HURRICANE *GILBERT*: CARIBBEAN RECORD-BREAKER[1]

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AT 1400 GMT on 12 September 1988 the eye of hurricane *Gilbert* made landfall on the south-eastern tip of Jamaica, with a central pressure somewhere below 950 mbar and sustained windspeeds in the core of 60 $m s^{-1}$ (200 $km h^{-1}$). Within less than 36 hours it had ascended the hierarchy from tropical disturbance, depression (TD), named tropical storm and rapidly up through hurricane intensity categories 1 to 4. At 2300 GMT the eye exited the country a few kilometres north of the resort town of Negril, and *Gilbert* was almost immediately identified as a category 5 hurricane, the most severe.

During that nine-hour rampage through the entire length of the island state, Jamaicans had rueful reason to appreciate the sentiment of geographers Briggs and Smithson (1985) p. 102:

> "To people who have never experienced a hurricane the devastation is unbelievable."

One quarter of all buildings in the country were rendered unusable at least temporarily, and a further 50 per cent sustained some damage. Half a million people had to vacate their dwelling or shelter and seek an alternative, most for a matter of hours only, but more than 50000 for periods from weeks to months. Total damage, estimated in the immediate aftermath, totalled J$40000 million[2] and a later, more careful evaluation has indicated direct damage to roofs alone at J$2000 million (Lambie 1988). Reinsurance transfers from London and elsewhere to Jamaican insurance companies are expected to total J$4370 million of which J$275 million has already been paid. This figure, of course, takes no account of the roughly 70 per cent of private buildings, mostly smaller ones, which are not covered by any insurance, nor of the entire devastated public sector infrastructure – schools, hospitals, roads, power, telephones and the rest – which, sadly, is also uninsured.

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[1] Editor's note: This article was written whilst Jamaica was still very badly affected by the hurricane and the author was without a power supply or a proper mail service. A preliminary account by Philip Eden appeared in the December 1988 issue.

[2] In October 1988 Jamaican $1 = 11 pence (£0.11 Sterling).

Photograph by J. Tyndale-Biscoe

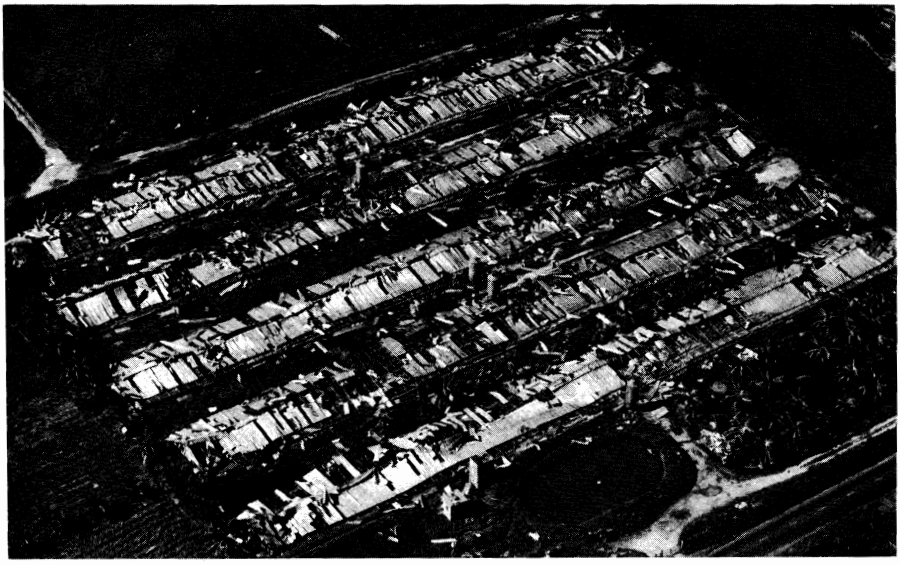
Damage to houses in Hamilton Gardens, St Catherine, Jamaica, on 15 September 1988

Despite truly heroic local efforts, assisted by quite unprecedented support from overseas, two months after *Gilbert* more than half the population of the country is still without electric power, fresh food or water that is potable without boiling, and many business firms have still not resumed operations. With the assistance of 90 linesmen and much equipment from Florida, New York and Puerto Rico, the Jamaica Public Service Company is reconstructing the entire national power grid virtually from scratch. These figures indicate a national disaster, when relative size and population are considered, on a scale only matched by Germany in 1945 or Korea in 1952. And in Jamaica's case, not only were cities affected, but more than two-thirds of the rural districts were significantly damaged.

Gilbert was a record-breaker on many counts, and many exceptional features are worthy of note. Its initial growth and intensification were phenomenal. It already had a central pressure of 970 mbar while it was still a tropical storm. The author was in the west of Jamaica at the time of the initial storm warning on 10 September, but by the evening of 11 September the storm had reached hurricane category 4 level, and branches and whole trees were already falling, effectively blocking the road to his home.

The upper air situation casts some light on this rapid intensification. An enormous upper tropospheric anticyclone centred north of Cuba was waiting with open arms to receive and prime the growing circulation of onrushing *Gilbert*. Riehl's crucial 'deep easterlies' above 500 mbar were present with a vengeance over the entire Caribbean (Riehl 1979). It was truly a textbook case.

The track of *Gilbert* was, as near as makes no difference, a great circle for the entire 4500 km of forward motion, with no more than a 5 km diversion to left or right. This was very nearly unique among two thousand catalogued hurricanes in the western hemisphere. This feature is clearly related to its size and power. Normally, a hurricane, whose vector of forward motion is directly aligned with Jamaica's west-north-west/east-south-east spine of mountains, is deflected to north or south of the island by the fairly powerful standing 'bow wave' in the easterlies. Not *Gilbert*. One may say that Jamaica was just overwhelmed.



Photograph by J. Tyndale-Biscoe

Damage to a chicken farm near Gutters, Jamaica, 15 September 1988

The most extraordinary characteristic of *Gilbert* was its size. It was far and away the largest cyclonic system ever observed in the western hemisphere tropics, and among the very largest in meteorological history in any tropical sector, out-rivalling the 'super-typhoons' of the north-west Pacific (Figs. 1 and 2). As early as 10 September, when still a depression about to be named, it had a circulation covering 25 degrees of latitude and 20 of longitude, and was drawing moist air from as far away as the central Amazon. At apogee, just after its turbulent exit from Jamaica, *Gilbert* had totally eliminated the ITCZ[3] from more than a sixth of the Earth's equatorial circumference. The huge, greedy vortex was being fed moist air by its attendant convergent spiral rainbands from a vast, super-heated area of ocean and land extending from south of Acapulco, Mexico to Ciudad Guyana in eastern Venezuela, and from central Florida to northern Ecuador and the Galapagos Islands. The radius of the entire system at that time averaged 1750km. Some 1.4×10^8km^3 of buoyant warm air of equatorial provenance was involved in *Gilbert*'s circulation.

If the computations of Lane (1966) and Riehl (1979) are anything near to reality, then we are dealing with an 'engine' producing a total of 3.8×10^{19}joules of energy or a similar output to the greatest explosive volcanic eruptions such as Thera and Krakatoa. Put another way, if the power generated by *Gilbert* in its passage over Jamaica could

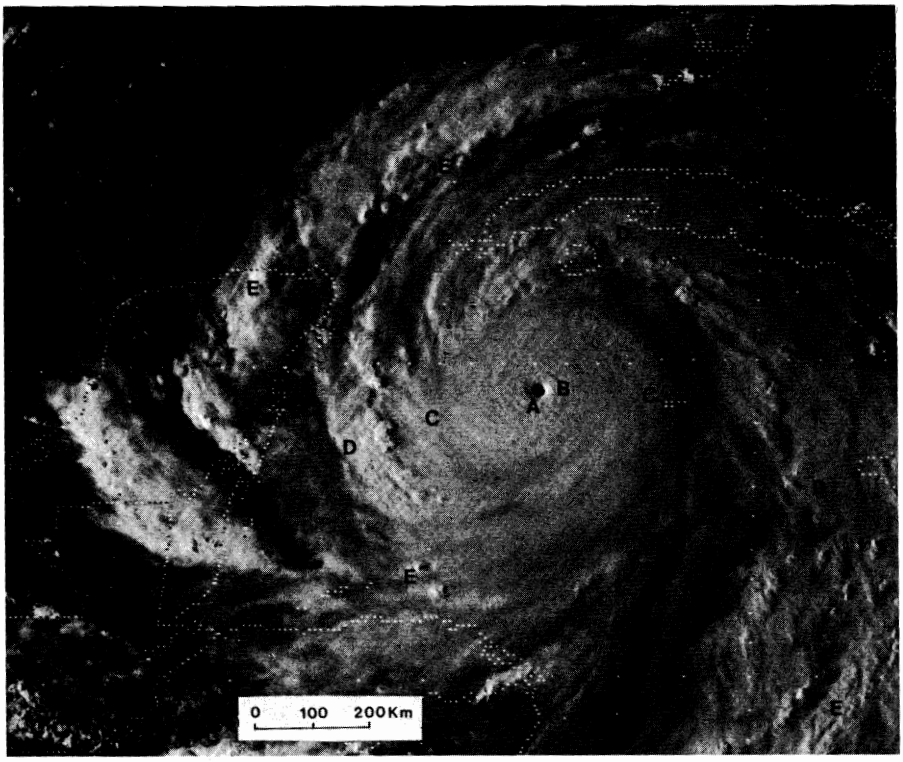


Fig. 1 NOAA *Satellite image of hurricane* Gilbert *13 September 1988, 2200GMT, where* **A:** *Eye, 20km diameter;* **B:** *Wall cloud, sustained winds 86ms^{-1};* **C:** *Circumference of hurricane winds 35ms^{-1};* **D:** *Circumference of tropical storm force winds 17ms^{-1}; and* **E:** *Spiral rainbands with convective towers to 16km altitude.*

[3] ITCZ: Inter-tropical convergence zone

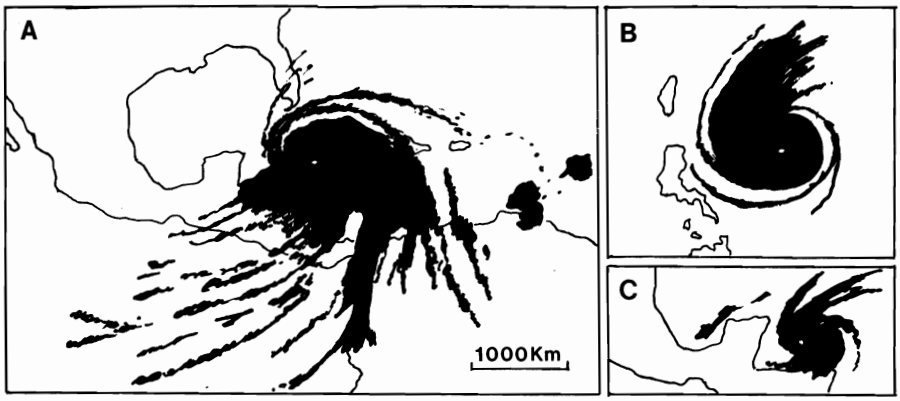


Fig. 2 Comparison on same scale of (a) Hurricane Gilbert *13 September, 1500 GMT; (b) Pacific 'super-typhoon' November 1967; (c) Average Caribbean hurricane, 1983.*

somehow have been fully harnessed (and stored!) it would have provided power for the country for the next thousand years or for Great Britain for eight years.

Gilbert was also among a few front-runners as one of the very wettest synoptic systems ever seen and experienced in modern times. Its leadership in this category was masked by the fact that more than 95 per cent of the generated precipitation fell on the sea. But its dousing of Jamaica and the Monterrey region of Mexico (where 200 deaths directly resulted from the very intense rainfall) is a small indication of *Gilbert*'s remarkable capacity as a rainmaker. Fig. 3 indicates the precipitation pattern for Jamaica approximating the actual passage of the hurricane core across the island on 12 September. Most of this occurred during an 8-hour period; values should be more than doubled as a measure of precipitation from the entire system including the spiral rainbands. Raingauges from Sarasota, Florida to Panama, and from Puerto Rico to Monterrey recorded precipitation in the range 260–500 mm d^{-1} which corresponds in intensity with other hurricanes (Riehl 1979, Simpson and Riehl 1981). However, the number and extremely large surface area of individual convective cells embedded in the spiral bands, particularly the intermediate ones as indicated by heavy radar echoes, and the narrow bands of divergence between the bands, ensured that *Gilbert*, during its six days over water, guzzled and regurgitated over the Caribbean and environs something like 1.69×10^{12} cubic metres of water.

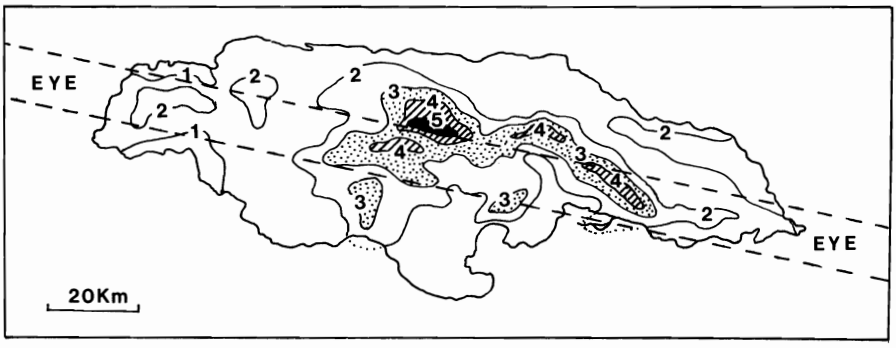


Fig. 3 Estimated precipitation (in hundreds of millimetres) in Jamaica 1400 to 2300 GMT 12 September 1988 during passage of the eye of Gilbert *across the island.* (Based on data from Calvin Gray, Climatologist, Jamaica Meteorological Service, Kingston, with grateful acknowledgement.)

To scoop up and precipitate all this water must have required the concentration into the storm system of the water vapour from a rectangle of ocean surface of temperature >27°C of size 5000km by 2000km, evaporating at 40mmd^{-1} for at least four days prior to and during the storm – which is why the ITCZ vanished!

There was only one aspect in which *Gilbert* was unexceptional. The Office of Disaster Preparedness in Jamaica was expecting a record storm surge to hit the coastal town of Portmore (population 80000) and actually initiated evacuation, but it did not occur. The eye passed north of the town, so that it passed beneath the left forward quadrant, where the hazard is much less. Only between Morant Point and Hector's River, in extreme eastern Jamaica, did storm surge occur, and then it was attenuated by offshore bathymetry and coastal topography.

For Jamaica at least, *Gilbert* was a record-breaker, the kind of storm whose return period is in fact virtually incalculable since there are no previous records of such an event. Inevitably, questions are being raised: was *Gilbert* the first of a new breed of super-hurricanes that with the greenhouse effect and global warming we shall see more of in the not too distant future? Evidence of the presence of such visitors in the early Holocene is not lacking in Jamaica.

Riehl (1979) has a fascinating speculation about why weather in the temperate latitudes is mainly a train of vortices, somewhat in excess of a thousand a year, separated by anticyclonic hiatuses, while in the tropics the steady state is a patchwork of relatively mild and stationary (albeit very wet) convective cells with only maybe fifty to a hundred aberrant vortices roaming around each year. Is there a thermal threshold to go beyond which the tropics (5 to 20 degrees north and south) will also reorganize into trains of super-storms separated by dry and sunny hiatuses? Time will tell.

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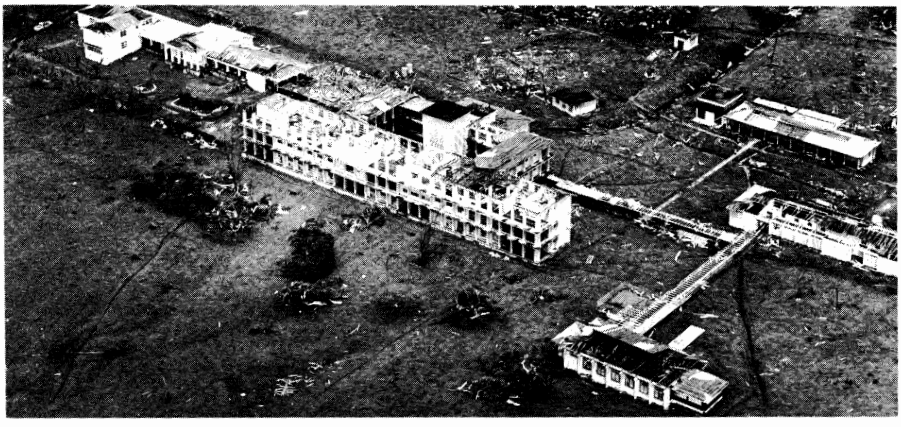

Photograph by J. Tyndale-Biscoe

Damage to Princess Margaret Hospital, Morant Bay, Jamaica, 15 September 1988