
Natural Hazards in the Caribbean

Earthquakes

Earthquakes are caused by sudden release of slowly accumulated strain energy along a fault in the earth's crust. Earthquakes and volcanoes occur most commonly at the collision zone between tectonic plates. Earthquakes represent a particularly severe threat due to the irregular time intervals between events, lack of adequate forecasting, and the hazards associated with these:

- Ground shaking is a direct hazard to any structure located near the earthquake's center. Structural failure takes many human lives in densely populated areas.
- Faulting, or breaches of the surface material, occurs as the separation of bedrock along lines of weakness.
- Landslides occur because of ground shaking in areas having relatively steep topography and poor slope stability.
- Liquefaction of gently sloping unconsolidated material can be triggered by ground shaking. Flows and lateral spreads (liquefaction phenomena) are among the most destructive geologic hazards.
- Subsidence or surface depressions result from the settling of loose or unconsolidated sediment. Subsidence occurs in waterlogged soils, fill, alluvium, and other materials that are prone to settle.
- Tsunamis or seismic sea waves, usually generated by seismic activity under the ocean floor, cause flooding in coastal areas and can affect areas thousands of kilometers from the earthquake center.

Volcanoes

Volcanoes are perforations in the earth's crust through which molten rock and gases escape to the surface. Volcanic hazards stem from two classes of eruptions:

- Explosive eruptions which originate in the rapid dissolution and expansion of gas from the molten rock as it nears the earth's surface. Explosions pose a risk by scattering rock blocks, fragments, and lava at varying distances from the source.
- Effusive eruptions where material flow rather than explosions is the major hazard. Flows vary in nature (mud, ash, lava) and quantity and may originate from multiple sources. Flows are governed by gravity, surrounding topography, and material viscosity.

Hazards associated with volcanic eruptions include lava flows, falling ash and projectiles, mudflows, and toxic gases. Volcanic activity may also trigger other natural hazardous events including local tsunamis, deformation of the landscape, floods when lakes are breached or when streams and rivers are dammed, and tremor-provoked landslides

Landslides

The term landslide includes slides, falls, and flows of unconsolidated materials. Landslides can be triggered by earthquakes, volcanic eruptions, soil saturated by heavy rains or groundwater rise, and river undercutting. Earthquake shaking of saturated soils creates particularly dangerous conditions. Although landslides are highly localized, they can be particularly hazardous due to their frequency of occurrence. Classes of landslide include:

- Rockfalls, which are characterized by free falling rocks from overlying cliffs. These often collect at the cliff base in the form of talus slopes which may pose an additional risk.
- Slides and avalanches, a displacement of overburden due to shear failure along a structural feature. If the displacement occurs in surface material without total deformation it is called a slump.
- Flows and lateral spreads, which occur in recent unconsolidated material associated with a shallow water table. Although associated with gentle topography, these liquefaction phenomena can travel significant distances from their origin.

The impact of these events depends on the specific nature of the landslide. Rockfalls are obvious dangers to life and property but, in general, they pose only a localized threat due to their limited areal influence. In contrast, slides, avalanches, flows, and lateral spreads, often having great areal extent, can result in massive loss of lives and property. Mudflows, associated with volcanic eruptions, can travel at great speed from their point of origin and are one of the most destructive volcanic hazards.

Flooding

Two types of flooding can be distinguished: (1) land-borne floods, or river flooding caused by excessive run-off brought on by heavy rains, and (2) sea-borne floods, or coastal flooding, caused by storm surges, often exacerbated by storm run-off from the upper watershed. Tsunamis are a special type of sea-borne flood.

Coastal flooding

Storm surges are an abnormal rise in sea water level associated with hurricanes and other storms at sea. Surges result from strong on-shore winds and/or intense low pressure cells and ocean storms. Water level is controlled by wind, atmospheric pressure, existing astronomical tide, waves and swell, local coastal topography and bathymetry, and the storm's proximity to the coast.

Most often, destruction by storm surge is attributable to:

- wave impact and the physical shock on objects associated with the passing of the wave front

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- Hydrostatic/dynamic forces and the effects of water lifting and carrying objects. The most significant damage often results from the direct impact of waves on fixed structures. Indirect impacts include flooding and undermining of major infrastructure such as highways and railroads.

Flooding of deltas and other low-lying coastal areas is exacerbated by the influence of tidal action, storm waves, and frequent channel shifts.

River flooding

Land-borne floods occur when the capacity of stream channels to conduct water is exceeded and water overflows banks. Floods are natural phenomena, and may be expected to occur at irregular intervals on all stream and rivers. Settlement of floodplain areas is a major cause of flood damage.

Tsunamis

Tsunamis are long-period waves generated by disturbances such as earthquakes, volcanic activity, and undersea landslides. The crests of these waves can exceed heights of 25 meters on reaching shallow water. The unique characteristics of tsunamis (wave lengths commonly exceeding 100 km, deep-ocean velocities of up to 700 km/hour, and small crest heights in deep water) make their detection and monitoring difficult. Characteristics of coastal flooding caused by tsunamis are the same as those of storm surges.

Hurricanes

Hurricanes are tropical depressions which develop into severe storms characterized by winds directed inward in a spiraling pattern toward the center. They are generated over warm ocean water at low latitudes and are particularly dangerous due to their destructive potential, large zone of influence, spontaneous generation, and erratic movement. Phenomena which are associated with hurricanes are:

- Winds exceeding 64 knots (74 mi/hr or 119 km/hr), the definition of hurricane force. Damage results from the wind's direct impact on fixed structures and from wind-borne objects
- Heavy rainfall which commonly precedes and follows hurricanes for up to several days. The quantity of rainfall is dependent on the amount of moisture in the air, the speed of the hurricane's movement, and its size. On land, heavy rainfall can saturate soils and cause flooding because of excess runoff (land-borne flooding), it can cause landslides because of added weight and lubrication of surface material, and/or it can damage crops by weakening support for the roots.
- Storm surge (explained above), which, especially when combined with high tides, can easily flood low-lying areas that are not protected.

**Annual Average Number of People
Reported Killed or Affected by Disasters**

by Country, 1970-1994

Country	Killed	Affected
Haiti	168	219,861
Dominican Republic	84	102,566
Puerto Rico	47	160
Guyana	36	10,859
Cuba	33	65,335
Jamaica	19	54,187
Suriname	7	N.A.
Bahamas	4	N.A.
Dominica	2	3,600
St. Lucia	2	2,944
Martinique	2	1,060
Anguilla	1	N.A.
Belize	1	3,731
Bermuda	1	N.A.
Trinidad & Tobago	0	2,000
Barbados	0	8
Antigua & Barbuda	0	3,000

Source: World Disasters Report 1996

Major Disasters in the Caribbean: 1899—1989

Country	Date	Hazards	Comment
Cuba	20/10/26	Hurricane	600 killed
	09/11/32	Hurricane	2,500 killed
	28/09/35	Storm Surge	Many fatalities
	18/10/44	Storm	--
	21/09/48	Hurricane	Heavy Damage
	05/10/48	Hurricane	--
	04/10/63	Hurricane	Alma
	06/06/66	Hurricane	Flora
	30/09/66	Hurricane	Inez
	13/10/68	Hurricane	Gladys
	19/02/76	Earthquake	--
	06/77	Floods	Eastern area
	11/02/78	Storm	Gale
	03/06/82	Hurricane	Alberto
	Feb/Mar/83	Rains/floods	10 weeks of Torrential rains
	25/05/85	Heavy rains	+ tornadoes
	18/11/85	Hurricane	Kate
	06/86	Floods	+ landslides
	08/87	Fire	--
26/05/88	Flood	20 killed, 90,000 affected	
28/05/90	Flood	6,000 affected	
06/02/92	Flood	9,127 affected	
25/05/92	Earthquake	7 Richter Scale,000 affected	
Dominica	04/03/03	Earthquake	--
	16/02/08	Earthquake	Slight damage
	04/02/35	Earthquake	--
	21/05/46	Earthquake	7.0 Richter scale
	25/09/63	Hurricane	Edith
	08/79	Hurricanes	David & Frederick
	09/10/84	Hurricane	--
	09/03/86	Earthquake	--
9/89	Hurricane	Hugo	
Dominican Republic	03/09/30	Hurricane	2,000 killed
	02/10/63	Hurricane	Flora
	08/64	Hurricane	Cleo
	04/65	Forest Fire	--
	29/09/66	Hurricane	Inez
	1968	Drought	Nationwide
	27/04/79	Floods	N/N-E areas
	08/79	Hurricanes	David & Frederick
	May 81	Floods	Heavy rains
	12/02/83	Forest fire	--
	29/05/86	--	--
	02/09/87	Hurricane	Emily
	08/88	Flood	1,191,150 affected

Country	Date	Hazards	Comment
Grenada	1955 03/09/63 27/04/90	Hurricane Hurricane Fire	Janet Flora --
Guadeloupe	12/09/28 11/08/56 06/10/63 22/08/64 27/09/66 20/08/70 30/08/76 16/03/85	Hurricane Hurricane Tropical Storm Hurricane Hurricane Tropical Storm Volcano Eruption Earthquake	Betsy Helena Cleo Inez Dorothy Mt. Soufriere 6.6 Richter scale
Guyana	07/71 18/11/78	Floods Accident	21,000 affected 900 killed, Jonestown Massacre
Haiti	12/11/09 12/08/15 21/10/35 27/10/52 12/10/54 03/10/63 14/11/63 24/08/64 29/09/64 1968 07/08/72 1974-75 1977 31/08/79 11/05/80 05/08/80 1980-81 20/05/85 16/05/86 01/06/86 03/06/86 Apr-Oct 86 23/10/86 10/07/87 12/87 11/09/88	Hurricane Hurricane Hurricanes Earthquake Hurricane Hurricane Floods Hurricane Hurricane Drought Fire Drought Drought Hurricane Fire Hurricane Drought Floods Fire Floods Floods Floods Fire/floods Floods Heavy rains Flood Hurricane	150 killed 1,600 killed Jeremie & Jacme 6 killed Hazel Flora 500 killed Cleo Inez 210,000 affected Port-au-Prince N/W Peninsula countrywide David 10,000 affected Allen S/W area 40,000 affected 3,300 homeless Extensive Damage Heavy rains - Emergency 100 homeless Extensive damage 3,000 affected Gilbert: 54 dead, 870000 affected

Major Disasters in the Caribbean: 1899—1989

Country	Date	Hazards	Comment
Jamaica	10/08/03	Hurricane	Heavy damage
	14/01/07	Earthquake	1,200 killed
	04/11/09	Flood	53 killed
	12/11/12	Hurricane	Heavy damage
	23/11/37	Flood	111 killed
	18/11/40	Flood	125 killed
	20/08/44	Hurricane	26 dead
	17/08/51	Hurricane	Charhe
	03/10/63	Hurricane	Floca
	1968	Drought	Nationwide
	17/10/73	Tropical storm	Gilda
	25/04/79	Floods	Western area
	06/79	Floods	Widespread
	05/08/80	Hurricane	Allen
	11/11/85	Hurricane	Kate
	15/05/86	Floods	Islandwide
30/10/87	Floods	Tropical Storm	
12/09/88	Hurricane	Gilbert (49 killed, 810,000 affected)	
21/05/91	Flood	550,000 affected	
Martinique	08/05/02	Volcano eruption	Mt Pelee 40,000 killed
	08/08/03	Hurricane	Heavy damage
	16/02/06	Earthquake	--
	17/04/14	Earthquake	--
	26/09/9	Earthquake	--
	02/09/51	Hurricane	Crops destroyed
	19/03/53	Earthquake	Building damage
	10/07/60	Hurricane	Abby
	25/09/63	Hurricane	Edith
	07/09/67	Hurricane	Buelah
	20/08/70	Tropical storm	Dorothy
	08/79	Hurricane	David
04/10/90	Hurricane	Klaus 6 killed, 1,500 affected	
Montserrat	28/08/24	Hurricane	Heavy damage
	12/09/28	Hurricane	Heavy damage
Martinique	12/12/34	Earthquake	Building damage
	10/11/35	Earthquake	Building damage
	16/03/85	Earthquake	6.6 Richter scale
	17/09/89	Hurricane	Hugo
Netherland Antilles	Aug 1899	Hurricane	Heavy damage
	01/09/50	Hurricane	Dog
	04/09/80	Hurricane	Donna

Country	Date	Hazards	Comment
Puerto Rico	Aug 1899 06/09/10 11/10/18 24/10/18 23/07/26 13/09/28 10/09/31 08/32 12/08/56 08/60 1989	Hurricane Hurricane Earthquake Earthquake Earthquake Earthquake Earthquake Earthquake Earthquake Hurricane Hurricane	6,000 killed San Juan damaged Extensive damage Deaths/damages Deaths/damages Deaths/damages Deaths/damages Deaths/damages Deaths/damages Donna Hugo
St Kitts (Saint Christopher) and Nevis	13/09/28 12/50 02/10/55 1984 16/03/85 05/87 17/09/89	Hurricane Earthquake Hurricane Floods Earthquake Flood Hurricane	Heavy damage Heavy damage Alice In Basseterre 6.6 Richter scale -- Hugo
St. Maarten/Saba	30/12/54 04/09/60	Hurricane Hurricane	Alice Donna
St. Lucia	16/02/06 21/05/46 19/03/53 10/07/60 25/09/63 07/09/67 03/08/80 08/83 08/09/86	Earthquake Earthquake Earthquake Hurricane Hurricane Tropical Storm Hurricane Storm Tropical Storm	Extensive damage Building damage Building damage Abby Edith Beulah Allen Gale force winds Danielle
Saint Vincent and the Grenadines	08/05/02 17/07/02 17/09/06 26/09/28 21/05/46 19/03/53 23/09/55 08/09/67 17/10/71 13/04/79 03/08/80 08/09/86 21/09/87	Volcanic Eruption Earthquake Earthquake Earthquake Earthquake Earthquake Hurricane Tropical Storm Volcanic Eruption Volcanic Eruption Hurricane Trop Storm/Flood Hurricane	Mt. Soufriere (1,565 killed) Buildings damaged -- -- -- Buildings damaged Janet Beulah Mt Soufriere Mt Soufriere Allen Darnielle Heavy damage Emily
Suriname	01/08/69	Floods	4,600 affected

Major Disasters in the Caribbean: 1899—1989

Country	Date	Hazards	Comment
Trinidad & Tobago	31/01/04	Earthquake	Building damage
	26/03/15	Earthquake	Building damage
	24/02/18	Earthquake	Building damage
	04/12/54	Earthquake	Building damage
	27/06/33	Hurricane	Heavy damage
	30/09/63	Hurricane	Flora
	14/08/74	Tropical Storm	Alma
Turks and Caicos Islands	20/11/85	Hurricane	Kate
	21/09/87	Hurricane	Emily
US Virgin Islands	Aug 1899	Hurricane	Heavy damage and major flood surge
	Aug 1899	Hurricane	Heavy damage to St. Thomas
	01/10/01	Hurricane	Damage to St. Croix
	22/08/09	Tropical Storm	Major flooding
	14/07/16	Hurricane	Damage to St. Croix
	21/08/16	Hurricane	Heavy damage
	09/10/16	Hurricane	Heavy damage
	28/08/24	Hurricane	Heavy damage
	12/09/28	Hurricane	Heavy damage
	10/09/31	Hurricane	Heavy damage
	26/09/32	Hurricane	Heavy damage
	07/05/60	Flood	Heavy damage to St. Thomas
	01/03/69	Flood	Heavy damage
	05/70	Flood	Heavy damage
10/70	Flood	Extensive damage to St. Thomas	
1989	Hurricane	Hugo	

Source: *Disaster Information Kit for the Media (ver 05/95)* Data based on records available from:

1. OFDA Disaster History: "Significant Data On Major Disasters Worldwide, 1900 - present of June 87"
2. PCDPPP'S "Caribbean Disaster News," issues Nos 1-11 (1984-present)
3. PCDPPP Documentation Centre, 1988
4. UNDRO's computerized list of situation/information reports ("sitrep Prints")
5. World Map of Natural Hazards, Muenchener Rueckversicherungs Gesellschaft, 1978