

**COASTAL DAMAGE INSPECTION  
SOUTHWEST VITI LEVU, FIJI  
AFTER CYCLONE SINA**

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## OBJECTIVE

The objective of this report is to show the coastal changes which occurred on hotel beaches southwest Viti Levu, Fiji, because of the passage of Cyclone Sina on 27-28 November 1990. This was not a specific task on the SOPAC Work Programme; however, SOPAC member countries have an ongoing concern with coastal erosion and protection works. In response to this concern SOPAC conducted a coastal workshop in September 1990 during which several coastal development sites were visited. This report will complement that workshop by showing cyclone damage at the same sites which the workshop participants visited before the cyclone. This work was supported by the Canadian Government.

## INTRODUCTION

In September 1990, two months before Cyclone Sina, SOPAC had conducted a workshop which inspected and photographed several coastal sites on the west coast of Viti Levu (Figure 1).

On 27 and 28 November 1990, Cyclone Sina passed along a southeasterly track off the west and south shores of Viti Levu (Figure 2). On the evening of 27 November, there were hurricane force onshore winds on the west coast of Viti Levu. On the morning of 28 November, Sina moved southeast between Viti Levu and Kadavu and the south coast of Viti Levu was exposed to the onshore winds. Cyclone Sina caused wind and wave damage of varying severity along the west and south coasts of Viti Levu.

After the passage of Sina, it was suggested by Alfred Simpson of Fiji Mineral Resources Department that the same coastal sites, which were photographed at the September Workshop, be photographed again for comparison purposes. This was carried out on 1 December 1990.

## METHODS

Using some September photographs as a guide, on 1 December the writer photographed shoreline features at the Sheraton Hotel, the Regent Hotel, and the Fijian Hotel to show the coastal changes resulting from Sina. A brief description of the changes noted at these coastal sites is given below.

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For figures see from page 9 onwards

## RESULTS

### **Sheraton Hotel**

At the Sheraton Hotel, there is a south-facing, decorative, rock and mortar seawall with concrete cap slabs. After Sina, there was about 0.3 m more sand at the foot of the wall; however, the concrete cap slabs were knocked off some parts of the wall, and there was about 0.3 m eroded off the lawn behind the wall (Figures 3-9).

The Sheraton also has a large rock groyne running south from the western corner, (Figures 10, 11) where the shoreline turns about 90 degrees and runs northward. In September, this groyne had a build-up of sand on its updrift (eastern) side and a scarcity of sand on its western side. On the western side of this groyne, the shoreline runs northward for the remainder of the Sheraton property and was protected by a rubble (rock and gabion) seawall. After Sina, this shoreline was eroded from about 7 to 15 m and only remnants of the rubble seawall remained in a line along the beach (Figures 12-15). The area behind this seawall appears to have been landfill because of the fill debris evident in the eroded bank (Figures 13, 15).

### **Regent Hotel**

The Regent Hotel has beach frontage, with no seawall, and is located immediately northwest of the Sheraton. It appeared that this beach had eroded badly, because sand had been dumped at the edge of the lawn and a bulldozer was grading the beach on 1 December. Since restoration work had already begun, it was not possible to see and photograph the state of erosion following Cyclone Sina. A 15 cm plastic outfall pipe, which was exposed on the beach in September, was now broken and spilling onto the beach (Figure 15).

### **Fijian Hotel**

The Fijian Hotel has a small vertical log seawall on the seaward side of a narrow sandy spit. This seawall is in a bay and is relatively sheltered from the open ocean. The top of the logs are only slightly above high water and the wall was backfilled with sand against a plastic sheet. After Sina, there was some sand washed out behind the wall and one set of wooden steps was gone. Most of the damage in this area seemed to be wind damage to recreation equipment and associated structures (Figures 16-18).

## DISCUSSION

Beaches are basically shaped by waves. The particular shape of a beach is a result of the local wind and wave climate acting on the beach material over the local tidal range for a long period of time. A beach is dynamic and varies on a daily, monthly and yearly basis but is relatively stable on a long term basis. Most beaches have developed to their present state of equilibrium over the last several thousand years, since the last major sea level change. The natural slope and profile of a beach, from the beach berm to deep water, is a result of the wave climate acting over the range of water levels given by local tides and storm surges. Natural beach slopes are dynamically stable even though they may change considerably with the seasons and with major storm events.

Waves move any loose material on a shoreline up and down the foreshore with each successive wave impact. When waves impact the shore at an angle, the up and down movement of material becomes a zig-zag motion with a net component along shore. In this manner any loose material on a beach is moved alongshore in the same direction that the waves are moving. This longshore movement of material is called littoral drift or littoral transport. When the material moves into a sheltered area, such as a pocket in the shoreline or the back of a bay, the material gathers and a beach is formed.

Waves also move beach material onshore and offshore with the variations in wave climate. Shallow water waves (long crested low waves) move material onshore and build a beach. Examples of shallow water waves are swell waves and the gravity waves that are formed when large swell waves break on the fringing reef. Steep wind waves (short crested high waves) which occur during strong winds and storms tend to move material offshore. If the bottom slope is not too steep, an underwater bar will be formed a short distance offshore and this bar will be returned back to the beach by shallow water waves. Thus the beach is built up during periods of quiet shallow waves and is eroded and moved to an offshore bar during periods of storm waves. This onshore-offshore beach movement is usually cyclic with seasonal and storm events and enables the beach to adjust to particular wave conditions.

If material is removed from a beach by mining, or material is added for land reclamation, the beach slope will be reshaped by the wave climate rather than maintain a man-made artificial shape. If material is mined from a beach, the waves will attempt to re-establish the original natural slope by eroding the land until the removed material is replaced. If an area is reclaimed by landfilling, the waves will attempt to re-establish the original slope by erosion of the filled area. If the filled area is protected by a seawall, scouring will occur in front of the seawall. This process

will continue until a new stable beach slope is established in front of the seawall, or the seawall collapses. Natural beaches are much more stable and better able to withstand storm events than artificial structures such as seawalls.

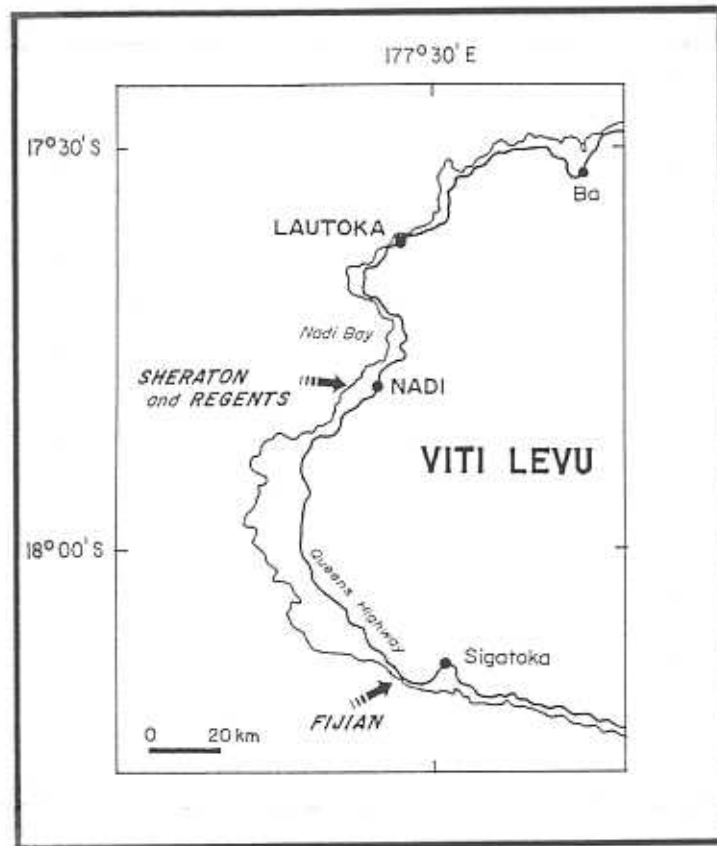
Vertical seawalls tend to reflect the incoming waves and sometimes cause a standing wave much higher than the incoming wave in front of the wall. This phenomena causes scour in front of the wall and the result is a beach which is lower than the original natural beach. The effect of this scour could be seen in September 1990 at the toe of the Sheraton seawall (Figure 5). The buildup of sand at the toe of this seawall after Cyclone Sina indicates that the storm waves did not hit the wall directly. The waves which impacted this beach must have been refracted and attenuated so as to be essentially shallow water waves. These waves also lifted the cap slabs off the wall and overtopped the wall to scour the lawn behind the wall Figures 6, 7).

Properly designed rubble mound seawalls are generally the best method of coastal protection. Proper design means having appropriately graded filter layers and adequately sized armour stone. The rubble mound seawall on the west side of the Sheraton was obviously not designed properly because it disappeared completely (Figure 14). On this side of the Sheraton the storm waves appear to have hit the shore directly because the material was removed offshore.

The vertical log seawall at the Fijian appears to have behaved in a similar manner to the vertical seawall at the Sheraton (Figures 16-18). An additional problem at the Fijian appears to be the mining of beach sand for use in developing the golf course. If sand is mined from a beach, the shoreline will try to adjust to achieve its original slope and profile.

If these hotel beaches had been left in their natural state with the natural gentle slope, it is probable that they would have sustained little damage. This is shown in the area east of the seawall where the natural beach slope has been left essentially unaltered except for scour at the end of the wall (Figure 4). A natural gently sloping beach is better able to absorb storm waves than a seawall. If the beach hotels had been built back (setback) from the natural boundary of the sea, there would likely be much less erosion damage (Holden 1987).

[8]



Site Map - Western Viti Levu



1990: Sheraton-Regent-Denarau Site  
Oblique air photo

Figure 1.

[TR148 - Holden]





September 1990: Sheraton seawall before Sina.



December 1990: Sheraton seawall - after Sina. Note the buildup of sand fronting wall.

Figure 3.



December 1990: Sheraton seawall - after Sina. Note scour around the east end of the seawall but the adjacent original natural beach slope is changed little.



December 1990: Sheraton seawall - after Sina. Note original natural beach east of seawall has an extra layer of sand and gravel after the storm.

Figure 4.



September 1990: Sheraton seawall - before Sina. Note under cutting of wall in foreground.



December 1990: Sheraton seawall - after Sina. Note buildup of sand fronting wall.

Figure 5.



September 1990: Sheraton seawall - before Sina.



December 1990: Sheraton seawall - after Sina. Note buildup of sand fronting wall and removal of concrete capstones.

Figure 6.



December 1990: Sheraton seawall - after Sina. Note: removal of concrete capstones and scouring behind wall.



December 1990: Sheraton seawall - after Sina. Note: scouring and broken capstones.

Figure 7.



September 1990: Sheraton seawall - before Sina. Note: scouring of bottom step.



December 1990: Sheraton seawall - after Sina. Note: buildup (0.5 m) of sand at bottom step.

Figure 8.



September 1990: Sheraton seawall - before Sina. Note: concrete slab toe protection in front of wall.



December 1990: Sheraton seawall after Sina. Note: sand buildup (0.5 m) flush with concrete slab and boulder (1 m diam.) upon concrete slab.

Figure 9.



September 1990: Sheraton groyne - before Sina. Note: buildup of sand and vegetation.



December 1990: Sheraton groyne - after Sina. Note: sand and vegetation scoured.

Figure 10.



September 1990: Sheraton groyne - before Sina. Note: sand and gravel path on top of groyne.



December 1990: Sheraton groyne - after Sina. Note: sand and gravel path is gone.

Figure 11.



September 1990: Sheraton west side - before Sina.



December 1990: Sheraton west side - after Sina. Note: about 10 m of erosion.

Figure 12.



December 1990: Sheraton west side - after Sina. Note: erosion and sand thrown up on lawn.



December 1990: Sheraton west side - after Sina. Note: erosion of lawn exposing irrigation pipes. Debris in bank indicates that this was reclaimed land.

Figure 13.



September 1990: Sheraton west side - before Sina. Note: poorly designed rubble mound protection.



December 1990: Sheraton west side - after Sina. Note: rubble mound protection is gone.

Figure 14.



December 1990: Sheraton west side - after Sina. Note: irrigation pipes exposed and debris in bank indicating reclaimed land.



December 1990: Sheraton west side - after Sina. Note: outfall pipe near Regent Hotel is broken and spilling onto beach.

Figure 15.



September 1990: Fijian Hotel - before Sina.



December 1990: Fijian Hotel - after Sina. Note: more scouring behind log seawall.

Figure 16.

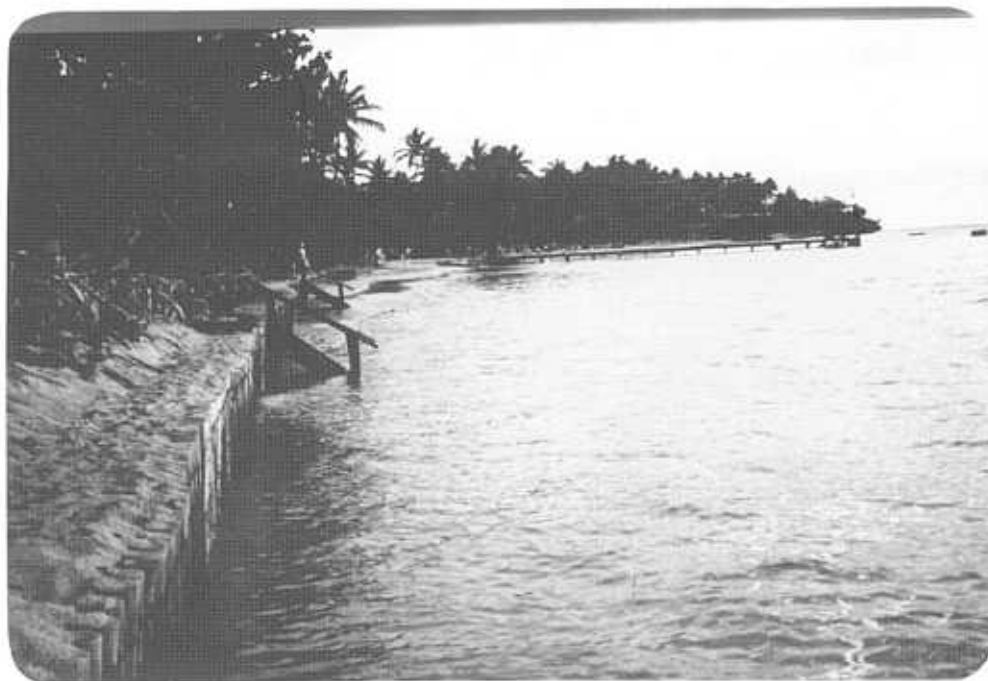


September 1990: Fijian Hotel - before Sina.



December 1990: Fijian Hotel - after Sina. Note: scouring behind seawall.

Figure 17.



September 1990: Fijian Hotel - before Sina.



December 1990: Fijian Hotel - after Sina. Note: sand scoured from behind wall.

Figure 18.