IWMI Mobile Weather Station

Repair & Maintenance Manual

Contents

1 - Background description of the System

Pole structure

The Pole structure (Fig. 1) is variable according to the local make. It is most often steel and covered by rust resistant coating. The pole is dug into the earth and immersed in a concrete foot (rarely it is held by bolts/screws to a similar concrete structure).

Figure 1: NALLAMUDAWA_MAWATHAWEWA station

External weather sensors

The weather stations have three external weather sensors: wind speed, wind direction, and rain. The wind speed and wind direction are together on one arm and the rain gauge is separated from the other sensors. The earlier rain gauges were held on an arm near the wind sensors. The upgrade done in 2017 introduced a separated, WMO-certified rain gauge to the systems. These must be installed separately on a concrete platform, leveled and precisely set up. For continuity and logic, they have been set up within 3 feet from the manual rain gauges, when available and when the cable length permitted (default is 15 m).

Figure 3: Original (left), manual and WMO-certified rain gauges (right) in UO_ATHURUWELA.

Figure 4: Wind sensors in NALLAMUDAWA_MAWATHAWEWA station

Casing and Air flow

The casing for the electronics, battery and battery charger is a common pvc electric box (10’x8’x6’) found in most of the electric shops around the island. It is perforated on one side (with an iron soldering tip) to let air flow. Where possible, two used pc fans (8x8cm) are fixed inside the box, in opposite manner, so that one fan moves air from outside into the box, and another one moves air from inside to outside, to generate a constant airflow.

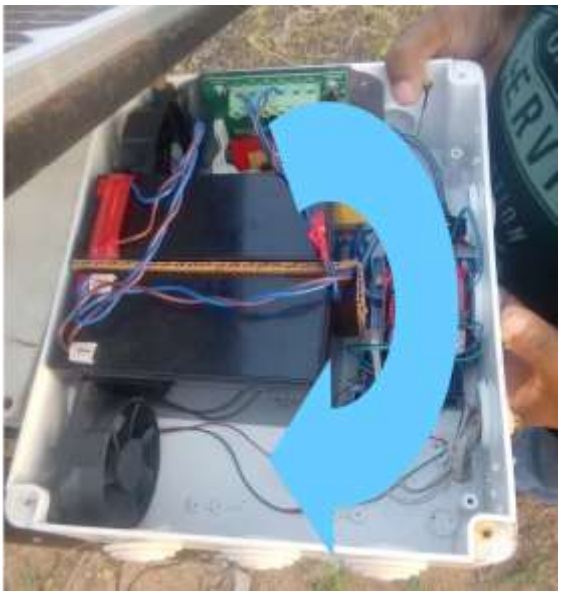

Figure 5: Air flow in a standard electric box (IP65:300x250x120)

Power supply subsystem

Power is supplied by a 20W solar panel mounted on the pole structure and connected to a solar battery charger, and a set of two identical 7Ah dry batteries (figure 5) connected inside the electrical box. The power components are available in electrical shops widely. Regulators are used to ensure a constant 5V input to the system (Figure 6), they are fitted with 2x capacitors of 64.104F values.

Figure 6: Regulator between solar controller and circuit boards

Communications

The communication subsystem is a sim900 standard GSM/GPRS circuit board, it has a sim card that sends SMS when needed.

Figure 7: sim900 circuit board on the Arduino Mega (below)

Arduino and weather shield

The Arduino Mega board is a large blue board at the bottom of the electronic circuits stack. It is the micro-controller, the “brain” of the machine. The weather shield, is typically a red board at the top of the electronic circuits stack. If it is made in Sri Lanka, the weather shield is blue. The weather shield is an analog to digital interface for the external weather sensors. It is also hosting a few sensors (temperature, humidity, pressure, light) onboard.

Figure 8: Weather shield (red)

Data logging

The data is logged all the time on a microSD card hosted on a coin size red circuit board. Normal activity on an 8Gb storage card would lead to ~5 years of 5 minutes data storage uninterrupted.

Figure 9: Data logger in the box

2 - Replacement & Maintenance

Pole structure

Despite anti rust-treatment, and painting, the hinges, soldered corners and pole top may suffer oxidation. Appropriate measures should be taken to track any corrosion, remove rust and reapply anti-rust treatment.

Figure 10: Signs of aging of the pole structure: rusting.

A test on stability of the pole should be done to detect any shaking or moving of the foot in the earth. Stability of the pole might be a concern with extreme dry or wet weather. Earth may separate from the concrete footing, giving the structure possibility to move, shake or lean. Radial concrete footing could extend the actual concrete, or similar extension of the base.

Figure 11: Pole structure leaning to the right in UO_ATHURUWELA

External weather sensors

Algae is often present on the plastic of the sensors, but most important is the mechanical properties of the wind sensors, some strong noise on rotation, or the absence of rotation is a sign of the end of life of the sensor, requiring replacement of that sensor.

Wind sensors are particularly sensitive instruments, and may fail to work, not rotating, or making stronger than usual noise. Replace them without waiting and return the damaged sensors to analyze the failure. Rarely, a failed wind sensor can be fully refurbished. However, it is usually less costly to replace the sensor, since replacements are cheap.

Figure 12: Original Raingauge after a year in the field

Rain gauges may be physically blocked by termites, spider webs, or other nesting insects (or nesting birds for large ones!). It is often a security issue to disturb some insects like bees or wasps. Precautionary measures apply. Removing the rain gauge and replacing it will allow for cleaning and diagnosing a faulty one back to office. Spare parts or a full replacement can be ordered easily.

Casing and Air flow

Physical damage to the box that does not endanger its structural integrity, should be sealed with a waterproof sealant. Screws of the box might have rusted, and should be changed to Inoxidable ones.

Fans may be stuck by dust, spider webs, ants/termites, etc. cleaning them should be enough to restore the airflow in the box. If the airflow was stopped in the April-June period, spend extra time inspecting the electronics (T>50-60 C with high humidity for a long time can damage electronics). Non-industrial grade electronics are not designed to work well above 60 C.

PC fans can eventually break or completely grind down their bearings. If so, the fan will be making a loud noise. Replace the fan.

Figure 13: broken fan, rusted aerial cable and misbehaving solar controller interface

Power supply subsystem

Batteries: A multimeter is needed to check the voltage and amperage of the batteries while in operation, first together, then individually. If battery output is low consider whether the previous days were particularly cloudy so that solar recharge was not optimum. If it has been sunny, battery output is still low, and the battery has been operating more than 2 years, replace it.

Solar Controller: Some solar controller interfaces (Figure 13) can age quickly. Bring a new solar controller at each service trip (5A 12/24V: locally available < 2,000 LKR).

Communications

The first sign that a weather station is not functioning properly is usually that the station is no longer sending SMS messages. The most common causes are:

- The location is too remote for a reliable mobile (GSM) connection. In this case, the station would not have sent any messages. Mobile signal strength should be tested before installation.
- The sim card has not been recharged. Prepaid sim cards have been used in the stations in the testing phase. The account balance on the sim cards must be adequate to continue sending text messages. Recharging the sim cards is possible on the internet. Using a post-paid account would eliminate this issue, and might also reduce fees, and increase reliability of the system.
- The system has suffered a power failure. A power failure could be caused by multiple cloudy days in succession when the solar panel is not able to keep the batteries charged, or by old batteries that are no longer charging a charge. When the weather station is not receiving adequate power, the weather station will turn off, but the solar

panel will continue to charge the batteries. The station will need to be manually switched back on by pressing the black on/off button on the solar controller (The button on the bottom right of Figure 13.)

Other types of communications failures may be more difficult to diagnose, and it might be easier to simply exchange the circuit boards with new ones, and bring the failing boards to office for a full diagnosis.

Arduino and weather shield

Arduino and weather shield failures are rare. However, high temperatures (>60 C) may result in failure. There were issues with Lanka Rain Water Harvesting Forum (LRWHF) Sri Lankan made weather shields for the first manufactured batch. The humidity sensor did not function in two cases. This was found very early in the deployment of the system, and a standard replacement solved the issue.

Over the longer term, high temperature and humidity in Sri Lanka can age the circuit boards prematurely. This was known from the beginning of the weather station design, and is one of the reasons why low cost off the shelf components were used: for easy/cheap replacement.

Data logging

The microSD card is to be manipulated gently, as one would do with a microSD card in a mobile phone. The data logger is small and is linked by soft jumper cables to the main boards, so caution is required so the connection is not broken. The data loggers support hot-swapping, so the microSD card can be removed (pressure-click-remove) and re-inserted (pressure-click-release) while the weather station continues to work. Please download the data and empty the card completely before re-inserting it in the data logger. It is even better to swap the microSD card with an empty one and return the microSD card to office for later download.

Our first set of stations had a problem in data logging. This problem can be caused by improperly uploading new instruction code to the weather station. When uploading new instruction code to the weather station operators need to remove the Rx cable of the Open logger that is plugged in the Tx pin of the weather shield. Failing to do so will result in the code uploading to the data logger, and not to the Arduino board, resulting in a non-operational data logger thereafter.

3 – Recommended Maintenance Summary

Regular maintenance is recommended to keep the weather stations functioning continuously and reliably. Those performing the maintenance should carry a full set of replacement parts and tools for repair. For the first year of testing, we recommend checking the devices monthly and whenever they stop sending sms messages.

Although many repairs can be performed in the field, carrying a full set of replacement boards that have already been prepared and programmed is recommended, so that the full set of electronics can simply and quickly be replaced in the field in case of a fault in any of the circuit boards. The failing boards can then be taken back to the office for troubleshooting. An entire spare electrical box with all internals ready and programmed makes replacement even quicker and easier. In this case, only the connection from the solar panel to the solar controller and the connections to the external sensors need to be changed in the field.

This section provides a summary of sections 1 and 2 with subsections listing the contents of a maintenance kit, a brief monthly maintenance checklist, and a brief trouble-shooting guide.

Maintenance kit

Tools:

- Screwdrivers (for opening the electronic boxes and mounting circuit boards)
- Pliers
- Wrenches (for adjusting pole structure if necessary)
- Rust treatment and paint
- Plastic ties
- Multimeter (for testing power supply)
- Water and towels for cleaning

Replacement Parts

- 8 GB MicroSD cards
- Wind direction sensor (Figure 3 and 4)
- Wind speed sensor (Figure 3 and 4)
- Rain gauge (Figure 3 and 4)
- pc fans (8x8cm) (Figure 5 and 13)
- Solar charger/controller (Figure 13)
- 7Ah dry batteries
- Arduino Mega board
- GSM/GPRS shield (Figure 7)
- Weather shield (Figure 8)
- GPS receiver board
- Data logger (Figure 9)
- Jumper Wires

Monthly Maintenance Checklist

- Check pole structure to ensure it is straight, stable and secure
- Check pole structure for any rust
- Check wind sensors to ensure they are clean and move freely
- Take cover off rain gauge and clean. Clean out any dust, spider webs, or other debris in the rain gauge that could prevent it from functioning properly.
- Clean solar panel
- Open electrical box
    - Check that fans are functioning properly
    - Replace microSD card so that data can be extracted.
    - Check battery power and capacity
    - Ensure that air circulation is not blocked

Field Troubleshooting Guide

The first sign of a problem with a weather station is usually that it stops sending sms messages. The following simple steps may help to get the station running again:

1. Charge the sim: Ensure that the mobile SIM account has been paid. Remotely recharging a pre-paid sim may be all that is necessary. Other trouble-shooting steps require physically visiting the station.
2. Press the power button on the solar controller: Open the electrical box and check if the fans are running. If the fans have stopped, it is in indication that the Arduino board stack (including the GSM/GPRS and Weather shields) are not receiving power. Also check if any of the LEDs on the Arduino board stack are lit. If the fans have stopped and/or the LED lights on the Arduino board stack are not lit, then press the black button on the bottom right of the solar controller. The fans should start running again and the LED lights on the Arduino board stack should start to light.

Even if the fans are running and lights lit, the power can be switched off with the lower right button and then switched on again, so that the device is reset. After a reset, the station should send an sms message to notify that it is initializing.
3. Check the mode of the solar controller: The first two steps above are usually enough to get the station running again. If the station still does not initialize, ensure that the solar controller mode is set properly. The LED lights at the top left of the solar controller should be lighting to show power is being received, and the display on the top right should be switching between 0 and 16. If not, press and hold the mode button on the bottom right for a few seconds. Then press several times to cycle through the modes until it gets to 16.
4. Test power supply system: If the station is still not initializing, use a multimeter to test the batteries and the power through the solar controller power input and outputs. Wires must be pushed hard into the solar controller to make a good connection.

5. Replace the electronics: If the board is still not initializing, simply replace the circuit boards (or entire electrical box) and bring the old boards back to the office for further diagnostics.