

Report of 21st Aban 1396 (12th Nov. 2017) Sar Pol Zahab Earthquake, Kermanshah Province
20th Azar 1396 (11th Dec. 2017), IIEES, Tehran, Iran.

Site Effects of 21st Aban Sarpol-e Zahab-Kermanshah Earthquake; An Interim Report

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with Special Thanks to

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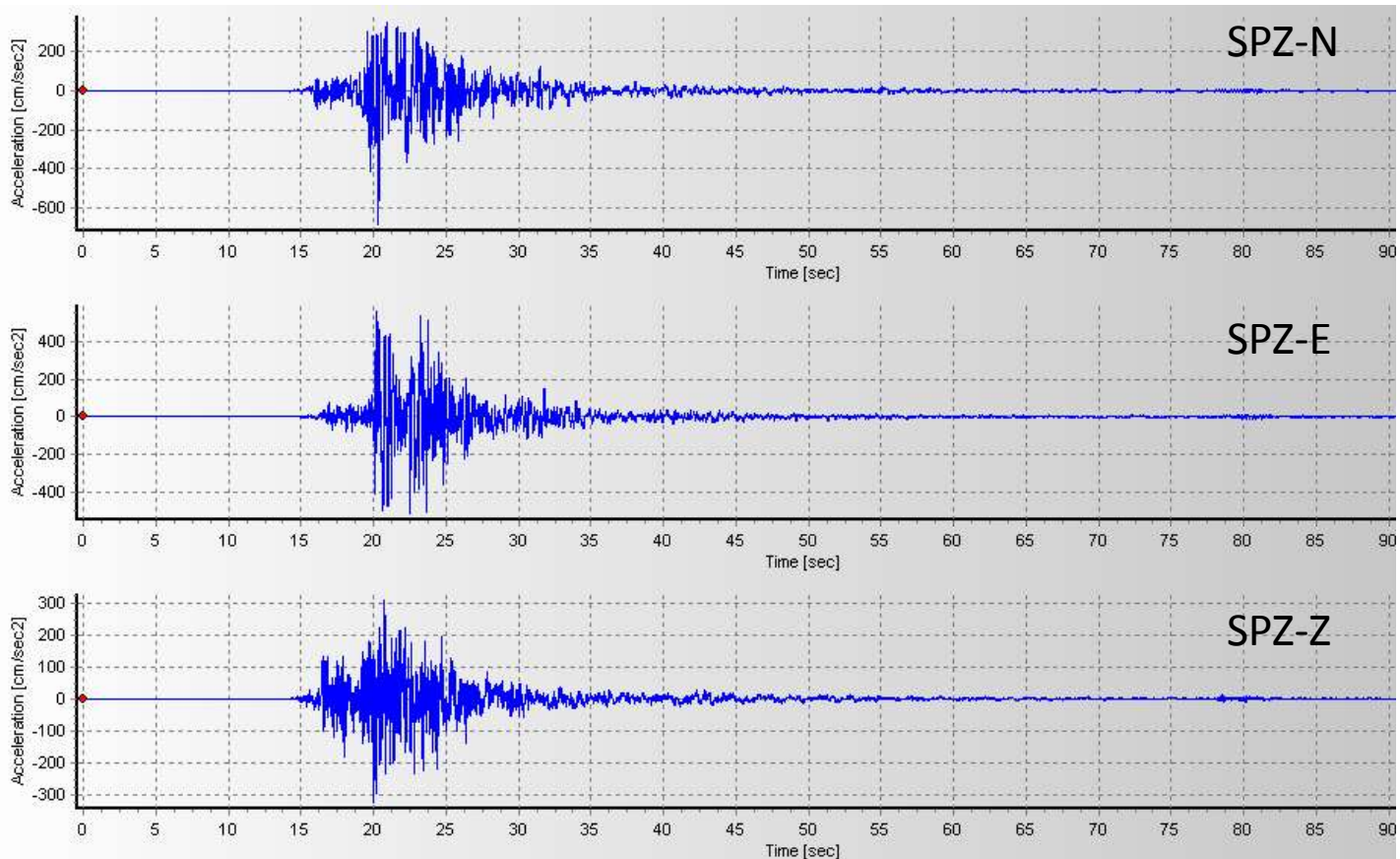
in Collaboration with

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The Event; $M_w=7.3$ an odd EQ. in Zagros



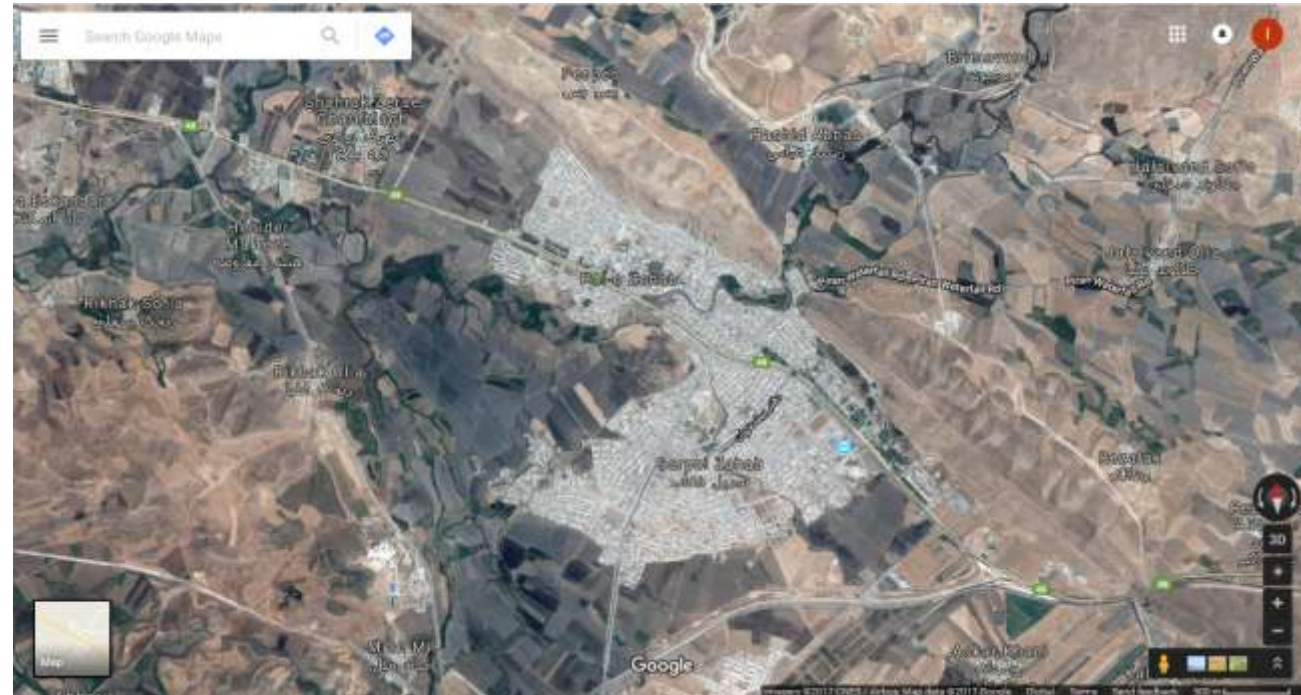
Station	Comp.	PGA cm/s ²	Sus. PGA cm/s ²	Mean Prd (s)	Sig. Dur. (s)	Brak. Dur. (s)
SPZ	N	686	366	0.39	10.8	24.6
	E	563	517	0.32	9.8	29
	Z	325	298	0.28	10.5	29.4
KRD	N	204	161	0.54	15	47
	E	283	244	0.57	15.6	41.7
	Z	115	102	1.02	22.4	48.4
ELA	N	124	77.4	1.15	35.5	78
	E	95.6	87.9	1.16	37.3	88
	Z	55.2	39.6	1.4	44	86.8
KRM1	N	58.3	43.6	1.03	27.5	70
	E	36.6	33.2	0.98	37.4	69.6
	Z	24.6	19.6	1.5	42.7	71
KRM2	N	68.2	48.4	1.2	41	94.5
	E	111.2	54	1.2	37.8	71.8
	Z	35.2	32.8	1.03	36.4	94.7



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Sarpol-e Zahab, Epicentral Dist. 37 km (NW)

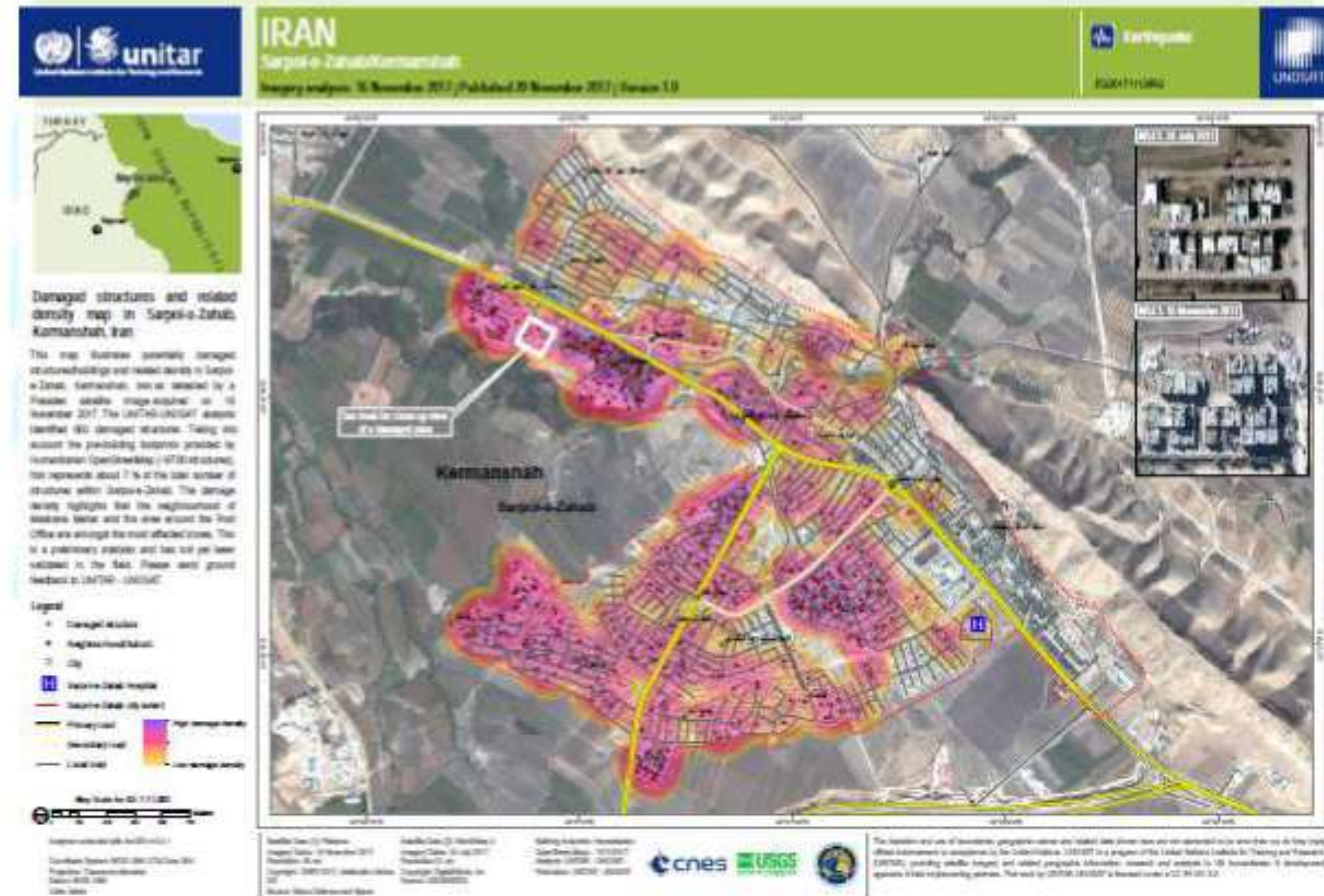
- Generally extended around the Alvand river branch, which originates from northern mountains at Rijab.
- From northeast blocked by the hills of Zagros ranges. From southwest stretches to the planting farms probably generated by the river's alluvium.
- Field observations confirm the thickness of the alluvium varies considerably from northeast to southwest from zero up to tens of meters. This give rise to the hypothesis that the distribution of building damages could be interpreted by site amplification of the earthquake.



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Sarpol-e Zahab, Damage Distribution

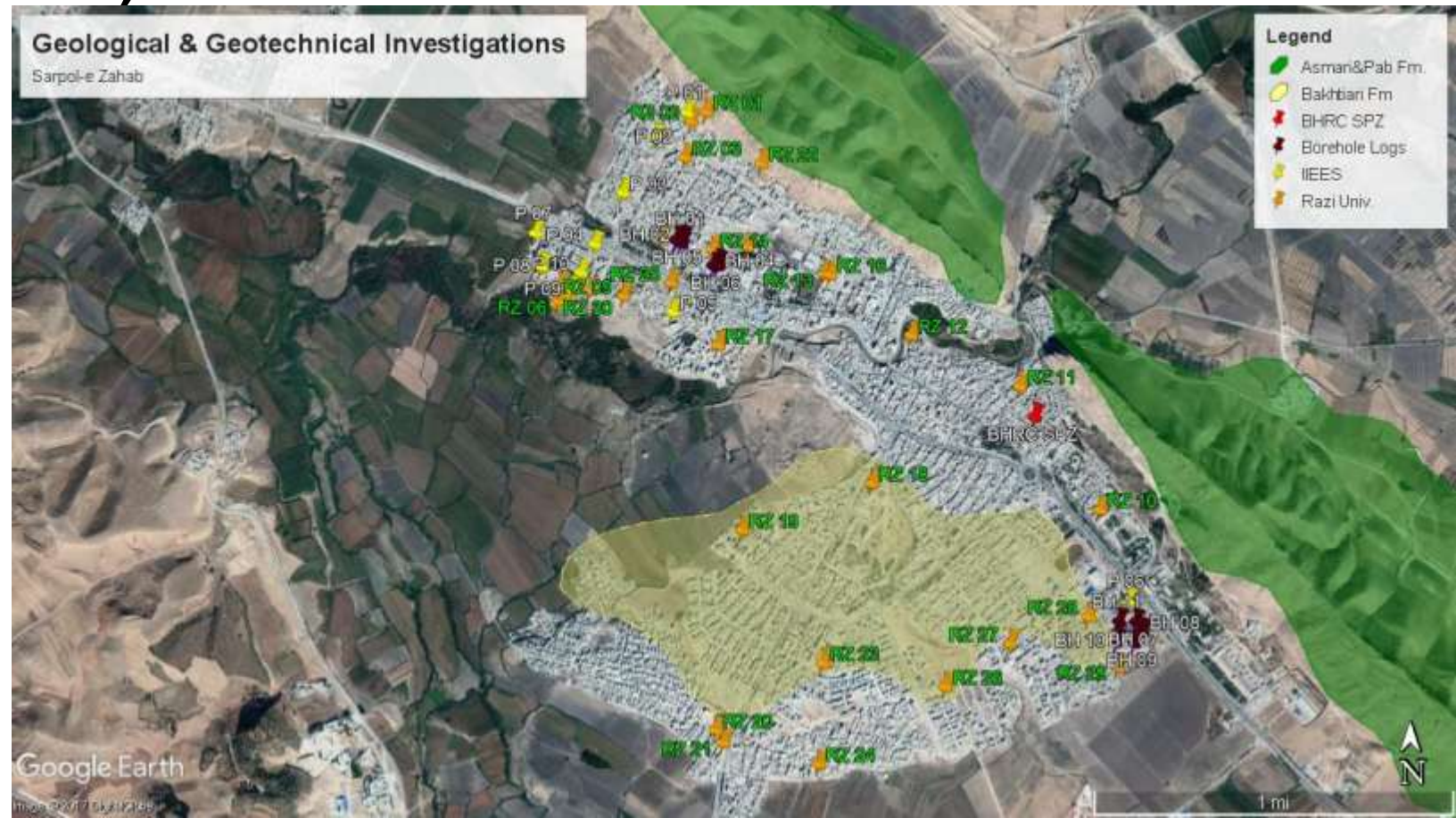
- Earthquake Damages to the structures are magnificent to the buildings lay below the Rah-e-Karbala Blvd. extended from southeast to northwest of the city. (Unitar image)



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Sarpol-e Zahab, Microtremor tests

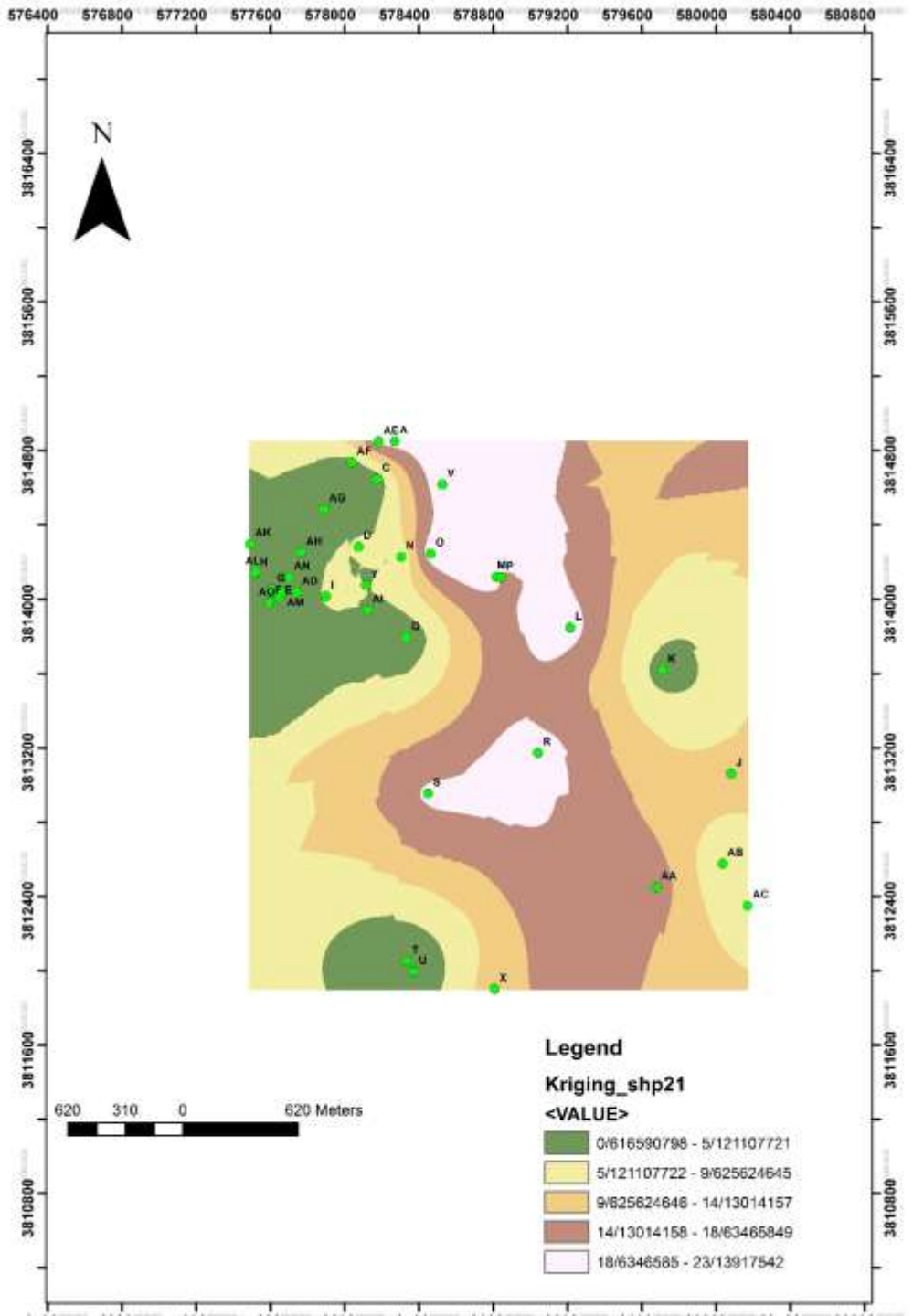
- The fastest way to validate the site effects of the earthquake was measurements of microtremors. Due to numerous after shocks, the records include them.
- To this time, 41 measurements were done within the vicinity of the city. (30 pts. by CME-4111 Broad Band Seismometer, 11 pts. by 5sec. Lennartz).



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Sarpol-e Zahab, Ground Na

- The Natural frequency and amplification maps were drawn.
- The Frequency map matches good with the geological map of the region.



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Sarpol-e Zahab, Ground Natural Frequency

- The proposed ground natural frequency map was validated by available borehole logs.
- Available borehole logs show layers of hard CL and very dense GC down to 10m at NE and 15m at NW. N_{SPT} ranges from 20 to 40 down to 10m and is almost >50 at lower depth.
- Unfortunately, no borehole logs were found yet in highly damaged regions.



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Sarpol-e Zahab, Microtremor on buildings

- Ambient Vibrations on top of 14 buildings (relatively damaged to undamaged) were measured (9 by CME 4111 and 5 by Lennartz) to capture 1st mode frequency of buildings after earthquake.



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Site $f_0 = 0.65$ Hz

Sarpol-e Zahab, Geohazard & Site E

- Extension of undamaged buildings including Code based buildings and non resistant building can be explained by the relative natural frequency of building and the ground.
- Extension of significantly damaged buildings may not be interpreted only by the closeness of site and building frequency but site-structure amplification can be named as second hand reason of the damage level.



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Report of 21st Aban 1396 (19th Nov 2017) Sanjoli Zahab Earthquake, Kermanshah Province

20th /



$f_0 = 0.9 \text{ Hz}$
BH Logs

ral Dist. $\approx 110 \text{ km}$



$f_0 = 1.3 \text{ Hz}$

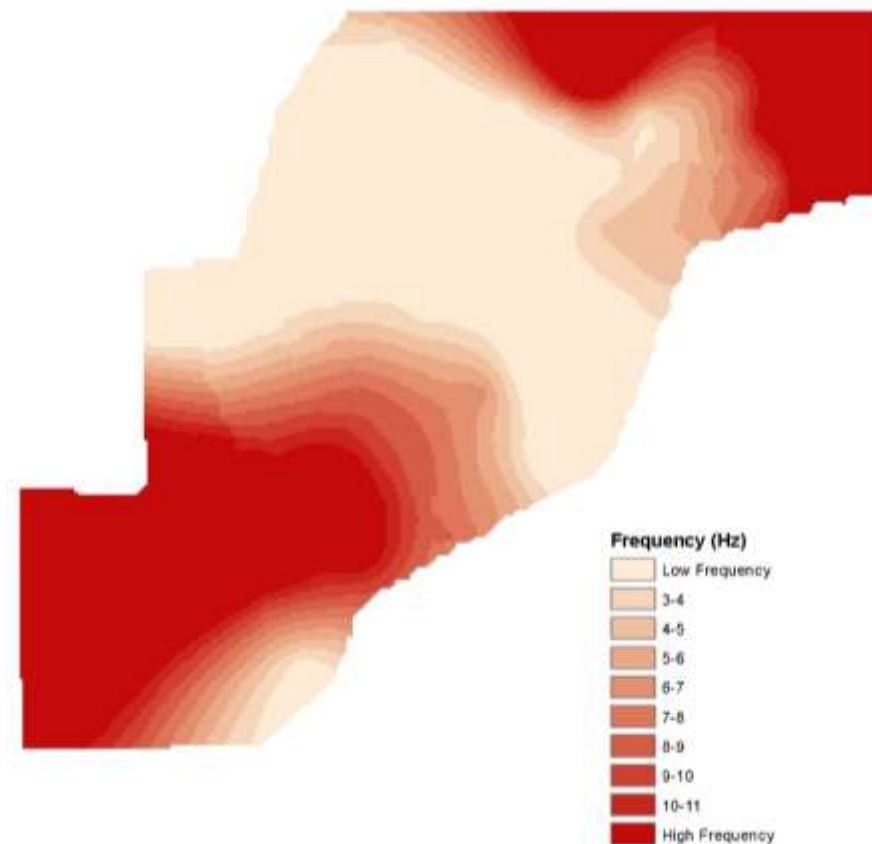


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Kermanshah, Epicentral Dist. \cong 130km

- Generally, the structural damage level was low, but the nonstructural damage was medium to high at central parts of the city where the ground natural frequency is below 3 Hz even for newly built structures.
- Surprisingly, the old texture of the city did not suffer damage of the earthquake, where they were built on stiff and rock sites.
- Surprisingly, the seismic microzonation of the Kermanshah city was performed according to world bank contract in 2008 and a research contract between Razi Univ. and MRUD in 2013, which predicted such damages.



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Concluding Remarks:

- Geohazards like site amplifications, lateral spreading, liquefaction, and landslide were observed in Sarpol-e Zahab.
- Geohazards can interpret the geographical distribution of damaged buildings, this is more obvious in far epicentral distances.
- Geohazards can also interpret the local distribution of damaged and undamaged buildings in closer epicentral distances.
- Results and knowledge from 21st Aban 1396 must be analyzed by expertise more to be used for local regulations in favor of less human and economic loss.

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Thanks to:

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- Razi University & IIEES.
- Kermanshah DRES office.
- **Every kind individuals who helped us on field observations and local Geotechnical tests.**