Summary

Two stations with tipping bucket precipitation sensors, installed by SNET and NGI, have been operating since October 2002.

The intention of using existing satellite download infrastructure at SNET to receive the precipitation data from the two stations has been fulfilled.

Due to a failure in the data logger installed at San Vicente a period of the rain season of 2003 has not been recorded for this station.

To make a final conclusion about the usefulness of the system, it is recommended that have an operational period of al least two additional years.

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1 INTRODUCTION

Landslides, as a result of heavy rainfalls and earthquakes, represent a significant risk to residents in El Salvador. This type of hazard has been known for a long time and was clearly demonstrated during the hurricane Mitch in October 1998.

One of the tasks in the institutional cooperation project between NGI and SNET, supported by the Ministry of Foreign Affairs in Norway, is an early warning system for landslides. The hazard evaluation will be based on the detailed precipitation information gathered from 2 rainfall stations.

This report summarises the experience gained from the first full year operation of the two stations. The report also includes some of the data that has been received.

2 DESCRIPTION OF INSTALLED METEOROLOGICAL STATIONS

2.1 Equipment

Each station is complete with the following components:

- Data Recorder with GOES transmitter and GPS time receiver.
- Power system including solar charge source capability, regulator and all necessary cabling.
- 3 Meter Tower with Lightning Protection and Grounding Hardware
- Satellite Antenna.

In addition, each station is equipped and pre-wired for the following sensors:

- Wind Speed/Direction
- Temperature/Relative Humidity
- Precipitation

2.2 Location and station Id

Station San Vicente
Latitude: 13° 36.75', N Longitude: 88° 50.33' W
GOES Sat ID: 50308454 , Transmission Time: 0049
Antenna direction: 132.67 ° Antenna elevation: 66.9 °

Figure 1 Rainfall station (San Vicente)

2.3 Station Las Pilas

Latitude:	14° 21.90' N	Longitude:	89° 05.40' W
GOES Sat ID:	50309722	Transmisión Time:	0050
Antenna direction:	133.83 °	Antenna elevation:	66.2 °

Figure 2 Rainfall station (Las Pilas)

3 OPERATIONAL EXPERIENCE

The Las Pilas station has been working almost continuously since the recording started in October 2002. Only small problems due to battery failure have been experienced. These battery problems were successfully repaired with a couple of visits to the station along the year.

With respect to the San Vicente station, it was working very well until February 2003 when the signal was lost. After several field visits and after several tries during March, it was determined that the transmitter was not working properly and it was the cause of the problem. After several consults with Sutron in April and May, the damaged part was sent to the factory for warranty repair. After a couple of months in Sutron, the transmitter was received back in SNET at the end of August 2003and it was installed in middle September. Since then, the station has been in operation again.

4 SOFTWARE

4.1.1 General

There are up to 5 Sutron software modules running during normal operation. They are all 16 bits (word size) programs which mean that they are not well suited to run with the present 32 bit operating systems like Windows 2000 or Windows XP. Also the technology used for data exchange with other programs, DDE (Dynamic Data Exchange), is an obsolete interprocess communication system compared to OLE /Active X.

The Sutron software is running on a dedicated computer located in the Meteorological/Hydrological department. This computer is reading data from all Sutron stations in El Salvador through the local satellite data download station. A netDDE server is running on this computer to distribute the recorded data on the network.

All programs made by NGI use netDDE to request data from the data server database and thus depends on the stability of the server computer to maintain a regular reading of the stations.

5 RAINFALL MEASUREMENTS

5.1 The rainfall season 2002

The stations were installed in October, and since the rainfall season normally ends this month, only small amounts of precipitation were recorded for the rainfall season in 2002.

Some key parameters from the rainfall season in 2002

	Max. hourly rainfall [mm]	Date and time	Max. daily rainfall [mm]	Date
Las Pilas	16.4	26.10.2002 22:00	41.2	26.10.2002
San Vicente	27.4	30.10.2001 20:00	42.6	30.10.2002

5.2 The dry season 2002/2003

Due to a technical problem with the data logger at San Vicente no data was recorded between February and October in 2003. At Las Pilas, the measurements show that the precipitation is close to zero in the period November 2002 to May 2003, except for a some rainfall in end of March.

5.3 The rainfall season 2003

This is the first complete measurement for a full rainy season. There have been no hurricanes or severe tropical storms in El Salvador in this period according to the tropical cyclone tracks presented in figure 3.

Key parameters from the rainfall season in 2003

	Max. hourly rainfall [mm]	Date and time	Max. daily rainfall [mm]	Date
Las Pilas	34.2	28.09.2003 21:00	64.2	20.09.2003
San Vicente[1)]	47.8	27.10.2003 7:00	88.4	04.10.2003

1) Rainfall data only recorded after 02.10.2003

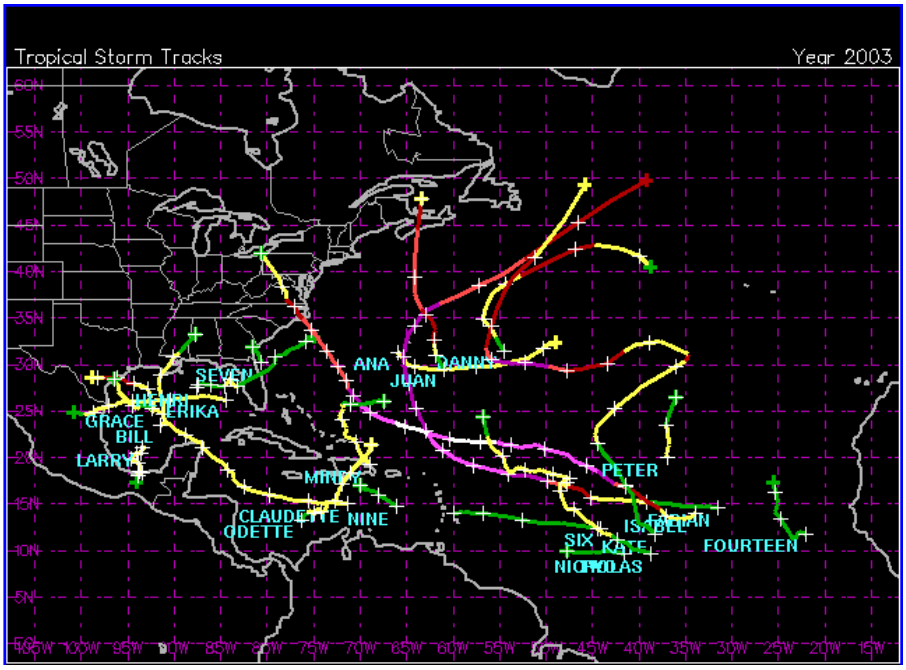

Figure 3 Tropical cyclone tracks for 2003

5.3.1 Recorded precipitation

The following plot (figure 4) shows hourly rainfall measurements from the two meteorological stations in October 2003. The San Vicente area is clearly more exposed to heavy rainfall compared to the Las Pilas area.

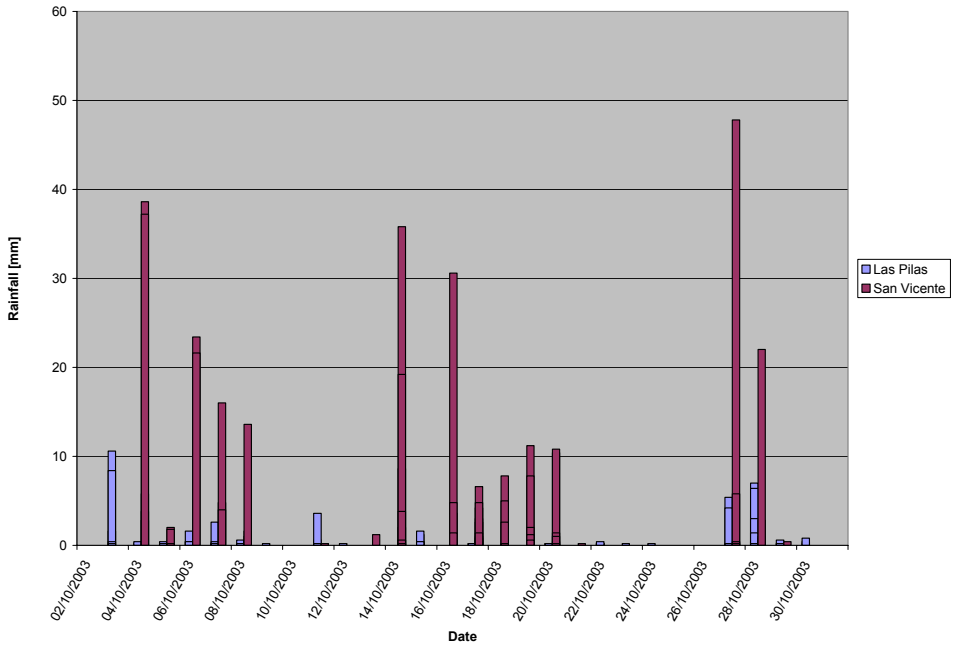

Figure 4 Hourly rainfall measurement in October 2003.

In figure 5 and 6 the measured precipitation from the date of installation until December 2003 is presented for both stations. Due to transmission failure data from the San Vicente station is missing for the major rain periods in 2003.

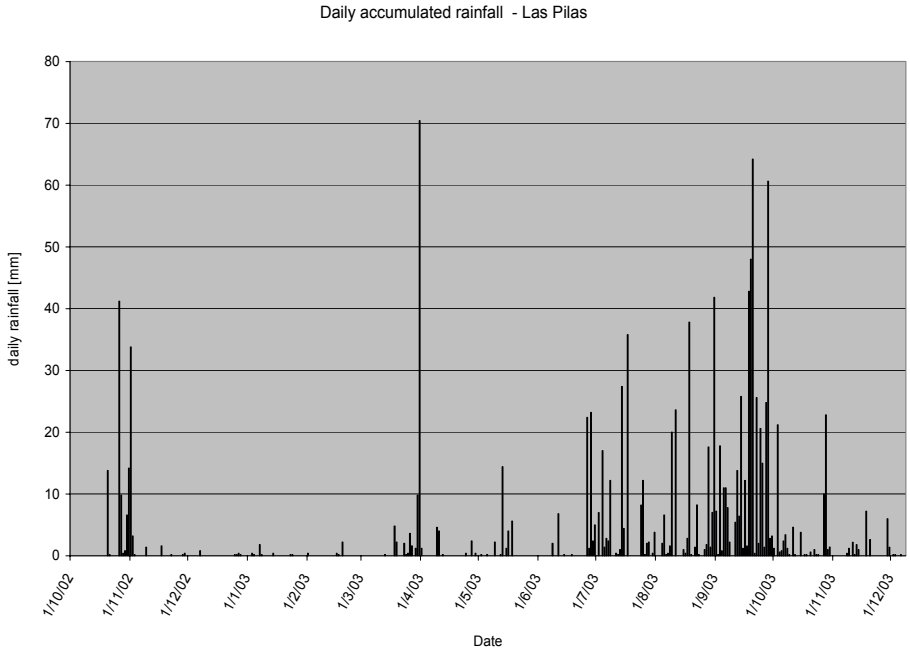

Figure 5 Daily rainfall measurements – Las Pilas station

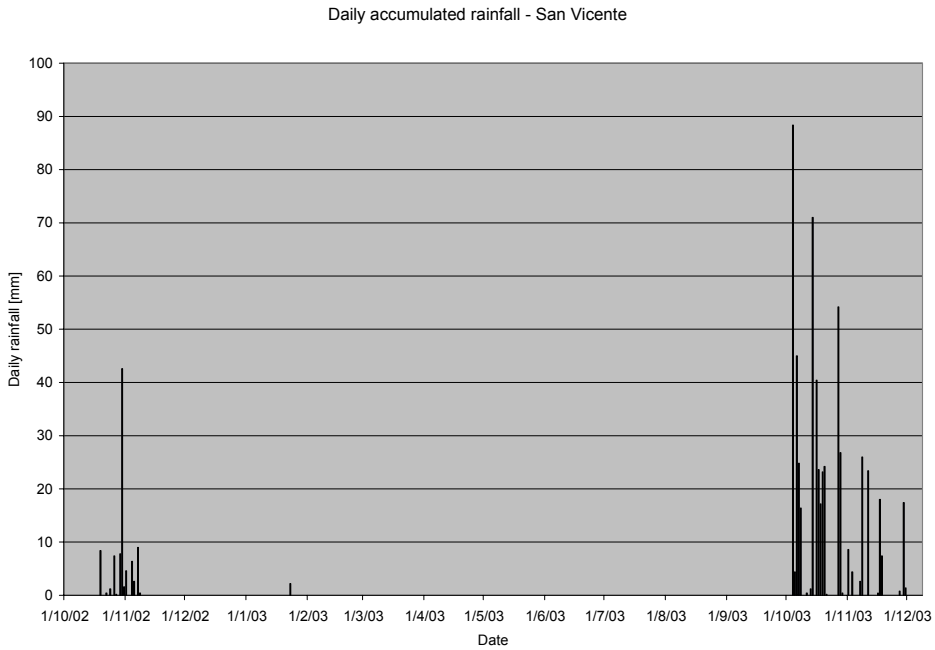

Figure 6 Daily rainfall measurements – San Vicente station

6 OVERALL EVALUATION

6.1 Hardware/Software

The internal timing of the data logger is a critical value due to the limited time window that is dedicated to the station for transmission of data. The maximum deviation from UTC should be within a few seconds. Based on our experience so far it seems that the new GPS receiver integrated with the data logger has been giving a stable clock signal.

We have not received any report from Sutron regarding the warranty repair that was performed on the data recorder from San Vicente. In general we feel that a repair period of several months is not acceptable under any circumstances.

6.2 Protection

The equipment is partly galvanized (tower, brackets) and partly nickel-plated (rainfall sensor). Since none of these metal finishing treatments have resisted completely the corrosive environment in the areas that the stations are installed, a treatment with anti-corrosion painting has been carried out on all surfaces that are exposed. This treatment should be repeated when necessary. The cabinet sealing must be treated with silicon on regular basis, and it is also important that all electrical connections are checked and treated with special protection spray.

6.3 Transmission

The stations are self-timed to transmit data every 3 hour during normal conditions. During heavy rainfall a random message is sent if 1 hour rainfall data has exceeded 50 mm. If this rainfall is measured during the first part of the hour the delay before data is received can be up to 1 hour. Also if the rainfall is distributed evenly before and after the hour no random transmission will take place even if the total rainfall is above 50 mm.

For typical heavy rainfall incidents the intensity is very high during a short period of time, typically 15 - 20 minutes. With the 1 hour measurement period the existing trigged alarm message will not represent an instantaneous alarm.

6.4 Service

The set-up and use of Sutron software is cumbersome for an inexperienced user. For an engineer it will take many hours with hands-on experience before he/she is able to do qualified maintenance work on the system. Also to change the internal set-up and the Basic program of the 8210 unit requires a good training.

The present situation at SNET regarding system knowledge is satisfactory. This is also true regarding the installed data download system for GOES

transmitted data. A training program has been accomplished with Sutron personnel, and there is a good cooperation between the different departments at SNET which use Sutron equipment.

6.5 Warning procedure

The threshold values are based on NGI report 20011148-6. The Alarm Monitor program generates a sound alarm and sends out e-mail messages according to an address list defined in the configuration file. It is necessary to outline a more detailed procedure for handling of such situations also accounting for other the outlook in terms of f weather predictions and hurricane warning. Communication with Civil Defense representatives and information approach to inform the public need should also be considered.

6.6 Data requirements

With only one full rain season with below average rainfall we do not have a good basis to make a final conclusion about the real value of the system. We need at least two additional rain seasons to gain enough knowledge about the operational reliability, and to study the correlation between rainfall and landslide in the specific areas, before a final judgment can be given. This implies that field inspection to detect new lahars should be accomplished after periods of heavy rainfall.

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