



CAPRA

CENTRAL AMERICA PROBABILISTIC RISK ASSESSMENT
EVALUACIÓN PROBABILISTA DE RIESGOS EN CENTRO AMÉRICA

BELIZE

TASK I
HAZARD IDENTIFICATION, HISTORICAL REVIEW
AND PROBABILISTIC ANALYSIS

TECHNICAL REPORT TASK 1.1 B
REVIEW: EXISTING STUDIES





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1 General

An inventory of natural events which had the greatest impact over time is made up for each country. The impact is measured in terms of effect on infrastructure and the population. Historical events are studied in relation to seismic hazard, the formation of tsunami, hurricane, heavy rains, landslides, floods and volcanoes.

The collection of information came from different sources, among which there are several webpages of organisations related to this type of study, State agencies and private entities in the countries in which the research is conducted, information from regional newspapers, and studies of different disciplines prepared earlier for each country.

All the information compiled was subjected to a process of classification, and editing and recording in the database. The classification is based on the special valuation of each natural event, taking account not only of the place affected by the location of the phenomena at a specific point, but the influence of the phenomena on a distant zone from the origin, with important impact.

The database of historical events has the additional information referring to location, date of occurrence, a particular properties of each type of hazard (for example, intensity and magnitude for earthquakes), and qualitative description of the most important effects of the phenomenon. In some cases, there is information related to economic loss, loss of life, the population affected and major damage caused by the natural event.

Table 1-1 gives a summary of natural disasters which occurred between 1972 and 2001 in Latin America and the Caribbean. It can be seen that about half of them were derived from hydrometeorological phenomena, such as heavy rain, droughts, tropical storm and hurricanes. The largest number of deaths reported was therefore that of the Guatemala earthquake of 1976 (23,000); while the highest number of direct victims was reported during the phenomenon of ENSO between 1982 and 1983 for Bolivia, Ecuador and Peru (3,840,000 persons affected). The highest loss reported was for 1998, in the Andean coast of South America during ENSO phenomenon of in 1987-1998, totalling \$7,694 million.

Table 1-1
Some disasters due to natural events between 1972 and 2001 in Latin America and the Caribbean

(Source: Economic Commission for Latin America and the Caribbean/ Interamerican Development Bank (ECLAC/IDB))

Country, year	Event type	Affected		1998 US Millions of Dollars
		Killed	Damaged	Total Loss
Nicaragua, 1972	Earthquake	6,000	300,000	2,968
Honduras, 1974	Hurricane Fifi	7,000	115,000	1,331
Grenada, 1975	Tropical storm	-	-	29
Antigua and Barbuda, 1975	Earthquake	-	4,200	61
Guatemala, 1976	Earthquake	23,000	2'550,000	2,147
Dominica, 1979	Hurricane David	42	60,060	118
Dominican Republic, 1979	Hurricanes David and Federico	2,000	1'200,000	1,869
Nicaragua, 1982	Flooding	80	70,000	599
El Salvador, 1982	Earthquake	600	20,000	216
Guatemala, 1982	Intense rainfall	610	10,000	136
Nicaragua, 1982	Flooding and drought	-	-	588
Bolivia, Ecuador y Peru, 1982-1983	ENSO	-	3'840,000	5,651
Mexico, 1985	Earthquake	8,000	150,000	6,216
Colombia, 1985	Nevado del Ruiz volcano eruption	22,000	200,000	465
El Salvador, 1986	Earthquake	1,200	520,000	1,352
Ecuador, 1987	Earthquake	1,000	82,500	1,438
Nicaragua, 1988	Hurricane Joan	148	550,000	1,160
Nicaragua, 1992	Cerro Negro volcano eruption	2	12,000	22
Nicaragua, 1992	Tsunami	116	40,500	30
Anguilla, 1995	Hurricane Luis	-	-	59
Netherlands Antilles, 1995	Hurricanes Luis and Marilyn	-	-	1,112
Costa Rica, 1996	Hurricane Cesar	39	40,260	157
Nicaragua, 1996	Hurricane Cesar	9	29,500	53
Costa Rica, 1997-1998	ENSO	-	119,279	93
C. Andina, 1997-1998	ENSO	600	125,000	7,694
Dominican Republic, 1998	Hurricane Georges	235	296,637	2,193
Central America, 1998	Hurricane Mitch	9,214	1'191,908	6,008
Colombia, 1999	Earthquake	1,185	559,401	1,580
Venezuela, 1999	Intense rainfall	-	68,503	3,237
Belize, 2000	Hurricane Keith	10	57,400	265
El Salvador, 2001	Earthquake	1,159	1'412,938	1,518
Total		84,249	13'625,086	50,365

Table 1-2 presents the principal characteristics of the 10 largest natural disasters in the Caribbean during the 20th century. It can be seen that more than half correspond to hurricanes and tropical storms. The largest loss of life was for the volcanic eruption of May 1902 (Martinique), when 40,000 people died, while the Figure for victims was higher for the tropical storm of September 22, 1998 (4,686,292 in Antigua and Barbuda, Cuba, Haiti and the Dominican Republic).

Table 1-2

Principal disasters due to natural events of the 20th century in the Caribbean

(Source: Catholic University of Louvain, "EM-DAT", The OFDA/CRED International Disaster Database", Brussels (<http://www.cred.be/emdat/intro.html>), 2001.¹)

Disaster	Date	Country	Killed	Damaged
Volcanic eruption	8 may 1902	Martinique	40,000	-
Tropical storm	2 oct. 1963	Grenada, Trinidad and Tobago, Bahamas, Dominican Republic, Haiti, Jamaica, Cuba.	7,258	-
Tropical storm	3 sept. 1930	Dominica, Dominican Rep.	6,500	20,000
Tropical storm	9 nov. 1932	Cuba	2,500	-
Tropical storm	12 sept. 1926	Guadalupe. Monserrat. Saint Kitts and Nevis, Puerto Rico	2,300	-
Tropical storm	22 sept. 1996	Antigua and Barbuda, Cuba, Haiti, Dominican Republic	491	4'686,292
Intense rainfall	15 nov. 1994	Cuba, Haiti, Jamaica	1,124	1'697,558
Tropical storm	11 sept. 1986	Haiti, Jamaica, Saint Lucia	148	1'680,000
Tropical storm	aug 1979	Dominican Republic, Dominica	1,451	1'651,713
Flooding	24 aug. 1988	Dominican Republic	-	1'191,150

This report gives a general summary of the main events of hazards occurring in the countries studied, such that it will serve as a reference point for subsequent evaluations of hazards and risks due to natural phenomena.

¹ Extracted from La Sostenibilidad del Desarrollo en América Latina y del Caribe. Capítulo V - Vulnerabilidad Socioambiental.

2 General statistics for the country

Among the phenomena which have affected that he during the 20th century, and the early 21st century, the most important have been storms followed by floods. Table 2-1 summarises the most important disasters which have struck Belize during this period, and the information related to loss of lifes, material losses and total number of people affected.

Table 2-1

Disasters due to natural events between the beginning of 20th century up to 2008 in Belize
(Source: Catholic University of Louvain, "EM-DAT", The OFDA/CRED International Disaster Database", Brussels (<http://www.emdat.be/Database/CountryProfile/countryprofile.php#top10lists>), 2009.)

Disaster	Date	Killed	Damaged	Total Loss (US\$ Millions)
Storm	30/09/2000	14	62,570	277,460
Storm	08/10/2001	30	20,000	250,000
Storm	30/10/1961	275	-	60,000
Storm	21/08/2007	-	20,000	14,847
Storm	14/11/2005	3	-	-
Storm	10/09/1931	1,500	-	7,500
Storm	18/09/1978	5	6,000	6,000
Storm	28/09/1955	16	-	5,000
Storm	02/09/1974	-	70,000	4,000
Storm	25/10/1998	9	60,000	-
Storm	31/05/2008	7	10,000	-
Flooding	19/10/2008	1	38,000	9,697
Flooding	10/1995	-	2,600	-
Flooding	12/1979	-	17,000	-
Extreme temperature	1990	-	-	2,250

Further, Table 2-2 provides a compendium of information regarding total and average values of losses caused by some significant events, classified by type of disaster.

Table 2-2

Total and average values of losses due to disasters in Belize for important events

(Source: Catholic University of Louvain, "EM-DAT", The OFDA/CRED International Disaster Database", Brussels (<http://www.emdat.be/Database/CountryProfile/countryprofile.php#top10lists>), 2009.)

		Number of events	Killed	Damaged	Loss US\$(000's)
Extreme temperature	Cold	1	-	-	2,250
	Average per event	-	-	-	2,250.0
Flooding	Not specified	3	-	19,600	2,700
	Average per event	-	-	6,533.3	900.0
	General flooding	1	1	38,000	9,697
	Prom. Por evento	-	1.0	38,000.0	9,697.0
Storm	Tropical cyclone	13	1,859	24,8570	624,857
	Average per event	-	143.0	19,120.8	48,065.9

3 Specific statistics by event

3.1 Earthquake

A database of important seismic events has been created, which also serves as a basis for statistical analysis of events. Based on this inventory, the recurrence curve of earthquakes by year and decade is generated, with the distribution of earthquakes as a function of magnitude, amongst other things. The database includes both macro-events identified, and the more moderate events taken from recent historical records. The information related to historical events includes, in most cases, information regarding parameters of location, magnitude and intensity force, and to a lesser extent, records related to the effects and losses produced by each event. These latter data will serve to calibrate and validate the analysis models

This database does not claim to replace the official catalogue of seismicity for the country. The intention, on the contrary, is to verify that no important events are missing from the official catalogue (of which we do not have a copy).

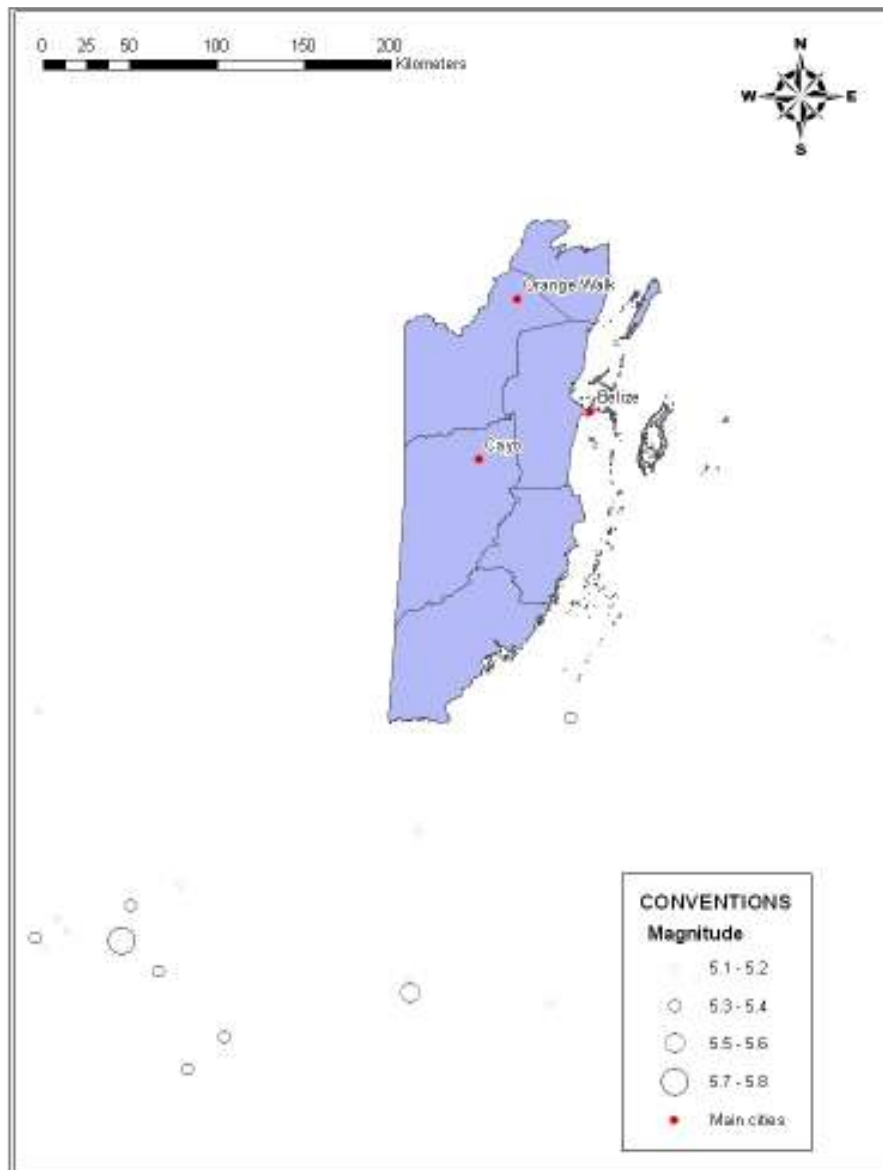
The database includes a field for location, date, and comments, and the source from which information was obtained (*date, time, location, comment and source*). In addition, there are data for magnitude of the earthquake on different scales, depth, intensity and information of the epicentre. For some earthquakes, though is information on losses, deaths, disappearances, injuries, persons affected, etc. The sources of this database are principally matched in a georeferenced format, documents and studies of individual events, or descriptions of groups of events, information available on the Internet, and catalogue of events generated by the Belize entities. Table 3-1 describes the fields associated with the earthquake database.

Table 3-1
Fields associated with the earthquake data catalogue

FIELD	DATA TYPE	COMMENT
Country	Text	Country name
Hazard type	Text	Earthquake
Name	Text	Event name (if available)
Date	Date	Date of event
Hour	Hour	Hour of event
Location X	Decimal	Longitude
Location Y	Decimal	Latitude
Magnitude ML	Decimal	Magnitude in ML scale (Richter Scale)
Magnitude Mw	Decimal	Magnitude in Mw scale (Momentum)
Magnitude MC	Decimal	Magnitude in MC scale
Magnitude	Text	Magnitude of the earthquake in a different scale (the type of scale is defined into the cell)
Depth (km)	Decimal	Earthquake depth
Intensity	Decimal	Intensity (Mercalli scale)
Epicenter	Text	Description of epicenter
Location	Text	Description of location
Description and effects of the event	Text	General description of event characteristics
Direct economic loss	Currency	Currently unavailable
Indirect economic loss	Currency	Currently unavailable
Consequential economic loss	Currency	Currently unavailable
Killed	Integer	Currently unavailable
Disappeared	Integer	Currently unavailable
Injured	Integer	Currently unavailable
Affected	Integer	Currently unavailable
Recovery time (Days)	Integer	Currently unavailable
Source	Text	Bibliographic source

The complete database of earthquakes appears in Annex ERN-CAPRA-T1.1B-1. A total of 189 earthquakes with a magnitude of 3.0 or higher on the Mb scale are included, in the period between 1766 and 2008. Based on this catalogue, the average number of earthquakes per year is 0.431, if the entire period of analysis is used (242 years). If we consider only the period since seismic instrumentation began in the country (1973-2008), the average frequency was 2.98 earthquakes per year.

Figure 3-1 to Figure 3-3 show the relative location of earthquakes included in the database, classified by intervals of magnitude. We observe that the largest number of points is to be found in the range 3-5 in the Mb scale.



*Figure 3-1
Seismic catalogue for Belize (earthquakes of 3-4 Mb)*

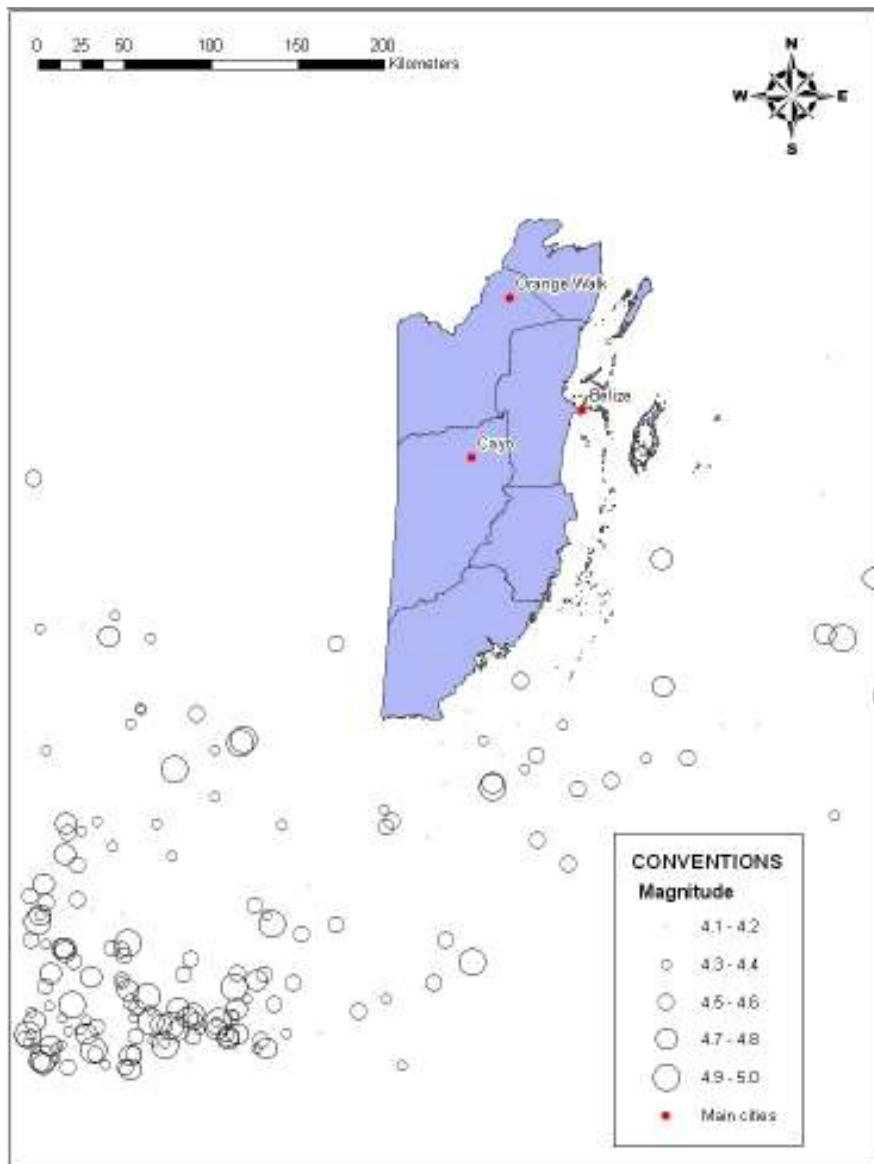
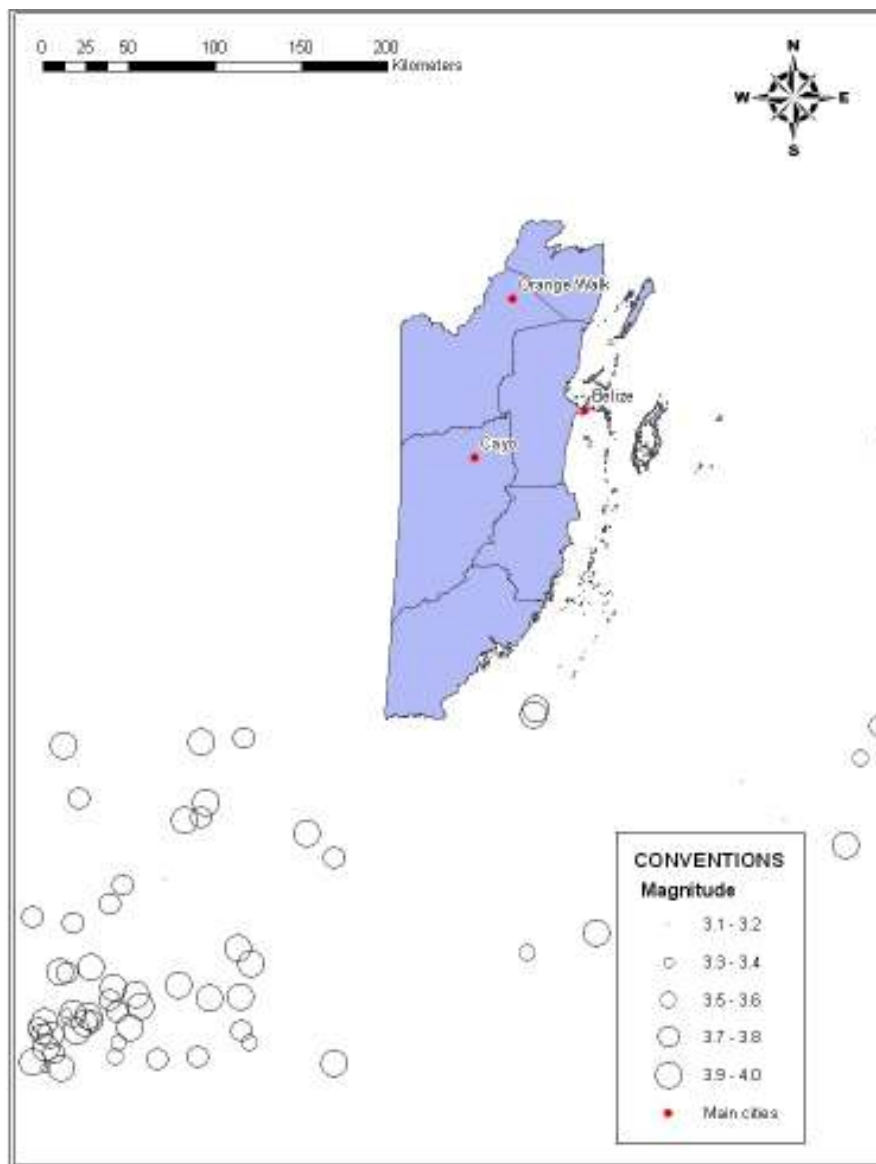


Figure 3-2
Seismic catalogue for Belize (earthquakes of 4-5 Mb)



*Figure 3-3
Seismic catalogue for Belize (earthquakes of 3-4 Mb)*

3.1.1 Statistical curves

We now present statistics associated with the preceding information represented in the graphs, which show the variability in time of the phenomenon, and the characteristics proper to frequency.

With regards to the variability in time, Figure 3-4 years a schematic report on the number of earthquakes occurred but a year between the 1766 and 2008. It can clearly be seen that since 1973 a greater number of earthquakes began to be recorded, with the increase in

seismic instrumentation. Figure 3-5 indicates details of the number of earthquakes per year for the range 1973-2008.

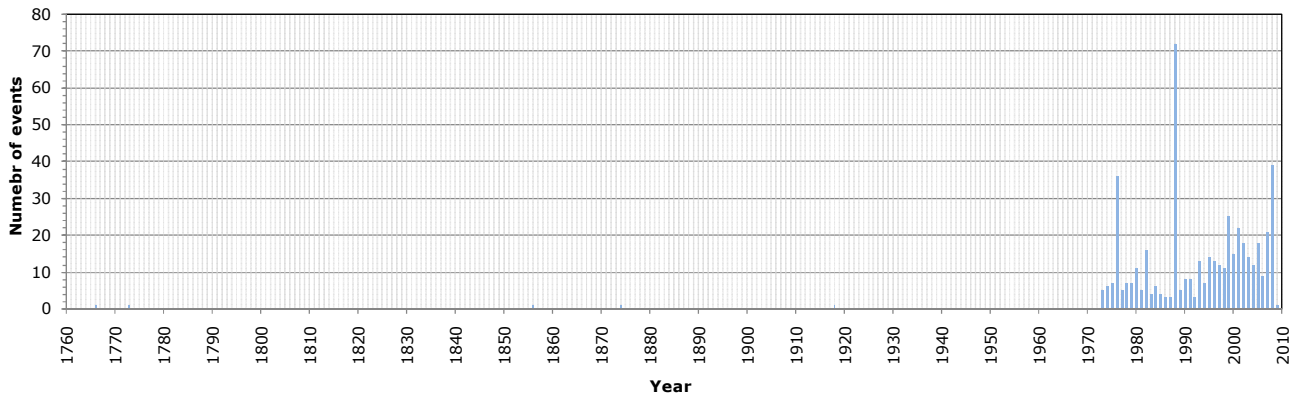


Figure 3-4
Number of earthquakes per year recorded in Belize for the entire analysed period

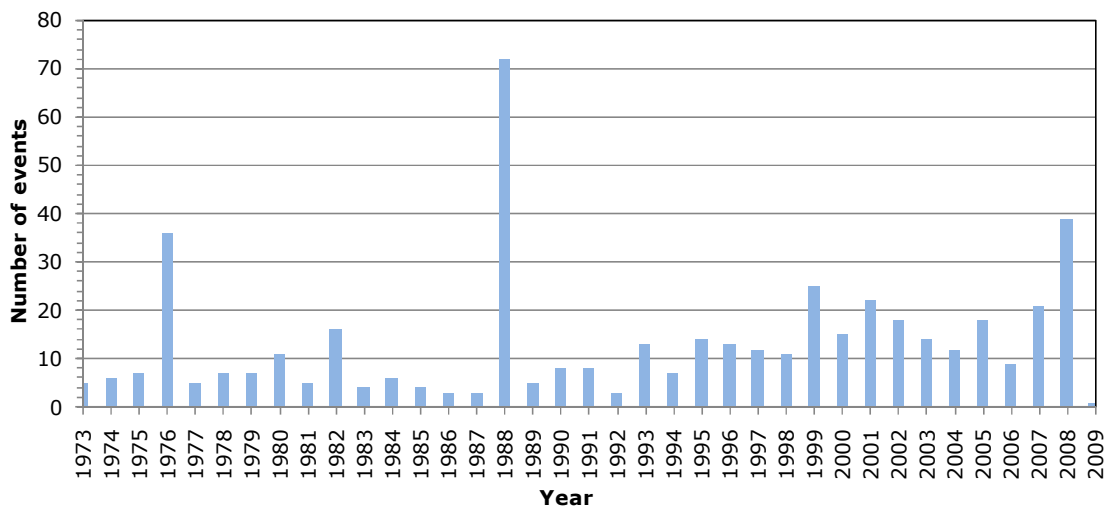


Figure 3-5
Number of earthquakes per year recorded in Belize for the period of instrumentation

For its part, Figure 3-6 indicates the frequency of earthquakes with a magnitude of 2.0 or more, by decades. Figure 3-7 shows details of the period by decades with the largest number of records.

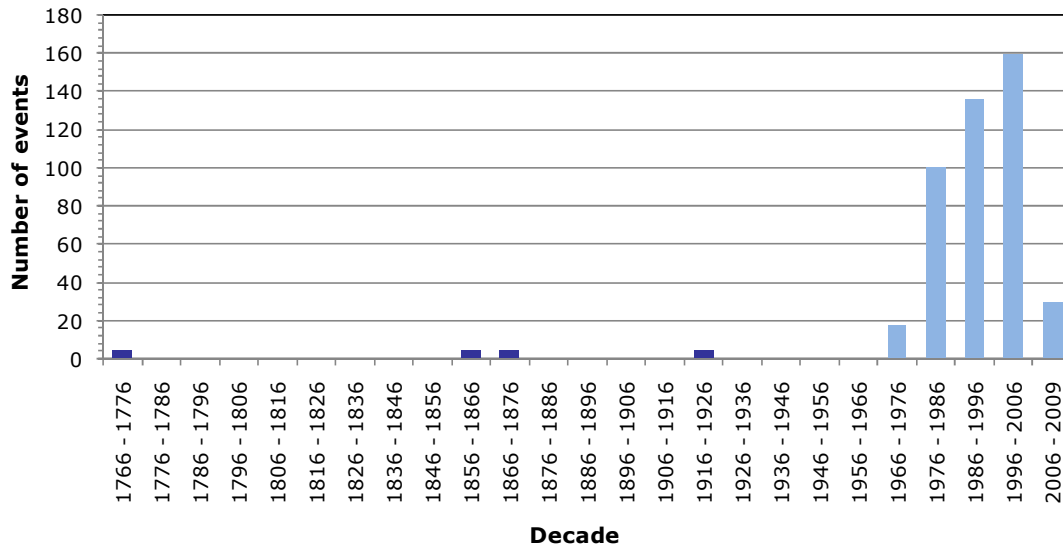


Figure 3-6
Number of earthquakes per decade recorded in Belize for the entire analysed period

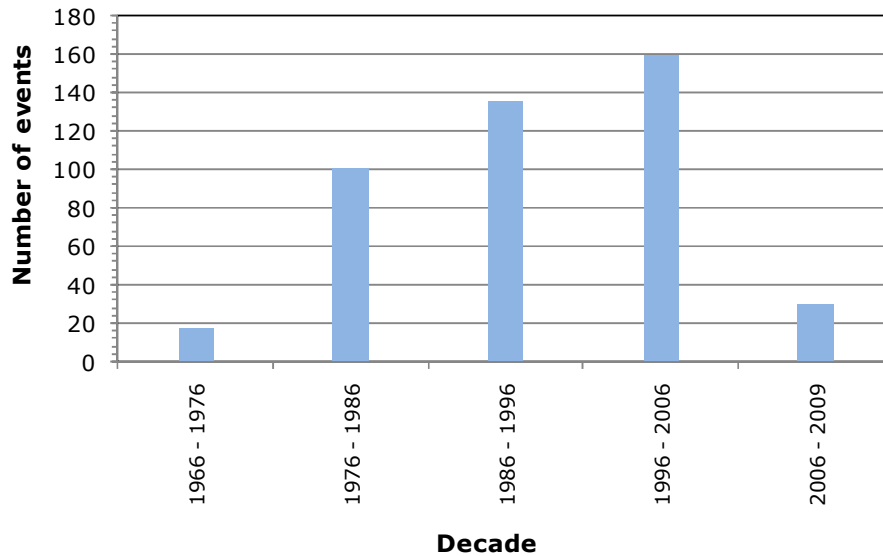


Figure 3-7
Number of earthquakes per decade recorded in Belize for the period of instrumentation

Figure 3-8 is the Gutenberg Richter recurrence curve for seismic events from the catalogue, classified by magnitude in Mb. Like the plans shown in the catalogue, the curve indicates that the greater number of records had magnitude of 4-5Mb, and there are no records of magnitudes higher than 6 or lower than 3.

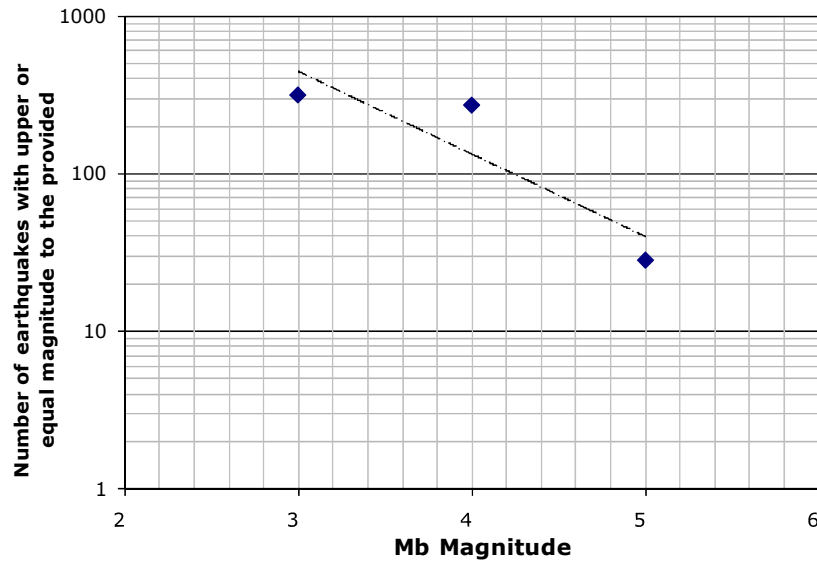


Figure 3-8
Gutenberg Richter curve for the Belize seismic catalogue

Figure 3-9 classifies the number of earthquakes as a function of depth, which indicates that the largest number of records lie between 30 and 40 km, a few between zero and 10 and between 80 and 110 km, and very small values of data for greater depths.

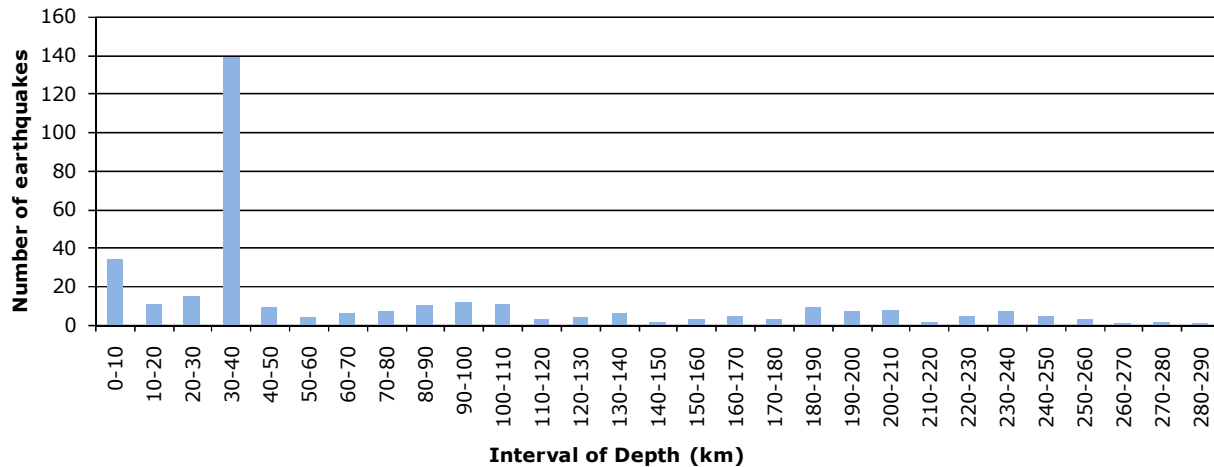


Figure 3-9
Number of seismic events by depth for Belize

The diagram which represents the number of earthquakes per year was made for the earthquakes classified on the Mb. scale of magnitude. The distribution of earthquakes over time in the data catalogue was used to obtain curves for the period of greatest instrumentation that is the last 35 years (1973-2008). Figure 3-10 shows the results. It may be observed that there is much variability in results with the change of the time-range selected.

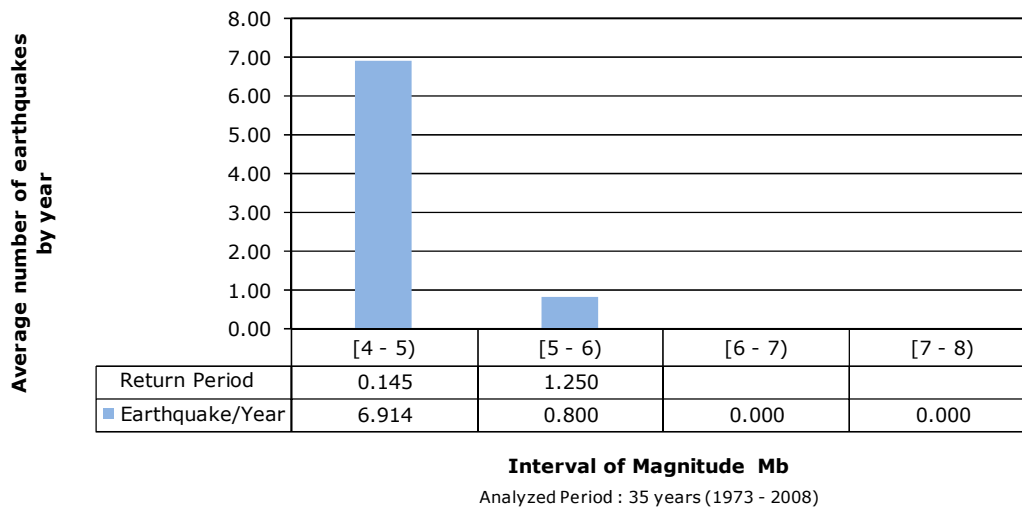


Figure 3-10
Number of seismic events of the year for each interval of Mb magnitude- Belize (Period 1973 to 2008)

Currently, Belize does not have data for economic loss, loss of life, number of injured or otherwise affected, and it is therefore not possible to show a summary table of information on economic and human loss.

3.1.2 Important historical events

The following are some of the principal seismic events which have affected Belize. In Annex ERN-CAPRA-T1.1B-1 there is a list of all the events which form the seismic catalogue for Belize collected to date. The information was obtained mainly from the US Geological Survey, and from seismic records from other countries, recording events also felt in Belize.

All the earthquakes presented below events which mostly affected the territory of other countries, but due to their magnitude and intensity, were felt and recorded in Belize.

February 4th, 1976

The epicentre was at coordinates 15.32° north and 89.1° west, at a depth of 5 km and a magnitude of 7.5 mb Gs.

August 20th, 1977

The epicentre was at 16.7° north and 86.61° west, at a depth of 36 km and a magnitude of 6.1 UKPAS.

August 9th, 1980

The epicentre was 15.9% North and 88.52° West, at a depth of 22 km, and a magnitude of 6.7 UKBRK.

September 18th, 1991

The epicentre was at 14.65° north and 90.99° west, depth of 5 km and a magnitude of 6.2 MwHRV

July de 1997

The epicentre was at 16.16° north and 87.92° west, depth of 33 km, magnitude of 6.1MwGS

May 28th, 2009

310 km north-west of Tegucigalpa, Honduras, at a depth of 10 km and a magnitude of 7.3 Mw. Belize suffered power cuts and severe damage to housing

3.2 Tsunami

There are no records of tsunami phenomena for Belize, as having affected the country. Several databases were consulted, and no information was found on any of them.

3.3 Hurricanes

The database for Hurricanes is used to make a statistical analysis of events, and to obtain curves of a number of events per year, decade, and frequency of occurrence as a function of the Category of the phenomenon, on the Saffir-Simpson scale. The hurricane catalogue includes both identified macro events, and more moderate events taken from recent historical records. The database contains a broad range of information in general, regarding the name, type of event, location, date of occurrence, and particular properties of the phenomenon. There is some information available referring to the effects of the phenomenon, and to data of economic and human loss reported.

Most of the data had been taken from recent historical records published by a range of entities, such as the National Oceanic and Atmospheric Administration (in particular, HUR-DAT), the Unisys Weather, and the Organisation of American States (OAS).

The database has fields for identification and location (*event type, name, date*) and detail prices on the event (*windspeed, pressure, Category, place affected, description and source*). There are also fields for information on the main effects of the event (*economic loss, deaths, disappeared, injured, affected, and recovery time*). Table 3-2 indicates all the fields associated with the complete catalogue, which appears in Annex ERN-CAPRA-T1.1B-3. As a guide, Table 3-3 shows the main characteristics of the Saffir-Simpson scale.

Table 3-2
Fields associated with the hurricane catalogue

FIELD	DATA TYPE	COMMENT
Event type	Text	Wind hurricane or Rain hurricane
Name	Text	Hurricane name
Date	Date	Date of event
Wind speed	Decimal	Wind speed in Knots
Pressure	Decimal	Pressure in mb
Category	Text	Saffir-Simpson Category
Affected area	Text	Affected places by the event
Description and effects	Text	General description of event characteristics
Direct economic loss	Currency	Currently available for some cases
Indirect economic loss	Currency	Currently unavailable
Consequential economic loss	Currency	Currently unavailable
Killed	Integer	Currently available for some cases
Disappeared	Integer	Currently available for some cases
Injured	Integer	Currently unavailable
Affected	Integer	Currently available for some cases
Recovery time (Days)	Integer	Currently unavailable
Source	Text	Bibliographic source

Table 3-3
Categories of hurricane in the Saffir-Simpson scale
(Source: <http://weather.unisys.com/Huracán/index.html>)

Type	Category	Pressure (mb)	Wind Speed	Wind Speed
			(knots)	(mph)
Tropical Depression	TD	-----	< 34	< 39
Tropical Storm	TS	-----	34-63	39-73
Hurricane	1	> 980	64-82	74-95
Hurricane	2	965-980	83-95	96-110
Hurricane	3	945-965	96-112	111-130
Hurricane	4	920-945	113-135	131-155
Hurricane	5	< 920	>135	>155

The selection of hurricanes which have affected Belize on the basis of the hurricane catalogue for all Central America was made taking account of information found in articles, studies, reports and records, in which there were direct effects on that territory, in addition to events whose trajectories are included in an area of 200 km around Belize territory. The Belize database has 95 events in total, of which 90 refer to Hurricanes classified as wind Hurricanes, and 5 classified as rain Hurricanes. Wind Hurricanes occurred between 1864 and 2007, and rain Hurricanes between 1931 and 2001. The specifications were established depending on the type of impact of the phenomena in the region. The events analysed range from tropical storms to Force 5 Hurricanes, on the Saffir-Simpson scale.

Figure 3-11 shows the relative location of hurricanes included in the database.

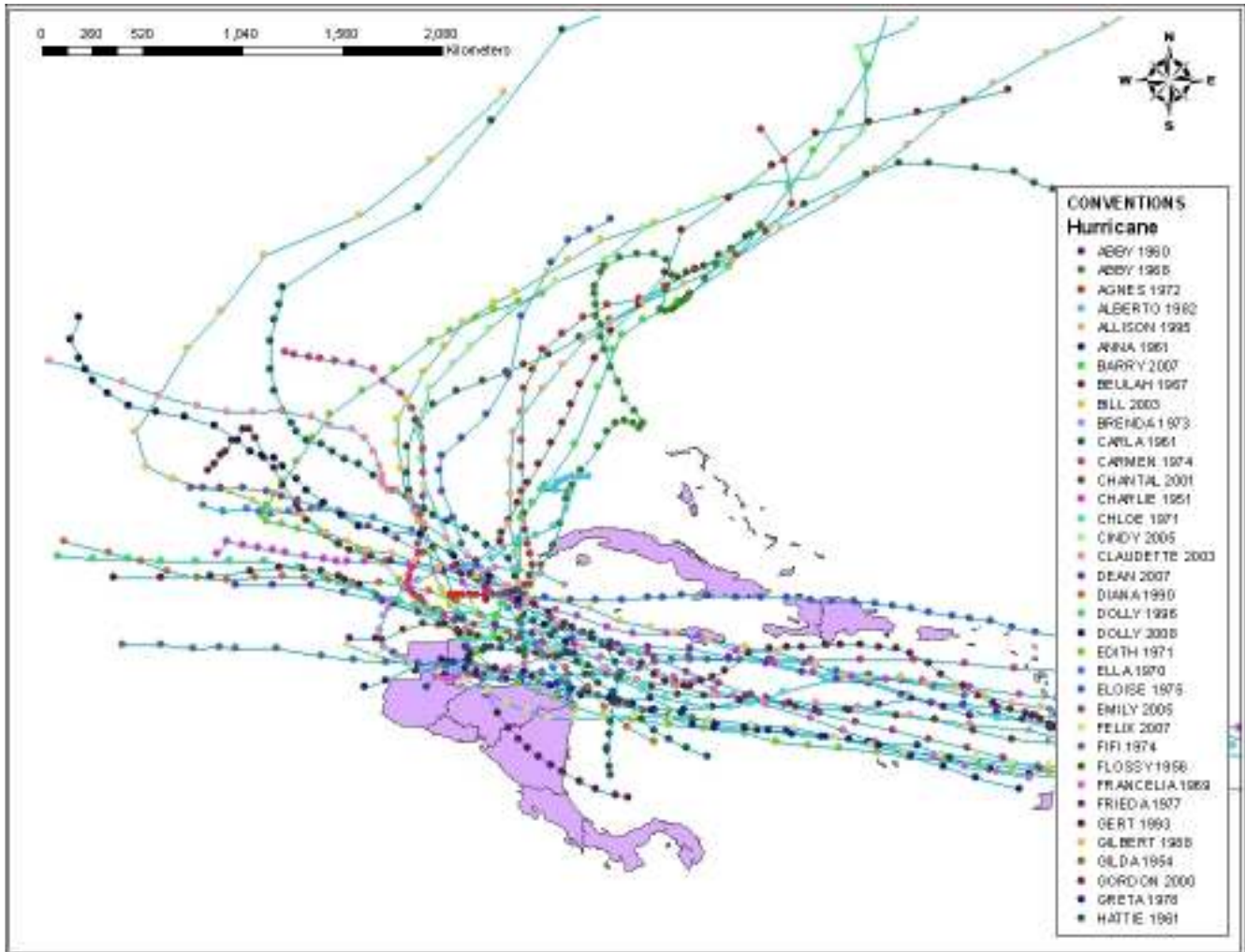


Figure 3-11
Hurricanes affecting Belize

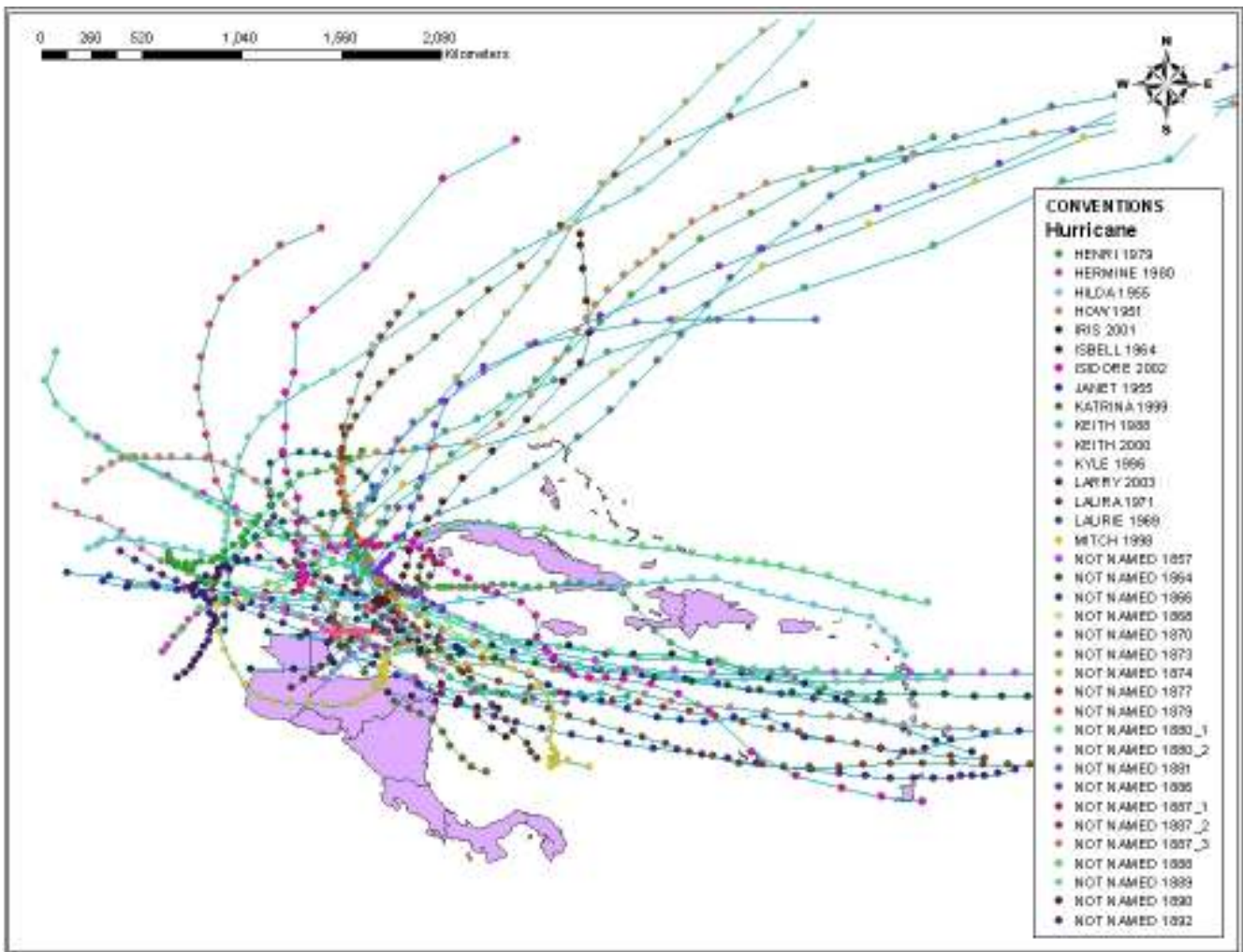


Figure 3-11
Hurricanes affecting Belize (Continued)

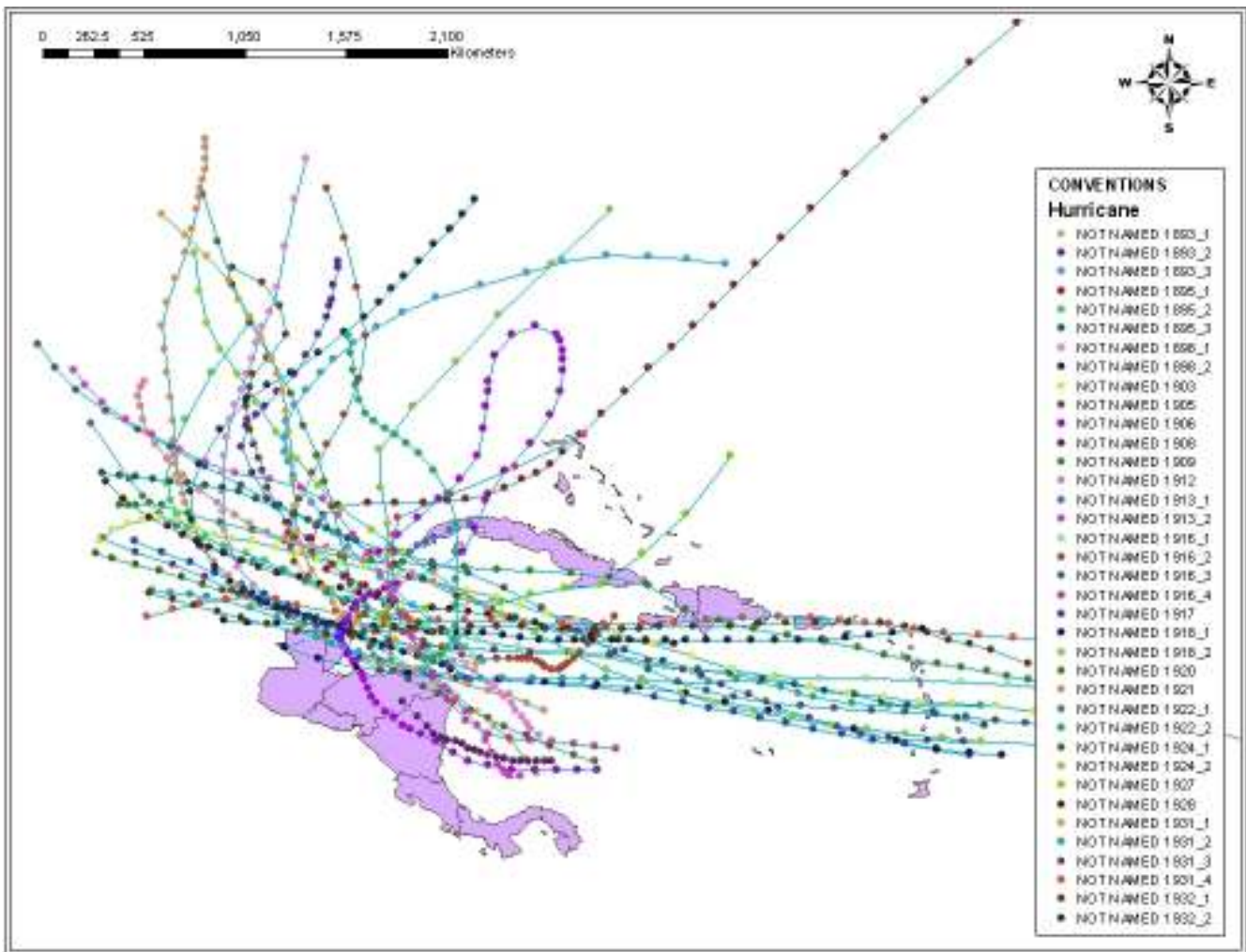


Figure 3-11(Continued)

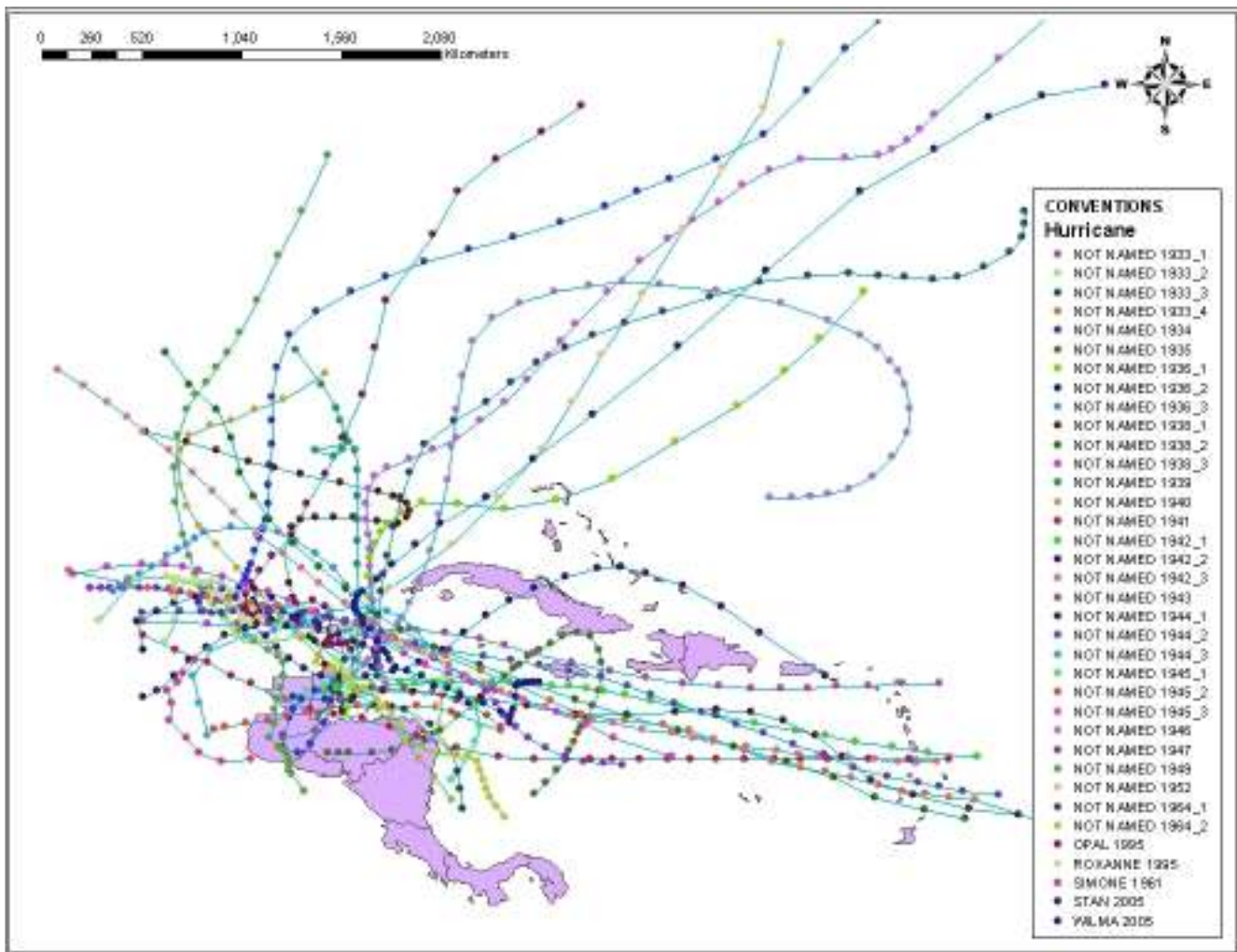


Figure 3-11(Continued)

3.3.1 Statistical curves

The graphs below show that distribution in time of hurricane events, and the frequency of occurrence of events contained in the catalogue. La Figure 3-12 illustrates the number of wind Hurricanes per year 1850 and 2008.

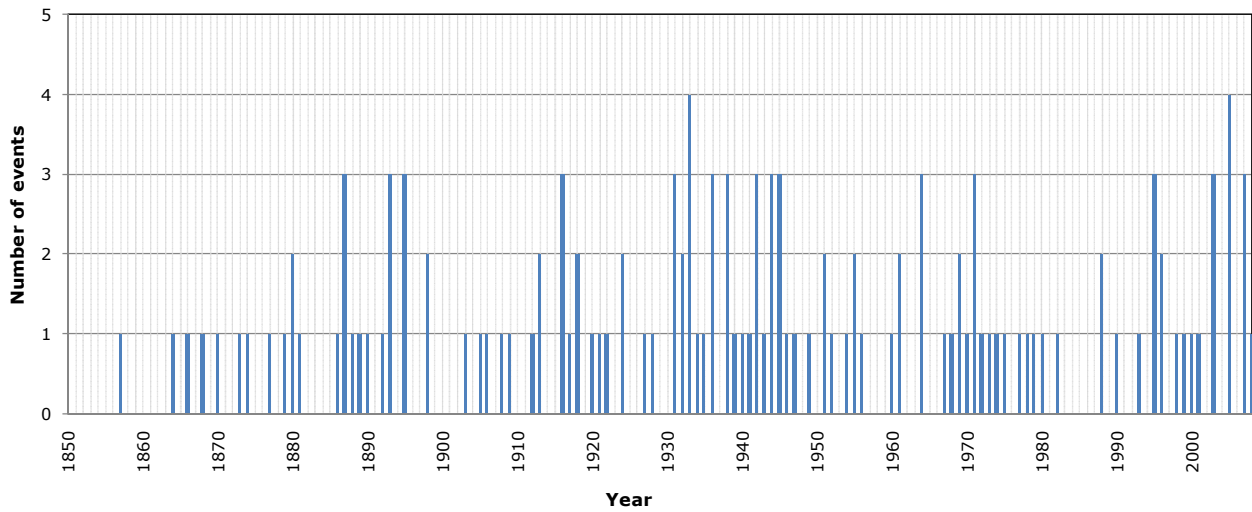


Figure 3-12
Number of wind Hurricanes per year, recorded in Belize, during the entire analysed period

Figure 3-13 shows the distribution of events by decade. The most frequent occurrence of events took place between 1930 and 1940, according to available catalogues.

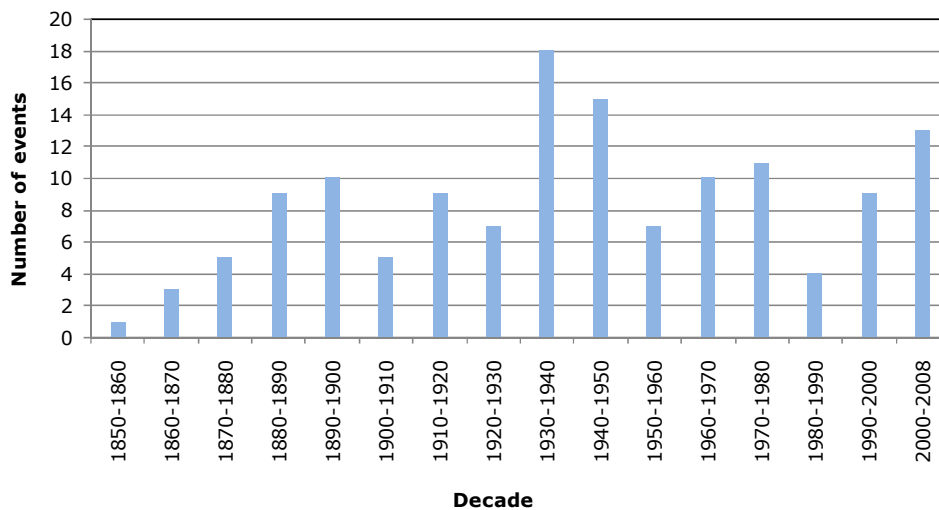


Figure 3-13
Number of wind Hurricanes per decade, recorded in Belize for the entire analysed period

Figure 3-14 shows the number of wind hurricane events which equals or exceeds each Category in the Saffir-Simpson scale. Most of these events are in Categories 1 and 2.

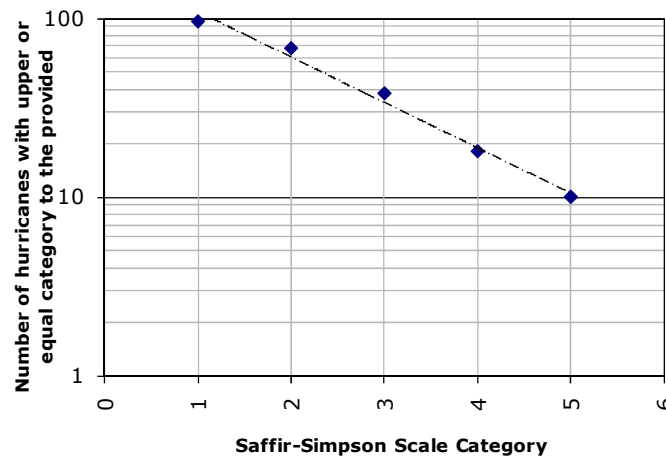


Figure 3-14
Frequency curve for wind Hurricanes in Belize.

The frequency of occurrence of a hurricane as a function of its Category is shown in Figure 3-15. Since there is continuity of events throughout the time covered by records, the period taken into account to obtain frequency values (hurricanes per year), covers 1857 to 2008. According to statistics from the catalogue of events, the average value of wind Hurricanes per year is 0.15, which means that on average, there is a wind Hurricane every 9.29 years which directly affects that country.

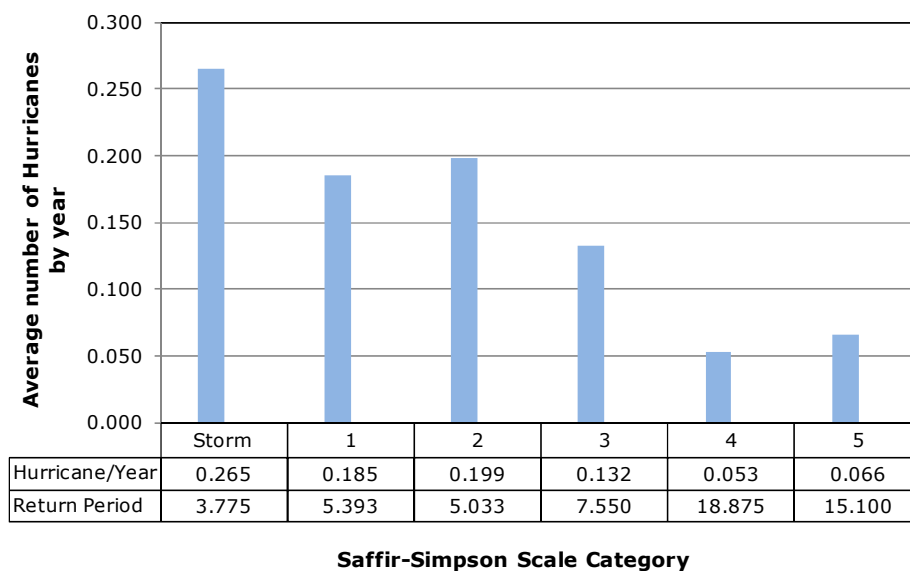


Figure 3-15
Number of wind hurricanes per year by Category, on the Saffir-Simpson scale-Belize (1857- 2008)

The graphs presented below show the distribution over time of events of rain hurricanes, and the frequency of occurrence of events contained in the catalogue Figure 3-16 illustrates the number of rain hurricanes per year for the period 1915 - 2002.

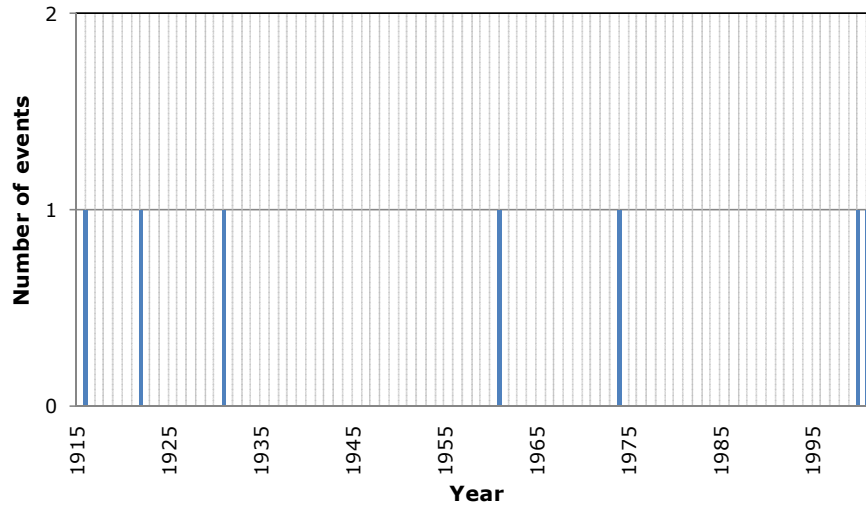


Figure 3-16

Number of rain hurricanes per year, recorded in Belize, during the entire analysed period

Figure 3-17 shows the distribution of events by decade. The largest number of events occurred between 2000 and 2002.

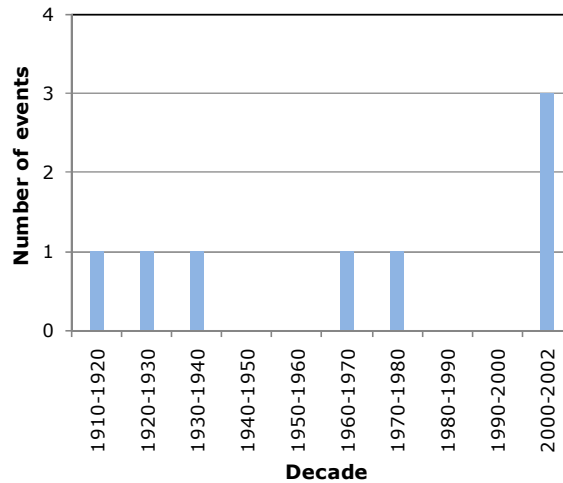


Figure 3-17

Number of rain hurricanes per decade, recorded in Belize for the entire analysed period

Figure 3-18 indicates the frequency of rain hurricane events as a function of Category on the Saffir-Simpson scale.

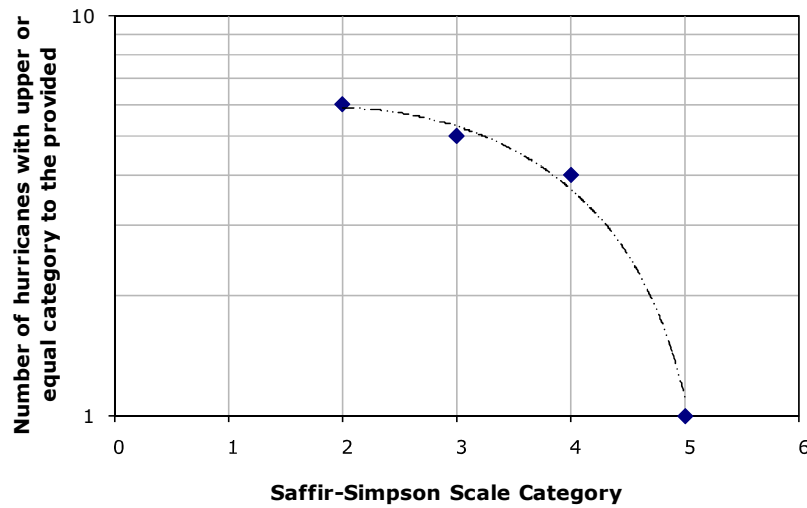


Figure 3-18
Frequency curve for rain hurricanes in Belize

Further, the number of rain hurricanes per year as a function of their Category is shown in Figure 3-19. As with wind hurricanes, these records have certain continuity, and the period taken into account to obtain frequency values (hurricanes per year), is the entire period 1916-2002. From this, it can be seen that the largest number of events is in Category 4. Finally, according to rain hurricane data per year, it is possible to establish that the average value for events three year is 0.012, that is, that a rain hurricane directly affecting Belize occurs every 66.9 years, and causes major impact.

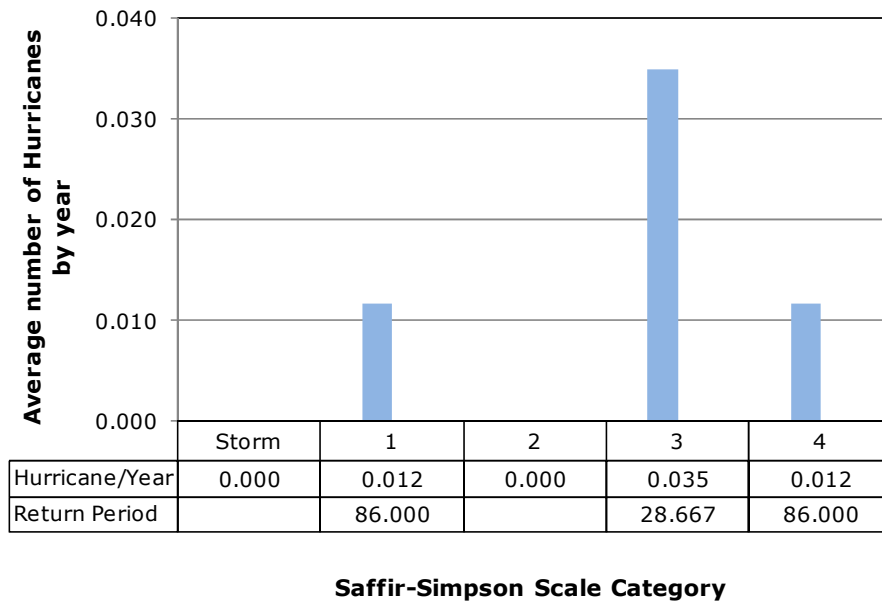


Figure 3-19
Number of rain hurricanes per year, for each Category on the Saffir-Simpson scale-Belize (1916-2002)

Table 3-4 shows Category 4 and 5 Hurricanes which have affected Belize. In the next section, there is a general summary of some of the most important events which have affected Belize.

Table 3-4
Hurricane damage reports in Belize

Name	Year	Direct loss(millions of dollars)	Killed	Affected
Hurricane Not Name	1970	-	-	-
Hurricane Not Name	1996	-	-	-
Hurricane JANET	1994	-	-	-
Hurricane HERMINE	1980	-	30	175,000
Hurricane HATTIE	1961	440	319	-
Hurricane FIFI	1974	900	8000-10,000	-
Hurricane EDITH	1988	380	35	2,800
Hurricane CARMEN	1996	152	4	-
Hurricane GRETA	1996	-	-	-
Hurricane OPAL	1969	3.9	35	150,000
Hurricane MITCH	1998	6,500	11,000-18,000	-
Hurricane KEITH	1995	225	18	-
Hurricane IRIS	1993	66.2	23	100,000
Hurricane DEAN	1958	-	39	-
Hurricane FELIX	1966	50.4	133	-
Hurricane KEITH	2000	225	18	-
Hurricane IRIS	2001	66.2	23	100,000

3.3.2 Important historical events

Belize's Caribbean coast is a territory which has been much affected by hurricane. In 1961 a hurricane completely destroyed the then-capital, Belize City, obliging survivors to move to the centre of the country, to what is now the capital of Belize, Belmopan.

Below we present the information on hurricanes which have had the most impact on Belize territory since 1960, in the Atlantic hurricane seasons.

Hurricane Hattie (1961)



Figure 3-20
Image of the track of hurricane Hattie
(Source: http://es.wikipedia.org/wiki/Archivo:Hattie_1961_track.png)

Hurricane Hattie-Simone forms part of the hurricane season in the Atlantic from 1961. It was a Category 5 hurricane on the Saffir-Simpson scale, and it affected Belize, Honduras and Guatemala. The hurricane developed, and affected Central America between October 27 and November 1, 1961. Winds of up to 300 km an hour and pressures of 92kPa were recorded.

In its track across Central America, it is estimated that it caused 319 deaths, and damage of US\$440,000,000, at present value². Its passage over Belize City caused the destruction of 75% of its houses and shops.

Hurricane Fifi (1974)



Figure 3-21

Satellite image of hurricane Fifi

(Source: http://es.wikipedia.org/wiki/Archivo:Fifi_1974_track.png)



Figure 3-22

Image of the track of hurricane Fifi

(Source: http://es.wikipedia.org/wiki/Archivo:Fifi_1974_track.png)

Hurricane Fifi belongs to the 1974 Atlantic Ocean hurricane season. It crossed the Atlantic as hurricane Fifi, and reached the Pacific, where it was renamed hurricane Orlene. Hurricane Fifi-Orlene developed between September 14 and 22, 1974, from a tropical wave in the Caribbean. It struck Belize territory on September 19 as a Category 2 hurricane, on the Saffir-Simpson scale, with sustained winds of 175 kph, and pressures of 970 mb.

² Gordon E Dunn and Staff /March 1961) “The Hurricane Season of 19612”, Monthly Weather Review

Hurricane Fifi cause damage totalling US\$900,000,000 (USD-1974), in Central America, that is, US\$4,000 million in present value. The event was catalogued as the 4th most deadly in history, with 8,000-10,000 fatalities.

Hurricane Hermine (1980)



Figure 3-23

Satellite image of hurricane Hermine

(Source: [http://es.wikipedia.org/wiki/Archivo:Tropical_Storm_Hermine_\(1980\).JPG](http://es.wikipedia.org/wiki/Archivo:Tropical_Storm_Hermine_(1980).JPG))



Figure 3-24

Image of the track of hurricane Hermine

(Source: http://es.wikipedia.org/wiki/Archivo:Hermine_1980_track.png)

Hermine belongs to the 1980 Atlantic Ocean hurricane season, and it developed on September 20-25, 1980, from a tropical wave coming from Africa.

On September 22, it touched the mainland in Belize with sustained winds of 110 kph and a minimum pressure of 990 mb. It is estimated that there were major floods in Honduras and Belize, but there are no records of damage estimates.

Hurricane Keith (2000)



Figure 3-25

Image of the track of hurricane Keith

(Source: http://es.wikipedia.org/wiki/Archivo:Keith_2000_track.png)

Hurricane Keith belongs to the 2000 Atlantic Ocean hurricane season. It developed between September 28 and October 6, 2000, with maximum sustained winds of 193 kph (Category 4 on the Saffir-Simpson scale) and minimum pressures of 941 mb.

Hurricane Keith touched land in Belize on October 1, where it weakened down to Category 1. It is estimated that the total damage caused by hurricane Keith in Belize was US\$225,000,000 (US\$-2000)

Hurricane Iris (2001)

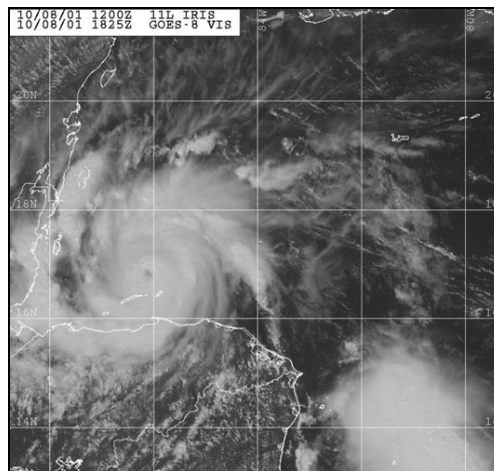


Figure 3-26

Satellite image of hurricane iris

(Source: http://geografica.cenapred.unam.mx/SIAT/2001/Oct/08/IRIS11_image011.jpg)

Hurricane Iris belongs to the 2001 Atlantic Ocean hurricane season. It developed between October 4-9, 2001, with Category 4 on the Saffir-Simpson scale and sustained winds

stronger than 230 kph.

In Belize, it arrived at Monkey River Town on October 9. 23 people reportedly died, 20 of them on the coast. The damage caused by hurricane Iris in Belize totalled an estimated US\$66.2 million (US\$-2001)

3.4 Intense rainfall

A database has been formed with events of intense rainfall, are based on which statistical analysis was made of them. Based also on this inventory, the rainfall curves were generated for each year and events by decade. The databases base includes mainly the events for which information is available on the Internet, since in most cases, due to the level of impact caused by these rains, they have the attention of the media.

Although quantitative information is quite limited - in a few cases only, there are data of millilitres of water, records obtained described the zones involved and the infrastructure affected. Most of the phenomena with considerable impact in the zone are related to Hurricanes which have passed through Central America, cold fronts (polar thrust), tropical waterway waves, convective and orographic processes, the synoptic position of the inter-tropical convergence zone, and episodes of El Niño/La Niña/ENOS.

The sources of information were the International Disaster Database-EM-BAT, and Red Desastres-Belize. The rainfall catalogue has general fields. Location in space and time (*hazard type, date, time, location*), data for specific properties of the rainfall for a few cases (*mm of water*), and a record of the effects generated (*economic loss, deaths, persons affected*). Table 3-5 describes all fields of the associated database, which is presented in the Annex ERN-CAPRA-T1.1B-4.

Table 3-5
Fields associated with the rainfall catalogue

FIELD	DATA TYPE	COMMENT
Event type	Text	Intense Rainfall
Date	Date	Date of event
Hour	Hour	Hour of event
Place	Text	Location of event
Level of water	Integer	Maximum water depth in mm
Description and effects	Text	General description of event characteristics
Direct economic loss	Currency	Currently available
Indirect economic loss	Currency	Currently unavailable
Consequential economic loss	Currency	Currently unavailable
Killed	Integer	Currently available for some cases
Disappeared	Integer	Currently unavailable
Injured	Integer	Currently unavailable

FIELD	DATA TYPE	COMMENT
Affected	Integer	Currently available for some cases
Recovery time (Days)	Integer	Currently unavailable
Source	Text	Bibliographic source

The rainfall database has six different events, between 1931 and 2008. Due to the lack of available information, there are no measurements of intensity for most of the events in the catalogue, and this greatly limits the statistical analysis which may be done. A rainfall map associated with each district cannot be produced, since there is no information available for it.

3.4.1 Statistical curves

The graphs below were obtained from the catalogue made up of important rainfall events. Figure 3-27 illustrates the number of events for each year in the period of analysis (1931-2008).

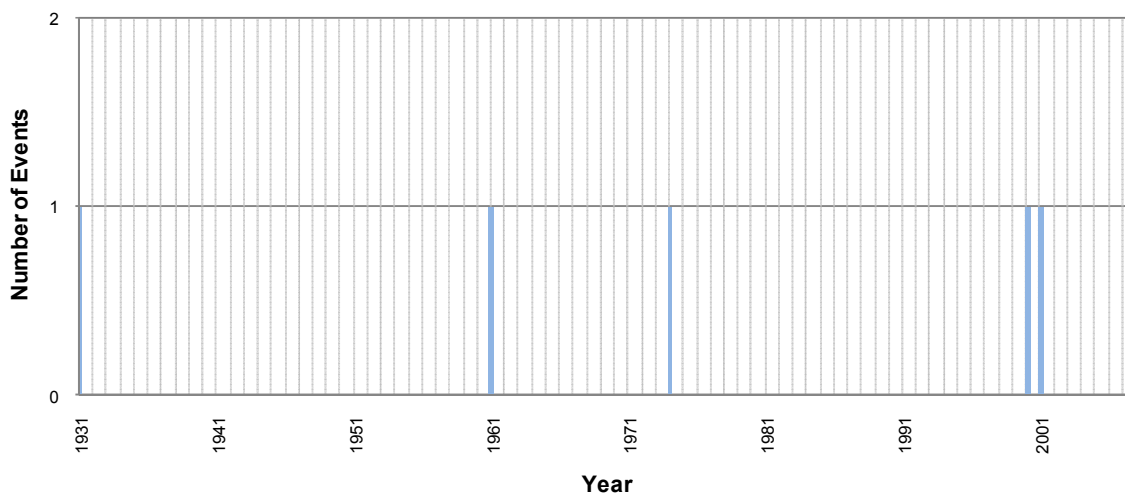


Figure 3-27
Number of intense rainfalls per year recorded in Belize, 1931-2008

Figure 3-28 shows the number of events per decade. Most of the events were reported for the period 2000-2008.

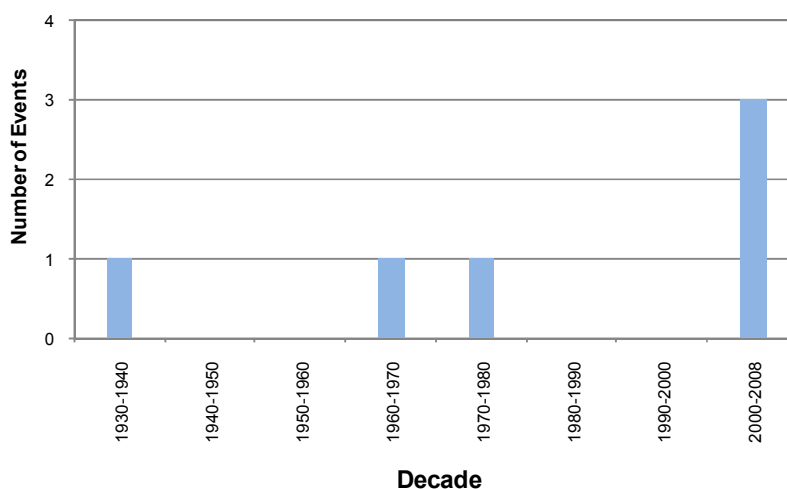


Figure 3-28

Number of high-impact rainfalls by decade recorded in Belize, 1931-2008

Finally, Table 3-6 shows some data of human and material damage in the events contained in the catalogue.

*Table 3-6
Loss of lives due to intense rains in Belize*

Date	Direct loss	Killed	Affected
10/09/1931	7.5	1,500	-
30/10/1961	60.0	275	-
02/09/1974	4.0	-	70,000
30/09/2000	277.5	14	62,570
08/10/2001	250.0	30	20,000
31/05/2008	26.0	-	-

3.4.2 Important historical events

There follows information on some of the most important storms which have affected Belize between 1900 and 2009. The information was taken from the emergency events database (EM-DAT) website³.

1931

The storm occurred on September 10, leaving estimated damage of US\$7.5 million, and an estimated 1,500 fatalities

³ <http://www.emdat.be/Database/CountryProfile/countryprofile.php>

1961

The storm occurred on October 30, leaving damage estimated at US\$60,000,000, with an estimated 275 fatalities.

1974

The storm occurred on September 2, leaving damage of US\$4,000,000, and an estimated 70,000 persons affected.

2000

The storm occurred on September 30, leaving material damage of US\$277.5 million, with 14 fatalities, and 62,570 persons directly affected.

2001

The storm occurred on October 8, leaving material damage of US\$250 million. There were 30 fatalities, and 20,000 people were affected.

3.5 Flood

A flood database can also be used for statistical analysis of events. Based on this catalogue, graphs and events were generated by year, decade, and district.

The data had been taken from documents statistics of the International Disaster Database-DN-EM-DAT, and UNDP, amongst others. The database has fields for identification and location (*type of hazard, date, location*) and details parameters of the event (*river, region affected, duration, severity, principal cause, description, effects, source*). Table 3-7 indicates all fields associated with the complete catalogue, to be seen in Annex ERN-CAPRA-T1.1B-5.

*Table 3-7
Fields associated with the flood catalogue*

FIELD	DATA TYPE	COMMENT
Event type	Text	Flood
Date	Date	Date of event
Location	Text	Location of the event
Rivers	Text	Involved rivers
Affected Region	Integer	Affected area in km ² . Currently unavailable
Time of the event	Integer	Time in days (Currently available for some cases)
Severity class	Integer	Level of severity given by the Regional Natural Hazard Atlas of Central America. The classification goes from 1 to 3 (see Table 3-8). Currently available for some cases
Main cause	Text	Main cause
Description and effects of the event	Text	General description of event characteristics

FIELD	DATA TYPE	COMMENT
Direct economic loss	Currency	Currently available for some cases
Indirect economic loss	Currency	Currently unavailable
Consequential economic loss	Currency	Currently unavailable
Killed	Integer	Currently available for some cases
Disappeared	Integer	Currently unavailable
Injured	Integer	Currently unavailable
Affected	Integer	Currently available for some cases
Recovery time (Days)	Integer	Currently unavailable
Source	Text	Bibliographic source

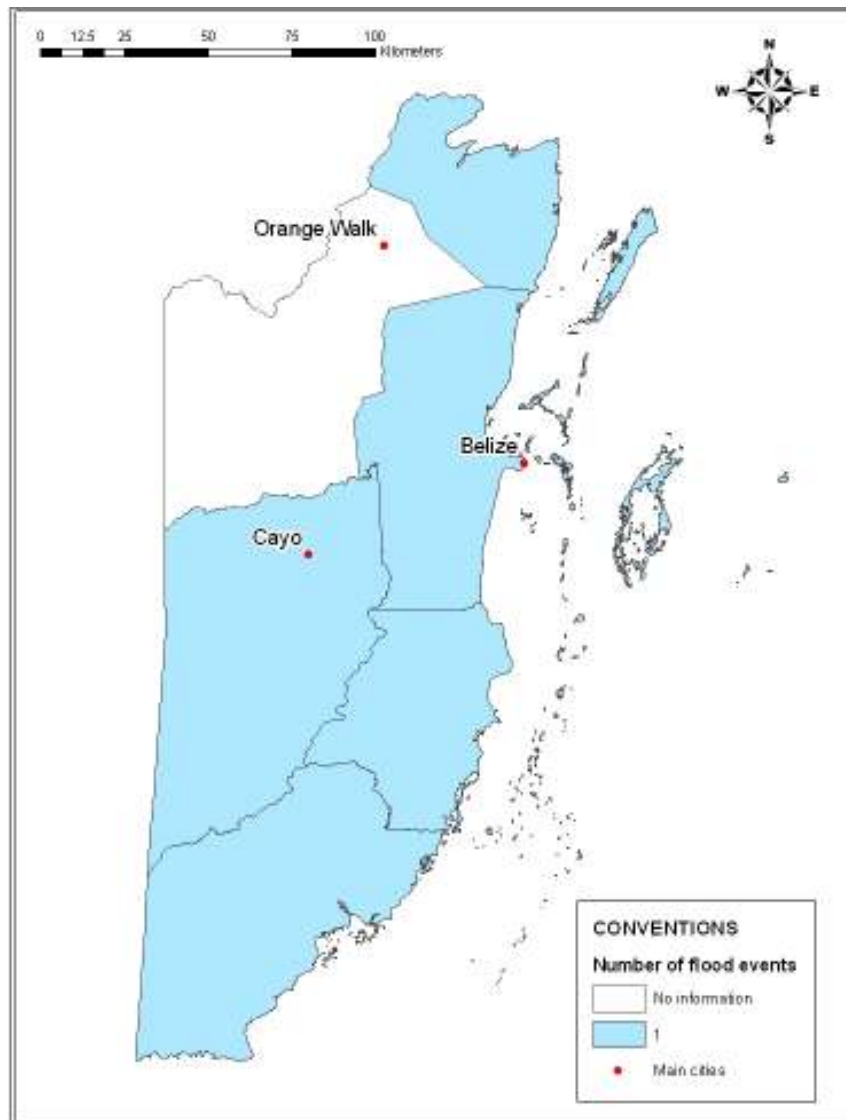
Table 3-8 shows classification by severity of flood, given in the regional absence of natural hazards in Central America, which is about included in the database formed by the this type of event.

Table 3-8
Severity of floods

(Source: <http://atlas.snet.gob.sv/atlas/files/Inundaciones/HistoriaInundacionesCA.html>)

SEVERITY CLASS	IMPACT LEVEL	FREQUENCY
1	Events of big floodings. Significant damage in structures or fields. Fatalities.	1-2 decades
2	Big events. Damage with collective impact.	Recurrence interval (between 20 and 100 years).
3	Extreme events. Massive damage of infrastructure. High level of fatalities.	Recurrence interval upper than 100 years

The catalogue of floods for Belize has six events in total reported between 1979 and 2008. As there are few records of flooding, an average value of events per year as a functional duration could not be obtained. Figure 3-29 shows the number of floods recorded by district.



*Figure 3-29
Number of floods by districts in Belize*

3.5.1 Statistical curves

The following curves present the analysis made using available data for floods. Figure 3-30 shows the number of flood events per year in the analysis period 1970-2008.

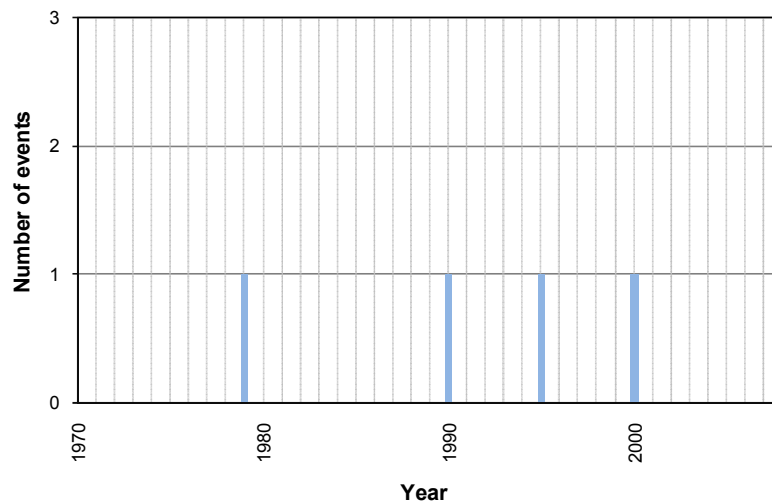


Figure 3-30

Number of floods for each year recorded in Belize throughout the analysed period

Figure 3-31 shows events by decade. The largest number of records appears for the period 2000-2008.

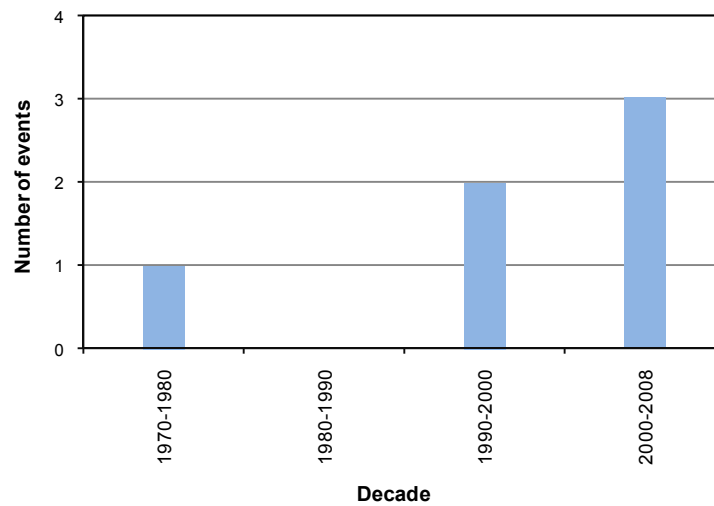


Figure 3-31

Number of floods per decade, recorded in Belize

Figure 3-32 the number of events classified by district.

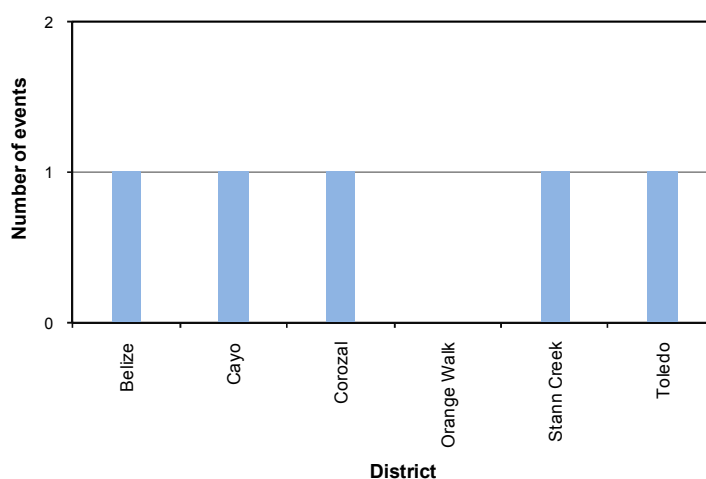


Figure 3-32
Number of floods by district in Belize

Table 3-9 which shows the records of highest economic losses (US\$9.7 million) and largest number of persons affected (38,000) by flooding, from 2008 (October 19, 2008). The next section summarises the most important flood events.

Table 3-9
Economic losses and deaths due to floodings in Belize

Date	Direct loss (millions of dollars)	Killed	Affected
12/1979	-	-	17,000
10/1995	0.5	-	2,600
20/05/1990	2.2	-	-
01/10/2000	-	1	3,296
31/05/2008	-	5	8,000
19/10/2008	9.7	1	38,000

3.5.2 Important historical events

The following is information about the most important floods which have occurred in Belize between 1900 and 2009. The information was taken from the emergency events database (EM DAT)⁴.

1979

December, with approximately 17,000 affected

⁴ <http://www.emdat.be/Database/CountryProfile/countryprofile.php>

1995

October, with 2,600 directly affected direct economic loss over 0.5 million dollars.

2008

October 19, 2008, with 1 death, 38,000 affected, and US\$9.7 million in material losses

3.6 Landslide

There are no records of landslides affecting Belize.

3.7 Volcanic eruption

Belize has no volcanoes in its territory, and therefore this type of evaluation does not apply.

ANNEX LIST

- Annex ERN-CAPRA-T1.1B-1 Earthquakes Belize.xls – Digital Annex
- Annex ERN-CAPRA-T1.1B-3 Hurricanes Belize.xls – Digital Annex
- Annex ERN-CAPRA-T1.1B-4 Intense rainfall Belize.xls – Digital Annex
- Annex ERN-CAPRA-T1.1B-5 Floods Belize.xls - Digital Annex