ПӘНДЕР АРАЛЫҚ ҒЫЛЫМДАР
МЕЖДИСЦИПЛИНАРНЫЕ НАУКИ
INTERDISCIPLINARY SCIENCES

CENTRAL ASIAN SCIENTIFIC JOURNAL
ISSN 3135-3061
2026. No. 4 (32), Vol. 2. pp. 694–706
DOI: https://doi.org/10.5281/zenodo.24459497
Journal website: https://cajournal.kz

UDC 550.34:614.8

ARE STRONG EARTHQUAKES DEADLIER IN POORER COUNTRIES? INCOME, PEOPLE NEAR THE EPICENTRE AND DESTROYED HOUSES, 1950-2022

Sabirova Dalal
Secondary School No. 125, Almaty, Kazakhstan

Sabirova Dalal — Grade 11 student, Secondary School No. 125, Almaty, Kazakhstan.

Scientific supervisor: Kurakbay Myrzabek — Student, Gwangju Institute of Science and Technology (GIST), Gwangju, South Korea.

© Sabirova Dalal, 2026

Abstract: This paper asks whether strong earthquakes kill more people in poorer countries and how much of the difference comes from the number of people living near the epicentre. It uses the 249 earthquakes of magnitude 7.5 or more in 1950-2022 from the NOAA Significant Earthquake Database that could be matched to the country's GDP per capita, and counts the people within 100 km of each epicentre on a global population grid. More than 100 people died in 27.7% of these earthquakes in the poorest third of countries and in 7.2% in the richest third (ratio 3.8, 95% CI 1.6-8.9); the richest third's earthquakes mostly struck nearly empty places, but this explained only a minority of the gap, and with people nearby, magnitude, depth and year taken into account each doubling of income still went with about half the odds of a deadly earthquake (odds ratio 0.48, 95% CI 0.31-0.76). In 404 earthquakes that destroyed houses, richer countries lost fewer houses, but this result was not stable across samples, and how much of the link between income and deaths runs through destroyed houses could not be estimated.

Keywords: earthquake deaths, income, population exposure, building collapse, natural disasters, NOAA, GHS-POP

1. Introduction

The author has seen the results of two large earthquakes herself. In her words (8 November 2026, translated from Russian): "I was in Marrakesh visiting relatives after the big earthquake in 2023, and I saw the consequences with my own eyes. And in 2026 I was in Turkey (Malatya) and also saw destruction." The Al Haouz earthquake of 8 September 2023 near Marrakesh had a magnitude of 6.8 and killed 2,946 people; the Kahramanmaraş earthquake of 6 February 2023 had a magnitude of 7.8 and killed 56,697 people in Turkey and Syria [1]. Yet the same database lists many strong earthquakes after which almost nobody died. Her supervisor proposed the question of this paper: why an earthquake of the same strength kills hundreds in one country and almost nobody in another, and whether that is linked to how rich the country is.

Earlier studies found that money matters. Using deaths from natural disasters in 73 countries in 1980-2002, Kahn reported that richer nations do not have fewer disasters but do suffer fewer deaths from them [2]. Toya and Skidmore found smaller disaster losses in countries with higher income, more education, greater openness, more complete financial systems and smaller government [3]. For earthquakes, Anbarci, Escaleras and Register called the link between deaths and income per person "hardly novel" and tested, on 269 large earthquakes from 1960 to 2002, how

inequality changes it [4]; a study of 344 earthquakes from 1975 to 2003 found more deaths where public-sector corruption is higher, after controlling for magnitude, distance from population centres and the level of development [5]. Ambraseys and Bilham calculated that 83% of all deaths from building collapse in earthquakes over the previous 30 years occurred in countries that are anomalously corrupt [6]. These last two studies are about the quality of government rather than income, and the second ties it directly to buildings that collapse.

There is a second, simpler reason why the same shaking can have very different results: how many people live where it strikes. Holzer and Savage showed that the number of earthquakes killing more than 100,000 people has grown with world population [7]. If the strongest earthquakes in rich countries tend to happen far from people, a simple comparison of rich and poor countries would credit money with what is really geography.

This paper separates the two on open data. It takes every earthquake of magnitude 7.5 or more in 1950-2022 that the NOAA database lists, whatever damage it did, counts the people within 100 km of each epicentre on a one-kilometre population grid, and asks how much more often a strong earthquake kills more than 100 people in a poorer country, how much of that gap the number of people nearby explains, and whether destroyed houses show how money is linked to deaths. The order of the paper is the author's choice. After reading her supervisor's summary of the first results on people nearby and destroyed houses, she wrote (13 November 2026, translated from Russian): "I'm opening with money: why, with shocks of the same strength, many times more people die in poor countries. This question hooks you right away, and it is easier to build the article on it: first this big gap, and then that the main role is actually played by the number of people nearby, and money works precisely through houses not collapsing." The second half of this sentence repeats the conclusions of that preliminary summary, which contained a calculation error; Section 5 shows that the full analysis does not support the first of them and cannot establish the second.

2. The author's hypothesis

On 7 November 2026, after she chose this topic and before any data were analysed, her supervisor asked her why an earthquake of the same strength takes hundreds of lives in one country and almost none in another, how much it matters whether the country is rich, and what else may play a role. She answered on 8 November (translated from Russian): "1. Well, it depends on the area itself. If the country is in mountainous terrain, the damage will be greater and, accordingly, so will the number of victims. 2. Well, I think that no country can be safe from an earthquake, and the budget will not affect this in any way. But it can simply remove all the consequences that were caused by the earthquake."

Two expectations follow. (H1) Earthquakes in mountainous places kill more people; this is tested in Section 4.6. (H2) A country's budget cannot protect it from an earthquake, but can help to deal with its consequences. The first half can be read in two ways. If it means that wealth does not stop earthquakes from happening, it is not a question for these data. If it means that wealth does not reduce the damage, it can be checked with the number of destroyed houses (Section 4.5). The second half cannot be tested directly, because the data do not record what happened after an earthquake; Section 4.5 gives only an indirect check.

On 12 November her supervisor sent her the first results by income and terrain. In the same message he wrote that part of the income gap seemed to come from where the earthquakes struck, not only from money, and that he would check this next with the number of people around the epicentre. She replied (translated from Russian): "I was surprised by the number of deaths in Turkey and Syria, and in Japan." "At the same time, the research shows that mountainous terrain does not always mean more victims, so it is important to take other factors into account, for example the people who live near the epicentre." "As for a country's income, it affects only how quickly services work and how fast help is given. And this is linked to whether the country is rich or not." Her idea about the speed of help is discussed in Section 5.

© Central Asian Scientific Journal, 2026

3. Data and methods

3.1. Earthquakes

The earthquakes come from the NCEI/WDS Global Significant Earthquake Database of the U.S. National Oceanic and Atmospheric Administration (NOAA), downloaded on 12 November 2026 [1]. It contains earthquakes that meet at least one of these criteria: about $1 million of damage or more, 10 or more deaths, magnitude 7.5 or greater, Modified Mercalli Intensity X or greater, or a tsunami [1]. Below magnitude 7.5 an earthquake enters only if it did damage or killed people, and $1 million of damage is easier to reach in a rich country, so such a sample would favour rich countries before any analysis. Earthquakes of magnitude 7.5 or more enter whatever their damage, so the main sample uses only them: 355 from 1950 to 2022. The U.S. Geological Survey catalogue [8] lists 298 earthquakes of magnitude 7.5 or more in the same years; matched by date (within one day) and place (within 500 km), 286 of them (96%) appear in the NOAA database and 274 (92%) among its earthquakes of magnitude 7.5 or more.

An earthquake is called deadly if it killed more than 100 people. The count is NOAA's total for the event, including deaths from a tsunami; where only deaths from shaking are given, those are used, and where NOAA gives only a range code, the code is used. For 116 of the 249 earthquakes in the final sample NOAA gives no death count. They are counted as not deadly, because an earthquake that killed more than 100 people would rarely be left without a count; Section 4.1 repeats the analysis without them.

3.2. Income, people near the epicentre and terrain

Income is GDP per capita in the year of the earthquake from the Maddison Project Database 2023 [9], in the copy published by Our World in Data [10]. Because the world grew richer between 1950 and 2022, each country's GDP per capita is divided by the median of all countries in the same year; this ratio is called relative income (1 is a typical country of that year, 2 is twice as rich). Each earthquake was matched to the country that NOAA lists for it. For 106 of the 355 earthquakes there is no income figure in this sample: 75 in six Pacific island states (25 in Papua New Guinea, 21 in the Solomon Islands, 9 in Vanuatu, 8 in Fiji, 7 in Tonga and 5 in Samoa), which have no Maddison series; 13 in the open ocean, in Antarctica and in South Georgia; and 18 that NOAA lists under territories of richer countries (10 Kermadec Islands, 3 New Caledonia, 3 US territory, 1 UK territory, 1 Azores), which were left out by a coding rule. The remaining 249 were split into three groups of 83: the poorest third (relative income below 0.86), the middle third (0.86-1.98) and the richest third (above 1.98).

The number of people near the epicentre comes from GHS-POP R2023A of the European Commission's Joint Research Centre [11], for 2020, on a grid of 30 arc-seconds (about 1 km). For each earthquake the population of every cell whose centre lies within 100 km of the NOAA epicentre was added up; sea cells hold no people. The 249 earthquakes were also split into three groups of 83 by this number: fewest people (up to 3,085), middle (3,085-413,709) and most people (over 413,709). Terrain comes from the ETOPO1 relief model [12], read at the epicentre and at eight points 0.2 degrees (about 20 km) around it. An epicentre is on land if its elevation is above sea level, and relief is the difference between the highest and lowest land points among the nine. Table 1 lists the sources.

© Central Asian Scientific Journal, 2026

Table 1 – Data sources

Source	What was taken	Used for
NOAA Significant Earthquake Database	Date, place, magnitude, depth, deaths, houses destroyed, tsunami	The sample and the outcome
USGS ANSS Comprehensive Catalog	Earthquakes of magnitude 7.5 or more, 1950-2022	Checking that the NOAA list is complete
Maddison Project Database 2023	GDP per capita by country and year	Relative income
GHS-POP R2023A, year 2020	Population of cells of about 1 km	People within 100 km of the epicentre
ETOPO1	Elevation at the epicentre and 8 points around it	Land or sea; relief

Note: all sources were downloaded on 12-13 November 2026. Sources: [1, 8, 9, 11, 12].

3.3. Statistical methods

For each group the share of deadly earthquakes is given with a 95% Wilson confidence interval [13], and groups are compared by the ratio of their shares, with a 95% confidence interval on the log scale. These intervals treat earthquakes as independent; because several earthquakes often strike the same country, the main ratios were also given intervals from a bootstrap that resamples whole countries (4,000 draws, percentile intervals). To look at income and people nearby together, while allowing for the fact that stronger and shallower earthquakes are more dangerous and that the world changed over 72 years, a logistic regression was fitted (equation 1):

$$\mathit{logit}\, P = b_0 + b_1 \cdot \ln I + b_2 \cdot M + b_3 \cdot \ln(1 + D) + b_4 \cdot T + b_5 \cdot \ln(N + 1000) \quad (1)$$

Here P is the probability that an earthquake kills more than 100 people, I is relative income, M is magnitude, D is depth in kilometres, T is the number of decades since 1990 and N is the number of people within 100 km of the epicentre (1,000 is added so that empty places can be included). Six earthquakes without a depth are left out, so the regressions use 243. The income effect is reported as an odds ratio per doubling of relative income and the population effect per tenfold increase of N + 1,000. Standard errors are clustered by country [14]. All calculations were done in Python with statsmodels [15]. The results were repeated with the median income computed on a fixed panel of 141 countries, with thirds cut by percentile rank, with each earthquake sequence counted once, with only earthquakes that the USGS also rates at 7.5 or more, without the earthquakes that have no death count, without the USA, Russia and Australia, and with the 75 Pacific-island earthquakes placed first in the poorest and then in the richest third.

4. Results

4.1. The money gap

More than 100 people died in 23 of the 83 earthquakes in the poorest third of countries (27.7%, 95% CI 19.2-38.2%), in 16 of 83 in the middle third (19.3%, 12.2-29.0%) and in 6 of 83 in the richest third (7.2%, 3.4-14.9%) (Figure 1). A strong earthquake in the poorest third was 3.83 times as likely to be deadly as one in the richest third (95% CI 1.65-8.93; 1.9-16.0 with the country bootstrap), and the poorest and middle thirds together 3.25 times (1.43-7.37).

© Central Asian Scientific Journal, 2026

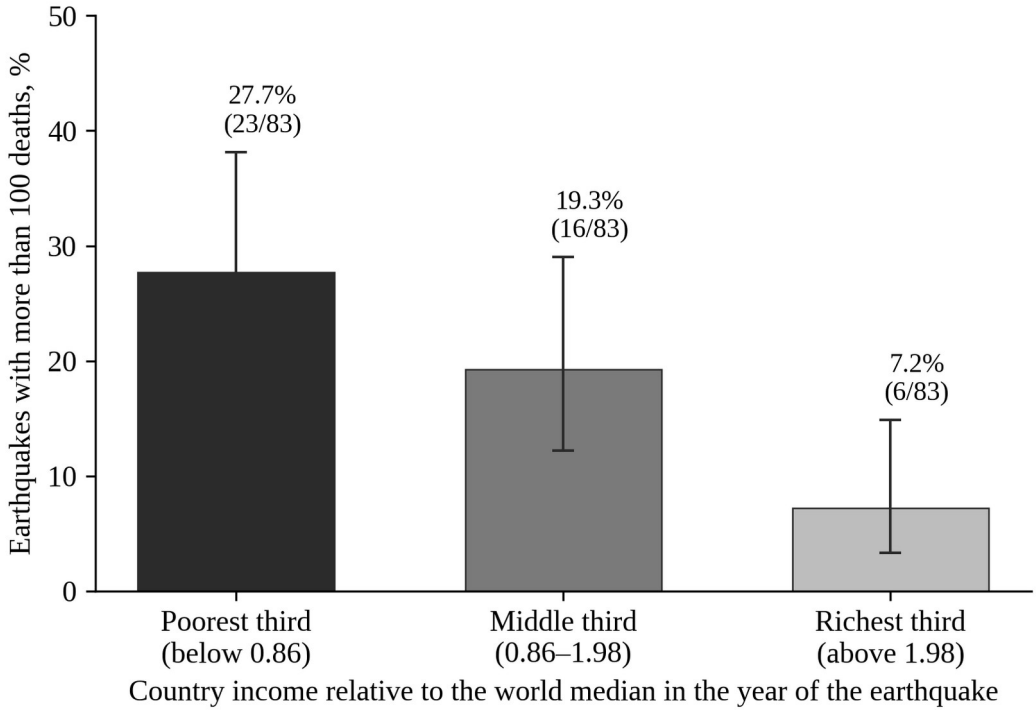


Figure 1 - Share of earthquakes of magnitude 7.5 or more (1950-2022) that killed more than 100 people, by the country's income relative to the world median in the same year. Lines show 95% Wilson intervals. Sources: [1, 9]; own calculations

The gap is not a matter of earthquake strength: with magnitude, depth and year in the regression (model M1 in Table 2), each doubling of relative income went with odds of a deadly earthquake 0.44 times as high (95% CI 0.28-0.69, $p < 0.001$). Figure 2 shows the ratio under most of the checks. It stays between 3.7 and 4.7 with a fixed panel of countries, percentile thirds, sequences counted once and only earthquakes that the USGS also rates at 7.5 or more. It falls to 2.43 (95% CI 1.11-5.28) without the 116 earthquakes that have no death count, which are most common in the richest third (52 of 83, against 34 and 30), and to 2.22 (0.91-5.40) without the USA, Russia and Australia. This last drop is the first sign that the gap partly depends on where the earthquakes happened. Placing the 75 Pacific-island earthquakes all in the poorest third gives 2.19 (0.94-5.12), and all in the richest third 5.47 (2.56-11.70); adding the 18 earthquakes near territories of richer countries, none of them deadly, to the richest third gives 4.66 (1.99-10.92). With only the 94 epicentres on land the ratio is 2.90 (0.93-9.00), and without tsunami earthquakes 4.14 (0.54-31.76); both rest on few deadly earthquakes (22 and 9).

© Central Asian Scientific Journal, 2026

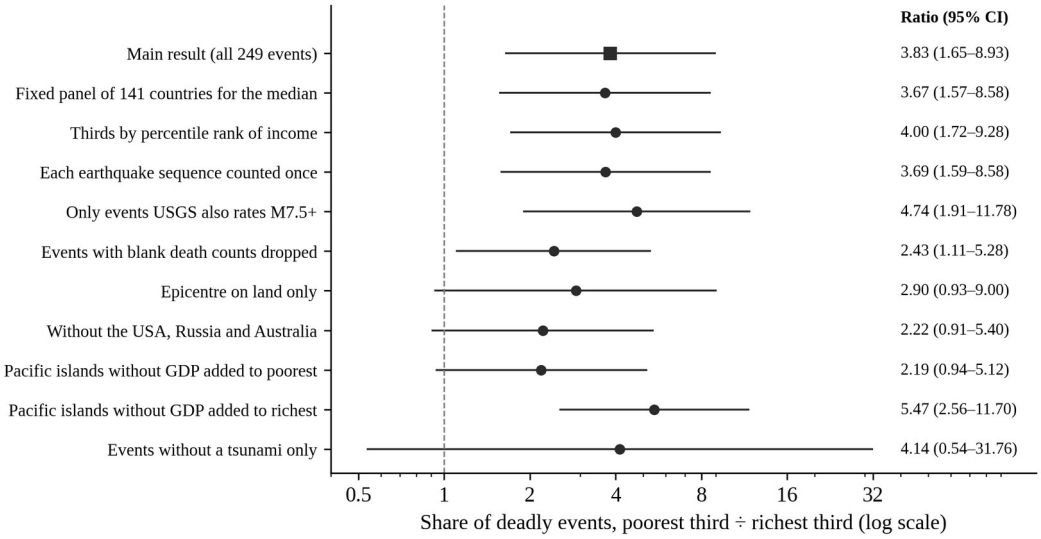


Figure 2 - How many times more often an earthquake of magnitude 7.5 or more was deadly in the poorest third of countries than in the richest third, in the main analysis and under most of the checks. Lines show 95% confidence intervals; the dashed line marks no difference. Sources: [1, 8, 9]; own calculations

4.2. Where the strong earthquakes struck

The income groups did not have their earthquakes in the same kinds of places (Figure 3). The median number of people within 100 km of the epicentre was 262,438 in the poorest third, 158,678 in the middle third and 205 in the richest third. In the richest third 73.5% of the earthquakes struck where fewer than 50,000 people lived within 100 km, against 36.1% in the poorest and 28.9% in the middle third. The 55 earthquakes in the USA, Russia and Australia (among them Alaska and the Aleutian Islands, the Kuril Islands, Kamchatka and Macquarie Island) had a median of 47 people within 100 km, against 226,250 for all others. Across all 249 earthquakes, richer countries had fewer people near the epicentre (Spearman correlation -0.30, $p < 0.001$).

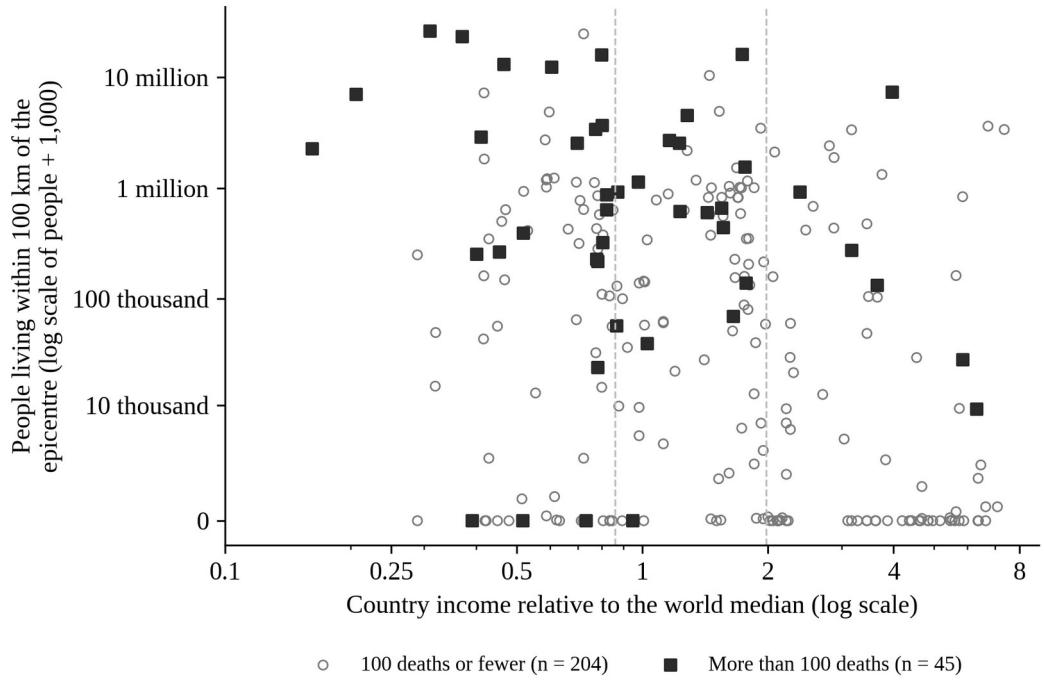


Figure 3 - Relative income of the country and the number of people living within 100 km of the epicentre for 249 earthquakes of magnitude 7.5 or more, 1950-2022. The vertical axis is on a log scale of the number of people plus 1,000. Dashed lines mark the borders of the income thirds. Sources: [1, 9, 11]; own calculations

4.3. People near the epicentre

Split by the number of people nearby instead of by income, the same 249 earthquakes also differ strongly (Figure 4). More than 100 people died in 4 of 83 earthquakes in the places with the fewest people (4.8%, 95% CI 1.9-11.7%), in 15 of 83 in the middle group (18.1%, 11.3-27.7%) and in 26 of 83 in the places with the most people (31.3%, 22.4-41.9%), a ratio of 6.5 (95% CI 2.37-17.81). The country bootstrap gives a lower bound of 2.5 but no upper bound, because in 13% of the resamples none of the earthquakes in the fewest-people group was deadly.

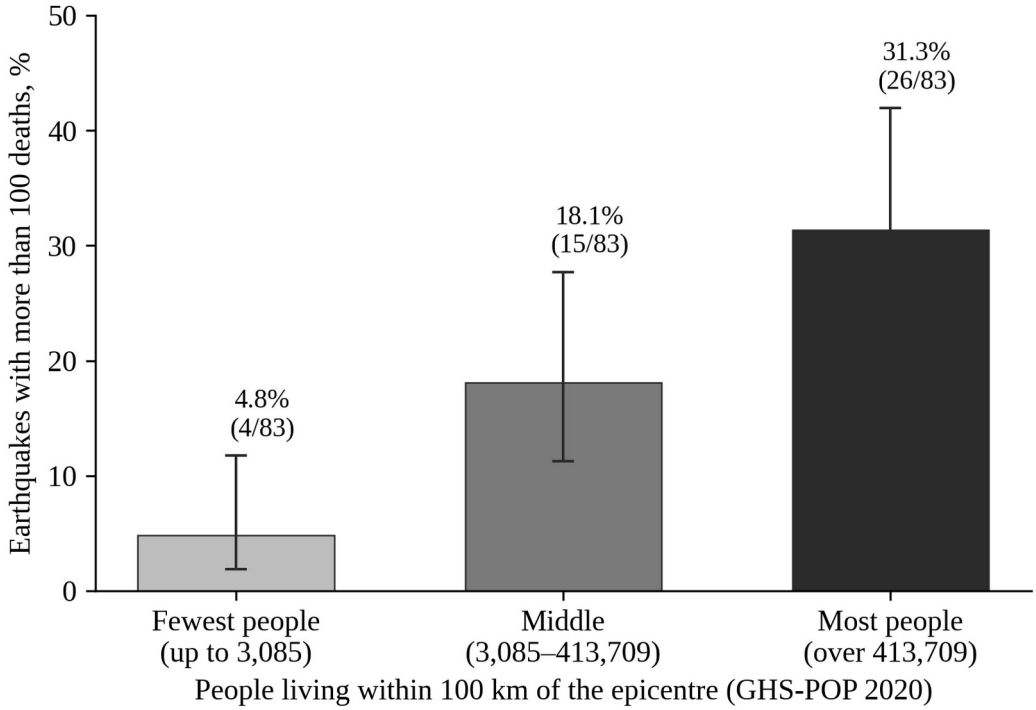


Figure 4 - Share of earthquakes of magnitude 7.5 or more (1950-2022) that killed more than 100 people, by the number of people living within 100 km of the epicentre. Lines show 95% Wilson intervals. Sources: [1, 11]; own calculations

4.4. Does income still matter once people are counted?

Figure 5 compares income groups inside each population group. Where the fewest people lived, 3 of 23 earthquakes in the poorest third were deadly and none of 49 in the richest third (Fisher's exact test p = 0.03). In the middle population group the counts were 7 of 26, 4 of 38 and 4 of 19 (poorest to richest ratio 1.28, 95% CI 0.44-3.75); where the most people lived, 13 of 34, 11 of 34 and 2 of 15 (ratio 2.87, 0.74-11.16). In these two groups the gap cannot be told apart from chance. Combining the three groups (Mantel-Haenszel ratio) gives 2.43 instead of the crude 3.83: comparing places with similar numbers of people removes about a third of the gap on the log scale. Because one epicentre point and a 2020 population grid describe the exposure only roughly, these adjustments are likely to understate the part of the gap that is due to where earthquakes struck.

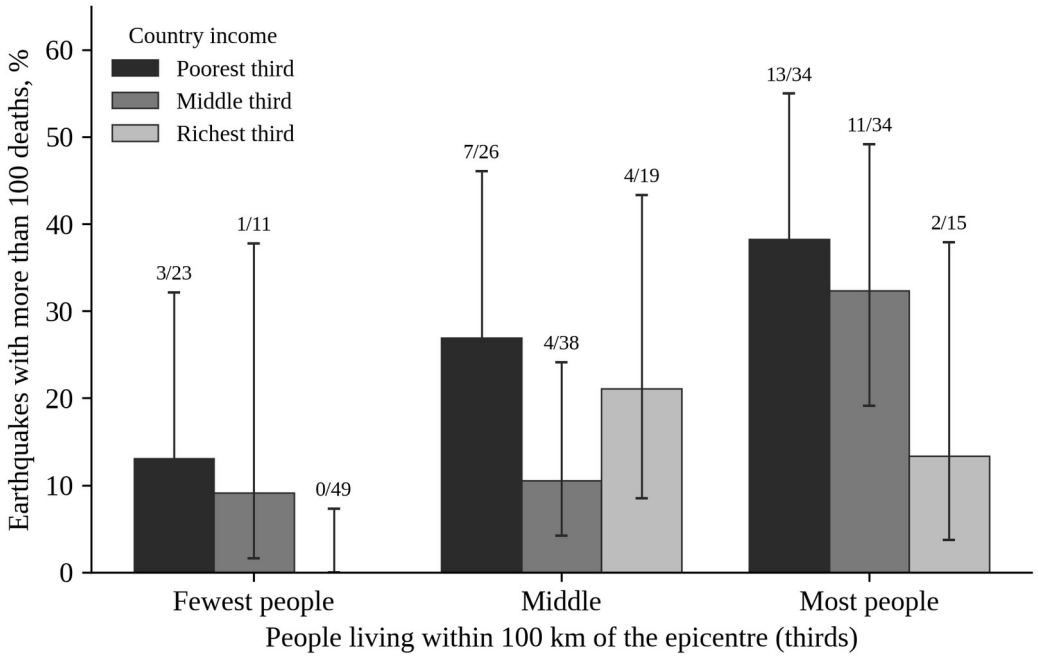


Figure 5 - Share of deadly earthquakes (more than 100 deaths) by income third inside each third of people living within 100 km of the epicentre. Numbers above the bars are deadly earthquakes out of all earthquakes in the group; lines show 95% Wilson intervals. Sources: [1, 9, 11]; own calculations

The regressions in Table 2 use the full range of both measures. With both in the same model (M3), each tenfold increase in people nearby went with odds of a deadly earthquake 2.70 times as high (95% CI 1.60-4.56), and each doubling of relative income with odds 0.48 times as high (0.31-0.76); adding people nearby moved the income odds ratio only from 0.44 to 0.48, about an eighth of the income effect on the log scale. To compare the two on one scale, both were also entered in standard-deviation units (one standard deviation is 1.19 doublings of income and 1.35 tenfold steps of people). One standard deviation more people nearby went with odds 3.82 times as high (1.88-7.77), and one standard deviation less income with odds 2.38 times as high (odds ratio 0.42 for more income, 0.24-0.72); the data cannot tell which of the two is larger. The pattern holds when an epicentre on land and a tsunami are added (M4), without the earthquakes that have no death count, and without the USA, Russia and Australia.

Table 2 – Odds of a deadly earthquake (more than 100 deaths) by income and people nearby: logistic regressions, magnitude 7.5 or more, 1950-2022

Model	Earthquakes (deadly)	Income: odds ratio per doubling (95% CI)	People within 100 km: odds ratio per tenfold (95% CI)
M1: income	243 (45)	0.44 (0.28-0.69)	–
M2: people nearby	243 (45)	–	2.94 (1.64-5.30)
M3: income and people nearby	243 (45)	0.48 (0.31-0.76)	2.70 (1.60-4.56)
M4: M3 + epicentre on land + tsunami	243 (45)	0.41 (0.22-0.79)	2.68 (1.60-4.50)
M3 without earthquakes that have no death count	131 (45)	0.45 (0.26-0.78)	2.01 (1.23-3.27)
M3 without the USA, Russia and Australia	189 (43)	0.55 (0.32-0.95)	2.35 (1.45-3.81)

Note: every model also includes magnitude, the logarithm of depth and the year, as in equation (1); people nearby is N + 1,000; standard errors are clustered by country. An odds ratio below 1 means fewer deadly earthquakes. Sources: [1, 9, 11]; own calculations.

© Central Asian Scientific Journal, 2026

4.5. Destroyed houses

NOAA records destroyed houses, which allows an indirect check of whether income is linked to deaths before the earthquake, through how many houses collapse, or after it, through how many people die for each collapsed house. For this check all earthquakes of any magnitude in 1950-2022 were used that destroyed at least one house, have at least one recorded death (NOAA leaves the death count blank rather than printing zero) and could be matched to an income figure: 404 in all, split into thirds by relative income within this sample.

Linear regressions with standard errors clustered by country were fitted on base-2 logarithms of destroyed houses plus 1 and deaths plus 1. All of them include magnitude, depth (the 6 missing depths set to the median depth of all NOAA earthquakes of 1950-2022), people nearby (plus 1,000) and the calendar year. Each doubling of relative income went with 0.79 times as many destroyed houses ($p = 0.039$), and each doubling of people nearby with 1.33 times as many ($p < 0.001$). This income result is not stable: among the 207 earthquakes that killed at least 10 people, which enter NOAA whatever their damage, it was 0.87 ($p = 0.31$), and among the 52 of magnitude 7.5 or more 0.46 ($p = 0.007$). Each doubling of income went with 0.74 times as many deaths ($p = 0.019$); with destroyed houses added to the model, 0.81 times ($p = 0.061$). The income link with deaths therefore weakened when destroyed houses were taken into account, but the share that runs through houses cannot be estimated precisely (country bootstrap 95% interval from -33% to 141%). The median number of deaths per 1,000 destroyed houses did not fall from poor to rich (Table 3).

Table 3 – Destroyed houses and deaths in 404 earthquakes of any magnitude, 1950-2022

Income third (house sample)	Earthquakes	Median houses destroyed	Median deaths	Median deaths per 1,000 destroyed houses
Poorest (below 0.73)	137	1,046	13	22.2
Middle (0.73-1.23)	132	1,150	8.5	15.1
Richest (above 1.23)	135	529	10	24.1

Note: earthquakes with at least one destroyed house, at least one recorded death and an income figure; income thirds are cut within this sample. Sources: [1, 9]; own calculations.

In this sample fewer houses collapsed in richer countries, and part of the lower death toll may go with that, but the result depends on which earthquakes are included. The check is indirect: an earthquake enters this sample only if houses were destroyed and deaths were recorded, and the number of destroyed houses is itself an estimate.

4.6. Mountains

For the terrain check an epicentre on land needs at least five of the nine relief points on land and a known depth; 87 earthquakes of magnitude 7.5 or more meet this, 19 of them deadly. More than 100 people died in 12 of the 43 with relief above the median of 0.85 km (28%) and in 7 of the 44 with lower relief (16%). In a logistic regression with magnitude, each extra kilometre of relief went with odds of a deadly earthquake 1.87 times as high (95% CI 1.16-3.02, clustered by country), and 1.90 times (1.11-3.23) with income, depth and year added. The pattern is uneven, however: split into three groups by relief, the shares were 21%, 10% and 34%. Among land earthquakes of any magnitude that killed at least 10 people (377 earthquakes), the number of deaths was not linked to relief ($p = 0.43$; $p = 0.96$ with income; robust standard errors not clustered by country).

5. Discussion

The answer to the question in the title is yes, and geography explains only part of the gap that these data can measure. Strong earthquakes in the poorest third of countries were about four times as likely to kill more than 100 people as those in the richest third. Many of the richest third's earthquakes struck nearly empty places: 38 of its 83 were in the USA and Russia, many of them off Alaska, the Aleutian and Kuril Islands and Kamchatka. Comparing places with similar numbers of people reduced the gap from 3.8 to 2.4 times, and in the regression people nearby changed the

income effect only from 0.44 to 0.48. So the measured number of people nearby explains a minority of the income gap, roughly an eighth to a third depending on the method, although a better measure of exposure might explain more. People nearby was itself strongly linked to deadly earthquakes, but the data do not show that it matters more than income. Her supervisor's preliminary summary of 13 November, which contained a calculation error, had said the opposite, and the author took it into her plan ("the main role is actually played by the number of people nearby"); the full analysis does not support that summary.

Her hypothesis H2 said that a country's budget cannot protect it from the earthquake but helps to deal with its consequences. If the first half is read as being about damage, the data lean against it, though not firmly: richer countries lost fewer houses in the full sample of 404 earthquakes, but not clearly among earthquakes that killed at least 10 people. If it is read as being about the earthquake itself, these data cannot test it. The second half, and her later idea that income affects "only how quickly services work and how fast help is given", cannot be tested here, because the NOAA database does not record the speed of help. The indirect check gives a mixed picture: the link between income and deaths weakened somewhat when destroyed houses were taken into account, but the data cannot say how much of it runs through houses, so the summary's statement, taken into her plan, that "money works precisely through houses not collapsing" is not established, and faster help is not ruled out. Ambraseys and Bilham found that deaths in collapsed buildings are concentrated in corrupt countries [6]; that study is about government rather than income, but it also points to buildings. Her first expectation H1, about mountains, found some support on land, but the pattern is uneven, as she herself noted after reading the first results: "mountainous terrain does not always mean more victims".

Her own observations are about buildings too. About Malatya, which she visited in 2026, she wrote (11 November 2026, translated from Russian): "In Malatya there was destruction everywhere, because the city is built on mountains. All the boutiques and shops were destroyed. Residential buildings, for example multi-storey ones, had cracks, and inside the residential buildings there were fractures in the walls. When I was there, the city had only begun to rebuild, and everything was in tractors, stones and dust. But I did not notice much specific damage to houses, because I was in a village, where there are usually two-storey buildings, which were not badly damaged." She describes cracked multi-storey buildings in the city and two-storey buildings in a village that were not badly damaged, the kind of difference between buildings that Section 4.5 can see only indirectly. The Kahramanmaraş earthquake of 2023 falls after the period studied and serves only as an illustration: NOAA records 542,461 destroyed houses [1], and about 5.59 million people lived within 100 km of the epicentre in 2020 [11]. Turkey's GDP per capita in 2022 was 2.12 times the world median, just above the border of the richest third (1.98), so a country high on the income scale can still lose tens of thousands of people when a strong earthquake strikes a populated place.

About Marrakesh she wrote (11 November 2026, translated from Russian): "In Marrakesh many people died. And it was precisely near the Atlas Mountains that most of the victims were. In Marrakesh itself, historic buildings were damaged. The mountains there are on stone, not like ours in Kazakhstan, and amid this there was rubble." NOAA gives one death count for the whole earthquake and does not split it by place, so the database cannot confirm where most people died. It agrees with her that the epicentre lies in the Atlas Mountains, at about 2,860 m in ETOPO1 [12]; about 467,000 people lived within 50 km of it and 3.31 million within 100 km, a circle that takes in the city of Marrakesh, about 70 km away. Morocco's relative income in 2022 was 0.65, which would place it in the poorest third.

Her surprise at the toll in Japan has a clear reading too. The Tohoku earthquake of 11 March 2011, in the richest third, killed 18,423 people, of whom NOAA attributes 1,474 to the shaking itself and the rest to other effects, above all the tsunami [1]. Nobody lived within 50 km of its epicentre at sea and 272,348 people within 100 km, while the tsunami struck coasts that a circle around one point does not describe. This is the clearest example of the limits of the method.

© Central Asian Scientific Journal, 2026

Limitations. An earthquake is described by one epicentre point, while a rupture can be hundreds of kilometres long and a tsunami can kill far away. The population grid is for 2020, so for an earthquake in 1950 it shows how populated the place is now. The 116 earthquakes without a death count were counted as not deadly; without them the gap is smaller (2.43 times) but still clear of 1. NOAA mixes magnitude scales, and 54 of the 249 earthquakes could not be matched to a USGS earthquake of magnitude 7.5 or more; keeping only those that the USGS rates at 7.5 or more gives a larger gap (4.74 times). The 75 Pacific-island earthquakes without an income figure give a gap of 2.19 times if all are placed in the poorest third and 5.47 times if all are placed in the richest. With income in constant dollars instead of relative to the world median, the richest third is unchanged (6 of 83 deadly), but the middle third has more deadly earthquakes than the poorest (22 against 17), so only the gap between the richest third and the rest is stable. Deaths are counted for the whole event, sometimes in several countries, while income is that of the one country NOAA lists. The richest third has only 11 countries, and the country bootstrap gives wider intervals than the usual ones. There are only 45 deadly earthquakes, so the larger models estimate up to eight coefficients from few events, and all results describe associations, not causes.

6. Conclusion

Among 249 earthquakes of magnitude 7.5 or more from 1950 to 2022, those in the poorest third of countries killed more than 100 people about four times as often as those in the richest third. The richest third's strong earthquakes mostly happened in nearly empty places, and places with more people nearby had many more deadly earthquakes, but this explains only a minority of the income gap: comparing similar places, poorer countries still had deadly earthquakes more often, and in the regression each doubling of income went with about half the odds. In earthquakes that destroyed houses, richer countries lost fewer houses in the full sample, but not clearly among the deadlier ones, and the data cannot say how much of the income link with deaths runs through destroyed houses. Testing the author's idea about the speed of help would need data on rescue times, which the database used here does not contain.

Author contributions and use of AI tools

Sabirova Dalal chose this topic on 6 November 2026 from three proposed by her supervisor, and wrote the hypothesis quoted in Section 2 on 8 November 2026, before any data were analysed. She wrote the accounts of Marrakesh and Malatya quoted in Sections 1 and 5 (8 and 11 November 2026). After reading the first results, in which her supervisor said he would next check the number of people around the epicentre, she named it as a factor to take into account and proposed that income works through the speed of help (12 November 2026); after reading his summary of the population and house results she chose the order in which the paper presents them (13 November 2026). Her quotations were translated from Russian. She did not do the calculations or write the English text. Her supervisor, Kurakbay Myrzabek, set the research question, proposed the topics, found the earlier studies, chose the data and the method and, using a generative AI tool (Claude, Anthropic), downloaded the data, wrote the analysis code, computed the numbers, made the figures, translated her quotations and wrote the English text around them. Every number was computed by the analysis code from the public data, and the numbers, quotations and references were checked in review rounds by separate AI agents; the author and her supervisor take responsibility for the content. The AI tool is not an author.

Data availability

All data are public: the NOAA Significant Earthquake Database [1], the USGS catalogue [8], the Maddison Project Database 2023 [9], GHS-POP R2023A [11] and ETOPO1 [12]. The analysis scripts (Python) and the list of earthquakes with every value used are available from the supervisor on request.

© Central Asian Scientific Journal, 2026

Funding and conflicts of interest

No grant funding was received for this study. The supervisor's work was part of a paid university-admissions mentoring service used by the author's family; that mentoring includes support with this paper, which the author may use in university applications. There are no other conflicts of interest.

References:

[1] National Geophysical Data Center / World Data Service. NCEI/WDS Global Significant Earthquake Database [Electronic resource]. NOAA National Centers for Environmental Information, 1972-. URL: https://www.ncei.noaa.gov/products/natural-hazards/tsunamis-earthquakes-volcanoes/earthquakes. DOI: 10.7289/V5TD9V7K (accessed 12.11.2026).

[2] Kahn M.E. The death toll from natural disasters: the role of income, geography, and institutions // Review of Economics and Statistics. 2005. Vol. 87, No. 2. P. 271-284. DOI: 10.1162/0034653053970339.

[3] Toya H., Skidmore M. Economic development and the impacts of natural disasters // Economics Letters. 2007. Vol. 94, No. 1. P. 20-25. DOI: 10.1016/j.econlet.2006.06.020.

[4] Anbarci N., Escaleras M., Register C.A. Earthquake fatalities: the interaction of nature and political economy // Journal of Public Economics. 2005. Vol. 89, No. 9-10. P. 1907-1933. DOI: 10.1016/j.jpubeco.2004.08.002.

[5] Escaleras M., Anbarci N., Register C.A. Public sector corruption and major earthquakes: a potentially deadly interaction // Public Choice. 2007. Vol. 132, No. 1-2. P. 209-230. DOI: 10.1007/s11127-007-9148-y.

[6] Ambraseys N., Bilham R. Corruption kills // Nature. 2011. Vol. 469, No. 7329. P. 153-155. DOI: 10.1038/469153a.

[7] Holzer T.L., Savage J.C. Global earthquake fatalities and population // Earthquake Spectra. 2013. Vol. 29, No. 1. P. 155-175. DOI: 10.1193/1.4000106.

[8] U.S. Geological Survey, Earthquake Hazards Program. Advanced National Seismic System (ANSS) Comprehensive Catalog of Earthquake Events and Products [Electronic resource]. 2017. DOI: 10.5066/F7MS3QZH (accessed 12.11.2026).

[9] Bolt J., van Zanden J.L. Maddison-style estimates of the evolution of the world economy: a new 2023 update // Journal of Economic Surveys. 2025. Vol. 39, No. 2. P. 631-671. DOI: 10.1111/joes.12618.

[10] Our World in Data. GDP per capita - Maddison Project Database [Electronic resource]. URL: https://ourworldindata.org/grapher/gdp-per-capita-maddison-project-database (accessed 12.11.2026).

[11] Schiavina M., Freire S., MacManus K. GHS-POP R2023A - GHS population grid multitemporal (1975-2030) [Electronic resource]. European Commission, Joint Research Centre (JRC), 2023. DOI: 10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE (accessed 13.11.2026).

[12] Amante C., Eakins B.W. ETOPO1 1 Arc-Minute Global Relief Model: procedures, data sources and analysis. NOAA Technical Memorandum NESDIS NGDC-24. National Geophysical Data Center, NOAA, 2009. DOI: 10.7289/V5C8276M (accessed 12.11.2026).

[13] Wilson E.B. Probable inference, the law of succession, and statistical inference // Journal of the American Statistical Association. 1927. Vol. 22, No. 158. P. 209-212. DOI: 10.1080/01621459.1927.10502953.

[14] Cameron A.C., Miller D.L. A practitioner's guide to cluster-robust inference // Journal of Human Resources. 2015. Vol. 50, No. 2. P. 317-372. DOI: 10.3368/jhr.50.2.317.

[15] Seabold S., Perktold J. Statsmodels: econometric and statistical modeling with Python // Proceedings of the Python in Science Conference (SciPy 2010). 2010. P. 92-96. DOI: 10.25080/Majora-92bf1922-011.

© Central Asian Scientific Journal, 2026