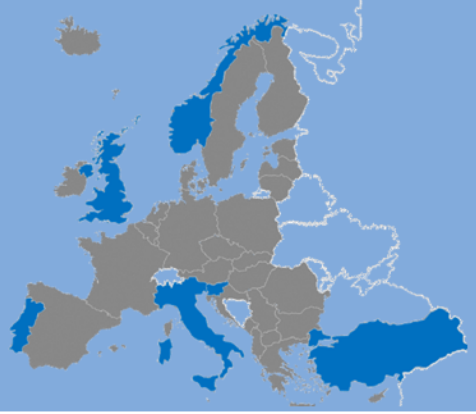
European Commission

Horizon 2020
European Union funding
for Research & Innovation

liquefACT



IL PROGETTO LIQUEFACT IN EMILIA-ROMAGNA

February 17, 2021

ZONAZIONE MULTI-SCALA DEL RISCHIO DI LIQUEFAZIONE SISMO-INDOTTA. MICROZONAZIONE DEL COMUNE DI CAVEZZO (MODENA)

UNIPV-Dicar: Prof. Ing. Carlo G. Lai
EUCENTRE: Ing. Francesca Bozzoni
UNIPV-DSTA: Prof. Claudia Meisina

UNIVERSITÀ DI PAVIA

UNIVERSITY OF PAVIA – EUCENTRE

EUCENTRE
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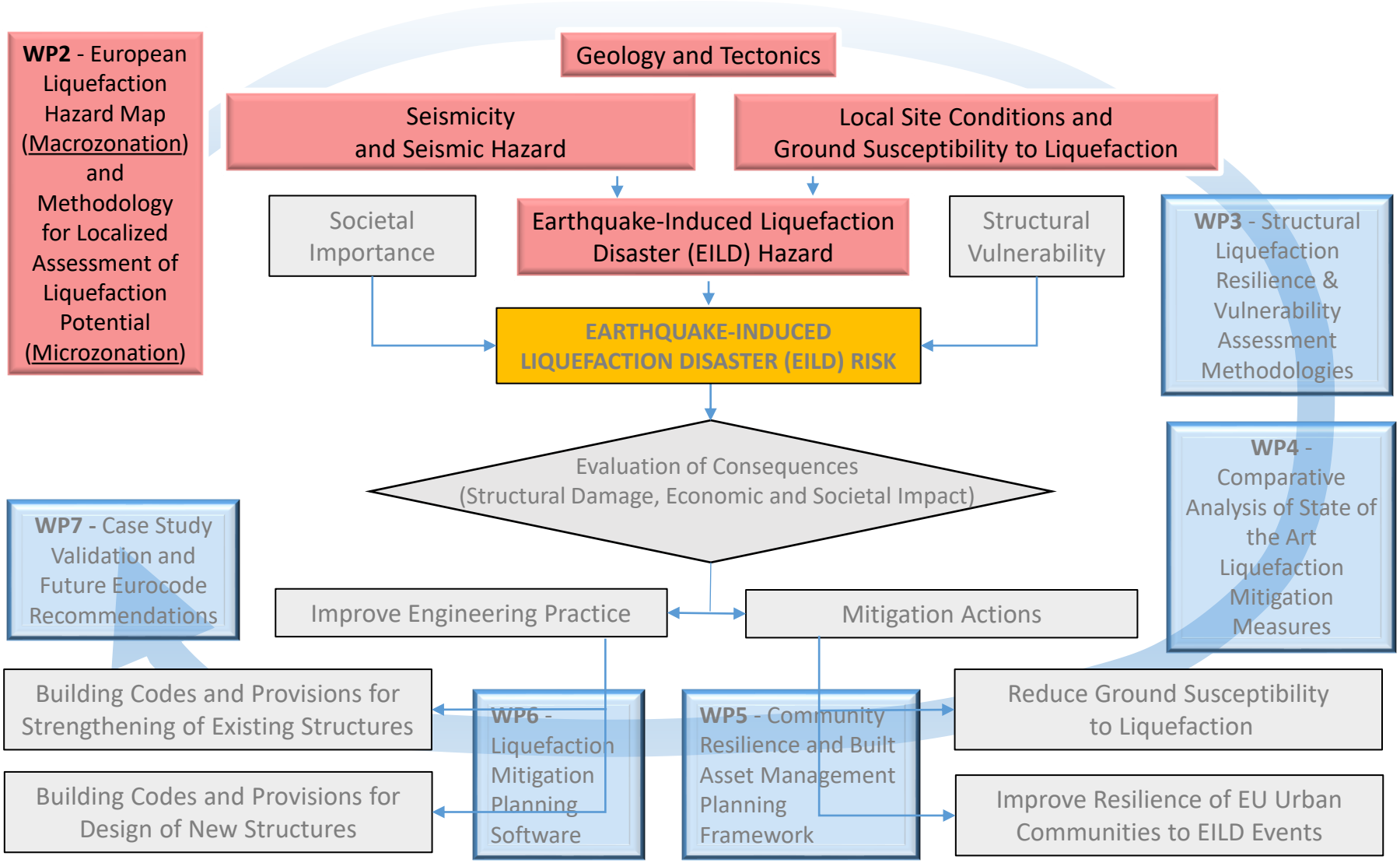
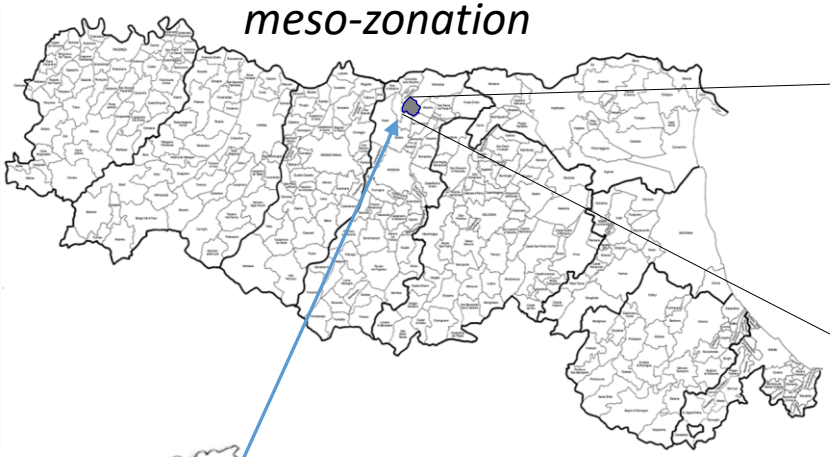
LIQUEFACT Project

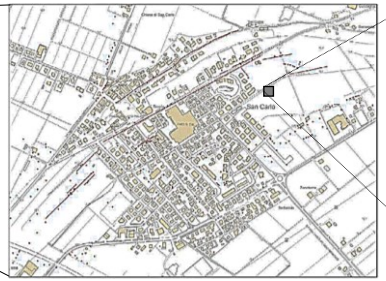


ABOUT SPATIAL SCALES….

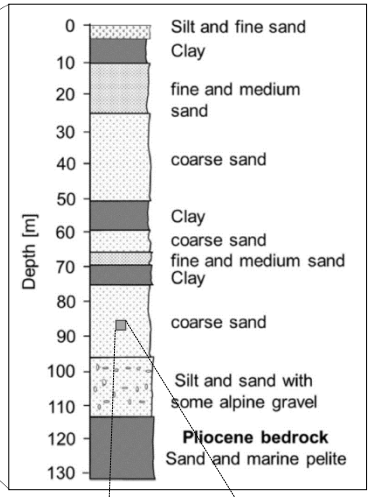
meso-zonation



micro-zonation

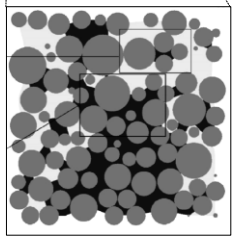


soil profile



macro-zonation

mega-zonation



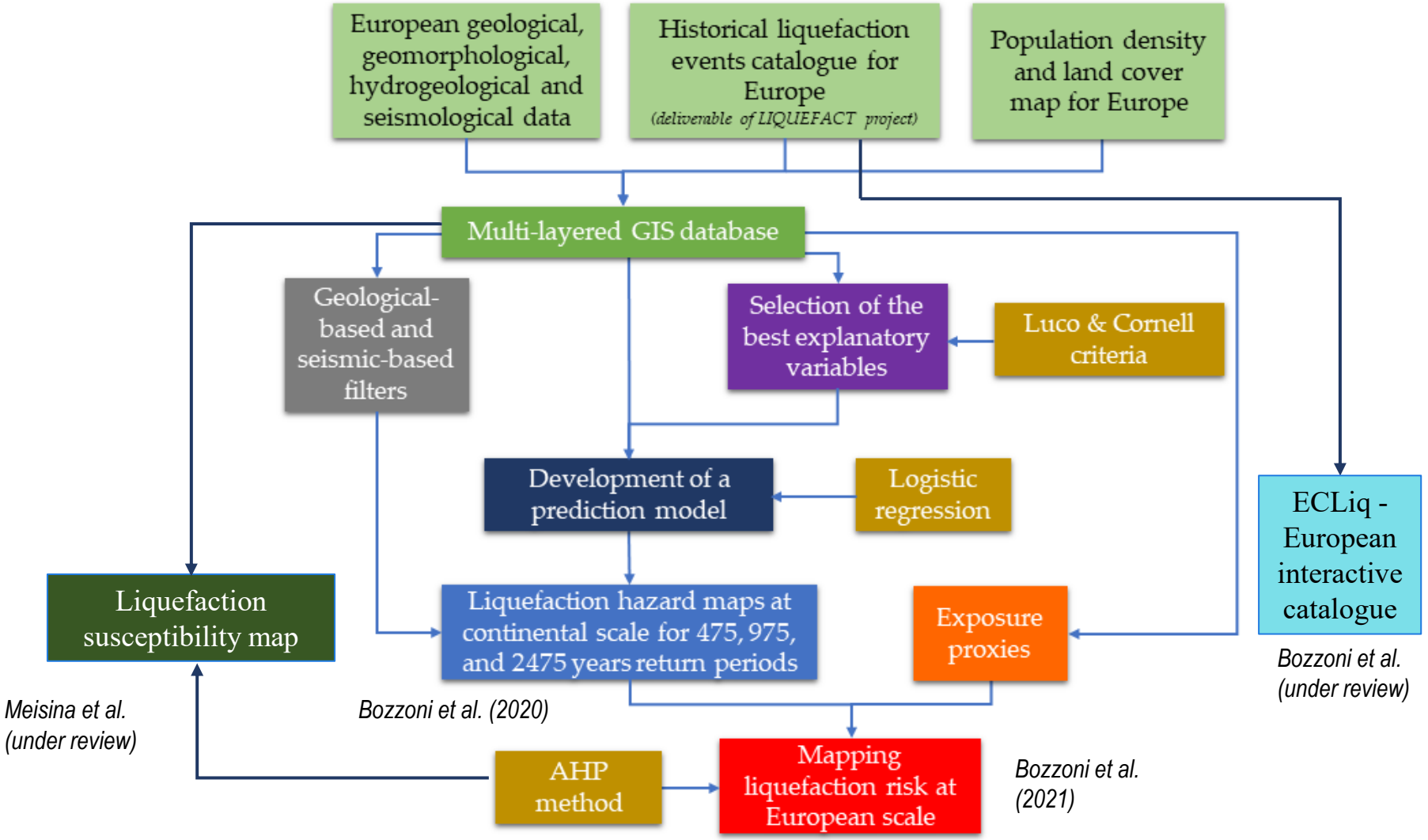
Chareyre et al. (2018)

soil grains

liquefaction

MEGA-ZONATION

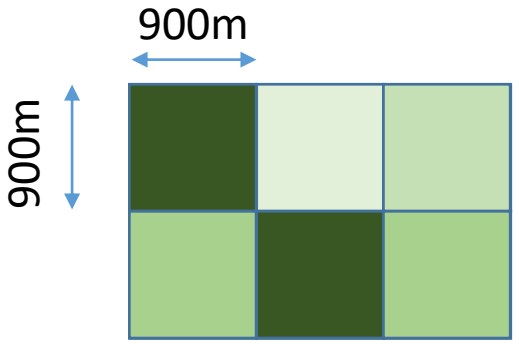
METHODOLOGY OVERVIEW



MEGA-ZONATION

- PGA – Extracted from SHARE project
- PGAm (PGAxMWF)*
- CTI – derived from DEM
- Vs30 – derived from DEM
- River distance - derived from DEM
- Coast distance
- Waterbody distance (i.e. distance from the nearest river/coast/lake)
- TPI (Topographic Position Index) - derived from DEM
- TRI (Terrain Roughness Index) - derived from DEM
- European Soil Database (ESDB) v2.0 **

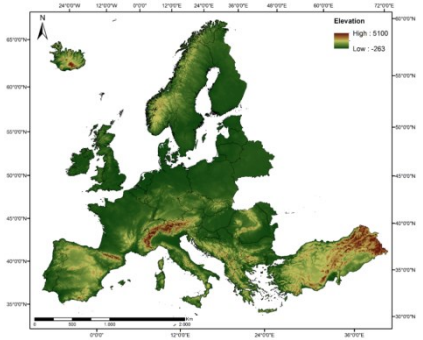
INPUT DATA



**only for susceptibility assessment

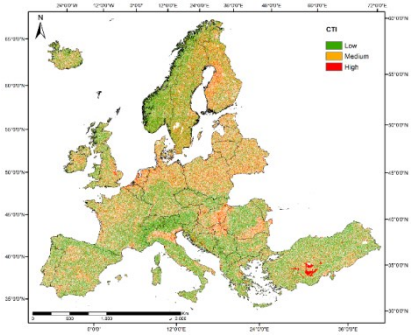
*Magnitude-Weighting Factor: $MWF = {M^{2.56}}/{10^{2.24}}$

DEM

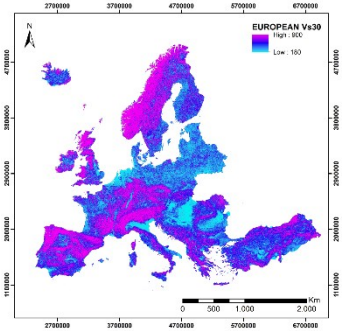


http://srtm.csi.cgiar.org

CTI

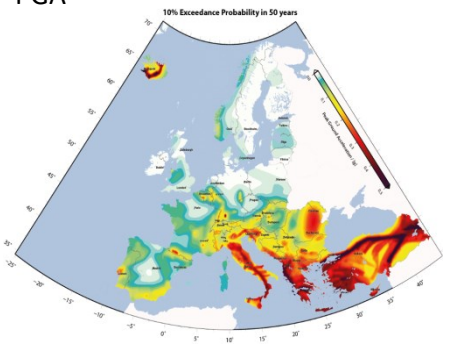


Vs30



https://earthquake.usgs.gov/data/vs30/

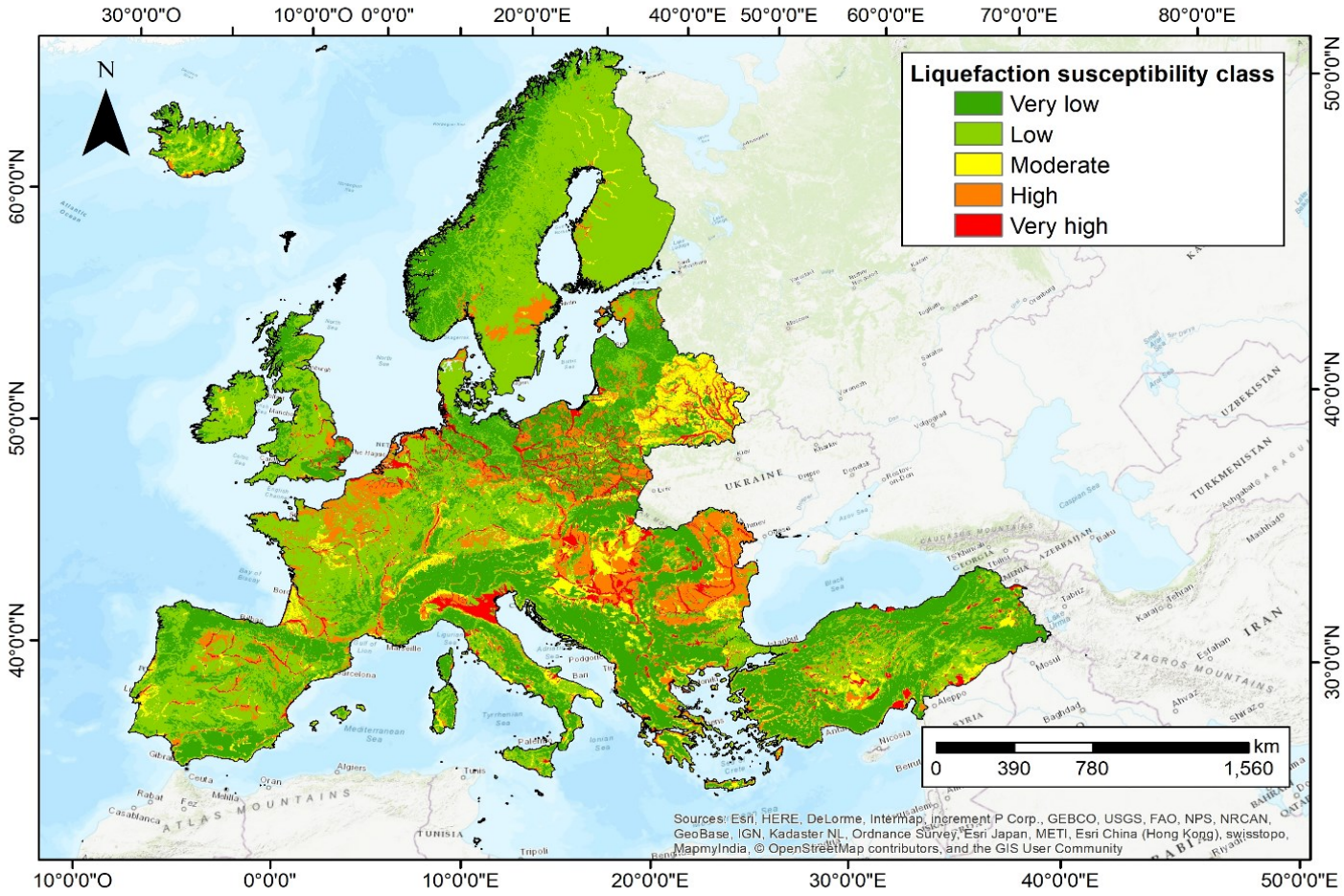
PGA



http://www.efehr.org:8080/jetspeed/portal/HazardMaps.psml

MEGA-ZONATION

SUSCEPTIBILITY MAP

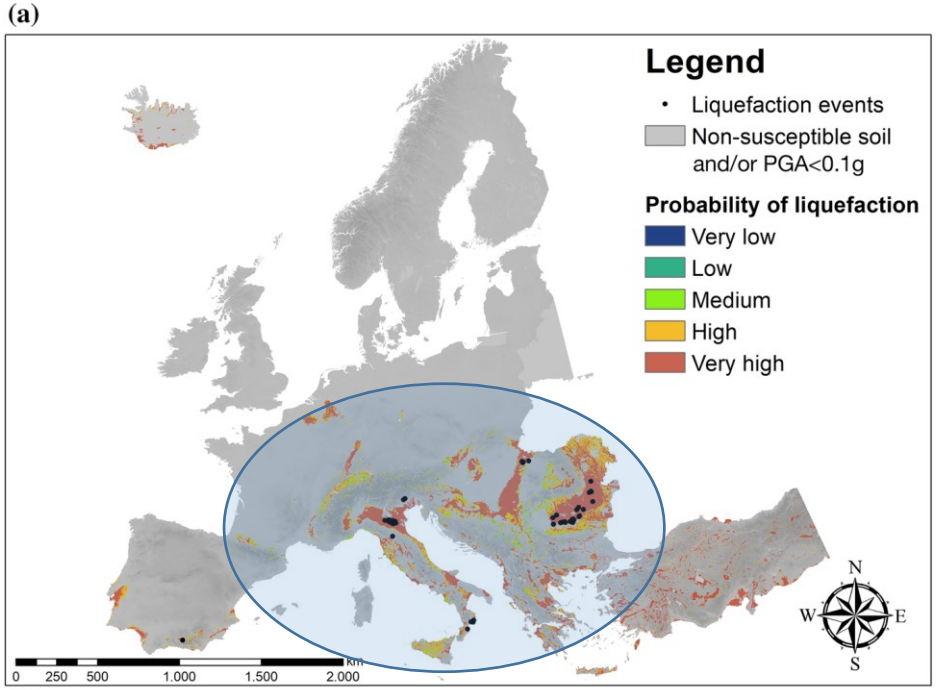


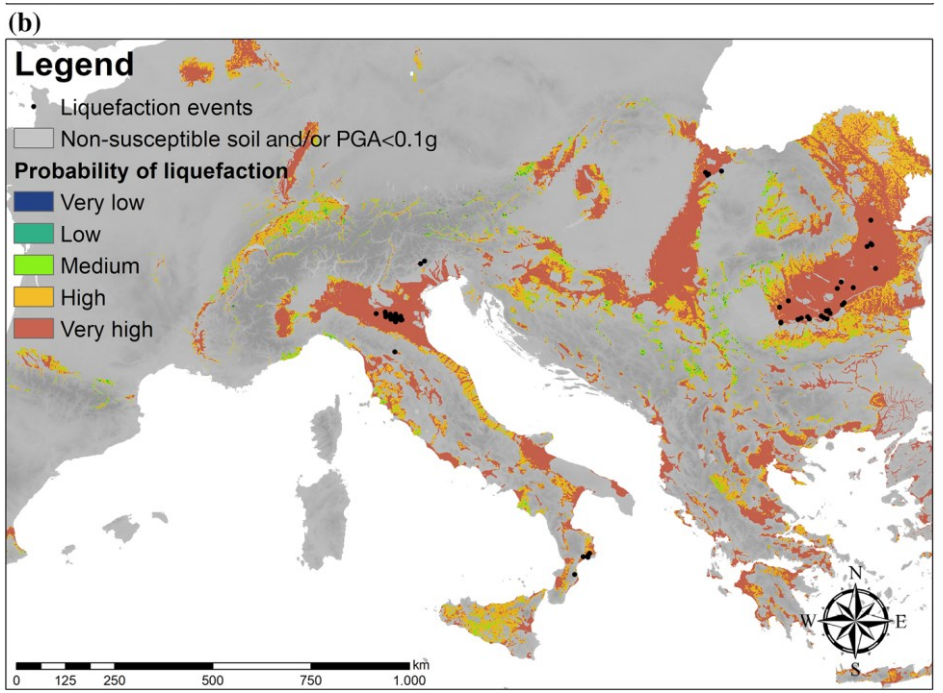
Meisina et al. (under review)

MEGA-ZONATION

HAZARD MAP

Validation with the liquefaction catalogue events characterized by a RT = 475 years

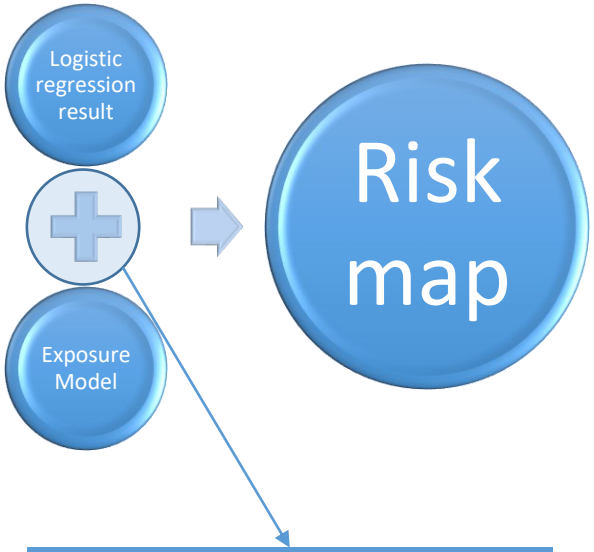




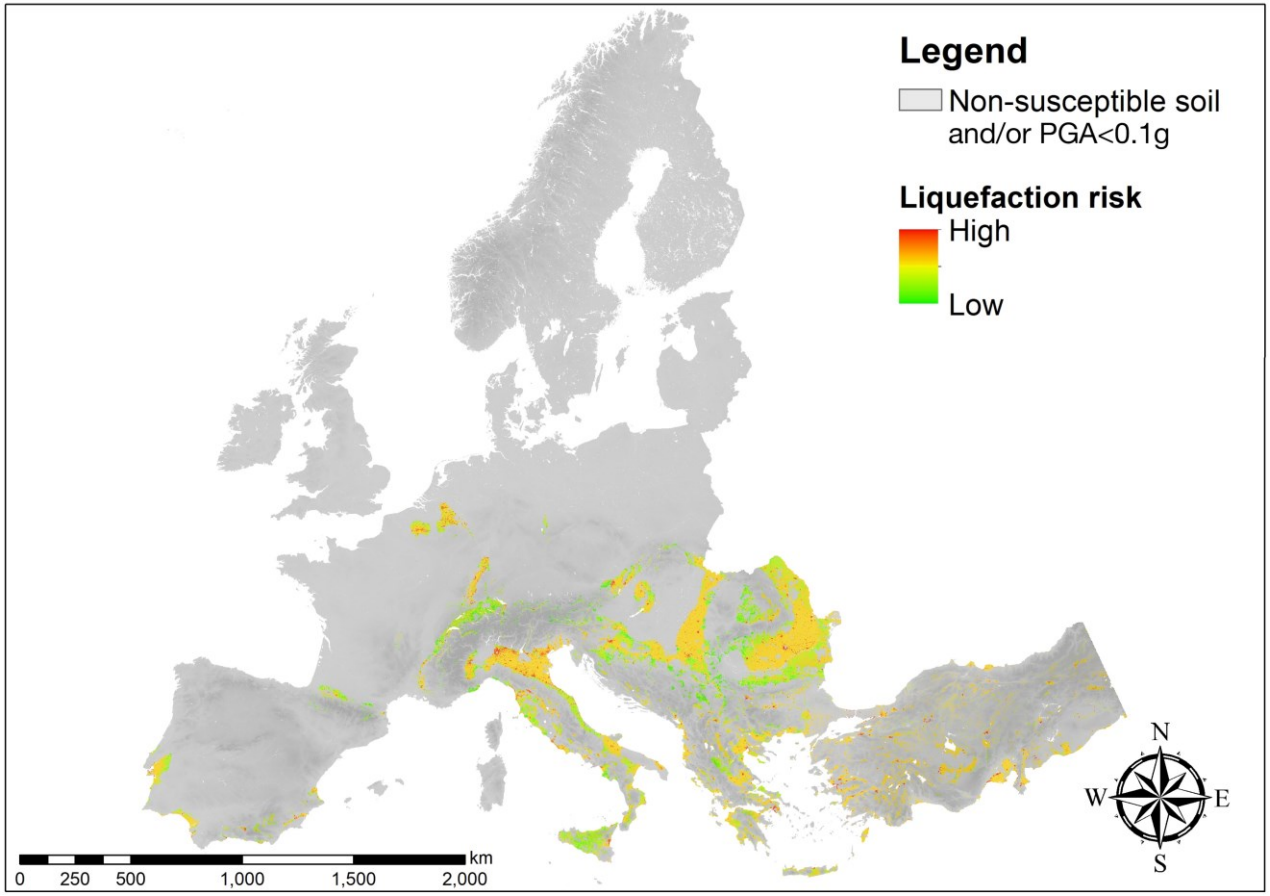
Bozzoni et al. (2020)

MEGA-ZONATION

RISK MAP



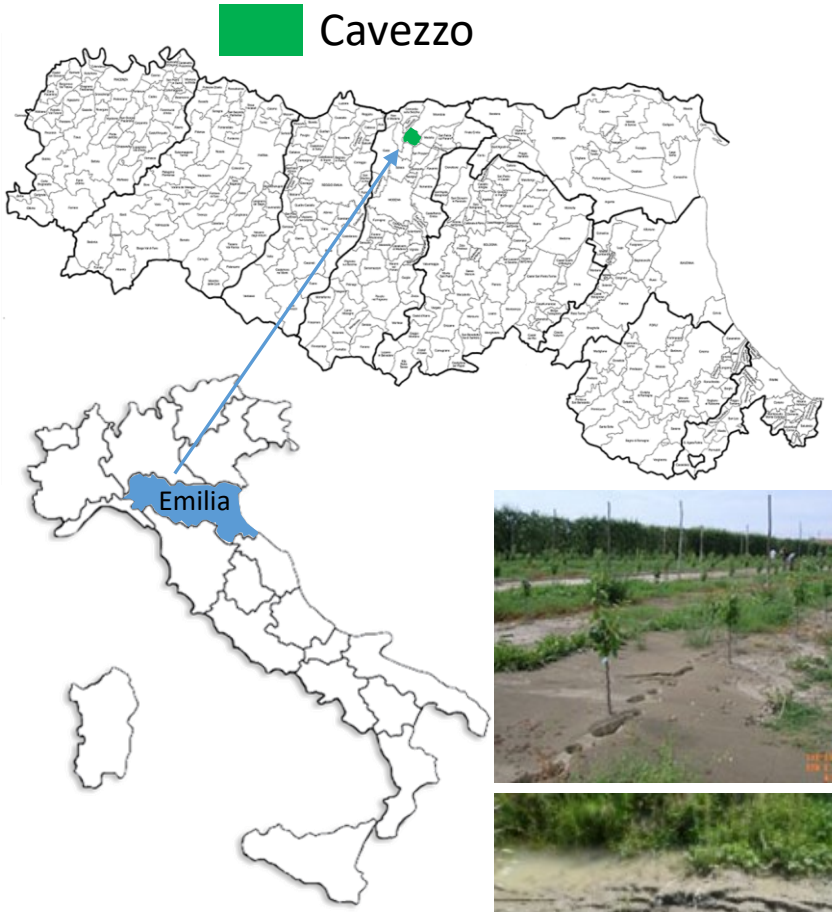
RT = 475 years



Bozzoni et al. (2021)

MICRO-ZONATION

EMILIA REGION, ITALY CAVEZZO MUNICIPALITY



Liquefaction in Cavezzo May, 29 2012 M6 EQ

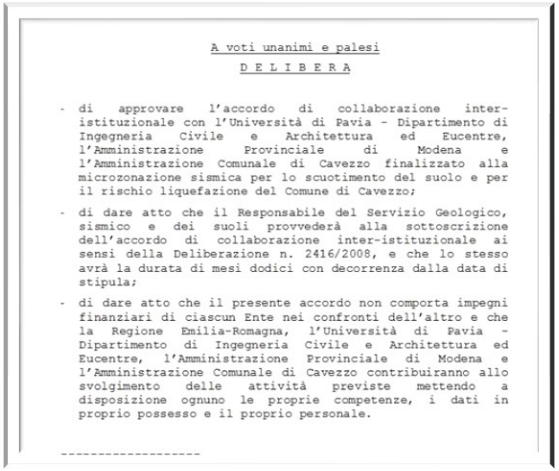
INTER-INSTITUTIONAL AGREEMENT FOR MICRO-ZONATION STUDY AT CAVEZZO

Regione Emilia-Romagna

Provincia di Modena

EUCENTRE
FOR YOUR SAFETY.

UNIVERSITÀ DI PAVIA
Dipartimento di Ingegneria Civile e Architettura



A voti unanimi e palesi

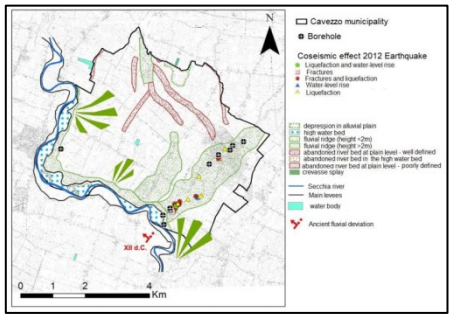
D E L I B E R A

- di approvare l'accordo di collaborazione inter-istituzionale con l'Università di Pavia - Dipartimento di Ingegneria Civile e Architettura ed Eucentre, l'Amministrazione Provinciale di Modena e l'Amministrazione Comunale di Cavezzo finalizzato alla microzonazione sismica per lo scuotimento del suolo e per il rischio liquefazione del Comune di Cavezzo;
- di dare atto che il Responsabile del Servizio Geologico, sismico e dei suoli provvederà alla sottoscrizione dell'accordo di collaborazione inter-istituzionale ai sensi della Deliberazione n. 2416/2008, e che lo stesso avrà la durata di mesi dodici con decorrenza dalla data di stipula;
- di dare atto che il presente accordo non comporta impegni finanziari di ciascun Ente nei confronti dell'altro e che la Regione Emilia-Romagna, l'Università di Pavia - Dipartimento di Ingegneria Civile e Architettura ed Eucentre, l'Amministrazione Provinciale di Modena e l'Amministrazione Comunale di Cavezzo contribuiranno allo svolgimento delle attività previste mettendo a disposizione ognuno le proprie competenze, i dati in proprio possesso e il proprio personale.

MICRO-ZONATION

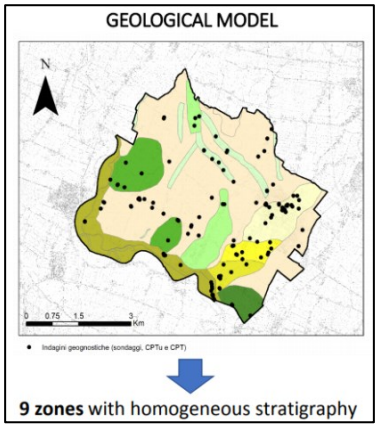
METHODOLOGY OVERVIEW

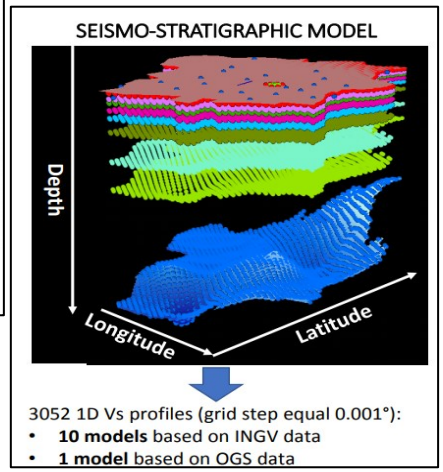
1. Geological, geo-morphological and hydro-geological framework



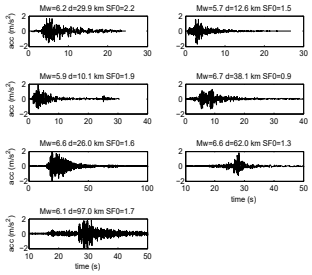
2. Investigation campaigns for geotechnical characterization

3. Definition of subsoil model



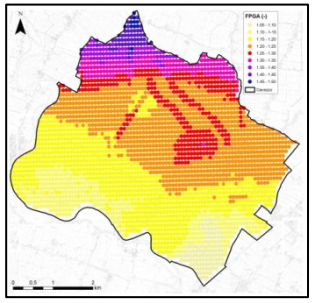


4. Definition of reference seismic Input



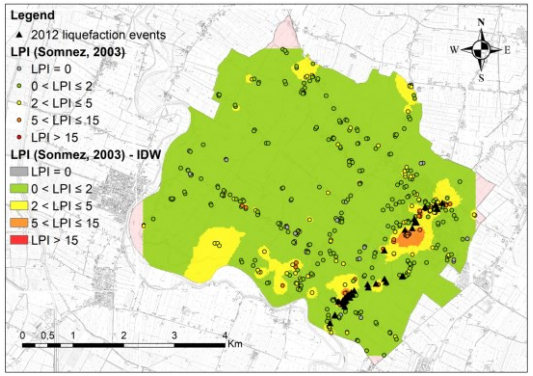
Set of 7 real sismo- and spectrum-compatible accelerograms

5. Ground Response Analyses



- 475, 975,2475 yrs return periods
- ground response analysis

6. Micro-zoning territory of Cavezzo for liquefaction risk



MICRO-ZONATION

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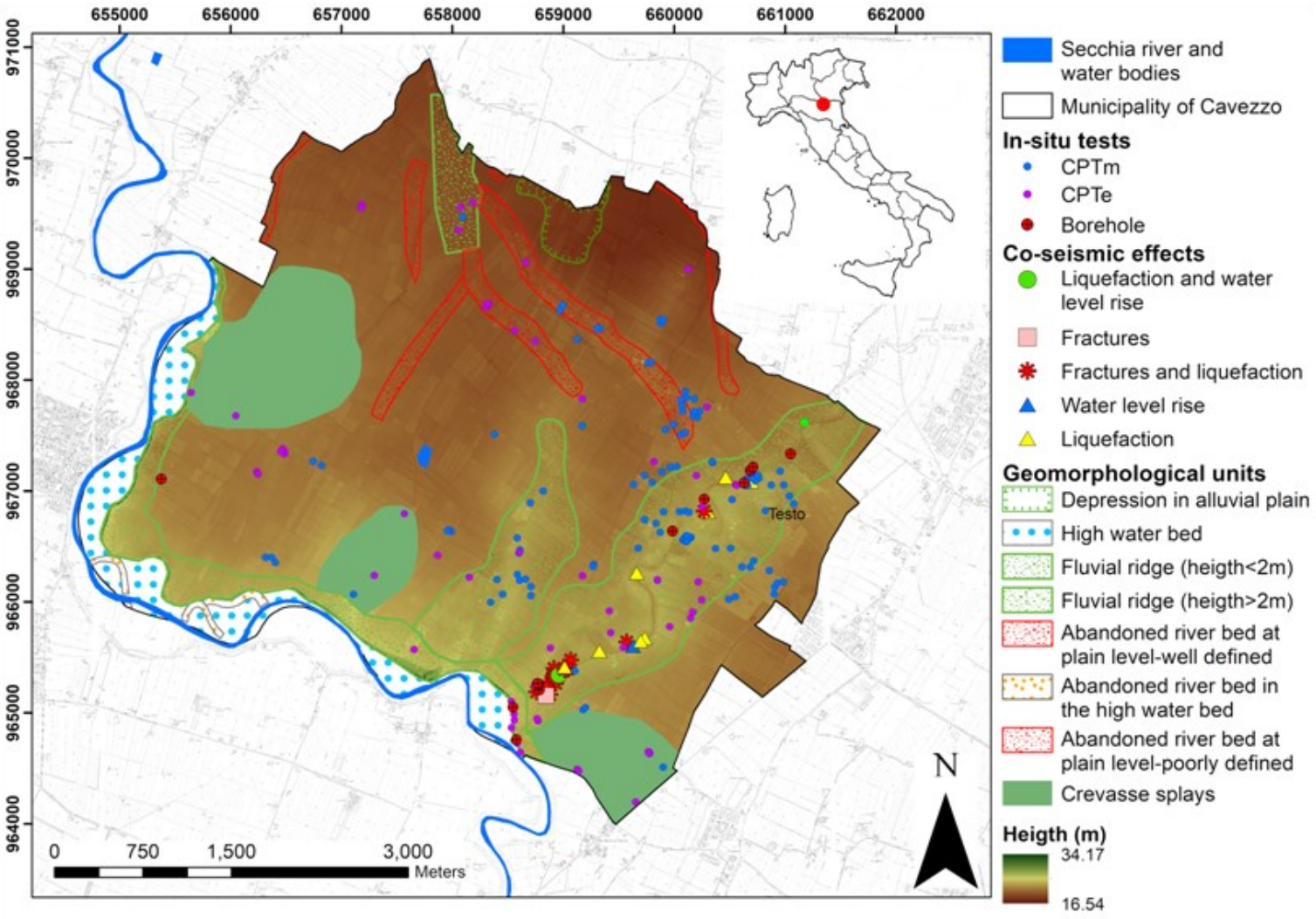
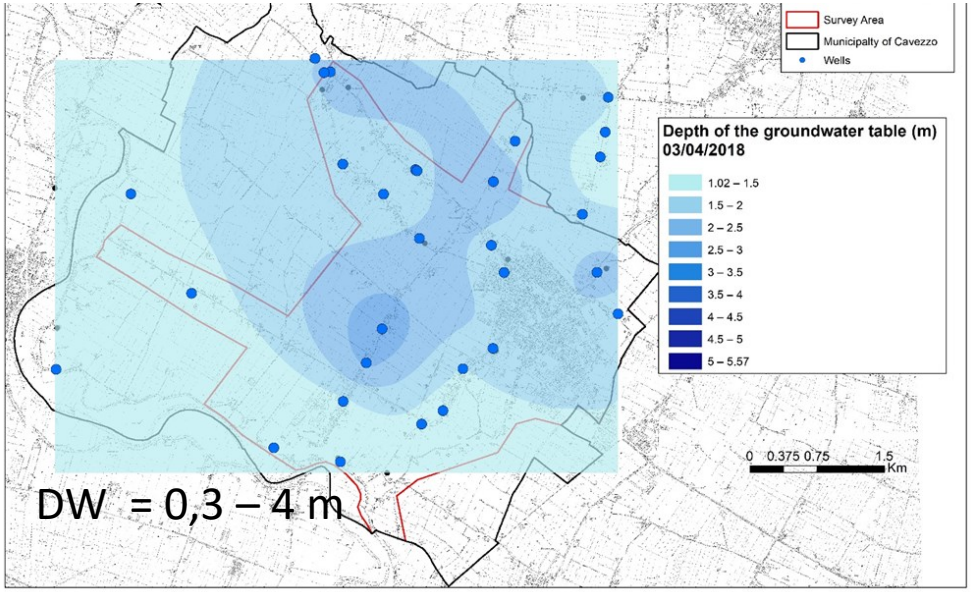


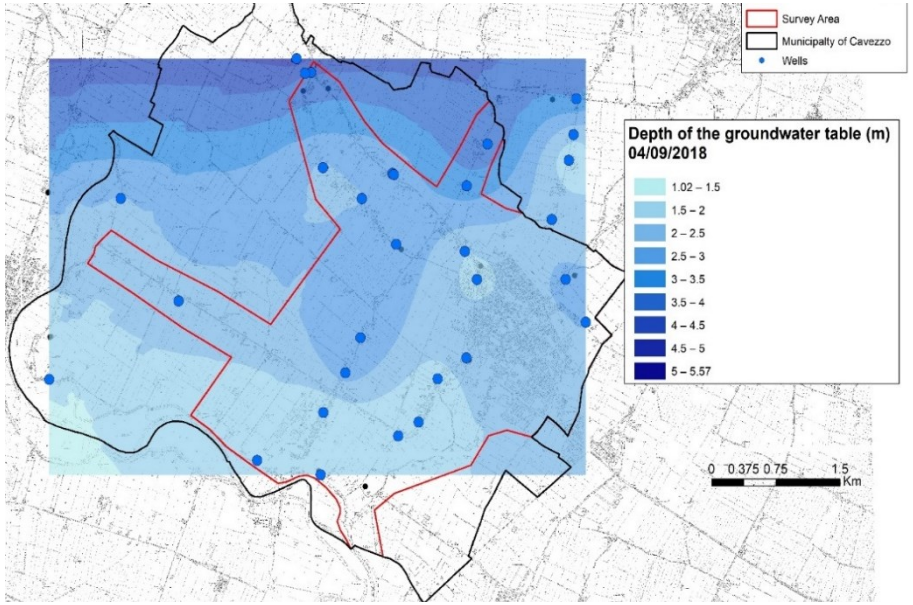
Collaboration with

UNIMORE Università degli Studi di Modena e Reggio Emilia — Dipartimento di Scienze Chimiche e Geologiche

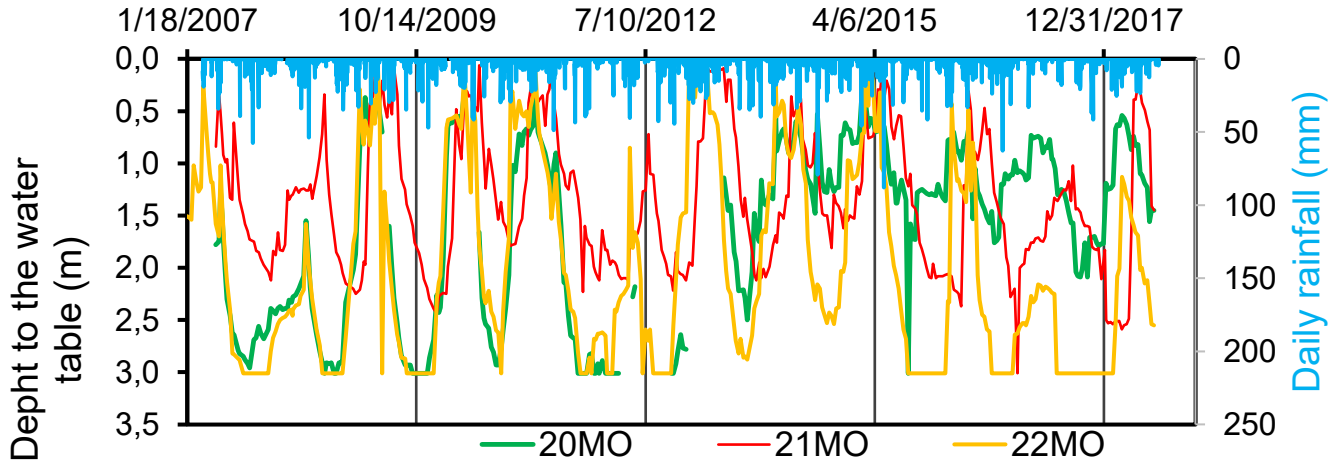
MICRO-ZONATION

1. Geological, geo-morphological and hydro-geological framework





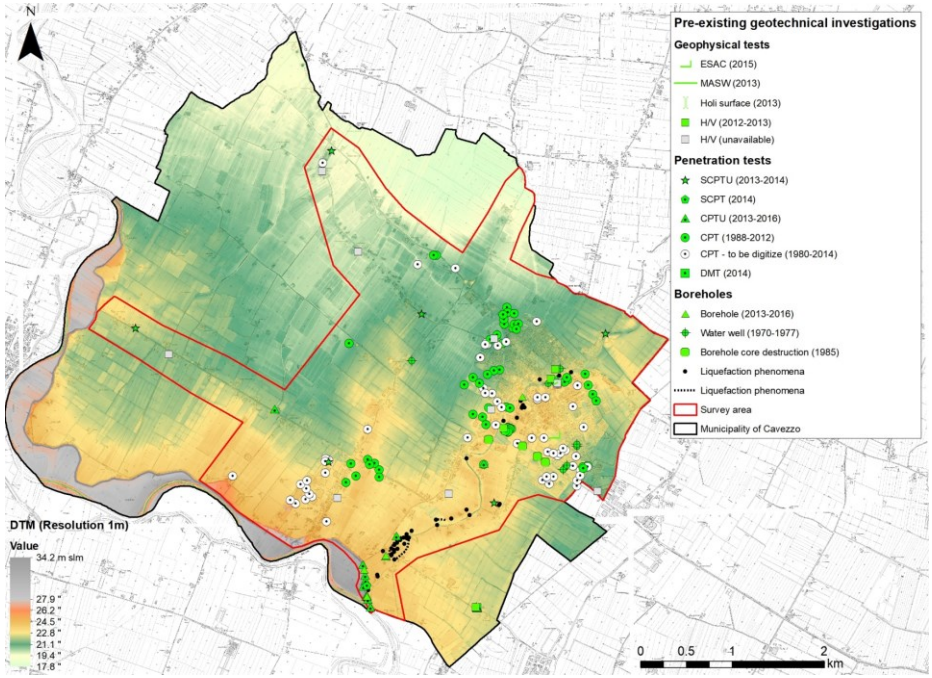
Continuous measurement of GWT in 3 wells: *oscillation of 2.5 m*



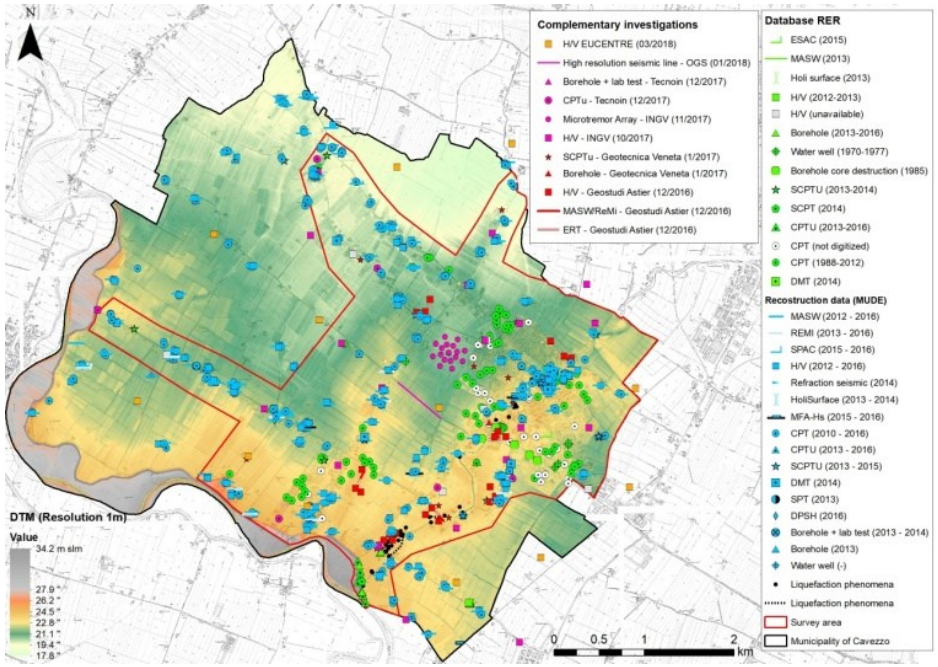
MICRO-ZONATION

2. Investigation campaigns for geotechnical characterization

existing data available before LIQUEFACT



data acquired during LIQUEFACT



Database Regione Emilia Romagna (RER)

Collection and digitization of post-2012 earthquakes data (MUDE)

LIQUEFACT investigation campaigns

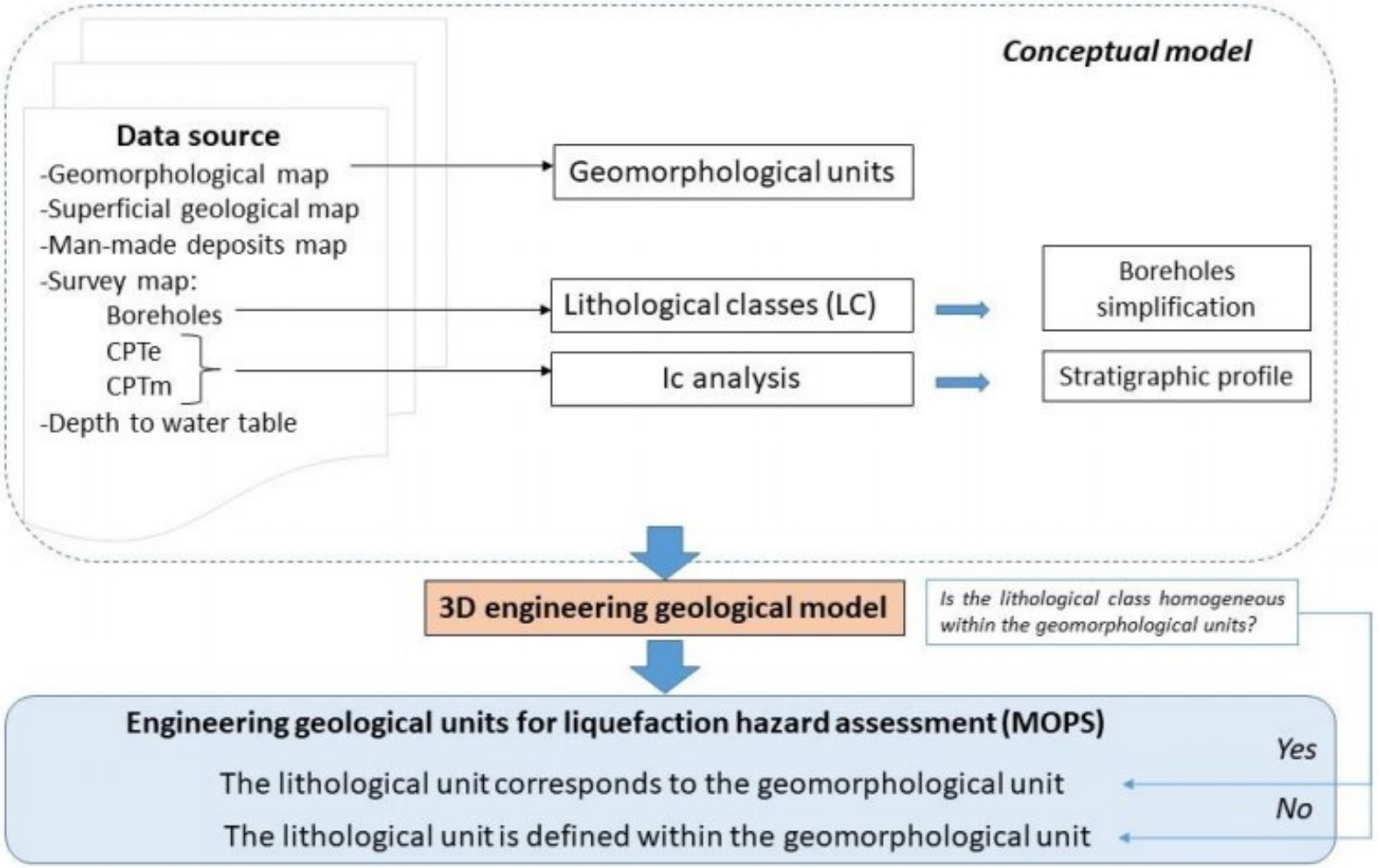
LIQUEFACT investigation campaigns – Phase 2 INGV, OGS

Investigation campaigns funded by Comune di Cavezzo and RER

EUCENTRE investigation campaign

MICRO-ZONATION

3. Definition of subsoil model



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MICRO-ZONATION

3. Definition of subsoil model

Reconstruction of stratigraphic profile by the interpretation of CPT tests :

- CPT→ Ic computation using Robertson et al. 2009 and Ic correction using the approach proposed by Facciorusso et al. 2017
- CPTu → Ic computation using Robertson et al. 2009 (CPeT-IT2 software) and Ic correction using the formula derived from the empirical calibration of Ic versus Ic from boreholes

Lithological classes (LC) recognition		
Ic	**LC**	**LU code**
< 1.3	coarse sands and gravelly soils	S/G
1.3 - 1.8	clean sands	S
1.8 - 2.1	sand with smail amount of fines	Sl
2.1 - 2.6	sandy silts and non-plastic silts	Ls
2.6 - 3.5	non- liquefiable silt/clayey soil	A - ADD.
> 3.5	Clay with peat	At

Lithological classes prososed by Cubrinovski et al. 2017

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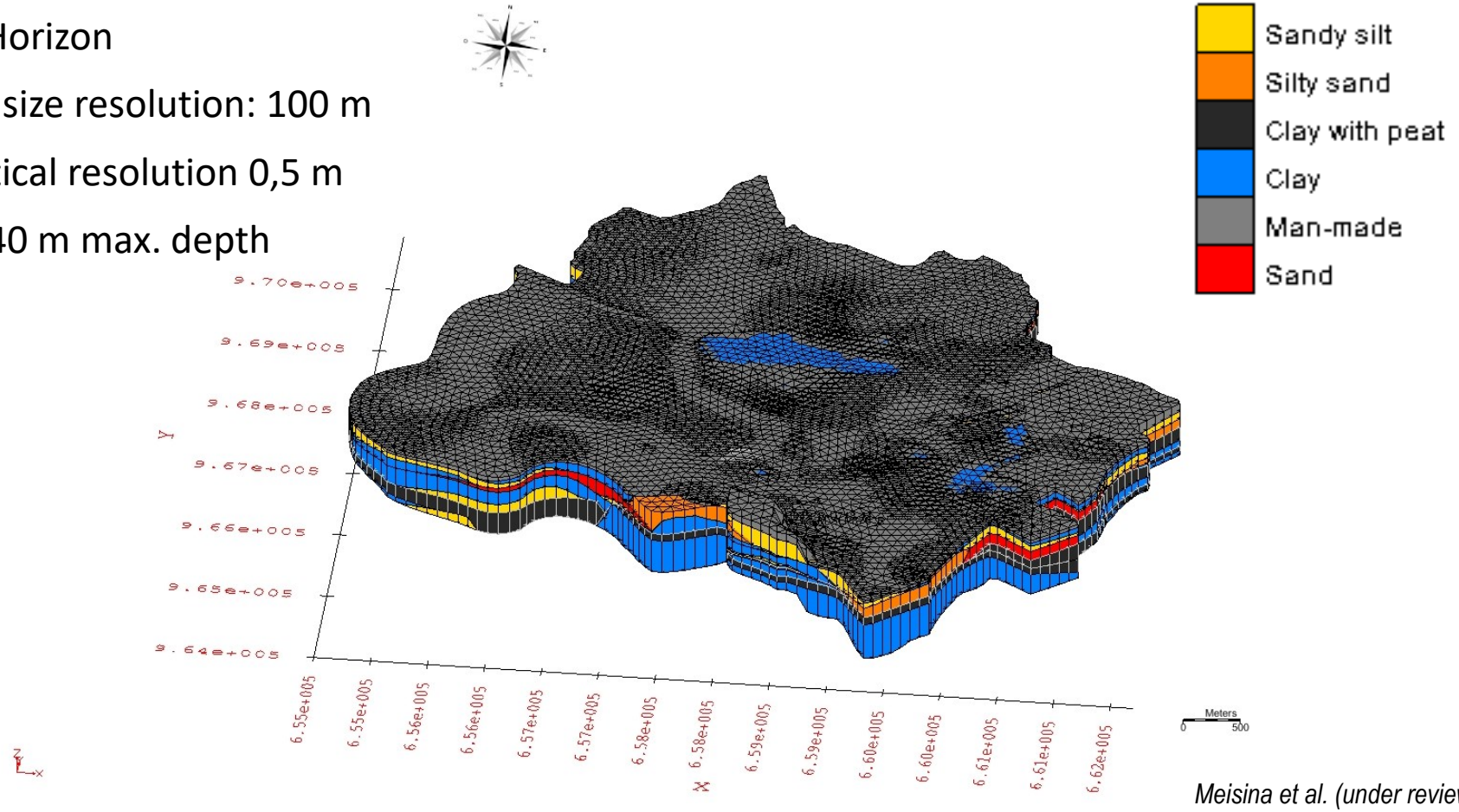
MICRO-ZONATION

3. Definition of subsoil model

- IDW interpolation with cross-sections guide
- 30 Horizon
- Cell size resolution: 100 m
- Vertical resolution 0,5 m
- 30-40 m max. depth



Meisina et al. (under review)

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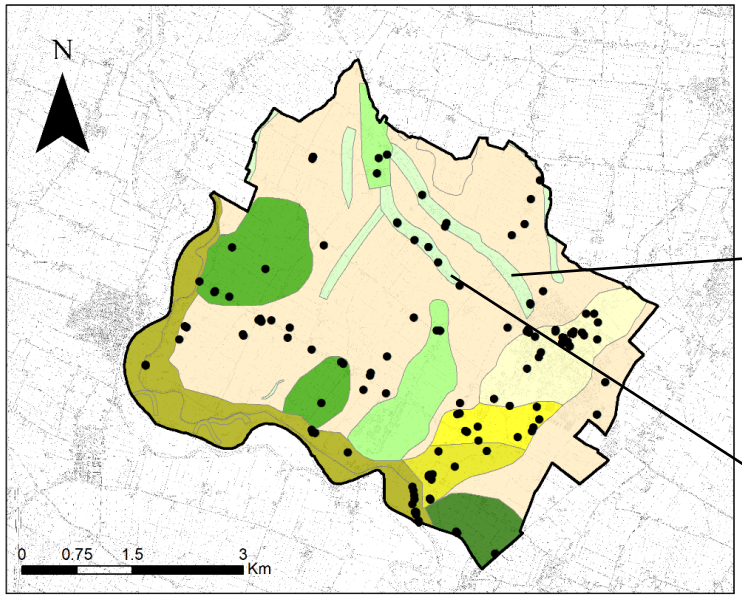
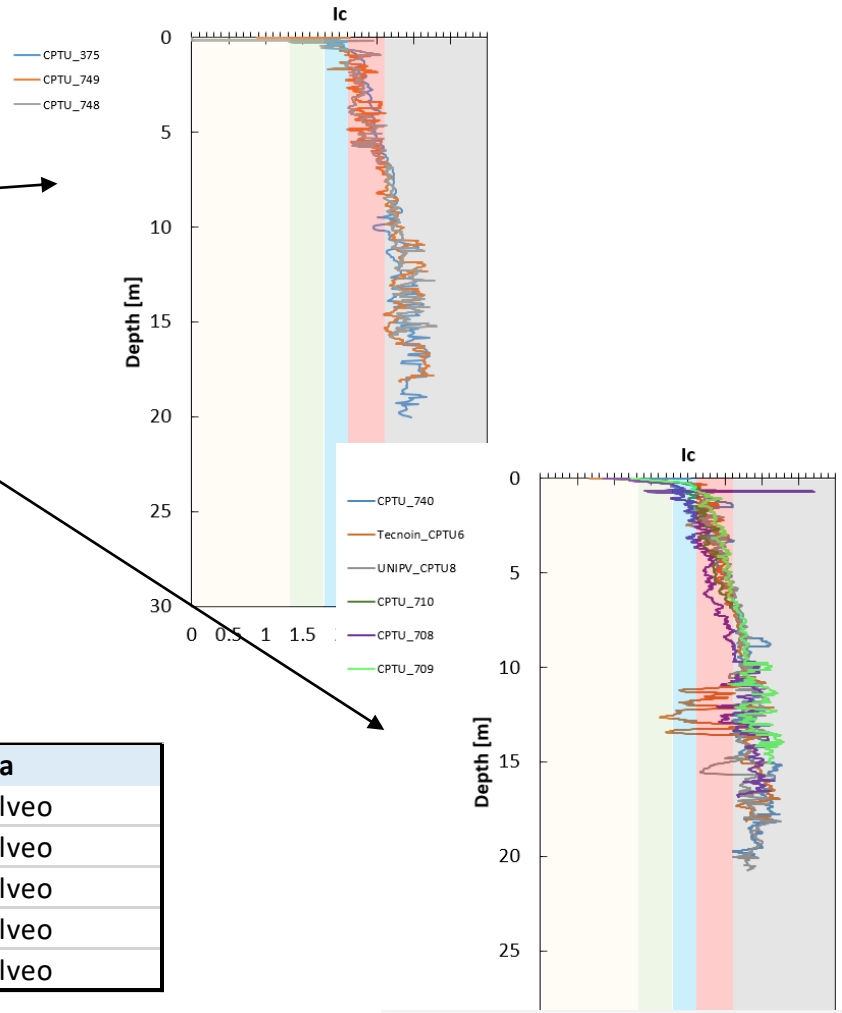
3. Definition of subsoil model





ZONA 1	Spessore	Descrizione litologica tessiturale	Nota
Strato 1	0-2m	Riporto	Paleoalveo
Strato 2	6-7m	Limo sabbioso	Paleoalveo
Strato 3	5-7m	Argilla	Paleoalveo
Strato 4	0-1m	Sabbia	Paleoalveo
Strato 5	0-5m	Argilla	Paleoalveo

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