AIRCRAFT ACCIDENTS AND GROUND CASUALTIES NEAR AIRPORTS: EVIDENCE FROM GLOBAL SOUTH AND GLOBAL NORTH COUNTRIES

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ABSTRACT

Safety is an intrinsic characteristic of civil aviation, but while accidents are rare, they do happen. From 2011 to 2020, 67% of aircraft accidents occurred at takeoffs, landings, approach or initial climb flight phases, thus generally close to airports. This article investigates to what extent aircraft accidents affecting ground structures happened close to airports throughout a century of accident records and how they distribute geographically. An extensive database of aircraft accidents' descriptions was evaluated. From 1926 to 2020, 833 accidents were identified as affecting some structure on the ground, of which 327 happened in a known, identifiable location ranging from 0.10km to 45km outside the airport site, many of them causing ground casualties. Of these, 77% of the events and fatalities happened within 5 km from the airports' limits. The distribution of these 327 events and 1,798 ground casualties was analyzed considering distance from the airports and the Human Development Index (HDI) to classify countries as global North and global South. Results upon such classification show that the number of events is fairly balanced (52.91% at global North and 47.09% at global South) but the number of ground casualties is otherwise very unbalanced: 75.14% at global South *versus* 24.86% at global North countries. Moreover, the vast majority of ground casualties at global South countries happened within the ranges of 0.1km-1.0km and 1.1km to 2.0km from the airports sites. This indicates that, safety-wise, urban planning has been more effective around global North countries' airports, while the urban dynamics of no or poor land use control around airports of global South countries resulted on dense residential areas occupying their proximities, which is a contributing cause for such unbalance. This brings further burden for airport and urban planners of global South Countries to effectively manage the airport-community conflict.

Keywords: Aviation Safety, Ground Casualties, Airport Vicinities, Global North, Global South.

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1. INTRODUCTION

Although safety is an intrinsic and important aspect of aviation, accidents do happen. Throughout history, the number of aircraft accidents divided by the number of take offs has been much higher, thereby aviation as a whole became a lot safer over the past decades.

However small the number of accidents divided by take offs, aircraft accidents are psycho-sociological events high publicized by the media and press, and fear of flying leads feelings of anxiety that takes place at airports, prior to the boarding of passengers, as taking off is optional, but landing is mandatory.

Also, statistical records show that, decades after decades, the majority of aircraft accidents happen on the flight phases of landing, final approach, take off and initial climb rather than *en-route* or at cruise speeds and altitudes (when accidents happen, but are less often, and many times caused by factors out of control of commanding crew, such as sabotage and terrorist bombings).

The flight phases with more accidents are closer to airports, placing an additional impact of these key infrastructure elements. Although aircraft noise may be considered the major impact of airports, safety around airports haunt many neighbors given the high coverage from media despite relatively low statistical significance. Other impacts of airports include ground access congestion, urban segmentation (given they require lots of land), air pollution (emissions from ground vehicles, on the access and aggresses of people and cargo etc.), deviation of water bodies, filling of wetlands and beaches, creating artificial islands (rare few cases), loss of natural habitats, and even light emissions at night confusing birds. The perception of safety risk in its neighborhoods is probably second only to aircraft noise.

This study investigated an extensive data base of aircraft accidents with over a hundred years of records, spanning from 1919 to 2020. By reviewing entries' descriptions (over 20,000, most of them relatively short), it was possible to segregate records of aircraft accidents where some ground structure was affected and, within them, the cases in which there were ground casualties – fatal victims who were not aboard the aircraft involved on the accident.

The next step was to evaluate, either at indicated location or within the descriptions, the distance from airports that such accidents happened, to compute if the number of events and the number of ground casualties correlate with distance from the airport. It was found that the number of events and the number of ground casualties is significantly higher when close to airports than in the cases known to have happened far away from airports.

Finally, the geographical location variable was studied by separating the records from countries of the so-called global North (richer and more developed) from those of the global South (poorer, less developed and more populated) by computing the Human Development Index (HDI) published by United Nations Development Program (UNDP).

The number of accident events affecting ground structures is quite similar at global North and global South countries, but the number of ground casualties is substantially higher at global South countries as compared to global North ones, especially within short distances from the airports of origin or destination. This indicates that the challenges of aviation safety considering potential accidents around airports are larger and different at poorer, undeveloped countries of the global South than from those of the richer and more developed countries of the global North.

2. THE NORTH-SOUTH GEOGRAPHY

The end of World War II quickly established a new world geopolitical order, with western countries aligned with the United States and western European countries *versus* countries within the sphere of influence of the former Soviet Union. This changed the geopolitical balance of the world as, for over four decades both blocks challenged each other in the so-called "cold war", with local and limited disputes such as in the Koreas and Vietnam but never entering into direct conflict or using nuclear weapons against each other.

This triggered a series of theories and practices, institutionalized by the Conflict Resolution Movement, which involved several “think tanks” on the issue on the United States from 1956 to 1971 (Harty & Modell, 1991). A whole periodical – *The Journal of Conflict Resolution* – was dedicated to the matter, based on the thoughts of authors like Kenneth Boulding (1957) and Thomas Schelling (1960).

United Kingdom, France, Netherlands, Belgium and Italy set their former colonies free. The number of newly independent countries increased. Both Soviet Union and the United States-led coalition of western democratic states competed for hegemony in undeveloped countries in Latin America, Africa, the Middle East and Asia-Pacific. Some of these former colonies and long-time independent states migrated to the Soviet influence, such as Egypt, during the crisis of nationalizing the Suez Canal and then building the Aswan High Dam (Sant'Anna, 2015).

The Soviet Union collapsed a couple of years after the start of Glasnost and Perestroika (Gorbachev, 1987). It became clear that the key division of geopolitics was not exactly East *versus* West; rather it was North *versus* South.

In “North-South: a program for survival”, the Independent Commission on International Development Issues chaired by (west)-Germany’s former premier Willy Brandt, already highlighted this new, enduring and more complex division of the planet, shown on Figure 1.

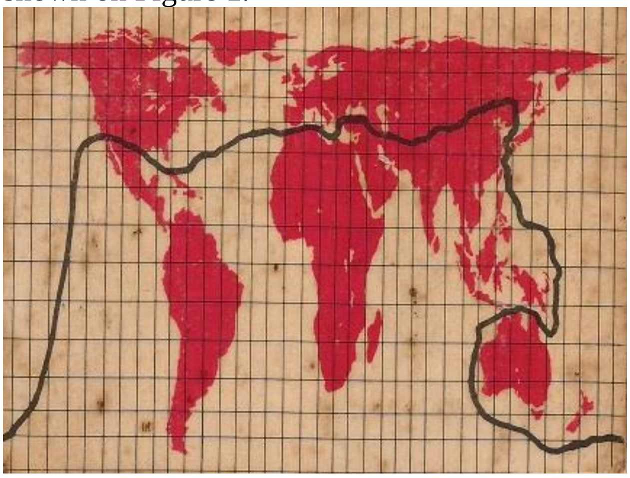

Figure 1 The North-South Division of the World Proposed by the Brandt Commission

This indicated North America (Canada and United States), the whole Europe (western and eastern), the former Soviet Union, Japan and Australia and New Zealand as “North” and the rest of the world – including Latin America and the Caribbean, Africa, the Middle East (including Turkey) and Asia Pacific (including the Koreas, China and India) as “South” (Brandt Commission, 1981).

Following the collapse of the Soviet Union, the terms “global North” and “global South” became quite common to refer to richer, more developed nations of the “North” (including Australia and New Zealand, both in Southern hemisphere) concentrating most the world’s wealth, and “global South” with undeveloped and/or developing nations, where most of the world population live.

This is relevant in different aspects: first, as shown Figure 2, in 2012 the number of people living in cities outnumbered the number of people living in fields and rural areas; second the total population of people living in rural areas is expected to decrease in absolute numbers starting sometime between 2025 and 2030; third, most of the world population growth is expected to happen in cities and urban areas of the less developed regions, while the number of people living in cities and urban areas of more developed regions of the world is expected to stabilize, first with a slight growth and then with a potential reduction in absolute numbers (United Nations, 2015).

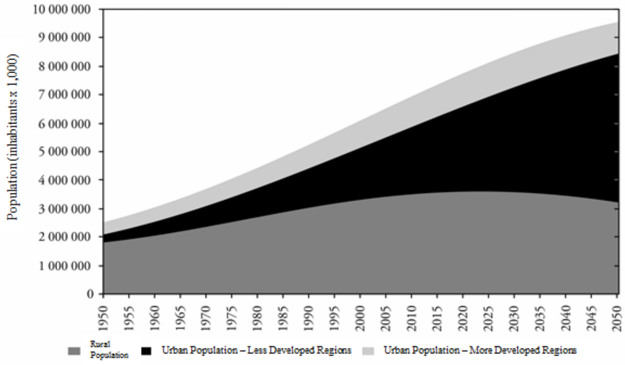

Figure 2 Population Growth Projected by the United Nations (actual 1950-2014; projections 2015-2050)

Although most commercial flights occur within the northern hemisphere (mostly among global North countries), most people in the world live in the global South –

increasingly in their cities – a significant growth of the number of flights is expected in the global South countries in the future. This justifies evaluating how airplane accidents affecting ground structures are geographically distributed between global North and global South as these groups of country may have different tools to successfully plan land use around their airports.

3. PLANE ACCIDENTS AFFECTING GROUND STRUCTURES

Safety is an intrinsic factor of civil aviation: air accidents are rare (Rose, 1992) due to a series of technological and regulatory improvements introduced over decades (Abeyratne, 1998). The number of accidents has decreased substantially over time. For example, 2017 had the lowest number of fatal accidents in several decades (ASN, 2022), despite the growth of aviation.

Most aircraft accidents happen on the flight phases of landing, final approach, take off and initial climb, which are closer to airports than the phases of flight of climb, *en-route* or at cruise speeds and altitudes, and initial descent (Boeing, 2021). Accidents also happen during the higher altitude and farther from airport flight phases, but rather less often and at times caused by factors out of control of the pilots, such as sabotage, high jacking, and terrorist bombings. These may be of interest of this study as their debris may fall onto ground structures, as the Lockerbie bombing of December 21, 1988 (ASN, 2022).

Error is part of human nature and even with technological improvements in the design and construction of airplanes (Angelucci, 1974) and navigation and flight control (Komons, 1989), they still happen. Complex systems (like aircrafts, air traffic control systems and even airports) have redundant control levels or structures which are designed to exceed the possibilities of single, individual faults. Several layers of control structures make the number of incident occurrences be as low as possible. Some incidents can go beyond the redundancy of the control structure, becoming accidents, and some accidents are fatal (Reason, 1990).

Even though aviation is the safest means of transport in terms of accidents per million operations and/or passengers x kilometers (Abeyratne, 1998), it is believed that the main procedures to increase safety that can be adopted in aviation are already in place. Safety procedures are mandatory practice in most countries, but there is a trend of flat asymptote from which the reduction of accidents should occur in a less intense way (Hart, 2004). Regardless all that, when air accidents occur, it is common for passengers to increase anxiety, triggering "an uncontrollable love-hate relationship between journalists from the popular media and professionals in the aviation sector" (Borfitz, 2001). It is likely that similar feelings happen with neighbors of airport when the accident crashes on its vicinities, affecting structures, goods and people on the ground.

Airplane crashes are part of what Barry Glassner (2003) called a "culture of fear": although the number of victims of plane crashes is very small, the coverage given by the press to each crash is enormous – especially by the local media. At the time of the introduction of jet aircraft (end of 1950's) there was one fatal accident for every 200,000 takeoffs; currently, there is not even one fatal accident for every 2 million takeoffs (Boeing, 2021). But "[air] accidents are profound psycho-economic occurrences" (Glassner, 2003, p. 317).

Modern society is not entirely risk-free; on the contrary, in 1986, Beck introduced the concept of "risk society" (Beck, 2010), in which the driving force would be the phrase "*I'm afraid!*", against the driving force phrase "*I'm hungry!*" of class society (Hier, 2003). Flying is one of the most anxious activities for people, and the fear of flying is not only manifested inside the planes, but also in the boarding process at airports. For Janic (2000), despite the growing perception that externalities (air pollution, noise, land use, water and soil pollution, waste management and access congestion) are important elements of the aviation system, risk and safety have always been present. Statistical risk is an exact science but personal risk perception is subjective (Slovic, 1987), relative (Renn, 2000), as well as psychosocially amplified (Kasperson, et al., 1988).

Between 2011 and 2020, takeoff and initial climb accounted for 2% of the total average flight time, but this is where 13% of fatal accidents occurred, causing 8% of fatalities; on final approach and landing, which corresponded to 4% of the average flight time, 54% of fatal accidents occurred, causing 40% of victims in air accidents (Boeing, 2021, p. 14). Takeoff and landing phases of flight take place inside airports, while the initial climb and final approach phases take place over their nearby vicinity.

Air crashes affecting structures on the ground are rare, but deaths of people who were not on the crashed planes (*ground casualties*) are not null, having a strong impact on the media (Glassner, 2003) and on the popular unconscious of the neighbors of the airports (Gordon, 2004).

Two airports were closed after accidents that caused many victims on the ground: *Grano de Oro*, in Maracaibo, Venezuela, and Medan-*Polonia*, in Indonesia. However, air accidents affecting structures on the ground are a minority, and throughout history (since 1919, when records of air accidents began, including World War II), 82,000 people died in planes, and 4,700 on the ground – including the nearly 2,800 victims of the September 11, 2001 attacks (ASN, 2022).

Thereby, the number of people who died in air crashes as well as ground casualties associated with such crashes along history is far smaller than that of people dying of the recent SARS-Cov-2 pandemics.

Given the augmented visibility by media coverage and the intrinsic need of aviation to keep a good safety track record, it is justifiable to investigate whether countries of the global North and the global South have similar patterns of aircraft accidents affecting man-made structures on the ground (events).

Given that land use planning around airports may be less effective in global South countries than in global North ones, it is also interesting to investigate the geographical distribution of ground casualties (fatalities).

Lastly, to justify the survey: "[statistics are] like bikinis: what they reveal is interesting but what they conceal is fundamental" (Dinning, 1953, p. 127).

4. METHODOLOGY

The database of Aviation Safety Network (ASN, 2022) was extensively analyzed: nearly 20,000 records of accident were reviewed. The analysis was performed in three batches: the first batch involved reading the accidents' descriptions from 1945 to 2004 and contacting the webmaster with a spreadsheet summarizing ground casualties, which led him to include the number of ground casualties on the main page of the template of the descriptions, as applicable. This analysis was performed by the author from 2005 to 2007.

The second batch of analysis covered the period from 1919 to 1944, when the original database was complemented, and a third batch covering from 2005 to 2020 were both carried out from 2018 to 2021. This means that some new entries on each of these periods may have been added by the webmaster along time, and may not be included on this survey.

By reading every single accident description, the author discarded the cases of air accidents of planes that crashed on mountains, forests, sea etc., selecting those affecting man-made structures on the ground. It is important to state that there is no disregard to the pain of victims involved in accidents that did not affect structures on the ground; rather, it is solely a methodological filter as part of this study.

The selected accident descriptions were summarized in an MS Excel® spreadsheet. Each description takes one of the 833 lines with information spread on 25 columns.

These columns include: (A) a number of order, (B) the year of the record (1919 to 2020), (C) the number of events in that year, (column D) the date of the event, (column E) the closest airport's name and (column F) its IATA or ICAO code. This was followed by the identification of the city of the event (Column G), country (column H), and air carrier name (column J). The following column (K) includes initials of the flight phase, which can be: en-route (EN), initial climb (ICL), takeoff (TO), landing (LD), approach (AP), taxiing (TXI), maneuvering (MN), standing (ST), and unknown (UNK).

Column L indicates the nature of the flight: domestic scheduled passenger (DSP), international scheduled passenger (ISP), domestic non-scheduled passenger (DNSP), international non-scheduled passenger (INSP), cargo, training, test, demonstration, ferry, and military (MIL).

Column M indicates if the event happened during daytime (with daylight), recording either Y = yes, N= No and UNK = unknown (when either the time is not shown on the accident description, or the hour of the day could not determine if it was during daylight or not due to the season of the year).

Columns N, O and P are filled by numbers of the people aboard (passengers and crew), the casualties of those aboard and the ground casualties (zero if no-one was killed on the ground despite some man-built structure being affected).

Column Q shows a brief description of the event and/or accident with somewhat standardized wording, while columns R and S indicate if the event happened outside or inside the airport site (accidents with the aircraft hitting but not passing through the airport's perimeter fence or wall were marked "X" on both columns).

For all cases of accidents outside the airport, column T shows a text describing the location of the event, which can be unknown (in cases of simpler and older accidents' descriptions), qualitative (depending on the interpretation of the description: far away, close to the airport, near the airport, very near the airport) or more specific, when an address or neighborhood is mentioned, or even the distance from runway end, from airport as a whole, sometimes with a numeric distance, in kilometers from such reference point. As a consequence, to facilitate filtering the cells of the spreadsheet, column U shows a quick indication of distance from the airport, which can be unknown (UNK), far away (FA), near the airport (N), very near the airport (VN), perimeter fence (PF), and the distance from the airport (with 0.1km precision).

The following columns V, W, X, and Y indicate the Maximum Takeoff Weight (MTOW) of the aircraft (as an indicator of its size, in case of possible correlation with the events or the ground casualties), and the Human Development Index (HDI) of the country where the accident happened.

MTOW was computed in metric tons from the reference of the aircraft description on the ASN data base (ASN, 2022).

The HDI is an indicator of quality of life computed by the United Nations Development Program (UNDP, 2018) for countries which considers (a) life expectancy at birth (years), (b) expected years of schooling (years), (c) mean years of schooling (years), and Gross National Income *per capita* (Potential Power of Purchase, in constant United States Dollars for 2017).

HDI is always a number between 0.000 and 1.000, being considered low as < 0.550, medium from 0.550 to 0.699, high from 0.700 to 0.799, and very high when > 0.800.

In this study, HDI values for 2017 above 0.800 (very high) were considered as global North countries, while all other values classified the country as part of global South.

Any of the 25 columns can be filtered, allowing ranking the spreadsheet in variables such as country, city, airport, aircraft type, air carrier, day/night, number of ground casualties, number of on-board casualties, distance from the airport (quick indication of distance and actual distance from the airport, in km), MTOW, country HDI, and country insertion as global North or global South. Results were both tabled and plotted in graphs to allow visual perception of their nature and geographical distribution.

5. RESULTS

Table 1 summarizes the information of 833 accident events' records affecting ground structures from 1926 to 2020 (there were no such cases from 1919 to 1925). Of these, 327 cases affecting ground structures had the effective distance from the airport known (or determined by identifying an address or location indicated at the accident's description based on Google Maps®), with distances ranging from 0.1km to 45.0km. Correlations with several variables were tested: MTOW, the country itself, the country's HDI, and the country's insertion as global North and global South, based on HDI being very high (>0.800) or under this threshold.

Turkey is the only country that shifted from global South at the Brandt Commission report (see **Figure 1**) to global North considering its HDI value.

Table 1 Summary of Information on Accidents Affecting Ground Structures, 1926-2020

Distance from Airport	*Number of Cases*	*% of the Total*
Unknown	107	12.85%
Within the Airport Site	195	23.41%
Far Away from the Airport	45	5.40%
Near the Airport	48	5.76%
Very Near the Airport	87	10.44%
Hitting Perimeter Fence	24	2.88%
Distance or Location Indicated (km or address/name)	327	39.26%
Total Accidents Affecting Ground Structures	833	100.00%

Source: computed by the Author based on (ASN, 2022)

Figure 3 shows the dispersion of distances that could be established in relation to the airport of origin and/or destination, of all the 327 cases with known distance from the airport.

Most of the events and fatalities were close to the airports: 60% of the accumulated cases and 70% of the accumulated ground casualties happened within a 2 km range from the airport. As the graph is clearly asymptotic, 80% of accumulated events and ground casualties are found to have occurred within a 6.0 to 7.0km distance from the airport, while 90% of both events and ground casualties accumulate between 10.0 and 11.0km from the airport.

Aircraft MTOW does not reveal an important correlation with the number of victims, nor does the HDI of the country in which the accident occurred. However, the inclusion of the countries in which the events occurred (fatal or not for people on the ground) in the global North and global South categories shows important results: despite the events in global North countries being slightly higher than those in global South countries (52.91% against 47.09%), the number of victims on the ground is much higher in countries of the global South (75.14% of the total) than in countries of the global North (24.86%), as can be seen in Table 2.

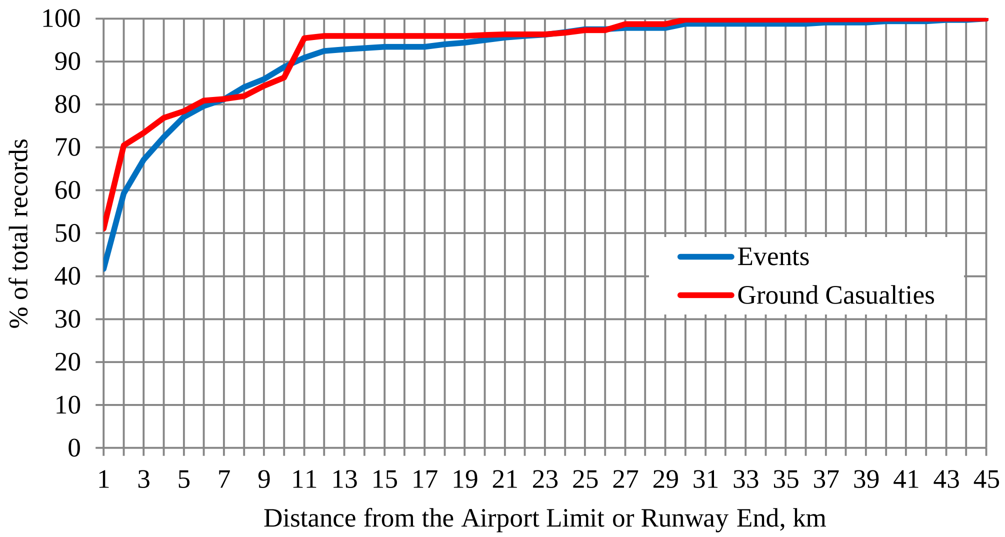

Figure 3 Accumulated Dispersion of Events and Ground Casualties *versus* Distance from the Airport (km)

Source: Computed by the Author, based on (ASN, 2022)

Figure 4 plots the total fatalities on the ground in the intervals of Table 2 divided by the number of kilometers involved in the interval, showing the much higher lethality of such accidents when occurring in global South countries, despite the number of accidents in these countries being quite similar to the accidents that occurred in the countries of the global North.

Finally, Table 3 summarizes the 20 worst accidents ranked by the number of ground casualties, not including the events of September 11, 2001, which were result of premeditated terrorism.

Table 2 Distribution of Events and Ground Casualties *versus* Distance Intervals from the Airport, Global North and Global South

Distance Interval	*Total*				*Global North*				*Global South*			
	Events		*Casualties*		*Events*		*Casualties*		*Events*		*Casualties*	
	Nr.	*Σ*	*Nr.*	*Σ*	*Nr.*	*Σ*	*Nr.*	*Σ*	*Nr.*	*Σ*	*Nr.*	*Σ*
0.1-1.0km	137	137	959	959	70	70	119	119	67	67	840	840
1.1-2.0km	59	196	333	1.292	33	103	109	228	26	93	224	1.064
2.1-3.0km	25	221	51	1.343	12	115	8	236	13	106	43	1.107
3.1-4.0km	17	238	60	1.403	8	123	6	242	9	115	54	1.161
4.1-5.0km	15	253	26	1.429	8	131	6	248	7	122	20	1.181
5.1-10.0km	37	290	141	1.570	20	151	76	324	17	139	65	1.246
10.1-20.0km	21	311	162	1.732	12	163	64	388	9	148	98	1.344
>20km	16	327	66	1.798	10	173	59	447	6	154	7	1.351

Source: Computed by the Author, based on (ASN, 2022)

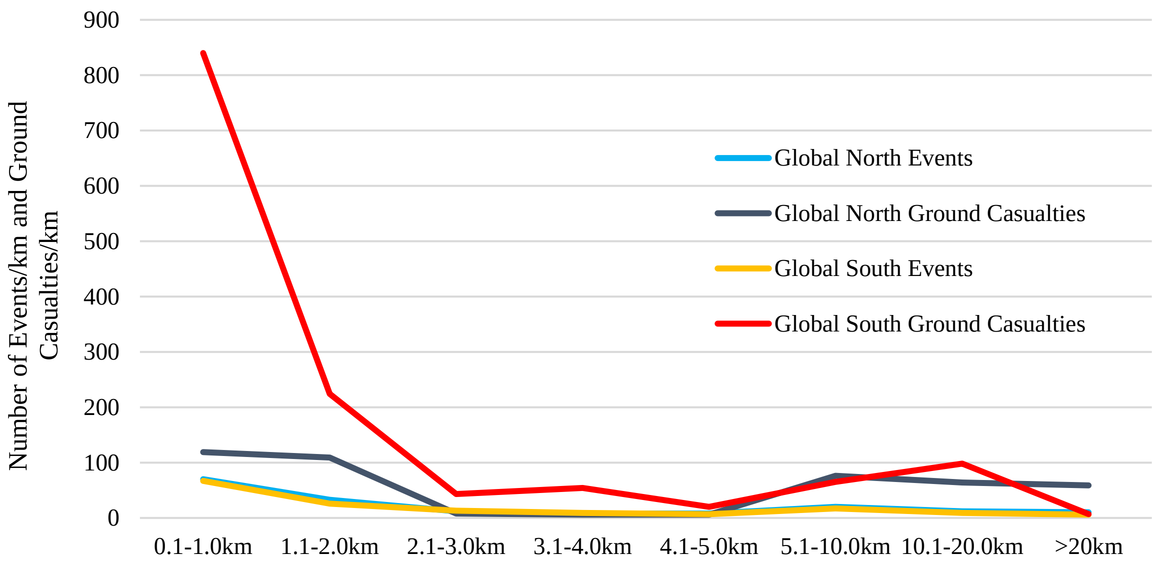

Figure 4 Number of Events/km and Number of Ground Casualties/km *versus* Distance Intervals from the Airports, Global North, and Global South

Source: Computed by the Author, based on (ASN, 2022)

Excluding the intentional attacks of September 11, 2001, the worst record is that of an overweight cargo plane that failed to take off from Kinshasa-*N'Dolo* airport in Congo Democratic Republic in 1996, killing 237 people at a street market 600 meters from the runway threshold – no-one was killed aboard (ASN, 2022).

The worst cases in the global South involve crashes over residential areas less than 2.0km from the airport of origin or destination. On the other hand, in the global North, the most lethal accidents occurred within the aerodrome or more than 10km from it, where it seems unreasonable to provide safety buffer areas.

Another notable result of the MS Excel® spreadsheet selecting only the events affecting ground structures from the original ASN database is that, despite accidents at airports such as Kinshasa-*N'Dolo* airport being very lethal, the airport with the highest frequency of accidents affecting ground structures (including non-fatal accidents) is São Paulo-*Congonhas*, with 11 events in the database (5 fatal, totaling 27 ground casualties, with the worst accident killing 12 people on the ground in July 17, 2007). Next comes the former

Quito-*Mariscal Sucre* airport (7 events, 4 of which were fatal, the worst with 49 victims out of a total of 64 fatalities on the ground), and Guatemala City-*La Aurora* airport, with 7 events, of which 3 were fatal, causing 24 casualties (the worst event with 16 casualties on the ground) (ASN, 2022).

Table 3 Summary of More Lethal Accidents Affecting Ground Structures, Ranked by Ground Casualties of Each Event

Ground Casualties	*City/Airport*	*Country*	*Global Insertion*	*Year*	*Distance from Airport*	*Comments*
237	Kinshasa -*N'Dolo*	D.R. Congo	South	1996	0.6km	Overshot the runway and hit a market
109	Kinshasa -*N'Djili*	D.R. Congo	South	2000	In the Site	Military ammunition explosion
107	Da Nang	Vietnam	South	1966	2.0km	Crashed on 66 houses
88	Santa Cruz de La Sierra-*Viru Viru*	Bolivia	South	1976	0.6km	Crashed on houses and a football field
87	Ankara-*Esenboga*	Turkey	North	1963	10.5km	Crashed on houses at the Ulus neighborhood after a flight collision
85	Lvov-*Smilow*	Ukraine	North	2002	In the Site	Aerobatic accident at air show
78	Kano-*Amimu*	Nigeria	South	2002	0.8km	Hit 23 houses, 1 school and 1 mosque
71	Maracaibo-*Grano de Oro*	Venezuela	South	1969	1.0km	It hit electrical wires and fell on houses
49	Quito-*Mariscal Sucre*	Ecuador	South	1984	0.5km	Crashed on 25 houses
47	Medan-*Poland*	Indonesia	South	2005	0.3km	Crashed on a residential area
45	Irkutsk	Russia	North	1997	1.6km	Crashed on a residential area
44	Seoul-*Yeouido Base*	South Korea	South	1967	Next	Crashed on neighboring slums
44	Mexico-*Benito Juarez*	Mexico	South	1987	Unknown	Crashed on the Mexico- Toluca road
39	Amsterdam-*Schiphol*	Netherlands	North	1992	11.0km	Crashed on a building in Bijlmermeer
37	Goma	D.R. Congo	South	2008	0.1km	Crashed on a residential area
35	Bishkek-*Manas*	Kyrgyzstan	South	2017	1.9km	Crashed on a trailer parking lot
32	Munich-*Riem*	Germany	North	1960	8.7km	Crashed on a crowded streetcar
32	Beijing-*Xijiao*	China, PRC	South	1979	Unknown	Crashed on a factory
28	Kinshasa-*N'Djili*	DR Congo	South	2007	2.0km	Crashed on a residential area
25	Svetlogorsk-*Hrabovo*	Russia	North	1972	27.0km	Crashed on an elementary school playground
25	Brazzaville-*Maya Maya*	Congo	South	2012	1.0km	Crashed on a residential area
24	Nha Tang	Vietnam	South	1969	Very Near	Crashed into homes and schools after onboard bomb blast
23	Fayetteville-*Air Base*	USA	North	1994	In the Site	Soldiers hit by military plane
23	Blanket	Ecuador	South	1996	4.0km	Crashed on houses and restaurant
22	Wichita-*Air Base*	USA	North	1965	11.0km	Crashed on a street
22	Medellin-*Enrique Olaya Herrera*	Colombia	South	1963	Unknown	Crashed on a factory building after hitting electrical wires
22	Sao Paulo-*Guarulhos*	Brazil	South	1989	2.0km	Crashed on a slum before the runway
20	Asunción-*Silvio Pettirossi*	Paraguay	South	1996	2.0km	Crashed on an amusement park

6. CONCLUSIONS

Aviation Safety Networks (ASN) is a complete and very reliable database with nearly 20,000 accident descriptions from 1919 to date. All these entries were reviewed, allowing the selection of 833 entries which affected some kind of man-made ground structure. The profiles of these descriptions included eventual ground casualties – i.e., death of people who were not aboard the aircrafts involved in these accidents.

As safety around airports is one of the key worry factors of their neighborhoods, the selected data was organized in a spreadsheet allowing filtering and ranking the data of the 833 entries according to several variables, including distance from airports of origin and destination and the geographical distribution in terms of the global North (most rich and developed countries) and global South (most populated but less developed countries). These 833 entries include 1,798 casualties, not considering the nearly 2,800 casualties of the terrorist attacks of September 11, 2001.

The proximity of events and ground casualties on these accidents relative to the closest airports could be precisely determined in 327 entries, identifying the distance from the airports or the airports' runway end.

Half of the cases and 70% of all affecting ground structures at a known distance from the closest airports happened within 2km from the airports or their runway ends. Casualties and events concentrate 80% of the cases from 6.0 to 7.0km from the airports, while 90% happened within 10.0 to 11.0 km from them.

In terms of geographical distribution considering countries part of the global North and global South (according to their Human Development Index), the number of events is fairly balanced (52.91% on the former and 47.09% on the latter), but the number of ground casualties is not: 75.14% of the ground casualties happened in accidents in countries of the global South, with the remainder 24.86% happening in countries of the global North. Global South countries concentrate most of the ground casualties within the Aviation Network database.

Democratic Republic of Congo alone counts 411 ground casualties, followed by Vietnam, with 131 fatalities and Bolivia, with one single event claiming 88 lives on the ground.

The airports with more frequent events affecting ground structures off from the airport site are São Paulo-Congonhas, Quito-Mariscal Sucre (old airport, now defunct) and Guatemala City-La Aurora, all in countries of the global South (Brazil, Ecuador and Guatemala, respectively), but none of these are among the deadliest events or airports of the survey.

Most of the more lethal accidents in the global South and the vast majority of the ground casualties are identified within 2.0km from the airports or their runway ends. On the other hand, the deadliest events in countries in the global North recorded ground casualties at least 10.5km off from the airport, or within the airport site in acrobatic airshows, where there is little action by urban planners to diminish risk.

Twenty-eight events caused more than 20 ground casualties each, totaling 1,500 ground casualties – 83.43% of the total excluding the victims of the September 11, 2001 terrorist attacks. Only 8 of these 28 more lethal events happened at countries of the global North; the other 20 events happened in countries of the Global South.

This indicates that the vicinities of airports in the global South are far riskier than those of airports in the global North. As global South cities tend to grow in population far more than global North cities, there might be more complex challenges for urban planners and for airport authorities in the future.

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