Progetto DPC-ReLUIS 2024-2026 WP 4
task 4.1 - Pericolosità (scenari di scuotimento e misure di intensità)

PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

Validazione di un database di accelerogrammi simulati physics-based

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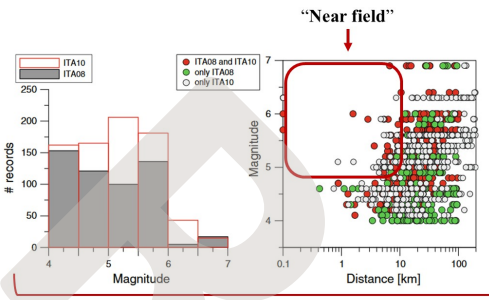


"Near field": distance from the epicenter by which most damage is observed.

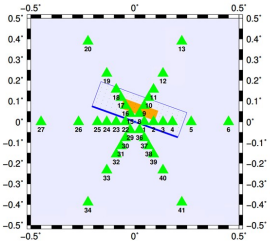
In the "near field", the scarcity of ground-motion records hinders the empirical derivation of high-quality GMPEs for Seismic Hazard Assessment.

It affects both Hazard and Fragility

Physics-based Simulations - PBS

1. Simulation of the fault rupture process on the fault plane (***Extended Source Model***)
2. Simulation of seismic wave propagation and calculation of synthetic accelerograms for the sites of interest (***Discrete Wave Number***)

- **3 Fault geometry**
  - *ITIS120 – Gemona South (Thrust)*
  - *ITIS131 – Paganica (Normal)*
  - *ITIS052 – San Giuliano (Strike-slip)*
- **Magnitudes** (Mw) = [5.5, 6.0, 6.5, 7.0, 7.5]
- **Soil categories** (EC8) = [A, B, C]
- **Distances** (km) = [5, 10, 15, 20, 30, 50, 100]
- **Angles** (°) = [60, 120, 180, 240, 300]
- **Rupture Realizations** = 10



Total accelerograms = 89000

Data processing and IMs calculations

Flat file (89000x1300)

name	FAULT	MAGNITUDE_W	RUPTURE_REALIZATION	SOIL_CATEGORY	CENTRAL_DISTANCE	ANGLE	PGA_E
ITIS120.55.R0001.A.10.0.SNS.ACC.ASC	ITIS120	55	R0001	A	10	0	3.492852
ITIS120.55.R0001.A.10.120.SNS.ACC.ASC	ITIS120	55	R0001	A	10	120	46.372144
ITIS120.55.R0001.A.10.180.SNS.ACC.ASC	ITIS120	55	R0001	A	10	180	7.104941
ITIS120.55.R0001.A.10.240.SNS.ACC.ASC	ITIS120	55	R0001	A	10	240	27.979304
ITIS120.55.R0001.A.10.300.SNS.ACC.ASC	ITIS120	55	R0001	A	10	300	53.48671
ITIS120.55.R0001.A.10.60.SNS.ACC.ASC	ITIS120	55	R0001	A	10	60	77.824335
ITIS120.55.R0001.A.15.0.SNS.ACC.ASC	ITIS120	55	R0001	A	15	0	2.04994
ITIS120.55.R0001.A.15.120.SNS.ACC.ASC	ITIS120	55	R0001	A	15	120	27.413112
ITIS120.55.R0001.A.15.180.SNS.ACC.ASC	ITIS120	55	R0001	A	15	180	2.068485
ITIS120.55.R0001.A.15.240.SNS.ACC.ASC	ITIS120	55	R0001	A	15	240	15.735234
ITIS120.55.R0001.A.15.300.SNS.ACC.ASC	ITIS120	55	R0001	A	15	300	28.688353
ITIS120.55.R0001.A.15.60.SNS.ACC.ASC	ITIS120	55	R0001	A	15	60	59.673255
ITIS120.55.R0001.A.20.0.SNS.ACC.ASC	ITIS120	55	R0001	A	20	0	3.959161
ITIS120.55.R0001.A.20.120.SNS.ACC.ASC	ITIS120	55	R0001	A	20	120	26.947191
ITIS120.55.R0001.A.20.180.SNS.ACC.ASC	ITIS120	55	R0001	A	20	180	4.268688
ITIS120.55.R0001.A.20.240.SNS.ACC.ASC	ITIS120	55	R0001	A	20	240	18.161518
ITIS120.55.R0001.A.20.300.SNS.ACC.ASC	ITIS120	55	R0001	A	20	300	35.987536
ITIS120.55.R0001.A.20.60.SNS.ACC.ASC	ITIS120	55	R0001	A	20	60	52.888203
ITIS120.55.R0001.A.30.0.SNS.ACC.ASC	ITIS120	55	R0001	A	30	0	4.939903
ITIS120.55.R0001.A.30.120.SNS.ACC.ASC	ITIS120	55	R0001	A	30	120	9.481348
ITIS120.55.R0001.A.30.180.SNS.ACC.ASC	ITIS120	55	R0001	A	30	180	5.292119
…	…	…	…	…	…	…	…

Validation

The seismological validation is carried out by **plotting the simulated data over the median and $\pm\sigma$ lines** obtained from existing GMPEs.

Moreover, a **residual analysis** is also carried out, in which the residuals are calculated as follows:

$$Res(D) = \frac{\log(obs(D)) - \log(sim(D))}{\sigma_{GMPE}}$$

The existing GMPEs used for the comparison are the following:

- *Bindi et al., 2011*
- *Cheng et al., 2014*
- *Sandikkaya et al., 2016*

The **IM** investigated are the following:

- Relative Energy Input (***V_{EIR}***)

$$m\ddot{x} + c\dot{x} + kx = -m\ddot{x}_g$$

$$E_{Ir} = -\int m\ddot{x}_g dx = \frac{m\dot{x}}{2} + \int (c\dot{x})dx + \frac{kx^2}{2}$$

$$V_{EIr} = \sqrt{2E_{Ir}/m}$$

- Cumulative Absolute Velocity (***CAV***)

$$CAV = \int_0^T |a(t)|dt$$

- Arias Intensity (***I_A***)

$$I_A = \frac{\pi}{2g}\int_0^T (a(t)^2)dt$$

- Pseudo-spectral Acceleration (***PSA***)