A 8.4-σ ANOMALY IS FOUND FROM THE 189 FILTERED EARTHQUAKES WITH THE MAXIMAL HORIZONTAL SHAKING RATIO $10^{M_w}/R^2_{EPI}$ AROUND 371 CITIES AFTER THE YEAR 1959, OVER 393 CITIES HAVING ENOUGH SEISMIC DATA AND AMONG A TOTAL OF 1230 LARGEST CITIES.

ALEXIS ZAGANIDIS

Abstract. A Specific Magnitude Budget for the Detection of 44 Nuclear Earthquakes near Large Urban Areas subject to a Natural Seismic Hazard was crucial for finding the typical parameters of the Nuclear Earthquakes : $5.9 - 7.9$ M_w, from 1st January 1960 to 15th September 2023, $R_i < 160$ km with the index i spanning the 1230 largest cities and having a maximal horizontal shaking ratio $10^{M_{w},i}/R_i^2$ for each specific city i satisfying these typical parameters. Therefore, it allows to build a filter $\mathcal{F}_Z$ and to filter out a total of 189 earthquakes around 372 cities with a relatively low background of Natural Earthquakes with respect to the Nuclear ones. By including the 189 filtered earthquakes around these 372 cities, there is a total of 393 cities having enough seismic data, with respect to a sufficiently large background of the recent smaller earthquakes around these same cities ($M_w \geq M_{w,0} = 4.0$, 1980-2022, $R_i < R_{max} = 160$ km, Gutenberg-Richter law and $\Delta N_i \geq 10^{5.9-4.0} > 79$ in the case of an absence of filtered earthquakes with the filter $\mathcal{F}_Z$), in order to derive the Probability Estimation of having a such maximal horizontal shaking ratio. Finally, there is a 8.4-σ anomaly from a statistical excess of the maximal horizontal shaking ratio of the filtered earthquakes with the filter $\mathcal{F}_Z$ and with a Probability Estimation Cutoff of < 0.43 (There is an artifact close to 1 arising from an exponential behavior inside the Probability Estimation formula of having a such maximal horizontal shaking ratio). Of course, by taking some random positions for the 1230 largest cities, it vanishes completely that 8.4-σ anomaly.

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The Probability Estimation of having a such maximal horizontal shaking ratio at a specific city i is the following :

$$dP_i \left(x > X_i = \frac{10^{M_{w,i}}}{R_i^2} \right)$$

$$= \frac{Log\,(10)}{10^{-M_w^{min}} - 10^{-M_w^{max}}} \int_{M_w^{min}}^{M_w^{max}} dm\ 10^{-m} \int_0^{Min\left(\sqrt{\frac{10^m}{X}}, R_{max}\right)} \frac{2\pi r dr}{\pi R_{max}^2}$$

$$\frac{(1 + \Delta N_i)}{\Delta T_i} \frac{10^{-M_w^{min}} - 10^{-M_w^{max}}}{10^{-M_{w,0}}} dt$$

(1) $$1/\tau_i = \Gamma_i = \frac{dP_i}{dt} \left(x > X_i = \frac{10^{M_w}}{R_i^2} \right)$$

(2) $$= Log\,(10)\, 10^{M_{w,0}} \frac{1 + \Delta N_i}{\Delta T_i} \int_{M_w^{min}}^{M_w^{max}} dm\ 10^{-m} Min \left(10^{m - M_{w,i}} \frac{R_i^2}{R_{max}^2}, 1 \right)$$

With the following values for the parameter of the filter $\mathcal{F}_Z$:

(3) $$P_i = 1 - e^{-T/\tau_i}\ with\ T = 63.7043\ years$$

$$M_w^{min} = 5.9\ ,\ M_w^{max} = 7.9\ ,\ M_{w,0} = 4.0$$

$$R_{max} = 160\ km$$

$$\Delta T_i = 2023 - 1980$$

$$- \Delta\tilde{T}\,(8\ years\ exclusion\ encompassing\ the\ X_i's\ aftershock\ sequence)$$

$$\Delta T_i = \|\,[1980, 2023]\,/\,[T_i, T_i + 8]\,\|$$

(4)

Where ΔN_i is the background number of the recent smaller earthquakes around a specific city i with $M_w \geq M_{w,0}$, $R_i < R_{max} = 160\ km$, from $1980 - 01 - 01T00 : 00 : 00.00$ to $2023 - 01 - 01T00 : 00 : 00.00$ with an exclusion period of 8 years encompassing the earthquake X_i's aftershock sequence and starting just before it. X_i is the powerful earthquake making the maximal horizontal shaking ratio at the specific city i within the above mentioned filtering ranges from the filter $\mathcal{F}_Z$. 837 cities have zero filtered earthquakes and do NOT have enough seismic data with respect to a sufficiently large background of the recent smaller earthquakes around them ($\Delta N_i < 10^{(M_{w,min} - M_{w,0})} = 10^{5.9-4.0} < 80$).

The recent smaller earthquakes are less detected and are less reported than the stronger earthquakes. Therefore, an additional empirical factor is needed to be included in the above formula :

$$\frac{1}{\left(10^{m1}-10^{m2}\right) R^2} 10^{-m} \left(10^{m} \left(10^{m1}-10^{m2}\right) R^2 \,\mathrm{Boole}\left[10^{m1} \geq \frac{10^{m} R^2}{r^2} \,||\, \frac{10^{m} R^2}{r^2} \leq 1\right] + 10^{m1+m2} (m1-m2)\, r^2 \,\mathrm{Boole}\left[\frac{10^{m} R^2}{r^2} \geq 10^{m2}\right] \mathrm{Log}[10] + 10^{m1}\,\mathrm{Boole}\left[\frac{10^{m1}}{R^2} < \frac{10^{m}}{r^2} < \frac{10^{m2}}{R^2}\right] \left(10^{m} R^2 + 10^{m2} r^2 \left(-1 + m1\,\mathrm{Log}[10] - \mathrm{Log}\left[\frac{10^{m} R^2}{r^2}\right]\right)\right)\right)$$

The Analytic Integral result from the Probability Estimation of having a such maximal horizontal shaking ratio is the following : $\frac{Log(10)}{10^{-m1}-10^{-m2}} \int_{m1}^{m2} dm' \; 10^{-m'} Min\left(10^{(m'-m)} \frac{r^2}{R^2}, 1\right)$ where $m1 = M_w^{min}, \; m2 = M_w^{max}, \; R = R_{max}, \; r = R_i, \; m = M_{w,i}$.

$$1/\tau_i = \Gamma_i = \frac{dP_i}{dt}\left(x > X_i = \frac{10^{M_{w,i}}}{R_i^2}\right)$$

(5) $$= Log\,(10)\, 10^{M_{w,0}} \frac{\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right)(1+\Delta N_i)}{\Delta T_i}$$

(6) $$\int_{M_w^{min}}^{M_w^{max}} dm \; 10^{-m} Min\left(10^{m-M_{w,i}} \frac{R_i^2}{R_{max}^2}, 1\right)$$

(7) $$\alpha\,(4.0, 5.9, 7.9) = 1.68$$

By taking some random positions for the 1230 largest cities, with the latitude ranging between 25° and 55°, we can find precisely the empirical detection factor $\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right) = 1.68$ with the constraint of a flat distribution for the Probability Estimation of having a such maximal horizontal shaking ratio.

The standard parameters of the 1230 largest cities are automatically imported with Mathematica. The 1st largest city is Shanghai with 24 870 895 inhabitants and the 1230th largest city is Skopje with 506 926. The 1977 Vrancea earthquake is 156.928 km away of Bucharest in Romania. The number of independent variables is not the 1230 largest cities since a single very powerful earthquake around a cluster of cities can make a maximal horizontal shaking for multiple cities. Moreover, a vast majority of cities (837 over 1230) do not have enough seismic data with respect to a sufficiently large background of the recent smaller earthquakes around the 1230 cities or do not have any filtered earthquakes with the filter $\mathcal{F}_Z$.

In the case of no earthquakes X_i is found for the maximal horizontal shaking ratio with the above mentioned filtering ranges from the the filter $\mathcal{F}_Z$ and in the case of a NOT sufficiently large background number of the recent smaller earthquakes ($N_i < 10^{\left(M_w^{min}-4.0\right)} < 80$), the seismic data are not enough and the median value of 1/2 is chosen for the Probability Estimation of having a such maximal horizontal shaking ratio. 837 cities over the 1230 cities are in that case.

In the case of no earthquakes X_i is found for the maximal horizontal shaking with the above mentioned filtering ranges from the filter $\mathcal{F}_Z$ and in the case of a sufficiently large background number of the recent smaller earthquakes ($N_i \geq 10^{\left(M_w^{min}-M_w^0\right)} = 10^{5.9-4.0} > 79$), we can derive a lower bound for the Probability Estimation of having a such maximal horizontal shaking ratio at that specific city i

(21 cities over a total of 1230 in that combined case). Therefore, in that combined case, the corresponding average Probability Estimation is the following :

$$\frac{1}{\tau_i^{min}} = \Gamma_i^{max} = \frac{dP_i^{max}}{dt}\left(x > X_i = \frac{10^{M_{w,i}}}{R_i^2}\right)$$

$$= \frac{10^{-M_w^{min}} - 10^{-M_w^{max}}}{10^{-M_{w,0}}} \frac{\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right)(1+\Delta N_i)}{\Delta T_i} \tag{8}$$

$$\bar{P}_i = \frac{1 - e^{-T/\tau_i} + 1}{2} = 1 - \frac{e^{-T/\tau_i}}{2} \tag{9}$$

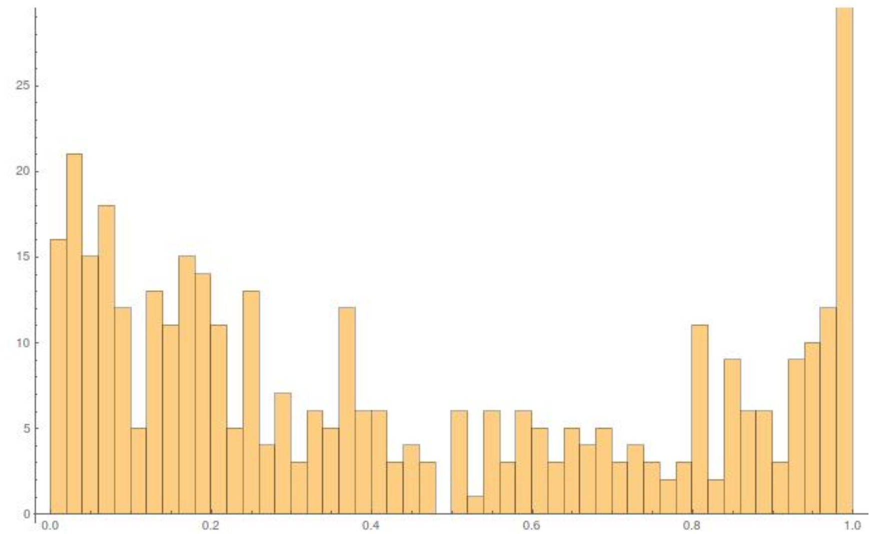
$$\alpha\,(4.0, 5.9, 7.9) = 1.68$$

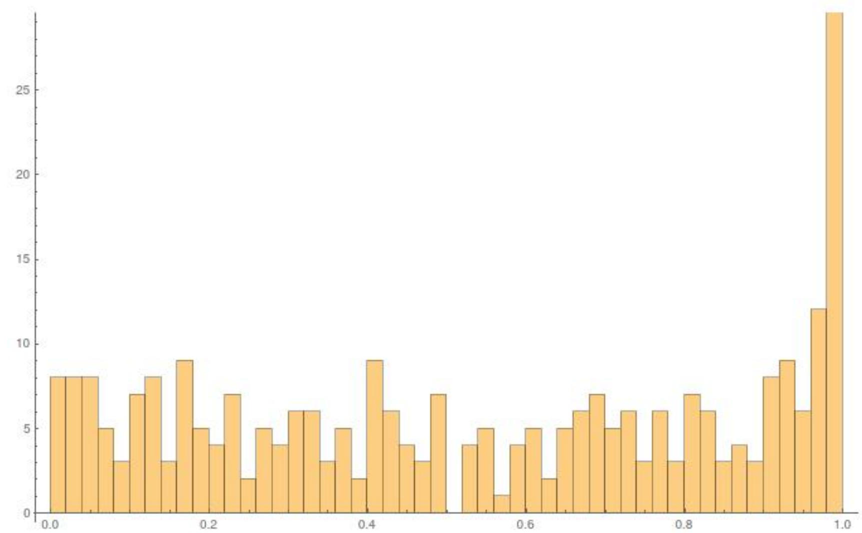
Only 21 cities over the 1230 cities are in that previous above case.

There is a 8.4-σ anomaly from a statistical excess of the maximal horizontal shaking ratio of the filtered earthquakes with the filter $\mathcal{F}_Z$ and with a Probability Estimation Cutoff of < 0.43. Among the 1230 largest cities, that statistical excess give the following interval range for the total number of Nuclear Earthquakes around the 93 large cities having enough seismic data AND satisfying the Probability Estimation Cutoff of < 0.43 (393 cities involved without that Probability Estimation Cutoff) : $[24, 73]$ with a median value of 48.

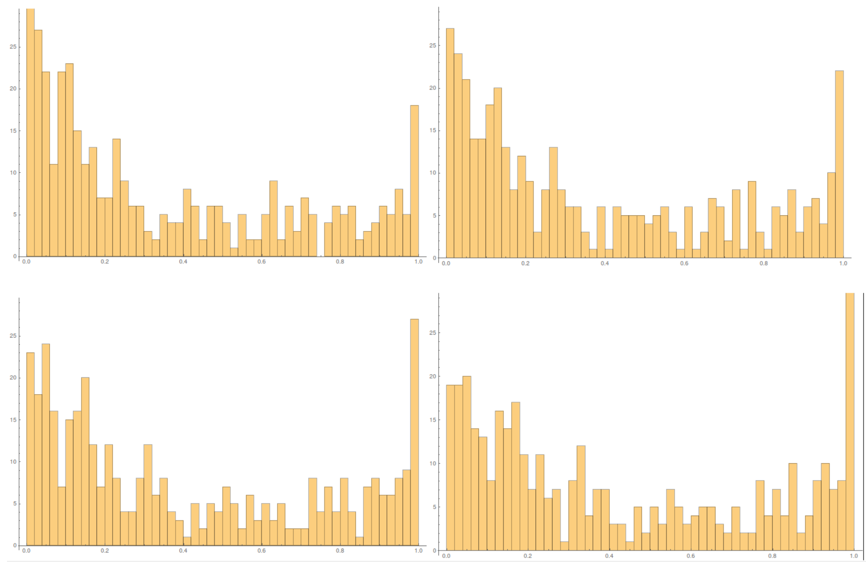
If we significantly relax the criteria for having enough seismic data with respect to a sufficiently large background of the recent smaller earthquakes ($N_i \geq 0.5 \times 10^{\left(M_w^{min} - 4.0\right)} > 39$), there is a small anomaly reduction down to 6.5-σ from a statistical excess of the maximal horizontal shaking ratio of the filtered earthquakes with the filter $\mathcal{F}_Z$ and with a Probability Estimation Cutoff of < 0.43. In that case, with the same filter $\mathcal{F}_Z$, we can still filter out a total of 189 earthquakes around 372 cities with a relatively low background of Nuclear Earthquakes. Including these 189 filtered earthquakes around the 372 corresponding cities, there is a total of 421 cities having enough seismic data (instead of a previous total of 393 cities) with respect to a sufficiently large background of the recent smaller earthquakes around these same cities ($M_w \geq M_{w,0} = 4.0$, 1980-2022, $R_i < R_{max} = 160\ km$, Gutenberg-Richter law and $\Delta N_i \geq 0.5 \times 10^{5.9-4.0} > 39$ in the case of an absence of filtered earthquakes with the filter $\mathcal{F}_Z$). Finally, by taking some random positions for the 1230 largest cities, with the latitude ranging between 25° and 55°, and with the empirical detection factor $\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right) = 1.68$, we still have a flat distribution for the probability Estimation but there is an unwanted anomaly enlargement up to 1.6-σ.

The largest cities of the following six former USSR countries in central Asia have experienced only 3 maximal horizontal shaking ratios despite there are a lot of seismic faults and a lot of mountain formations due to the Himalaya's neighborhood : Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and Mongolia. Moreover, the 3 maximal horizontal shaking ratios are all below the 63th position over a total of 189.





The abscissa of the two histograms is the Probability Estimation of having a such maximal horizontal shaking ratio for the 393 cities (the ones having enough seismic data for the Probability Estimation of having a such maximal horizontal shaking ratio or having a filtered earthquake with the filter $\mathcal{F}_Z$), among the 1230 largest cities. It is derived from the 179 independent filtered earthquakes with the filter $\mathcal{F}_Z$ and from the absence of the filtered earthquakes at 21 specific cities with respect to a sufficiently large background of the recent smaller earthquakes around these same cities ($M_w \geq M_{w,0} = 4.0$, 1980-2022, $R_i < R_{max} = 160\ km$ and Gutenberg-Richter law). The artifact close to 1 arises from an exponential behavior inside the Probability Estimation formula of having a such maximal horizontal shaking ratio. The second histogram is made by taking random positions for the 1230 largest cities for comparison. The empirical detection factor is $\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right) = 1.68$.



The abscissa of the two histograms is the Probability Estimation of having a such maximal horizontal shaking ratio for the 393 cities (the ones having enough seismic data for the Probability Estimation of the the maximal horizontal shaking ratio or having a filtered earthquake with the filter $\mathcal{F}_Z$), among the 1230 largest cities. It is derived from the 179 independent filtered earthquakes with the filter $\mathcal{F}_Z$ and from the absence of the filtered earthquakes at 21 specific cities with respect to a sufficiently large background of the recent smaller earthquakes around these same cities ($M_w \geq M_{w,0} = 4.0$, 1980-2022, $R_i < R_{max} = 160\ km$ and Gutenberg-Richter law). The artifact close to 1 arises from an exponential behavior inside the Probability Estimation formula of having a such maximal horizontal shaking ratio. The empirical detection factor are $\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right) = 1.00,\ 1.17,\ 1.34,\ 1.51$. Note, the first bar of the first histogram has a height of 31.

Cuba has experienced zero maximal horizontal shaking ratio while Haiti has experienced two maximal horizontal shaking ratio among the top ones.

The Korean peninsula has experienced zero maximal horizontal shaking ratio while Japan, near the Korean peninsula, has experienced 28 maximal horizontal shaking ratios among the top ones. For comparison, the Italian Peninsula has experienced 3 maximal horizontal shaking ratios while it is very far from the Ring of Fire unlike the Korean peninsula.

Despite it is the largest country of the world, Russia has experienced only 3 maximal horizontal shaking ratios among the smallest ones except for a relatively large one (48th position over a total of 189) in te Russian Republic of Dagestan, the most populated by Muslims in Russia.

Index	City	Population	GCS	Country	{r, Mw, 10^Mw/r^2, Probability, Inv Rate, Depth Renorm.}	{Date, GCS, Depth, Mw}
1	Agadir	600 000	{30.42, -9.61}	Morocco	{2.05554, 5.91, 192 374., 0.000282067, 225 816., 0.350944}	{1960-02-29T23:40:19.840Z, 30.434, -9.624, 10, 5.91}
2	Kumamoto	738 407	{32.8, 130.71}	Japan	{1.44027, 6.2, 764 032., 0.00221412, 28 739.9, 0.0845674}	{2016-04-14T12:26:35.730Z, 32.788, 130.704, 9, 6.2}
3	Dashiqiao	725 000	{40.64, 122.5}	China	{6.75099, 7, 219 414., 0.000666092, 95 607.1, 0.774472}	{1975-02-04T11:36:07.500Z, 40.641, 122.58, 33, 7}
4	Dujiangyan	610 000	{30.9, 103.5}	China	{20.4149, 7.9, 190 593., 0.00267842, 23 752.4, 0.420876}	{2008-05-12T06:28:01.570Z, 31.002, 103.322, 19, 7.9}
5	Tangshan	7 536 521	{39.62, 118.19}	China	{18.9967, 7.5, 87 628.6, 0.00224971, 28 284.8, 0.626353}	{1976-07-27T19:42:54.600Z, 39.57, 117.978, 23, 7.5}
6	Yuxi	2 143 600	{24.35, 102.533}	China	{18.3733, 7.1, 37 292.8, 0.010255, 6180.09, 0.281293}	{1970-01-04T17:00:41.090Z, 24.185, 102.543, 11.3, 7.1}
7	Gaziantep	1 556 381	{37.07, 37.39}	Turkey	{37.5254, 7.8, 44 807.3, 0.0155228, 4071.98, 0.419336}	{2023-02-06T01:17:34.342Z, 37.2256, 37.0143, 10, 7.8}
8	Carrefour	511 345	{18.53, -72.42}	Haiti	{18.6322, 7, 28 805.2, 0.0189149, 3335.98, 0.417046}	{2010-01-12T21:53:10.060Z, 18.443, -72.571, 13, 7}
9	Heyuan	3 489 800	{23.7333, 114.683}	China	{10.6406, 6, 8832.26, 0.00663448, 9570.11, 0.441609}	{1962-03-18T20:18:55.770Z, 23.82, 114.639, 15, 6}
10	Baku	2 122 300	{40.39, 49.86}	Azerbaijan	{17.6953, 6.8, 20 150.5, 0.0397229, 1571.65, 0.712181}	{2000-11-25T18:09:11.420Z, 40.245, 49.946, 50.4, 6.8}
11	Rasht	622 209	{37.3, 49.63}	Iran	{42.8778, 7.4, 13 662.7, 0.0296455, 2116.86, 0.387489}	{1990-06-20T21:00:09.980Z, 36.957, 49.409, 18.5, 7.4}
12	Kobe	1 536 499	{34.68, 135.17}	Japan	{17.5995, 6.9, 25 644.8, 0.0631339, 976.836, 0.0729146}	{1995-01-16T20:46:52.120Z, 34.583, 135.018, 21.9, 6.9}
13	Managua	1 042 641	{12.15, -86.27}	Nicaragua	{6.35552, 6.31, 50 547.3, 0.151623, 387.424, 0.0840371}	{1972-12-23T06:29:44.430Z, 12.184, -86.223, 10, 6.31}
14	Xinji	619 000	{37.91, 115.19}	China	{42.1419, 6.8, 3552.8, 0.0139048, 4549.54, 0.467946}	{1966-03-22T08:19:36.300Z, 37.545, 115.061, 20, 6.8}
15	Mexicali	689 775	{32.65, -115.47}	Mexico	{10.5532, 6.4, 22 554.6, 0.099279, 609.263, 0.951184}	{1979-10-15T23:16:53.910Z, 32.6673, -115.359, 15, 6.4}
16	Kathmandu	1 442 271	{27.71, 85.31}	Nepal	{81.1072, 7.8, 9591.39, 0.0448932, 1386.92, 0.1262}	{2015-04-25T06:11:25.950Z, 28.2305, 84.7314, 8.22, 7.8}
17	Adana	1 636 229	{37., 35.32}	Turkey	{13.6149, 6.3, 10 764., 0.0600633, 1028.44, 1.05878}	{1998-06-27T13:55:52.080Z, 36.878, 35.307, 33, 6.3}
18	San Jose	1 013 240	{37.2969, -121.819}	United States	{12.5059, 6.2, 10 133.8, 0.0621353, 993.058, 0.488244}	{1984-04-24T21:15:18.760Z, 37.3097, -121.679, 8.193, 6.2}
19	Maracay	955 362	{10.33, -67.47}	Venezuela	{29.7115, 6.6, 4509.74, 0.0286633, 2190.5, 0.892106}	{1967-07-30T00:00:04.220Z, 10.559, -67.33, 25, 6.6}
20	Xingtai	7 104 103	{37.07, 114.49}	China	{35.4527, 6.5, 2515.94, 0.0177362, 3559.83, $\frac{1}{2}$}	{1966-03-07T21:29:19.070Z, 37.156, 114.875, 25, 6.5}
21	Ürümqi	2 411 900	{43.8, 87.58}	China	{18.9418, 6.5, 8813.73, 0.0683619, 899.641, 0.871287}	{1965-11-13T04:33:53.500Z, 43.759, 87.809, 45, 6.5}
22	Quito	2 671 191	{-0.220169, -78.5121}	Ecuador	{9.24444, 6, 11 701.4, 0.0924528, 656.68, 0.965174}	{1967-03-02T02:47:33.450Z, -0.214, -78.595, 118.9, 6}
23	Rajkot	1 286 678	{22.31, 70.79}	India	{135.92, 7.7, 2712.88, 0.0301985, 2077.51, 0.57172}	{2001-01-26T03:16:40.500Z, 23.419, 70.232, 16, 7.7}
24	Mudanjiang	2 798 723	{44.58, 129.6}	China	{37.9869, 6.4, 1740.73, 0.0214356, 2939.92, $\frac{1}{2}$}	{2002-09-15T08:39:32.700Z, 44.833, 129.923, 586.3, 6.4}
25	Acapulco	687 608	{16.85, -99.92}	Mexico	{20.7565, 7, 23 210.9, 0.289846, 186.121, 0.432349}	{2021-09-08T01:47:47.437Z, 16.9465, -99.753, 20, 7}

The grid of filtered earthquake with the filter $\mathcal{F}_Z$ having a relatively low background of Natural Earthquake with respect to the Nuclear ones. The grid has been sorted with respect to the ratio of the Probability Estimation of having a such maximal horizontal shaking ratio to the value of that maximal horizontal shaking ratio.

26	Los Angeles	3 849 297	{34.0194, -118.411}	United States	{24.4617, 6.7, 8375.8, 0.12483, 477.769, 1.20446}	{1994-01-17T12:30:55.390Z, 34.213, -118.537, 18.202, 6.7}
27	Niigata	801 298	{37.92, 139.04}	Japan	{57.5727, 7.6, 12 010.6, 0.185835, 309.858, 0.146181}	{1964-06-16T04:01:43.570Z, 38.399, 139.29, 15, 7.6}
28	Djibouti	610 608	{11.56, 43.15}	Djibouti	{12.8395, 6.19, 9395.21, 0.146876, 401.034, 0.756904}	{1961-03-11T08:41:08.690Z, 11.64, 43.065, 15, 6.19}
29	Cangzhou	7 134 062	{38.32, 116.87}	China	{28.5402, 6.1, 1545.56, 0.0249045, 2525.96, $\frac{1}{2}$}	{1967-03-27T08:58:24.910Z, 38.474, 116.608, 29.7, 6.1}
30	Skopje	506 926	{42., 21.47}	North Macedonia	{10.3318, 6, 9368.03, 0.151376, 388.113, 0.652059}	{1963-07-26T04:17:17.770Z, 41.998, 21.345, 15, 6}
31	Istanbul	15 569 856	{41.1, 29.}	Turkey	{82.4691, 7.6, 5853.53, 0.0957202, 633.14, 0.69744}	{1999-08-17T00:01:39.130Z, 40.748, 29.864, 17, 7.6}
32	Chiba	975 669	{35.61, 140.11}	Japan	{5.39806, 5.9, 27 260., 0.471888, 99.7802, 0.626212}	{2021-10-07T13:41:24.528Z, 35.5736, 140.071, 62, 5.9}
33	Taichung	1 073 635	{24.15, 120.68}	Taiwan	{52.0416, 7.7, 18 505.4, 0.362993, 141.259, 0.646383}	{1999-09-20T17:47:18.490Z, 23.772, 120.982, 33, 7.7}
34	Bogor	1 030 720	{-6.58, 106.79}	Indonesia	{9.08081, 6, 12 126.9, 0.25302, 218.378, 0.811492}	{1974-05-17T20:55:11.200Z, -6.513, 106.837, 131, 6}
35	Marrakech	928 850	{31.63, -8.}	Morocco	{73.8373, 6.8, 1157.31, 0.0249055, 2525.85, $\frac{1}{2}$}	{2023-09-08T22:11:01.432Z, 31.0549, -8.3887, 19, 6.8}
36	Hiroshima	1 306 589	{34.39, 132.44}	Japan	{35.0403, 6.8, 5138.84, 0.126418, 471.349, 0.532586}	{2001-03-24T06:27:53.580Z, 34.083, 132.526, 50, 6.8}
37	Dali	616 000	{25.7, 100.15}	China	{14.5291, 6.1, 5963.81, 0.15316, 383.199, 0.183802}	{2021-05-21T13:48:37.193Z, 25.7274, 100.008, 9, 6.1}
38	Kupwara	875 564	{34.03, 74.26}	India	{83.7556, 7.6, 5675.08, 0.16567, 351.713, 0.432723}	{2005-10-08T03:50:40.800Z, 34.539, 73.588, 26, 7.6}
39	Padang	1 000 096	{-0.95, 100.35}	Indonesia	{59.4801, 7.6, 11 252.7, 0.366966, 139.326, 1.00656}	{2009-09-30T10:16:09.250Z, -0.72, 99.867, 81, 7.6}
40	Bekasi	2 663 011	{-6.22, 106.97}	Indonesia	{63.8463, 7.5, 7757.62, 0.256598, 214.841, 1.43845}	{2007-08-08T17:05:04.920Z, -5.859, 107.419, 280, 7.5}
41	Trujillo	682 834	{-8.11, -79.03}	Peru	{123.581, 7.9, 5201.09, 0.174831, 331.505, 0.460508}	{1970-05-31T20:23:29.780Z, -9.183, -78.737, 45, 7.9}
42	Tuxtla Gutiérrez	598 710	{16.75, -93.12}	Mexico	{38.4759, 7.2, 10 705.9, 0.377068, 134.591, 0.690864}	{1995-10-21T02:38:57.120Z, 16.84, -93.469, 159.3, 7.2}
43	Qinhuangdao	2 897 605	{39.93, 119.62}	China	{108.259, 7.4, 2143.24, 0.0783177, 781.124, 0.729036}	{1976-07-28T10:45:35.200Z, 39.664, 118.401, 26, 7.4}
44	Puebla	1 539 859	{19.05, -98.22}	Mexico	{62.388, 7.1, 3234.43, 0.118321, 505.88, 0.450481}	{2017-09-19T18:14:38.090Z, 18.5499, -98.4887, 48, 7.1}
45	Palembang	1 708 402	{-2.99, 104.75}	Indonesia	{105.897, 7.3, 1779.22, 0.0730676, 839.599, 1.40716}	{2004-07-25T14:35:19.060Z, -2.427, 103.981, 582.1, 7.3}
46	Lincang	2 396 000	{23.8833, 100.083}	China	{130.889, 7.7, 2925.45, 0.121117, 493.438, 0.47688}	{1988-11-06T13:03:19.340Z, 22.789, 99.611, 17.8, 7.7}
47	Lima	9 751 717	{-12.0433, -77.0283}	Peru	{86.9064, 7.6, 5271.04, 0.240447, 231.631, 0.115666}	{1974-10-03T14:21:29.100Z, -12.265, -77.795, 13, 7.6}
48	Makhachkala	592 976	{42.98, 47.5}	Russia	{37.4856, 6.7, 3566.73, 0.202042, 282.253, 0.239923}	{1970-05-14T18:12:26.610Z, 43.191, 47.14, 15, 6.7}
49	Athens	664 046	{37.98, 23.73}	Greece	{14.7386, 6.2, 7296.04, 0.417553, 117.858, 3.00327}	{1964-07-17T02:34:27.670Z, 38.092, 23.64, 152.7, 6.2}
50	Simao	2 496 400	{22.78, 100.98}	China	{19.6417, 6.04, 2842.11, 0.189314, 303.535, 0.260777}	{1971-04-28T15:32:02.450Z, 22.917, 101.101, 10, 6.04}

The grid of filtered earthquake with the filter $\mathcal{F}_Z$ having a relatively low background of Natural Earthquake with respect to the Nuclear ones. The grid has been sorted with respect to the ratio of the Probability Estimation of having a such maximal horizontal shaking ratio to the value of that maximal horizontal shaking ratio.

Azerbaijan under the Turkey influence has experienced a maximal horizontal shaking ratio 15x larger than the one experienced by the neighboring country Armenia under the Russia influence.

USSR has developed very much and very early : heavy machinery, automated guidance of satellites, nuclear submarines and gyrotron $\rightarrow$ automated and autonomous guidance of Nuclear-Powered subterrenes carrying a dozen of nuclear warheads $\rightarrow$ 44 Nuclear Earthquakes near Large Urban Areas subject to a Natural Seismic Hazard. These nuclear warheads should have an underground spatial configuration that minimizes the seismic P-waves with destructive interferences.

51	Yogyakarta	636 660	{-7.78, 110.37}	Indonesia	{21.7978, 6.3, 4199.28, 0.286377, 188.809, 0.0779212}	{2006-05-26T22:53:58.920Z, -7.961, 110.446, 12.5, 6.3}
52	San Salvador	567 698	{13.69, -89.19}	El Salvador	{45.1476, 7.29, 9566.01, 0.685394, 55.0869, 0.579666}	{1982-06-19T06:21:58.540Z, 13.332, -89.387, 73, 7.29}
53	Sulaymaniyah	656 100	{35.55, 45.45}	Iraq	{84.7883, 7.3, 2775.41, 0.20332, 280.262, 0.313066}	{2017-11-12T18:18:17.180Z, 34.9109, 45.9592, 19, 7.3}
54	Chiclayo	524 442	{-6.76, -79.84}	Peru	{119.043, 7.6, 2809.27, 0.209267, 271.319, 0.168204}	{1960-11-20T22:01:57.160Z, -6.775, -80.918, 15, 7.6}
55	Salta	535 303	{-24.79, -65.41}	Argentina	{21.4139, 6.3, 4351.2, 0.357956, 143.77, 0.0290183}	{2010-02-27T15:45:37.000Z, -24.872, -65.602, 10, 6.3}
56	Villavicencio	516 802	{4.15, -73.64}	Colombia	{22.3349, 6.1, 2523.67, 0.214062, 264.467, 0.120664}	{2023-08-17T17:04:48.717Z, 4.3451, -73.5921, 10, 6.1}
57	Villa Nueva	1 500 000	{14.53, -90.59}	Guatemala	{14.4834, 6.2, 7555.41, 0.659756, 59.0898, 1.33316}	{2013-03-25T23:02:12.770Z, 14.487, -90.463, 189, 6.2}
58	Cebu City	922 611	{10.3111, 123.892}	Philippines	{53.9363, 7.1, 4327.5, 0.37815, 134.098, 0.11675}	{2013-10-15T00:12:32.050Z, 9.8796, 124.117, 19.04, 7.1}
59	Arequipa	1 000 351	{-16.39, -71.53}	Peru	{22.867, 6.49, 5909.93, 0.549837, 79.8154, 0.733279}	{1964-01-26T09:09:35.250Z, -16.402, -71.744, 117.7, 6.49}
60	Fukuoka	1 567 189	{33.59, 130.41}	Japan	{35.3327, 6.6, 3188.94, 0.299134, 179.228, 0.142553}	{2005-03-20T01:53:41.830Z, 33.807, 130.131, 10, 6.6}
61	San Pedro Sula	719 063	{15.47, -88.03}	Honduras	{115.956, 7.5, 2351.88, 0.22524, 249.624, 0.129531}	{1976-02-04T09:01:43.400Z, 15.324, -89.101, 5, 7.5}
62	Malang	820 243	{-7.98, 112.62}	Indonesia	{32.9476, 6.6, 3667.34, 0.356531, 144.493, 0.908451}	{1998-09-28T13:34:30.490Z, -8.194, 112.413, 151.6, 6.6}
63	Bishkek	937 400	{42.87, 74.57}	Kyrgyzstan	{114.912, 7.3, 1511.01, 0.149188, 394.298, 0.78507}	{1992-08-19T02:04:37.410Z, 42.142, 73.575, 27.4, 7.3}
64	Seattle	737 015	{47.6205, -122.351}	United States	{37.2038, 6.7, 3620.98, 0.362933, 141.289, 13.7585}	{1965-04-29T15:28:45.750Z, 47.288, -122.406, 64.7, 6.7}
65	Cape Town	3 740 026	{-33.93, 18.46}	South Africa	{113.02, 6.3, 156.204, 0.0160025, 3948.97, $\frac{1}{2}$}	{1969-09-29T20:03:30.590Z, -33.268, 19.386, 15, 6.3}
66	Sana	1 937 451	{15.38, 44.21}	Yemen	{77.6513, 6.3, 330.904, 0.0350339, 1786.32, $\frac{1}{2}$}	{1982-12-13T09:12:48.050Z, 14.701, 44.379, 5, 6.3}
67	Dongying	1 845 900	{37.5, 118.52}	China	{128.958, 6.9, 477.643, 0.0571851, 1081.84, $\frac{1}{2}$}	{1969-07-18T05:24:47.580Z, 38.31, 119.572, 10, 6.9}
68	San Jose del Monte	574 089	{14.8139, 121.045}	Philippines	{97.1509, 7.7, 5310.14, 0.66141, 58.824, 0.135615}	{1990-07-16T07:26:34.610Z, 15.679, 121.172, 25.1, 7.7}
69	Vladivostok	583 673	{43.13, 131.9}	Russia	{118.014, 7.3, 1432.61, 0.180259, 320.497, 0.44388}	{1994-07-21T18:36:31.740Z, 42.34, 132.865, 471.4, 7.3}
70	Kagoshima	596 319	{31.59, 130.56}	Japan	{88.1672, 7.54, 4460.53, 0.576317, 74.1808, 0.317698}	{1961-02-26T18:10:52.290Z, 31.739, 131.475, 35, 7.54}
71	Baotou	2 195 900	{40.6, 110.05}	China	{38.0806, 6, 689.593, 0.0906392, 670.477, 0.567628}	{1996-05-03T03:32:47.110Z, 40.774, 109.661, 26, 6}
72	Utsunomiya	519 025	{36.56, 139.89}	Japan	{113.568, 7.9, 6158.72, 0.840534, 34.6988, 0.365534}	{2011-03-11T06:15:40.280Z, 36.281, 141.111, 42.6, 7.9}
73	Santiago	1 142 947	{19.48, -70.69}	Dominican Republic	{33.0728, 6.4, 2296.45, 0.337967, 154.457, 0.127849}	{2003-09-22T04:45:36.240Z, 19.777, -70.673, 10, 6.4}
74	Santiago	6 685 685	{-33.46, -70.64}	Chile	{103.803, 7.8, 5855.68, 0.885674, 29.3744, 0.714606}	{1971-07-09T03:03:20.680Z, -32.601, -71.076, 60.3, 7.8}
75	Algiers	2 239 613	{36.77, 3.04}	Algeria	{57.0751, 6.8, 1936.9, 0.317536, 166.745, 0.541484}	{2003-05-21T18:44:20.100Z, 36.964, 3.634, 12, 6.8}

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76	Valencia	1 408 400	{10.23, -67.98}	Venezuela	{53.5766, 6.4, 875.085, 0.163904, 355.867, 0.415765}	{2009-09-12T20:06:25.470Z, 10.709, -67.927, 14, 6.4}
77	Sendai	1 086 012	{38.26, 140.89}	Japan	{99.7106, 7.7, 5041., 0.969725, 18.2147, 0.477037}	{1978-06-12T08:14:26.400Z, 38.19, 142.028, 44, 7.7}
78	Kerman	515 114	{30.3, 57.08}	Iran	{75.7024, 7.1, 2196.75, 0.444287, 108.432, 0.926991}	{1981-07-28T17:22:24.620Z, 30.013, 57.794, 33, 7.1}
79	Sholapur	951 558	{17.67, 75.89}	India	{73.9176, 6.2, 290.071, 0.0632499, 974.986, $\frac{1}{2}$}	{1993-09-29T22:25:48.620Z, 18.066, 76.451, 6.8, 6.2}
80	Shizuoka	696 291	{34.98, 138.39}	Japan	{15.6014, 5.97, 3834.18, 0.849934, 33.5873, 0.291903}	{1965-04-19T23:42:00.970Z, 34.848, 138.332, 35, 5.97}
81	Zagreb	792 875	{45.8, 15.97}	Croatia	{47.3673, 6.4, 1119.55, 0.249985, 221.455, 0.434596}	{2020-12-29T11:19:54.762Z, 45.4244, 16.2573, 10, 6.4}
82	Zhaotong	5 610 400	{27.32, 103.72}	China	{34.0497, 6.2, 1367.01, 0.361524, 141.984, 0.222883}	{2014-08-03T08:30:13.570Z, 27.1891, 103.409, 12, 6.2}
83	Bucaramanga	521 857	{7.13, -73.13}	Colombia	{43.9399, 6.78, 3120.92, 0.894648, 28.3073, 0.537566}	{1967-07-29T10:24:25.750Z, 6.747, -73.032, 161.2, 6.78}
84	Izmir	2 847 691	{38.43, 27.15}	Turkey	{67.3317, 7, 2205.77, 0.638017, 62.6914, 0.851832}	{2020-10-30T11:51:27.348Z, 37.8973, 26.7838, 21, 7}
85	Bukavu	870 954	{-2.51, 28.84}	Democratic Republic of the Congo	{24.7117, 5.9, 1300.75, 0.393763, 127.285, 0.440964}	{2008-02-03T07:34:12.180Z, -2.296, 28.9, 10, 5.9}
86	Yerevan	1 060 138	{40.17, 44.52}	Armenia	{123.986, 7.3, 1297.95, 0.407413, 121.746, 1.07618}	{1976-11-24T12:22:18.800Z, 39.121, 44.029, 36, 7.3}
87	Perth	2 039 200	{-31.96, 115.84}	Australia	{124.351, 6.5, 204.505, 0.0654632, 940.92, $\frac{1}{2}$}	{1968-10-14T02:58:52.950Z, -31.566, 117.071, 15, 6.5}
88	Xalapa	525 147	{19.53, -96.92}	Mexico	{138.294, 7, 522.866, 0.176366, 328.323, 1.12184}	{1999-06-15T20:42:05.930Z, 18.386, -97.436, 70, 7}
89	Davao	1 632 991	{7.07306, 125.613}	Philippines	{108.402, 7.5, 2691.07, 0.972378, 17.7492, 0.212059}	{2001-01-01T06:57:04.170Z, 6.898, 126.579, 33, 7.5}
90	Cagayan de Oro	553 966	{8.48222, 124.647}	Philippines	{104.285, 7.3, 1834.65, 0.703619, 52.3837, 3.54757}	{1984-03-05T03:33:50.990Z, 8.147, 123.762, 649.1, 7.3}
91	Dehra Dun	578 420	{30.34, 78.05}	India	{84.8481, 6.8, 876.427, 0.342315, 152.028, 0.181925}	{1991-10-19T21:23:14.300Z, 30.78, 78.774, 10.3, 6.8}
92	Guayaquil	2 644 891	{-2.21, -79.9}	Ecuador	{63.9833, 6.8, 1541.23, 0.658056, 59.3643, 0.626811}	{2023-03-18T17:12:52.481Z, -2.7834, -79.8518, 68, 6.8}
93	Bucharest	2 106 144	{44.44, 26.1}	Romania	{156.928, 7.5, 1284.1, 0.600616, 69.4074, 0.391661}	{1977-03-04T19:21:54.100Z, 45.772, 26.761, 94, 7.5}
94	Tabriz	1 494 998	{38.08, 46.3}	Iran	{53.6559, 6.4, 872.498, 0.419551, 117.114, 0.223275}	{2012-08-11T12:23:18.190Z, 38.329, 46.826, 11, 6.4}
95	Naples	967 068	{40.85, 14.27}	Italy	{92.4136, 6.9, 930.096, 0.466172, 101.491, 0.0323955}	{1980-11-23T18:34:53.800Z, 40.914, 15.366, 10, 6.9}
96	Cali	2 445 281	{3.44, -76.52}	Colombia	{77.6162, 6.8, 1047.36, 0.546152, 80.639, 0.0671484}	{1994-06-06T20:47:40.530Z, 2.917, -76.057, 12.1, 6.8}
97	Lilongwe	674 448	{-13.97, 33.8}	Malawi	{73.2735, 6.2, 295.193, 0.154456, 379.7, 0.721772}	{1989-03-10T21:49:45.860Z, -13.702, 34.42, 30.3, 6.2}
98	Barcelona	620 555	{10.13, -64.72}	Venezuela	{144.657, 7, 477.885, 0.271222, 201.35, 0.793837}	{1997-07-09T19:24:13.170Z, 10.598, -63.486, 19.9, 7}
99	Qom	959 116	{34.65, 50.95}	Iran	{150.467, 7, 441.69, 0.256837, 214.608, 0.392226}	{1962-09-01T19:20:41.480Z, 35.656, 49.843, 15, 7}
100	Hailakandi	659 260	{24.67, 92.57}	India	{32.5993, 6, 940.986, 0.558056, 78.0144, 0.248874}	{1984-12-30T23:33:37.720Z, 24.641, 92.891, 22.6, 6}

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Russia may have hundreds of nuclear-powered underground nuclear missiles with fully automatic and autonomous guidance (measuring wheel, artificial horizon and compass for 3D guidance). These underground missiles may take between 2 and 15 years to reach their planned underground destination with the following speed :

$$v = \eta_G \frac{4P_{reactor}}{\pi R^2 H_{vap}} \cong 0.5 \times \frac{4 \times 190 \times 10^6}{\pi \times (15/4)^2 \times 25 \times 10^9} \times 3600 \cong 1.24\ m/hour \qquad (10)$$

The underground version of a nuclear submarine would be much longer because of a large heat dissipation constraint and would be significantly thinner to avoid an unnecessary energy consuming vaporization of rocks and to avoid a very energy

101	Yokohama	3 732 616	{35.47, 139.62}	Japan	{55.1514, 6.7, 1647.73, 0.999925, 6.70637, 0.637489}	{1987-12-17T02:08:19.920Z, 35.362, 140.214, 62.9, 6.7}
102	San Francisco	873 965	{37.7599, -122.437}	United States	{94.3482, 6.9, 892.345, 0.559663, 77.6678, 1.22429}	{1989-10-18T00:04:15.190Z, 37.0362, -121.88, 17.214, 6.9}
103	Santo Domingo	1 111 838	{18.48, -69.91}	Dominican Republic	{81.7992, 6.9, 1187.14, 0.803796, 39.116, 0.143609}	{1984-06-24T11:17:11.920Z, 17.984, -69.338, 23.9, 6.9}
104	Almaty	1 797 431	{43.32, 76.92}	Kazakhstan	{147.001, 7.1, 582.588, 0.394656, 126.912, 0.71283}	{1978-03-24T21:05:48.200Z, 42.839, 78.606, 33, 7.1}
105	Veracruz	552 156	{19.19, -96.14}	Mexico	{113.399, 6.8, 490.662, 0.338002, 154.437, 0.861987}	{1973-08-28T09:50:40.000Z, 18.267, -96.598, 84, 6.8}
106	Siliguri	513 264	{26.73, 88.42}	India	{114.238, 6.9, 608.661, 0.425644, 114.885, 0.709703}	{2011-09-18T12:40:51.830Z, 27.73, 88.155, 50, 6.9}
107	Diyarbakır	930 266	{37.92, 40.23}	Turkey	{75.1713, 6.7, 886.942, 0.620979, 65.6634, 1.34675}	{1975-09-06T09:20:10.900Z, 38.474, 40.723, 26, 6.7}
108	Quetta	1 172 000	{30.21, 67.02}	Pakistan	{67.8844, 6.7, 1087.58, 0.805139, 38.9517, 0.231393}	{1975-10-03T05:14:23.300Z, 30.251, 66.315, 11, 6.7}
109	Yibin	5 349 299	{28.77, 104.57}	China	{79.8425, 6.8, 989.763, 0.738077, 47.551, 0.287824}	{1974-05-10T19:25:15.000Z, 28.243, 104.015, 11, 6.8}
110	Tbilisi	1 118 035	{41.72, 44.79}	Georgia	{95.88, 6.8, 686.347, 0.517569, 87.3958, 0.128537}	{1988-12-07T07:41:24.200Z, 40.987, 44.185, 5.4, 6.8}
111	Kabul	3 678 034	{34.53, 69.17}	Afghanistan	{34.9985, 6, 816.396, 0.675383, 56.6206, 0.366645}	{1999-02-11T14:08:51.680Z, 34.259, 69.364, 33, 6}
112	Cochabamba	632 013	{-17.38, -66.17}	Bolivia	{61.6264, 6.3, 525.372, 0.447241, 107.458, 1.8594}	{2019-03-15T05:03:50.060Z, -17.8744, -65.9072, 359, 6.3}
113	Fresno	542 107	{36.7827, -119.794}	United States	{76.7668, 6.7, 850.459, 0.770489, 43.2832, 0.75939}	{1983-05-02T23:42:38.060Z, 36.2317, -120.312, 9.578, 6.7}
114	Medan	2 210 625	{3.59, 98.67}	Indonesia	{50.5491, 6.3, 780.861, 0.736153, 47.8122, 0.989378}	{2006-12-01T03:58:21.650Z, 3.39, 99.079, 204, 6.3}
115	Sapporo	1 951 523	{43.06, 141.34}	Japan	{63.5249, 6.6, 986.534, 0.981702, 15.9223, 0.198738}	{2018-09-05T18:07:59.150Z, 42.6861, 141.929, 35, 6.6}
116	Palermo	673 735	{38.12, 13.36}	Italy	{41.5804, 6, 578.393, 0.579257, 73.5843, 0.0210651}	{2002-09-06T01:21:28.600Z, 38.381, 13.701, 5, 6}
117	Bacolod City	561 875	{10.6667, 122.95}	Philippines	{79.3467, 6.7, 796.053, 0.815941, 37.6392, 0.137057}	{2012-02-06T03:49:12.520Z, 9.999, 123.206, 11, 6.7}
118	Mandalay	1 225 133	{21.98, 96.09}	Myanmar	{115.903, 6.8, 469.692, 0.51054, 89.1653, 0.103007}	{2012-11-11T01:12:38.870Z, 23.005, 95.885, 13.7, 6.8}
119	Hachiōji	576 768	{35.66, 139.33}	Japan	{37.7299, 6.1, 884.357, 0.999991, 5.48702, 0.532597}	{1968-07-01T10:45:12.550Z, 35.999, 139.348, 60.6, 6.1}
120	Longnan	2 567 718	{33.4, 104.917}	China	{101.003, 6.9, 778.63, 0.888614, 29.0258, 0.603218}	{1976-08-16T14:06:45.900Z, 32.752, 104.157, 16, 6.9}
121	Barquisimeto	1 995 770	{10.05, -69.3}	Venezuela	{49.8304, 6.1, 507.003, 0.589414, 71.5642, 1.02254}	{1975-04-05T09:34:36.600Z, 10.04, -69.755, 33, 6.1}
122	Hamamatsu	793 904	{34.72, 137.73}	Japan	{138.586, 7.2, 825.205, 0.998182, 10.0955, 1.67294}	{1984-01-01T09:03:38.850Z, 33.683, 136.894, 368.1, 7.2}
123	Dar es Salaam	4 715 000	{-6.82, 39.28}	Tanzania	{81.8783, 6, 149.164, 0.190189, 301.981, 0.70149}	{2020-08-12T17:13:16.180Z, -7.3327, 39.8126, 17.55, 6}
124	Denizli	511 751	{37.78, 29.08}	Turkey	{152.638, 7.23, 728.913, 0.931356, 23.7807, 0.745804}	{1970-03-28T21:02:26.710Z, 39.098, 29.57, 25, 7.23}
125	Irkutsk	578 073	{52.33, 104.24}	Russia	{80.5894, 6.3, 307.216, 0.394494, 126.979, 0.550529}	{2008-08-27T01:35:32.150Z, 51.607, 104.158, 16, 6.3}
126	Pimpri	1 729 320	{18.62, 73.8}	India	{134.621, 6.54, 191.325, 0.246533, 225.048, 0.295643}	{1967-12-10T22:51:23.470Z, 17.412, 73.885, 15, 6.54}
127	Guangyuan	3 127 300	{32.43, 105.87}	China	{44.3444, 6.1, 640.209, 0.851628, 33.3874, 0.732127}	{2008-05-25T08:21:49.990Z, 32.56, 105.423, 18, 6.1}
128	Wahran	645 984	{35.7, -0.62}	Algeria	{50.5935, 5.9, 310.321, 0.414586, 118.977, 0.407349}	{1994-08-18T01:13:05.780Z, 35.52, -0.106, 8.7, 5.9}
129	Jand	1 883 556	{33.43, 72.02}	Pakistan	{65.5226, 6.3, 464.748, 0.687594, 54.7546, 0.323546}	{1992-05-20T12:20:32.850Z, 33.377, 71.317, 16.3, 6.3}
130	Panzhihua	1 115 800	{26.58, 101.68}	China	{43.0597, 6, 539.333, 0.819691, 37.1869, 0.226909}	{2008-08-30T08:30:53.010Z, 26.241, 101.889, 11, 6}
131	Nagoya	2 331 078	{35.15, 136.91}	Japan	{105.824, 6.8, 563.42, 0.982001, 15.8569, 0.0384461}	{1961-08-19T05:33:35.630Z, 36.088, 136.712, 15, 6.8}
132	Bandar Lampung	879 651	{-5.44, 105.27}	Indonesia	{119.399, 6.9, 557.184, 0.988021, 14.3977, 0.166524}	{1994-02-15T17:07:43.800Z, -4.967, 104.302, 23.1, 6.9}
133	Jiangyou	887 000	{31.77, 104.76}	China	{97.0441, 6.7, 532.184, 0.999229, 8.88705, 1.24978}	{1976-08-23T03:30:07.600Z, 32.492, 104.181, 33, 6.7}
134	Surabaya	3 457 409	{-7.24, 112.74}	Indonesia	{153.655, 7, 423.555, 0.818994, 37.2708, 1.21203}	{2023-04-14T09:55:45.220Z, -6.0413, 112.048, 597, 7}
135	Ashgabat	1 031 992	{37.95, 58.38}	Turkmenistan	{100.925, 6.5, 310.46, 0.630586, 63.9705, 0.28877}	{1997-02-04T10:37:47.140Z, 37.661, 57.291, 10, 6.5}
136	Shache	851 374	{38.42, 77.25}	China	{154.454, 7.04, 459.622, 0.934194, 23.4118, 0.473885}	{1961-04-13T16:34:44.590Z, 39.762, 77.712, 35, 7.04}
137	Hermosillo	884 342	{29.07, -110.97}	Mexico	{150.607, 6.6, 175.513, 0.368672, 138.509, 0.687567}	{2006-01-04T08:32:32.400Z, 28.164, -112.117, 14, 6.6}
138	San Cristobal	645 925	{7.77, -72.25}	Venezuela	{46.2499, 6, 467.497, 0.999992, 5.40149, 0.0395085}	{1994-05-31T17:41:55.580Z, 7.414, -72.033, 11.6, 6}
139	Bogotá	8 034 649	{4.63, -74.09}	Colombia	{49.1811, 5.9, 328.4, 0.791092, 40.6833, 0.0933564}	{2008-05-24T19:20:42.490Z, 4.33, -73.764, 8.9, 5.9}
140	Málaga	560 631	{36.72, -4.42}	Spain	{82.7436, 6.3, 291.428, 0.735123, 47.9525, 10.4517}	{2010-04-11T22:08:12.790Z, 36.965, -3.542, 609.8, 6.3}
141	Shihezi	635 000	{44.3, 86.03}	China	{58.7222, 6, 289.998, 0.753272, 45.5203, 0.307046}	{2016-12-08T05:15:04.600Z, 43.8229, 86.3451, 17.55, 6}
142	Shiraz	1 565 572	{29.63, 52.57}	Iran	{59.5523, 6.1, 354.979, 0.994456, 12.2626, 0.316327}	{1994-03-01T03:49:00.830Z, 29.096, 52.617, 12.9, 6.1}
143	Leshan	3 235 759	{29.57, 103.74}	China	{116.075, 6.6, 295.478, 0.874619, 30.6802, 0.339684}	{2013-04-20T00:02:47.540Z, 30.308, 102.888, 14, 6.6}
144	Tijuana	1 696 923	{32.53, -117.02}	Mexico	{112.061, 6.6, 317.024, 0.96098, 19.6395, 0.662309}	{1968-04-09T02:28:58.390Z, 33.1798, -116.103, 10, 6.6}
145	Zhangye	1 303 700	{38.93, 100.45}	China	{142.713, 6.6, 195.466, 0.615865, 66.5833, 0.326469}	{2022-01-07T17:45:30.809Z, 37.8283, 101.29, 13, 6.6}
146	Fangshan	814 367	{39.69, 115.96}	China	{150.619, 6.3, 87.9507, 0.280825, 193.248, 0.353801}	{1976-11-15T13:53:00.600Z, 39.444, 117.688, 15, 6.3}
147	Taixing	1 197 000	{32.17, 120.}	China	{152.886, 6, 42.7825, 0.137125, 431.936, $\frac{1}{2}$}	{1984-05-21T15:38:58.730Z, 32.688, 121.509, 18.2, 6}
148	Rome	2 873 494	{41.89, 12.5}	Italy	{118.664, 6.6, 282.725, 0.966691, 18.726, 0.307324}	{2016-10-30T06:40:18.670Z, 42.8621, 13.0961, 8, 6.6}
149	Konya	1 220 795	{37.88, 32.48}	Turkey	{130.728, 6.5, 185.038, 0.655783, 59.7331, 0.0886322}	{2002-02-03T07:11:28.410Z, 38.573, 31.271, 5, 6.5}
150	Semarang	1 555 984	{-6.97, 110.42}	Indonesia	{131.867, 6.6, 228.944, 0.847477, 33.8773, 1.20315}	{1994-09-28T16:39:51.670Z, -5.786, 110.352, 637.5, 6.6}

The grid of filtered earthquake with the filter $\mathcal{F}_Z$ having a relatively low background of Natural Earthquake with respect to the Nuclear ones. The grid has been sorted with respect to the ratio of the Probability Estimation of having a such maximal horizontal shaking ratio to the value of that maximal horizontal shaking ratio.

consuming vaporization of rocks. The nuclear-powered rear propeller of the underground version of a nuclear submarine would be replaced by a nuclear-powered forward gyrotron powered by 3 to 8 nuclear reactors about.

To conclude, a reduction of the empirical detection factor $\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right) \rightarrow 1$ creates an anomaly enlargement up to 14.5-σ from a statistical excess of the maximal horizontal shaking ratio of the filtered earthquakes with the filter $\mathcal{F}_Z$ and with a Probability Estimation Cutoff of < 0.43. Since, the network of seismic stations is much more dense around cities, the earthquakes are better detected around cities than around random positions. Therefore, a realistic anomaly is between 8.4-σ and 14.5-σ from a statistical excess of the maximal horizontal shaking ratio of the filtered earthquakes with the filter $\mathcal{F}_Z$ and with a Probability Estimation Cutoff of < 0.43. In the worst case, if we significantly relax the criteria for having enough seismic data with respect to a sufficiently large background of the recent smaller earthquakes ($N_i \geq 0.5 \times 10^{\left(M_w^{min}-4.0\right)} > 39$), there is a small anomaly reduction down to 6.5-σ from a statistical excess of the maximal horizontal shaking ratio of the filtered earthquakes with the filter $\mathcal{F}_Z$ and with a Probability Estimation Cutoff of < 0.43. However, in that worst case, by taking some random positions for the 1230 largest cities, with the latitude ranging between 25° and 55°, and with

101	Yokohama	3 732 616	{35.47, 139.62}	Japan	{55.1514, 6.7, 1647.73, 0.999925, 6.70637, 0.637489}	{1987-12-17T02:08:19.920Z, 35.362, 140.214, 62.9, 6.7}
102	San Francisco	873 965	{37.7599, -122.437}	United States	{94.3482, 6.9, 892.345, 0.559663, 77.6678, 1.22429}	{1989-10-18T00:04:15.190Z, 37.0362, -121.88, 17.214, 6.9}
103	Santo Domingo	1 111 838	{18.48, -69.91}	Dominican Republic	{81.7992, 6.9, 1187.14, 0.803796, 39.116, 0.143609}	{1984-06-24T11:17:11.920Z, 17.984, -69.338, 23.9, 6.9}
104	Almaty	1 797 431	{43.32, 76.92}	Kazakhstan	{147.001, 7.1, 582.588, 0.394656, 126.912, 0.71283}	{1978-03-24T21:05:48.200Z, 42.839, 78.606, 33, 7.1}
105	Veracruz	552 156	{19.19, -96.14}	Mexico	{113.399, 6.8, 490.662, 0.338002, 154.437, 0.861987}	{1973-08-28T09:50:40.000Z, 18.267, -96.598, 84, 6.8}
106	Siliguri	513 264	{26.73, 88.42}	India	{114.238, 6.9, 608.661, 0.425644, 114.885, 0.709703}	{2011-09-18T12:40:51.830Z, 27.73, 88.155, 50, 6.9}
107	Diyarbakır	930 266	{37.92, 40.23}	Turkey	{75.1713, 6.7, 886.942, 0.620979, 65.6634, 1.34675}	{1975-09-06T09:20:10.900Z, 38.474, 40.723, 26, 6.7}
108	Quetta	1 172 000	{30.21, 67.02}	Pakistan	{67.8844, 6.7, 1087.58, 0.805139, 38.9517, 0.231393}	{1975-10-03T05:14:23.300Z, 30.251, 66.315, 11, 6.7}
109	Yibin	5 349 299	{28.77, 104.57}	China	{79.8425, 6.8, 989.763, 0.738077, 47.551, 0.287824}	{1974-05-10T19:25:15.000Z, 28.243, 104.015, 11, 6.8}
110	Tbilisi	1 118 035	{41.72, 44.79}	Georgia	{95.88, 6.8, 686.347, 0.517569, 87.3958, 0.128537}	{1988-12-07T07:41:24.200Z, 40.987, 44.185, 5.4, 6.8}
111	Kabul	3 678 034	{34.53, 69.17}	Afghanistan	{34.9985, 6, 816.396, 0.675383, 56.6206, 0.366645}	{1999-02-11T14:08:51.680Z, 34.259, 69.364, 33, 6}
112	Cochabamba	632 013	{-17.38, -66.17}	Bolivia	{61.6264, 6.3, 525.372, 0.447241, 107.458, 1.8594}	{2019-03-15T05:03:50.060Z, -17.8744, -65.9072, 359, 6.3}
113	Fresno	542 107	{36.7827, -119.794}	United States	{76.7668, 6.7, 850.459, 0.770489, 43.2832, 0.75939}	{1983-05-02T23:42:38.060Z, 36.2317, -120.312, 9.578, 6.7}
114	Medan	2 210 625	{3.59, 98.67}	Indonesia	{50.5491, 6.3, 780.861, 0.736153, 47.8122, 0.989378}	{2006-12-01T03:58:21.650Z, 3.39, 99.079, 204, 6.3}
115	Sapporo	1 951 523	{43.06, 141.34}	Japan	{63.5249, 6.6, 986.534, 0.981702, 15.9223, 0.198738}	{2018-09-05T18:07:59.150Z, 42.6861, 141.929, 35, 6.6}
116	Palermo	673 735	{38.12, 13.36}	Italy	{41.5804, 6, 578.393, 0.579257, 73.5843, 0.0210651}	{2002-09-06T01:21:28.600Z, 38.381, 13.701, 5, 6}
117	Bacolod City	561 875	{10.6667, 122.95}	Philippines	{79.3467, 6.7, 796.053, 0.815941, 37.6392, 0.137057}	{2012-02-06T03:49:12.520Z, 9.999, 123.206, 11, 6.7}
118	Mandalay	1 225 133	{21.98, 96.09}	Myanmar	{115.903, 6.8, 469.692, 0.51054, 89.1653, 0.103007}	{2012-11-11T01:12:38.870Z, 23.005, 95.885, 13.7, 6.8}
119	Hachiōji	576 768	{35.66, 139.33}	Japan	{37.7299, 6.1, 884.357, 0.999991, 5.48702, 0.532597}	{1968-07-01T10:45:12.550Z, 35.999, 139.348, 60.6, 6.1}
120	Longnan	2 567 718	{33.4, 104.917}	China	{101.003, 6.9, 778.63, 0.888614, 29.0258, 0.603218}	{1976-08-16T14:06:45.900Z, 32.752, 104.157, 16, 6.9}
121	Barquisimeto	1 995 770	{10.05, -69.3}	Venezuela	{49.8304, 6.1, 507.003, 0.589414, 71.5642, 1.02254}	{1975-04-05T09:34:36.600Z, 10.04, -69.755, 33, 6.1}
122	Hamamatsu	793 904	{34.72, 137.73}	Japan	{138.586, 7.2, 825.205, 0.998182, 10.0955, 1.67294}	{1984-01-01T09:03:38.850Z, 33.683, 136.894, 368.1, 7.2}
123	Dar es Salaam	4 715 000	{-6.82, 39.28}	Tanzania	{81.8783, 6, 149.164, 0.190189, 301.981, 0.70149}	{2020-08-12T17:13:16.180Z, -7.3327, 39.8126, 17.55, 6}
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125	Irkutsk	578 073	{52.33, 104.24}	Russia	{80.5894, 6.3, 307.216, 0.394494, 126.979, 0.550529}	{2008-08-27T01:35:32.150Z, 51.607, 104.158, 16, 6.3}
126	Pimpri	1 729 320	{18.62, 73.8}	India	{134.621, 6.54, 191.325, 0.246533, 225.048, 0.295643}	{1967-12-10T22:51:23.470Z, 17.412, 73.885, 15, 6.54}
127	Guangyuan	3 127 300	{32.43, 105.87}	China	{44.3444, 6.1, 640.209, 0.851628, 33.3874, 0.732127}	{2008-05-25T08:21:49.990Z, 32.56, 105.423, 18, 6.1}
128	Wahran	645 984	{35.7, -0.62}	Algeria	{50.5935, 5.9, 310.321, 0.414586, 118.977, 0.407349}	{1994-08-18T01:13:05.780Z, 35.52, -0.106, 8.7, 5.9}
129	Jand	1 883 556	{33.43, 72.02}	Pakistan	{65.5226, 6.3, 464.748, 0.687594, 54.7546, 0.323546}	{1992-05-20T12:20:32.850Z, 33.377, 71.317, 16.3, 6.3}
130	Panzhihua	1 115 800	{26.58, 101.68}	China	{43.0597, 6, 539.333, 0.819691, 37.1869, 0.226909}	{2008-08-30T08:30:53.010Z, 26.241, 101.889, 11, 6}
131	Nagoya	2 331 078	{35.15, 136.91}	Japan	{105.824, 6.8, 563.42, 0.982001, 15.8569, 0.0384461}	{1961-08-19T05:33:35.630Z, 36.088, 136.712, 15, 6.8}
132	Bandar Lampung	879 651	{-5.44, 105.27}	Indonesia	{119.399, 6.9, 557.184, 0.988021, 14.3977, 0.166524}	{1994-02-15T17:07:43.800Z, -4.967, 104.302, 23.1, 6.9}
133	Jiangyou	887 000	{31.77, 104.76}	China	{97.0441, 6.7, 532.184, 0.999229, 8.88705, 1.24978}	{1976-08-23T03:30:07.600Z, 32.492, 104.181, 33, 6.7}
134	Surabaya	3 457 409	{-7.24, 112.74}	Indonesia	{153.655, 7, 423.555, 0.818994, 37.2708, 1.21203}	{2023-04-14T09:55:45.220Z, -6.0413, 112.048, 597, 7}
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136	Shache	851 374	{38.42, 77.25}	China	{154.454, 7.04, 459.622, 0.934194, 23.4118, 0.473885}	{1961-04-13T16:34:44.590Z, 39.762, 77.712, 35, 7.04}
137	Hermosillo	884 342	{29.07, -110.97}	Mexico	{150.607, 6.6, 175.513, 0.368672, 138.509, 0.687567}	{2006-01-04T08:32:32.400Z, 28.164, -112.117, 14, 6.6}
138	San Cristobal	645 925	{7.77, -72.25}	Venezuela	{46.2499, 6, 467.497, 0.999992, 5.40149, 0.0395085}	{1994-05-31T17:41:55.580Z, 7.414, -72.033, 11.6, 6}
139	Bogotá	8 034 649	{4.63, -74.09}	Colombia	{49.1811, 5.9, 328.4, 0.791092, 40.6833, 0.0933564}	{2008-05-24T19:20:42.490Z, 4.33, -73.764, 8.9, 5.9}
140	Málaga	560 631	{36.72, -4.42}	Spain	{82.7436, 6.3, 291.428, 0.735123, 47.9525, 10.4517}	{2010-04-11T22:08:12.790Z, 36.965, -3.542, 609.8, 6.3}
141	Shihezi	635 000	{44.3, 86.03}	China	{58.7222, 6, 289.998, 0.753272, 45.5203, 0.307046}	{2016-12-08T05:15:04.600Z, 43.8229, 86.3451, 17.55, 6}
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143	Leshan	3 235 759	{29.57, 103.74}	China	{116.075, 6.6, 295.478, 0.874619, 30.6802, 0.339684}	{2013-04-20T00:02:47.540Z, 30.308, 102.888, 14, 6.6}
144	Tijuana	1 696 923	{32.53, -117.02}	Mexico	{112.061, 6.6, 317.024, 0.96098, 19.6395, 0.662309}	{1968-04-09T02:28:58.390Z, 33.1798, -116.103, 10, 6.6}
145	Zhangye	1 303 700	{38.93, 100.45}	China	{142.713, 6.6, 195.466, 0.615865, 66.5833, 0.326469}	{2022-01-07T17:45:30.809Z, 37.8283, 101.29, 13, 6.6}
146	Fangshan	814 367	{39.69, 115.96}	China	{150.619, 6.3, 87.9507, 0.280825, 193.248, 0.353801}	{1976-11-15T13:53:00.600Z, 39.444, 117.688, 15, 6.3}
147	Taixing	1 197 000	{32.17, 120.}	China	$\{152.886, 6, 42.7825, 0.137125, 431.936, \frac{1}{2}\}$	{1984-05-21T15:38:58.730Z, 32.688, 121.509, 18.2, 6}
148	Rome	2 873 494	{41.89, 12.5}	Italy	{118.664, 6.6, 282.725, 0.966691, 18.726, 0.307324}	{2016-10-30T06:40:18.670Z, 42.8621, 13.0961, 8, 6.6}
149	Konya	1 220 795	{37.88, 32.48}	Turkey	{130.728, 6.5, 185.038, 0.655783, 59.7331, 0.0886322}	{2002-02-03T07:11:28.410Z, 38.573, 31.271, 5, 6.5}
150	Semarang	1 555 984	{-6.97, 110.42}	Indonesia	{131.867, 6.6, 228.944, 0.847477, 33.8773, 1.20315}	{1994-09-28T16:39:51.670Z, -5.786, 110.352, 637.5, 6.6}

The grid of filtered earthquake with the filter $\mathcal{F}_Z$ having a relatively low background of Natural Earthquake with respect to the Nuclear ones. The grid has been sorted with respect to the ratio of the Probability Estimation of having a such maximal horizontal shaking ratio to the value of that maximal horizontal shaking ratio.

the empirical detection factor $\alpha\left(M_{w,0}, M_w^{min}, M_w^{max}\right) = 1.68$, we still have a flat distribution for the Probability Estimation but there is an unwanted anomaly enlargement up to 1.6-σ.

Remark 01 : A total of 17 671 earthquakes have been considered for the building of the filter $\mathcal{F}_Z$ with a low background a Natural Earthquakes with respect to the Nuclear ones: $5.9 - 7.9\ M_w$, from 1st January 1960 to 15th September 2023, $R_i < 160\ km$ with the index i spanning the 1230 largest cities and having a maximal horizontal shaking ratio $10^{M_{w,i}}/R_i^2$ for each specific city i satisfying these filtering ranges.

Remark 02 : A total of 440 351 earthquakes have been considered for the background of the recent smaller earthquakes around the 1230 largest cities ($M_w \geq M_{w,0} = 4.0$, 1980-2022, $R_i < R_{max} = 160\ km$, Gutenberg-Richter law and $\Delta N_i \geq 10^{5.9-4.0} > 79$ in the case of an absence of filtered earthquakes with the filter $\mathcal{F}_Z$).

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