

LATE 19TH CENTURY TROPICAL STORMS AND HURRICANES IN TUVALU

R.F. McLean

Department of Geography and Oceanography
Australian Defence Force Academy
Canberra, ACT
Australia

Doug Munro

School of Humanities and Social Science
Bond University
Gold Coast, Queensland
Australia

ABSTRACT

During the late 19th Century at least four tropical storms were experienced in Tuvalu, only one of which (February 1891) is included in historical and contemporary summaries of southwestern Pacific hurricanes. Eyewitness accounts or first reports of traders, missionaries and naval officers who visited the archipelago during the 1880's and 1890's have been used to identify three other storms in February 1881 (Niutao), December 1883 (Funafuti and Nukulaelae), and March 1886 (Nukulaelae). Descriptions of the local weather or impact of the four storm events are given, but historical records provide insufficient evidence to detail tracks and intensities. Other problems associated with reconstructing the precise dates and storm extent are discussed. The addition of three more storm events in the 1880's to the three commonly reported as having occurred over the following century (February 1891, January 1958 and October 1972) suggests that either low latitude storms are more frequent than previously believed or that during the decade 1881-1891 there was an unusually large number of storms in the Tuvalu region.

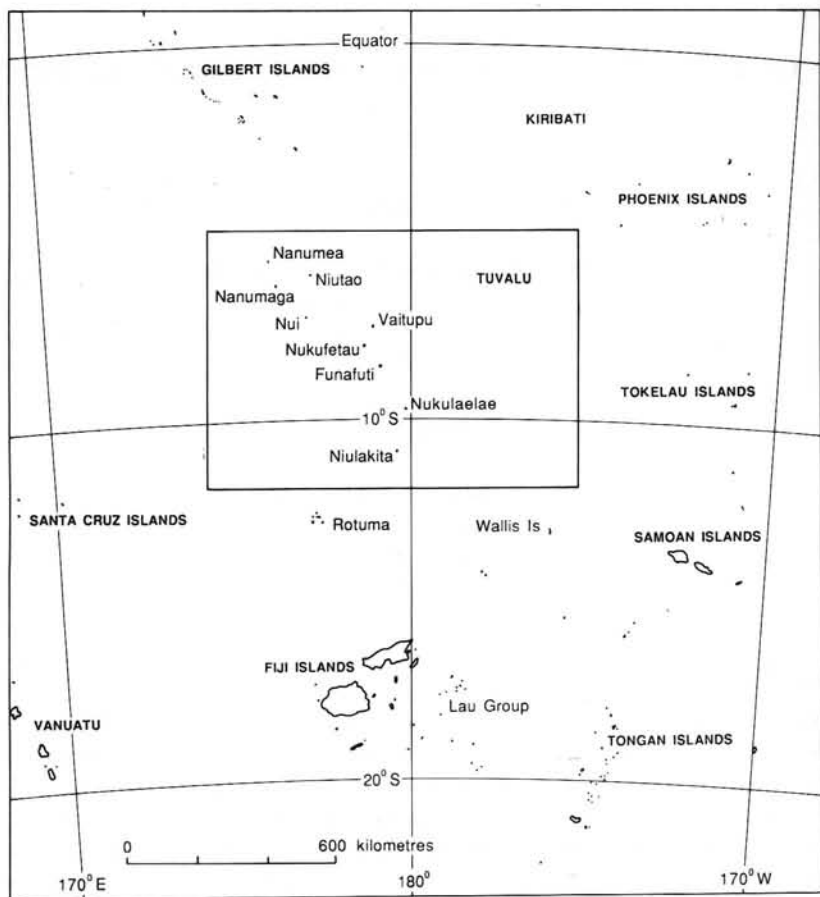


Figure 1. Location of Tuvalu in relation to adjacent island groups in the southwest Pacific.

INTRODUCTION

Storms of hurricane intensity are rare, but not unknown, in low latitudes. In a study of seasonal patterns and frequency of low latitude cyclones Brunt (1969) pointed out that their small size together with the sparsity of reporting networks in most equatorial regions would contribute toward the lack of data on such phenomena in the pre weather-satellite era. In addition, it is obviously very difficult to determine when a vortex reaches an intensity sufficient to produce sustained winds of gale force (34 knots) and above if it is located over an oceanic area of low network density as in the mid-Pacific. Lack of data also stems from the fact that frequently consulted lists of tropical cyclones - particularly those dealing with historical sources - are not always complete as their compilers and users readily acknowledge. The absence of data in such volumes does not necessarily mean that descriptions of relevant events do not exist. For areas of high cyclone frequency, a single occurrence may make little difference in computing expected frequencies and trends, but in low latitudes, particularly in the southern hemisphere, a single event takes on greater significance.

Tuvalu comprises nine coral atolls and reef islands situated between 5° 40'S and 10° 45'S in the southwest Pacific (Figure 1). The group thus lies just to the north of the southern hemisphere's 'hurricane belt', and although tropical cyclones occasionally begin to develop close to Tuvalu (most south of latitude 9°S), Thompson (1987, p.8) notes that "it is very rare for them to become storms while in this area." Yet tropical cyclones, however infrequent, do occur in Tuvalu, with the depression following Tropical Cyclone OFA, which formed in the region on 31 January 1990 and caused extensive damage on Vaitupu, being a timely reminder of this fact.

But the most recent major event was Hurricane BEBE which devastated Funafuti atoll in October 1972. Hickman (1973) described BEBE as a notable storm for a number of reasons including the fact that it occurred so early in the season (October), that it reached hurricane force in an unusually low latitude, about 8°S, and that the "only previously recorded hurricanes in the Ellice Group occurred in 1891 and 1958" (p.35). Similar comments are made in Bureau of Meteorology (1975, p.92) and by Baines, Beveridge and Maragos (1974, p.495) who refer only to Funafuti and who earlier claimed that "On the basis of accurate historical records, Bebe was only the third severe storm to strike Funafuti Atoll during the past 140 years" (Maragos, Baines and Beveridge, 1973, p.1163). And, recently Thompson (1987) confirmed that there have been three known tropical cyclones to result in serious damage to Tuvalu; these occurred on 18 February 1891, 2 January 1958 and 19 October 1972.

In the light of these comments the purpose of this paper is:

- (i) to describe a number of hurricanes or tropical storms that occurred in Tuvalu in the late 19th Century;
- (ii) to assess records relating to the 1891 hurricane which is the only event generally recognized as having occurred during this time;
- and (iii) to evaluate the historical records commonly consulted by contemporary authors to obtain summaries of hurricanes, and in turn trace the sources of this information.

Wherever possible, eyewitness accounts or first reports are quoted at some length, in order to provide details for the reconstruction of storm tracks and intensities, and information regarding geomorphic, biotic, economic and social effects. Regrettably, the reports are frequently inadequate for these purposes.

1881 FEBRUARY - NANUMAGA

Writing to his mother from the northern island of Nanumaga (6° 17' S, 176° 19' E), on the 21st of February 1881, Louis Becke, a trader on the island, reported that a hurricane had levelled his trading station on 2 February. Becke's letter is quoted below in part, but for the sake of clarity his erratic punctuation and occasional spelling error has been corrected.

... on the 2nd of this month my station was destroyed by a hurricane ... For nearly two months past it had been blowing heavily from the westward, but on the 1st the wind fell and the sea made a curious sound like the bellowing of some beast. Next day it commenced to blow and my anxiety was great lest the house would give way, but although it withstood the force of the wind it succumbed to a new and unexpected danger. At three o'clock in the morning it then being pitch dark and raining and blowing furiously and dead low water ... with a strange roaring sound the sea rose up like a wall and dashed over the reef in one mighty wave and swept up into the village, sweeping away fifteen houses like chaff. The next wave dashed into my front room and filled it with coral rocks and sand ... the wind was at its height and the sound it made was like the droning of countless flocks of bees, and sea after sea rolled up into the village. In a few minutes my house, trade house, copra house, pig houses etc. were things that had been, and were piled up without much regard for regularity in a heap, together with sundry drowned pigs and other livestock. The next wave they went away with the sea together with a few other houses ...

Becke (1881) concludes his letter by saying that "some hundreds of thousands of young coconuts have been destroyed" and that the inhabitants said "it is 35 years since such a storm as this visited the island." Much of this account is also quoted in Day (1967, p.34).

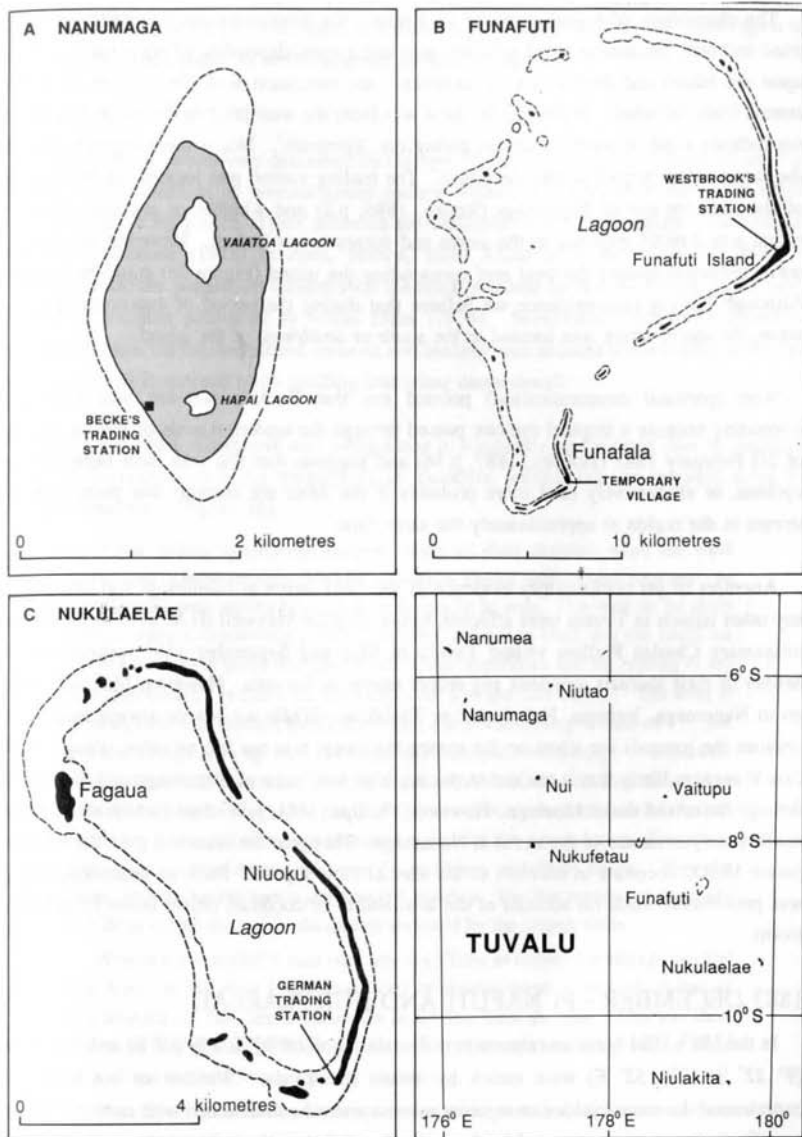


Figure 2. Key location on islands that experienced hurricanes in the late 19th Century in Tuvalu

The chronology of events outlined by Becke - the forerunner swell, commencement of wind and rain, increase in wind velocity, seas and surges, deposition of coral rocks and sand upon the island and destruction of coconuts - are consistent with descriptions of tropical storms from elsewhere. Although the wind was from the west prior to the storm, Becke does not indicate wind or wave directions during the 'hurricane'. Nor is there any evidence that the storm centre passed across the island. The trading station was located on the west side of the southern end of Nanumaga (Rooke, 1886, p.2) and whether or not this part of the island was directly exposed to the storm and surges is not known. However, considerable wave refraction around the oval reef surrounding the island (Figure 2a) could be expected. Although lacking firm evidence we believe that during the period of maximum wind and wave, the storm centre was located to the south or southwest of the island.

Kerr (personal communication) pointed out that Becke's account was particularly interesting because a tropical cyclone passed through the eastern islands of Fiji on the night of 2/3 February 1881 (Holmes, 1887, p.36) and suggests that this may have been the same cyclone, or alternatively (and more probably if the dates are correct) that there were two storms in the region at approximately the same time.

Attempts to get confirmatory evidence of the 1881 storm at Nanumaga and determine if any other islands in Tuvalu were affected, failed. Captain Maxwell (H.M.S. *Emerald*) and the missionary Charles Phillips visited Tuvalu in May and September 1881 respectively, but neither of their journals mentions any recent storms in the area. However, Maxwell did not go to Nanumaga, Vaitupu, Nukulaelae or Niulakita. While we cannot always assume that because the journals are silent on the matter the storm was not felt on other islands, in this case it appears likely that it tracked to the south or southwest of Nanumaga and did not pass through the rest of the archipelago. However, Phillips (1881, p.14) does furnish some indirect confirmatory evidence of the storm at Nanumaga. That year the islanders gave their Samoan pastor 10,000 coconuts in addition to his normal cash stipend. Such an unprecedented gift was presumably made on account of the availability of coconuts blown down by the recent storm.

1883 DECEMBER - FUNAFUTI AND NUKULAEAE

In the 1883-1884 hurricane season both Funafuti atoll (8°30' S, 179°10' E) and Nukulaelae (9° 22' S, 179° 52' E) were struck by severe hurricanes. Whether or not both atolls experienced the same cyclone or separate events cannot be determined with certainty because specific dates are not mentioned in the main descriptions. However, there is circumstantial evidence to suggest that the same storm affected both atolls in December 1883 and intuitively we believe this is the case. The unsatisfactory nature of the historical records in attempting

to reconstruct cyclone occurrences, dates and paths, a point which will be elaborated upon in a later section of the paper, is well illustrated in this instance.

1. *Funafuti*

The hurricane is evocatively described by George Westbrook, a trader on Funafuti atoll at the time, in a collection of reminiscences mostly written 45 years after the event when Westbrook was in his sixties. Three accounts are available. The first, an original manuscript typed by Westbrook (1928) in Apia, Samoa, titled *Alone in a hurricane* and dated 1 December 1928; the second, an unpublished manuscript edited by R.A.K. Mason (n.d.); and, the third an account published by Julian Dana (1935). Westbrook's original manuscript provided the basis for the two edited versions and because this account is not readily available it will be quoted from here (with spelling and other corrections).

In December 1883, Westbrook was living alone in Fongafale on the main islet of Funafuti, the rest of the population being temporarily on Funafala, another islet on the atoll some 14 km to the southwest (Figure 2b).

It was getting towards the eleventh week [of their absence] when the wind commenced to blow strongly from the westward, getting stronger and stronger. At night the stars were shining bright and not a cloud to be seen. This went on for about 36 hours when it commenced to rain in torrents, and got so black that one could not see very far even in broad daylight. From former experience and the reading of my glass [barometer], I realised that we were in for a proper hurricane . . . The wind in the mean time was blowing harder than ever, and it was raining in torrents . . . fine sand was being blown up from the beach and penetrated everything . . . trees were blowing down in all directions. First my copra-house went, then my cook-house, then the roof of my house was blown flat . . . The other houses on the beach side had all been blown down, and were soon all buried up in sand like a snow storm. Everything went, church, school-house, missionary's residence, and Fono house. With the church, nothing but the bare walls were left standing. The few houses not destroyed were those on the lee side of the church sheltered by the church walls.

When there was a lull I went with [my dog] Toby to inspect the damage that had been done. In one place I saw about sixty or seventy coconut trees which had all been snapped off like carrots about five or six feet from the base. This was most unusual as they generally blow right over, on account of there being such a small depth of soil on these low lying coral islands.

I had barely got home again when the wind which had died off almost to a calm commenced to freshen again, and in a few minutes it blew harder than ever from another quarter [the north according to Dana, 1935, p.226]. I was more sheltered than

when it was blowing broad-side on, but it took some of the huts that had been sheltered by the walls of the church.

The place was certainly a terrible mess, and I suppose it was the most disastrous hurricane the island had suffered from in memory. It was quite unusual to see heavy seas breaking on the beach inside the lagoon. During the night between lulls there were some heavy squalls, and one would think that hell had been let loose. I was fagged out and dropped off to sleep . . . when I woke up the sun was out and the sky was clear.

The next morning a German man-o-war anchored in the lagoon . . . The ship was the *Hyaene*, Capt. Geisler, and was from Samoa bound to the Marshall Islands with Dr Stuebel, German Consul from Samoa aboard. [Westbrook, 1928, p.4-5]

The date of the *Hyaene's* arrival at Funafuti was 25 December 1883 (Geisler, 1884, p.1), which if Westbrook's report is correct, dates the hurricane 23-24 December 1883.

Westbrook then goes on to say that two canoe loads of people arrived that night, and were quite surprised to see the state the place was in. On the island they had been (Funafala) "they had experienced a blow, but not of severe hurricane proportions" (Westbrook, 1928, p.6). According to Geisler, the people came back from Funafala on the evening of 28 December after being delayed by bad weather during the last few days.

The falling barometer, rain and gusty winds, increase in both wind velocity and rainfall intensity then lull for two and a half hours followed by a change in wind direction and increase in strength before subsiding to squally conditions and finally clearing skies, leave little doubt that the hurricane crossed Funafuti island. But the location of the storm centre and the direction of its track are less clear. The initial westerly "broadside" winds, and movement of sand from the lagoon beach on to the island, suggest that the centre was then to the south of the village from where Westbrook was observing (Figure 2b), though it is not clear whether the winds were directly from the west or from the northwest or southwest. Any of these three directions would result in the generation of waves across the lagoon sufficient to move sand on to the island. Nor is it clear where the storm tracked after the lull. A shift from southwest to northerly winds gives a likely south of west movement. However, we cannot place much reliance on Dana's statement that the wind was from north after the lull. Also, the fact that the storm apparently was not so severe on Funafala also presents problems, though this area of the atoll is much less exposed, being sheltered in the west, north and south by an almost continuous chain of islets and by a shallow lagoon with limited fetch.

While we cannot completely accept that "the description of the hurricane is perfectly true as related" as stated in a footnote to his manuscript (Westbrook, 1928, p.7), a brief second

report on reconstruction after the hurricane is available. In 1884 the London Missionary Society's barque John Williams III paid its annual visit to Tuvalu and called at Funafuti on 19-22 July. Charles Phillips, the L.M.S. missionary on board reported that:

The hurricane had also been felt severely here but not so as to produce any famine. The roof of their large fine church was blown away while a small church was very much shattered. The latter had been repaired and the former they were engaged upon when we arrived. Twenty-six households also disappeared but were speedily replaced. [Phillips, 1884, p.14]

2. *Nukulaelae*

Phillips first mentions the hurricane in the section on Nukulaelae, which he visited on 25th August, 1884. Nukulaelae atoll is located some 130 km south of Funafuti. Phillips reported:

In the early part of the year a severe hurricane - quite an unusual occurrence in these latitudes - had swept over this and neighbouring islands. But it had done its worst here. The teacher's house had been blown down...A great many of the houses had also been destroyed. A tidal wave had also swept completely over the island swamping and completely ruining their plantations. Trees had fallen extensively and as their coconuts were soon exhausted gaunt famine was staring upon them. Happily the land on the opposite side of the lagoon had not suffered so extensively so they were able by purchasing the nuts from the foreigner to whom the land was leased and by extensive fishing keep themselves alive. The foreigner himself had lost (?) 0,000 lbs of dried Cocoa Nuts; 3000 lbs of Beche le Mer and eleven houses, all being swept into the sea [Phillips, 1884, pp.12-13]

(Cf. Munro, Iosefa and Besnier, 1990, p.38.)

Apart from the destruction of houses, pulaka pits and coconut trees and the dramatic socio-economic and nutritional effects on the population, the main points from this report are that a wave swept over the island and that degrees of damage differed on islets around the atoll although all were affected. Because the Islanders had 'summer' and 'winter' residences on both sides of the atoll, we cannot be certain which was occupied when the hurricane struck (Figure 2c). When H.M.S. *Espiegle* visited in May 1883, a few months before the hurricane, Fagaua islet was deserted and the Samoan missionary and King resided on Motuloa. The trader's station was at the "southern end of the largest island" (Le Hunte, 1883, para.4) or "Nukulailai proper" (Bridge, 1883, p.1), now known as Niuoku. If this was still the situation when the hurricane struck then the zone of maximum damage was over the northern half of the atoll with lessening effects from west to east. The fact that the plantations (pulaka pits) were swamped and ruined supports this view, as these were mainly located on the

northwestern islets of Motuloa and Fagaua. It is thus likely that the storm tracked from north to south to the west of the atoll.

Although we cannot be certain that both Nukulaelae and Funafuti experienced the same storm, it does appear most likely, as Phillips (1884, p.12) noted that the hurricane "had swept over this (Nukulaelae) and neighbouring islands." In this case, if our deduction is correct, that the hurricane was felt at Funafuti on 23-24 December 1883, then it is likely that it was experienced shortly thereafter on Nukulaelae, and not in the early part of 1884 as mentioned by Phillips and by Newell, the missionary who visited Tuvalu the year after Phillips. With reference to Nukulaelae, Newell (1885, p.12) wrote: "Owing to the hurricane last year food had been scarce and all the money the people had was taken to Funafuti to buy cocoanuts to eat."

However, the possibility does remain that there was not one, but two, hurricanes in the 1883-1884 season, one in December (Funafuti) the other in the 'early part of 1884' (Nukulaelae). Further support for the December 1883 event has been given by Kerr (personal communication) who, based on reports in the Fiji Times (29 December, 1883) and in Holmes (1887) suggested that a "tropical cyclone passed southward to the west of Fiji on the night of 27/28 December. Although it is not too easy to fit the portions of track together I think this could be the same cyclone [as the one that earlier struck Funafuti and Nukulaelae]."

1886 MARCH - NUKULAEAE

The sources reveal that Nukulaelae was struck by another hurricane just over two years later. In the last days of May 1886, H.M.S. *Miranda* called at the island and its captain reported:

The huts and coconut trees suffered severely in the hurricane on 17th March or 18th March 1886. All the inhabitants are now living on Fangaua [Fagaua] Island, which did not suffer from the hurricane as much as Moluloa [Motuloa] Island, their former home. [Rooke, 1886, p.10]

Part of this statement was incorporated in the British Pilot (2nd edition, 1891, p.232). Brief mention is also made of this event in the journal of the missionary, Wilson (1886, p.6): "Though the people had suffered severely from the effects of a hurricane in March last, they had this year contributed to the funds of the L.M.S. \$40.00."

Despite their brevity, these two independent reports suggest the occurrence of a hurricane. While there are no reports of this storm from other islands in Tuvalu, it is likely that the hurricane tracked in a southwest direction to pass close to Rotuma (12°39' S, 177° 02' E), 250

km SSW of Nukulaelae (Figure 1). Referring to his visit to Rotuma, Rooke (1886) mentions the hurricane twice: "...in consequence of the fruit crops having suffered heavily from the hurricane of March 17th food is somewhat scarce" (p.3) and "A hurricane of 17th March this year did a great deal of damage to the fruit trees, also blew down several houses and some churches" (p.9).

In view of the distance between Rotuma and Nukulaelae and the fact that Rooke visited Rotuma first, it is likely that storm was felt at Nukulaelae on the 14th-15th March rather than the 17th or 18th March. This storm is clearly a different event to the hurricane which struck Fiji on 3rd-4th March 1886, which had its origin to the north-west of Wallis Island (Holmes, 1887).

1891 FEBRUARY - ELLICE GROUP

The three hurricanes described above have not been reported previously. Not so, however, the 1891 event which has been noted by Hickman (1973, p.35), Baines, Beveridge and Maragos (1974, p.495), Wiens (1962, p.474), Thompson (1987, p.8) and others. The most frequently quoted secondary source is Visher (1925) in which the following entry is included in his pioneering work on tropical cyclones of the Pacific: "1891, February 18; hurricane (severe): entire Ellice Islands devastated" (p.41). An equivalent, but not identical entry, appeared in Visher and Hodge (1925, p.51). The sources referenced by Visher include both the British and American Pacific Islands Pilot (e.g. Great Britain, Hydrographic Department, 1918, Vol.2, p.558; U.S. Hydrographic Office, 1920) which contain the same entry: "The Ellice Group in February 1891 was almost devastated by a severe hurricane, during the lifetime of the oldest inhabitant this is the only one that has ever occurred."

This item first appears in the British Pilot, 3rd edition 1900, and continued unchanged until the 7th edition 1943. It is a verbatim quotation of the original source, the official report of Captain Davis (1892, p.46) who visited Tuvalu in H.M.S. *Royalist* in July and August 1892. It is perhaps a pity this particular quotation was selected for the Pilot, as the second part of the sentence, based only on hearsay, is misleading. It would have been preferable to use the other quotation from Davis' report which has no historical connotation: "In February 1891 the group was visited by a Hurricane, which destroyed many nut trees and nearly washed the houses away" (p.60). Regrettably Davis does not expand on the hurricane or its effects, nor does he specify the islands it visited or the actual date in February.

We have attempted to get confirmation and further details of the 1891 storm, but without success. The 1891 missionary report has eluded our searches, but none of the other reports we have seen of naval captains, missionaries, or government officials who visited the islands

in the years 1891-94 mention the hurricane, either directly or indirectly. Neither the Fiji Times (8, 15 April 1891) nor the Samoa Times (17, 28 February, 1891) mention the Ellice Islands in their account of a hurricane which was experienced at Uvea (Wallis Islands), Lau Islands (Eastern Fiji) and Tonga in February 1891. Whether or not this was the same event as that described by Davis (1892) in the Ellice is not certain, although Visher (1925) indicates it is: "1891, February 18-19: Lau, severe in Ellice island and Tonga; southwest, southeast" (p.34). And, Brunt (1969) notes that: "Maps of the western Pacific Ocean in Meteorological Office (1947) show that at least one cyclone (February 1891) commenced between the Gilbert and Phoenix Groups at about 3°S, 176°W" (p.70).

We are left with quite unsatisfactory evidence as to the extent and effects of the February 1891 hurricane in the Ellice Islands, and yet, paradoxically, this remains the only frequently referenced cyclone for the Group. Our suspicion is that the entire Ellice Islands were not devastated, as Visher (1925, p.41) believed they were. It should be recalled that the primary source, Davis (1892) said "almost devastated" and "nearly washed the houses away." Moreover, in both references Davis refers to the Ellice Group and we cannot be certain whether he meant the entire Ellice Islands, or just the islands of Funafuti atoll which had been known as "Ellice Group." Surprisingly, there is no direct mention of the 1891 hurricane in any of the numerous papers from the three scientific expeditions to Funafuti atoll, 1896-98 (e.g. Royal Society, 1904), although Hedley (1896) does state: "Hurricanes seldom occur, but a few have impressed their memory upon residents" (p.19). Regrettably, Hedley does not expand upon this comment. And, although Mrs David (1899) notes: "There are ruins of a fine coral cement church on Funafala; one side of the roof of it was destroyed by a hurricane a few years ago" (p.257) she does not give a specific date for the hurricane. Thus, the 1891 event remains somewhat of an enigma.

NATURE OF HISTORICAL SOURCES

It is clear from the preceding comments, that the historical sources leave much to be desired. The basic data is fragmentary and incomplete, often non-specific as to location and date, and sometimes erroneous or misleading. Constant cross-checking of 'facts' is required. Eye-witness accounts are rare, second-hand reports more common. Such is the nature of our sparse sources. From this data four hurricanes occurring in February 1881, December 1883, March 1886 and February 1891 have been described. But it would be wrong to assume that because the records are silent, no others occurred in Tuvalu during the late 19th Century. The 1881 hurricane for example is not mentioned in the report of the missionary (Phillips) who visited Nanumaga eight months later, presumably because there was no visible sign and perhaps also because no one bothered to inform him. Alternatively, he may have known but not thought it worth recording. Nor did Becke mention the event in an autobiographical

fragment of his residence at Nanumaga during 1880-81 (Becke, 1909 pp 54-104). In other words, had Becke not written that letter to his mother and had the Becke Papers not subsequently been preserved, we would be none the wiser of the 1881 storm on Nanumaga.

The incompleteness of the written records are also revealed by the report of the missionary (Newell) who visited Tuvalu eighteen months after the 1883 hurricane. The Nukulaelae section of his report mentions the hurricane whereas the Funafuti section does not, a possible reason being that Funafuti had recovered from the disaster whereas the people of Nukulaelae were still feeling its effects and could not afford to give any donation to their Samoan pastor or to the London Missionary Society. Nor does the captain (Moore) of H.M.S. *Dart*, which visited Funafuti only four months after the event, make any reference to a recent hurricane.

Then there is the problem of faulty evidence. There is no need to doubt any part of Becke's letter to his mother regarding the 1881 hurricane but his later (and more accessible) writings on the matter leave much to be desired. Also, one may well demur at accepting Westbrook's account of the 1883 hurricane as final proof on the grounds that his book of reminiscences is not notable for its factual accuracy; it was mostly written in the 1920s, forty years after the alleged event, when Westbrook was in his sixties, and the circumstances surrounding its publication are a shade dubious (Munro, 1972). Fortunately, however Westbrook's descriptions are confirmed in the essentials by other evidence.

Dates have also proved a problem. For instance, for the 23-24 December 1883 storm, the date is deduced from Geisler's report on when *Hyaene* was at Funafuti. Westbrook only mentions the year, 1883, and not month, while the missionary Phillips' account states the hurricane was in the 'early part of the year' (1884). And, as noted by Rodgers and Cantrell (1987) there are still some ambiguities surrounding the precise number and year(s) of storm event(s) in the early 1890s.

Turning to secondary source materials, other problems emerge. Entries in the frequently consulted Pacific Islands Pilot are normally based on ship reports, but the actual item selected for inclusion may not always be the most appropriate one. Earlier we pointed out that the reference to the 1891 hurricane in the Pilot was misleading, and that it would have been preferable to enter Captain Davis' other note reporting the event. The same entry was included in four editions of the British Pilot. On the other hand, the 1886 hurricane at Nukulaelae was mentioned in only one edition (2nd, 1891, p.232) thereby escaping the notice of later investigators, including Visher (1925).

Finally there is the vexed question of event definition, when using historical sources, a point discussed in detail by Kerr (1976) and Rodgers and Cantrell (1987). While we are satisfied that the storms described here equate with comparable events to those described as tropical storms or hurricanes by Kerr, we have rejected several late 19th Century reports which do not meet these criteria, including Westbrook's account of the wreck of the Tokelau at Niutao on New Year's Day 1887, which is described in three places as a hurricane (Dana, 1935, p.235-238).

CONCLUSIONS

During the late 19th Century at least four hurricanes were experienced in Tuvalu, only one of which has been previously reported in scientific literature (February 1891) and this is the one we have no eye-witness accounts of, nor much confirmatory evidence. Descriptions of each event have been presented as completely as the sources and space allow, but these details fall short for determining tracks and intensities with any certainty. They do, however, confirm the geomorphic role of catastrophic storms in island building and the fact the ecologic and socio-economic effects were extremely severe.

The addition of three storm events in February 1881, December 1883 and March 1886 doubles the number of known tropical cyclones in the Tuvalu region - February 1891, January 1958, October 1972 (Thompson, 1987). This record suggests that during the decade 1881-1891 there was an unusually large number of tropical cyclones in the region. This observation may be pertinent in connection with identifying temporal trends and variations in low latitude tropical cyclone frequencies over the long term.

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