HANDBOOK RELATED TO BUOY SYSTEM FOR FRESHWATER QUALITY MONITORING PLATFORM (USER)

Call COLCIENCIAS 794 of 2017

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CONTENT

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2. PRESENTATION

The system described in this document is part of a social impact project financed by Colciencias - Minciencias, Boyacá Government and Colombia BIO Program; leaded by Santo Tomás Tunja Basic Sciences department in alliance with Andes University and Germán Franco Carbón SAS Company, from the municipality of Samacá. The system has the utility of allowing easy characterization of the state of fresh water by continuous measuring of 5 quality parameters (temperature, pH, oxide-reduction potential, electric conductivity and dissolved oxygen) using a semi-autonomous measurement unit.

3. INTRODUCTION

The importance that hydric resources have for regions' (one of them, Samacá) welfare, health and economy, where it is based on agriculture, livestock and mining [1], and has a high hydric potential [1] and, the fact of the pollution high risk that water can have in these regions, due to different activities [2], are relevant reasons for develop a solution to characterize the water in base of 5 quality parameters measurements, which consists of a system with energy autonomy that has the capacity to carry out measurements and visualize the respective results remotely, making easier monitoring the state of the water and giving to community the possibility of submitting the collected information to subsequent analyzes that indicate possible affections on rivers.

4. HANDBOOK OBJECTIVE

This paper, tries to give you easy instructions for handling this system, called "freshwater quality monitoring platform". Thus, you can understand the use of each system part, how you can assemble those parts and put them on a measure point (river, lake, dam or reservoir) and see the remote results.

There is included a calibration section and a glossary terms one, for help you (respectively) to make periodic sensors calibration and have a better understand of system components.

5. SYSTEM DESCRIPTION

1. Measurement unit

   a. Floater: square unit of 82 cm x 82 cm, made with PVC pipes of 3 inches, filled with polyurethane foam. It has 3 center holes for setting support structure on them.

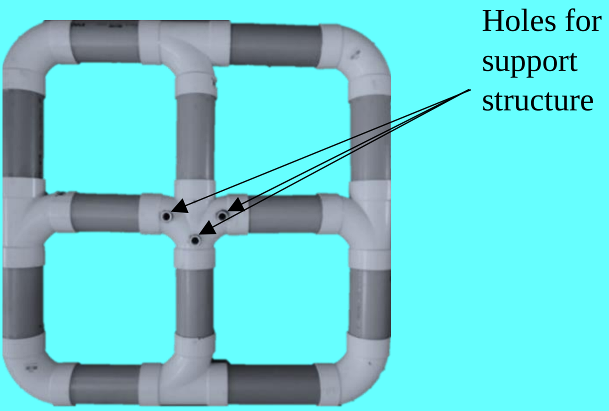

Figure 1. Floater.

   b. Support structure: CPVC pipes of ½ inches with height of 1 m and a central rectangular adjustable section. It lets both set self-secure the box and anchored with the floater. Furthermore, above rectangular section, it has 3 solar panels wings supports.

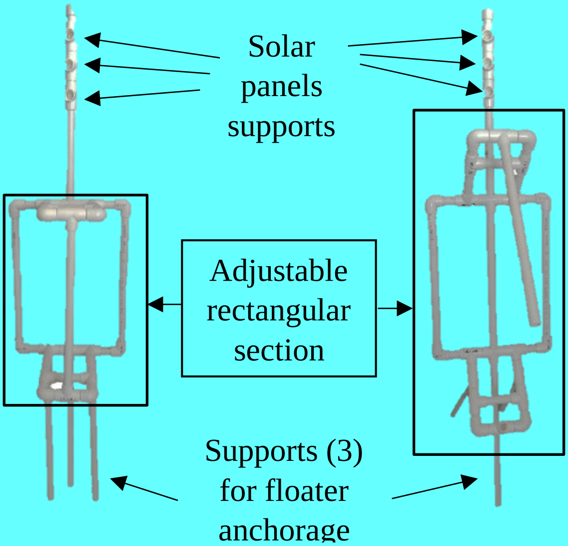

Figure 2. Support structure.

C. Measuring main box: 25 cm x 30 cm plastic box where are located electric devices of instrumentation and communication systems for water measuring and data sending. This box is screwed closed and has no enter for dust or water squirts (IP65). Also, it has a lateral key switch and other external components as antennas on the upper side, lateral sensor probes and solar panels' lateral connector.

Figure 3. Measuring main box.

d. Solar panels wings: 3 H CPVC pipes supports, each one with a solar panel. These wings are set on the upper side of the support structure, just above the box. They can turn around the central axis, tilt themselves and be removed. Panels' wires are attached with 1 connector, which is needed to be connected with its respectively pair, set on the box.

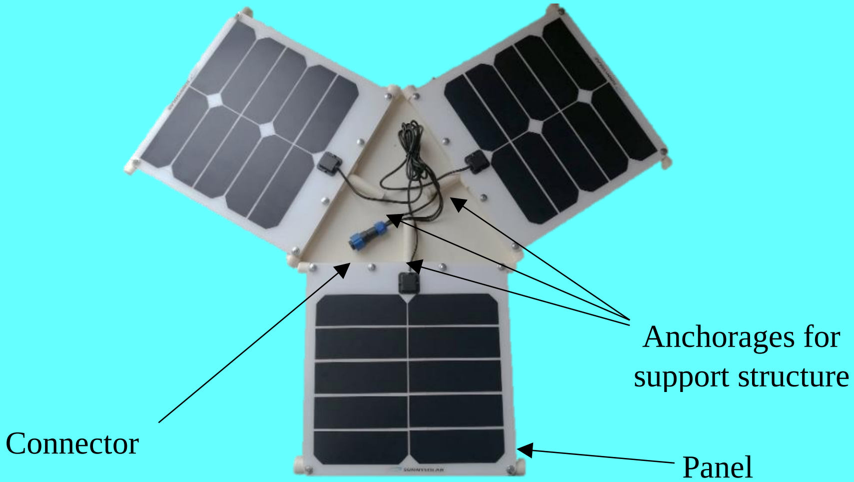

Figure 4. Solar panels.

e. Weather station: set of devices intended to measure climatic parameters such as wind speed, level of precipitation, temperature, humidity and others. It is fixed on top of the support structure.

Figure 5. Weather station above support structure.

2. Receiver box

a. Receiver box: small unit of 13 cm x 17 cm. It contents the devices that receive and save measuring data results for future display. Furthermore, the box has its own additional charger. It's needed to be connected to a power plug for the correct system operation.

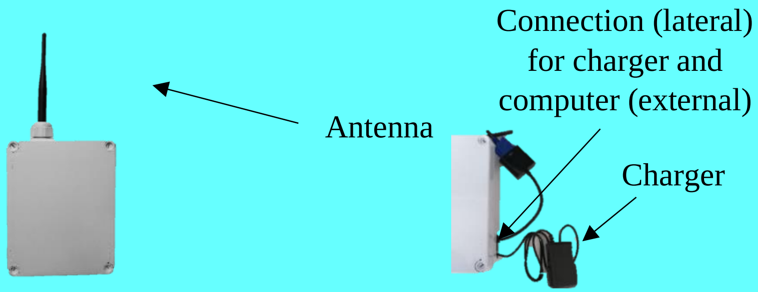

Figure 6. Receiver box.

b. Graphic User Interface for data display: shows measuring data results. "Alertas" label is shown for GPS lost or weak signal.

Figure 7. Graphic Interface.

6. SYSTEM HANDLING

Follow these steps for start the system operation:

a) Starting up

1. Put the receiver box in a location with mobile (cellular) signal.

2. On the side of the box, connect an HDMI cable to display the information on a monitor or TV. Then, connect the charger to turn on receiver box.

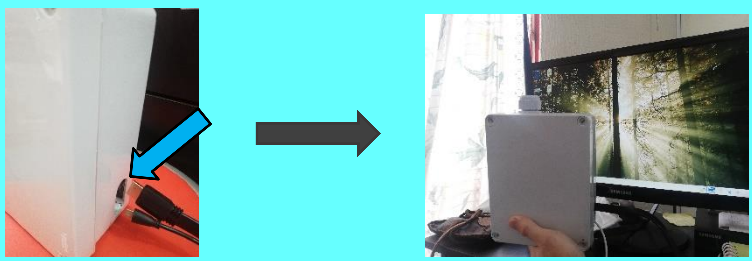

Figure 8. Receiver box connection and starting.

3. Search "interfaz.py" file at main window. Using a *mouse*, open it and run with the green button of the top bar. Thus, you can see the graphical interface for data display.

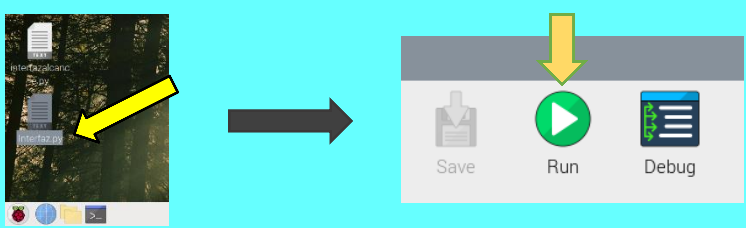

Figure 9. File execution for data display.

4. Go to the place where you have to take the measures.
5. Set and secure the measuring unit box on the support structure (remember to handle antennas and other external elements with caution).

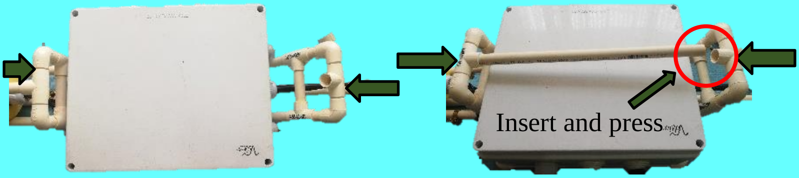

Figure 10. Getting secure main box on support structure.

6. Check if 3 antennas (GPS, Sim, XBee) are connected. Otherwise, connect them.

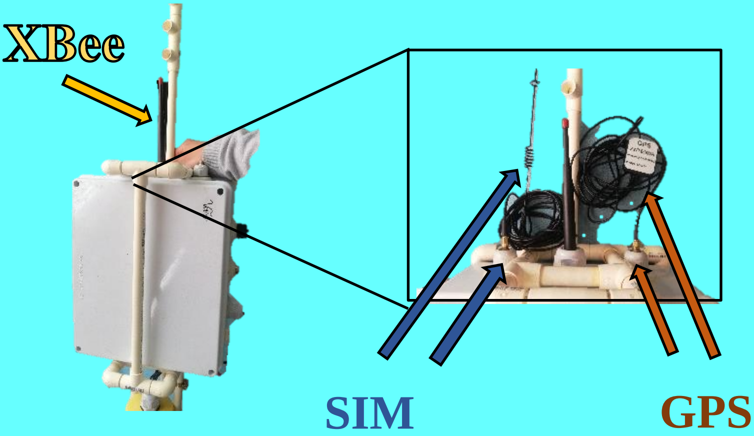

Figure 11. XBee, SIM and GPS antennas connection.

7. Anchor the support structure to the floater.

Figure 12. Anchoring support structure to floater.

8. Secure the wings of the solar panels so all 3 can receive sunlight and connect them to the box.

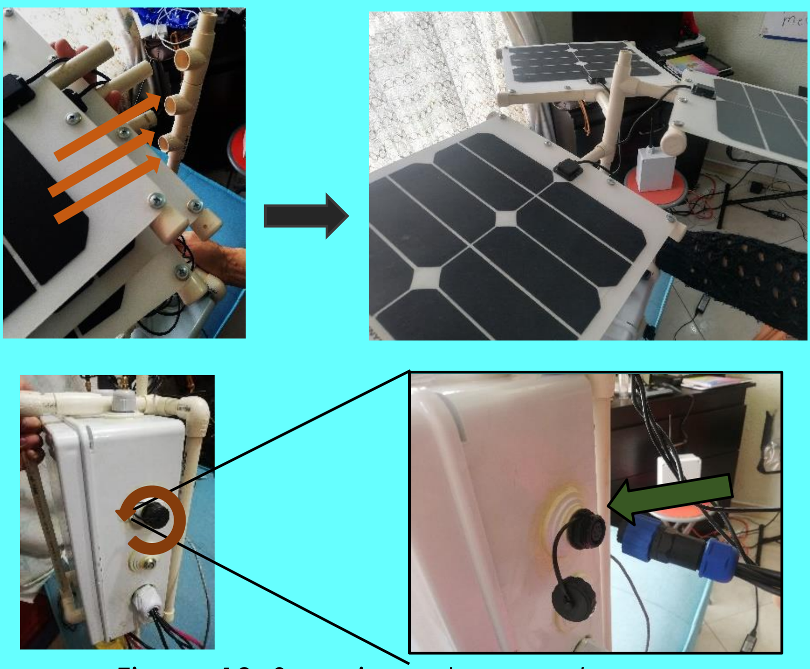

Figure 13. Securing solar panels.

9. Set weather station on the top of support structure.

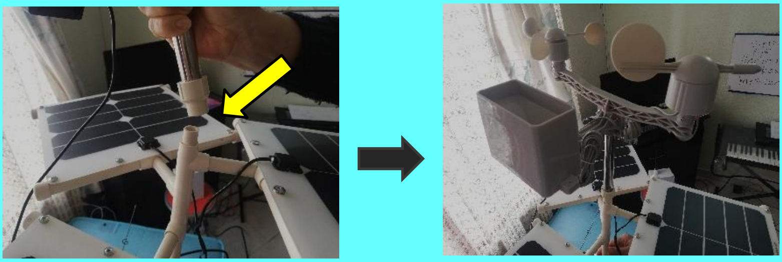

Figure 14. Securing weather station above support structure.

10. Turn on the measurement unit using the lateral key switch (turn it clockwise).

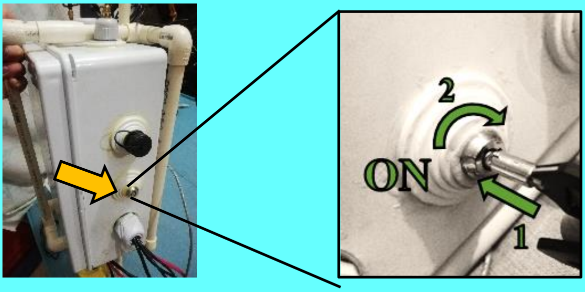

Figure 15. Turning on measurement unit.

11. Carefully remove the protections from the sensor probes (without spilling the liquids) and keep them.

Figure 16. Removing probes protections.

12. Put the measuring unit on the body of water to be measured and leave it there for the measurement time you need.

13. Use your mobile phone app for receiving data measuring results. Also, you can check them on your email inbox (sent from boyacentralsamaca@gmail.com). You can see your data results on the receiver unit interface too.

b) After measuring

1. After measurement finish, remove your measurement unit from the water.

2. Wash the sensor probes with pure water (preferably distilled or deionized). Shake them without hitting them and put them their respective protection. Make sure the liquid-protected sensors have enough. If not, pour a little into the bottle (see calibration guide).

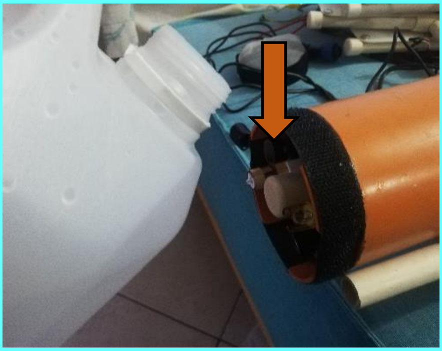

Figure 17. Washing sensor probes.

3. Turn off the box of the measurement unit (turning the key anti-clockwise) and disconnect the solar panels.

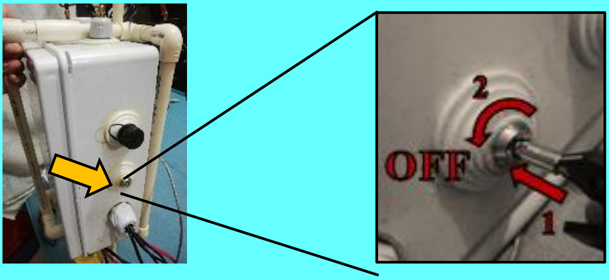

Figure 18. Turning off measuring unit.

4. Remove weather station from the support structure.

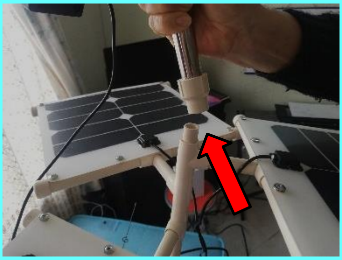

Figure 19. Weather station removing.

5. Carefully remove the solar panels wings.

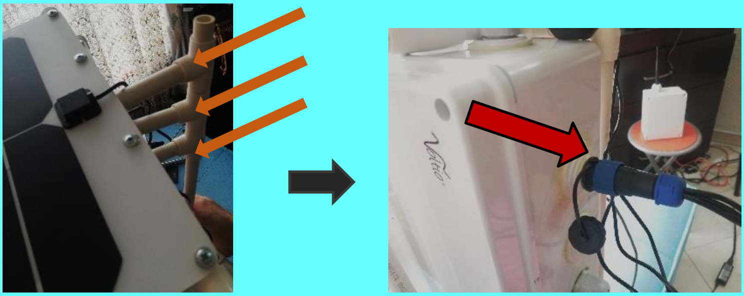

Figure 20. Solar panels removing.

6. Remove the support structure from the floater.

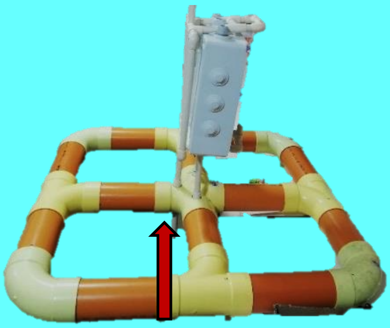

Figure 21. Removing support structure from the floater.

7. Disconnect GPS and Sim module antennas.

Figure 22. SIM and GPS antennas disconnection.

8. Press "*salir*" button of the data interface. Then, choose start option and turn off the receiver box with *shutdown* option.

Figure 23. Turning off receiver unit.

9. Disconnect receiver box charger.

Figure 24. Receiver box disconnection.

7. RECOMMENDATIONS

- Read carefully whole manual.

- For normal operation be sure of bring an Internet data plan for both measuring unit (3103915058 of Claro) and receiver unit (3218986965 of Claro).

- The measuring unit box avoids water to filter inside. However, it is recommended not to immerse it or put it in direct contact with water (with the exception of the sensor probes), to avoid future damage to the other external components.

- Do not open the box of the measurement unit or the receiver unit one.

- Handle the solar panels with caution.

- When making measurements, ensure that the measurement unit could not be washed away by water currents (as the case may be).

- Store in a clean and dry place.

- Do not lose the on/off keys.

- Make sure that the sensors that need liquid protection (pH and ORP) have enough. If not, pour a small amount into its jars.

- Do the sensors calibration at least once per year (see calibration guide).

8. DATA DISPLAY

Data display can be done in different ways, making it easier for the user to be actually the final destination of the information of the measurement results. This has been indicated in step 10 of section 6, "Use and operation" of this document, where there is the possibility of viewing the data in the interface shown in Figure 6 in section 5, "System description" as well as in the email and text message inbox of assigned addresses. However, the system can also be linked to a mobile application and a WEB server.

9. CALIBRATION GUIDE

In this section, the considerations for the calibration of the sensors are briefly detailed, which is recommended to be done once per year. However, technical assistance is required in this process.

Calibration liquids	Sensors	Variables	Values
	-	pH y ORP (liquid protection)	Don't applies
		pH	4, 7 and 10
		Oxide-Reduction Potential (ORP)	225 mV
		Electric Conductivity (EC)	12880 µS and 80000 µS
		Dissolved Oxygen (DO)	0 mg/L
Don't needs		Temperature (RTD)	Don't applies

Table 1. Sensors and calibration liquids [3].

Calibration

Once the prototype has been implemented; it must be calibrated following the steps established by the sensors manufacturer, atlas-scientific. The following are the recommendations and procedures to take into account for this calibration:

The most important thing in calibration is the continuous observation of the data that is acquired through any sensors. A constant value should be evidenced if the probe is in the calibration process.

- pH: In small containers (one per liquid), pour a small amount of each liquid. Make the calibration at each point, immersing the end of the probe in each container (it is necessary to stabilize the measurements in each case) in the following order:

1. pH 7 (middle point).
2. pH 4 (low point).
3. pH 10 (high point).

Three point calibration provides high precision over the full pH range, these three values 4.00, 7.00 and 10.00 should be considered as calibration standards. The relationship of the calibrated points to the total pH range is shown below.

Figure 25. pH range with three point calibration [4].

- ORP (Oxide-Reduction Potential): The ORP probe calibration protocol indicates that its calibration depends on a single verification point, for which purpose a 225 mV calibration solution is used, where the probe is immersed until stabilizing the measurements obtained. It is recommended to perform this calibration at least once a year.

Figure 26. ORP probe calibration process [5].

- EC (Electric Conductivity): For the calibration of this sensor, you must have liquid solutions in the order of µS, then, in small containers (one per liquid), pour a small amount of each liquid and shake the probe to avoid air bubbles accumulated in the sensor area. Make the calibration at each point, immersing the end of the probe in each container, it is necessary to stabilize the measurements in each case with a maximum range of 40% in the following order:

1. 0 µS (Air calibration).
2. 12,880 µS (low point).
3. 80,000 µS (high point).

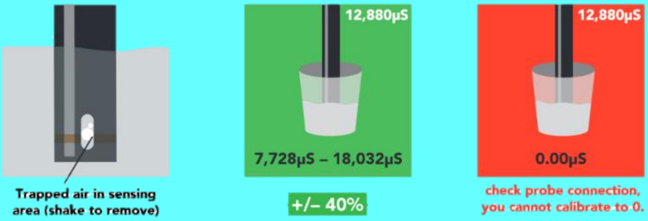

Figure 27. EC probe calibration process [6].

- DO (Dissolved Oxygen): For the calibration process, the probe must first be exposed to air until data stabilization (air calibration). Then insert the probe into the container until the measurements stabilize. It must be set by programming to 0 mg / L (liquid calibration).

Figure 28. DO probe calibration process [7].

10. GLOSSARY

Antenna: wire or copper thread which makes easier data sending.

Buoy: floating unit.

Calibrate: adjust an instrument or sensor to a specific measurement (pattern).

GPS: Global Position System module which gets objects and people location.

Pour: put a little quantity of liquid into a cup.

Probes: measuring ends of the sensors. They can be submerged (only probes).

Receiver: unit capable of receiving data or information.

Semi-autonomous: with some autonomy. In this case, the measurement unit takes the measurements by itself, but its setting and movement depend on the user.

Sensors: instruments for measuring water quality variables.

SIM: communication system whose functioning is similar to mobile one.

Solar panel: square unit with the ability to convert solar energy into electrical energy.

XBee: wireless communication module. It can transmit data too far (about 100 m – 24 km).

11. REFERENCES

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