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Fifty Years of Peril: A Comprehensive Comparison of the Impact of Terrorism and Disasters Linked to Natural Hazards (1970-2019)

Abstract

We compare the realised impact of terrorism and disasters linked to natural hazards. Using fifty years of data from two databases covering 99 percent of the global population, we find that natural hazard disasters were more then 20 times more impactful than terrorism. The former had a larger realised impact in all regions in both gross and per-capita terms. The largest cross-peril difference was in Asia, where natural hazard disasters took 324 million Lifeyears, while terrorism took ten. Similar results were found across countries grouped by income status and development status. Low and lower-middle income countries bore the vast majority of the impact of both terrorism and natural hazard disasters. Given the multitude of prevalent global threats, our findings are relevant in the allocation of scarce public resources to mitigate and adapt. Our results suggest that significantly greater public spending should be applied to natural hazard disasters than terrorism.

JEL-Codes: Q540.

Keywords: terrorism, disaster, lifeyears, shock.

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1. Relative investments in risk reduction – a lopsided ledger

Humanity faces many perils. Climate change, armed conflict, terrorism, disinformation, cyber attacks, inequality, pandemics. The list continues. In early 2022, the Secretary-General of the United Nations announced a landmark report portraying "an atlas of human suffering" (UNSG, 2022a). He was referring to the effects of climate change. On that same day, the Secretary-General also called for an end to the fighting in Ukraine,[1] and, in a separate address, he spoke of the COVID-19 pandemic, forced displacement, pollution, the erosion of trust, inequality, pollution and the loss of biodiversity.[2] The list of perils is long.

Humanity has scarce resources to address these perils. Allocating resources to each peril is vexing. Countering terrorism, for example, is expensive. Counter-terrorism spending by the United States alone, amounted to 2,800 billion USD (current prices) between 2002 to 2017, 60 per cent of which was related to emergency and overseas contingency operations, according to Stimson (2018).[3] This does not include counterterrorism spending at the state level, which can amount to billions more.[4]

These sums vastly outweigh the expenditures made to address a contemporaneous, competing threat – natural hazards. In the thirty years to 2021, for example, only 15 billion USD was made available by the Hazard Mitigation Grant Program of the Federal Emergency Management Agency (FEMA, 2021). Such a lopsided ledger of relative investments in risk reduction arguably reflects public sentiment. Haner et. al. (2019), for example, found that Americans are more afraid of terrorism than they are of natural disasters. Should they be?

If our experience is anything to go by, then answering this question requires a comparison of the realised impact of terrorism and natural hazard disasters. Which has caused more suffering, and by how much? Such analysis is directly relevant to a public policymaker's decision of which peril requires more of our scarce attention. And yet, there is no clear answer. Research into the question has been hamstrung by the absence of a universally agreed measure of impact. How does one compare the impact of a flood wiping out the sole bridge of a small village against the terrorist hijacking of a plane?

We present a comprehensive attempt to do so for all terrorism and disasters caused by natural hazards (hereafter referred to as natural hazard disasters) over the past fifty years.[5] We take more than 200,000 observations and apply a consistent, measure of impact – the Lifeyears Index – to enable meaningful

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[1] Refer (UNSG, 2022b)

[2] This address was a video message from the Secretary-General in response to an award given to him by the Universidade de Coimbra, (UNSG, 2022c).

[3] The war in Afghanistan that concluded in 2021 cost the United States (US) at least 816 billion USD, or about 4,087 dollars per taxpayer by the end of financial year 2020, US Department of Defense (2021).

[4] For example, the New York Police Department's operating expenses for the 2019 fiscal year included 208 million USD on intelligence and counterterrorism, according to the Koeze and Lu (2020)

[5] Drawing on the disaster risk reduction literature, we intentionally resist the use of the term 'natural disasters' to avoid implying that such disasters are inevitable or devoid of human influence.

comparison across perils. The Lifeyears Index accounts for the diverse impacts that disasters have across rich and poor countries, across economies and lifespans, while also providing a consistent methodology (Noy, 2016). It replicates the approach of epidemiological research, which has used the disability-adjusted life-years (DALYs) methodology to overcome similar difficulties in comparing the impact of different diseases.[6]

Our results provide strong evidence that natural hazard disasters were significantly more impactful than terrorism. In fact, the former were at least 20 times more impactful than the latter. This difference held across all regions and within country groupings of development status and income status.

Our analysis is based on natural hazard disasters measured in the Emergency Events Database (EM-DAT) of the Centre for Research on the Epidemiology of Disasters at the Université Catholique de Louvain (CRED 2021). They include geophysical, meteorological, hydrological, climatological, biological and extra-terrestrial disasters. The terrorism examined in this paper is that which is defined in the Global Terrorism Database (GTD) at the National Consortium for the Study of Terrorism and Responses to Terrorism in the University of Maryland (START 2019). As will be discussed more below, this limits our analysis to terrorism conducted by non-state actors acting with the intent specified in the inclusion criteria of the database.

Our period of analysis is 1970 to 2019, inclusive, being the largest contiguous time period with full data from both datasets. During this period, there were 6,500 natural hazard disasters and 10,000 terrorism events that met our inclusion criteria. We find that disasters linked to natural hazards have led to global losses of 456 million Lifeyears. Terrorism caused 19 million, or less than five percent that of natural hazard disasters.

The most damaging single natural hazard disaster was the Tangshan Earthquake of 1976 in China. It resulted in nearly 26 million Lifeyear losses alone. In comparison, the most damaging single terrorist event was the Camp Speicher Massacre in June 2014 where at least 1,570 people were murdered by a terrorist group in Iraq, causing Lifeyear losses of 0.1 million.

Event-level comparisons like these are constrained by the fact that terrorism events are categorised in more discrete, singular packages than natural hazard disasters (which we discuss further below). The September 11 attacks in the United States, for example, are categorised as four separate events. Nonetheless, the quantum of difference remains unmissable. The Tangshan Earthquake alone caused more Lifeyear losses than all terrorist events combined during the last fifty years.

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[6] Promulgated by the World Health Organization (WHO), DALYs provide a measure of the overall burden of a given disease over time by accounting for years of healthy life lost to premature mortality, disability, and states of less than full health (WHO, 2020). Although not without its critics, for example, Anand and Hanson (1997), the DALY's have facilitated considerable analysis and discussion on the impact of diseases.

Our findings are robust to most countries. We examined 178 countries, whose combined population represented to 99 percent of the global population in 2019. Of these countries, we found that the cumulative impact of natural hazard disasters was greater than the cumulative impact of terrorism for 149 countries. In contrast, only 20 countries experienced a greater impact from terrorism, while nine countries recorded no terrorism or natural hazard events that met our inclusion criteria.

This paper and its findings are novel because they present, for the first time as far as the authors are aware, a comprehensive global analysis of both terrorism and natural hazard disasters, compared against each other using a validated measurement methodology (the Lifeyears Index). They also draw implications at both the regional level and by development status. The findings are valuable for resource allocation decisions, particularly in the public sphere where preliminary indications suggest a misalignment of spending priorities; relative to terrorism, natural hazard disasters warrant far greater investments in mitigation and adaption.

This paper is structured as follows. Section Two introduces the databases examined by this paper. Section Three introduces the Lifeyears Index. Section Four details the results of our comparisons across countries, time periods, regions and groupings by income and development status. Section Five examines the sensitivity of these findings. Section Six concludes.

2. Data

Our primary variables of interest are events of natural hazard disasters and terrorism. The former are drawn from the International Emergency Disaster Database (EM-DAT)[7] who defines a disasters as a 'Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance' (CRED, 2021a). We restrict our analysis to 'Natural' Disasters, which EM-DAT defines to include geophysical, meteorological, hydrological, climatological, biological and extra-terrestrial disasters (CRED, 2021b). We exclude technological disasters (such as industrial or transport accidents) as well as complex disasters that are a mix of natural and technological disasters. While EM-DAT includes disaster events going back to 1900, we limit our analysis to the period from 1970 onwards because our companion database for terrorism begins in that year. We also omit the year 1993 because of data concerns in that year.[8] Section Five explores the sensitivity of our results to different time periods. We find that even when the period of analysis is limited to the most recent decade of data, when data collection methodologies are at their most advanced, our findings generally hold.

We draw our terrorism data from the Global Terrorism Database (GTD),[9] which defines terrorism as 'the threatened or actual use of illegal force and violence by a non-state actor to attain a political, economic,

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[7] EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium.

[8] The GTD has large data gaps for the year 1993 due to issues that arose when the custodianship of the data was transferred, according to the GTD's codebook: START 2021.

[9] START, (2019).

religious, or social goal through fear, coercion, or intimidation' (START 2021). By employing this definition, the database excludes terrorism that is conducted by a government, sometimes referred to as state-sponsored terrorism.

The two databases employ different inclusion criteria. For EM-DAT, an event will only be included if ten or more people killed, one hundred or more affected, there is a declaration of a state of emergency or a call for international assistance. These criteria are focused on the *magnitude* of the event. In contrast, the GTD inclusion criteria are primarily limited to *intention* and *method*. Specifically, an event will only be included in the database if it was intentional, involves violence (or the threat of violence) and is perpetrated by a non-state actor. The GTD therefore includes many events in which the fatalities and injuries are minimal, while the EM-DAT does not.

Our focus is on comparing the magnitude of disasters and terrorism. Therefore, to ensure consistency across the two databases we overlay an additional minimum magnitude criteria to both. Specifically, we limit our analysis to only those events for which ten or more people were killed, or 100 or more people were injured. Applying these criteria we are left with 16,866 events, consisting of 10,331 terrorism events and 6,535 natural hazard disasters.

We perform analysis at the country level, standardising by GDP per capita from the World Bank (2021)[10], as well as total population and median-age, both from the United Nations (2021a).[11] Analysis of geographic groupings and development status employ designations from United Nations (2021b). We limit our analysis to only those 178 for which we have data from all databases of interest, specifically, EM-DAT, GTD, the World Bank (2021), United Nations (2021a) and United Nations (2021b). The combined population of these countries was 7.65 billion in 2019, representing 99 per cent of the global population, using data from United Nations (2021a).

Missing values are higher for natural hazard disasters than for terrorism. On the face of things, this would lend further weight to the overall finding of the paper (that natural hazard disasters are significantly more impactful than terrorism). However, it relies on the assumption that there is no bias in the value of the missing observations across each dataset. We scrutinise this issue further in Section 5.

While there are more observations of terrorism, the magnitude of these events tends to be smaller. The median fatalities per terrorist event was 16. The median number of people injured was seven. In comparison, the median fatalities and injuries per natural hazard disaster was 33 and 104 respectively. The

[10] In instances where a country's GDP observation was missing for a given year, we applied the following procedure to fill that missing value. We calculated average GDP levels per decade for each country and used the current decade value to fill the missing value. If data did not permit that calculation, then we used the average from the previous decade. If that also was not available, we used the country's average GDP for the full period of analysis (1970 to 2019).

[11] The median age of country-level populations was only available in five yearly intervals in United Nations (2021a). Linear estimates were used to fill these intervals.

picture of economic damages is similar. The median damage caused by a natural hazard disaster was 100 million USD. The median damage of a terrorist event was 20 thousand USD.

As discussed further below, the construction of the Lifeyears Index usually includes the use of data on the number of people directly affected by these events. This data is missing for the terrorism events. Therefore, we use injuries per event as a proxy for directly affected. We discuss the implications of this constraint under Section Four.

3. Methodology: Measuring impact using the Lifeyears Index

We use the Lifeyears Index to measure the impact of both terrorism and disasters, applying the methodology advanced in Noy (2016). Central to this approach is the premise that the value of a human life is equal in all countries, while the economic damages inflicted by an event should be standardised relative to income of the economy in which they are inflicted. Accordingly, Lifeyears lost are calculated as a function of mortality (*L*), directly affected people (*I*), and economic damages (*DAM*) (Equation 1).

$$Lifeyears = L\left(M, A^{death}, A^{exp}\right) + I(N) + DAM(Y, P) \qquad (1)$$

The first component addresses the mortality implications of an event (Equation 2).

$$L\left(M, A^{death}, A^{exp}\right) = M * \left(A^{exp} - A^{death}\right) \qquad \textbf{(2)}$$

Lifeyears lost due to mortality are derived from the total number of deaths (M) from an event, multiplied by the difference between the life expectancy of those who died (A^{exp}) and the age at death (A^{death}). We employ a uniform life expectancy of 92, based on WHO approach for calculating DALYs and discussed more in this context by Noy (2016). In the absence of individual specific age data for almost all events, we use the median age of the population of the country in which the disaster took place, using data from the United Nations Populations Division (United Nations (2021a)).

The second component of the Lifeyears Index computes Lifeyears lost to injuries or otherwise being affected by the disaster, where N is the absolute number of such people (Equation 3).

$$I(N) = NeT \qquad \textbf{(3)}$$

The number of people injured or directly affected (N) is multiplied by the estimated welfare reduction rate of disasters (e), and the estimated time taken for an individual to recover from a disaster (T). For reasons more fully elaborated in Noy (2016) and Doan and Noy (2021), we set e to 0.054 and T to three years. We explore the implications of adjusting these variables between disasters and terrorism in Section Four. To facilitate comparison between terrorism and disasters related to natural hazards, we limit N, in this case, to only those who are reported as injured by the event. This is because START (2019) only reports data on injuries in an attack, while CRED (2021) reports both injuries and those directly affected (e.g., because their house was damaged). The implications of this limitation are discussed in Section Five.

The final component of the Lifeyears Index calculates those Lifeyears lost because of the need to rebuild or repair damaged capital assets, such as infrastructure, commercial buildings, and residential property (Equation 4).

$$DAM(Y, P) = (1 - c)Y/P$$

Income per capita (P) is discounted by (c) which represents the proportion of an individual's time not spent on work-related activities. Y is the loss of capital due to damage, which, in principle, should be measured by reference to the value of that capital, rather than its replacement value.

Our data on economic damages for terrorism events and natural hazard disasters are measured in a roughly comparable manner with one limitation. Natural hazard disasters are measured in current value. They purport to measure all economic losses both directly and indirectly related to the event.

Terrorism losses are also measured in current value. However, in the case of terrorism, economic losses are limited to direct losses only. They do not include indirect losses. Section 5 explores the implications of this limitation, where we argue that it does not detract from our overall finding (that natural hazard disasters are much more impactful than terrorism). Indeed, the deficiencies in our combined data on capital loss tend, on balance, to suggest that we are under-estimating the excess impact of natural hazard disasters over terrorism, rather than over-estimating them.

4. Results

We find that global Lifeyears lost due to disasters from natural hazards were nearly 25 times greater than those from terrorism between 1970 and 2019 (Table 001). In total, natural hazard disasters took 456 million Lifeyears. Terrorism took 19.

[Table 001]

The relative difference in impact is largely driven by the higher mortalities and economic damages components due to natural hazard disasters. The injuries component is also significantly higher on a relative basis, (roughly 38 times greater), yet the relatively small size of the injured component means that its overall contribution to the difference is minimal.

[Figure 001]

The difference in impact over time is most pronounced in the four decades until 2010 (Figure 001). A reduction in this difference (albeit a modest one) corresponds with a significant uptick in terrorism impact in mid 2010s, with a relatively small impact of natural hazard disasters after 2010. The most tragic year on record was 1983, driven by droughts/famines in Ethiopia and Sudan.

[Table 002]

[Table 003]

China bore the greatest impact from natural hazard disasters, at more than twice the impact felt by India (Table 002). This is perhaps not surprising given the large populations of both countries. Neither country feature in the list of the ten most affected countries on a per capita basis (Table 003). Haiti is the most affected country on this account. Concerning terrorism, Iraq and Afghanistan are the two most affected countries on an absolute basis, followed by Nigeria. On a per capita basis, the top two most affected countries are Central American. They are Nicaragua and El Salvador, who were most affected by terrorism in the 1980s. As will be explored more below, all of the countries featuring in Tables 002 and 003 are developing countries.

Event analysis

The Tangshan Earthquake of 1976 in China was the largest single natural hazard disaster (Table 002). That event alone caused more Lifeyears lost than all of terrorism combined. The Ethiopian drought of 1983 to 1984, estimated to have caused 300,000 deaths, was followed by the 1970 tropical cyclone in Bangladesh.

[Table 004]

The ten largest terrorist events are of a different order of magnitude. The terrorist event with the greatest Lifeyears losses was the murder of at least 1,570 people in Iraq, in June 2014, known as the Camp Speicher Massacre. This event was broadly equivalent, in terms of the Lifeyears index, to the attack on the Sri Lankan airport in 2001, in which five planes were destroyed and 21 people died.

The difference in event-level impacts across the two perils is partially a result of the fact that the EM-DAT treats multi-year disasters as single events, where-as GTD tends to treat individual events in more discrete terms. [12] We explore this discrepancy further in Section 5.

[Table 005]

The fifth most impactful terrorist event was the murder of than 1,000 refugees in a Catholic Church not far from Kigali during the Rwandan Genocide. The inclusion criteria and the GTD definition of terrorism means that only a fraction of the nearly one million fatalities of the Genocide are included in our analysis, as well as only a fraction of the millions of lives lost in the Democratic Republic of the Congo after the Genocide. On a per capita basis, this event was the second most impactful terrorist event, following the

[12] The 11 September 2001 attacks in the United States illustrate the single event rules applied in the GTD. The GTD considers multiple incidents to be part of the same event if they took place at the same time and location. If either the time or location are different, however, then they are classed as different events. Flights AAL 11 and UA 175 crashed into the World Trade Center Towers at separate times (8.46 am and 9.03 am local time). They were therefore coded as separate events, although the impact was attributed equally across the two events because of the inextricable connection. Meanwhile, these two events were also classified separately from Flight AA 77 which crashed into the Pentagon and Flight UA 93 which came down in Pennsylvania, even though they were all organised by the same organisation and are commonly conceived of as a singular attack.

1976 bombing of Cubana Flight 455. However, the calculated per capita impact of this event is contestable. This bombing has been coded to Barbados, whose population was about 250,000 in 1976. Where-as it has been generally accepted that the target of the event, and the felt impact of it, was Cuba, whose population was about 10 million. This highlights the limits of our event-specific comparisons using these datasets, while not speaking to the gravity of the event, whose political significance is still felt today.[13]

With respect to natural hazard disasters, the most impactful event on a per capita basis was the Haiti Earthquake of 2010. The per capita toll of this disaster was more than double that of the second most impactful event – the 1983-1985 drought and famine that struck Sudan.

Impact by region, income and development status

The impacts of natural hazard disasters and terrorism have been felt throughout the world (Figure 002). Asia has borne the greatest combined impact of both perils (Table 006). This is largely due to its relatively large population compared with other regions. On a per capita basis, however, Africa has been the most affected region by both perils. The per capita impact of both perils on Africa was 7.7 times greater than the equivalent impact on Europe.

[Table 006]

There is a strong divide between countries grouped by income status. The per capita impact of both perils on low income and lower middle income countries is significantly greater than the equivalent for upper middle income and high income countries [Table 006]. The same is true for development status, as we foreshadowed earlier when noting that all of the ten most impacted countries are developing countries. Indeed, the cumulative per capita on developing countries was more than five times greater than the impact on developed countries.

Total Lifeyear losses from natural hazard disasters were greater in developing countries every year in the last fifty years. The per capita impact was also greater in all years except 2003, 2011, 2017 and 2018. The year in which the per capita impact in developed countries exceeded that of developing countries by the most was in 2003. In that year, Europe was struck by a period of extreme heat that caused fatalities across Spain, Italy, France, Portugal and Croatia, as well as Luxemburg, whose small population meant that the per capita impact was very high.

These findings are consistent with existing literature, such as Tselios and Tompkins (2019), who examine the relationship between vulnerability and disaster impact across developed and developing countries. It is also consistent with other, novel transmission mechanisms proposed, such as Vaillancourt and Haavisto (2016), who find suggestive evidence of a relation between country-level logistics performance and

[13] See, for example, (Blackistone, 2016)

disaster impact, with developing countries tending to have weaker logistics performance and therefore, greater disaster impact.

A similar pattern emerges among terrorism losses. Other than in 2001, and the first half of the 1970s, the Lifeyear losses were greater in developing countries in per both per capita and absolute terms. The 1970s were dominated by significant events took place in Greece, Italy, Ireland, Israel and the United Kingdom. The 2001 outlier is due to the September 11 attacks.

This finding is also consistent with the latest research on the impact of terrorism. IEP (2020) rank the countries most impacted by terrorism. All the 20 countries identified as being highly impacted or very highly impacted by terrorism in 2019 were developing countries.

5. Sensitivity

The methods used in the construction of each database, as well as the assumptions behind the Lifeyears Index calculation, require further scrutiny to delineate the validity of our findings.

Peril specific parameters

The construction of the Lifeyears Index involves the allocation of fixed values that we have kept constant for both terrorism and disasters linked to natural hazards. These parameters are the estimated welfare reduction rate due to injuries from disasters (e), the estimated time taken for an individual to recover from a disaster (T), and the proportion of an individual's time not spent on work-related activities (c). Differences in these values across perils would affect our results.

Sensitivity analysis suggests that such differences do not compromise our results because they are of insufficient magnitude. Take the welfare reduction rates (e). If we hold this rate constant for natural hazard disasters (0.054), while increasing the corresponding rate for terrorism to its theoretical maximum (1.0), [14] the impact of terrorism remains a fraction (about four percent) of the impact of natural hazard disasters. We achieve a similar result if we increase the time taken to recover from injuries (T) to its theoretical (although unrealistic) maximum of 92 for terrorism, while leaving natural hazard disaster recovery times unchanged. Our results equally remain unchanged to cross-peril variations in the proportion of an individual's time not spent on work-related activities (c).[15] Even setting all three variables (e), (T) and (c), to their unrealistic, yet theoretically possible maximums at the same time, does not alter our results. The Lifeyears impact of terrorism remains only eight percent that of natural hazard disasters.

[14] While a welfare reduction rate (e) of 1 is theoretically possible, it nonetheless unrealistic, because it would imply that all those injured have zero welfare after the event.

[15] Even if such variations did have an impact on our results, it is difficult to see identify a plausible explanation for why the proportion of an individual's time not spent on work-related activities would differ across terrorism and natural hazard disasters.

The final assumption employed in our calculations was to set the age at death (A^{death}) to be the median age of the population. This is an arbitrary assumption because we do not know the age of those killed. Perhaps those killed in terrorism events might, on average, be younger than the median age of their country at the time of death? If this were to be the case for terrorism, but not natural hazard disasters, then our calculations would be over-estimating the difference in magnitude between the two perils.

We are not aware of an established body of literature lending weight to this concern. Moreover, our results remain robust even if the relevant parameters are adjusted to their theoretical maximums for terrorism, as we applied above to (e), (T) and (c).

Injuries versus affected

The GTD does not include data on those affected by an event. Therefore, we used data on injuries as a proxy for this measure, adopting the same practice for natural hazard disasters even though data was available. The absence of data on those affected, not just injured, by terrorism events leaves open the possibility that our findings might be undermined by differential measurement bias across the datasets. If, for instance, much more people are affected for each person injured in a terrorist event than is the case for a natural hazard disaster, then our results would be over-estimating the excess of Lifeyears lost from the later over the former.

We are not aware of compelling evidence for this concern in the literature. Moreover, given the magnitude of the difference in realised impact across perils, this difference is unlikely to be of sufficient significance to overturn our main findings.

Direct versus indirect economic damages, and the risk of bias

Our introductory remarks highlighted that EM-DAT data purports to include both direct and indirect economic damage data per event, while the GTD does not. We are therefore missing the indirect economic damages from terrorism, which, may be significant. Indeed, the inherent nature of terrorism with its focus on generating fear is likely to have pervasive effects throughout markets and economies that are difficult to measure.[16] While similar concerns have been raised for natural hazard disasters, if we assume that EM-DAT captures at least some of these costs and GTD does not, then the use of these data sources would lead us to over-estimate an excess of Life years lost to natural hazard disasters over terrorism. This concern is buttressed by our headline results which report a significant difference between the damages components of Lifeyears lost to terrorism versus the equivalent for natural hazard disasters.

[16] At the risk of doing injustice to a wide and growing literature, some examples include: Benchimol and El-Shagi (2020)'s findings that terrorism has a negative impact on the accuracy of exchange rate and inflation forecasting, at least in Israel, Alexander (2012) demonstrating the pervasive societal effects of trauma (trauma being a major consequence of terrorism). In contrast to these findings, McCoy, S., McDonough, I., and Roychowdhury, P., (2020) suggest that terrorism events can temporarily boost social capital, which, might have positive economic benefits.

Nonetheless, EMDAT suffers from a large amount of missing data on economic damages relative to the GTD. Of our 14,269 natural hazard disasters events analysed, we are missing data on economic damages for 83 percent of those events [refer online appendix].[17] In comparison, we are only missing economic data for 19 percent of our terrorism events.

In addition, there is doubt whether EM-DAT economic damages data fully captures indirect economic damages. Panwar and Sen (2020) for example, identify that the nature of losses is not clearly defined in EM-DAT, citing it as one reason why estimated impacts of droughts, floods, earthquakes and storms are different in EM-DAT than they are from another, similar global database, DesInventar.

Missing values

Values may be missing at the event level, or the event-attribute level. In either case, differences in the distribution of missing values could bias our results.

Concerning EM-DAT, missing data has been addressed an issue of priority concern by its custodians, particularly in respect of economic losses (CRED 2021c). Gaps of EM-DAT's coverage have been identified, such as Harrington and Otto (2020), for example, who identify missing values on heatwaves in Sub-Saharan Africa, in part, due to weak heatwave detection frameworks in the region.[18] There are fewer such critiques of the GTD, with the exception of coverage for the year 1993, in which nearly all data is missing due to a data legacy issue (START 2021). To address this, we exclude 1993 from our analysis, unless otherwise stated.

While we do not have visibility over comparative rates of missing event-level data, we do have coverage of missing event-attribute data. This is important because omitted attributes could lead the event to be erroneously excluded from our analysis for lack of meeting the inclusion criteria. This concern is more prevalent in EM-DAT where 29 percent of identified events are missing data on fatalities and 75 percent are missing data on injuries. In comparison, the GTD is missing only six percent of data on fatalities and nine percent of data on injuries. Therefore, missing attribute data does not appear to compromise our finding that natural hazard disasters are more impactful than terrorism. Indeed, it might suggests that our findings are only a lower bound.

Of course, missing attribute data may still be present among those events who were identified and met in the inclusion criteria. However, this also seems to be more of a problem for EM-DAT than the GTD. Of those natural hazard disaster events which met our inclusion criteria, 64 percent were missind data on damages, while only 19 percent of terrorism events were missing equivalent data. EM-DAT also has more

[17] This result is consistent with analysis of EM-DAT data during the period 2000 to 2020, which found that 80% of all entries were missing economic data, (CRED 2021c).

[18] More specifically, Harrington and Otto (2020) identify that EM-DAT has systematically under-estimated the impacts of heatwaves in Sub-Saharan Africa. This is driven, at least in part, by the weak heatwave detection frameworks in the region, in comparison to other regions such as Europe, where investments were made for early warning systems following the 2003 heatwave that the region experienced.

missing data on fatalities and injuries [refer online appendix]. This lends further lend weight to our conclusion that natural hazard disasters have proven more impactful than terrorism and that our estimate of this excess is likely to be a lower bound.

Remaining issues

Other forms of measurement bias might differentially affect each database. We briefly explore the primary contenders.

Time bias

The GTD data custodians and developers acknowledge concerns that time bias might impact the measurement of terrorism events in their database. Indeed, improved data collection and methodologies introduced in 2012 have coincided with an increase in the frequency of terrorism incidents from this period onwards. While acknowledging that these modifications may explain some of the increase in the frequency in terrorism incidents identified, the GTD data custodians have detailed the steps that they have taken to address this risk, which including checking and updating pre-2012 data (Jenson, 2013). They also highlight other contemporaneous events during this period that explain the observed increase in the frequency of terrorist attacks, such as the emergence of Boko Haram in Nigeria as a powerful terrorist organisation that the region was not prepared for.

Such concerns are not unique to the GTD. They have also been raised in respect of EM-DAT (see, for example, Loayza et. al. (2012), Panwar and Sen (2019), Panwar and Sen (2020)). Nonetheless, if we take the concern seriously and restrict our analysis to only the period 2012 to 2019, the results of our analysis do not significantly change. Natural hazard disasters were responsible for 34 million Lifeyears lost during this period. Terrorism is responsible for nine. While the gap between the realised impact of the two perils has shrunk, it remains 25 million.

Endogeneity in economic damages

Loayza et. al. (2012) highlight the potential for endogeneity in the economic damage variable of EM-DAT, as the quantum of damage may be positively correlated with growth rate at the time of the disaster. Once more, however, the key question for our purposes, is whether these differences are systematically different between EM-DAT and GTD. We are not aware of a theoretical framework of explanation that would suggest this is the case.

Compilation errors

Loayza et. al. (2012) highlight that EM-DAT's reliance on data from multiple sources[19] runs the risk of compilation errors. While GTD has a less diversified range of type of source institution (it focuses

[19] According to CRED (2021d) These sources include agencies of the United Nations (UN), non-governmental organisations, insurance companies, research centres and the media. Data from the UN, governments and the International Federation of Red Cross and Red Crescent Societies are given priority on the basis that they are considered to be of higher quality, with broader scope and with less political limitations.

primarily on news media), the range of news media and languages is wide, leading to similar concerns.[20] Indeed, GTD draws upon more than 55,000 unique sources (Jensen, 2013). We are not aware of research delineating the relative risk of such errors across natural hazard disasters and terrorism. It would be a useful inquiry for future research.

Single incident determination

Our analysis is limited to only those events which resulted in ten fatalities or 100 injuries. The GTD has binding single incident determination procedures, where-as EM-DAT includes multi-year events (described more in section 2). This might provide a partial explanation for why only five percent of the nearly 200,000] terrorism events met our inclusion criteria. In contrast, 30 percent of the 21,500 natural hazard disasters met our inclusion criteria and were analysed.

We relax the inclusion criteria to address the risk that the criteria disproportionately eliminate terrorism events rather than natural hazard disasters. In this scenario, we find that natural hazard disasters are responsible for 481 million Lifeyears lost between 1970 and 2019. Terrorism is responsible for 34 million. Limiting our analysis to only the period 2012 to 2019 (when both databases are arguably at their most accurate) natural hazard disasters are responsible for 36 million Lifeyears lost, while terrorism is responsible for 17.

6. Conclusions

Natural hazard disasters have had a significantly greater realised impact than terrorism during the last fifty years. The Tangshan Earthquake of 1976 alone caused more harm than all terrorism events combined during this period. Our results are robust to multiple sensitivity measures, most of which suggest that, if anything, our findings of excess impact by natural hazard disasters over terrorism are a lower bound estimate.

Our findings are relevant to the Sustainable Development Goals and the Financing for Development Agenda. We find that low income countries bore the brunt of both perils, on both gross and per-capita measures. Despite this, the amount of official development assistance provided for disaster prevention and preparedness is paltry. It amounts to roughly one percent of all development aid (Kellet and Sparks, 2012). Between 2002 and 2019 (inclusive), the total development assistance provided for disaster prevention and preparedness to all donors amounted to 17 billion USD in current prices, or about one

[20] Under GTD's latest data collection and coding methodology, the database developers typically download about 1.3 million news articles per day. Automatic filtering typically identifies about 7,000 news articles with content pertaining to terrorism. After de-duplication procedures, there are about 2,500 articles which are further filtered using machine-learning techniques, and finally, they are read and coded by humans (Jensen 2013).

billion USD per year.[21] This annual spend is slightly less than the average annual expenditure of France alone in anti-terror operation in the Sahel.[22]

Set against the backdrop of an established literature demonstrating that the allocation of humanitarian aid is not driven by need alone,[23] our findings raise questions about the factors that determine public policy responses to the relative risks of terrorism and natural hazard disasters. Potential mechanisms relating to the benefit accruing to public decision-makers are likely to be relevant.[24]

Inquiry into the relationship between the realised impact of natural hazard disasters and terrorism on the one hand, and other global policy challenges on the other hand, would also be worthwhile. In particular, the relative impact of the dual crises of climate change and global biodiversity loss on our two perils of interest (terrorism and natural hazard disasters) will influence the extent to which our current findings hold into the future. Assuming that climate change and biodiversity loss are positively associated with terrorism incidence and the impact of some natural hazards, there is increasing policy relevance to be found in the growing literature demonstrating that ex ante prevention measures tend to be underfunded relative to ex post, emergency response measures.[25] Further research into the relationship between terrorism, natural hazards and other global developments, such as climate change and biodiversity loss, would be valuable.

[21] Author's calculations using data from the Creditor Reporting System of the OECD DAC, accessed at OECD (2021).

[22] Operation Barkhane was launched in 2014 to address terrorist organisations in The Sahel. It has proven costly. More than 50 French soldiers have died in the Sahel since 2013 when the predecessor to Operation Barkhane, Operation Serval, began and was successful in expelling Islamic militants from the north of Mali (de Fougières 2021, Demir 2021).

[23] See, Fink and Redaelli (2011) for example who find that donors tend to be more favourably inclined toward countries geographically closer beneficiaries, those who are oil exporting and their former colonies (among other factors).

[24] For example, Keefer, Neumayer and Plümper (2011) identify that countries with fewer incentives to provide public goods are less likely to invest in earthquake construction regulation. In those countries, counter-terrorism provides a more immediate benefit to those in power, thereby incentivising investments in that field, rather than the more diffuse returns from broad-scale disaster risk reduction.

[25] See, for example, Kellet and Sparks, (2012).

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Fifty years of peril

Tables and Figures

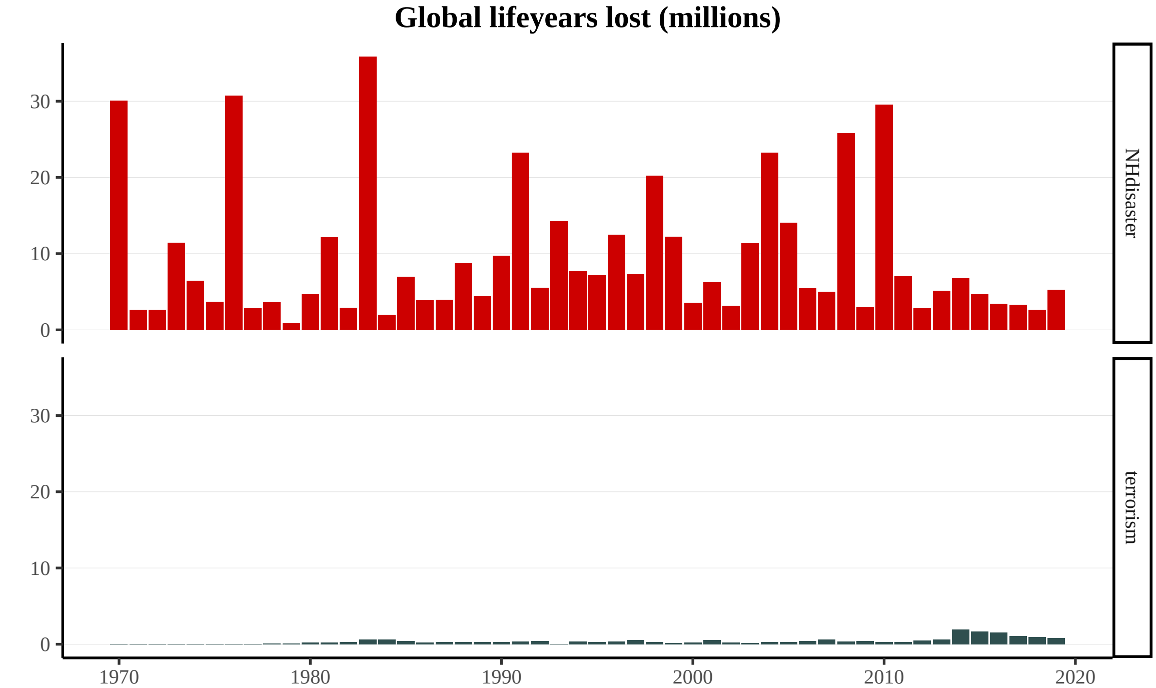
Table 1

Global lifeyears lost millions from 1970 to 2019

	Fatalities component	**Injuries component**	**Damages component**	**Total**
terrorism	18.6	0.0	0.3	**18.9**
NHdisaster	253.1	1.4	201.9	**456.4**

Calculations performed on 2022-05-24 using the panel saved in '202203'. Deaths were measured using var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed. Minimum impact inclusion criteria for events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.

Figure 1



Calculations performed on 2022−05−24 using the panel saved in '202203'.
ing var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed.
st 100 injuries. No damage threshold was set.Annualised by taking the sum of L and adding zero values for years in which no peril occured.

Table 2

Cumulative Lifeyear losses by country, ten largest (1970 to 2019)

Terrorism		NH Disasters	
Iraq	3,249,292	China	120,438,988
Afghanistan	2,162,286	India	52,987,126
Nigeria	1,366,647	Bangladesh	51,827,799
Syrian Arab Republic	966,540	Ethiopia	31,012,628
Sri Lanka	845,363	Haiti	19,767,670
Pakistan	802,903	Indonesia	19,037,866
Nicaragua	674,272	Pakistan	17,002,843
El Salvador	642,178	Sudan	12,432,478
Peru	590,940	Myanmar	11,771,217
India	571,462	Iran (Islamic Republic of)	10,621,430

Authors Notes: Calculations performed on 2022-05-24 using the panel saved in '202203'.
Deaths were measured using var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed.
Minimum impact inclusion criteria for events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.

Table 3

Cumulative per-capita losses by country, ten largest (1970 to 2019)

Terrorism		NH Disasters	
Nicaragua	186	Haiti	2,031
El Salvador	134	Ethiopia	852
Iraq	102	Honduras	759
Afghanistan	64	Sudan	746
Lebanon	60	Nicaragua	738
Syrian Arab Republic	55	Mozambique	725
Sri Lanka	47	Somalia	641
Burundi	42	Bangladesh	639
Rwanda	37	Peru	488
Somalia	36	Grenada	396

Per capita losses calculated at the country-level, per event using population at the time of the event. Cumulative losses are the sum of these event and country-specific per-capita values.;
Authors Notes: Calculations performed on 2022-05-24 using the panel saved in ’202203’.
Deaths were measured using var: ’dth_1’. Injuries were measured using var: ’inj_1’. Damages were measured using var: dmg_1’ .All values for 1993 were removed.
Minimum impact inclusion criteria for events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.

Table 4

Largest lifeyear losses by event

N.H. Disasters			Terrorism		
Location	**Year**	**Losses**	**Location**	**Year**	**Losses**
China	1976	25,769,752	Iraq	2014	113,442
Ethiopia	1983	22,432,680	Sri Lanka	2001	106,416
Bangladesh	1970	22,417,283	United States of America	2001	92,915
Haiti	2010	17,449,687	United States of America	2001	92,915
Indonesia	2004	12,011,096	Rwanda	1994	87,720
Bangladesh	1991	11,701,537	Iraq	2014	68,863
Sudan	1983	11,321,880	Iraq	2014	48,412
China	2008	11,255,938	Somalia	2017	44,557
Myanmar	2008	10,778,106	Nepal	2004	37,389
China	1998	9,302,134	Syrian Arab Republic	2014	35,628

Calculations performed on 2022-05-24 using the panel saved in '202203'.
Deaths were measured using var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed.
Minimum impact inclusion criteria for events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.

Table 5

Largest lifeyear losses per capita by event

N.H. Disasters			**Terrorism**		
Location	**Year**	**Losses**	**Location**	**Year**	**Losses**
Haiti	2010	1,754	Barbados	1976	21
Sudan	1983	703	Rwanda	1994	15
Mozambique	1981	620	Djibouti	1992	13
Ethiopia	1983	588	Djibouti	1992	7
Nicaragua	1972	538	Djibouti	1992	7
Somalia	1973	399	New Caledonia	1988	7
Grenada	2004	396	Maldives	1988	7
Peru	1970	389	Lebanon	1983	7
Bangladesh	1970	349	United Arab Emirates	1983	6
Honduras	1974	329	Sri Lanka	2001	6

Calculations performed on 2022-05-24 using the panel saved in '202203'.
Deaths were measured using var: 'dth__1'. Injuries were measured using var: 'inj__1'. Damages were measured using var: dmg__1' .All values for 1993 were removed.
Minimum impact inclusion criteria for events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.

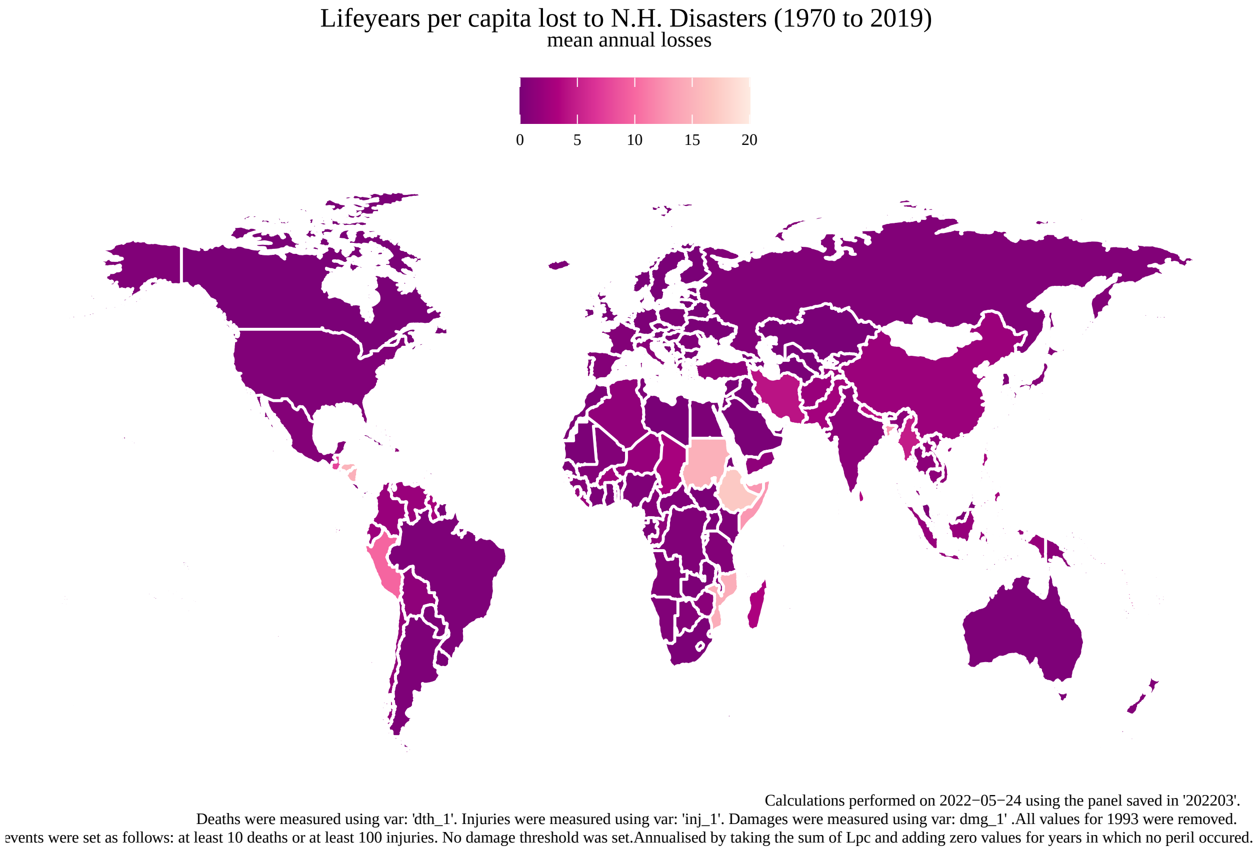
Table 6

Losses from both terrorism and N.H. disasters (1970 to 2019)

	Lifeyears			Lifeyears per capita*		
	NH Disasters	Terrorism	Combined	NH Disasters	Terrorism	Combined
Africa	76	5	81	68.08	2.92	71.00
Americas	57	3	60	38.30	2.15	40.45
Asia	324	10	334	50.76	1.28	52.04
Europe	13	0	13	9.03	0.23	9.25
Oceania	1	0	1	13.67	0.10	13.77
Total	**471**	**19**	**490**			
Developed	24	1	25	10.09	0.28	10.37
Developing	446	18	465	54.83	1.81	56.64
Total	**471**	**19**	**490**			
Low income	311	7	318	78.08	3.45	81.53
Lower middle income	114	9	123	41.38	3.43	44.81
Upper middle income	26	2	29	12.91	0.66	13.57
High income	19	0	20	10.17	0.25	10.41
Total	**471**	**19**	**490**			

*Per capita impact calculated using the annual total Lifeyear losses of the country group (e.g. Africa) divided by total population of the group in that year.;
Author's notes:
Aggregation of calculations performed on 2022-05-24.
Calculations performed on 2022-05-24 using the panel saved in '202203'.
Deaths were measured using var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed.
Minimum impact inclusion criteria for events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.Annualised by taking the sum of L and adding zero values for years in which no peril occured.

Figure 2


Lifeyears per capita lost to N.H. Disasters (1970 to 2019)
mean annual losses
0
5
10
15
20
Calculations performed on 2022−05−24 using the panel saved in '202203'.
Deaths were measured using var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed.
events were set as follows: at least 10 deaths or at least 100 injuries. No damage threshold was set.Annualised by taking the sum of Lpc and adding zero values for years in which no peril occured.

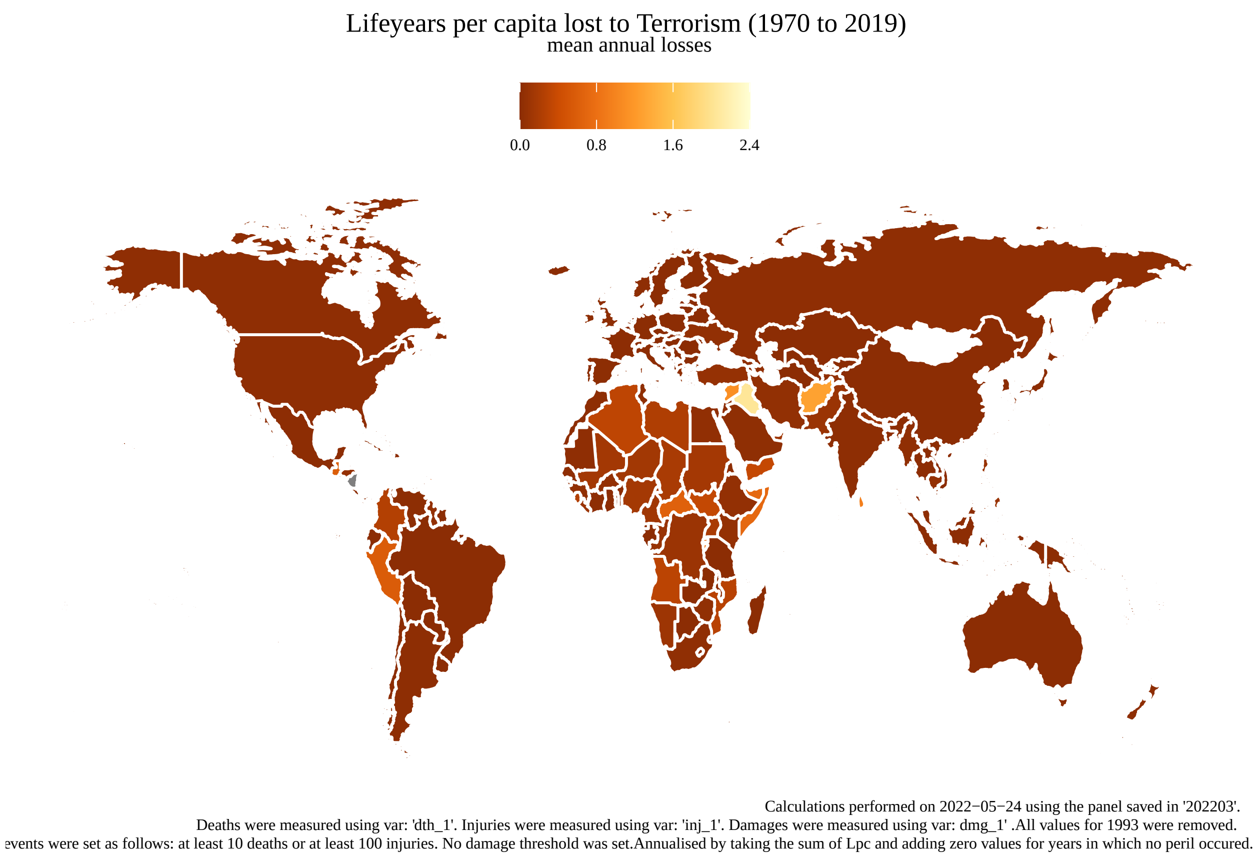

Lifeyears per capita lost to Terrorism (1970 to 2019)
mean annual losses
0.0
0.8
1.6
2.4
Calculations performed on 2022−05−24 using the panel saved in '202203'.
Deaths were measured using var: 'dth_1'. Injuries were measured using var: 'inj_1'. Damages were measured using var: dmg_1' .All values for 1993 were removed.
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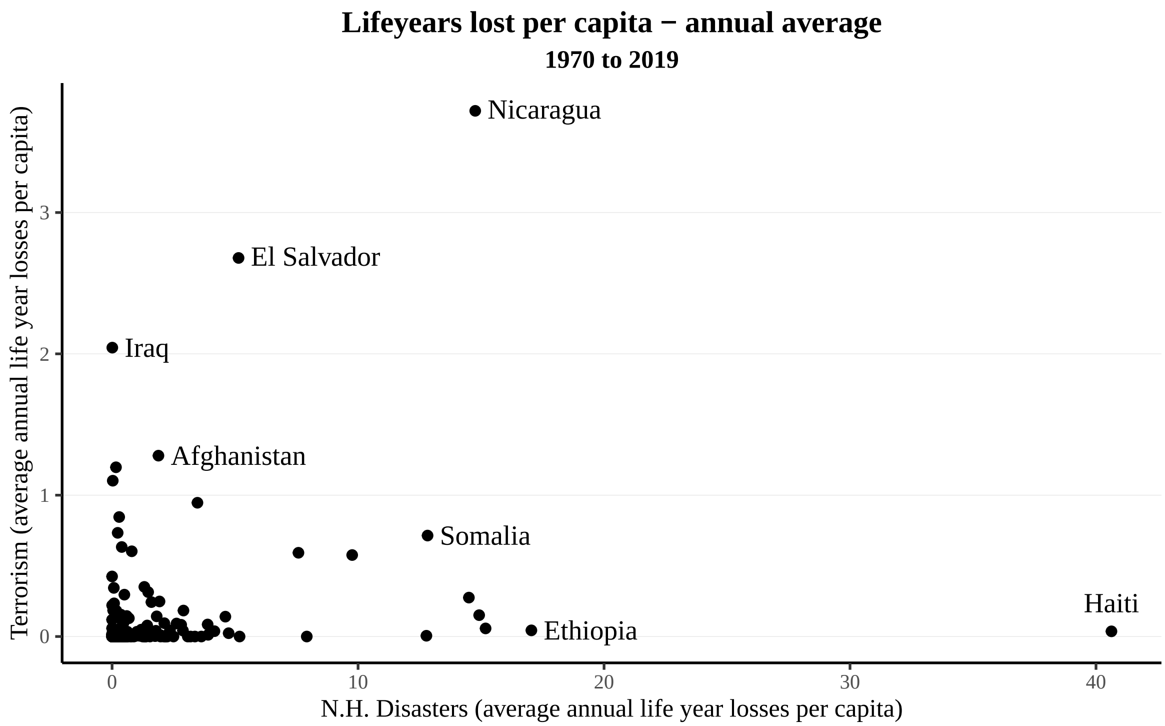
Figure 3



Calculations performed on 2022−05−24 using the panel saved in '202203'.
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