2 HAZARDS

2.1 General

The primary natural hazards facing the islands of the Caribbean are earthquakes and hurricanes. Some of the islands are also subjected to instances of volcanic activity, including Barbados, as was seen during the eruption of La Soufrière in St. Vincent in April 1979. This, however, is outside the scope of this report.

Torrential rains can also, by themselves, be considered natural hazards since they often occur without the concurrent occurrence of hurricanes and sometimes result in disastrous flooding of low-lying areas. Accounts have been given of an incident of flooding which affected the Hospital in October 1970, which is described later in this report.

2.2 Earthquakes

Seismic activities in the Eastern Caribbean, where Barbados is located, are principally associated with a zone of subduction at the junction of the Caribbean Plate and the Americas Plate. Figures 1, 2 and 3 (at the end of this sub-section) show the tectonic setting of the Caribbean, the main physical features of the Eastern Caribbean, and a cross section through the island arc at the latitude of Barbados.

The most recent earthquake to have caused significant damage in Barbados occurred on 26 September 1928, with a Modified Mercalli intensity of VII. An earlier seismic event of note occurred on 11 January 1839, with a MSK[1] intensity of VII. Isoseismal maps of these earthquakes, and a third event which affected Barbados, are reproduced in figures 4, 5, and 6. These were provided by Dr J Grases.

The Caribbean Uniform Building Code (CUBiC) recommends a **Z**-factor of 0.375 for Barbados. This is generally at the lower end of **Z**-factors for the Eastern Caribbean, with the Leeward Islands and northern Windward Islands having a **Z**-factor of 0.75, and a **Z**-factor of 0.5 recommended for St. Vincent and Grenada.

More recently, the work of Dr J Shepherd for the Pan American Institute for Geography and History (PAIGH) developed the iso-acceleration map that is reproduced in figure 7 at the end of this section. The PAIGH study indicates peak ground accelerations between 175 gals[2] and 225 gals with a 10%

[1] Medvedev-Sponheuer-Kárník, *circa* 1964.

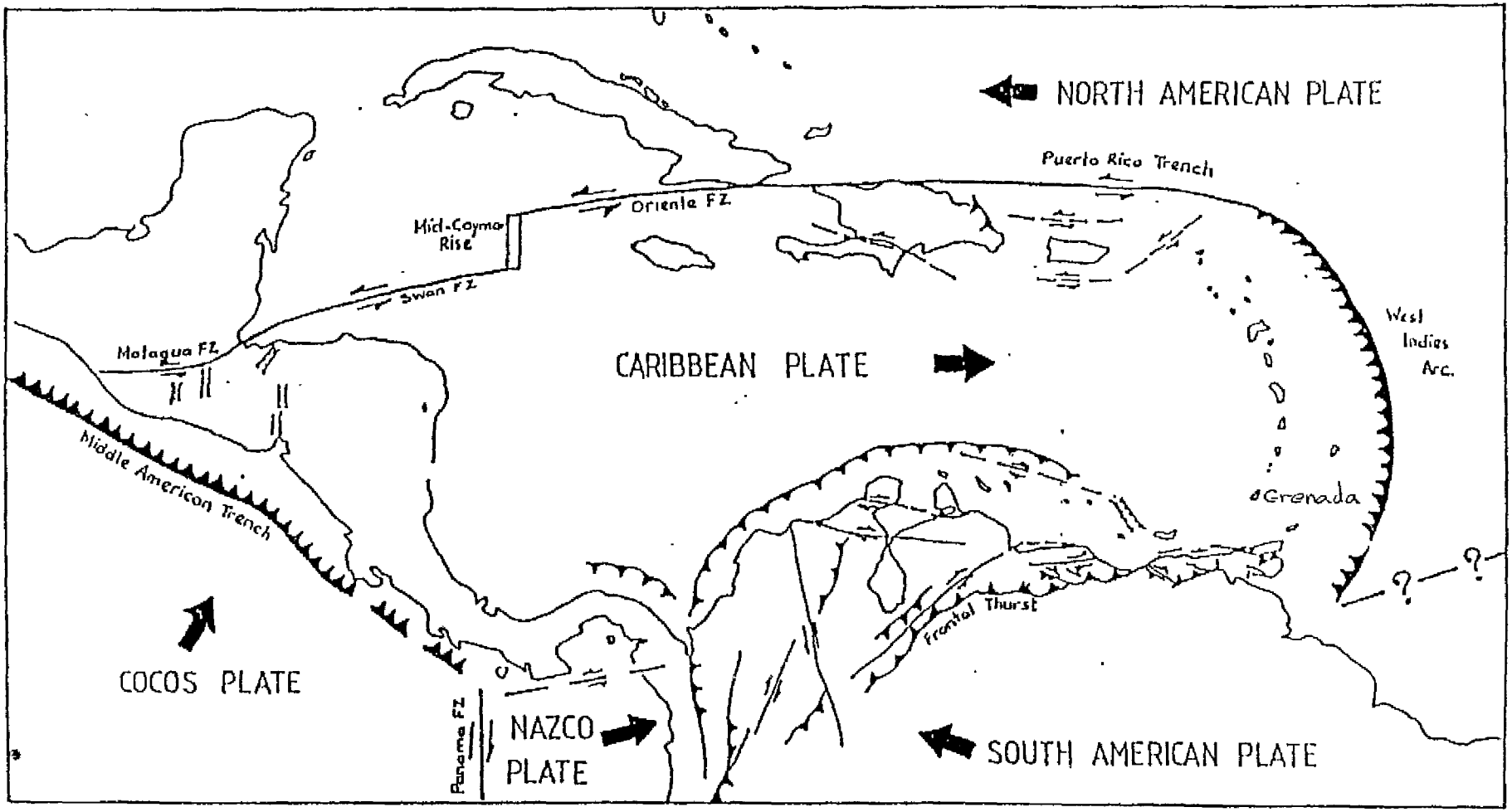
[2] 1000 gals is approximately equal to the acceleration due to gravity.

probability of exceedance in 50 years.

The level of seismicity in Barbados is therefore considered to be moderate. However, it is sufficiently important not to be ignored.

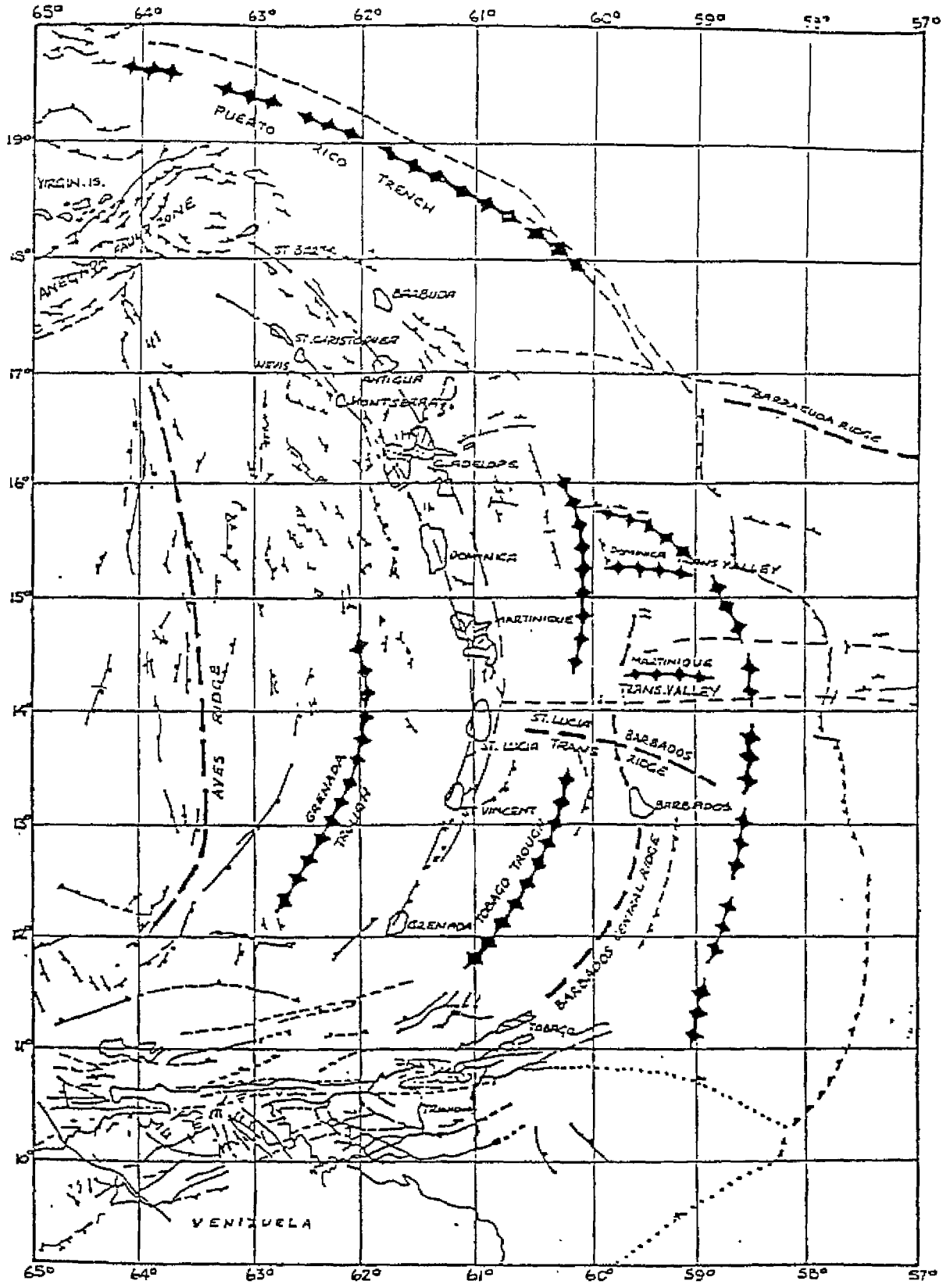
The pages following this section contain the following figures:

Fig 1	Tectonic Setting of the Caribbean
Fig 2	Main Features of the Eastern Caribbean
Fig 3	Structure in the Region of Barbados
Fig 4	Earthquake of 11 January 1839
Fig 5	Earthquake of 26 September 1928
Fig 6	Earthquake of 19 March 1953
Fig 7	Iso-acceleration map in the region of Barbados



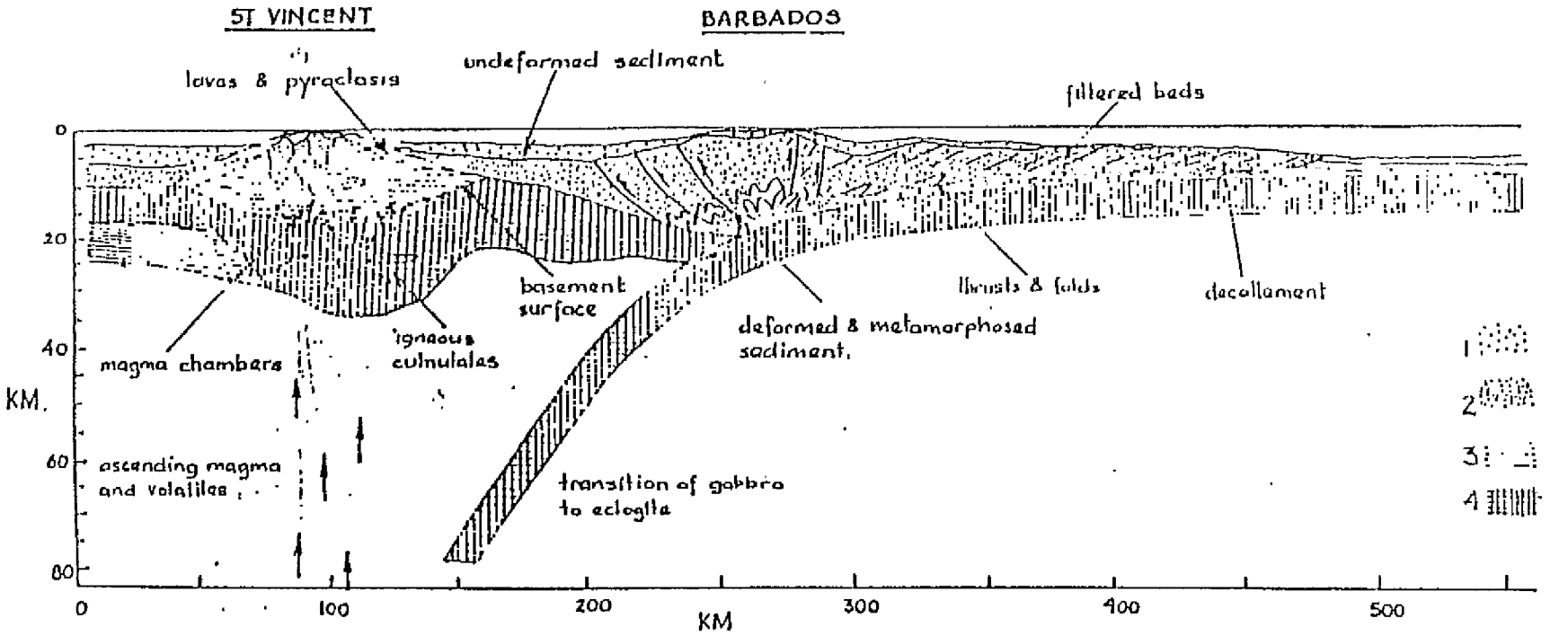
Tectonic Setting of the Caribbean
(after Molnar and Sykes, 1969)

Figure 1



Main Features of Eastern Caribbean
(based on compilation by J E Case and T A Holcomb USNOO
and from Peter and Westbrook, 1976)

Figure 2



Diagrammatic cross-section of the Eastern Caribbean Island arc illustrating the structure and the processes acting on it. 1. Undeformed sediment. 2. Deformed and/or consolidated sediment. 3. Igneous crust produced by the volcanic arc. 4. Main oceanic crustal layer and lower crust of arc. Vertical exaggeration 2:1.

Structure in Region of Barbados
(Westbrook, 1970)

Figure 3

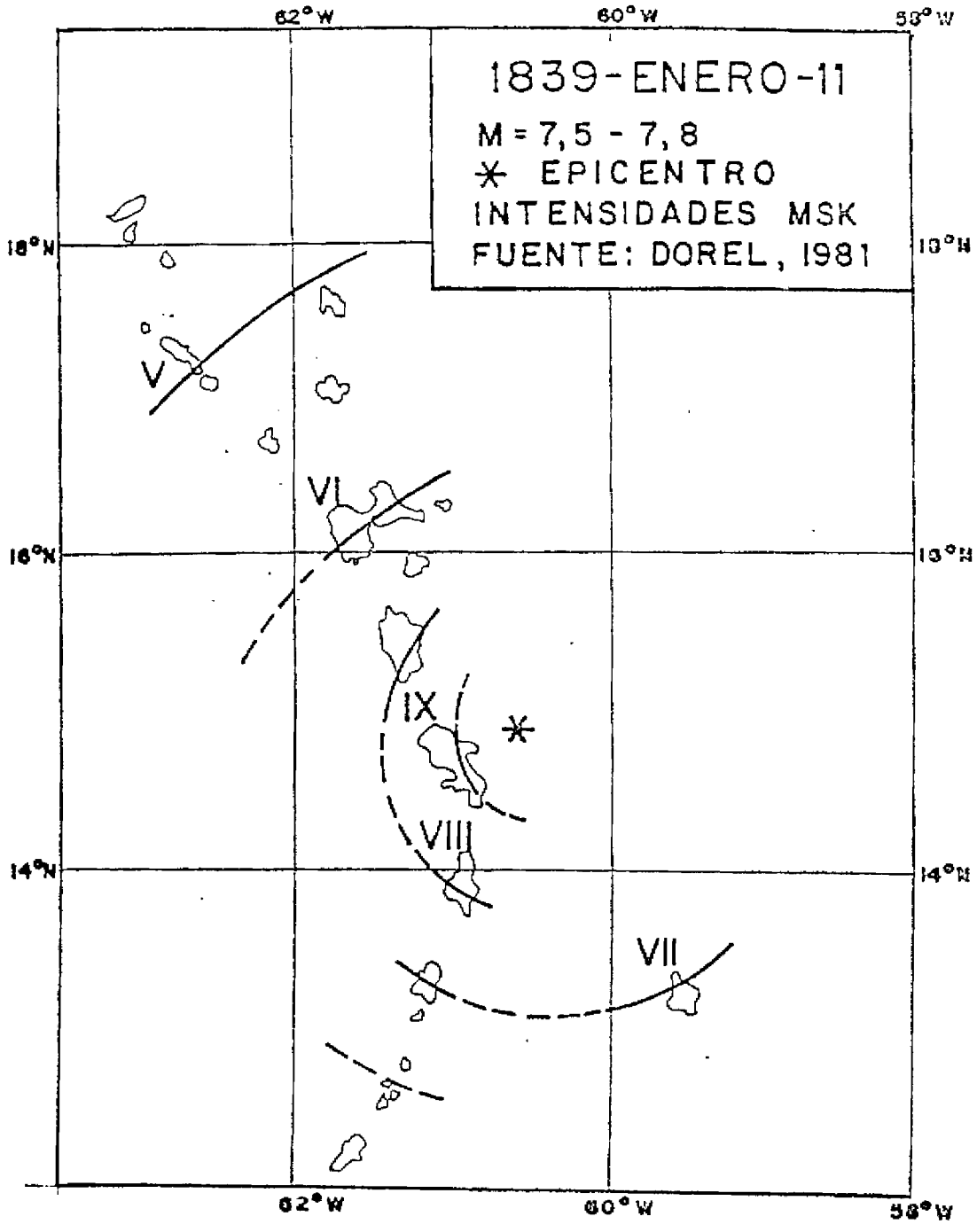

62°W
60°W
58°W
1839-ENERO-11
M = 7,5 - 7,8
✳ EPICENTRO
INTENSIDADES MSK
FUENTE: DOREL, 1981
18°N
16°N
14°N
V
VI
IX
VIII
VII

Figure 4

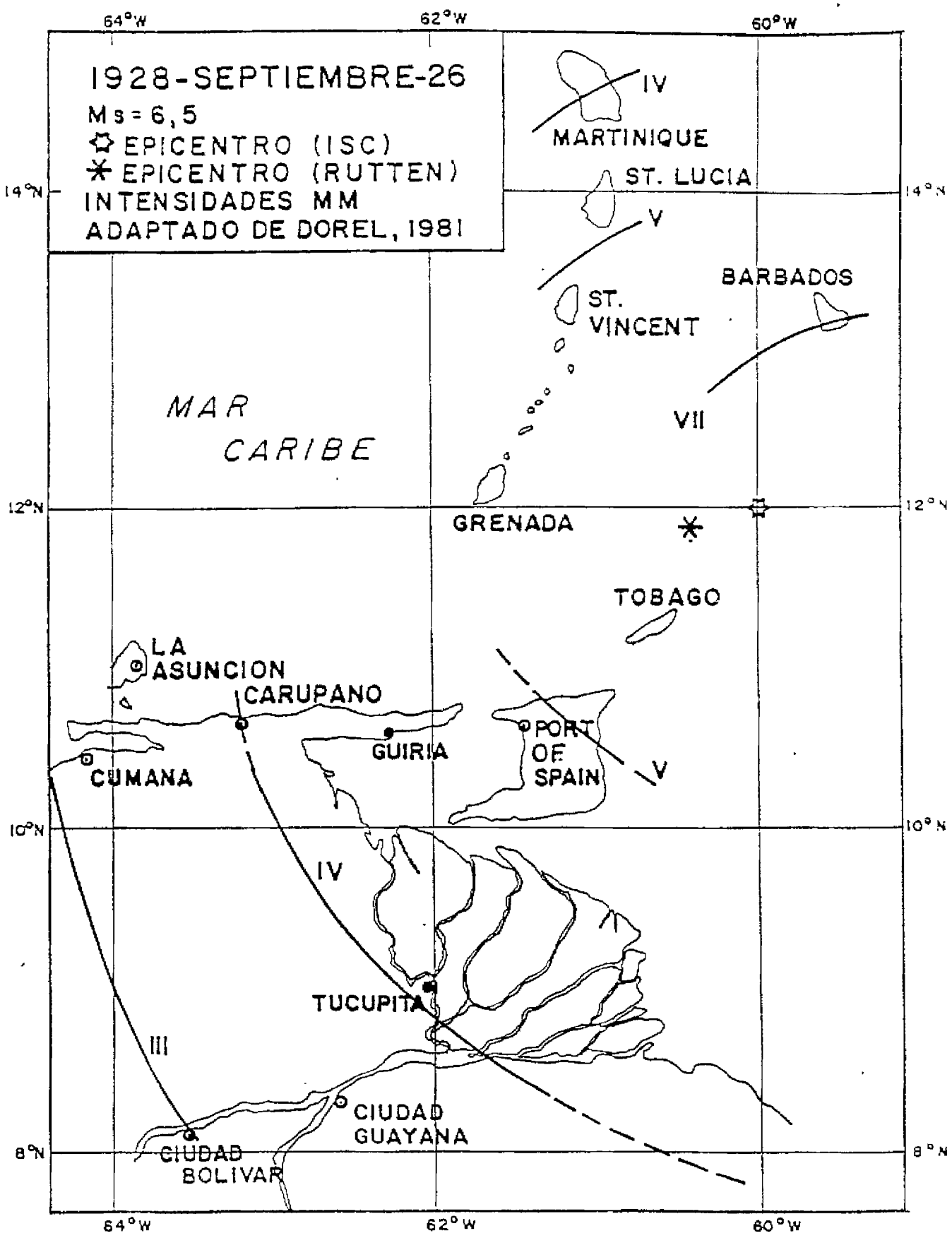

1928-SEPTIEMBRE-26
Ms = 6,5
EPICENTRO (ISC)
EPICENTRO (RUTTEN)
INTENSIDADES MM
ADAPTADO DE DOREL, 1981
64°W
62°W
60°W
14°N
12°N
10°N
8°N
IV
MARTINIQUE
ST. LUCIA
V
BARBADOS
ST.
VINCENT
MAR
CARIBE
VII
GRENADA
TOBAGO
LA
ASUNCION
CARUPANO
GUIRIA
PORT
OF
SPAIN
CUMANA
IV
TUCUPITA
III
CIUDAD
GUAYANA
CIUDAD
BOLIVAR

Figure 5

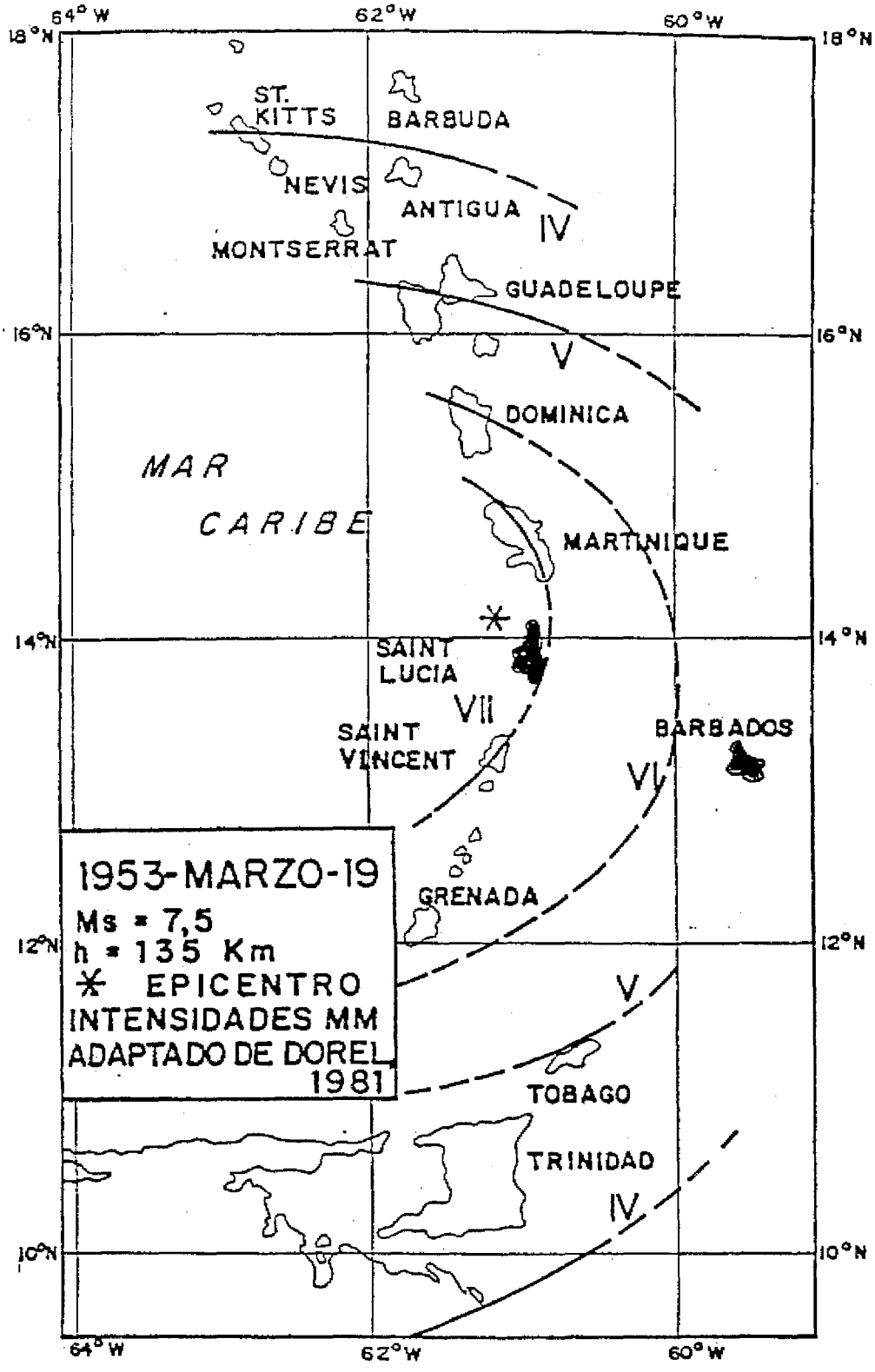

64° W
62° W
60° W
18° N
16° N
14° N
12° N
10° N
ST. KITTS
BARBUDA
NEVIS
ANTIGUA
MONTSERRAT
GUADELOUPE
DOMINICA
MAR CARIBE
MARTINIQUE
SAINT LUCIA
SAINT VINCENT
BARBADOS
GRENADA
TOBAGO
TRINIDAD
IV
V
VI
VII
1953-MARZO-19
Ms = 7,5
h = 135 Km
EPICENTRO
INTENSIDADES MM
ADAPTADO DE DOREL 1981

Figure 6

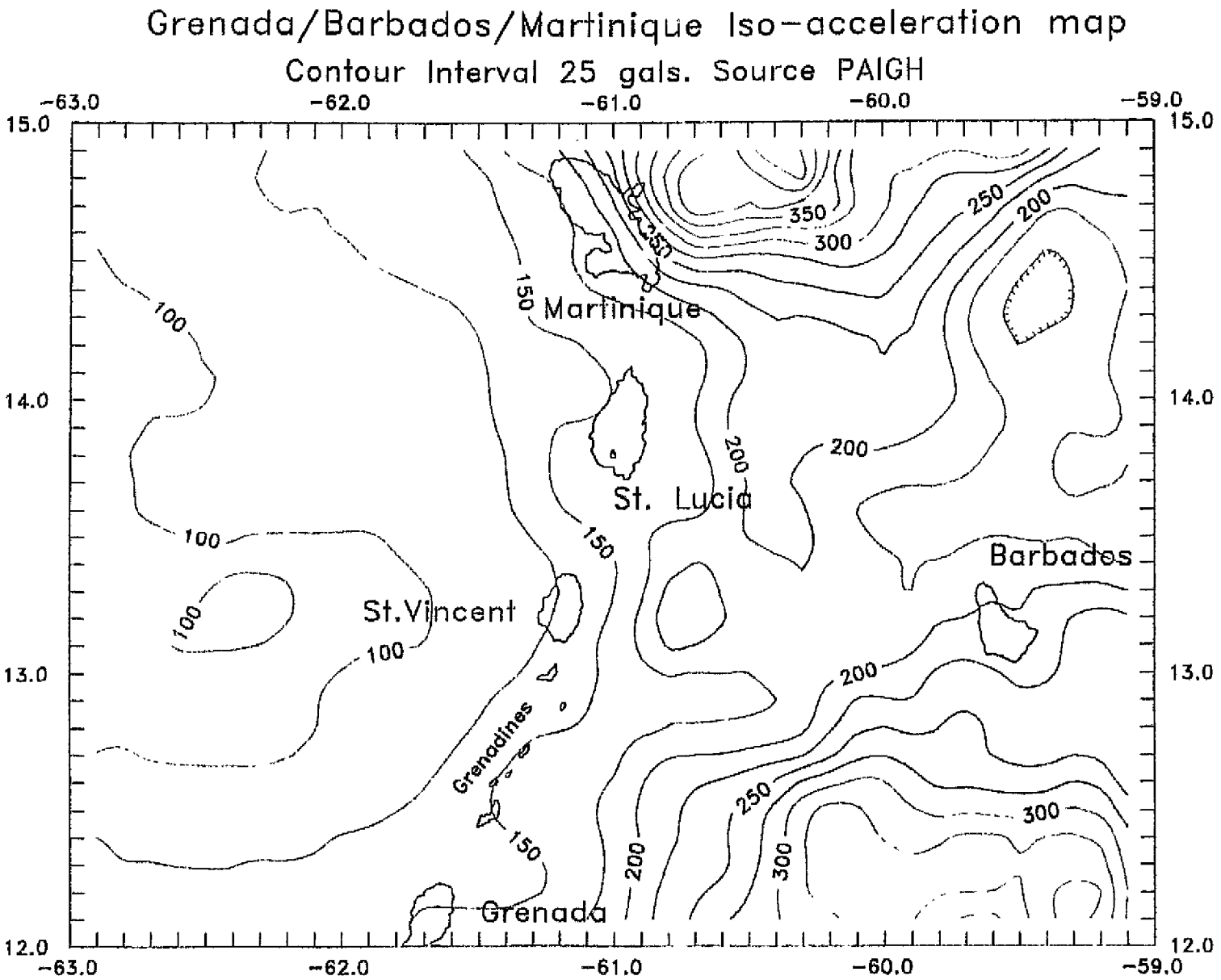

Grenada/Barbados/Martinique Iso-acceleration map
Contour Interval 25 gals. Source PAIGH
-63.0
-62.0
-61.0
-60.0
-59.0
15.0
14.0
13.0
12.0
Martinique
St. Lucia
Barbados
St.Vincent
Grenadines
Grenada
100
150
200
250
300
350

Figure 7

2.3 Hurricanes

Barbados lies in the North Atlantic Ocean, one of the six main tropical areas of the Earth where hurricanes may develop every year.

The destructive potential of a hurricane is significant due to high wind speeds and torrential rains that produce flooding and occasional storm surge with heights of several feet above normal sea level. Because of the elevation of the hospital site above sea level, storm surge is not expected to be an issue at the hospital.

The **Saffir/Simpson** scale is often used to categorize hurricanes based on wind speed and damage potential. The following five categories of hurricanes are recognized:

Wind Speed (one-minute sustained)			
Category	**mph**	**m/s**	**Damage**
HC1	74 to 95	33 to 42	Minimal
HC2	96 to 110	43 to 49	Moderate
HC3	111 to 130	50 to 58	Extensive
HC4	131 to 155	59 to 69	Extreme
HC5	> 155	> 69	Catastrophic

The normal criterion for the design of buildings to resist hurricane force winds is the 1-in-50-year wind, ie a wind which on average is not expected to be exceeded more that once in 50 years.

For buildings of a critical nature, such as hospitals, it is recommended practice in hurricane-resistant design to cater for a wind speed with a statistical return period of more than 50 years. Depending on the circumstances, a 1-in-100-year hurricane (HC3 for Barbados) or a 1-in-200-year hurricane (HC4 for Barbados) would be appropriate. This has the same effect as increasing the safety factor or the design wind speed.

Current wind-resistant design practice in Barbados makes use of the standard BNS 28[3]. For a 50-year return period, this standard quotes a basic (3-second) wind speed of 58 metres per second (m/s). This is equivalent to a one-minute wind speed of 48 m/s. (By way of comparison the CUBiC[4] reference wind

[3] The Barbados National Standard Institution's "Code of Practice for Wind Loads for Structural Design", 1981

[4] Caribbean Uniform Building Code, Part 2, Section 2, Wind Load, 1985

speed is equivalent to a 3-second wind speed of 51 m/s versus 58 m/s in BNS 28.)

The one-minute 100-year speed according to BNS 28 would be 52 m/s and the one-minute 200-year wind speed according to BNS 28 would be 60 m/s. These one-minute figures may be used in referring to the Saffir/Simpson scale.

2.4 Other Hazards

2.4.1 Torrential Rains

Although heavy rains often accompany hurricanes, severe rainfall events are also associated with troughs and tropical depressions. The risk of flooding is therefore not restricted to, nor more likely to occur during, hurricane events. Also, flooding may also occur in cases of prolonged rainfall of moderate intensity, and where stormwater drainage is inadequate. Generally, lower lying areas will be more susceptible to flooding than higher and sloping ground.

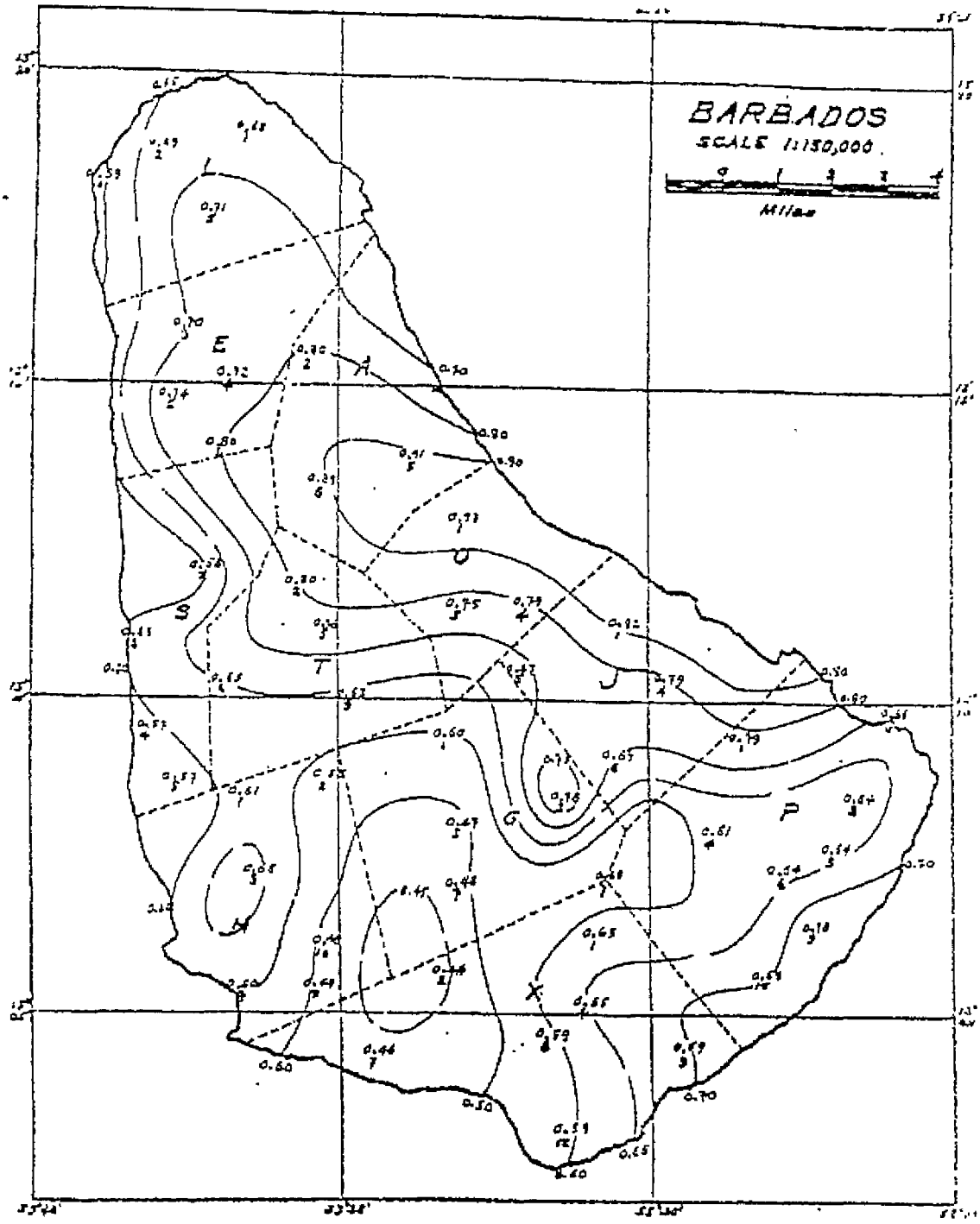
The damage caused by flooding depends on the type and elevation of facilities in the location. The results of flooding may range from the inconvenience of temporarily submerged driveways to the loss of equipment and finishes inside flooded buildings and consequential disruption of the functions.

A map showing rainfall isohyets for Barbados on 02 October 1970 is shown in Figure 8. Rainfall intensity across the island ranged from just below 0.4 inches per hour in the south-west to just above 0.9 inches per hour in the region of the Scotland District. (These are averages over a 24-hour period.) The amounts of rainfall collected at various rain gauges suggested that the duration of rainfall in different locations also varied. In the region of the QEH, a 24-hour rainfall intensity of approximately 0.5 inches per hour was recorded.

A chart showing the relationship between intensity, duration and frequency of rainfall in the years 1969-1970 is shown in Figure 9. The rainfall intensity in the area of the QEH was equivalent to a rainfall event with a statistical return period greater than 25 years.

The pages following this section contain the following figures:

Fig 8	Rainfall Isohyets for Barbados
Fig 9	Rainfall Intensity-Duration-Frequency Curves



Rainfall Isohyets for Barbados

Figure 8

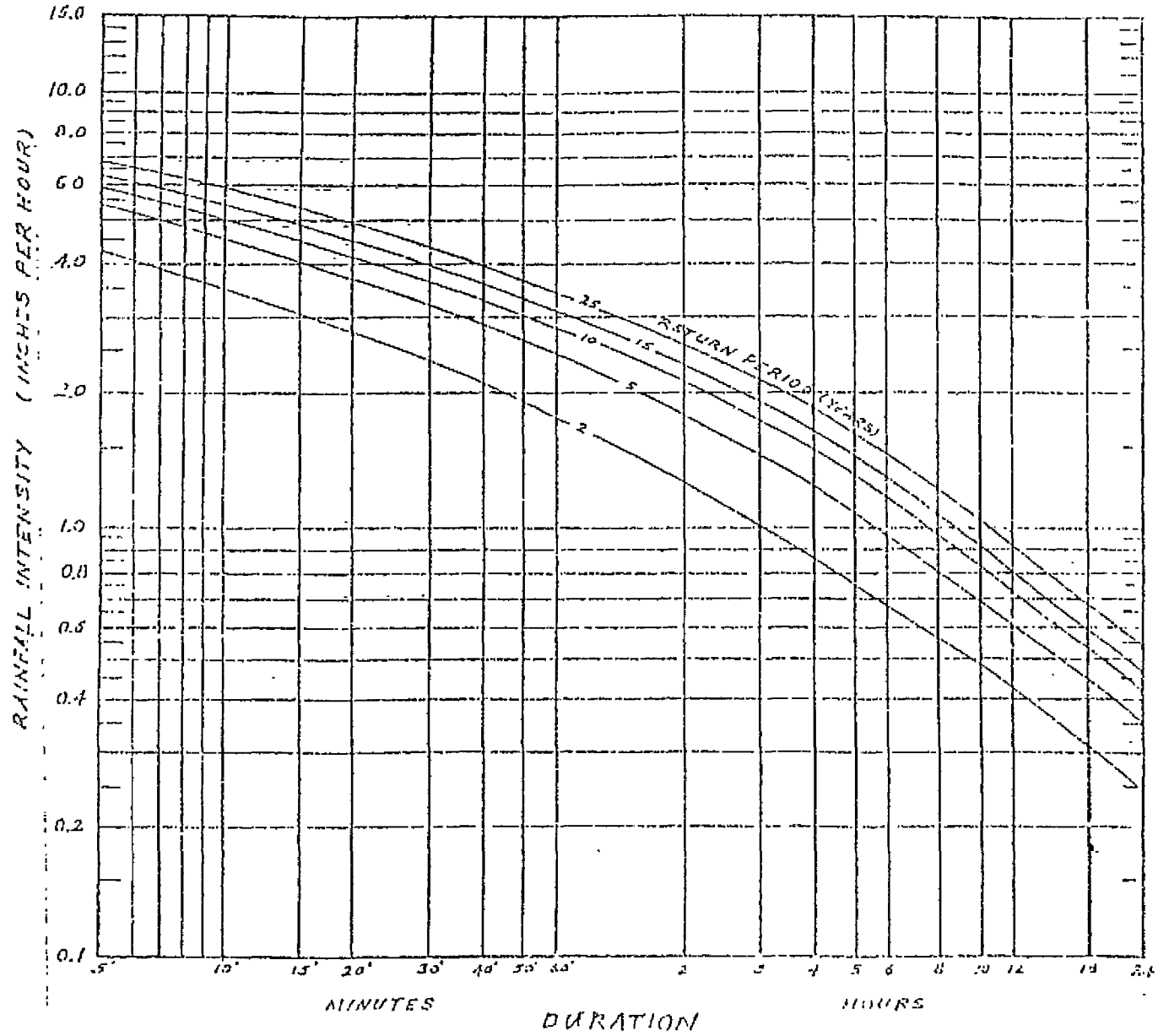


Figure 9

RAINFALL INTENSITY-DURATION-FREQUENCY CURVES

C.M.I., HUSBANDS (S 5)

Period: 1969 - 1970

Elevation: 370 feet above MSL