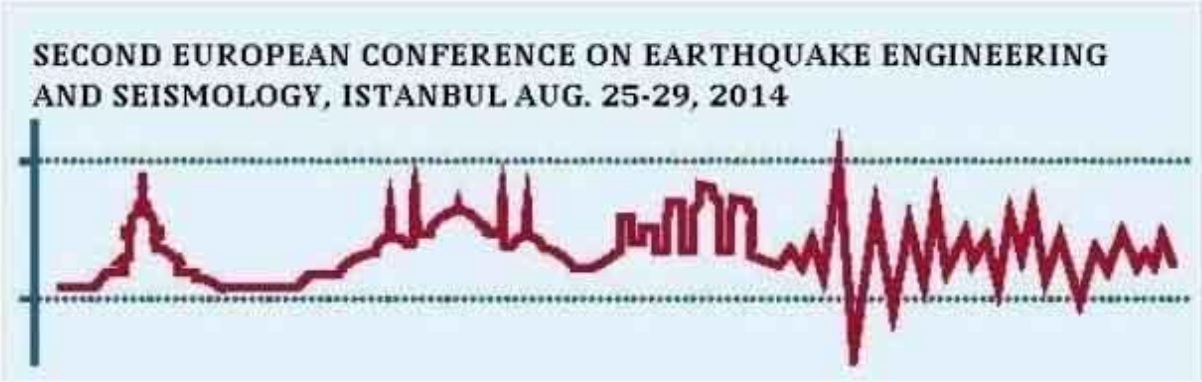

STUDY OF SITE EFFECTS IN THE DOWNTOWN OF CHLEF (FORMERLY EL-ASNAM), ALGERIA

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Weak-motion recordings of local earthquakes and ambient noise data in the 0.1–15 Hz frequency range are used to quantify the site effects in the downtown of Chlef city, in the Lower-Cheliff Basin, north central Algeria. This urban area has experienced several moderate to large earthquakes (Figure 1-a). The El-Asnam earthquake of 10 October 1980 had a moment magnitude Mw 7.2 and was one of the most destructive seismic events recorded in North Africa, killing more than 2600 people and causing extensive damage.

A temporary network of nine short period stations was installed in the city to sample variations in Neogene deposits (Figure 1-b). A total of 51 local events with duration magnitudes (M_d) between 1.7 and 4.6, and with good signal-to-noise ratios (>3) were selected (Figure 1-a).

Two experimental techniques were applied: the Receiver Function, RF (Field and Jakob, 1995; Lachet *et al*., 1996) and the H/V spectral ratio on ambient noise recording techniques, HVSRN (Nakamura, 1989).

The receiver function $HVSR_{ij}(f)$ can be computed at each j site for the ith event at the frequency f_k as follows:

$$HVSR_{ij}(f) = \frac{\sqrt{A_{ij}(f)|_{NS}^{2} + A_{ij}(f)|_{EW}^{2}}}{A_{ij}(f)|_{Z}}$$

$A_{ij}(f)|_{NS}$: spectral amplitude of the NS component
$A_{ij}(f)|_{EW}$: spectral amplitude of the EW component
$A_{ij}(f)\,)|_{Z}$: spectral amplitude of the Vertical component

For the data analysis of HVSRN of this study, we used the GEOPSY code (http://www.geopsy.org/). On the basis of geotechnical and geophysical data provided by Algerian engineering laboratory and found in previews studies (Talaganov et al., 1983; WCC, 1984), the 1D transfer function was also calculated for well-documented sites (PRC, ECJ, MUS, LYA, KAR, STO, and ECF) using SHAKE91 code (http://nisee.berkeley.edu/elibrary/getpkg?id=SHAKE91), in order to compare theoretical and experimental results.

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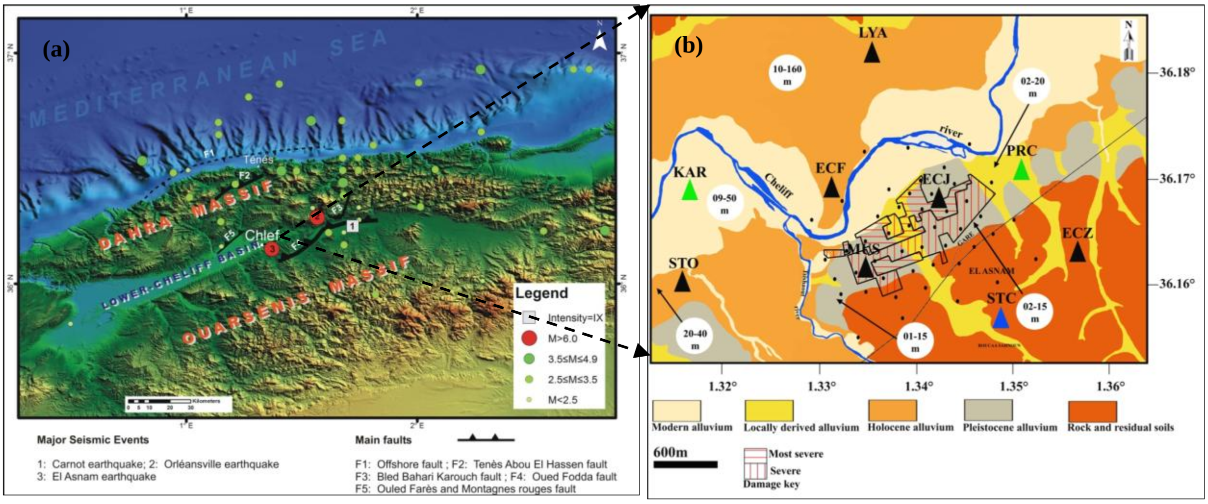

Figure 1: (a): Geographical and topographical situation of the Lower-Cheliff Basin. White square is an historical event and red circles are important instrumental seismic events occurred in the region. Degraded green circles are seismic events (2012-2013) used in this study. Black lines are main active faults of the region; (b) Geology map and seismic network. Triangles are the locations of the temporary seismological stations. Black filled circles show the locations of ambient noise measurements in the former downtown of the Chlef city. The black contour represents the downtown area of Chlef destructed by the 1980 El-Asnam earthquake. White filled circles show the depth of rock estimated by WCC (1984).

The resolved fundamental frequencies vary between 0.3 and 0.6 Hz with amplification factors of approximately 2.5 to 6 at all the selected sites found by RF and HVSRN techniques. A second frequency peak was occasionally observed for higher frequencies between 4 and 10 Hz depending on the nature of the alluvial deposits of the site, and the corresponding maximum amplification factor was approximately 4.

The possible explanation of the fundamental frequencies in the low frequency range is that could have been caused by a very thick sediment layer overlying very hard rock with a high impedance contrast. The 1D Numerical modeling using existing data did not allow for the observation of fundamental frequencies in the low frequency range, like those obtained from the experimental techniques using the earthquake and ambient noise data (Figure 2). This is possibly due to the lack of deep borehole data.

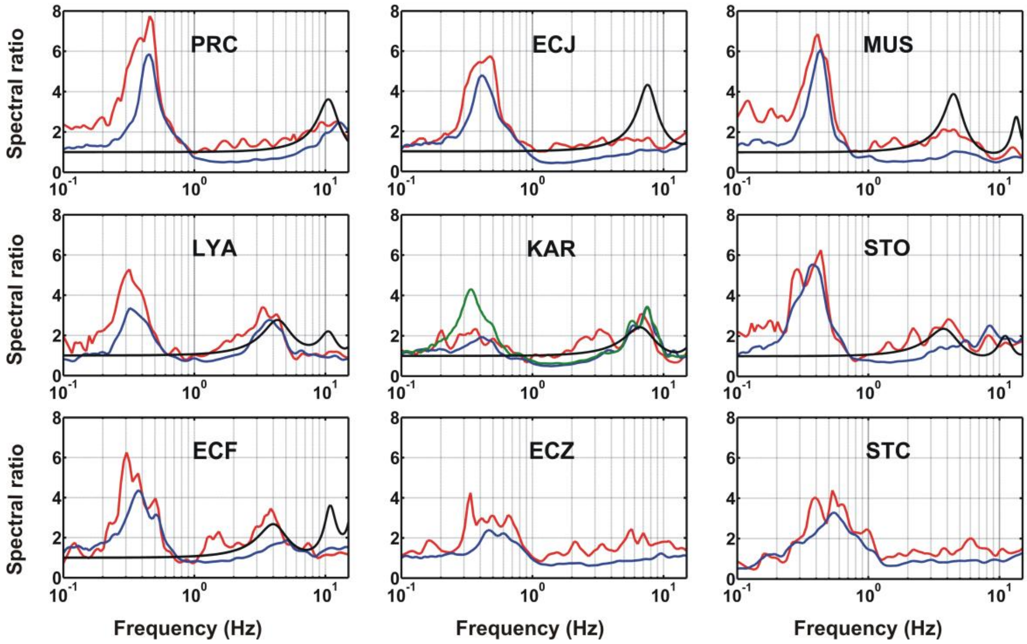

Figure 2: HV Spectral ratio estimates using earthquakes (red line) and ambient noise data (blue line) and the 1D transfer function (black line) of all stations of the temporary network. The thick green line at KAR site shows the true amplitude of the spectral ratio using noise recorded by a second seismic sensor after noticing an anomaly in the amplitude of the frequency peak at low frequency range.

REFERENCES

Field EH, Jacob KH, (1995) "A comparison and test of various site-response estimation techniques including three that are not reference-site dependent" *Bulletin of the Seismological Society of America,* 85(4):1127–1143

Lachet C, Hatzfeld D, Bard PY, Theodulidis N, Papaioannou C, Savvaidis A (1996) "Site effects and microzonation in the city of Thessaloniki (Greece): comparison of different approaches" *Bulletin of the Seismological Society of America*, 86(6):1692–1703

Nakamura Y, (1989) "A method for dynamic characteristics estimation of subsurface using ambient noise on the ground surface" *Quarterly Report of Railway Technical Research Institute*, 30:25–33

Talaganov K, Aleksovski D, Milutinovic Z, Ameur B, Arsovski M, Jancevski J, Andreevski V (1982) Studies for elaboration of the code for repair and strengthening of damaged buildings in the region of El Asnam: Engineering geology, geotechnical and geophysical characteristics of the town of El Asnam and other sites, Report IZIIS 82-55-7, Institute of earthquake engineering and engineering seismology, University Kiril and Metodij, Skopje

WCC (Woodward Clyde Consultants) (1984) Seismic microzonation of Ech-Chellif region, Algeria