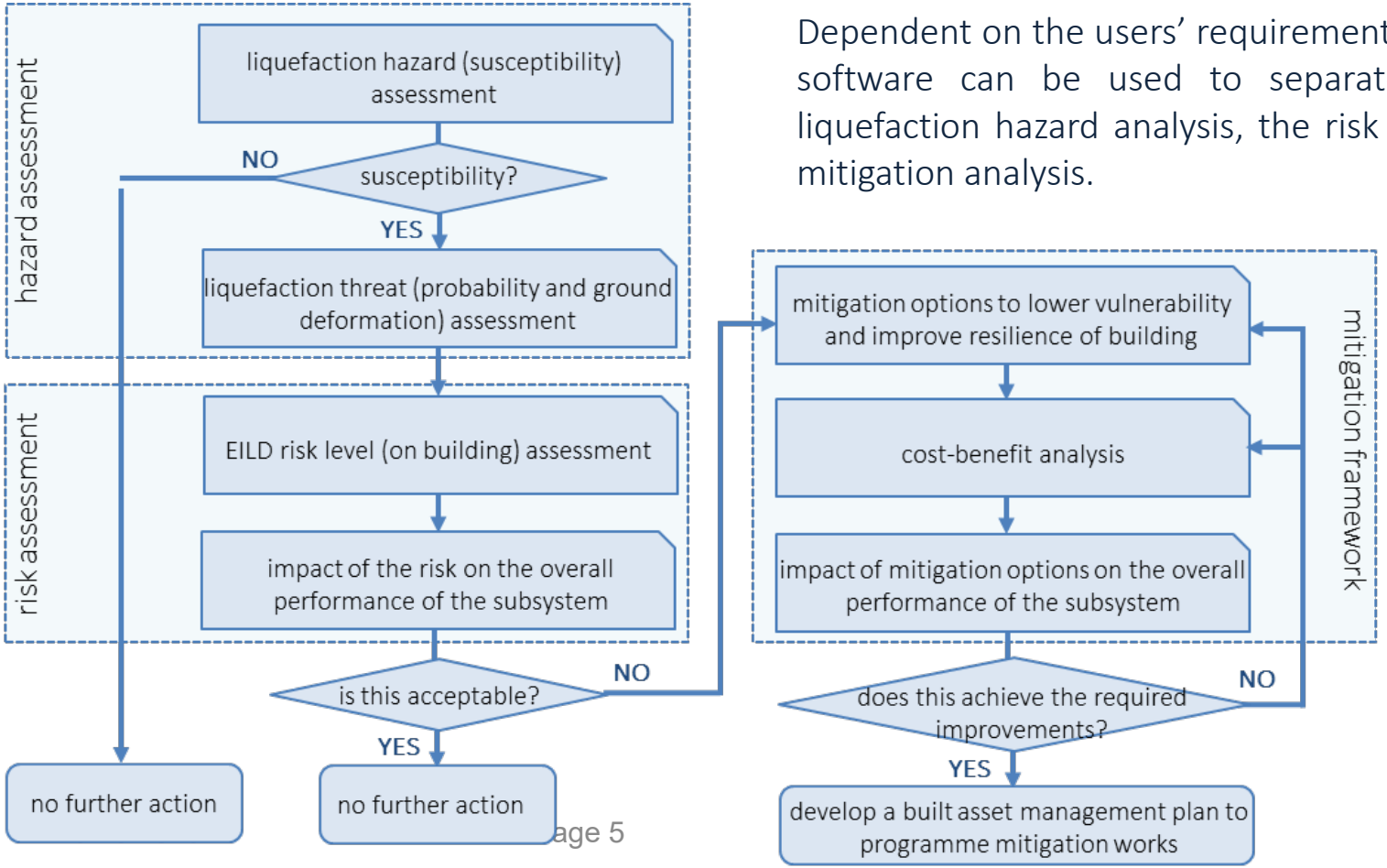


LIQUEFACT Software

LIQUEFACT software is a user-friendly toolbox for liquefaction mitigation planning and decision support, able to estimate and predict the likely consequences of an earthquake-induced liquefaction damage at individual structure /infrastructure, at regional or city level

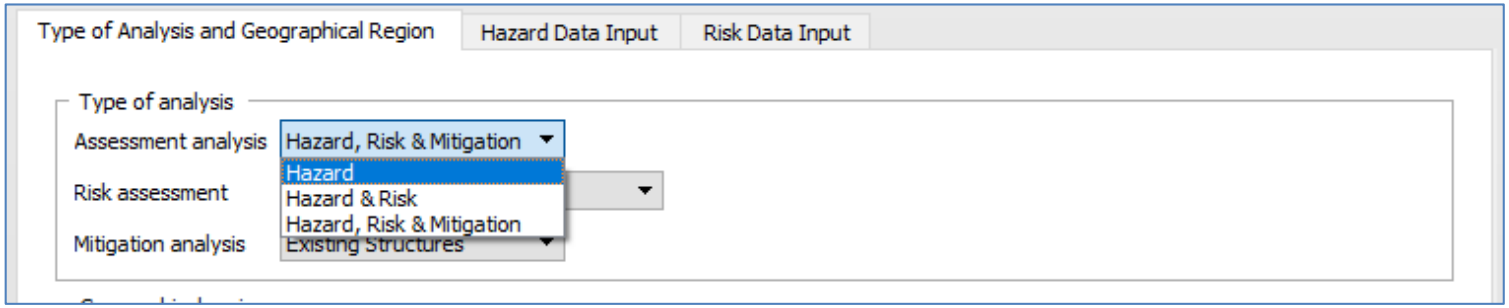


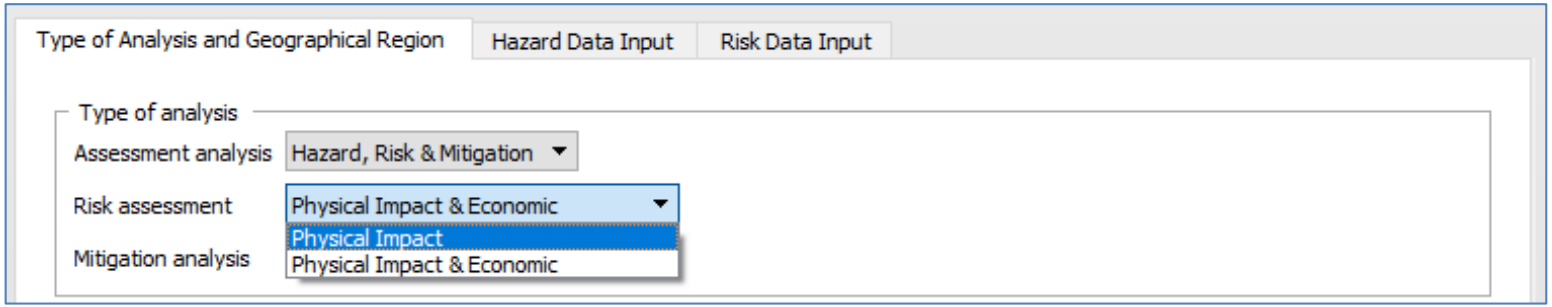
Processing and Analysis Concept

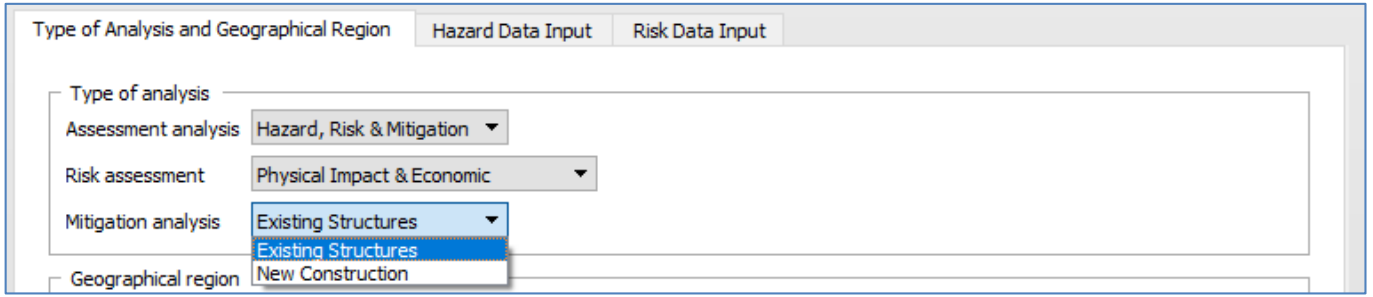


Dependent on the users' requirements, the LIQUEFACT software can be used to separately conduct the liquefaction hazard analysis, the risk analysis, and the mitigation analysis.

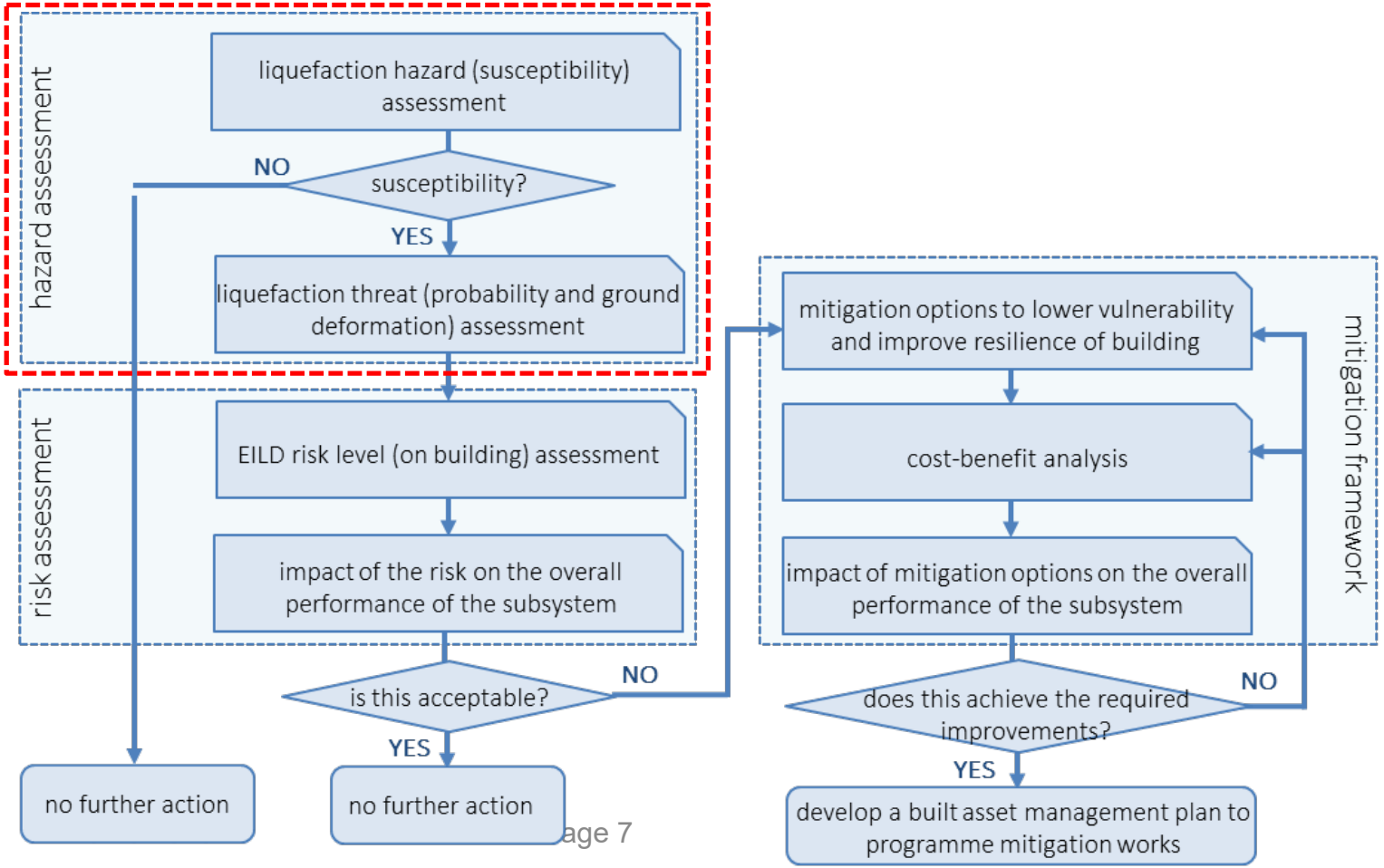
Processing and Analysis Concept







Liquefaction Hazard Assessment

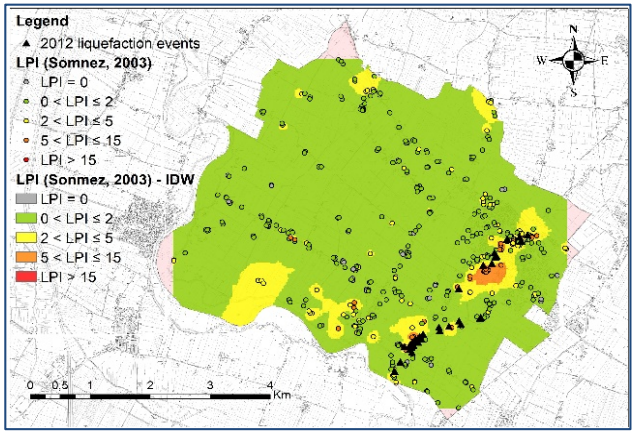


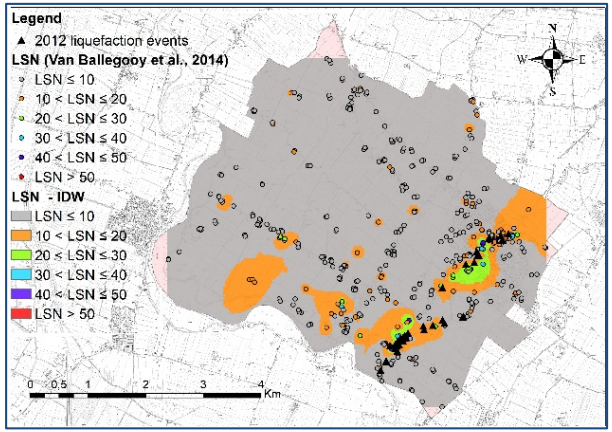
Liquefaction Hazard Assessment - Susceptibility

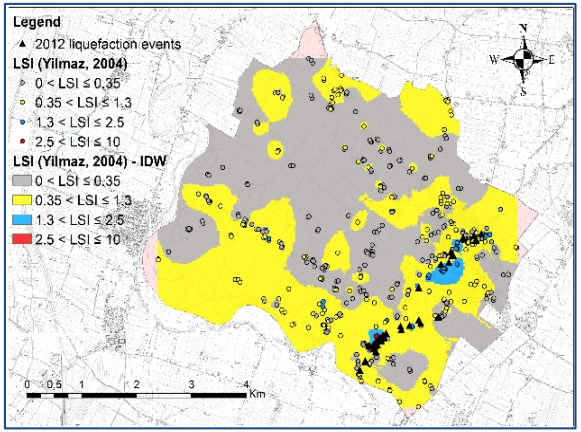
- User-Defined and Pre-Defined Model

Evaluation of liquefaction susceptibility of the soil at a specific location: qualitative analysis allowing end-users to identify how likely an asset (e.g. individual building/CI asset, portfolio of buildings/distributed infrastructure assets, etc.) is susceptible to liquefaction;

User-Defined: Microzonation maps







Ref: DELIVERABLE D2.7: Methodology for assessment of earthquake-induced risk of soil liquefaction at the four European testing sites (microzonation) (http://www.liquefact.eu)

Liquefaction Hazard Assessment - Susceptibility

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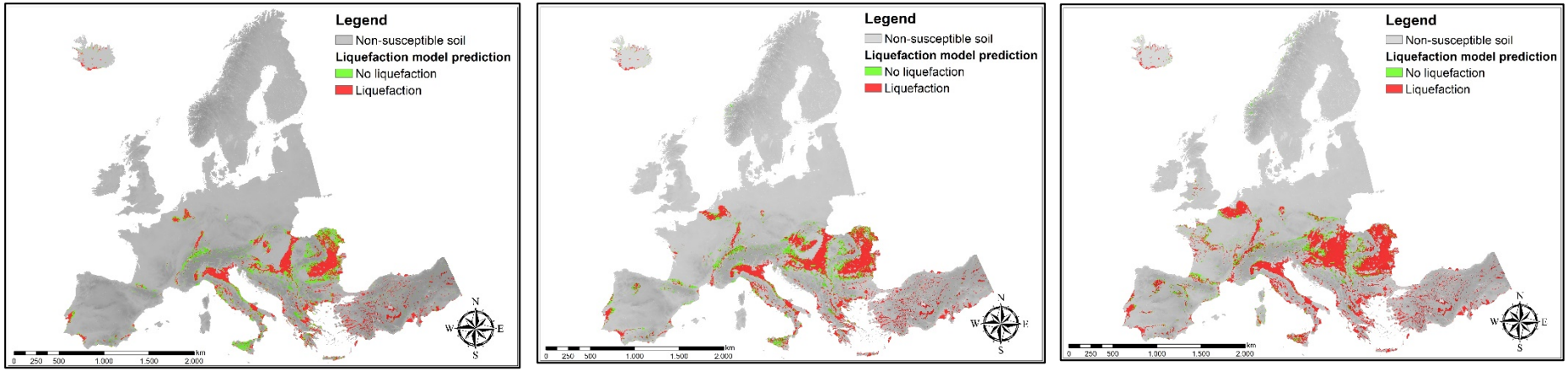
Evaluation of liquefaction susceptibility of the soil at a specific location: qualitative analysis allowing end-users to identify how likely an asset (e.g. individual building/CI asset, portfolio of buildings/distributed infrastructure assets, etc.) is susceptible to liquefaction;

Pre-Defined: Macrozonation maps



European liquefaction binary model (ADASYN) prediction maps for 475 years, 975 years and 2475 years return period.

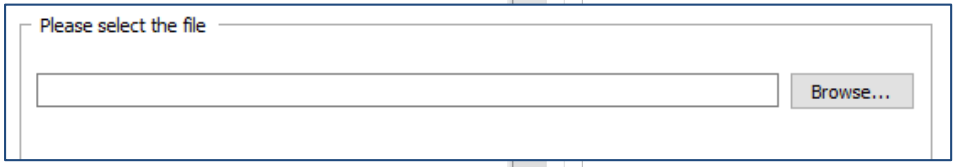
Ref: DELIVERABLE D2.6: Report to describe the adopted procedure for the development of the European liquefaction hazard map (http://www.liquefact.eu)

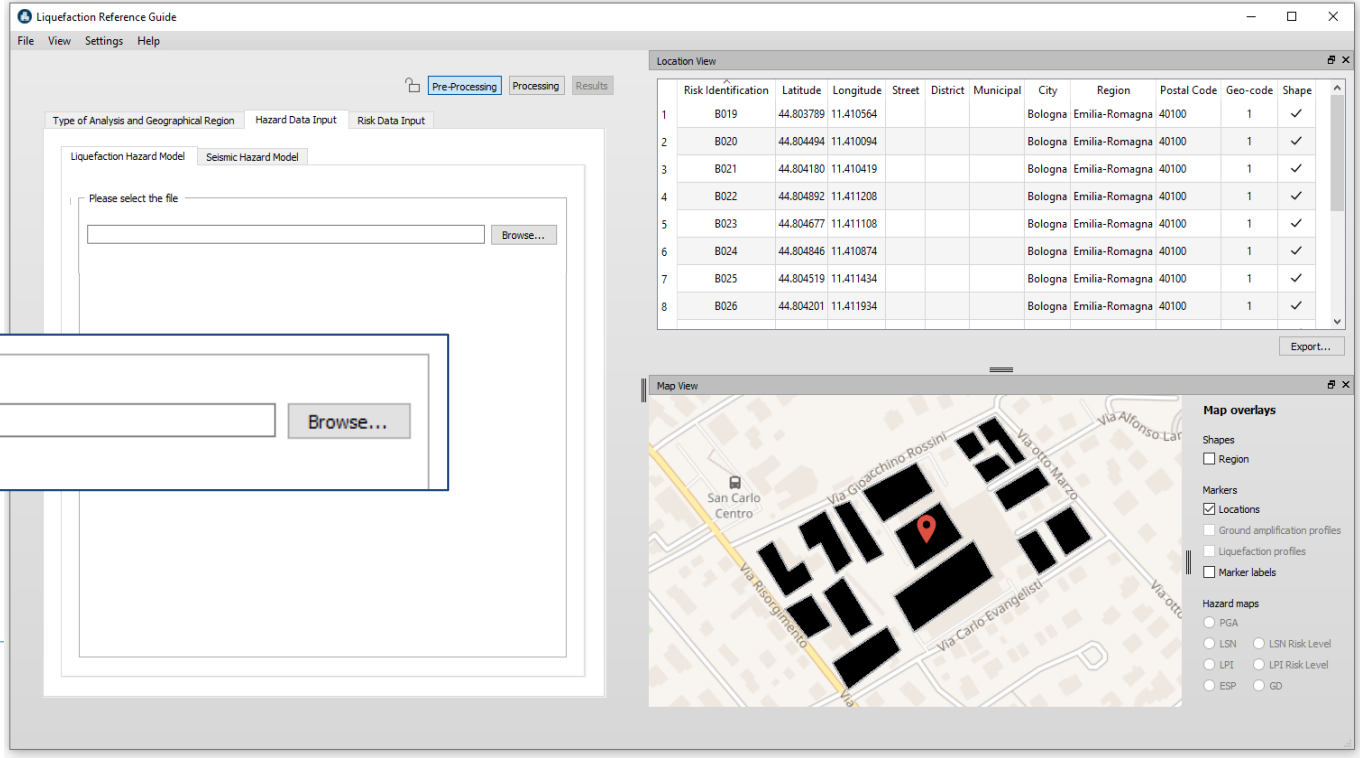
Liquefaction Hazard Assessment - Susceptibility

- **User-Defined and Pre-Defined Model**

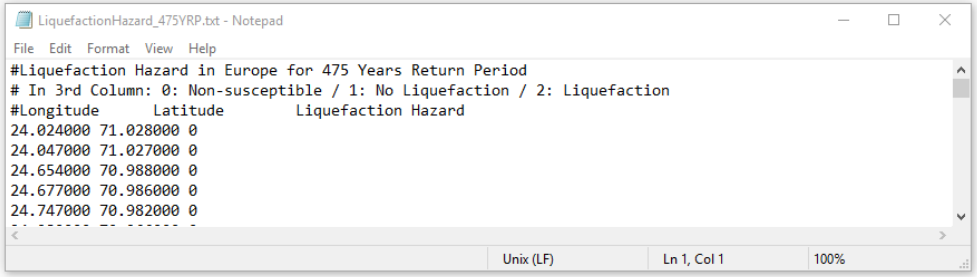
User-Defined: upload liquefaction hazard maps in terms of LPI, LSN, LSI, LDI, Settlement

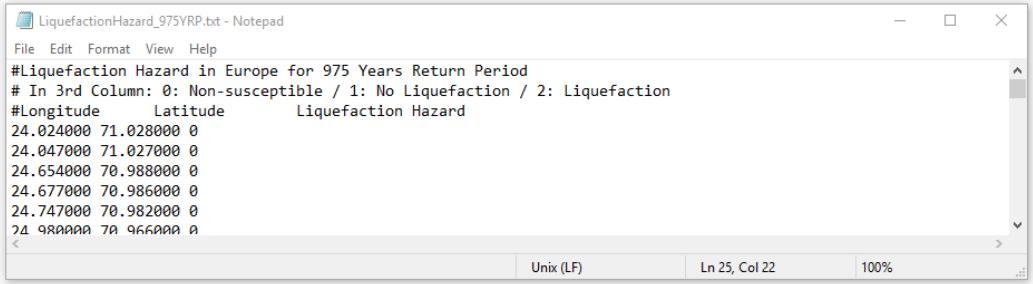
Pre-Defined: used embedded European Liquefaction Hazard map

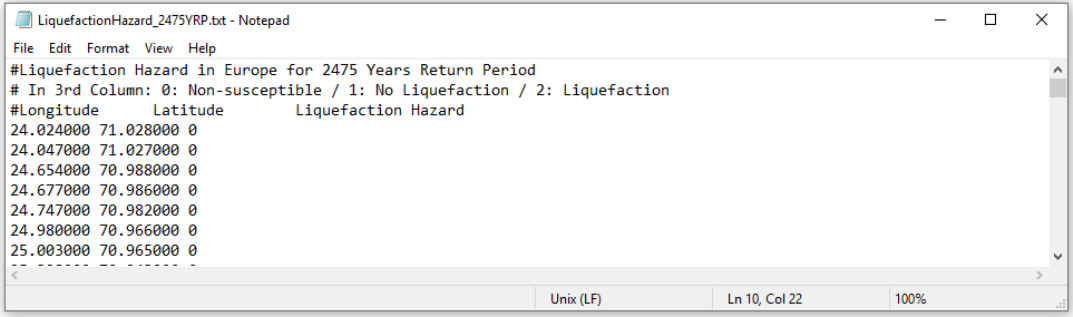




Liquefaction Hazard Assessment - Susceptibility



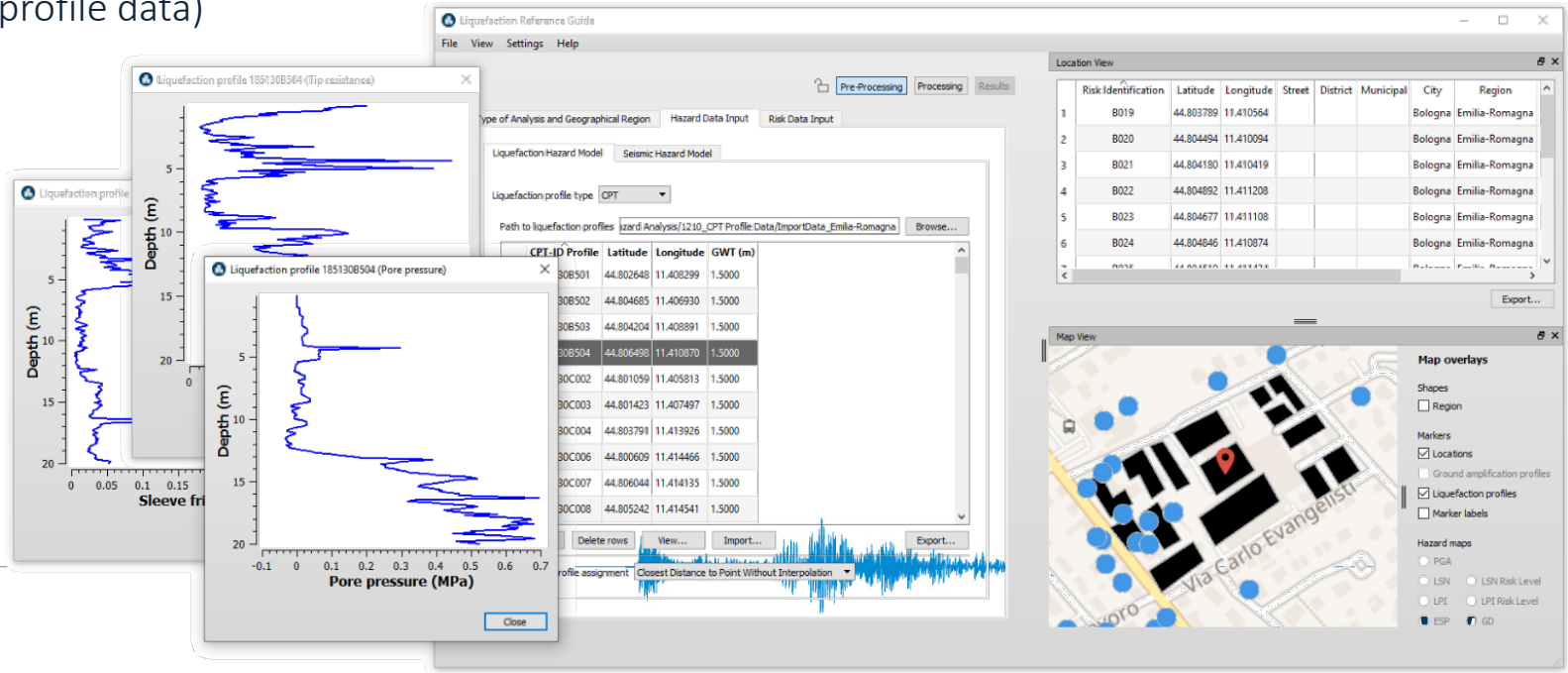




Liquefaction Hazard Assessment – Quantitative Analysis

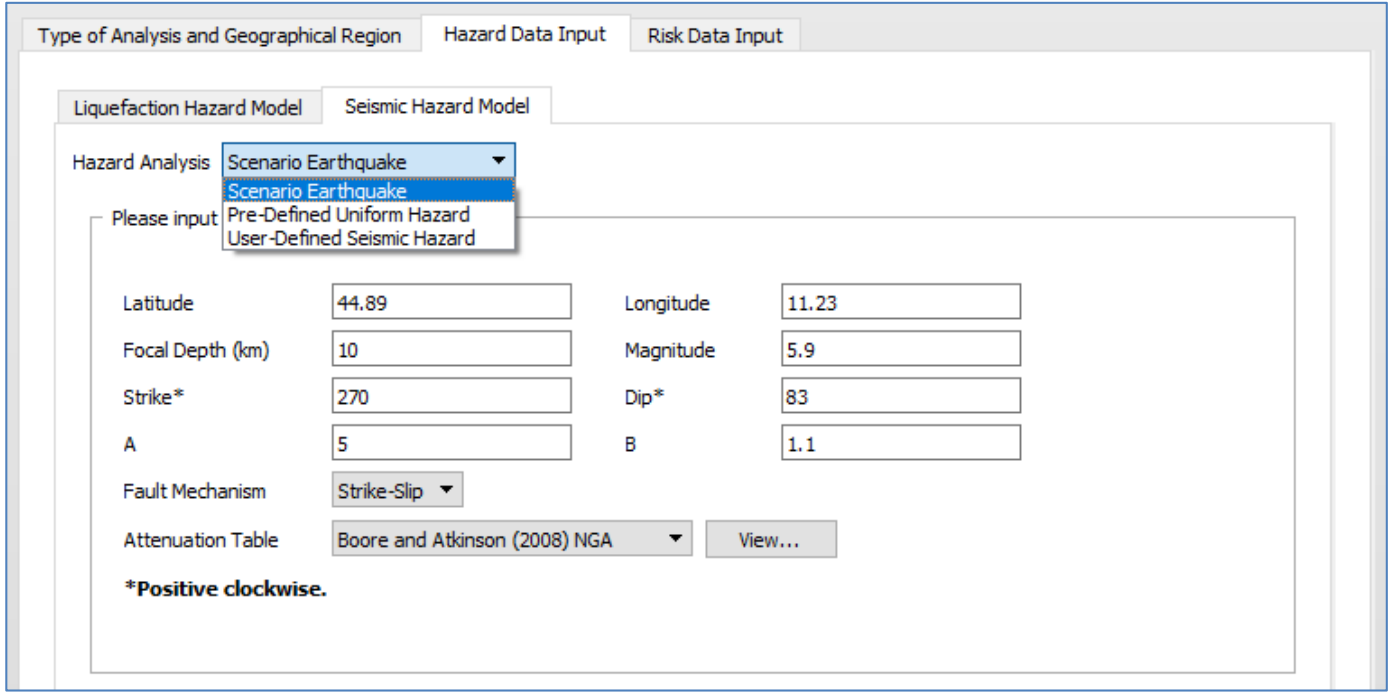
- CPT, SPT, Vs profile

evaluation of liquefaction probability for a given level of amplitude and duration of ground shaking: quantitative analysis for liquefaction potential allowing end-users to evaluate quantitatively the level of the threat. End-users will be able to provide different type of inputs data for liquefaction assessment (CPT, SPT, Vs30 profile data)



Liquefaction Hazard Assessment – Seismic Input at bedrock

- Scenario Earthquake
- Predefined Uniform Hazard
- User-defined seismic hazard



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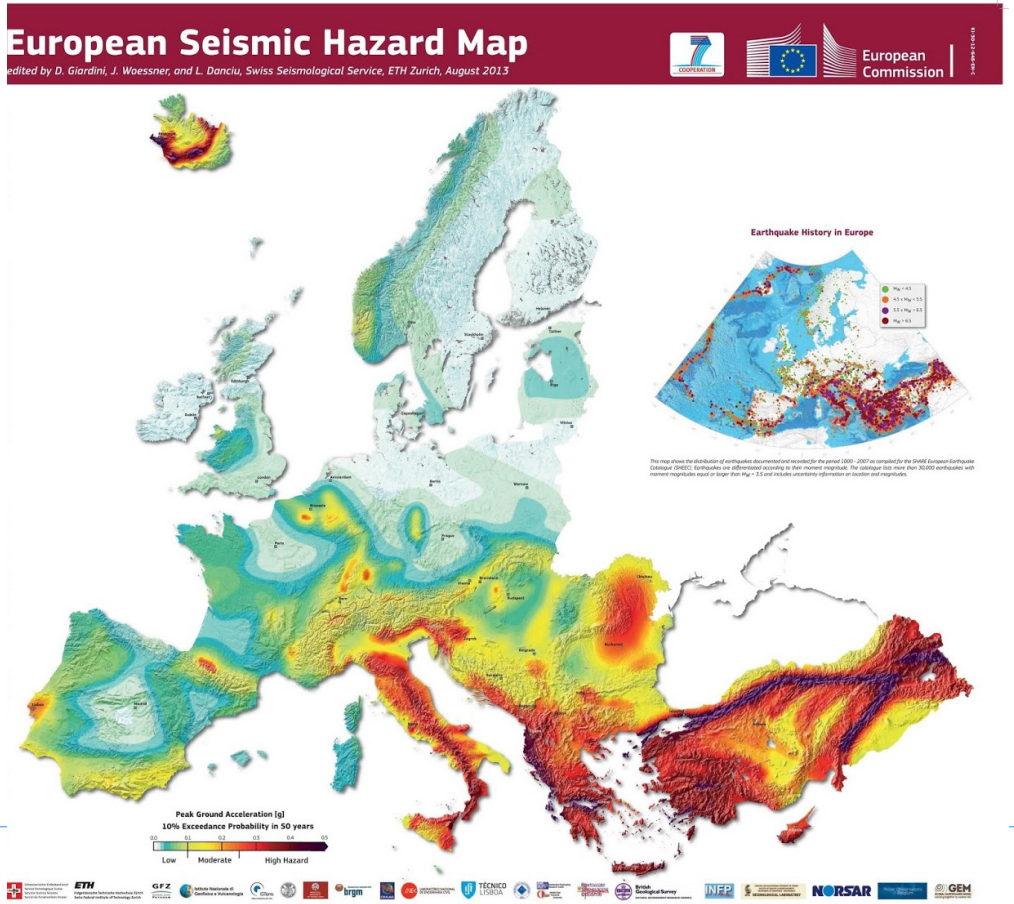
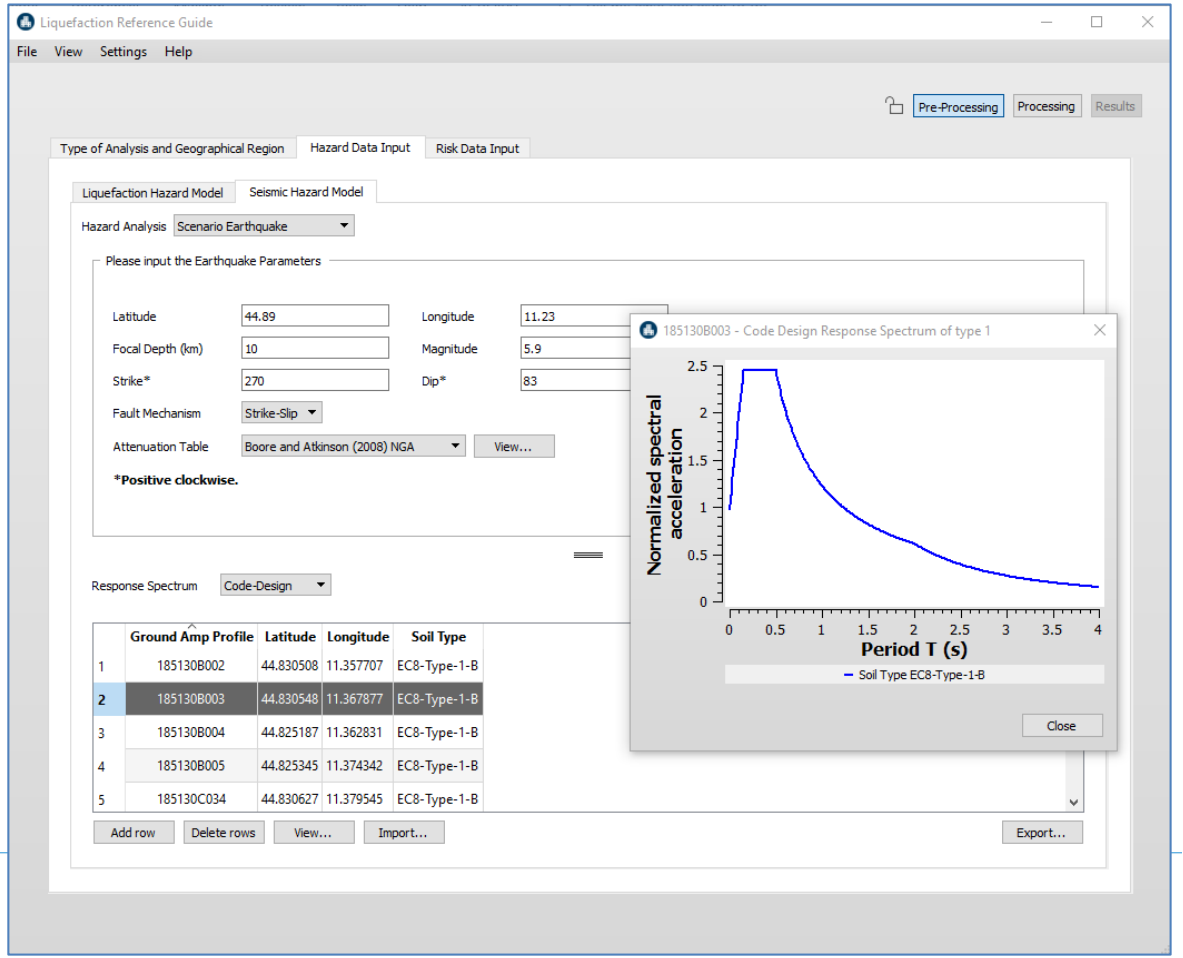


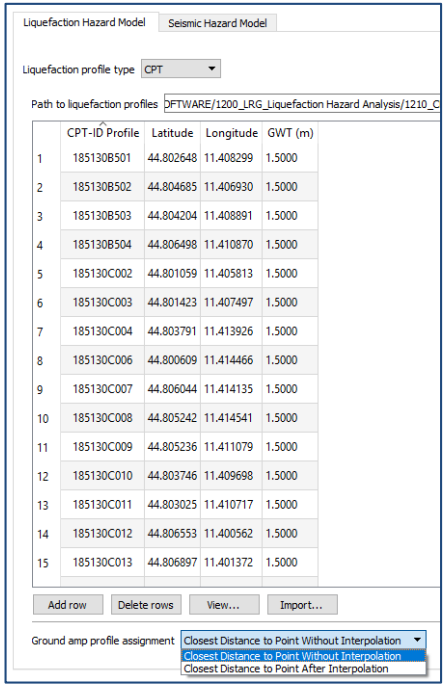
Liquefaction Hazard Assessment – Seismic action at ground surface

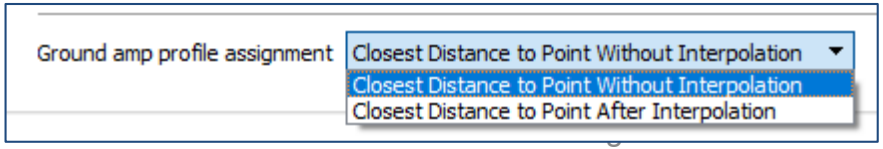
Response spectrum

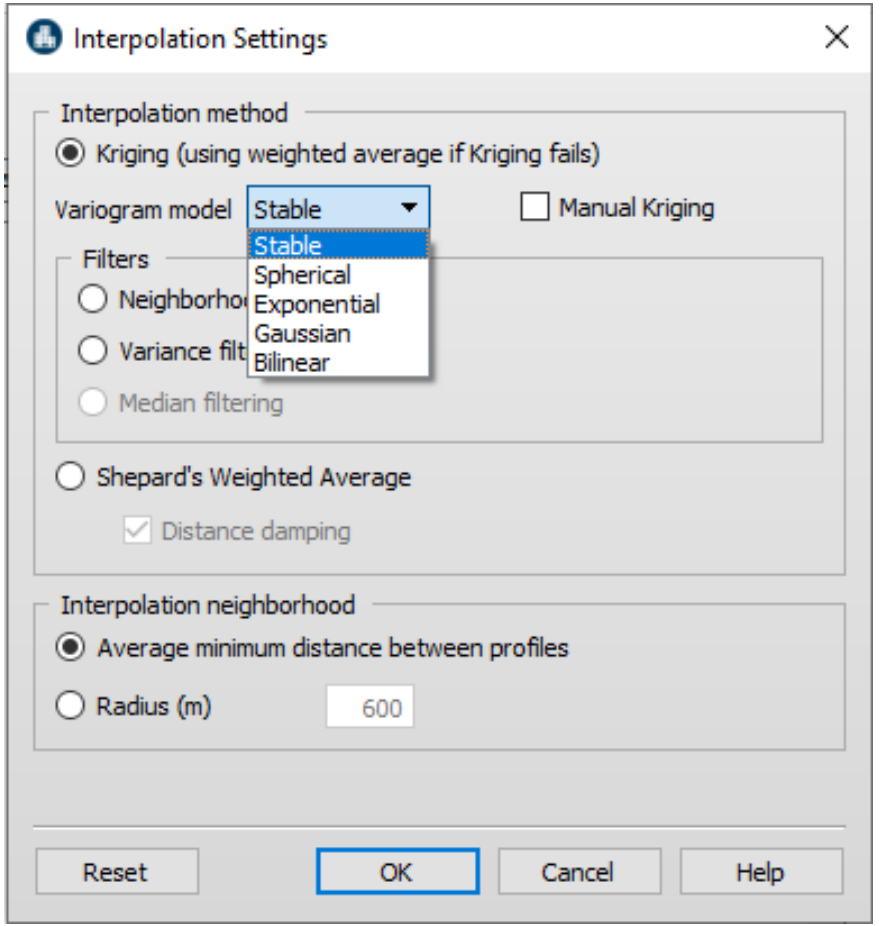
- Code-design (Eurocode-8)
- Site-specific (Vs30 profiles)



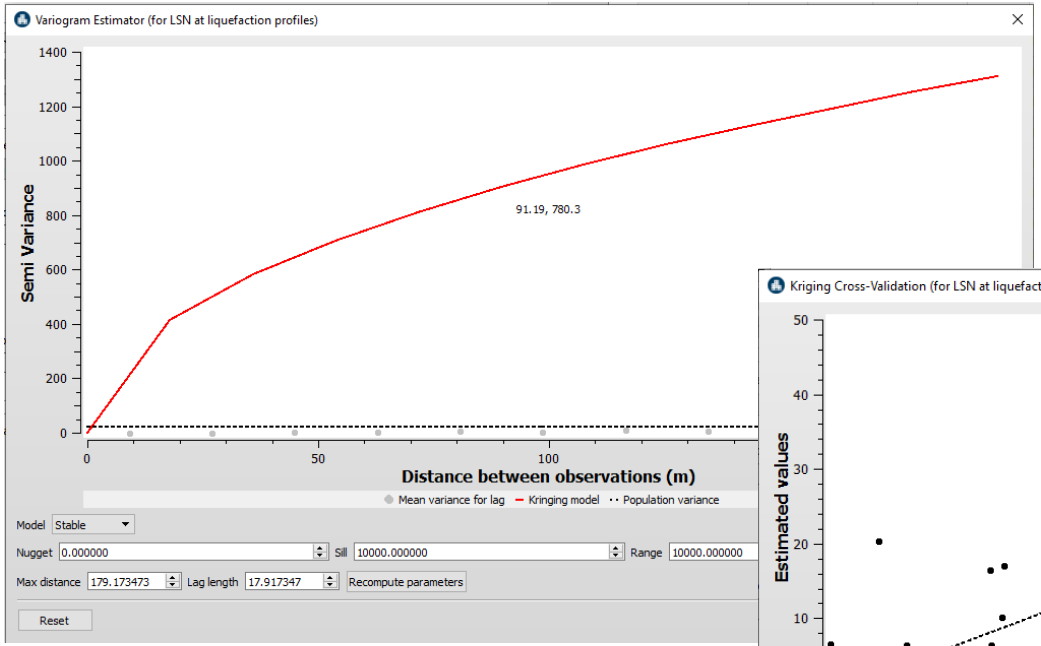
Liquefaction Hazard Assessment – Interpolation

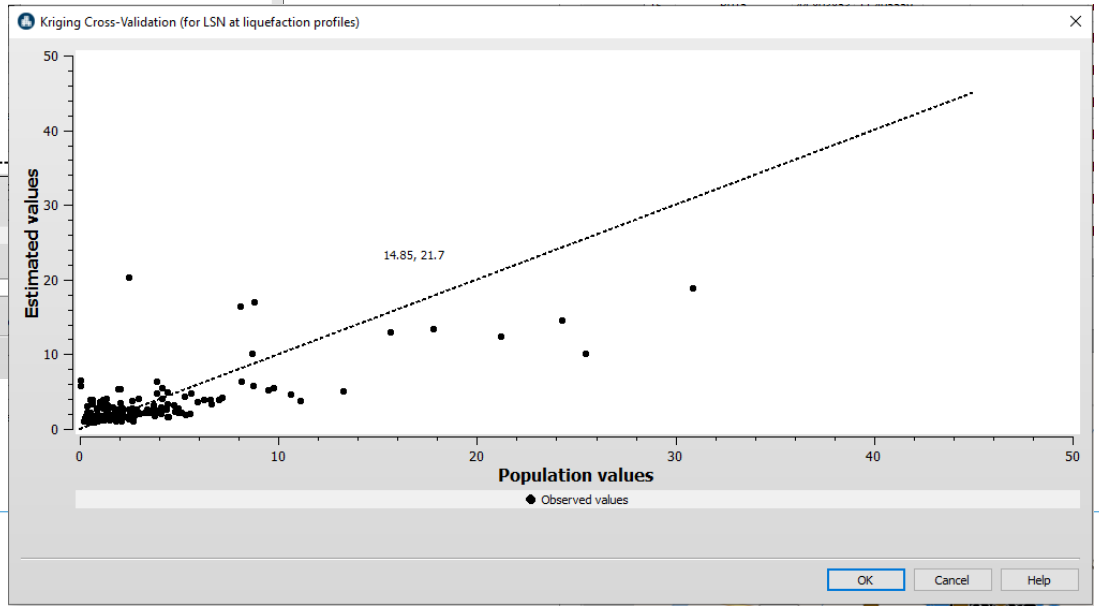






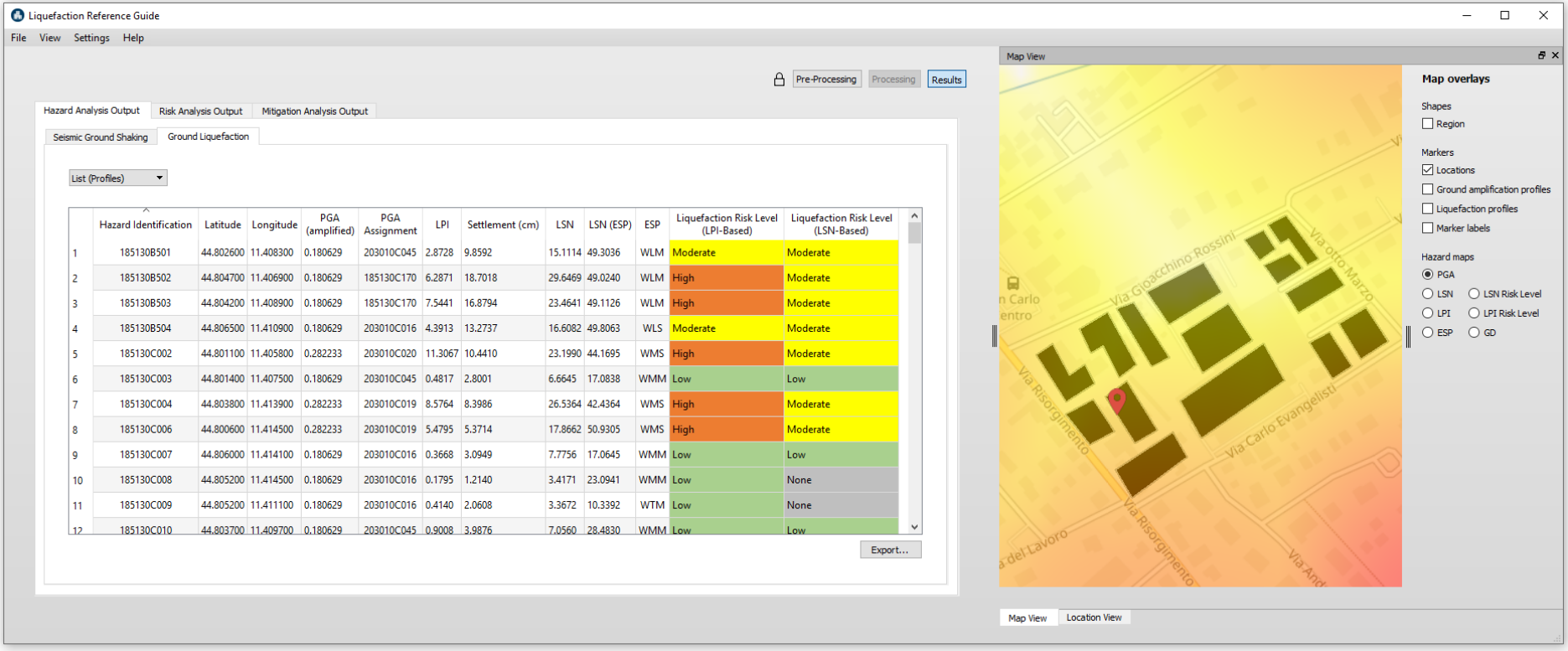
Liquefaction Hazard Assessment – Seismic action at ground surface





- Variogram estimator
- Kriging cross-validation

Liquefaction Hazard Assessment – Quantitative Analysis



	Hazard Identification	Latitude	Longitude	PGA (amplified)	PGA Assignment	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)
1	185130B501	44.802600	11.408300	0.180629	203010C045	2.8728	9.8592	15.1114	49.3036	WLM	Moderate	Moderate
2	185130B502	44.804700	11.406900	0.180629	185130C170	6.2871	18.7018	29.6469	49.0240	WLM	High	Moderate
3	185130B503	44.804200	11.408900	0.180629	185130C170	7.5441	16.8794	23.4641	49.1126	WLM	High	Moderate
4	185130B504	44.806500	11.410900	0.180629	203010C016	4.3913	13.2737	16.6082	49.8063	WLS	Moderate	Moderate
5	185130C002	44.801100	11.405800	0.282233	203010C020	11.3067	10.4410	23.1990	44.1695	WMS	High	Moderate
6	185130C003	44.801400	11.407500	0.180629	203010C045	0.4817	2.8001	6.6645	17.0838	WMM	Low	Low
7	185130C004	44.803800	11.413900	0.282233	203010C019	8.5764	8.3986	26.5364	42.4364	WMS	High	Moderate
8	185130C006	44.800600	11.414500	0.282233	203010C019	5.4795	5.3714	17.8662	50.9305	WMS	High	Moderate
9	185130C007	44.806000	11.414100	0.180629	203010C016	0.3668	3.0949	7.7756	17.0645	WMM	Low	Low
10	185130C008	44.805200	11.414500	0.180629	203010C016	0.1795	1.2140	3.4171	23.0941	WMM	Low	None
11	185130C009	44.805200	11.411100	0.180629	203010C016	0.4140	2.0608	3.3672	10.3392	WTM	Low	None
12	185130C010	44.803700	11.409700	0.180629	203010C045	0.9008	3.9876	7.0560	28.4830	WMM	Low	Low

Liquefaction Hazard Assessment – Quantitative Analysis

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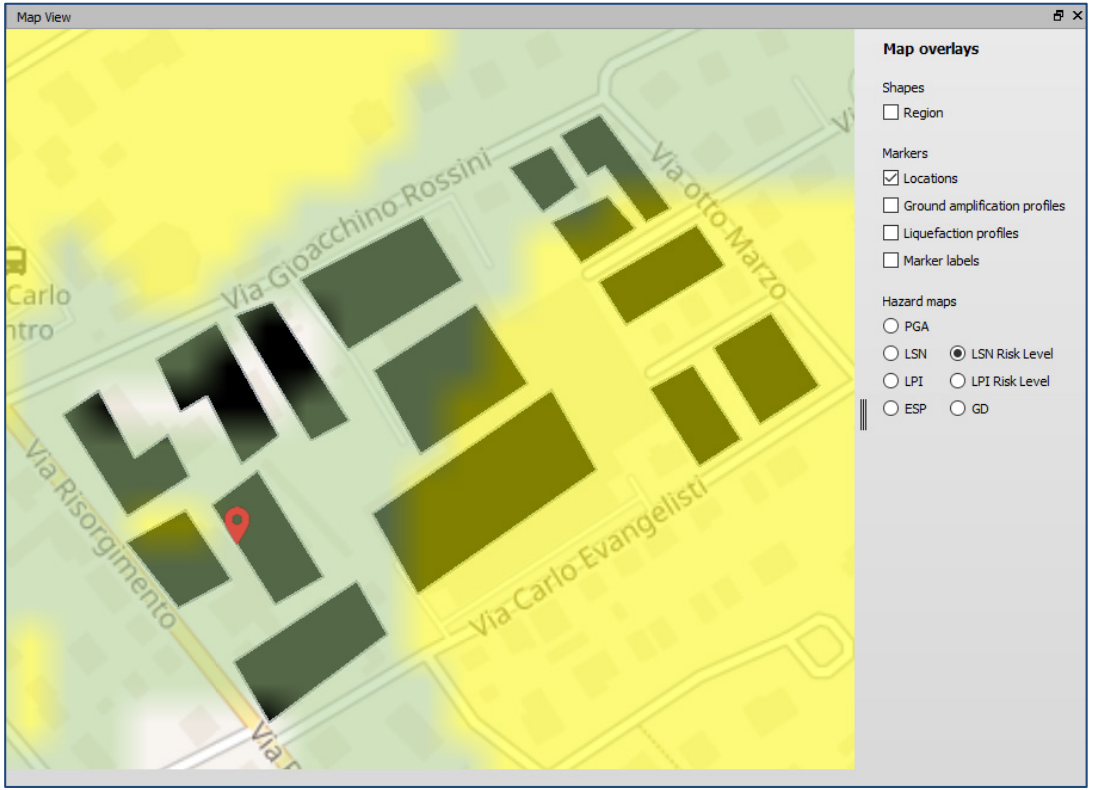
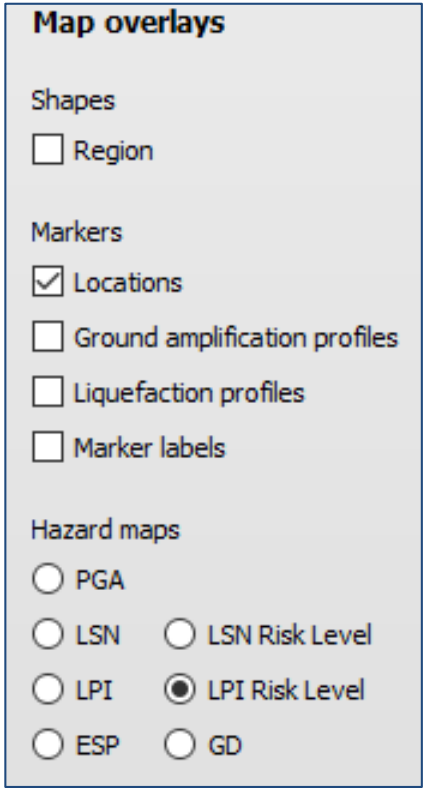
Liquefaction Hazard Assessment – Quantitative Analysis





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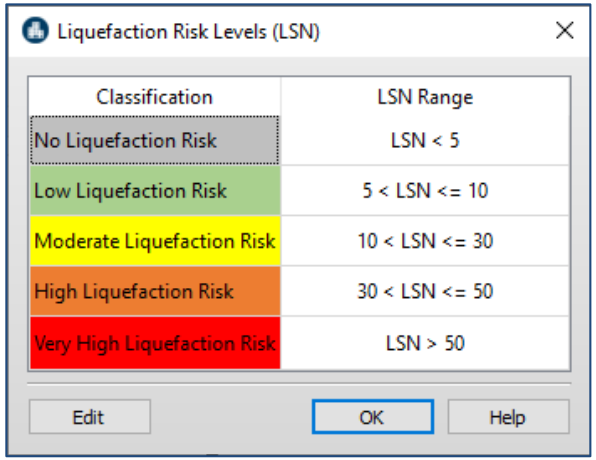

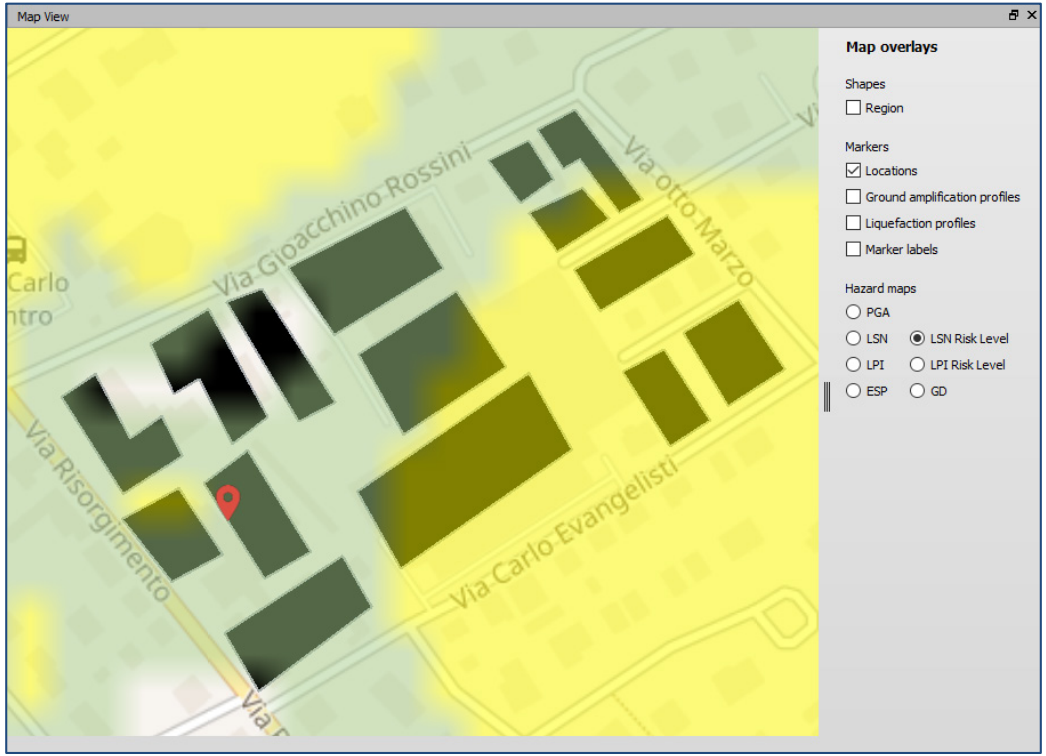

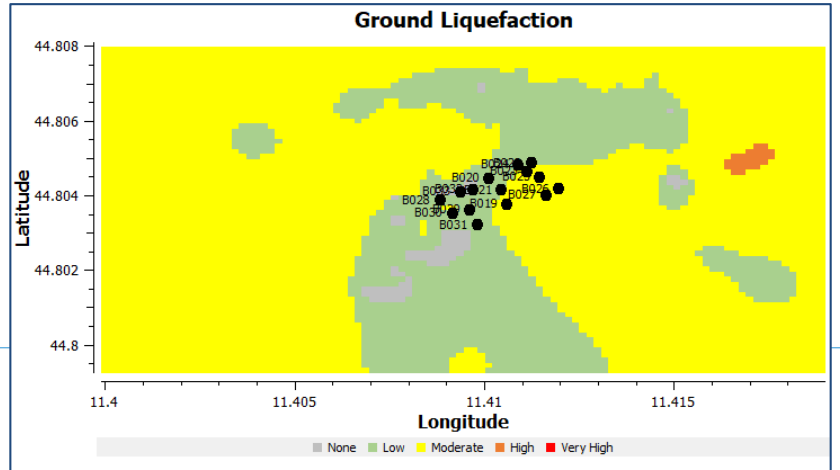

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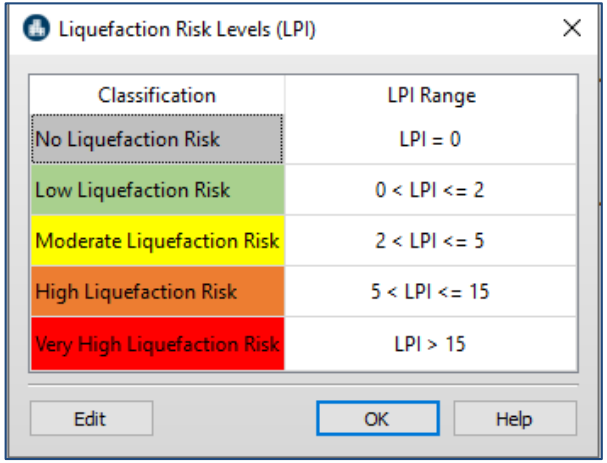
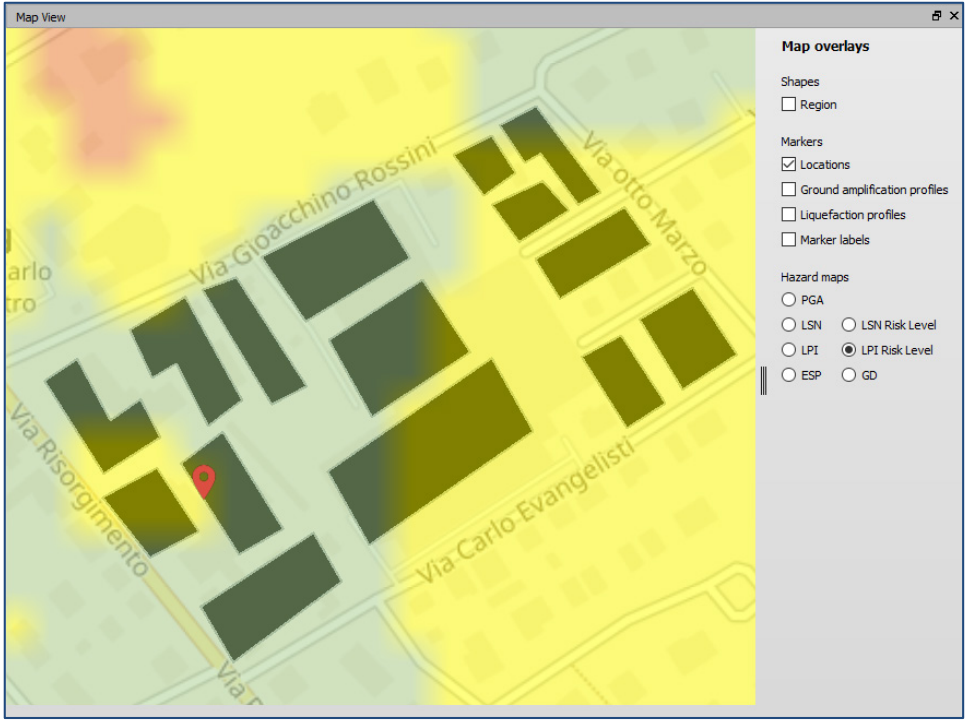
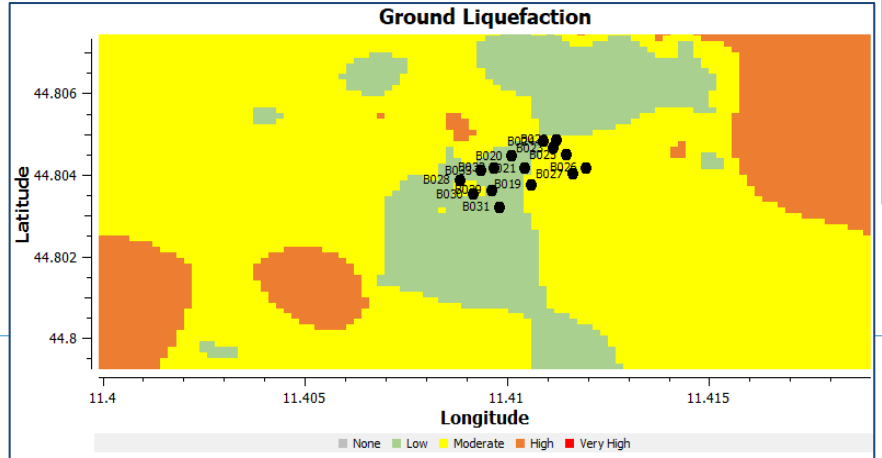
Liquefaction Hazard Assessment – Quantitative Analysis







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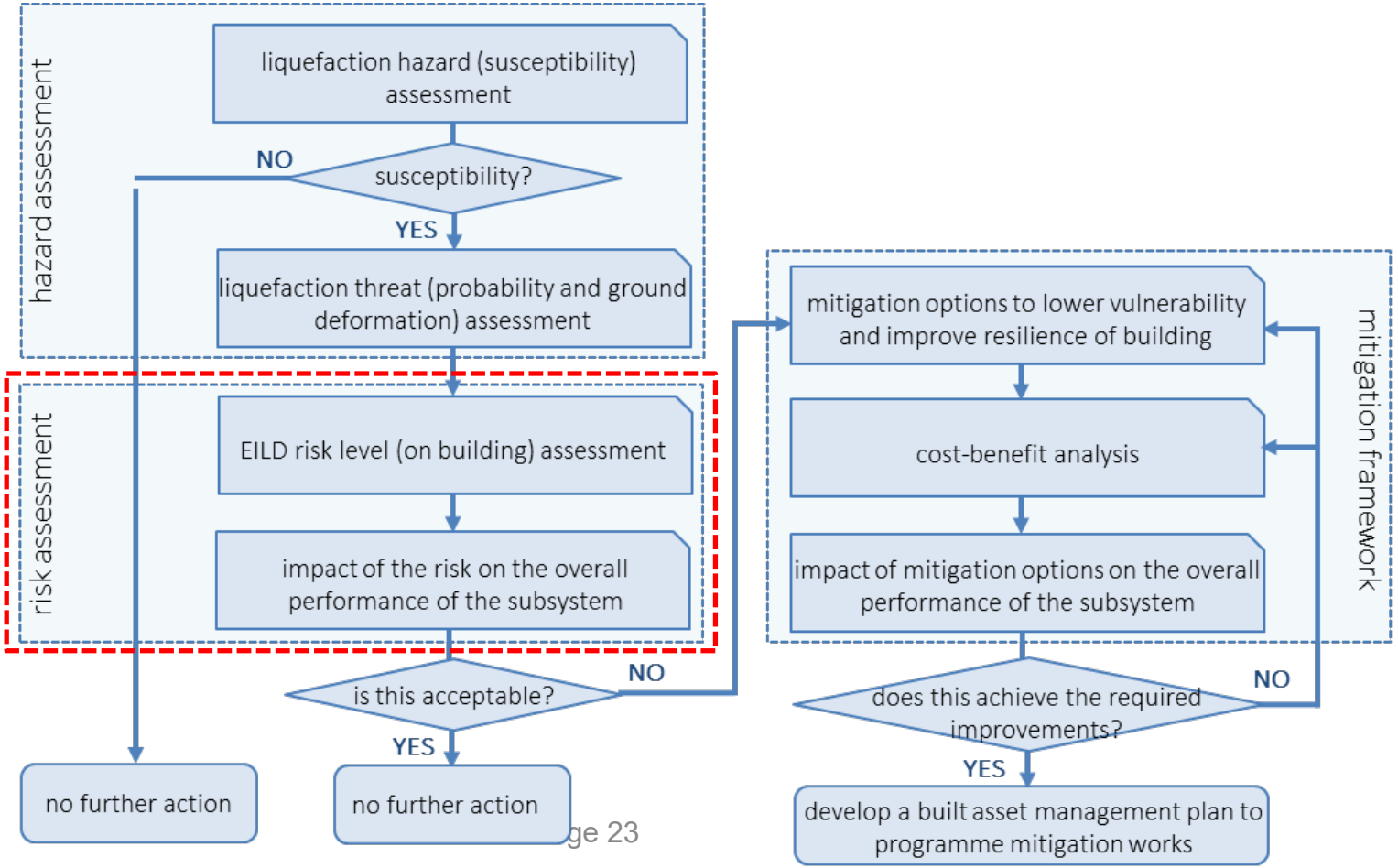
Risk Assessment



Risk Assessment

① Physical Impact

- Computation of Damage Probability and Loss Ratio
  - ESP-based Procedure
  - Conventional Procedure

② Economic Loss

- Owner Loss (Building, Contents, Business Interruption)
- Insurance Loss (Building, Contents, Business Interruption)

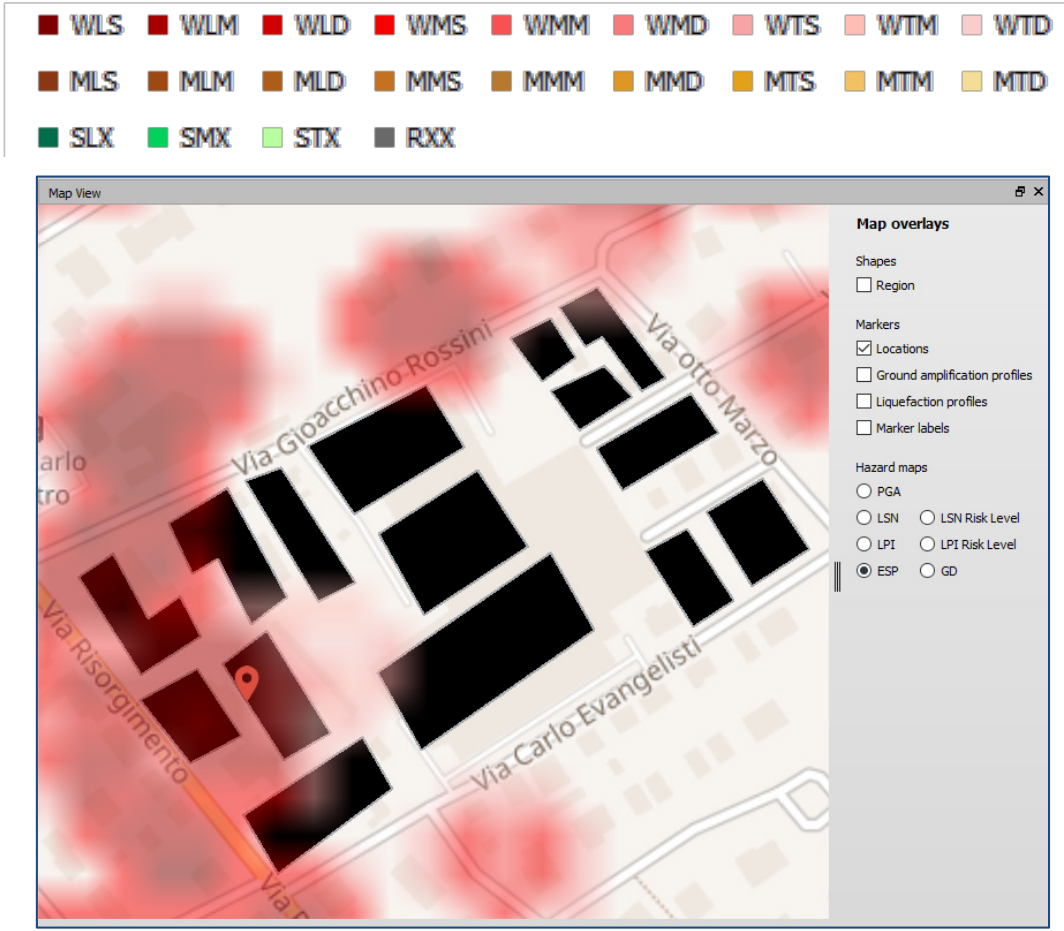
① Hazard for Risk Assessment

- Liquefaction
- Liquefaction + Ground Shaking (without liquefaction)

Physical Impact - Equivalent Soil Profile (ESP) method

Strength - Size - Position

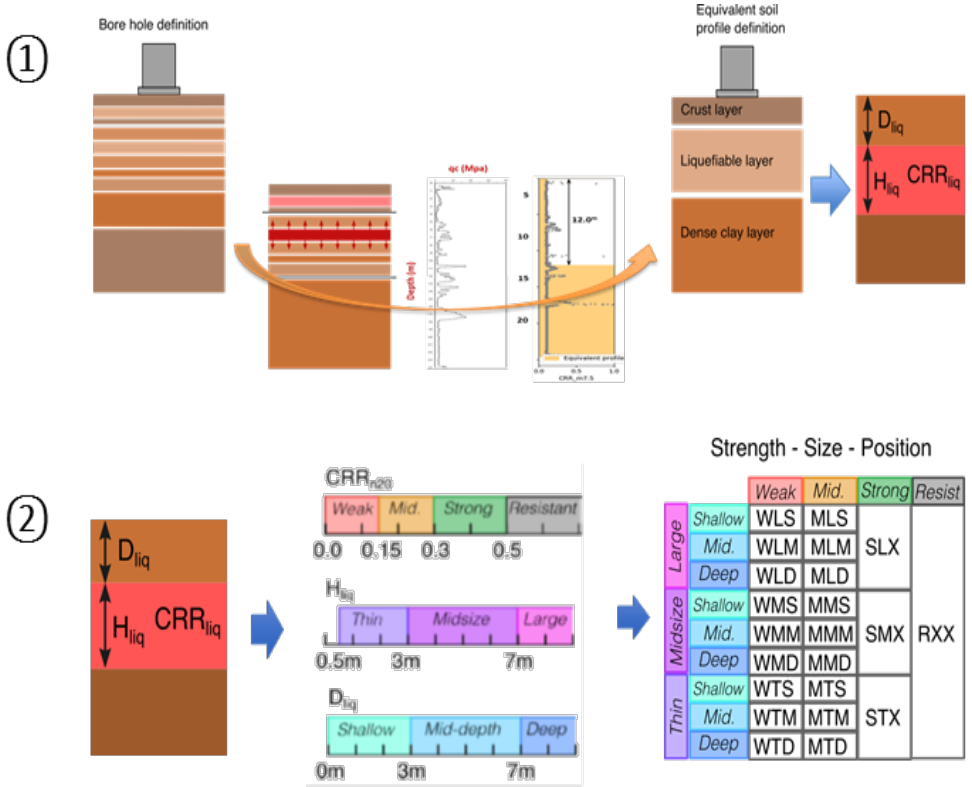
		Weak	Mid.	Strong	Resist
Large	Shallow	WLS	MLS	SLX	RXX
	Mid.	WLM	MLM		
	Deep	WLD	MLD		
Midsize	Shallow	WMS	MMS	SMX	
	Mid.	WMM	MMM		
	Deep	WMD	MMD		
Thin	Shallow	WTS	MTS	STX	
	Mid.	WTM	MTM		
	Deep	WTD	MTD		



Physical Impact - Equivalent Soil Profile (ESP) method

Step 1: is about generating an equivalent soil profile that will be used for the evaluation of liquefaction risk;

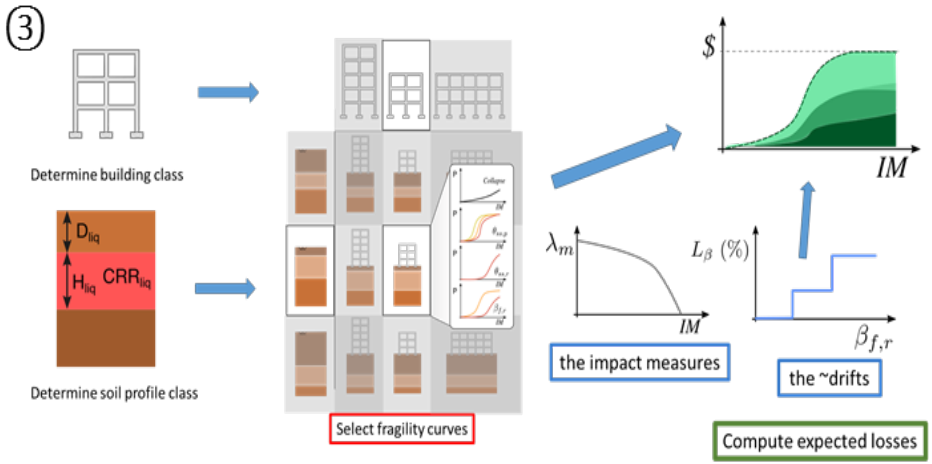
Step 2 uses of liquefaction soil profile criteria to identify the characteristics of the equivalent soil profile considering parameters of soil strength, thickness of liquefiable layer, depth of the liquefiable layer from the surface.

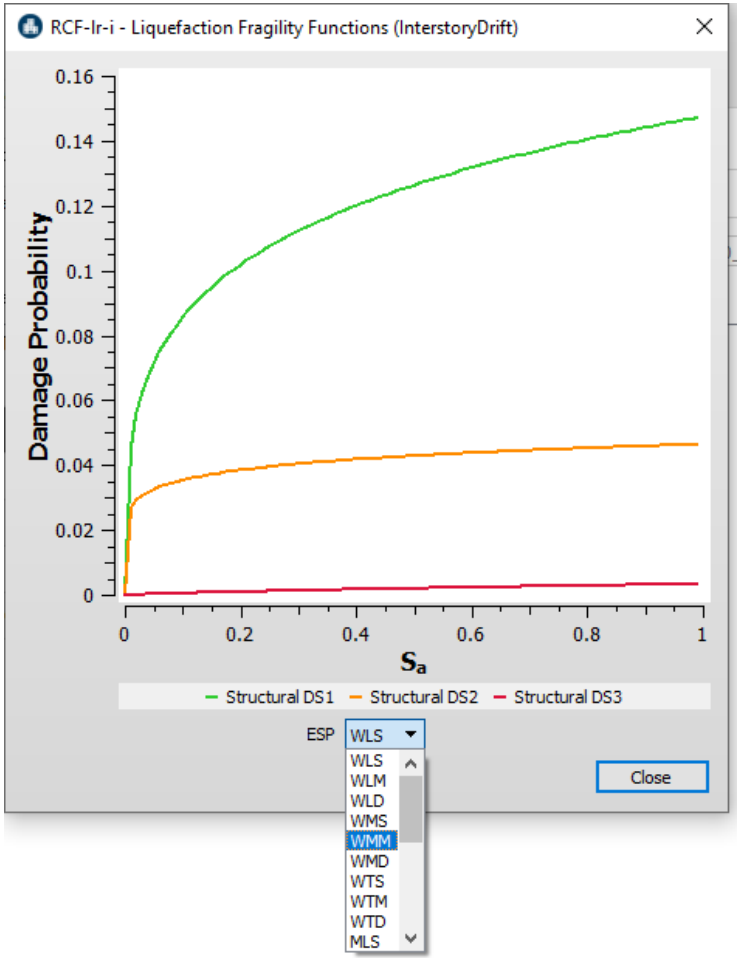


Ref: DELIVERABLE D3.3: Design guidelines for the application of soil characterisation and liquefaction risk assessment protocols (http://www.liquefact.eu)

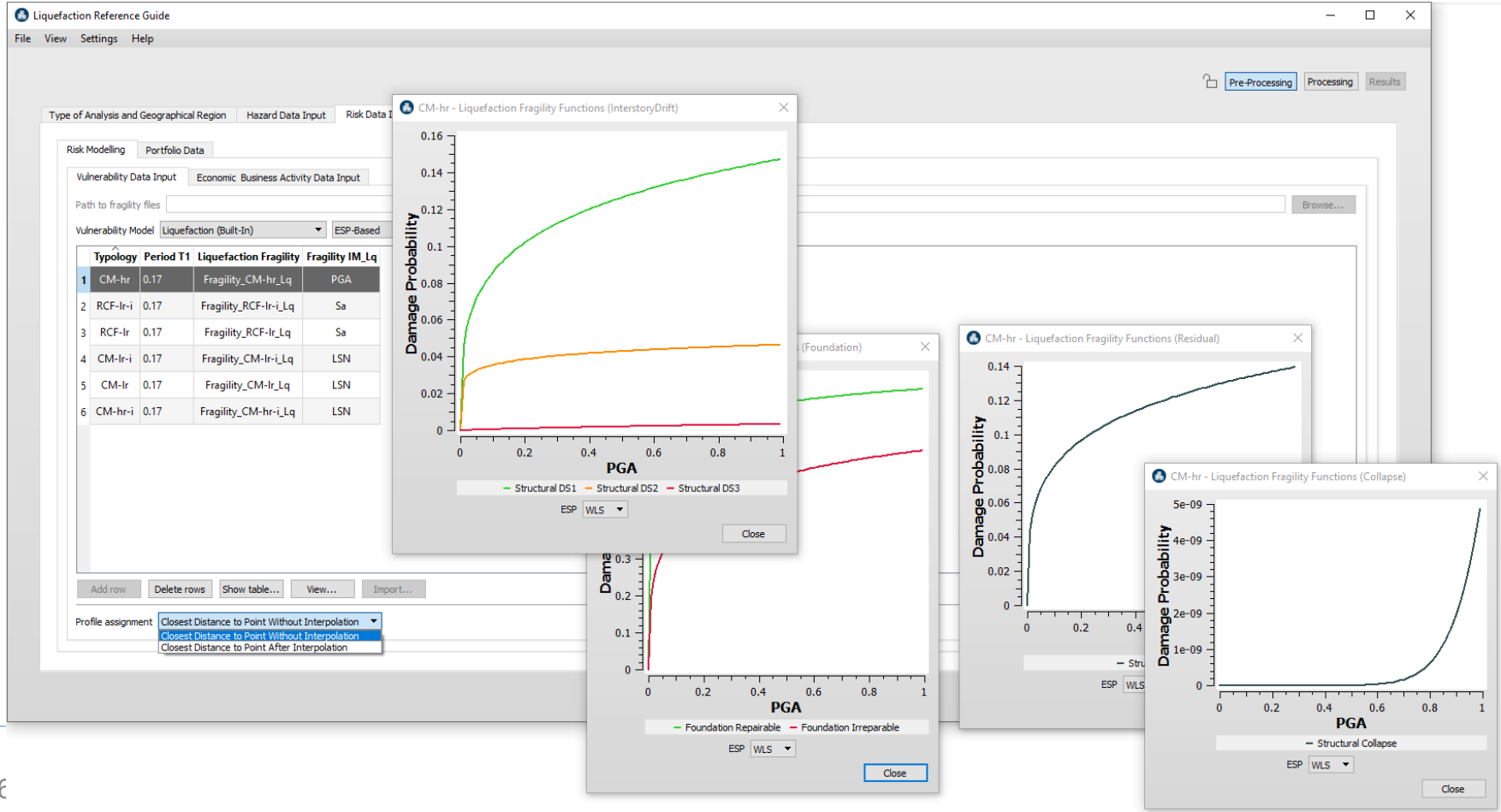
Physical Impact - Equivalent Soil Profile (ESP) method

Combines the selected building or infrastructure in terms of its typology/class with the determined equivalent soil profile class to select the associated fragility curves for the computation of physical impact and the expected losses.

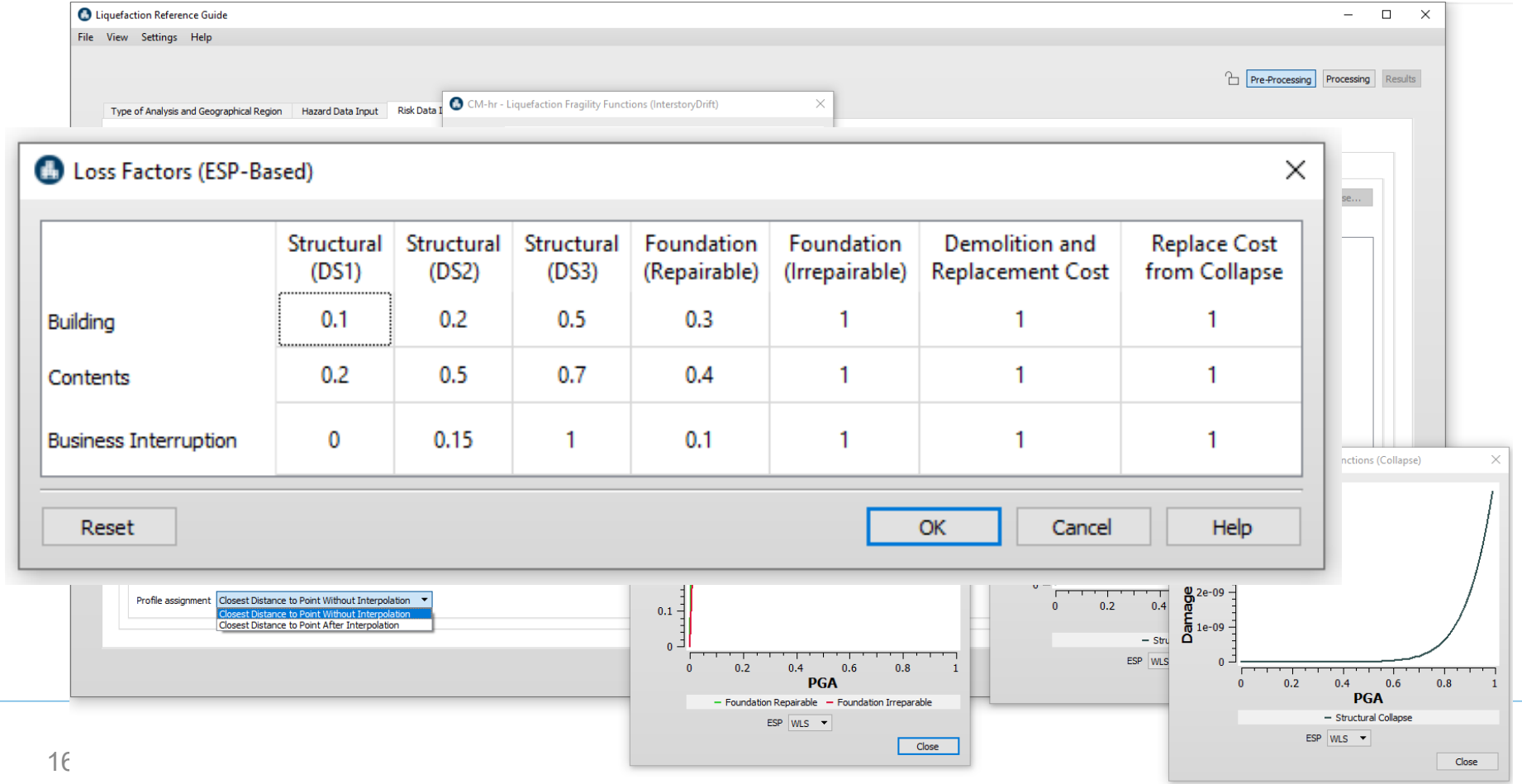




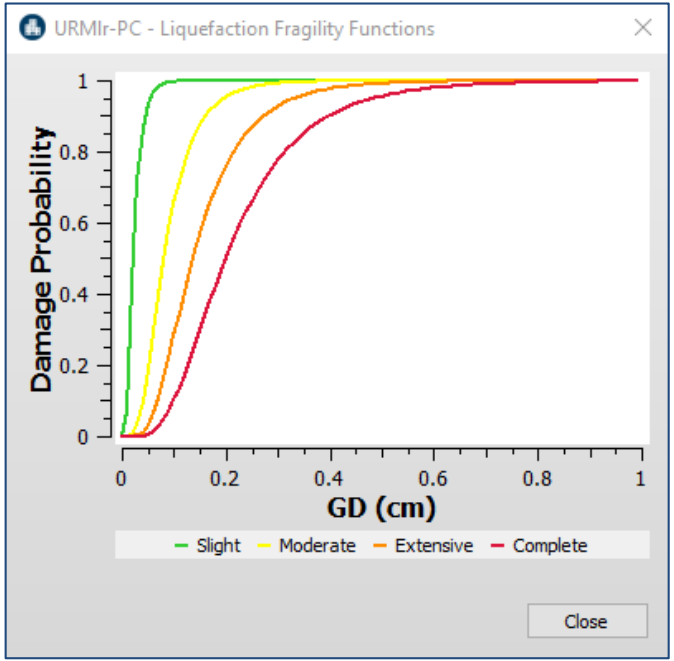
Physical Impact - Equivalent Soil Profile (ESP) method



Physical Impact - Equivalent Soil Profile (ESP) method



Physical Impact - Conventional method



URMIr-PC - Liquefaction Fragility

GD, Slight	beta Slight	GD, Moderate	beta Moderate	GD, Extensive	beta Extensive	GD, Complete	beta Complete
0.0221	0.54	0.0806	0.54	0.1365	0.54	0.1995	0.54

Close

Physical Impact – Limit States

Loss Factors (Conventional 2 State)

	Minor	Complete
Building	0.1	1
Contents	0.2	1
Business Interruption	0	1

Reset | OK | Cancel | Help

Loss Factors (Conventional 3 State)

	Damage Limitation	Significant Damage	Near Collapse
Building	0.1	0.6	1
Contents	0.2	0.7	1
Business Interruption	0	0.5	1

Reset | OK | Cancel | Help

Loss Factors (Conventional 4 State)

	Slight	Moderate	Extensive	Complete
Building	0.08	0.33	1	1
Contents	0.2	0.5	0.85	1
Business Interruption	0	0.15	1	1

Reset | OK | Cancel | Help

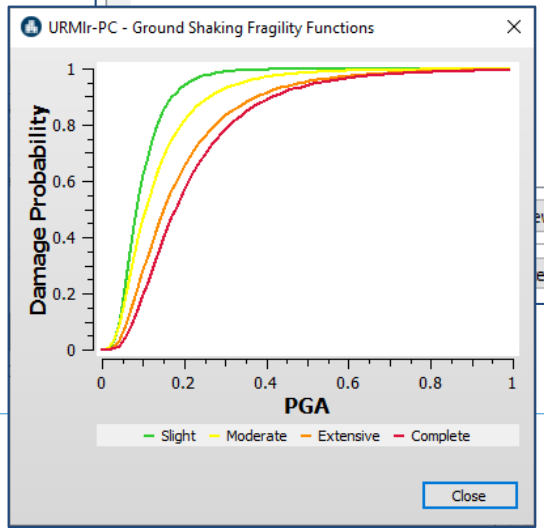
NORSAR

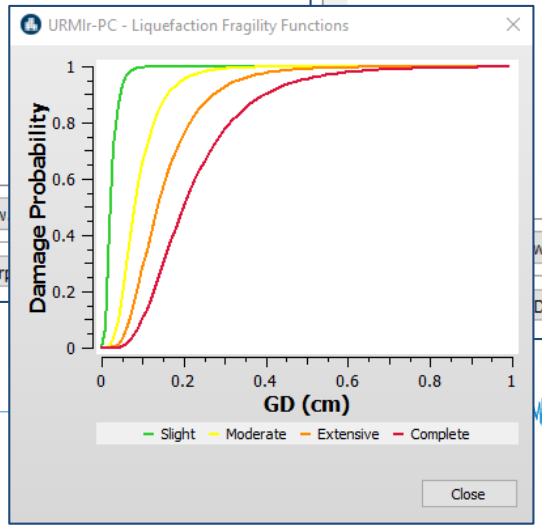
Physical Impact – Liquefaction and Ground Shaking

Risk assessment due to liquefaction

Vulnerability Model: Liquefaction | Conventional

	Typology	Period T1	Liquefaction Fragility	Fragility IM_Lq
1	RCFlr-LC	0.16	LQF_RCFlr-LC	GD
2	RCFmr-LC	0.32	LQF_RCFmr-LC	GD
3	RCFhr-LC	0.46	LQF_RCFhr-LC	GD
4	URMlr-PC	0.10	LQF_URMlr-PC	GD
5	URMmr-PC	0.25	LQF_URMmr-PC	GD





Risk assessment due to liquefaction and ground shaking

Vulnerability Model: Ground Shaking and Liquefaction | Conventional

	Typology	Period T1	Ground Shaking Fragility	Fragility IM_GS	Liquefaction Fragility	Fragility IM_Lq
1	RCFlr-LC	0.16	GSF_RCFlr-LC	PGA	LQF_RCFlr-LC	GD
2	RCFmr-LC	0.32	GSF_RCFmr-LC	PGA	LQF_RCFmr-LC	GD
3	RCFhr-LC	0.46	GSF_RCFhr-LC	PGA	LQF_RCFhr-LC	GD
4	URMlr-PC	0.10	GSF_URMlr-PC	PGA	LQF_URMlr-PC	GD
5	URMmr-PC	0.25	GSF_URMmr-PC	PGA	LQF_URMmr-PC	GD

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Distance to Point Without Interpolation

NORSAR

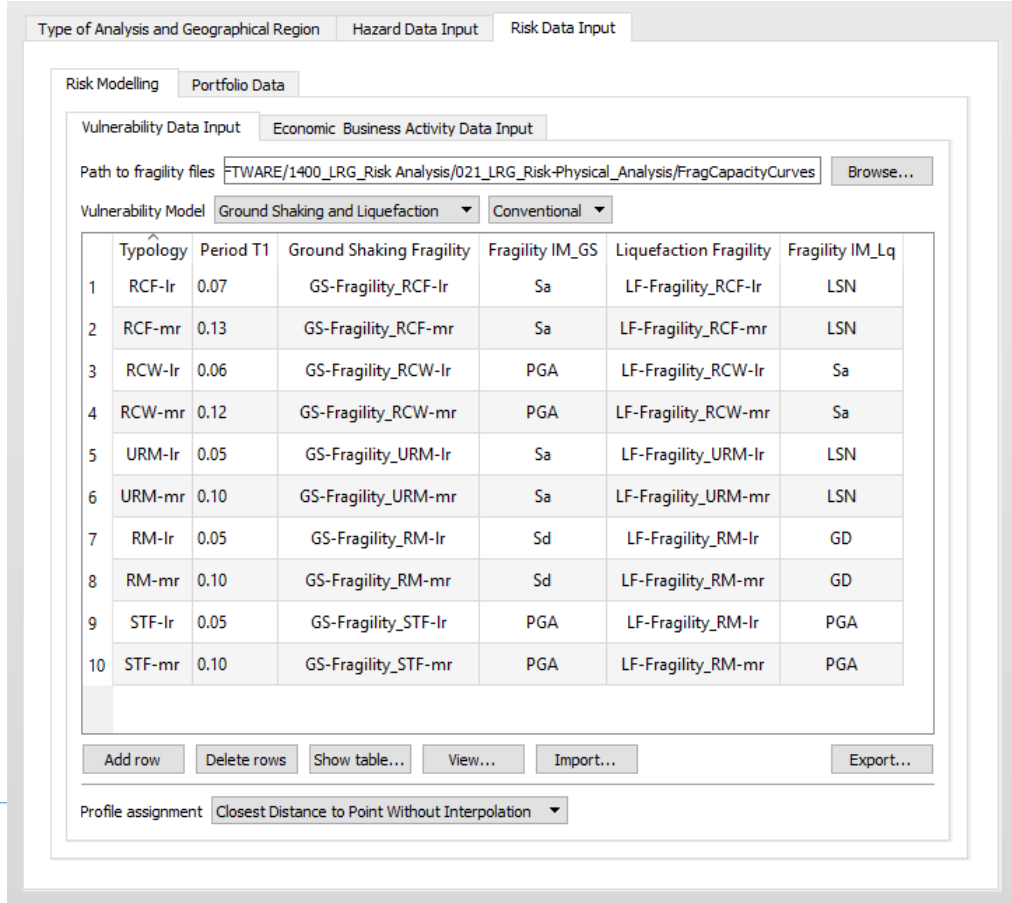
Physical Impact – Intensity Measures

IM for Liquefaction Fragility Curves

- PGA
- LSN
- LPI
- GD -Settlement

IM for Ground Shaking Fragility Curves

- PGA
- Sa
- Sd



	Typology	Period T1	Ground Shaking Fragility	Fragility IM_GS	Liquefaction Fragility	Fragility IM_Lq
1	RCF-lr	0.07	GS-Fragility_RCF-lr	Sa	LF-Fragility_RCF-lr	LSN
2	RCF-mr	0.13	GS-Fragility_RCF-mr	Sa	LF-Fragility_RCF-mr	LSN
3	RCW-lr	0.06	GS-Fragility_RCW-lr	PGA	LF-Fragility_RCW-lr	Sa
4	RCW-mr	0.12	GS-Fragility_RCW-mr	PGA	LF-Fragility_RCW-mr	Sa
5	URM-lr	0.05	GS-Fragility_URM-lr	Sa	LF-Fragility_URM-lr	LSN
6	URM-mr	0.10	GS-Fragility_URM-mr	Sa	LF-Fragility_URM-mr	LSN
7	RM-lr	0.05	GS-Fragility_RM-lr	Sd	LF-Fragility_RM-lr	GD
8	RM-mr	0.10	GS-Fragility_RM-mr	Sd	LF-Fragility_RM-mr	GD
9	STF-lr	0.05	GS-Fragility_STF-lr	PGA	LF-Fragility_RM-lr	PGA
10	STF-mr	0.10	GS-Fragility_STF-mr	PGA	LF-Fragility_RM-mr	PGA

Physical Impact – Portfolio

Type of Analysis and Geographical Region | Hazard Data Input | Risk Data Input

Risk Modelling | Portfolio Data

ALL | LOCATION | STRUCTURE

	Risk Identification	Latitude	Longitude	Street	District	Municipal	City	Region	Postal Code	Geo-code	Typology	Use	Width (m)	Length (m)	Height (m)	Stories Above Ground	Stories Below Ground	Shape
1	B019	44.803789	11.410564				Bologna	Emilia-Romagna	40100	1	URMIr-PC	Health System	7.00	5.00	2.80	1	0	✓
2	B020	44.804494	11.410094				Bologna	Emilia-Romagna	40100	1	URMIr-PC	Health System	9.00	12.00	5.60	2	0	✓
3	B021	44.804180	11.410419				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	8.00	10.00	2.80	1	0	✓
4	B022	44.804892	11.411208				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	20.00	10.00	8.40	3	0	✓
5	B023	44.804677	11.411108				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	15.00	20.00	8.40	3	0	✓
6	B024	44.804846	11.410874				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	18.00	10.00	5.60	2	0	✓
7	B025	44.804519	11.411434				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	8.00	15.00	8.40	3	0	✓
8	B026	44.804201	11.411934				Bologna	Emilia-Romagna	40100	1	URMIr-PC	Health System	20.00	10.00	5.60	2	0	✓
9	B027	44.804042	11.411598				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	20.00	15.00	2.80	1	0	✓
10	B028	44.803901	11.408807				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	15.00	10.00	5.60	2	0	✓
11	B029	44.803652	11.409595				Bologna	Emilia-Romagna	40100	1	URMIr-PC	Health System	5.00	8.00	2.80	1	0	✓
12	B030	44.803551	11.409127				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	7.00	4.00	8.40	3	0	✓
13	B031	44.803232	11.409781				Bologna	Emilia-Romagna	40100	1	RCFIr-LC	Health System	20.00	10.00	8.40	3	0	✓

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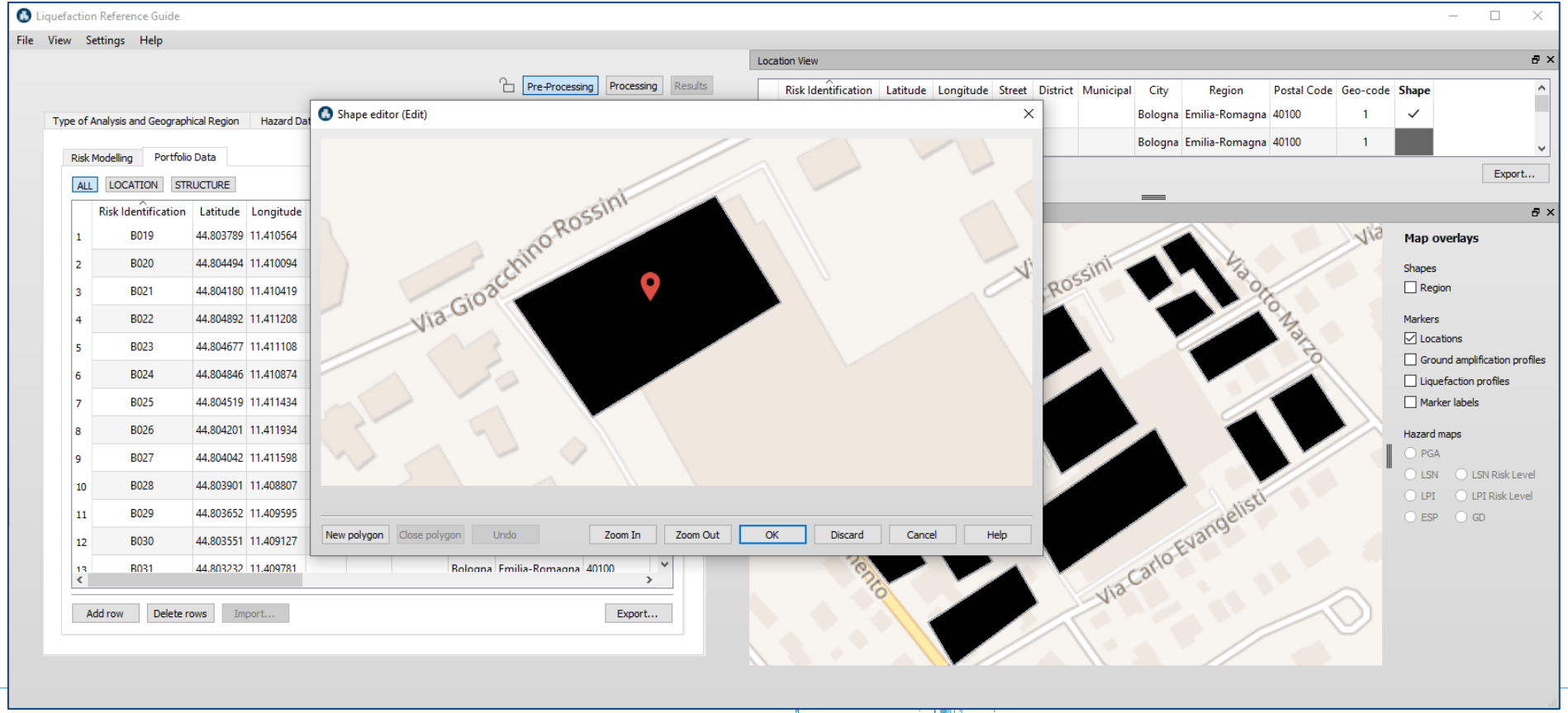
Physical Impact – Portfolio in GIS platform



Economic Model – Owner

Vulnerability Data Input | Economic Business Activity Data Input

ALL | ECONOMICAL MODEL | POLICY | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Monetary Values of Building	Monetary Values of Contents	Business Revenue Building	Time Horizon
5	B023	109 240.00	10 924.00	109.24	23
6	B024	162 900.00	6 516.00	162.90	20
7	B025	428 100.00	85 620.00	428.10	15
8	B026	160 750.00	6 430.00	160.75	35
9	B027	271 050.00	54 210.00	271.05	40
10	B028	327 100.00	13 084.00	327.10	42
11	B029	132 700.00	5 308.00	132.70	43
12	B030	506 250.00	21 250.00	106.25	46
13	B031	162 800.00	32 560.00	162.80	15
14	B032	107 700.00	21 540.00	107.70	35
15	B033	327 100.00	65 420.00	327.10	40

NORSAR

Economic Model – Insurance data

Vulnerability Data Input | Economic Business Activity Data Input

ALL | ECONOMICAL MODEL | POLICY | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Insured Amount (Building)	Facultative Reinsurance (Building)	Coinsurance (Building)	CEDED Reinsurance (Building)
5	B023	5 462.00	0.15	0.00	0.98
6	B024	3 258.00	0.15	0.00	0.98
7	B025	8 562.00	0.15	0.00	0.98
8	B026	3 215.00	0.15	0.00	0.98
9	B027	5 421.00	0.15	0.00	0.98
10	B028	6 542.00	0.15	0.00	0.98
11	B029	2 654.00	0.15	0.00	0.98
12	B030	2 125.00	0.15	0.00	0.98
13	B031	3 256.00	0.15	0.00	0.98
14	B032	2 154.00	0.15	0.00	0.98
15	B033	6 542.00	0.15	0.00	0.98

Economic Model – Insurance data

Vulnerability Data Input | Economic Business Activity Data Input

ALL | ECONOMICAL MODEL | POLICY | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Insured Amount (Contents)	Facultative Reinsurance (Contents)	Coinsurance (Contents)	CEDED Reinsurance (Contents)
5	B023	1 092.40	0.17	0.00	0.36
6	B024	651.60	0.17	0.00	0.32
7	B025	1 712.40	0.17	0.00	0.30
8	B026	643.00	0.17	0.00	0.30
9	B027	1 084.20	0.17	0.00	0.22
10	B028	1 308.40	0.17	0.00	0.20
11	B029	530.80	0.17	0.00	0.88
12	B030	425.00	0.17	0.00	0.68
13	B031	651.20	0.17	0.00	0.54
14	B032	430.80	0.17	0.00	0.50
15	B033	1 308.40	0.17	0.00	0.32

Economic Model – Insurance data

Vulnerability Data Input | Economic Business Activity Data Input

ALL | ECONOMICAL MODEL | POLICY | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Insured Amount (Business Interruption)	Facultative Reinsurance (Business Interruption)	Coinsurance (Business Interruption)	CEDED Reinsurance (Business Interruption)
5	B023	273.10	0.00	0.00	0.84
6	B024	162.90	0.00	0.00	0.84
7	B025	428.10	0.00	0.00	0.84
8	B026	160.75	0.00	0.00	0.84
9	B027	271.05	0.00	0.00	0.85
10	B028	327.10	0.00	0.00	0.85
11	B029	132.70	0.00	0.00	0.85
12	B030	106.25	0.00	0.00	0.85
13	B031	162.80	0.00	0.00	0.85
14	B032	107.70	0.00	0.00	0.85
15	B033	327.10	0.00	0.00	0.86

Risk Analysis Output – Owner Loss at Individual Level

- Resulted from liquefaction
- Building Loss

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Owner Loss | Risk Identification

ALL | BUILDING | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Building)	Monetary Values (Building)	Loss (Building)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	109 240.00	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162 900.00	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	428 100.00	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	160 750.00	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	271 050.00	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	327 100.00	327 099.99
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	132 700.00	132 700.00
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	506 250.00	506 249.99
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162 800.00	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	107 700.00	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	327 100.00	0.00

Export...

Risk Analysis Output – Owner Loss at Individual Level

- Resulted from liquefaction
- Contents Loss

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Owner Loss | Risk Identification

ALL | BUILDING | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Contents)	Monetary Values (Contents)	Loss (Contents)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	10 924.00	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	6 516.00	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	85 620.00	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	6 430.00	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	54 210.00	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	13 084.00	13 084.00
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	5 308.00	5 308.00
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	21 250.00	21 250.00
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	32 560.00	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	21 540.00	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	65 420.00	0.00

Export...

Risk Analysis Output – Owner Loss at Individual Level

- Resulted from liquefaction
- Business Interruption

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Owner Loss | Risk Identification

ALL | BUILDING | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Interruption)	Business Revenue	Loss (Interruption)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	109.24	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162.90	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	428.10	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	160.75	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	271.05	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	327.10	327.10
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	132.70	132.70
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	106.25	106.25
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162.80	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	107.70	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	327.10	0.00

Export...

Risk Analysis Output – Owner Loss at Geo-code Level

- Resulted from liquefaction

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Owner Loss | Geo-code

	Geo-code	Latitude	Longitude	Mean Loss Ratio (Buildings)	Monetary Values (Buildings)	Loss (Buildings)	Mean Loss Ratio (Contents)	Monetary Values (Contents)	Loss (Contents)	Mean Loss Ratio (Businesses)	Business Revenues	Loss (Businesses)	Total Loss
1	1	44.804153	11.410370	0.200000	4 259 630.00	851 925.99	0.200000	1 173 302.00	234 660.37	0.200000	3 859.63	771.93	1 087 358.28

Risk Analysis Output – Insurance Loss at Individual Level

- Resulted from liquefaction
- Building Loss

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Insurance Loss | Risk Identification

ALL | BUILDING | CONTENTS | BUSINESS INTERRUPTION

	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Building)	Insured Amount (Building)	Retained Loss (Building)	Facultative Loss (Building)	Coinsurance Loss (Building)	CEDED Loss (Building)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	5 462.00	0.00	0.00	0.00	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	3 258.00	0.00	0.00	0.00	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	8 562.00	0.00	0.00	0.00	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	3 215.00	0.00	0.00	0.00	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	5 421.00	0.00	0.00	0.00	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	6 542.00	0.00	145.23	0.00	6 396.77
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	2 654.00	0.00	58.92	0.00	2 595.08
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	2 125.00	0.00	47.17	0.00	2 077.82
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	3 256.00	0.00	0.00	0.00	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	2 154.00	0.00	0.00	0.00	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	6 542.00	0.00	0.00	0.00	0.00

Export...

Risk Analysis Output – Insurance Loss at Individual Level

- Resulted from liquefaction
- Contents Loss

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Insurance Loss | Risk Identification

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	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Contents)	Insured Amount (Contents)	Retained Loss (Contents)	Facultative Loss (Contents)	Coinsurance Loss (Contents)	CEDED Loss (Contents)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	1 092.40	0.00	0.00	0.00	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	651.60	0.00	0.00	0.00	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	1 712.40	0.00	0.00	0.00	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	643.00	0.00	0.00	0.00	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	1 084.20	0.00	0.00	0.00	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	1 308.40	830.91	220.20	0.00	257.28
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	530.80	0.00	62.38	0.00	468.42
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	425.00	65.82	71.53	0.00	287.65
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	651.20	0.00	0.00	0.00	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	430.80	0.00	0.00	0.00	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	1 308.40	0.00	0.00	0.00	0.00

Export...

Risk Analysis Output – Insurance Loss at Individual Level

- Resulted from liquefaction
- Business Interruption

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Insurance Loss | Risk Identification

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	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Interruption)	Insured Amount (Interruption)	Retained Loss (Interruption)	Facultative Loss (Interruption)	Coinsurance Loss (Interruption)	CEDED Loss (Interruption)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	273.10	0.00	0.00	0.00	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162.90	0.00	0.00	0.00	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	428.10	0.00	0.00	0.00	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	160.75	0.00	0.00	0.00	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	271.05	0.00	0.00	0.00	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	327.10	48.28	0.00	0.00	278.82
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	132.70	19.49	0.00	0.00	113.21
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	106.25	15.46	0.00	0.00	90.79
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162.80	0.00	0.00	0.00	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	107.70	0.00	0.00	0.00	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	327.10	0.00	0.00	0.00	0.00

Export...

Risk Analysis Output – Insurance Loss at Geo-code Level

- Resulted from liquefaction

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Insurance Loss ▾ | Geo-code ▾

	Geo-code	Latitude	Longitude	Mean Loss Ratio (Buildings)	Insured Amount (Buildings)	Retained Loss (Buildings)	Facultative Loss (Buildings)	Coinsurance Loss (Buildings)	CEDED Loss (Buildings)	Mean Loss Ratio (Contents)	Insured Amount (Contents)	Retained Loss (Contents)
1	1	44.804153	11.410370	0.200000	134 235.00	0.00	596.00	0.00	26 251.00	0.200000	6 711.75	579.17

Facultative Loss (Contents)	Coinsurance Loss (Contents)	CEDED Loss (Contents)	Mean Loss Ratio (Businesses)	Insured Amount (Interruption)	Retained Loss (Interruption)	Facultative Loss (Interruption)	Coinsurance Loss (Interruption)	CEDED Loss (Interruption)	Total Loss
220.74	0.00	542.43	0.200000	6 711.75	212.36	0.00	0.00	1 129.99	29 531.70

Risk Analysis Output – Owner Loss at Individual Level

- Resulted from ground shaking (without liquefaction)
- Building Loss

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Owner Loss | Risk Identification

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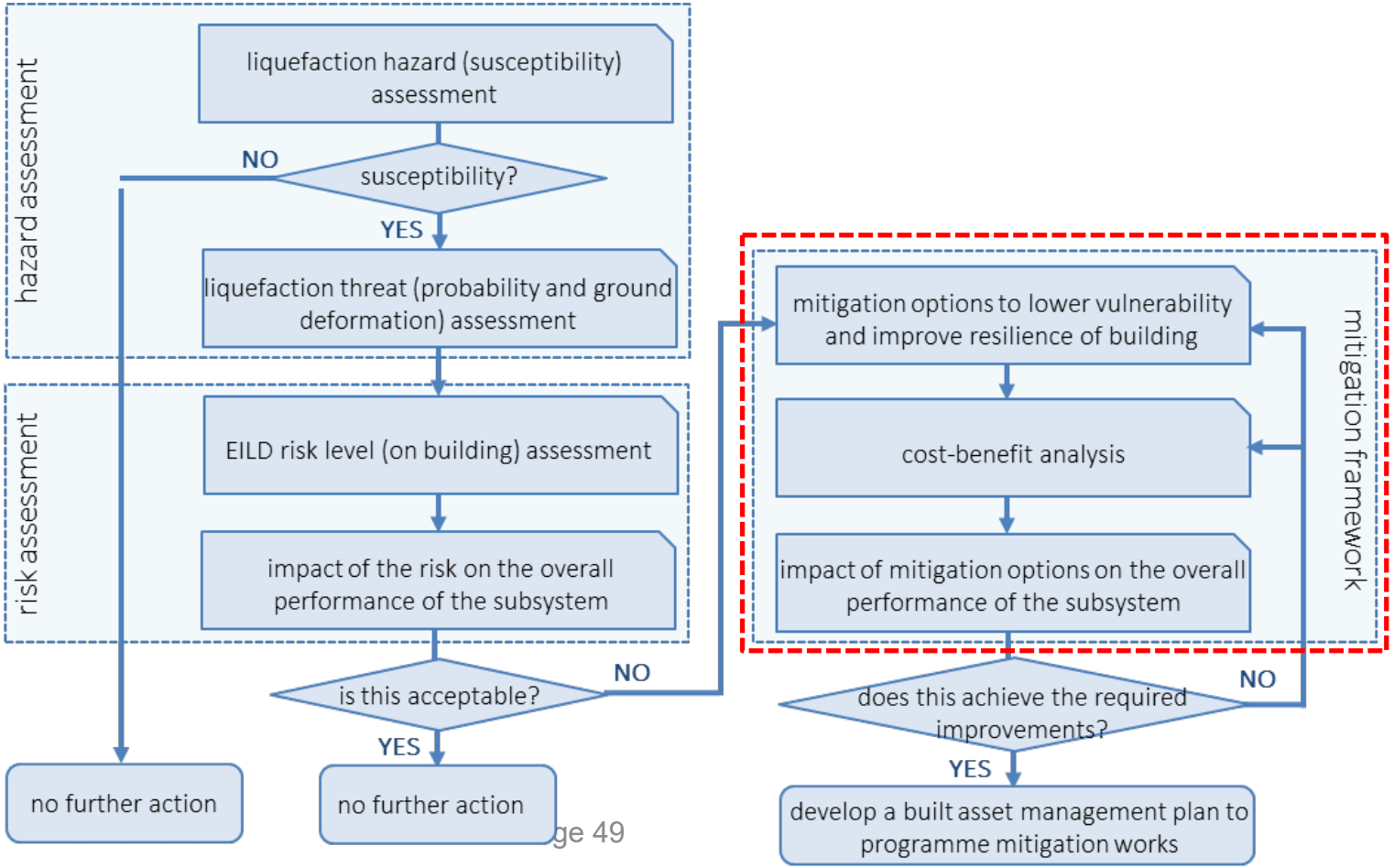
	Risk Identification	Latitude	Longitude	Geo-code	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Building)	Monetary Values (Building)	Loss (Building)	Mean Loss Ratio (Contents)	Monetary Values (Contents)	Loss (Contents)	Mean Loss Ratio (Interruption)	Business Revenue	Loss (Interruption)	Total Loss
5	B023	44.804700	11.411100	1	0.365638	0.194737	0.002946	0.204310	0.300770	109 240.00	32 856.15	0.377310	10 924.00	4 121.74	0.236467	109.24	25.83	37 003.72
6	B024	44.804800	11.410900	1	0.365638	0.194737	0.002946	0.204310	0.300770	162 900.00	48 995.48	0.377310	6 516.00	2 458.55	0.236467	162.90	38.52	51 492.56
7	B025	44.804500	11.411400	1	0.365638	0.194737	0.002946	0.204310	0.300770	428 100.00	128 759.77	0.377310	85 620.00	32 305.31	0.236467	428.10	101.23	161 166.31
8	B026	44.804200	11.411900	1	0.166542	0.192891	0.095171	0.242463	0.414611	160 750.00	66 648.76	0.453112	6 430.00	2 913.51	0.366568	160.75	58.93	69 621.19
9	B027	44.804000	11.411600	1	0.365638	0.194737	0.002946	0.204310	0.300770	271 050.00	81 523.79	0.377310	54 210.00	20 453.99	0.236467	271.05	64.09	102 041.88
10	B028	44.803900	11.408800	1	0.365638	0.194737	0.002946	0.204310	0.300770	327 100.00	98 381.97	0.377310	13 084.00	4 936.73	0.236467	327.10	77.35	103 396.05
11	B029	44.803700	11.409600	1	0.166542	0.192891	0.095171	0.242463	0.414611	132 700.00	55 018.91	0.453112	5 308.00	2 405.12	0.366568	132.70	48.64	57 472.67
12	B030	44.803600	11.409100	1	0.365638	0.194737	0.002946	0.204310	0.300770	506 250.00	152 264.97	0.377310	21 250.00	8 017.84	0.236467	106.25	25.12	160 307.94
13	B031	44.803200	11.409800	1	0.365638	0.194737	0.002946	0.204310	0.300770	162 800.00	48 965.41	0.377310	32 560.00	12 285.22	0.236467	162.80	38.50	61 289.13
14	B032	44.804200	11.409700	1	0.166542	0.192891	0.095171	0.242463	0.414611	107 700.00	44 653.63	0.453112	21 540.00	9 760.03	0.366568	107.70	39.48	54 453.14
15	B033	44.804100	11.409300	1	0.166542	0.192891	0.095171	0.242463	0.414611	327 100.00	135 619.34	0.453112	65 420.00	29 642.59	0.366568	327.10	119.90	165 381.83

Export...

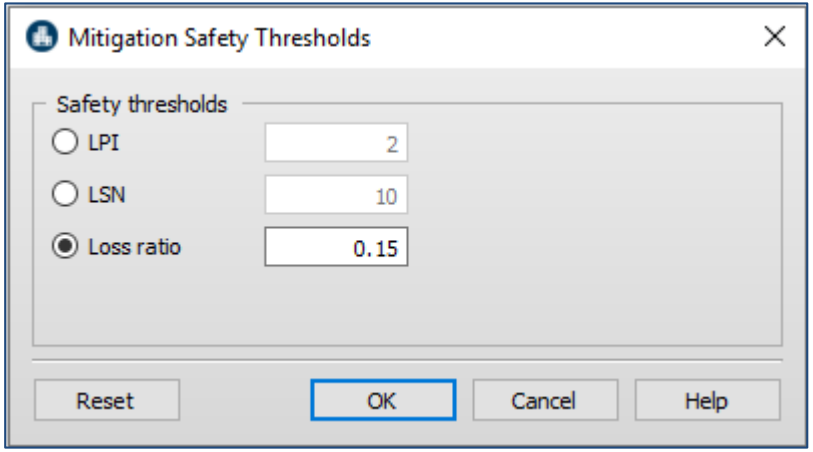
Mitigation Framework



Mitigation Framework

- Existing Structure or New Construction (Free Field)
- Mitigation Thresholds
- Mitigation Cost and Expected Benefit (in terms of reducing liquefaction risk)

Mitigation Safety Thresholds / Mitigation Cost and Expected Mitigation Solution Level



Mitigation Cost and Benefit

G.I. TECNOLOGY	Mitigation cost / m^3	Expected Mitigation Solution Level (%)
EARTHQUAKE DRAINS	100	80
DEEP DYNAMIC COMPACTION	100	60
VIBRO COMPACTION	100	40
BLASTING COMPACTION	100	50
VIBRO REPLACEMENT	100	55
INDUCED PARTIAL SATURATION	100	45
COMPACTION GROUTING	100	70
LOW PRESSURE GROUTING	100	65
JET GROUTING	100	75
DEEP SOIL MIXING	100	60

Constant discount rate (%) 3

Reset OK Cancel Help

Set Mitigation Parameters

Selected building for mitigation investigation based on pre-defined mitigation thresholds

Set mitigation parameters

Applicationable to Existing Buildings/Infrastructure

	Risk Identification	Soil Type	Stratigraphy	Depth of treatment zone	Size of Area	Foundation Type	Project Constraints	Subsurface Obstructions	Environmental Compatibility
1	B028	Gravel soils	Soil crust	<3 m	Small (<1000 m2)	Shallow foundations	Low overhead clearance	No	Yes
2	B029	Gravel soils	Soil crust	<3 m	Small (<1000 m2)	Shallow foundations	Low overhead clearance	No	Yes
3	B030	Gravel soils	Soil crust	<3 m	Small (<1000 m2)	Shallow foundations	Low overhead clearance	No	Yes

OK Cancel Help

Set Mitigation Parameters

Selected building for mitigation investigation based on pre-defined mitigation thresholds

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Seismic Ground Shaking | Ground Liquefaction

Owner Loss | Risk Identification

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	Risk Identification	Latitude	Longitude	Geo-code	LPI	Settlement (cm)	LSN	LSN (ESP)	ESP	Liquefaction Risk Level (LPI-Based)	Liquefaction Risk Level (LSN-Based)	Probability (Slite)	Probability (Moderate)	Probability (Extensive)	Probability (Complete)	Mean Loss Ratio (Building)	Monetary Values (Building)	Loss (Building)
5	B023	44.804700	11.411100	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	109 240.00	0.00
6	B024	44.804800	11.410900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162 900.00	0.00
7	B025	44.804500	11.411400	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	428 100.00	0.00
8	B026	44.804200	11.411900	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	160 750.00	0.00
9	B027	44.804000	11.411600	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	271 050.00	0.00
10	B028	44.803900	11.408800	1	9.7548	3.7707	7.1690	60.4450	WLS	High	Low	0.000000	0.000000	0.000002	0.999998	1.000000	327 100.00	327 099.99
11	B029	44.803700	11.409600	1	13.4352	5.1838	11.1685	80.6003	WMS	High	Moderate	0.000000	0.000000	0.000000	1.000000	1.000000	132 700.00	132 700.00
12	B030	44.803600	11.409100	1	8.6068	3.9682	4.0382	129.5341	WLD	High	None	0.000000	0.000000	0.000001	0.999999	1.000000	506 250.00	506 249.99
13	B031	44.803200	11.409800	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	162 800.00	0.00
14	B032	44.804200	11.409700	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	107 700.00	0.00
15	B033	44.804100	11.409300	1	0.0000	0.0000	0.0000	0.0000	RXX	None	None	0.000000	0.000000	0.000000	0.000000	0.000000	327 100.00	0.00

Export...

Mitigation Framework

Mitigation techniques applicability score

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Applicationable to Existing Buildings/Infrastructure

ALL | MITIGATION TECHNIQUES APPLICABILITY SCORE | MITIGATION COST | EXPECTED BENEFIT | COST BENEFIT RATIO (CBR)

	Risk Identification	Latitude	Longitude	EARTHQUAKE DRAINS (Score)	DEEP DYNAMIC COMPACTION (Score)	VIBRO COMPACTION (Score)	BLASTING COMPACTION (Score)	VIBRO REPLACEMENT (Score)	INDUCED PARTIAL SATURATION (Score)	COMPACTION GROUTING (Score)	LOW PRESSURE GROUTING (Score)	JET GROUTING (Score)	DEEP SOIL MIXING (Score)	HEIGHEST RANKED G. I. TECHNOLOGY
1	B028	44.803901	11.408807	173	141	192	90	128	236	227	256	209	191	LOW PRESSURE GROUTING
2	B029	44.803652	11.409595	173	141	192	90	128	236	227	256	209	191	LOW PRESSURE GROUTING
3	B030	44.803551	11.409127	173	141	192	90	128	236	227	256	209	191	LOW PRESSURE GROUTING

Mitigation Framework

Mitigation Cost

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Applicationable to Existing Buildings/Infrastructure

ALL | MITIGATION TECHNIQUES APPLICABILITY SCORE | MITIGATION COST | EXPECTED BENEFIT | COST BENEFIT RATIO (CBR)

	Risk Identification	Latitude	Longitude	EARTHQUAKE DRAINS (Mitigaton Cost)	DEEP DYNAMIC COMPACTION (Mitigaton Cost)	VIBRO COMPACTION (Mitigaton Cost)	BLASTING COMPACTION (Mitigaton Cost)	VIBRO REPLACEMENT (Mitigaton Cost)	INDUCED PARTIAL SATURATION (Mitigaton Cost)	COMPACTION GROUTING (Mitigaton Cost)	LOW PRESSURE GROUTING (Mitigaton Cost)	JET GROUTING (Mitigaton Cost)	DEEP SOIL MIXING (Mitigaton Cost)
1	B028	44.803901	11.408807	11 567	11 567	11 567	11 567	11 567	11 567	11 567	11 567	11 567	11 567
2	B029	44.803652	11.409595	4 824	4 824	4 824	4 824	4 824	4 824	4 824	4 824	4 824	4 824
3	B030	44.803551	11.409127	19 639	19 639	19 639	19 639	19 639	19 639	19 639	19 639	19 639	19 639

Mitigation Framework

Expected Benefit

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Applicationable to Existing Buildings/Infrastructure

ALL | MITIGATION TECHNIQUES APPLICABILITY SCORE | MITIGATION COST | EXPECTED BENEFIT | COST BENEFIT RATIO (CBR)

	Risk Identification	Latitude	Longitude	EARTHQUAKE DRAINS (Expected Benefit)	DEEP DYNAMIC COMPACTION (Expected Benefit)	VIBRO COMPACTION (Expected Benefit)	BLASTING COMPACTION (Expected Benefit)	VIBRO REPLACEMENT (Expected Benefit)	INDUCED PARTIAL SATURATION (Expected Benefit)	COMPACTION GROUTING (Expected Benefit)	LOW PRESSURE GROUTING (Expected Benefit)	JET GROUTING (Expected Benefit)	DEEP SOIL MIXING (Expected Benefit)	MAXIMUM BENEFIT
1	B028	44.803901	11.408807	16 604.50	12 453.40	8 302.24	10 377.80	11 415.60	9 340.03	14 528.90	13 491.10	15 566.70	12 453.40	EARTHQUAKE DRAINS
2	B029	44.803652	11.409595	7 255.38	5 441.53	3 627.69	4 534.61	4 988.07	4 081.15	6 348.45	5 894.99	6 801.92	5 441.53	EARTHQUAKE DRAINS
3	B030	44.803551	11.409127	30 268.90	22 701.70	15 134.40	18 918.10	20 809.90	17 026.20	26 485.30	24 593.50	28 377.10	22 701.70	EARTHQUAKE DRAINS

Mitigation Framework

Cost Benefit Ratio (CBR)

Hazard Analysis Output | Risk Analysis Output | Mitigation Analysis Output

Applicationable to Existing Buildings/Infrastructure

ALL | MITIGATION TECHNIQUES APPLICABILITY SCORE | MITIGATION COST | EXPECTED BENEFIT | COST BENEFIT RATIO (CBR)

	Risk Identification	Latitude	Longitude	EARTHQUAKE DRAINS (CBR)	DEEP DYNAMIC COMPACTION (CBR)	VIBRO COMPACTION (CBR)	BLASTING COMPACTION (CBR)	VIBRO REPLACEMENT (CBR)	INDUCED PARTIAL SATURATION (CBR)	COMPACTION GROUTING (CBR)	LOW PRESSURE GROUTING (CBR)	JET GROUTING (CBR)	DEEP SOIL MIXING (CBR)	MINIMUM CBR
1	B028	44.803901	11.408807	0.70	0.93	1.39	1.11	1.01	1.24	0.80	0.86	0.74	0.93	EARTHQUAKE DRAINS
2	B029	44.803652	11.409595	0.66	0.89	1.33	1.06	0.97	1.18	0.76	0.82	0.71	0.89	EARTHQUAKE DRAINS
3	B030	44.803551	11.409127	0.65	0.87	1.30	1.04	0.94	1.15	0.74	0.80	0.69	0.87	EARTHQUAKE DRAINS

Mitigation Framework

Overall result of mitigation and cost-benefit analysis for a selected building

Mitigation Result (B028)

G.I. TECNOLOGY	Score	Mitigation cost	Annual Freguency of Damage (%)	Expected Annual Loss Before Mitigation (EALI)	Expected Annual Loss After Mitigation (EALM)	Expected Loss Avoided (EALI - EALM)	Expected Benefit	Cost-Benefit Ratio
EARTHQUAKE DRAINS	173	11 567	0.072149	245.68	49.14	196.54	16 604.50	0.70
DEEP DYNAMIC COMPACTION	141	11 567	0.072149	245.68	98.27	147.41	12 453.40	0.93
VIBRO COMPACTION	192	11 567	0.072149	245.68	147.41	98.27	8 302.24	1.39
BLASTING COMPACTION	90	11 567	0.072149	245.68	122.84	122.84	10 377.80	1.11
VIBRO REPLACEMENT	128	11 567	0.072149	245.68	110.55	135.12	11 415.60	1.01
INDUCED PARTIAL SATURATION	236	11 567	0.072149	245.68	135.12	110.55	9 340.03	1.24
COMPACTION GROUTING	227	11 567	0.072149	245.68	73.70	171.97	14 528.90	0.80
LOW PRESSURE GROUTING	256	11 567	0.072149	245.68	85.99	159.69	13 491.10	0.86
JET GROUTING	209	11 567	0.072149	245.68	61.42	184.26	15 566.70	0.74
DEEP SOIL MIXING	191	11 567	0.072149	245.68	98.27	147.41	12 453.40	0.93

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