3.4.2: STMS – Water monitoring implementation manual

Work package 3. Testing

Activity 3.4. Development and implementation of short-term monitoring solution

Project acronym: EcoSUSTAIN

Project name: Ecological sustainable Governance of Mediterranean protected Area via improved Scientific, Technical and Managerial Knowledge Base

Programme priority axis: Priority Axis 3. Protecting and promoting Mediterranean natural and cultural resources

Programme specific objective: 3.2. To maintain biodiversity and natural ecosystems through strengthening the management and networking of protected areas

Document: Public/Confidential			
Responsible partner: RGO **Involved partners: All**			
Version	**Status**	**Date**	**Author**
1	Draft	27.11.2018.	RGO
2	Final	04.12.2018.	RGO
Notes:			

Table of Contents

Table of Figures

1 Executive Summary

The goal of the EcoSUSTAIN project is to maintain biodiversity and natural ecosystems through strengthening the management and networking of protected areas by means of the following specific objectives:

- increase management capacity of protected areas by developing integrated management and networking methodology;
- increase management capacity of protected areas by developing joint state-of-the-art water quality monitoring systems;
- create favourable transferability conditions to expand outputs to other protected areas of the Mediterranean basin.

As the leader of the work package 3 (WP 3 Testing), RGO was in charge of developing the in-situ short-term monitoring solution for water quality, to be implemented in four protected areas. This innovative ICT system we developed within the project detects an increase of certain pollutants in the water and notifies designated recipients in real time.

This water quality monitoring implementation manual for the short-term monitoring solution (STMS) contains detailed description of the process of implementation – from the inception of the idea, analysing the needs, finding the appropriate hardware and hardware vendors to the software implementation and using the system.

2 Defining the needs

As with any problem, the first step is to identify it. In case of water quality monitoring this means identifying the needs or answering the most important question:

What water quality parameters are the most important for this particular body of water?

To answer this question perform a risk analysis to find the most dangerous sources of contamination/pollution, think about other changes that can affect water quality (e.g. climate change) or simply pick the parameters you wish to monitor for any other reason (e.g. scientific research, etc.).

Water bodies within the EU are required to be monitored for water quality by EU law (Water Framework Directive) and national legislation should also be considered. This manual isn't made to cover this specific purpose but in case the water body is not being monitored by some national agency keep this in mind.

Figure 1 - Lake Visovac in National Park Krka

Once you know what you want to monitor, you can choose which sensors you'll purchase during the following stages of implementing the short term monitoring solution.

3 Identifying and analysing the optimal location(s)

To choose the location several factors need to be taken into account, including the homogeneity of potential pollution or water quality changes which affects the representativeness of the site for the entire waterbody. In case of heterogeneous changes to water quality, the best location for placement of sensors would be the place that is most likely to be affected by the pollution/changes in water quality terms , i.e. a location closest to the pressure/inflow which allows the sensors to act as an early alert system.

It is important to be aware of the salinity of the body of water that is to be monitored so take a note if the chosen body of water is seawater, brackish or fresh water, this information shall be important when picking the hardware. Another factor to take into account is the flow speed in case of a buoy installation. Rivers with high flow require bigger and more stable buoys to ensure safety of equipment. Finally, available depth at the measurement site location can be a factor, so try to estimate an expected minimum and maximum available depth at the location.

Available infrastructure is also quite important to be considered, i.e. availability of electricity and internet connectivity on or near the chosen location.

In most cases, solar power is the simplest solution since the power network is usually not nearby in case of fixed installation on or near the shore and especially so when a buoy is used.

Internet connectivity is mandatory for remote readings, so it is important to find out the options available to you at your location. The preferred option is mobile internet (2G/3G/4G) because of the price of both the hardware and the subscription, but check the network coverage on your site. In case there is no coverage, satellite data is an option but a more expensive one.

This process should enable you to pick which installation type suits you best. Simply pick any combination options provided for the installation, power supply and internet connectivity:

- Fixed shore based installation / buoy based installation
- Fixed power supply with a direct connection to a power network / solar powered
- Wireless or fixed internet connection from nearby infrastructure / mobile internet connection (2G/3G/4G) / satellite internet connection

In case you have identified multiple locations where you'd want to perform the in-situ monitoring of water quality, perform this complete analysis for each location separately.

4 Purchase of hardware

The previous two steps should have resulted with all the necessary information to successfully facilitate the purchase of hardware. Research the market and find several vendors of water quality monitoring hardware or complete solutions. Ask for a quotation while providing them with the following data (results from previous steps):

- A list of parameters which you would like to monitor – they shall provide you with a list of sensors that can cover the parameters. Depending on the number of sensors needed, they shall provide you with an appropriate base multiprobe unit as well.
- Type of installation (fixed or buoy) – hopefully they sell complete solutions or already have contacts/partners that can provide you with the buoy or mast for installation.
- Type of water (sea, fresh, brackish) – this information is important for the vendor to choose the appropriate type of probes/sensors.
- Flow speed – mostly important because of the type of buoy in case the buoy installation is chosen.
- Available depth range (expected minimum and maximum water levels throughout the year) – this information is important for picking the appropriate buoy/mast for installation.
- Available internet connectivity options (fixed/Wi-Fi/GSM/Satellite) – depending on the GSM coverage or availability of Wi-Fi the vendor can offer the most affordable solution.
- Available power sources – in case there is potential to use the power grid make sure to inform the vendor, otherwise solar power is the best approach, but make sure to take into account the amount of sunlight available. Also let the vendor know how much autonomy you'd like (how long the system should be able to operate only on the battery (i.e. no sunlight available).

Again, in case there are multiple measurement sites, provide this data for each site individually.

Here is a list of the hardware components that are required for a successful implementation of an in-situ water quality monitoring system:

- **Buoy/mast**
  - Available depth/water flow speed.
  - Must be able to hold the multiprobe base unit, battery, solar panels (if they are being used) and the data logger.
- **Multiprobe base unit**
  - Needs to be able to hold the chosen sensor probes.
  - In case of optical sensor heads a wiper is recommended (it also takes one spot in the multiprobe base unit).

- **Sensors (sensor heads)**
  - The resolution and reliability of measurements are a factor so make sure you are getting sufficient accuracy based on your needs.
  - Different types of sensor require different maintenance – optical sensors can work for much longer unsupervised and there isn't much else to be done for maintenance other than cleaning the sensor heads.
- **Power source**
  - In case of solar panels, keep in mind that the power needs to be able to charge the battery sufficiently when sunlight is available.
  - The number of solar panels can improve the input power and can also influence the percentage of time the panels are getting sunlight (different orientation configurations are available).
  - Solar panels also require a regulator that can provide an output appropriate for the battery.
- **Battery**
  - The battery needs to provide the correct voltage and amperage to power the system.
  - The capacity of the battery should be based on the required autonomy and the total power drain of the system (the power drain is mostly affected by the frequency of taking measurements and the frequency of sending the measurement data to the server).
- **Data logger**
  - Should be compatible with the multiprobe base unit to collect the data from the sensors (compatible connections).
  - Preferably contains local storage for situations when internet connection might not be available.
  - Should send data to the remote location (server) for storage.
- **Internet connectivity module**
  - GSM (2G/3G/4G) in most cases where there is sufficient GSM coverage.
  - Can be integrated with the data logger.

In case you followed the guide so far and the requirements were well thought out, all offers should be of satisfactory quality, so check the hardware specification and in case everything is in order pick the cheapest one. In case funding comes from an outside institution, government or an international programme, make sure to follow all the rules of that programme (e.g. EU funded projects).

5 Hardware installation & configuration

Once the hardware is acquired, the next step is installation. Depending on the type of installation, different approaches are required. In case the staff of your organization doesn't possess the required technical knowledge to perform this installation, consider hiring an external company to perform this work. Sometimes the vendor that provides the hardware also provides the service of installation. In this case communicate with them and make sure to prepare everything they need (e.g. buoy anchor and chain, any information about the location that they wish to know, prepare the place where the mast would be in case of a mast installation type, etc.).

Figure 2 - Installation and commissioning of the buoy

The main topics that need to be covered in this phase are:

- Installation of multi-sensor probe on the buoy/mast – this might require some adaptive tubes or extra material, explore these requirements in advance in case the buoy is not made primarily for this purpose.
- Installation of solar panels, battery, communication module (e.g. GSM modem) and data logger on the buoy/mast.

- Anchoring the buoy or necessary construction work to fix the mast into the ground – in case of a buoy type of installation, keep in mind that an anchor needs to be provided as well as a chain of appropriate length and strength.

Some hardware also needs to be configured, so make sure that everything is properly connected and configured before leaving the installation site. The most important is that the data logger is configured to send the measurement data to the desired location.

Figure 3 - Buoy installed on location

Some types of sensors need to be calibrated before use, keep this in mind and follow the instructions of hardware manufacturer.

6 Software

Bigger hardware manufacturers offer their own software solutions. After defining your specific needs explore this option and see if their software solution covers all your requirements.

Again, start with asking yourself what do I need the software to do? Identify the potential users of the software and what you want to do with the data.

Figure 4 - A report sample from the EcoSUSTAIN STMS solution

Here is a list of potential functionalities that the software could have and decide which ones you want:

- **Collection of water quality related measurements** – The primary functionality from the software is to collect all the measurement data and store it within a database.
- **Export measurement data** – To use the data outside of the application, it needs to be exported. Usually the data is exported to an Excel spreadsheet or a comma

separated values format (CSV). This is useful for data analysis and sending the data to third parties (e.g. scientific community).

- **Publicly available water quality information** – In case you wish to present the live measurement data to the public, look for software that can be configured for public access of certain parts or perhaps has a widget available which can be installed on your web site.
- **Creation of water quality monitoring reports** – In case you wish to create reports automatically for given periods. A simple report could contain some free text and automatically generated graphs with measurements from the selected period, along with minimum, maximum and average values of monitored parameters.
- **Alarms** – Perhaps the most important feature for your protected area, it notifies the subscribed users when any of the parameters go outside of the acceptable range (minimum and maximum available values should be configurable for each parameter by the user i.e. you). The notification can be sent via email, SMS or through a push notification on your mobile phone.
- **Other features** – In case you think of any other features you'd like to have, make sure you find a solution which contain these features as well.

In case the already available software solutions do not fulfil your needs, explore hiring a development company that can create software tailor made for you.

7 User training

The water quality monitoring software should be quite simple, but it is good practice to organise a training session with all potential users to introduce them to the software and show them all available features and how they are used.

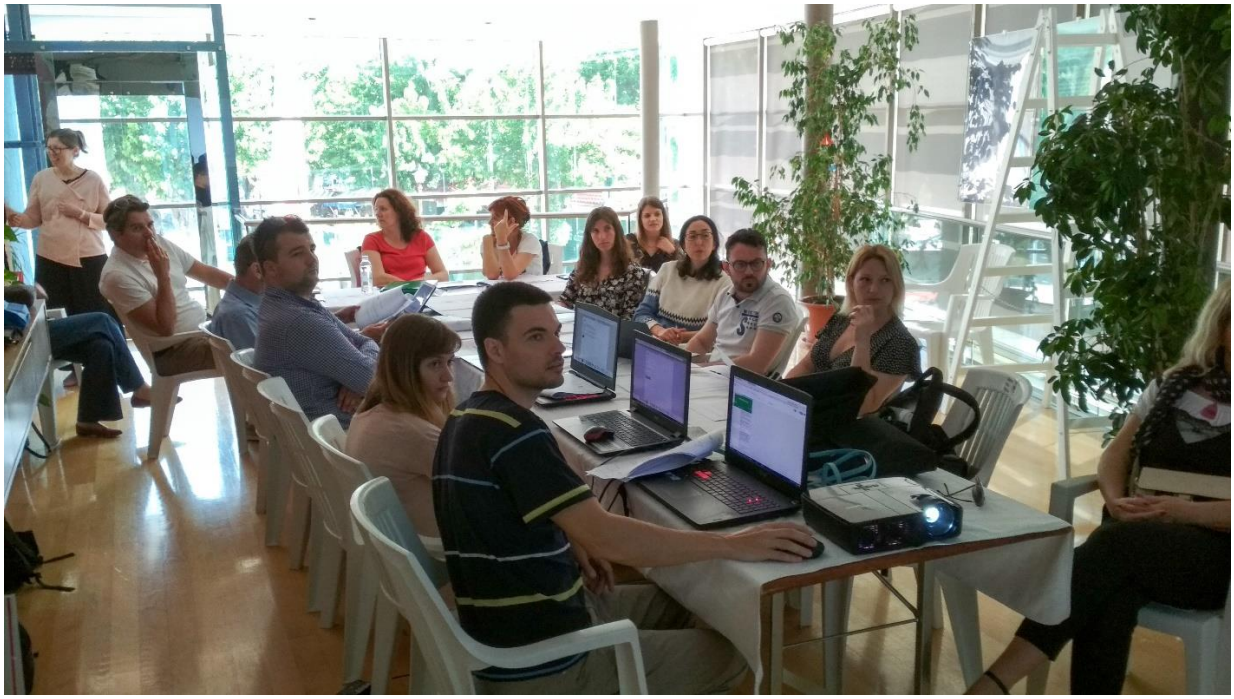

Figure 5 - Training course for STMS in Skradin

8 Maintenance

Finally, once everything is set up, regular maintenance of the equipment is crucial for optimal performance and longevity of the system. Follow all official guidelines for maintenance of the equipment provided by the hardware vendor.

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