

## **Geostatistical mapping of the shallow seismic impedance contrast in Venice (Italy)**

Sebastiano Trevisani (1) and Jacopo Boaga (2)

(1) Dipartimento DACC, Università IUAV di Venezia, Italy (strevisani@iuav.it), (2) Dipartimento di Geoscienze, Università degli Studi di Padova, Italy (jacopo.boaga@unipd.it)

Venice constitutes an emblematic study site from the viewpoint of the challenging characteristics that can be encountered in performing microzonation studies in historical centers. Venice presents high logistical difficulties in relation to the intense touristic fluxes, to the high building spatial-density and to the fact that many sites are reachable only on foot. Then, Venice is characterized by several non-favorable conditions for seismic prospecting required in microzonation studies. For example, anthropic disturbances on the seismic noise wavefield, the presence of paved ground and of highly compacted and heterogeneous shallow anthropic deposits are all negative characteristics for the seismic prospecting. Moreover, being in a coastal area, the seismic noise at low frequencies (e.g., <1 Hz) is influenced by the dynamical and meteorological conditions of the Adriatic Sea. Finally, the high stratigraphic heterogeneity characterizing the shallow deposits of Venice subsoil, marked by frequent lateral sedimentary transitions, increases the difficulties in prospecting. Accordingly, we conducted an extensive geophysical survey in the city of Venice based on single channel and multichannel analysis of seismic noise, by means of respectively HVSR and ReMi techniques (Nakamura 1989, Louie 2001). The HVSR and ReMi recordings have been analyzed critically in the light of site-specific stratigraphic knowledge, arising from published researches and an institutional geodatabase reporting stratigraphic and penetrometer tests conducted in the city. Several HVSR measurements permitted to detect a shallow impedance contrast, likely related to the passage between the soft Holocene lagoon sediments and the locally more stiff Pleistocene alluvial sediments constituted by fine/medium sand and/or over-consolidated silty/clay. This impedance contrast is not continuous and consequently is not always detectable due to stratigraphic reasons or in relation to seismic velocity inversions that deteriorate the readability of the HVSR curves. A soft-coding of HVSR peaks has been adopted, permitting to derive an indicator variable expressing the probability of occurrence of the shallow impedance contrast. The probability of occurrence of the impedance contrast has been then analyzed by means of a geostatistical approach, leading to the objective mapping of the shallow impedance contrast in the city of Venice.

### References

- Bonnefoy-Claudet, S., Cotton, F. & Bard, P.-. 2006, "The nature of noise wavefield and its applications for site effects studies. A literature review", *Earth-Science Reviews*, vol. 79, no. 3-4, pp. 205-227.
- Canal, E., 2015, "Archeologia della laguna di Venezia", Venezia, Cierre Edizioni.
- Goovaerts, P. 1997, "Geostatistics for natural resources evaluation", New York: Oxford University Press.
- Louie, J.N. 2001, "Faster, better: Shear-wave velocity to 100 meters depth from refraction microtremor arrays", *Bulletin of the Seismological Society of America*, vol. 91, no. 2, pp. 347-364.
- McClennen, C.E., Ammannan, A.J. & Schock, S.G. 1997, "Framework stratigraphy for the Lagoon of Venice, Italy: Revealed in new seismic-reflection profiles and cores", *Journal of Coastal Research*, vol. 13, no. 3, pp. 745-759.
- Nakamura, Y. 1989, "A method for dynamic characteristics estimation of subsurface using microtremor on the ground surface", *A Method for Dynamic Characteristics Estimation of Subsurface Using Microtremor on the Ground Surface*, , pp. 25-33.