Caribbean Cyclone-Resistant Housing Project

Information Bulletin

A joint research project between the University of the West Indies (St. Augustine) and the University of Waterloo, CANADA
Funded by the International Development Research Centre (IDRC), Ottawa, CANADA.

April 1992 ISSUE NO.2

How VULNERABLE* are houses to cyclones ?

In the first issue of the Information Bulletin (April 1991), it was stated the Caribbean region experienced a total of eight hundred and eighty-nine (889) cyclones between 1886 and 1990. In 1991, eight (8) tropical storms affected the North Atlantic basin, only two of which posed a threat to the Caribbean region.

The region is not likely to experience cyclones of greater number or severity in 1992 than occurred in 1991. There is, however, a greater chance in 1992 that cyclones will return to their usual southerly paths and it must, therefore, be remembered that housing is still quite vulnerable to the destructive power of cyclones.

It is usually quite difficult to appreciate how serious the problem of vulnerability is by simply looking at figures such as those just quoted. In fact, vulnerability depends not only on the frequency of cyclones but also on several other factors. Whenever we speak of vulnerability, we refer to the *"likelihood of damage"* that can occur to one's property not only from high winds but also from ancillary effects of cyclones such as flooding, landslides, and storm surges. Factors which influence the

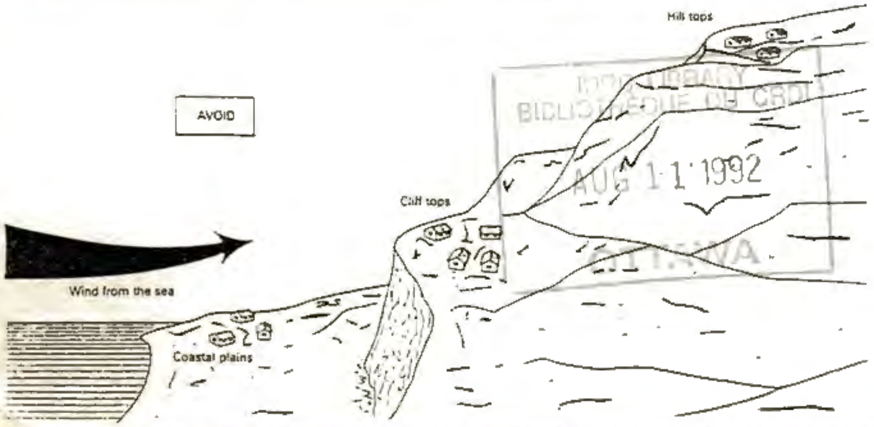


Fig. 1 These Exposed Areas are at Higher Risk to Increased Wind Speeds.

1991 HURRICANE SEASON

1991 was a near average year in terms of numbers of tropical storms in the North Atlantic Basin however no landmass around the Caribbean Sea was significantly affected by any storm, making 1991 somewhat unusual. In recent times, such a low number in the Basin and the absence of storms in the Caribbean occurred in the 1982 and 1983 hurricane seasons.

In 1982, six tropical storms were observed with one becoming a hurricane and, in 1983, four tropical storms, three of which became hurricanes, were recorded. All of these tropical storms veered northwards bypassing the Caribbean area. The 1982 Hurricane Alberto, which originated in the north-western extreme of the basin, was formed as a tropical depression off the Yucatan Peninsula and drifted off the north western tip of Cuba.

Table 1 lists the tropical storms and hurricanes of the 1991 season. Only Hurricane Grace (October 27-29, 1991) caused any substantial damage. This hurricane located near Bermuda was large and intense enough to cause considerable damage to coastal properties and towns from Miami to Cape Hatteras (North Carolina) in the United States ....

(cont'd on page 7)

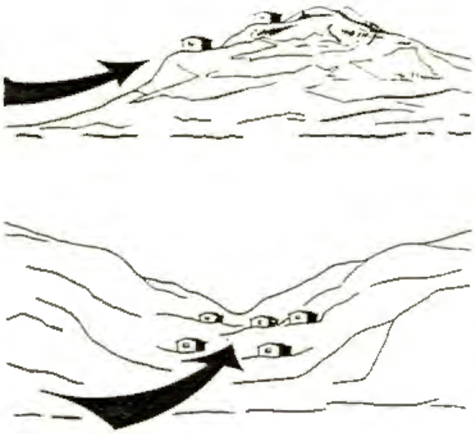


Fig. 2 Hills and open–ended valleys increase wind speeds

likelihood of damage to a building include its general location (e.g. valley, hillside, coastline; see Figures 1 and 2), the immediate surroundings (e.g. trees, utility poles, other buildings), the general shape or style of the roof (e.g. hip, gable, lean-to shed; see Figure 3) and, most importantly, techniques incorporated into roof connections at the time of construction. All of these factors contribute to the overall vulnerability of the building.

The present study of cyclone activity in the region has concentrated on the incidence, frequency and location of cyclones, the results of which have been compiled into a **Cyclone Profile**. Included in this Bulletin are three of a series of charts which indicate the geographical distribution of cyclones over the period 1886-1990.

The charts show a series of curved lines (isolines) superimposed over a map of the region (including parts of South, Central and North America) bounded by longitudes 50° and 100° West and latitudes 9° and 30° North. These boundaries define the area of main interest to the researchers. The purpose of this series of charts is essentially to help persons become visually aware of what has been taking place in the region since 1886.

The charts are relatively simple to use, even by persons who have no prior knowledge of basic geography. The lines running from top to bottom (vertical) on the chart are called ***lines of longitude*** and those running from left to right (horizontal) are called ***lines of latitude***. The value of each line increases by two (2) degrees as one moves from the bottom right-hand corner of the chart at 50° West 9° North to the top left-hand corner at 100° West 30° North. These vertical and horizontal lines cross each other to form grid boxes (four degree square), each representing a total area of approximately 48,840 km^2.

A computer program was used to classify each cyclone based on the highest recorded wind speed according to the Saffir/Simpson Scale. Each grid box was then checked to see whether the track passed within it. If this occurred the number of cyclones passing within that box was incremented by one (1). The final values obtained for each grid box was then used to generate isolines which represents points that have the same number of cyclone occurrences. The isolines on Figure 6 (pages 4 and 5) show how all cyclones which passed within the defined area were geographically distributed.

Generally the southern region of the chart shows very little cyclone activity and persons residing in these areas have been spared the devastating effects of major cyclones. As one moves north and west, the isolines tend to increase in value, indicating a general increase in the number of cyclones affecting those areas.

In order to find how many cyclones have affected a particular location, one should first choose the box appropriate to that location. Then, the numbered isoline nearest to or running through the box, is found. If the location is as shown in Figure 5 (a), a value of one (1) should be subtracted from the numbered value for each isoline crossed (between the exact location and the numbered isoline) as th exact location is approached. Otherwise, value of one (1) should be added to eac isoline crossed from the numbered isolin (Fig. 5 (b)). The final figure obtaine provides the approximate number c cyclones which have affected the locatio over the period 1886-1990.

The island of Dominica, for example, fal within the grid box 60°-62° West and 15° 17° North. The nearest labelled isoline ha the value 50. As one moves from tha isoline toward the exact location, tw isolines are crossed and therefore the valu is increased by 2, bringing the final figur to 52. This represents the approximat number of cyclones which have affected th island over the period. Figures 4 and 8 ar to be used in a similar manner but the give the approximate number of cyclones c a certain magnitude. For example, of th 52 cyclones which have affected Dominic approximately 9 were of Hurrican Category 2 and 9 were of Category 4.

Having seen how vulnerable a particul location is to cyclones, one can say wit some degree of confidence that the "retur period" would be obtained by dividing th number of years (105 in this case) by th number of cyclones obtained from th charts. For example, the return period fo Dominica is 105 divided by 52 which give approximately 2 years. In other words, it very likely that the island of Dominica wi experience the effects of at least or cyclone every two years.

Such vulnerability poses a number c questions. For example, what can be dor to reduce the chances of a house bein severely damaged by a cyclone over i lifetime? Moreover, can houses be mad cyclone-resistant and, if so, at what cost?

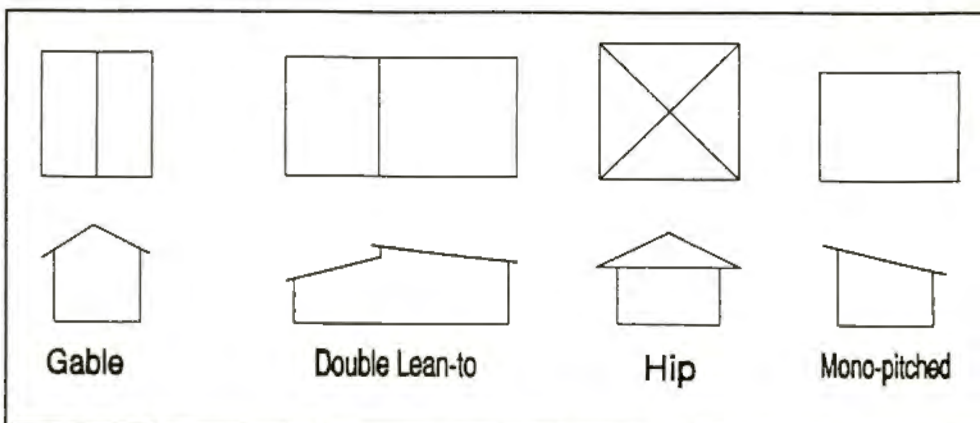


Fig. 3 Four commonly occurring roof shapes in Caribbean houses.

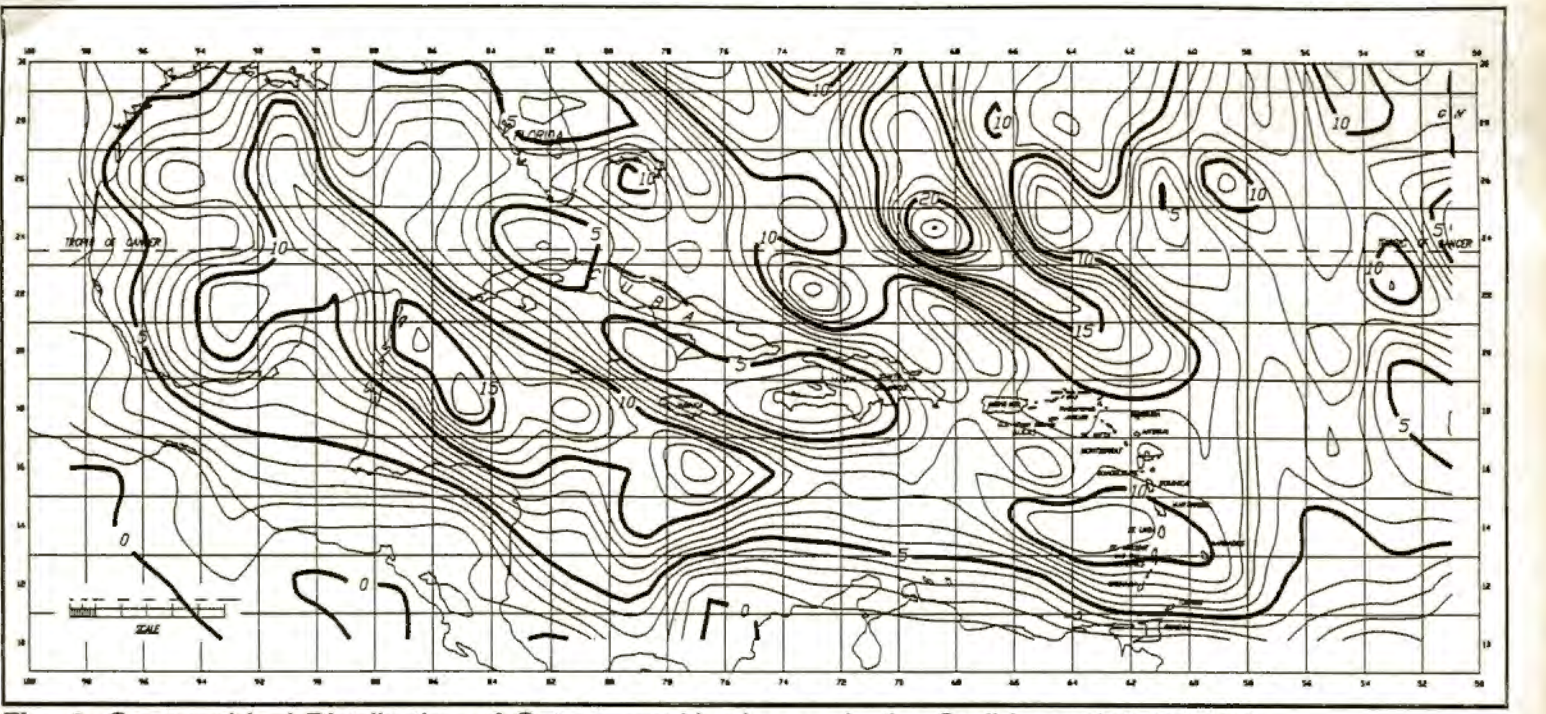


Fig. 4 Geographical Distribution of Category 2 Hurricanes in the Caribbean (1886–1990).

Answers to these questions can be given while answers to others are still being sought. Generally, structures can be made cyclone-resistant as the name of this Bulletin strongly implies. New houses can have cyclone-resistant features incorporated into their roofs, walls and foundations and these should provide adequate strength to resist the forces imposed on them. Existing houses can be "retrofitted" by various methods to improve their overall resistance to cyclonic forces.

Retrofitting relates to construction measures which may be taken to strengthen existing houses. The ultimate goal of retrofitting a house is to significantly reduce or eliminate the potential of damage due to cyclonic forces in a manner which is cost effective, complies with building standards and is acceptable in terms of appearance and liveability. Practical and cost-effective methods for reducing or eliminating the risk of existing houses being damaged are being developed by the researchers on this Project.

Data collected from field surveys done in Barbados, Dominica, Grenada, Jamaica, St. Kitts and St. Vincent are in the process of being analyzed but already much has become clear about the methods and techniques employed by builders and owner/builders in houses.

Some of the findings from the data include typical roof shapes (Fig. 3), details of roof connections currently used by builders, materials used for walls and foundations and typical house dimensions.

From the information obtained, scale models of different shapes of houses have been used for testing in the Boundary Layer Wind Tunnel at the University of Waterloo in Canada. Features such as porches, common to Caribbean houses, have been incorporated in the models used for these wind tunnel tests. The information emanating from these tests has been considerable and will take a long time to fully analyze. Some of the highlights of this information will be released in subsequent issues of this Bulletin while more detailed summaries will be provided in technical documentation.

Findings obtained from the field surveys have been used to carry out tests in the Structures Laboratory at the Department of Civil Engineering of the University of the West Indies. Static and dynamic tests have been undertaken on roof sheeting (corrugated galvanized iron and aluzinc) connected to timber laths; so have static tests on lath-to-rafter connections.

(cont'd on page 7)

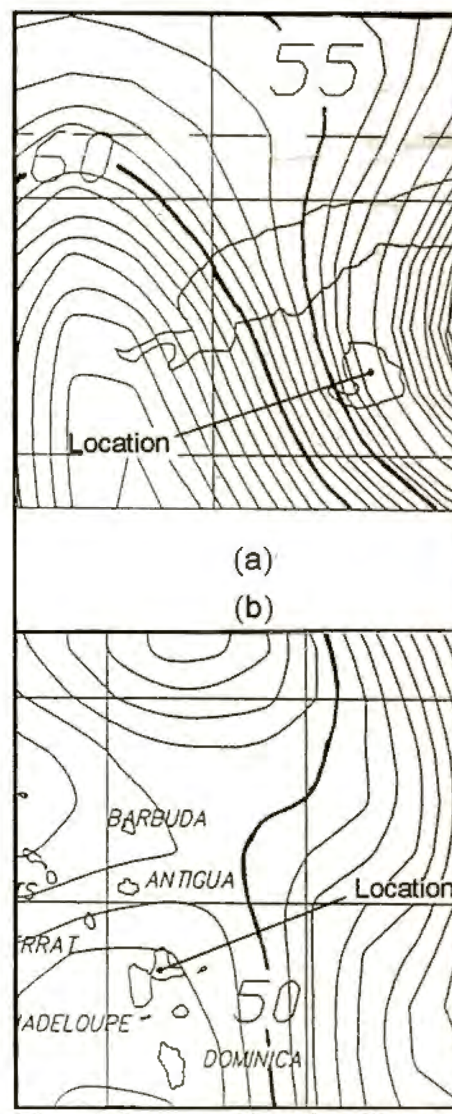


Fig. 5 How to Use the Charts

Cyclone P

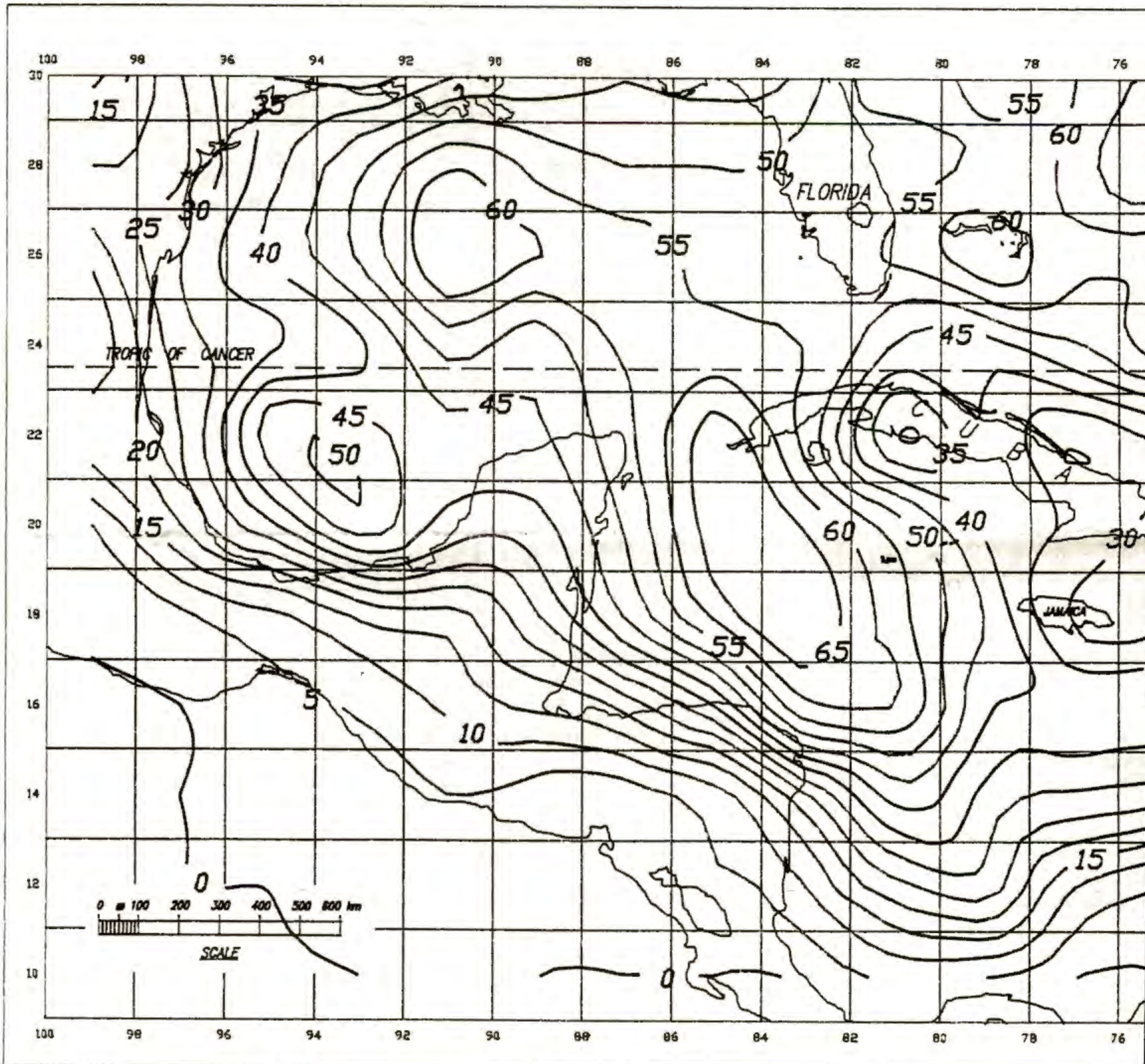
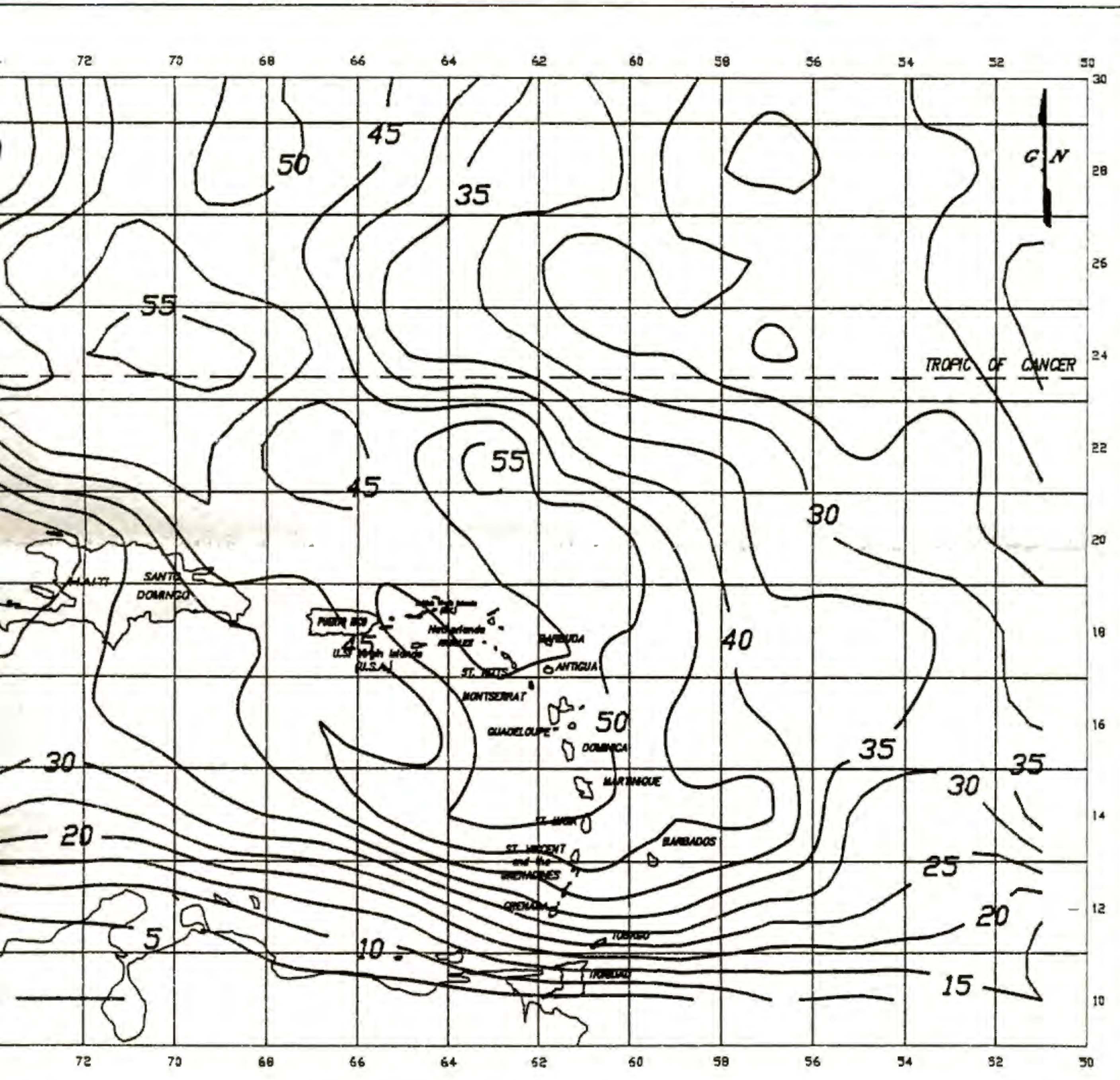


Fig. 6 Geographical Distribution of Cyclone Incidence. Isolines Depict the Number of Tropical Cyclones with Maximum Winds of at least 34 Knots Passing Within a Four Degree Square of Latitude and Longitude for the Period 1886 – 1990.

ofile Chart


72
70
68
66
64
62
60
58
56
54
52
50
30
28
26
24
22
20
18
16
14
12
10
45
50
35
55
TROPIC OF CANCER
55
45
30
HAITI
SANTO DOMINGO
45
BARBUDA
ANTIGUA
ST. KITTS
MONTSERRAT
40
GUADELOUPE
50
DOMINICA
MARTINIQUE
35
30
35
20
BARBADOS
ST. VINCENT and the GRENADINES
25
GRENADA
20
5
10
TOBAGO
TRINIDAD
15

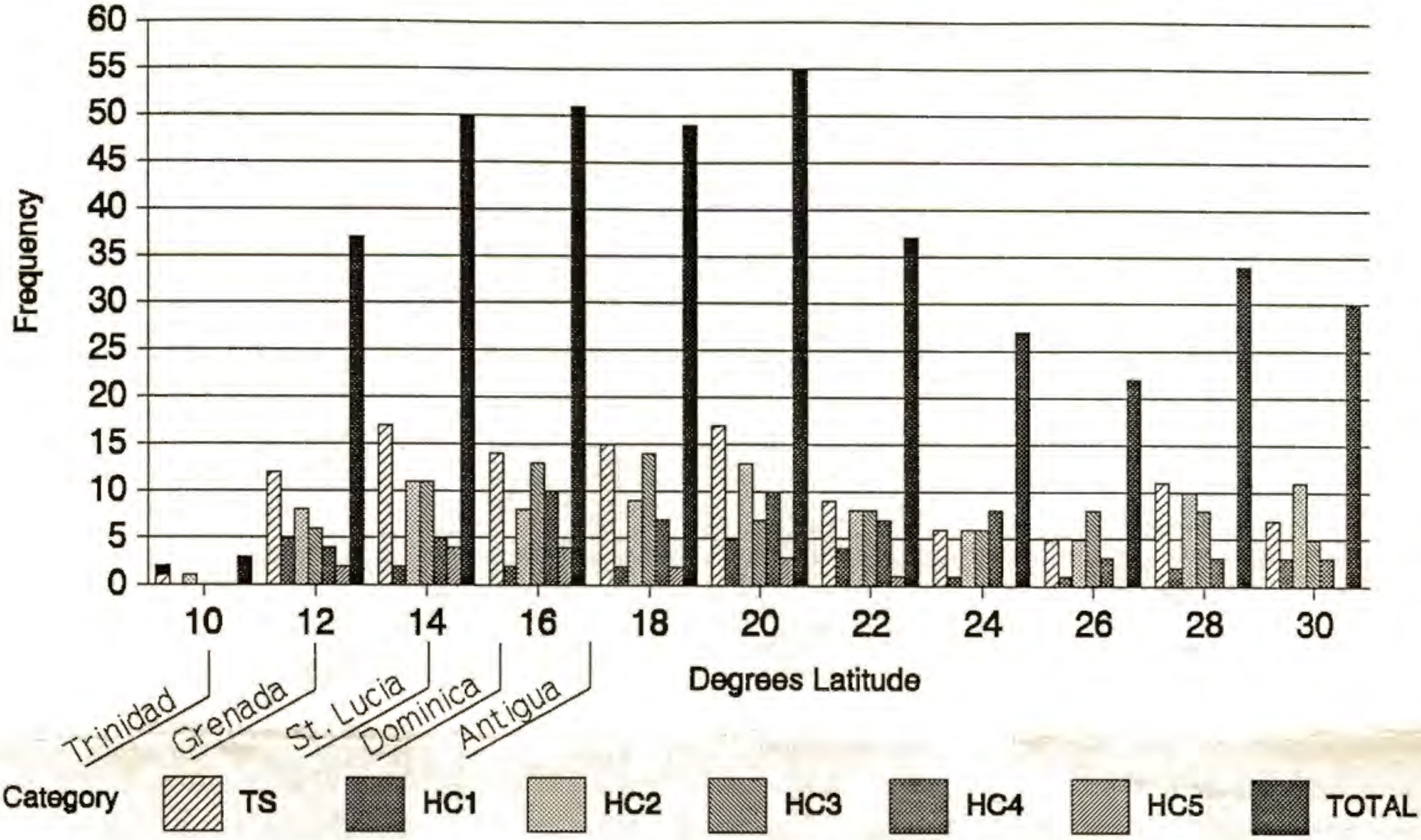


Fig. 7 Cyclone Distribution along Longitude 61° West

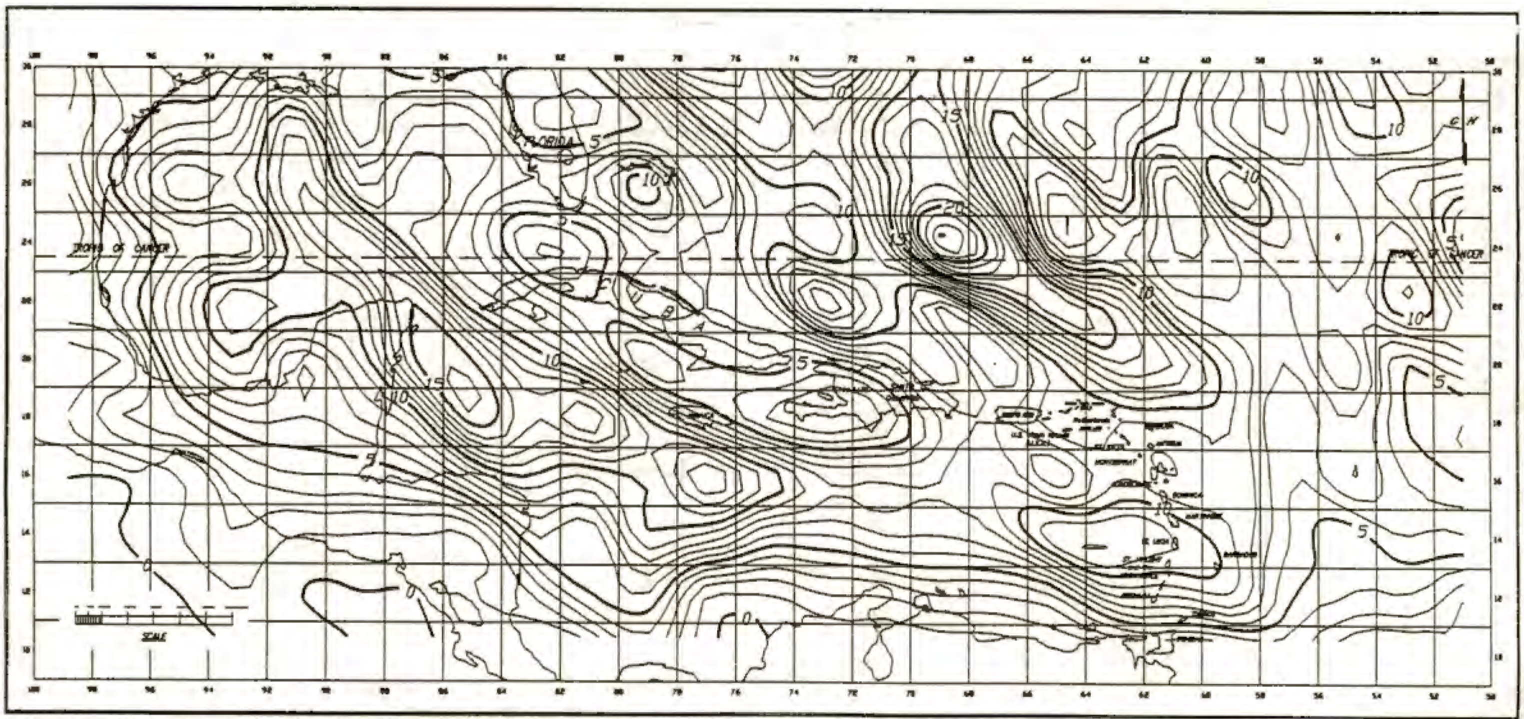


Fig. 8 Geographical Distribution of Category 4 Hurricanes in the Caribbean (1886–1990).

(Cont'd from page 3) Test results and other details related to roof shapes, connections, building techniques, site location and overall vulnerability will be combined to indicate a ***Damage Potential*** for Caribbean housing.

Cyclone Distribution Histogram

The distribution of tropical cyclones can also be represented by a histogram. Fig. 7 shows the frequency of occurrence (1886-1990) for all categories of cyclones along Longitude 61° degrees West.

Trinidad, located at the southern edge of the basin, is less vulnerable than most of the other islands as can be seen from this chart, since only three cyclones passed through this grid. There is a marked increase in number of occurrences as one moves from Latitude 10° to 12° North. The Lesser Antilles fall between Latitudes 12° N to 19° N and the average number of occurrences for these islands is 48 over the period 1886-1990.

The preliminary diagrams have been found to agree with work done by other researchers in the North Atlantic Cyclone Basin. This is the first time that this has been done specifically for the Caribbean islands and now made available to those doing further studies.

Histograms such as these can be produced along any line of interest or for a particular location within the defined area.

Building Authorities and Disaster Preparedness agencies may find these charts useful/beneficial in their planning and preparation exercises. Insurance companies can use this information to offer incentives such as lower rates to houseowners in certain high-risk areas, if cyclone-resistant features are incorporated into their houses.

Edited by Prof I.D.C Imbert
Graphics and Layout by D.O. Prevatt

This bulletin is produced by the Cyclone-Resistant Housing (Caribbean) Project. Please address any comments to the following persons:

Prof. I.D.C. Imbert, D. Prevatt, P. Drakes

The University of the West Indies
St. Augustine
TRINIDAD
Phone : 1-809-663-1334 Ext. 3434
Fax : 1-809-662-4414

TABLE I The eight tropical storms and hurricanes of 1991.

STORM NAME	CATEGORY	DATES
ANA	TS	2 – 4 July 1991
BOB	HC3	16 – 20 Aug 1991
CLAUDETTE	HC4	4 – 12 Sept 1991
DANNY	TS	8 – 11 Sept 1991
ERIKA	TS	9 – 12 Sept 1991
FABIAN	TS	15 – 16 Oct. 1991
GRACE	HC2	27 – 29 Oct. 1991
UNNAMED	HC1	28 Oct – 3 Nov 1991
TS = Tropical Storm, HC = Hurricane Category		

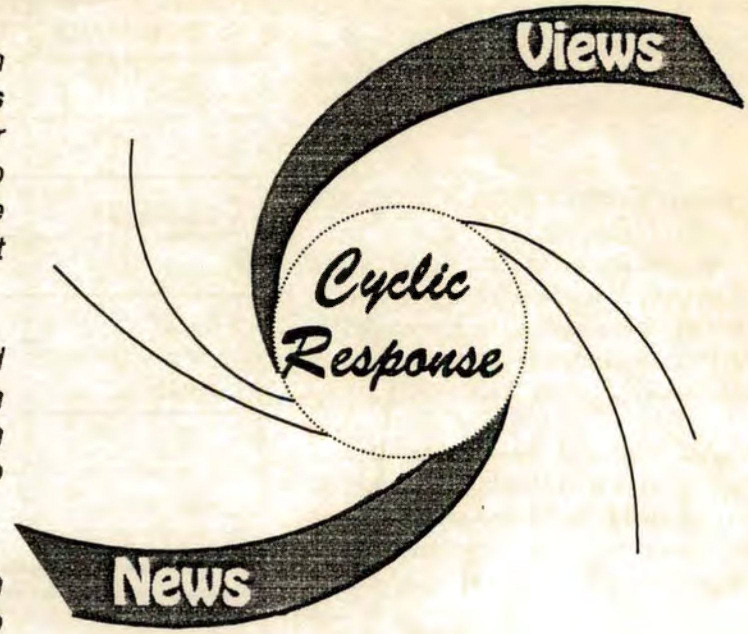
as a result of the large ocean swells generated by the wind. Bermuda was buffeted by 115 km/h winds as the hurricane passed immediately south of the island heading towards the open Atlantic.

Hurricane Grace was not a typical tropical cyclone and has been described by meteorologists as a ***hybrid storm***. It exhibited many extra-tropical storm characteristics, a major one being its large physical size. Significant wind speeds occurred up to 645 kilometres from its centre, significantly greater than the 80-km radius of maximum wind expected of a tropical cyclone of this strength.

It is being speculated that last year's mild tropical storm season occurred because of the disturbance of normal weather patterns associated with the effects of the ***El Niño Current***. The El Niño Current, which develops in the Pacific Ocean off the South American coastline of Peru, affects the high-altitude wind patterns by producing high-speed south-westerly wind flows over the Caribbean basin and the southern states of the United States. These high speed winds in 1991 could theoretically have caused shearing in cyclone-generating areas thus upsetting the thermodynamic cycle necessary for the favourable development of the tropical storm.

After a relatively mild season last year, no one knows for sure what the 1992 one is likely to be. From a statistical point of view, one should expect tropical storm activity in the Caribbean basin in 1992. However, it is likely that the 1991 El Niño effect could spill over into the 1992 hurricane season. Were this to occur, the 1992 season could have fewer storms than normal but some of these could still occur in the Caribbean. Hence, there is still a chance that more southward storm tracks may be observed with attendant destructive power. So we must be prepared!

Cyclic Response - News and Views



*In an effort to stimulate greater communication with you, we have inaugurated this **Letters Section** where we can address some of your concerns. This section will also be used to express appreciation to persons who have assisted in some way with the Cyclone-Resistant Housing (Caribbean) Project.*

We are indebted to the officers of the Trinidad and Tobago Meteorological Service, Messrs. Robin Maharaj and André Clarke for their assistance in preparing the Hurricane data of the past two seasons.

As we are still attempting to collect information on the damages caused by the wind, we would like to obtain any information you may have on the damages caused in your area.

If you need further data on your particular area please write and let us know and we would be happy to respond.

PORT OF SPAIN 30.3.92 TRINIDAD

TRINIDAD & TOBAGO $ 1.50 P.B.206 POSTAGE

Associate Director
International Development Research Centre
250 Albert Street
P.O. Box 8500 Ottawa
CANADA K1G3H9