



**SOUTH PACIFIC SEA LEVEL & CLIMATE MONITORING
(SPSLCM) PROJECT III SURVEY VISITS TO
MANUS ISLAND, PAPUA NEW GUINEA**

5-18 May 2002

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South Pacific Sea Level & Climate Monitoring Project Phase III

SOPAC Trip Report 309

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ACKNOWLEDGEMENT

The survey team of Mr Steven Turner, Mr Brian Ratcliff and Mr Andrick Lal is really thankful to the Lands and Surveys Department of Papua New Guinea (Manus Island) for their kind support and help throughout this project especially Mr Joe and Mr Alsoi.

PROJECT BACKGROUND

The 20-year SPSLCMP [South Pacific Sea Level and Climate Monitoring Project] is funded by AusAID and technically supported by the [Australia's] National Tidal Facility (out of Flinders University) has entered its third, 5-year phase. This Project began in October 1992.

SOPAC was approached by the Australia Marine Science & Technology Limited (AMSAT), the agency set up to coordinate the SPSLCM Project in the region, to support the Project by way of sharing the costs of a suitably qualified and experienced “**Assistant Surveyor**” to directly support the routine surveying and monitoring in the South Pacific Sea Level and Climate Monitoring Project [Phase III]. SOPAC would also act as a regional data archive for sea level, CGPS with the related data; and assist in the maintenance of the sophisticated suite of equipment that are part and parcel of the Project.

This Project was set up to provide quality meteorological and sea level data through an array of latest climate monitoring stations, backed by the precise geodetic survey data; and a series of high-resolution sea level stations has been established in eleven countries of the South Pacific Forum with data transmission via satellites to the National Tidal Facility in Adelaide. Research and results drawn from analysis of this data is to assist Forum island countries with their sustainable development agendas.

A series of high-resolution sea level recording stations has been established in twelve countries of the South Pacific Forum with data transmission via satellites to the National Tidal Facility in Adelaide.



South Pacific Sea Level and Climate Monitoring Survey Sites.

OBJECTIVES

The South Pacific Sea Level and Climate Monitoring Project aims to help Pacific Island countries understand the implications and scale of sea level and climate changes. The AusAID-funded Project has the following objectives:

- a. Set up high-resolution monitoring stations in the South Pacific region to compute relative motions of land and sea at each station based in each of the twelve countries.
- b. Carry out a geodetic survey program to measure movements of the crust at other strategic sites in each country with respect to the reference station.
- c. Help identify changes to sea levels with reference to a similar network of stations in Australia and elsewhere in the world, whether these changes are due to thermal expansion of the ocean, contributions from land ice or changing properties of water from different ocean zones.
- d. Provide a measure of regional vertical controls and exchange information and data with national, regional and international climate change centres in relation to the ongoing international geodetic programmes, which incorporate satellite altimetry and radio astronomy.

The Assistant Surveyor was involved, during this survey, in Precise Differential Levelling activities according to the following objectives:

- To provide assistance in the collection and reduction of precise leveling data between the Sea Level recorders, benchmark arrays and CGPS receivers in the field as part of the South Pacific Sea Level and Climate Phase III Project being funded by AusAID.
- To monitor and identify changes to sea levels in the South Pacific that is due to thermal expansion of the ocean, glaciations from the land ice or changing properties in the continental plates between zones.
- To accomplish the above tasks by providing survey assistance to Mr Steven Turner, Geodetic Surveyor of National Tidal Facility [NTF], Australia to carry out Differential Precise Leveling Survey in the Project sites.

“**Precise Differential Leveling**” is being defined as the operation required to determine the heights of points on the surface of the earth in relation to a known point [benchmark] upon a vertical datum, whereby all possible sources of errors are identified and field procedures are adopted to eliminate or minimize their effect as possible. This survey satisfies the requirements of a **CLASS A** survey, the error accounted for should be less than $2\sqrt{k}$ where k is the distance to any station in kilometers. The survey team is constantly trying to eliminate errors and get misclosure to within $1\sqrt{k}$, which is even more accurate.

SURVEY TEAM

The head of the Surveys and Geodesy Department of the National Tidal Facility, Mr Steven Turner is our survey team leader. The other members of the team are Mr Brian Ratcliff who is the Senior Technical officer from the South Australian Lands Department and myself, Mr Andrick Lal, am the Assistant Surveyor for the Project based at the South Pacific Applied Geoscience Commission.

ACTIVITIES UNDERTAKEN

The precise differential leveling survey was carried out in the district of Lumbrum on the island of Manus in Papua New Guinea where the Tide Gauge is situated. This survey was carried out from the Sea Level Fine Resolution Acoustic Measuring Equipment [SEAFRAME] station to the Tide

Gauge benchmark and to the inland Primary Benchmarks, which are driven deep into the soil and along the temporary benchmarks.

The Benchmarks have the property of exceptional stability and are also established in very stable rock formations or in structures established on stable formations. These benchmarks are referred to in terms of Mean Sea Level datum/Tide Gauge Zero or in terms of a country's datum where each benchmark has their known heights in relation to the datum.

This is the routine 18-month precise leveling re-survey of this site where all deep benchmarks were found undisturbed and as per survey some movement of marks was detected.

Some of the holding marks were replaced and additional holding marks were placed in the network. As usual the in-county lead agencies and survey offices were consulted and visited such as Lands & Survey Department. There were no unexpected happenings during the survey. The survey report, which will detail all the results for this survey; is being processed by the Survey Team Leader Mr Steven Turner of National Tidal Facility. The post-processed survey report will be sent to me once completed.

This survey visit required a lot of traveling to reach the designated subject site as per itinerary (see Attachment), therefore I left Suva on Sunday 5th May 2002 at 0700 hours for Nadi from where I left for Brisbane, Australia at 1045 hours. I checked in at the Airport Heritage hotel, which is only ten minutes drive from the airport.

On Monday 6th May at 1445 hours I left Brisbane for Cairns and Mr Steven Turner and Mr Brian Ratcliff were on the same flight. We arrived in Cairns at 1730 hours with all our survey equipment and spent the night at the Tropicana Lodge. The following day we left for Port Moresby at 1125 hours and checked in at the Gateway Hotel for an overnight stay. We left for Manus Island at 0900 hours in the morning.

Upon arrival we hired a Twin Cab from the Avis Rentals and checked in our luggage at the Harbourside Hotel. After freshening up we left for the field, which is half an hour's drive.

The Tide Gauge is stationed at the Lumbrum wharf jetty. The area is an old campsite for the Australian and American Army during World War II. The old campsite now is a station to house refugees from Afghanistan being looked after by the International Migration Office, the Australian Government and the EUREST.

A reconnaissance survey of the marks was carried out on the same afternoon with the three old deep benchmarks located and the temporary benchmarks located. A total of seven new temporary benchmarks were placed. The aluminum screws were placed and glued into the concrete. After placing the survey marks we came back to the hotel.

Next day on 9th May we left Lorengau where Harbourside Hotel is located at 0830 hours and reached Lumbrum at 0900 hours. Along the way to Lumbrum we picked up Joe and Alsoi from the Survey Department in Lorengau. Lorengau is the main town of the Manus Island. Upon reaching the survey site we were issued with the entry passes because security guards, due to the presence of the refugees, protect the area. We started placing the three deep benchmarks in our survey network, which were driven into the ground about 5.40 meters deep.



The Tide Gauge on the Lumbrum Wharf at the Manus Island in Papua New Guinea with the surveying equipment (Digital Level & Invar Bar Coded Staff) in the foreground. In this photograph are Andrick with Joe and Alsoi of the Survey Department of PNG checking on the Tide Gauge.

The deep benchmarks are stainless steel rods in lengths of 1.40 meters, which are screwed together when being driven down into the ground to the hard substratum. Joe and Alsoi helped us place the marks. Placing involves pile driving them into the ground.

After placing the marks, cementing them and placing plastic covers over them, the team began the precise differential survey the same afternoon. We carried out the survey from the first benchmark to the inland benchmark on the parade ground and finished off the survey at 4.00 pm.

The following day we carried out the survey covering about 750 meters going backwards and forward. Also the survey was carried out from the tide gauge to the inland arrays. The weather was still not better than last time as it was rainy and cloudy but we continued our survey. The survey was completed to the reference marks and PNG CGPS benchmarks. We took a break from the fieldwork at 4.00 pm and left Lumbrum for Lorengau.

On the Saturday, 11th May, we carried out about 1.5 kilometers of survey from the bottom of the hill to the reference mark of the CGPS station. After a hard days fieldwork we left Lumbrum at 3.30pm. At the Harbourside hotel we did all the reductions to the leveling data, which was recorded on the leveling sheets. Brian and myself reduced the data with Steve checking for errors and upon conclusion; data collected were within the specifications of the allowable limits of $2\sqrt{k}$ where k is the distance to any station in kilometers. The survey data collected were all reduced and checked and there were no errors that were not within allowable limits.

There are six primary [deep driven] benchmarks on Manus Island with known height datum from which holding points or temporary benchmarks were in connection to a known datum. The

process of precise leveling is based on the theory that it should be started and finished off from a known benchmark through a series of set-ups. The datum derived for these points is technically known as Reduced Levels. Approximately 2.0 kilometers of survey was carried out.

We set up during the Manus survey with Steven recording the field data onto the leveling sheets and sometimes doing observations through the Digital Level, whilst Brian was doing observations through the Digital Level on the way backwards upon closing a circuit and setting up the starve to forward. I was also doing observations through the Digital Level on the way forward from one benchmark to the next and also setting up starves backwards. We carried out the precise differential survey at intervals of 25 meters, which we measured using a 50-meter measuring tape. All ground distances are measured.

The following day, 12th May 2002, we went to the site at 9.00am and covered all benchmarks in the ground and took photographs of them for our records. We also checked out the Tide Gauge and locked the shovel and crow bar in the hut.

Basically when Precise Leveling is carried out, the observation and the closure of the survey line should be at the same point. Data collection, field reduction and a thorough check on the data were completed on the 13th of May 2002.

Next day we left Manus Island for Port Moresby and checked into the Gateway Hotel. After spending the night in Port Moresby we departed PNG the following evening and arrived in Cairns at night. We had cargo freighted all our survey equipment to Adelaide from Port Moresby. We spent the night in Tropicana Lodge in Cairns. On the 15th May we left Cairns to go to Brisbane, where we went our separate ways.

I had to spend two more nights in Brisbane waiting for my flight to Nadi. I never had much to do but to stay indoors and read. I finally left on the 17th May 2002 and reached Nadi late at night. After overnighting at the Raffles Gateway, I left Nadi early next morning for home at 0600 hours.

FIELD EQUIPMENT

Below is the list of instruments used by the Survey team in carrying out Precise Leveling surveys in the South Pacific Sea Level & Climate Monitoring Project (Phase III):

1. Leica NA3003 Digital Level
2. Instrument Tripod
3. Leica Invar Leveling Starves
4. Leveling Struts
5. Ground Plates
6. 50 m Measuring Tape
7. Electric Drill
8. Stainless Steel Rods
9. Aluminum Screws
10. Dropper Knocker
11. Spade
12. Crow Bar
13. Benchmark PVC casing

REFERENCE

- Turner, S. M., 1996, *Precise Vertical Survey Control Course*, National Tidal Facility, Adelaide, Australia.

ATTACHMENT**Travel Itinerary**

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| 1. | Sunday 5 th May 2002: | Depart Suva (0745)
Arrive Nadi (0815) |
| | Sunday 5 th May 2002: | Depart Nadi (1145)
Arrive Brisbane (1400) |
| 2. | Monday 6 th May 2002: | Depart Brisbane (1445)
Arrive Cairns (1700) |
| 3. | Tuesday 7 th May 2002: | Depart Cairns (1125)
Arrive Port Moresby (1250) |
| 4. | Wednesday 8 th May 2002: | Depart Port Moresby (0905)
Arrive Manus Island (1025) |
| 5. | Monday 13 th May 2002: | Depart Manus Island (1355)
Arrive Port Moresby (1515) |
| 6. | Tuesday 14 th May 2002: | Depart Port Moresby (1825)
Arrive Cairns (1950) |
| 7. | Wednesday 15 th May 2002: | Depart Cairns (0925)
Arrive Brisbane (1130) |
| 8. | Friday 17 th May 2002: | Depart Brisbane (1620)
Arrive Nadi (2150) |
| 9. | Saturday 18 th May 2002: | Depart Nadi (0645)
Arrive Suva (0715) |