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INSTITUTE of HYDROLOGY

# Variability of Tropical Rainfall in the Solomon Islands

Visit Report March 1988

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For the Overseas Development Administration of the British Government

# Contents

# 1. Background

This project was established to investigate the relationship between rainfall and altitude in a tropical environment. Following a visit to the Solomon Islands in 1982 by Dr M J Lowing of the Institute of Hydrology (IH) a north-south transect of six automatically recording raingauges was established across the island of Guadalcanal. Details are given in his visit reports (Lowing, 1982 & 1984). The project is being funded by the Overseas Development Adminstration of the British Government.

Figure 1 shows the location of the six gauges on the transect. The first four gauges were installed on the northern half of the transect in 1984, whilst the two on the southern part were not commissioned until May 1985. Details of these gauges are given in Table 1. The map references and altitudes of some of the gauges were previously in error, these have now been checked and the values adjusted accordingly.

The instruments used are 0.5 mm tipping bucket raingauges, manufactured by Rimco, and, initially, solid state data loggers designed and made at IH. A good return of data was obtained until September 1985, when problems started with the loggers and much of the data was lost. The primarily cause was loss of battery power. In August 1986 Dr C Green (IH) made a short visit to discuss the problems of data capture. Details are given in his visit report (Green, 1986). The major recommendation made was that the loggers should be replaced by a more reliable alternative. *The Didcot Rainlog* was chosen as the replacement.

Dr M Acreman (IH) was assigned to the project in December 1987, with the responsibility of testing and commissioning the new loggers.

*Table 1 Details of raingauges on the transect*

| Transect Number (m) | SIG Number | Site Name | Map Reference | Date of installation | Altitude (m) |
|---|---|---|---|---|---|
| 1 | 5006150 | SIPL | 6259 89548 | 08/11/84 | 13 |
| 2 | 5006650 | MBUMBULAKE | 6267 89465 | 21/05/84 | 141 |
| 3 | 5006651 | GOLD RIDGE | 6244 89405 | 23/11/84 | 377 |
| 4 | 5006652 | MT CHAUNAPAHO | 6217 89350 | 27/09/84 | 1250 |
| 5 | 5018151 | LEIVASUVASU | 6153 89203 | 22/04/85 | 495 |
| 6 | 5018150 | KAKAKE | 6165 89152 | 19/04/85 | 45 |

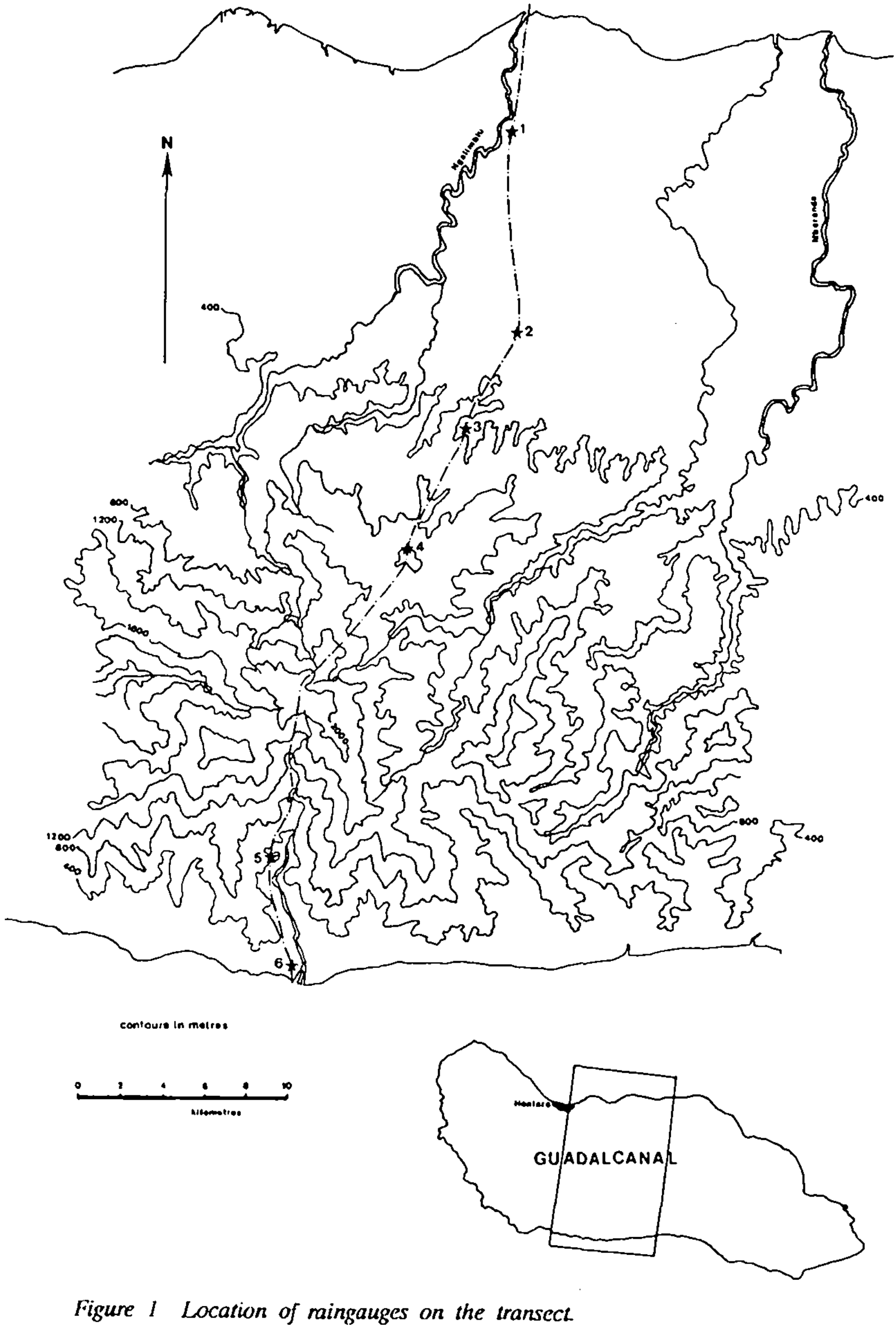


*Figure 1 Location of raingauges on the transect.*

# 2. Rainlog description and operation

The *Rainlog* had recently been developed by the Didcot Instruments Company. Designed specifically for use with a tipping bucket raingauge, it records the date and time of each bucket tip with a resolution of one minute using a real-time clock and calender. Each logger has an eight kilobyte random access memory (RAM) for data storage. Power is provided by internal batteries which are designed to last for three-four years. Under normal conditions the logger can be left in the field for several months. Converting the raingauges to handle the new loggers only required drilling two holes in the gauge baseplate. Adaptors were provided for the cable connections so that no soldering was required in the field.

The logger has no external switches or dials and is controlled by linking it to a microcomputer. Appropriate software (in BASIC) is supplied for the Epson HX 20 portable computer on a microcassette, but would normally reside in the computer RAM. Collected data can be stored on a microcassette and printouts of the data, in the form of tables and histograms, can be obtained by linking the computer to a compatible dot matrix printer. Data can also be output to other computer systems. An Epson HX 20 was already in use for transfering data from the IH loggers, so no additional expenditure on computer hardware was necessary. A version of the software is available for the standard HX 20, although the program supplied for the Solomon Islands project requires a 16K RAM extension. This extension was supplied by IH. A decision was made to buy 12 Rainlogs so that a replacement was always available for each of the six gauges.

The software code supplied with the loggers was adapted to make it more suitable for the Solomon Islands application. When executed the program presents a set of menus which allow various options to be selected. A strategy for managing the loggers and the rainfall data archiving was devised. A comprehensive manual has been written (Acreman, 1988) which describes the operation of the loggers using the adapted software and management strategy. The basic system is described below.

## 2.1 STOPPING AND STARTING THE LOGGERS

The first operation involves initialising the logger ready to accept data. The *START* option reads the current date and time from the Epson and sets the clock/calander in the logger. It is therefore important to keep the Epson correctly calibrated. A label giving this date and time is output on the microprinter. Spaces are also provided for the dates and times when the logger is connected to and disconnected from the raingauge, and for the gauge site. These printouts should be put in the plastic bag provided and attached to the logger with a rubber band. Previous labels must be removed when the logger is re-started. his information should also be recorded on separate 'site' and 'logger' sheets.

## 2.2 CHANGING THE LOGGERS

Once the logger is attached to the raingauge, each time the bucket is tipped a switch closure is registered in the logger RAM. At the end of each minute the time at the beginning of the minute is recorded in the logger RAM together with the number of switch closures in that minute. If no closures were recorded nothing is stored. If the date of any wet minute is different from that of the last wet minute the date is also stored. The *Rainlog* accepts up to 39 tips in any one minute interval. The logger has 8K of RAM available for data storage but the maximum amount of rainfall data which can be stored will depend on the rainfall regime. Based on the data collected so far, it was recommended that the loggers should be changed at least every two months. Under normal circumstances this can be extended safely to three months, especially in the dry season.

On the top of each logger is a small red LED which is activated by placing a magnet next to the strip on the logger casing marked <<TEST>>. Then, when the bucket is tipped, the LED should flash. Before the existing logger is disconnected 4 artificial tips of the bucket should be made with the magnet in place. The number of tips made, and the number of flashes seen, are recorded. The date and time of disconnection is recorded both on the logger label and on the separate site and logger sheets. The cover to the coaxial connector should be put on immediately to stop moisture collecting across the terminals.

The replacement logger is connected and a further 4 tips of the bucket are made. The date and time of connection and the raingauge site name are recorded both on the logger label and on the separate sheets.

## 2.3 READING AND STORING THE DATA

After the logger has been disconnected at the end of a recording period it must be stopped using the *STOP* option. The *READ* option is then used to read the data from the logger. These data can be stored permanently on a microcassette or output via the RS-232C port to a printer or another computer. Once the data have been read they are stored in the computer RAM, even if the computer is switched off. However, for safty, the data should be written immediately to a microcassette tape using the *TAPE* option, since the data are overwritten when another logger is read. A duplicate microcassette copy of the data should also be made and sent to the Institute of Hydrology. It is also recommended that a hardcopy of the data dump and a table and histogram are produced using the *OUTPUT* options in the *Rainlog* software, since visual inspection of the data in this form often highlights problems ith the equipment. Even if no rainfall occurred, artificial tips should have been made when the logger was connected and disconnected.

## 2.4 IDENTIFYING PROBLEMS WITH THE LOGGERS

If there are no data recorded by the logger the following tests can be carried out.

1. A check of whether rainfall was recorded at other gauges and that data were expected.

2. A check in the notes made when the logger was collected from the gauge. Were any artificial tips made and did the LED flash each time? This test can be repeated in the office by the logger and simulating a bucket tip by connecting a switch across the coaxial terminals. A switch has been supplied for this purpose with the appropriate connector.

3. The voltage can be checked by connecting a voltmeter across the terminals of the coaxial connector. The reading should be 4.0 - 6.5 volts.

4. The logger RAM can be checked by running the *TEST* option in Epson software. The memory size should be 8192.

If any of these tests fail it is recommended that the logger is returned to the Institute of Hydrology. It should not be openned in the Solomon Islands.

## 2.5 TRANSFERRING THE DATE TO MICRO-TIDEDA

The database currently used for storing the rainfall data from the transect is micro-TIDEDA implemented on an Altos micro-computer running a CPM operating system. The data are sent using the *DUMP* option of the *OUTPUT* menu with the Altos attached to the RS-232C port of the Epson. A new program was required to reformat the data from the *DUMP* into a form suitable for input to micro-TIDEDA. En route to the Solomon Islands I visited David Scott who had previously held the position of Water Resources Officer in Honiara. He had been responsible for setting up the raingauge transect and the computing facilities in the Water Resources Department. Immediately prior to my visit he had written a program called *TRX* to facilitate the data transfer from the Epson to the Altos. This program was tested, amended and re-tested using data from a *Rainlog*.

# 3. Rainlog testing

A demonstration logger was tested using a device which provides a switch closure, simulating a bucket tip, at regular specified intervals. The interval was set at one closure every two seconds and the logger was connected for a two day period. This was a fairly severe test of the *Rainlog*, simulating continuous rainfall of 900 mm per hour for 48 hours, a total of 86400 bucket tips. After two days the data were read from the *Rainlog*. Translation of the data began satisfactorily, but suddenly appeared erroneous, as though the logger had reset its internal clock to zero. The fault was traced to a bug in the Epson software. Re-reading the data produced good results. Variations existed in the number of tips per minute, ranging from 20 to 40. This was put down to inconsistant switch closure intervals in the generating device as the room temperature fluctuated during the tests. Otherwise the data were reproduced as expected. To make the tests more representative of conditions in the Solomon Islands, the test was repeated with the logger placed in a environmental cabinet set at 45°C. In two successive tests the start date was set to 31st December and 28th February, in a leap year, to test the internal calander. The *Rainlog* proved robust over all these tests.

Delivery was taken of the 12 *Rainlogs* on 16th February 1988. Each was tested for 24 hours using a similar automatic switching device. This had been adapted to allow three loggers to be connected in parallel for simultaneous testing. All 12 loggers performed satisfactorily.

A previous fault with the demonstration logger had been that one its internal batteries had reversed its polarity to a strength equal and opposite to that of the other two batteries powering the instrument. Thus no power was being provided. To ensure that this would not recur the manufacturers have modified the loggers by connecting a diode across each battery, thus allowing current to flow only one way.

# 4. Details of visit

A visit was made to the Solomon Islands from 28th February until 10th March 1988. Transport to the office and field sites was supplied by the Water Resources Department. The Water Resources Officer, Mr Bob Curry, made time available to discuss the project, familiarise himself with the new loggers and data handling system and to accompany me on some of the field visits. The opportunity was taken to visit other sites of hydrological interest in the vicinity of the rain gauges, including water level recorders and borehole drill sites.

## 4.1 OFFICE VISITS

The various options on the Epson software were tested in the Water Resources Department office. The transfer of data from the Epson to the Altos using *TRX* work satisfactorily. However, the cable brought for linking the Epson to the printer was equipped with a male plug which was not compatible with the male socket on the printer. A female plug was purchased in Honiara and soldered to the cable. The software was then amended so that the histogram and table printouts fitted on the available printer paper. The loggers were demonstrated to the hydrological staff and the data management strategy agreed.

Copies of all available data up to the time of the visit were transfered to floppy disk to be returned to IH. These included data transfered from the loggers collected from the field during the visit.

## 4.2 SITE VISITS

All six raingauge sites were visited during the ten days and a *Rainlog* installed at each. The old loggers were returned to IH. At two sites the Rimco raingauges had been removed and replaced by Oedipe recorders. The Rimco gauges were reinstalled during the visits. Due to lack of rainfall none of the new loggers were retreived from the field for testing during the visit.

With the exception of the SIPL gauge, each instrument is sited within a small (2m x 2m) compound, enclosed by a 1 metre wire fence. The gauges are fixed to a base-board of 6mm marine plywood. These boards perish quickly in the high humidity and temperature and require replacing each year. At each site a two-metre plastic pipe serves as a storage check gauge. A thin layer of oil is left in the gauge, this floats on the surface of the stored water to minimise evaporation.

Access was one of the major problems experienced with trying to plan the transect of raingauges across the islands. The only sealed road on Guadalcanal runs east-west along the northern coast in either direction from Honiara. The only roads running south into the interior are those built for special purposes such as mineral exploration and feasibility studies for a hydro-electric power scheme. As the name suggests the road to Gold Ridge was built to carry traffic for gold prospecting. The surface varies from a flat even gravel to steep bed rock with large pot-holes, but nevertheless provides access some 20km inland from the north coast. This road is the major artery for access to the rainfall transect on the northern side of the mountain divide.

1. *Solomon Islands Plantation Limited (SIPL)*

SIPL have large oil palm plantations on the flat, northern coastal plain of Guadalcanal, east of Honiara. They operate a meteorological recording site including, a daily read storage gauge, sunshine recorder and evaporation tank. These instruments are the responsibility of the agronomist whose office is adjacent to the site. There is also a Dines tilting syphon raingauge, but this has only been installed temporarily. It is in an ideal location in the centre of a large flat area, flanked by office buildings. The site was rebuilt after being devastated by cyclone Namu in Sept 1986. The IH Rimco tipping bucket raingauge, originally installed for the transect project was damaged and not replaced. However, an Oedipe raingauge, which had survive the cylcone and recorded data throughout the storm, was re-located after the site had been cleared. During the present visit the Rimco gauge was resited within the compound and a *Rainlog* attached. The Oedipe was to be left in place for an overlapping recording period of about a month.

## 2. Mbumbulake

Mbumbulake is about 10 km inland on the road to Gold Ridge where the land begins to rise from the coastal plain. The gauge is sited on a grassy knowle next to the road, near to a small collection of huts from which the site takes its name. The surrounding countryside is undulating and the vegetation cover varies from dense undergrowth in the valleys to tall grass on the hill tops. There are a number of small villages in the area which have clearings on which crops are grown. The site is typical of the altitude in the area. The knowle has a commanding view over the coastal plain suggests that the site is rather exposed to the north. The grass grows tall around the compound but does not grow over the gauge itself.

## *3. Goldridge*

The gauge is sited on a small spur within a larger valley with sides up to 600m. Rainfall recorded here may not be typical of its elevation and is probably more representative of the altitude of the surrounding hills. Due to problems with the IH loggers an Oedipe raingauge had been installed. At the time of the visit the Rimco gauge was replaced and a *Rainlog* connected. Ants had nested in the Oedipe cabinet but could not get into the instrument itself. They may be more of a problem with the unsealed Rimco gauge. The Oedipe gauge would be left for an overlapping period of one month.

The gauge is sited next to the small village of Tinomeat consequently much of the ground is bare. On the opposite side from the village the vegetation is dense but mainly grass. The gauge is somewhat exposed to the north.

## *4. Mount Chaunapaho*

The gauge is sited in a small clearing within dense forest, near the summit of Mount Chaunapaho. The temperature is consequently lower, about 25°C on the day of the visit. Cloud covers the mountains on most days, but little of the associated fine mist seems to condense into the raingauge.

The clearing is about 10m square and is littered with fallen trees which help to supress vegetation growth. The surrounding trees are up to 10m tall thus shadowing the gauge somewhat. However, the location is good given the local terrain and vegetation.

The site is reached by a 5km footpath from the end of the road at Gold Ridge. The path is steep and ill defined due to dense vegetation and infrequent use. The walk therefore takes about three hours.

Despite its remote location this gauge has suffered from vandalism, perhaps being mistaken for gold prospecting equipment. It was threfore moved 30 m from its original site next to the footpath into a small clearing not visable or easily accessible to passers-by.

The remaining two raingauges on the transect are sited on the southern side of the mountain divide and are reached from the south coast. For such trips the Ministry of Natural Resources have a number of 5 metre glass-fibre boats equipped with outboard motors. The journey to the south coast takes about six to seven hours from Honiara and therefore a trip to both gauges usually requires at least three days. The weather can be particularly inhospitable along this part of the island which is refered to as 'the weather coast'. On occassions the technicians have been standed there for more than a week due to heavy seas. An alternative is to fly to the airstrip at Haimarao and organise a local boat for the shorter journey along the coast. However, it is difficult to arrange water transport in advance, resulting in futher delays.

*5. Leivasuvasu*

The gauge is sited on a terrace overlooking a deeply incised river valley. The valley side has been dissected by a number of small steep streams. The vegetation which includes a number of palms grows tall around the compound. The local people grow sugarcane not far from the site. They have agreed to clear the compound of overhanging vegetation when they visit their allotments. The dense vegatations means that the gauge is not exposed but rather over-shadowed and records may therefore underestimate the actual rainfall.

The ply-wood base board had disintegrated in places and would require replacement on the next visit. The foot of the slope is reached in one to two hours by walking 5km along the dry bed of the river distributaries which are composed of large cobbles and boulders. The top of the spur is usually reached by a long steep footpath. Two locals showed us alternative, quicker route via a very steep bouldery stream. The necessity for physically robust loggers is exemplified by the number of slips and falls inevitable on the journey.

*6. Kakake*

The gauge is sited on a steeply sloping, south east facing, valley side immediately above the village of Kakake, only 15 minutes walk from the coast. The village provides overnight accomodation, if required.

The site is in a small, 3m square, clearing surrounded by dense vegetation. At the time of the visit a palm leaf was growing almost directly over the raingauge. This was cut back and locals were asked to visit the site each week and clear it of vegetation.

The physical difficulty of reaching the more remote gauges coupled with the high data loss has contributed to low moral on the project. Dense vegetation grows up around several of the gauges and requires clearing on each visit. Locals have been asked to keep the sites clear but cannot be relied upon. These gauges are likely to underestimate the rainfall.

## 4.3. VISIT TO SOLOMON ISLANDS METEOROLOGICAL SERVICE

On 10th March a visit was made to the Solomon Islands Meteorological Service based at Henderson Airport about 12km east of Honiara. The previous officer-in-charge, an ex-patriate meteorologist, had recently been replaced by a Solomon Islander named Letia Ta'ani. Rainfall at the airport is currently being recorded at four-hourly intervals on forms which contained other meteorological information such as wind speed and temperature.

Computer archiving was in an advanced stage and appeared to be well organised. A large number of temporary staff were employed at the time to collate daily rainfalls from all the Solomon Islands. These data were being entered onto a Apple micro-computer. Standard retrievals were available to service data requests. All available daily rainfall data since 1976 are about to be published.

# 5. Concluding remarks

Twelve *Rainlog* data loggers were purchased and tested. All six raingauge sites were visited and loggers attached. A spare logger is available for each gauge. A system for collecting and replacing loggers was established. Software has been developed and tested on the Epson microcomputer for retrieving data from the new loggers, obtaining tables and histograms and loading the data to the Altos computer. Programs on Altos have been developed and tested for receiving data and saving it to the micro-TIDEDA database.

All data up until time of visit have been collected and brought to IH. The availability of other rainfall data from the Solomon Islands Meteorlogical Service has been noted. Such data may allow extrapolation of results to other islands.

# 6. Recommendations

1. The progress of the new data logging system should be closely monitored and appropriate adaptions made if required. The rainfall data collected can be checked against the data from the Oedipe gauges.

2. The data collected so far should undergo quality control and be stored on an appropriate database at IH.

3. Preliminary analysis should be performed on the available data.

4. Two years data should be collected before full analysis is undertaken.

5. Options to maintain the gauges on a permanent basis should be sought.

# 7. References

Acreman, M.C. (1988) Rainlog Users Manual, for Solomon Islands, Institute of Hydrology, Wallingford, U.K.

Green, C.S. (1986) Variability of Tropical Rainfall in the Solomon Islands, Visit Report August 1986, Institute of Hydrology, Wallingford, U.K.

Lowing, M.J. (1982) Report on a visit to the Solomon Islands, May 1982, Institute of Hydrology, Wallingford, U.K.

Lowing, M.J. (1984) Report on a visit to the Solomon Islands, October 1984, Institute of Hydrology, Wallingford, U.K.

The demand for long-term scientific capabilities concerning the resources of the land and its freshwaters is rising sharply as the power of man to change his environment is growing, and with it the scale of his impact. Comprehensive research facilities (laboratories, field studies, computer modelling, instrumentation, remote sensing) are needed to provide solutions to the challenging problems of the modern world in its concern for appropriate and sympathetic management of the fragile systems of the land's surface.

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Land Use and Natural Resources

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Environmental Quality and Pollution

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Ecology and Conservation

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