SIGMA3: A further step for the reduction of epistemic uncertainties in PSHA

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ABSTRACT:

Today, the evaluation of seismic hazard and risk at critical facilities, such as nuclear installations, often relies on probabilistic site-specific approaches for return periods of 10,000 years, or more. In this context, results are very dependent on the current knowledge of local site conditions (i.e., geology, soil response) and on the level of uncertainties associated with every component of the seismic source model (SSM) and of the ground-motion model (GMM). This situation is heightened in low-to-moderate seismicity areas due to data scarcity or to large uncertainties in the models.

The research program SIGMA3 has been launched in 2024 over a period of 5 years to overcome such difficulties by developing data, methods and models that will contribute to the identification and, whenever achievable, to the reduction of epistemic uncertainties in seismic hazard assessment (SHA). By working in collaboration with a large international community of researchers in the fields of hazard assessment and earthquake engineering, we aim at improving current practices for risk assessment and for the safety demonstration of critical installations.

SIGMA3 is 100 % industry-funded, from international sponsors involved in the nuclear energy sector.

ΣIGMA³

2024 - 2028

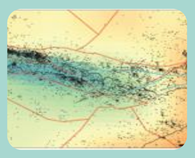
Methods

- Fault characterization methods
- Focal depth estimation for instrumental eqs. (surface waves, secondary arrivals, coda, machine-learning…)
- Reliable Mw estimates in instrumental catalogues
- Intensity Prediction Equations based on joint inversion of macroseismic/instrumental data
- Incompleteness of historical catalogues

- AI-based automated processing of GM datasets
- AI-based characterization of site conditions
- Effect of stations housing and sensor installation conditions on GM
- GIT, residual analyses and other approaches apply to GM in France
- Understanding GM variability over Northern and Western Europe
- Broadband local-scale attenuation properties
- Scaling of GM duration and phase-related information
- Empirical site characterization methods (SSR, SSRh, coda..)

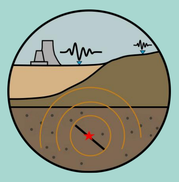
- Liquefaction in low seismicity areas
- Comparing site response methods at use in different countries
- Joint crosshole/downhole approach for soil characterization
- Seismic source modeling at basin scale
- Seismic site effect modeling from source to structure
- Quantify uncertainties in soil property estimates using ambient-noise
- Mitigation of site-effects: insight from numerical simulations

- Framework for the evaluation of epistemic uncertainties
- Guidelines for the propagation of uncertainties in PSHA
- Introducing aftershocks in PSHA
- Supplementary outputs for PSHA
- Evaluation of PSHA against observations & fragile geologic features
- Developments for the RVT approach
- GM record selection methods
- High-frequency GM vs. Damage potential
- VPSHA
- PFDHA



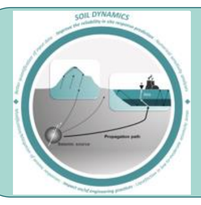
WP1
Seismic Sources

- Fault characterization methods
- Earthquake catalogues
- Seismogenic models



WP2
Ground Motion (GMM)

- Ground motion models
- Empirical site response
- GM simulations



WP3
Soil Dynamics

- Geotechnical site characterization
- Non-linear GM simulations, Liquefaction
- Mitigation of site-effects

WP4
Hazard and load calculation

- PSHA methodology, tools and extensions
- PSHA confrontation to observation
- Earthquake engineering

QUAKETEST
PSHA V&V

WP5
PSHA Simulation Platform

- Verify methods/input models against synthetic datasets
- Sensitivity analyses
- Develop synthetic case studies

Community events

- 2nd Workshop on Active Tectonics & Dating
- Benchmark: GM simulation on 2019 Le Teil earthquake (improved 3D model)
- Benchmark: Practical use of conditional spectra in earthquake engineering studies
- Training on 3-D simulations for earthquake engineering
- Training School: Seismic hazard for engineers & Earthquake engineering for seismologists

- Annual symposiums

Data

- Fault dating campaigns
- Historical and instrumental catalogues
- GM databases
- Empirical site and seismological station characterization
- In-situ soil characterization using cyclic PMT

Models

- Tools & models for PFDHA
- Crustal-scale stress-field characterization in Western Europe
- Crustal rheology in Western Europe
- Fault displacement models (discrete elements & physics-based)
- Seismic source models for France and Czech Republic

- GM model for the Fennoscandian very-hard rock
- Hard-rock reference GM for France
- Non-ergodic GM model for France
- Intrinsic attenuation model in France
- Physics-based GM models

- Simulation of ambient noise-based geophysical prospecting (H/V, SSRh, AVA…)

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