# Summary

Two rainfall stations have been installed in El Salvador as part of a co-operation project between SNET (Servicio Nacionale de Estudios Territoriales) and NGI (Norwegian Geotechnical Institute). The stations are part of an early warning system for landslides. Based on site investigations, statistical analysis of previous rainfall recordings and landslide activity, an empirical relationship between landslide risk and rainfall hourly recordings from the stations has been developed and integrated in the project software. The threshold values for critical rainfall that may trigger landslides is based on previous work carried out by NGI in Nicaragua, and need to be revised and updated when SNET has gathered more data with the established system. The installed system for landslide warning is to be considered as a pilot project

The stations which are manufactured by Sutron Corporation, measures in addition to rainfall also wind speed, wind direction, temperature and humidity. Data is transmitted every 3 hour to the Geostationary Operational Environmental Satellite (GOES) and downloaded at SNET. An application program with network functionality has been developed to display the rainfall data and distribute alarm messages.

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**Review and reference document**

# 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, and during the 17th January and 17th February Earthquakes in 2001.
One of the main products of a common 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 with data transmitted to an already established data centre.
This report contains a technical description of installations that was carried out in October 2002.

# 2 DESCRIPTION OF INSTALLED RAINFALL STATIONS

## 2.1 Purchase

Based on previous experience with installation of 3 rainfall stations in Nicaragua and knowledge about the existing weather monitoring systems in El Salvador, two complete rainfall stations were ordered from Sutron Corporation. The framework for this decision was also based on the following knowledge:

- Sutron has delivered the existing network of meteorological and hydrological stations in El Salvador, and all hardware will be compatible with these stations.
- A download station (DRGS Direct Readout Ground System) for this hardware is already established at SNET and makes it easy to obtain real-time data.
- Less additional hardware or software training will be required for SNET personnel regarding operation and maintenance.
- SNET has spares for their network of SUTRON 8210s, and this will reduce the need for any additional spares.
- SNET personnel are already trained and experienced using SUTRON equipment, and can provide the necessary maintenance.

## 2.2 Equipment

Each station is complete with the following components:

- Data Recorder with GOES transmitter and GPS 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

## 2.3 Data Collection Platform (DCP) with GOES Transmitter

The functional foundation of the Rainfall Station is the Sutron 8210 data recorder with SatLink Transmitter. The 8210 and the transmitter are mounted inside a sealed enclosure inside a NEMA4 fiberglass cabinet which also houses the battery, solar panel regulator, and surge arrestor.

Sensors connections to the DCP enclosure are easily identifiable and have unique connectors such that sensors cannot be connected in the incorrect position. All sensors may be connected or disconnected without opening the DCP or requiring additional tools. All connectors are military standard (MS) types that shield against humidity, rainfall, salinity and other external agents that may cause shorts, corrosion or damage to the connector pins.

For details about sensor connections and DCP assembly, see Drawing 520149-001 in Appendix A “Assembly, Meteorological Station”.

## 2.4 Power System

The power system comprised of a battery, solar panel and voltage regulator.

### 2.4.1 Solar Charge Source

The 20W Solar Panel is provided with u-bolt mounting hardware. The solar panel is mounted on south side of the tower with a downward tilt of 27 degrees. The cable assembly for 8210 to Solar Panel, 5.5 meter, has a compatible MS connector for enclosure connection.

Solar Regulator

Sutron’s 5100-0407, Solar Panel Regulator, is an integral part of a solar electric power system that includes photovoltic (PV) solar array and a battery. It provides years of protection for batteries from over-charging. This device has a built-in LED, which indicates when the battery is being charged by means of solar power.

## 2.5 Free Standing Tower

The 3 meters free standing tower kit consists of one (1) hinged base plate and one (1) tower top section. This is a rugged equilateral triangle tower with extra

heavy-duty 1-1/4" steel tubing side rails and continuous steel solid bracing electrically welded throughout. Each piece is Hot Dip Galvanised inside and outside after fabrication to protect all points of construction and welding against corrosion.

The Hinged Base Plate bolts to concrete foundation. The hinge allows the tower to be rotated up from base for ease of installation.
The Top Section has an overall height of 9'0".

## 2.6 Lightning Protection and Grounding

Direct hits to a remote unit will leave the unit inoperative, and are not possible to overcome. However transients to the DCP are minimised using proper grounding and lightning techniques.

Protection is build into each 8210 for all sensor inputs. High voltage protection is built into the wiring panel of the 8210. The RTU is connected to a common ground lug on the NEMA enclosure, which is connected to the tower ground and thus the ground rod for complete protection.

A coaxial protector is used for the radio transmitter. This protector connects to the coaxial cable to protect equipment from strike or wind blown static build-up. Since this is not a weatherproof device, the body is mounted inside the NEMA enclosure.

A Tower Lightning Protection Kit which includes ground wire, ground rod, and arial (lightning rod) with mounting hardware is provided.
The five (5) feet arial attaches to the 2" section of the tower top with two clamps. The first features a thread fitting which seats the base rod and the second supports the arial to the highest point of the tower.
A third clamp is provided for securing the ground wire to the tower leg at the base. The ground wire is run from the enclosure ground lug to the leg clamp and then terminates at the ground rod clamp provided.

## 2.7 Satellite Antenna

The Sutron Model 5000-0080 Yagi Antenna is used to transmit data from any certified Data Collection Platform (DCP) to the Geostationary Operational Environmental Satellite (GOES). The antenna is made of rust-resistant materials and is moisture-proof. The 5000-0080 is a field-proven unit for remote locations requiring high gain directional uplink antennas.

The Yagi Antenna cable connects between the N male RF connector on the exterior of the NEMA enclosure and the N male connector on the antenna jumper. A 15 meters antenna cable is provided.

All satellite antennas must be installed according to elevation and azimuth calculated from site latitude and longitude co-ordinates.

## 2.8 Sensors

### 2.8.1 Wind speed and direction sensor

The 5600-0201 wind sensor made by the R.M.Young company is a light weight construction made of thermoplastic materials to improves resistance to corrosion.

It features an integrated mounting which fits a one inch pipe, outside diameter 34mm (1.34”). Sutron’s cable assembly for WS/WD, is a 9 meter cable modified with compatible MS connector for enclosure connection and pre-wired to junction box on sensor mounting post.

### 2.8.2 Temperature and Relative Humidity

Sutron’s 5600-0311-S is a high accuracy AT/RH sensor with MS connector modification to 3 meter cable for enclosure connection. The 5600-0021-2 radiation shield is supplied with integrated mounting.

### 2.8.3 Rain Gauge

Stainless Steel 0.2mm Rain Gauge Tipping Bucket is a precision instrument with a sensitivity of 0.2mm per tip. It is supplied with 10 meter of cable modified with MS connector compatible for enclosure connection. The gauge should be located on the prevailing wind side of the tower as to not disrupt rainfall measurement. Mounting hardware is provided.

## 2.9 CONFIGURATION AND WIRING

The 8210 is pre-wired and pre-configured to continuously monitor the Rain Gauge Tipping Bucket, Wind Speed/Direction, Air Temperature, Relative Humidity, and Battery Voltage. The following sections provide details on the logging intervals of each sensor’s data. The units of measure are determined by the slope and offset of the sensor configuration in the 8210 and are discussed for each.

### 2.9.1 Air Temperature and Relative Humidity

The 8210 will measure and log instantaneous air temperature (AirTemp) and relative humidity (Humedad) every hour. The temperature is logged in degrees Celsius (°C) and relative humidity in percent (%). For the AirTemp input, a

slope of 100.0 and offset of –40.0 is used for Celsius units. For the Humedad input, a slope of 100.0 and offset of 0.0 is used for percentage units.

The 8210 also utilise a basic program to calculate and log the minimum and maximum air temperature and relative humidity. The basic programs runs every minute, measures the current values for each and compares them to the existing minimum and maximum values. The daily min/max values are logged on the 12:00:00Z hour only.

### **2.9.2** Wind Speed and Direction

For the wind speed (VelViento) and wind direction (DirViento), a vectored average will be computed and logged.
The VelViento input uses a slope of 0.098 and offset of 0.0 for units of meter per second. For the DirViento input, a slope of 72.0 and offset of 0.0 are used for degree (°) unit of measure.

These averages is calculated by the operating system according to the Sample Time, Sample Interval, and Samples to Average values in the Measurement Schedule Setup. The average wind speed and direction are logged hourly.

The 8210 also utilises a basic program to calculate and log the maximum windspeed or gust (#Racha) and direction of gust (#DirRacha). The basic programs runs every minute, measures the current values for each and compares them to the existing maximum values. The daily max values are logged on the 12:00:00Z hour only.
Note: If sensor name is changed, Tiny Basic must be changed to refer to new name.

### **2.9.3** Precipitation

Rainfall is accumulated in two formats, within each measurement interval (Lluvia) and a running accumulation (Precipit). Both are counter inputs, which are logged by the 8210 hourly. The slope of Lluvia is set to one-fifth (0.2) since the measurement per tip is 0.2mm. The Precipitation count is not recalculated to rainfall and must be multiplied by 0.2 to get actual rainfall.

In addition, the 8210 utilises the basic program to calculate and log daily rainfall (#DiaLluv). This portion of the basic programs runs once each day, measures the current accumulated precipitation and subtracts the logged precipitation value from 24 hours ago, and logs the value at 12:00:00Z hours.

### **2.9.4** Battery Voltage

Battery voltage, Bateria, is enabled for measurement and logging as well. Units of measure are volts. Slope for input is 1.0 and offset is 0.0.

For more information on station configuration, see Appendix D for 8210 Setup Listing and Tiny Basic Program.

### 2.9.5 Goes set-up

The SatLink transmitter is scheduled to transmit stored one-hour data every 3 hour on channel 093. The data is then available through an Internet connection to Wallops CDA or through the Direct Readout Ground System (DRGS) at SNET. If the rainfall exceeds 50 mm the last hour a Random Transmission is executed on channel 123 which means that the data is available for download immediately after the calculation of hourly accumulated rainfall is performed. See Appendix D for Goes set-up listing

# 3 LOCATION AND STATION ID

## 3.1 Station San Vicente

| | |
|---|---|
| Latitude: | 13° 36.75’ N |
| Longitude: | 88° 50.33’ W |
| GOES Sat ID: | 50308454 |
| Transmission Time: | 0049 |
| Antenna direction: | 132.67 ° (true north) |
| Antenna elevation: | 66.9 ° |

Fig.1 Installed rainfall station (San Vicente)

### 3.1.1 Installation

The station at San Vicente was installed on October 14. The location is close to a resident on the north side of the volcano at an altitude of 1327 meters. The necessary foundations for the tower and the raingauge were already prepared by Mr. Manuel Diaz from SNET who also provided help during the installation. SNET will construct a fence around the station to stop unauthorised access at a later stage.

## 3.2 Station Las Pilas

| | |
|---|---|
| Latitude: | 14° 21.90’ N |
| Longitude: | 89° 05.40’ W |
| GOES Sat ID: | 50309722 |
| Transmisión Time: | 0050 |
| Antenna direction: | 133.83 ° (true north) |
| Antenna elevation: | 66.2 ° |

Fig.2 Installed rainfall station (Las Pilas)

### 3.2.1 Installation

The station at Las Pilas was installed on October 16. The station was placed at the same location as an already established manual rainfall station on the outskirts of a cornfield at an altitude of 1940 m. As for San Vicente the necessary foundations for the tower and the raingauge were prepared in beforehand by Mr. Manuel Diaz. A small steel fence already exists at this location as can be seen from the picture.

# 4 SOFTWARE

## 4.1 Download and storage of data

The following application programs are used to download and store data. At SNET these programs are running on the CPH2 computer which downloads data from all the meteorological and hydrological stations that are transmitting data via the GOES satellite in El Salvador. The complete PcBase2 software description is found in the Sutron PcBase2 User Manual

A Direct Readout Ground System (DRGS) at SNET can download unprocessed data directly from the satellite and perform all the necessary processing to readable data. Another option available at SNET is to download retransmitted processed data. Both these systems use dish antennas to receive data. These systems are not described in this document.

### 4.1.1 DAPS Dialer

This program calls via telnet the satellite download location in Wallops US. Every 30 min. (this example) the data is read from the server (IP 128.154.62.173) and stored as <yyyymmdd.raw> datafiles in folder c:\pcbase2\raw. Note that all stations must be present in the download list. The program window shows a listing of communication messages (see fig.2). Data from the stations are stored for 72 hours in the download server.

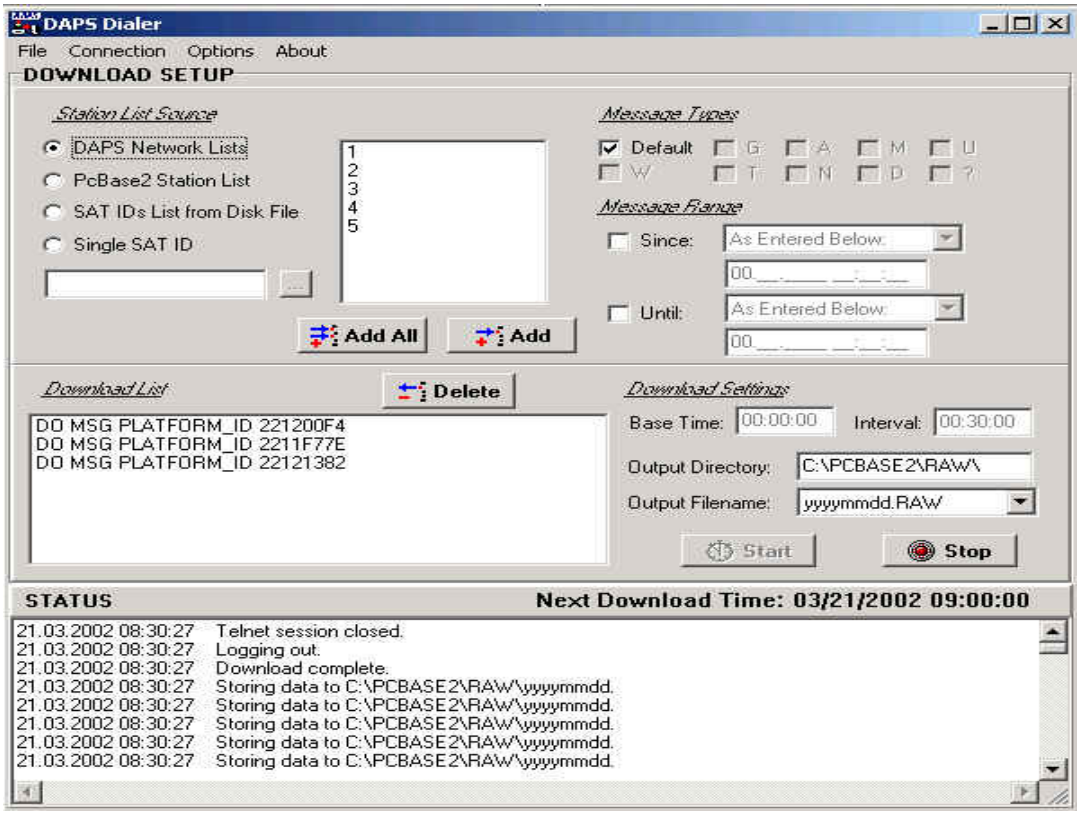


Figure 3. Configuration of DAPS Dialer with communication window.

### 4.1.2 Setup Server


Setup Server provides setup information to all the PCBASE2 programs that need it. Setup Server is designed to isolate PCBASE2 applications from the details of how setup information is stored and accessed. This allows the setup information for any application to be modified locally or remotely by any other application using DDE or NETDDE. The current implementation of the Setup Server stores information in the file PCBASE2.INI in an ASCII format, similar to other Windows .INI files. Because applications often cache setup information in their own local memory, the setup server supports a method of notifying applications that setup information has been changed.

### 4.1.3 Data Server

Data Server handles the storage of data into data files and provides data to applications that request it. In most systems, Data Server will set up a link to RTU Server or Decoder in order to receive the data comes in to the system and store the data to disk. Data Server also provides the data to programs that request it such as to Data Desktop when a graph or report is generated.

Data Server is designed so that the format of the physical data files on the disk is not important for accessing the data. This allows the underlying DBMS to be changed without effecting existing applications. Currently the underlying DBMS format is the Sutron .DAT format developed for PCBASE1. As open data base standards evolve, support for SQL, DBASE, and Paradox type data bases can be added.

The lights on the icon flash when data are being read and written to the datafile.

### 4.1.4 Logger

Logger is a general-purpose program designed to collect DDE points and record them on its screen and in ASCII files on disk. Logger's screen contains the last 100 logs made. Logger supports real time data (stamped with the current date and time) and time tag data (data which contains its own time stamp). It is possible to run multiple copies of Logger, each handling different data.

### 4.1.5 Decoder

Decoder is an optional program provided with the Satellite software. Decoder automatically or manually reads in ASCII files of satellite data messages and extracts sensor values. As the values are decided they are made available in Decoders database for real-time access or logging to disk. Decoder uses SETUPSERV to obtain information on how to process each message that is received.

### 4.1.6 Setup Desktop


Setup Desktop is used to setup PCBASE2 base stations. The setup defines the stations, sensors, communication ports, poll groups and data files. Other features of Setup Desktop include the ability to edit and import 8200 setups. Setup Desktop works with the Setup Server described below so that all PCBASE2 programs can have access to the setup.

### 4.1.7 Mux

Mux is an optional program provided with the Satellite software. Mux interfaces the PC to a Sutron receive site multiplexor. The output of Mux is an ASCII file of satellite data compatible with Decoder.

## 4.2 Display software

### 4.2.1 Data Desktop

Data Desktop is used to work with the data files collected by the system. The program can display, graph, generate reports, and import/export data, and maintain data files. Select data by File or Station, double-click on listed parameters to select sensor values. A shortcut is located on the desktop.

### 4.2.2 Weather Monitor

Display program for rainfall data. Station, time span, and parameter can be selected. Data is read from the central download computer with a NETDDE connection. The program can be installed on any computer on the same network as the central download computer to display data. See figure 4.

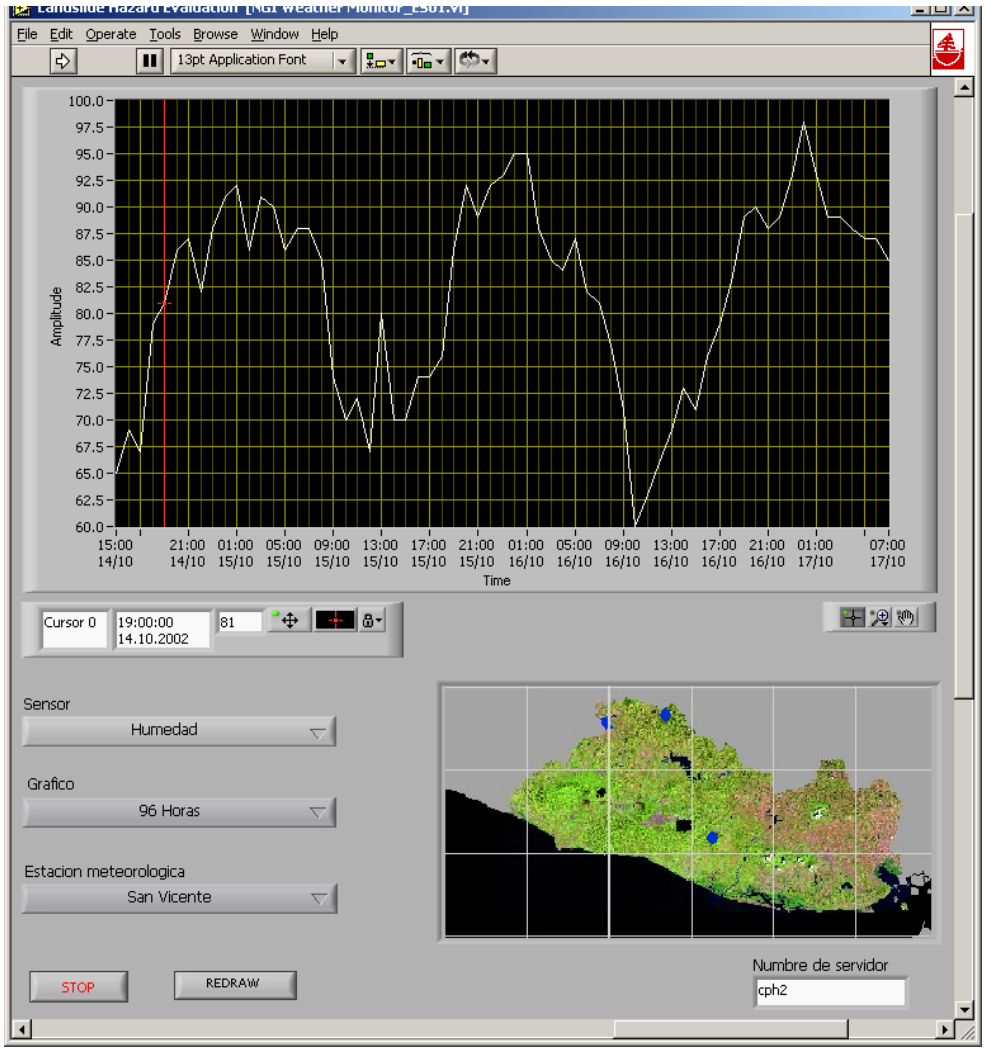


Figure 4. Weather Monitor Graphical user interface

### 4.2.3 Alarm Monitor

The alarm monitor gives an audio alarm, and sends e-mail messages to the listed recipients when a predefined rainfall level is reached during the last 3 hours. The alarm level is calculated from the accumulated rainfall during the last 96 hours and the last hourly reading according to the displayed formula. This connection between landslide risk and rainfall statistics ( landslip level ) is also presented graphically as shown in fig. 5. This alarm level is based on previous work carried out by NGI in Nicaragua. It is to be considered as preliminary and only to be used in the start phase of the project, before SNET has gathered more local data. The list of recipients, the decision criteria, and the decision level as expressed in percent of the landslip level can be changed when the program is running.
Note: Do not use <Enter> after changing parameters.

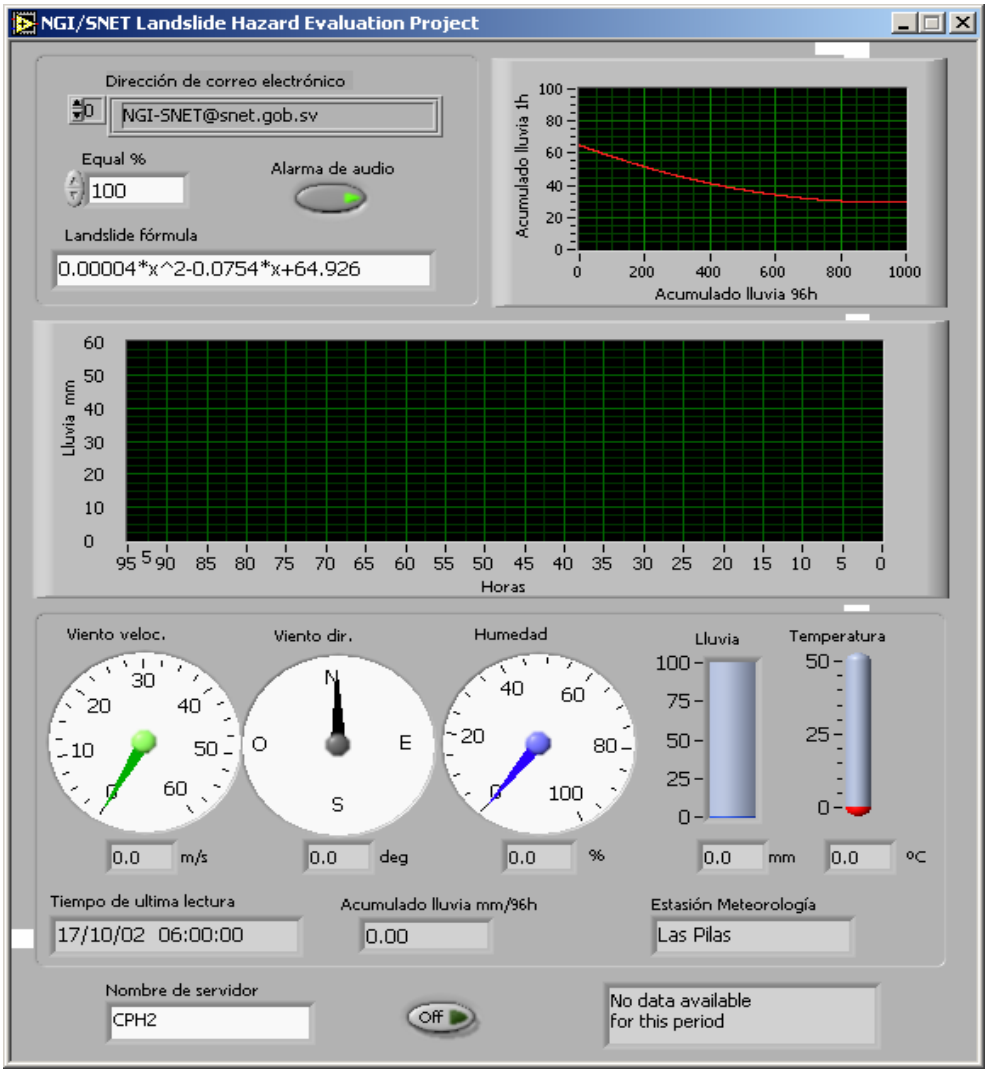


Figure 5. Alarm Monitor Graphical user interface

## 4.3 Folder structure/Utility programs

Note that these folders normally will reside in the computer that is running the download and decoding Pcbase2 software on a permanent basis.

### 4.3.1 C:\PCBase2\Raw

Contains raw data files (yyyymmdd.raw) which are automatically decoded. When processed a yyyymmdd.pos file is generated and located in the same folder. If these files are deleted the *.raw files will be reprocessed the next time Decoder is running. A backup of the *.raw files should be performed on regular intervals.

### 4.3.2 C:\PCBase2\Data

Contains the data files, (*.dat) which are the result of the decoding process. A backup of the *.dat files should be performed on regular intervals.

### 4.3.3 C:\PCBase2\Setup

Includes *.set files and *.bas files. The *.set files contains the setup for each 8210 station installed (see appendix B). These files can be uploaded to the logger unit if necessary by using the program TS8210.exe found in c:\pcbase2\utilities folder. SETMGR.exe in the same folder is used to convert the *.set files to readable ASCII character. The files should be updated (downloaded from the 8210) if system setting is changed.
The *.bas files are the source code for the Tiny Basic programs that are running in the 8210 units for calculation of statistics (see appendix B). The TS8210.exe program is used when file transfer to logger unit is necessary.

# 5 NOAA/NESDIS REQUIREMENTS

The satellite operator (http://dcs.noaa.gov/) requires that the DCS (Data Collection System) database is updated with station information. This includes station names, location, type, set-up information, and name and address of contact person. Access to this web page is approved when the correct user name and password is used.

## APPENDIX A : DRAWINGS

520149-001 3M Rainfall Station

# APPENDIX B : 8210 CONFIGURATION FILES

## Listing of the San Vicente setup

The Las Pilas setup is identical except the "UnitID" name, the "Satellite ID" and the transmission time "Timed Time" (see chapter 3.2)

```
MAIN SETUP                EEROM SETUP               PROTOCOL SETUP

Version=V40               TermMode=USER             MasterId=
UnitID=SANVICEN           UserRate=9600             RadioCarrierDelay=7
Interval=01:00:00         RadioRate=1200            RadioReplyDelay=0
TimeBetween=00:00:05      ComRate=9600              RadioAckDelay=100
SampleTime=00:00:00       DumpRate=9600             RadioNormalRate=00:00:
AverageTime=00:50:00      SDIRate=1200              00
ExcitationTime=00:00:0    EnterRequired=OFF         RadioAlarmRate=00:10:0
0                         DumpMode=ALL-BIN          0
Averages=120              UserTimeout=6666          RadioAlarmInterval=00:
LoggingRate=1             ExtPwrDelay=1             01:00
ExcitationMode=ON         AnalogDelay=5             RadioRetries=3
Enabled=ON                DruckDelay=5              UseRS485=OFF
BasicInterval=00:01:00    AutoKey=                  LongPackets=ON
BasicTime=00:00:25        PugnerBit=NORMAL          HWHandshake=OFF
Password=                 DateFormat=MDY            AutoDump=OFF
NumberResets=10           TermXmitDelay=0
LogSize=124928            BasicSize=3
RomCheck=48513            AmpGain=1.0

MODEM SETUP               GOES SETUP

DialOutEnable=OFF         TransmitMode=BOTH
AnswerMode=DATA           SatteliteID=50308454
NumRings=1                TransmitFormat=BINARY
ModemPassword=            LongCarrier=SHORT
DialInMsg=                TimedChannel=93
DialOutMsg=               TimedTime=00:49:00
PhoneNumber1=             TimedRate=03:00:00
PhoneNumber2=             TimedLogRecords=6
PhoneNumber3=             TimedLogTime=00:00:00
RedialTime=00:10:00       TimedLogInterval=01:00:00
                          International=OFF
                          RandomChannel=123
                          RandomRate=00:00:00
                          AlarmRate=00:20:00
                          AlarmXmits=2
                          AlarmInterval=00:04:00
                          RandomLogRecords=2
                          RandomLogTime=00:00:00
                          RandomLogInterval=01:00:00
```

```
; SENSOR SETUP -
Analog4
;
Sensor=Analog4
SensorNo=4
Name=HUMEDAD
EnableOn=ON
SampleOn=ON
LogOn=ON
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=100.0
Offset=0.0
DisplayOffset=0
RightDigits=0
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Analog5
;
Sensor=Analog5
SensorNo=5
Name=AIRTEMP
EnableOn=ON
SampleOn=ON
LogOn=ON
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=100.0
Offset=-40.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Encoder2
;
Sensor=Encoder2
SensorNo=11
Name=#DiaLluv
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Counter0
;
Sensor=Counter0
SensorNo=12
Name=Precipit
EnableOn=ON
SampleOn=ON
LogOn=ON
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Counter4
;
Sensor=Counter4
SensorNo=16
Name=#LastR
EnableOn=ON
SampleOn=OFF
LogOn=OFF
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=OFF
GroupNumber=
Control=
Trending=
HighAlarm=
LowAlarm=
ROCAlarm=
HiLimit=
LoLimit=
RateOfChange=
Deadband=
NamePhrase=
UnitPhrase=
```

```
; SENSOR SETUP -
Frequency0
;
Sensor=Frequency0
SensorNo=17
Name=#MaxAT
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Frequency1
;
Sensor=Frequency1
SensorNo=18
Name=#MinAT
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Frequency2
;
Sensor=Frequency2
SensorNo=19
Name=#MaxRH
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=0
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Frequency3
;
Sensor=Frequency3
SensorNo=20
Name=#MinRH
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=0
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Frequency4
;
Sensor=Frequency4
SensorNo=21
Name=#Racha
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Analog5
;
Sensor=Analog5
SensorNo=5
Name=AIRTEMP
EnableOn=ON
SampleOn=ON
LogOn=ON
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=100.0
Offset=-40.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
WindSpeed2
;
Sensor=WindSpeed2
SensorNo=23
Name=#DirRacha
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=OFF
SensorInterval=99:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=0
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
WindDir1
;
Sensor=WindDir1
SensorNo=26
Name=DirViento
EnableOn=ON
SampleOn=OFF
LogOn=ON
AverageOn=ON
SensorInterval=00:00:0
0
Slope=72.0
Offset=0.0
DisplayOffset=0
RightDigits=0
AlarmEnable=SLT1
GroupNumber=0100
Control=OFF
Trending=OFF
HighAlarm=OFF
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=0.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

```
; SENSOR SETUP -
Battery
;
Sensor=Battery
SensorNo=34
Name=BATERIA
EnableOn=ON
SampleOn=ON
LogOn=ON
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=1.0
Offset=0.0
DisplayOffset=0
RightDigits=2
AlarmEnable=OFF
GroupNumber=
Control=
Trending=
HighAlarm=
LowAlarm=
ROCAlarm=
HiLimit=
LoLimit=
RateOfChange=
Deadband=
NamePhrase=
UnitPhrase=
```

```
; SENSOR SETUP - Rain
;
Sensor=Rain
SensorNo=36
Name=Lluvia
EnableOn=ON
SampleOn=ON
LogOn=ON
AverageOn=OFF
SensorInterval=00:00:0
0
Slope=0.2
Offset=0.0
DisplayOffset=0
RightDigits=1
AlarmEnable=SLT1
GroupNumber=2100
Control=OFF
Trending=OFF
HighAlarm=ABOVE
LowAlarm=OFF
ROCAlarm=OFF
HiLimit=50.0
LoLimit=0.0
RateOfChange=0.0
Deadband=0.0
NamePhrase=0
UnitPhrase=0
```

## 8210 Basic Program

```
10 'Tiny Basic program for Met Stations
30 'Instantaneous Hourly AT/RH will be measured and logged by OS.
40 'Tiny Basic will take one minute reading of AT/RH and Log 24 hour Max/Min at 12:00:00Z
50 'WS/WD (VelViento/DirViento) will be a vectored average computed 10 min before the hour by OS
60 '24Hr gust(#Racha) and gust dir(#DirRacha) will be computed using TB and logged once at 12:00:00Z
70 'Accumulated Rain (Precipit) is computed using the OS with slope of 1 and offset of 0
90 '24Hr rain (DaiLluv) is computed using basic and is logged once at 12:00:00Z
100 '10Min Rain Intensity (Lluv10) is computed and logged once every 6 hours

180 If Q=0 then Gosub 3120
190 T=Time : H=Int(T mod 86400/3600) : M=int(T mod 3600/60)
200 A=Measure(Airtemp) : B=Measure(Humedad) 'Measure AT/RH
210 IF A>#MAXAT Then #MAXAT=A
220 IF A<#MINAT Then #MINAT=A
230 IF B>#MAXRH Then #MAXRH=B
240 IF B<#MINRH Then #MINRH=B
250 S=Measure(VelViento) : D=Measure(DirViento) 'Measure WS/WD
260 if S>#Racha Then #Racha=S : #DirRacha=D
270 'R=Measure(Lluvia) 'Measure Rain
280 'if R>#Lluv10 then #Lluv10=R
281 'Accumulate Daily Rain
282 P=(Precipit-#LastR)
283 if P<0 then #DiaLluv=#DiaLluv+((32767+P+1)*0.2)
284 if P>0 then #DiaLluv=#DiaLluv+(P*0.2)
285 #LastR=Precipit
290 'Check for the 0,6,12,18 hour and Log respective readings
310 'If (H=6) and (M=0) Then Gosub 2000
320 If (H=12) and (M=0) Then Gosub 3000
330 'If (H=18) and (M=0) Then Gosub 2000
340 'If (H=0) and (M=0) Then Gosub 2000
350 Stop
2000 'Log every 6th hour
2010 'Log T, #Lluv10, #Lluv10
2020 'Return
3000 'Log all 1200Z Values
3040 Log T, #MAXAT, #MAXAT
3050 Log T, #MinAT, #MinAT
3060 Log T, #Maxrh, #MAXRH
3070 Log T, #MinRh, #MinRh
3080 'Log T, #Lluv10, #Lluv10
3090 Log T, #DiaLluv, #DiaLluv
3100 Log T, #Racha, #Racha
3110 Log T, #DirRacha, #DirRacha
3111 Gosub 3120
3115 Stop
3120 'Initialization routine and Daily Reset
3125 Q=1
3130 #MaxAT=-99 : #MaxRH=-99
3140 #MinAT=99 : #MinRH=99
3150 '#Lluv10=0
3160 #DiaLluv=0 : #LastR=Precipit
3170 #Racha=0 : #DirRacha=0
3180 Return
```

# Kontroll- og referanseside/
# *Review and reference page*

| | |
|---|---|
| **Oppdragsgiver/*Client***<br>NGI<br><br>**Kontraktsreferanse/**<br>***Contract reference*** | **Dokument nr/*Document No.***<br>20021283-1<br><br>**Dato/*Date***<br>20 December 2002 |
| **Dokumenttittel/*Document title***<br>El Salvador: Landslide hazard evaluation<br>Rainfall Stations<br>**Prosjektleder/*Project Manager***<br>Oddvar Kjekstad<br>**Utarbeidet av/*Prepared by***<br>Klaus Tronstad | **Distribusjon/*Distribution***<br>☐ **Fri/*Unlimited***<br>☒ **Begrenset/*Limited***<br>☐ **Ingen/*None*** |
| **Emneord/*Keywords***<br>Rainfall station, rainfall, wind speed, wind direction, temperature, satellite communication, | |
| **Land, fylke/*Country, County***<br>El Salvador<br>**Kommune/*Municipality***<br><br>**Sted/*Location***<br>San Vicente, Las Pilas<br>**Kartblad/*Map***<br><br>**UTM-koordinater/*UTM-coordinates*** | **Havområde/*Offshore area***<br><br>**Feltnavn/*Field name***<br><br>**Sted/*Location***<br><br>**Felt, blokknr./*Field, Block No.*** |

**Kvalitetssikring i henhold til/*Quality assurance according to* NS-EN ISO9001**

| Kontrollert av/ *Reviewed by* | Kontrolltype/ *Type of review* | Dokument/*Document* Kontrollert/*Reviewed* Dato/*Date* | Sign. | Revisjon 1/*Revision 1* Kontrollert/*Reviewed* Dato/*Date* | Sign. | Revisjon 2/*Revision 2* Kontrollert/*Reviewed* Dato/*Date* | Sign. |
|---|---|---|---|---|---|---|---|
| FS | **Helhetsvurdering/** ***General Evaluation**** | | | | | | |
| | | | | | | | |
| FS | **Språk/*Style*** | | | | | | |
| FS | **Teknisk/Technical**<br>**- Skjønn/*Intelligence***<br>**- Total/*Extensive***<br>**- Tverrfaglig/** ***Interdisciplinary*** | | | | | | |
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| FS | **Utforming/*Layout*** | | | | | | |
| KT | **Slutt/*Final*** | | | | | | |
| JS | **Kopiering/*Copy quality*** | | | | | | |
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***On the basis of an overall evaluation of the report, its technical content and form of presentation***

| **Dokument godkjent for utsendelse/** ***Document approved for release*** | **Dato/*Date*** | **Sign.** |
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