Water Quality Integrated System (WQIS) User Manual

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Water Quality Integrated System (WQIS)

User Manual

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This manual was drawn up during the activities foreseen in the EU INTERREG Watercare project.

After the design and implementation of the WQIS in the pilot site of Fano, the authors have drafted this manual in order to be used for field operation by all partners of the project.

For more information about the WQIS, you can refer to the deliverables of the project that you can find at this link.

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1 MANUAL REVISION INDEX

Revision	Issue Data	Authors	Revision Description
0.1		Pierluigi Penna, Fabrizio Moro	First revision
0.2	2020-09-20	Elisa Baldrighi	Second revision
0.3	2020-09-21	Vedrana Špada	Third revision
0.4	2021-12-10	Pierluigi Penna, Fabrizio Moro	Final revision

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2 SOP - STANDARD OPERATING PROCEDURES

REAL-TIME DATA
Meteo – CTD – DO – Level

SAMPLING IN PROGRESS?

YES — NO

Next interval reached?

NO — YES

START EVENT Trigger *

NO — YES

WQIS – Alert
Start Automatic Sampling

Next n-Bottle filling

First Bottle filling

MANUAL SAMPLING
- Samples at sea
- Other manual samplings

AUTOMATIC SAMPLING

Last bootle?

NO — YES

WQIS – Alert
Automatic Sampling Ended

visual inspection of the collected samples

All right?

NO — YES

See Isco Avalanche Sampler manual (section 4) or Contact the technical support

collection of samples taken from the automatic sampler (see section 4)

Laboratory analysis

SAMPLES ANALYSIS
(see section 5)
Record the results of the analyzes using the specific web interface

Replace the carrier with clean Bottle and check the correct positioning (see section 4)

DATA VISUALIZATION
(see section 6)
displays the data recorded in real time and the analysis data

Press the ready button

WQIS – Alert
Automatic Sampler Ready to sample

SITE MANAGEMENT
(see section 3)
Access to the sampler management interface
- Manually set a sampling start date and time
And/or
-Set rain trigger limit
- Set other trigger condition
- Floodway trigger event
-Set sampling interval

* EVENT TRIGGER
- Consistent rain event in the next few hours;
- floodway event forecasts;
- another event to consider for the start of sampling;

WQIS – Alert
Event Trigger

3 SITE MANAGEMENT – Web Interface

3.1 INTRODUCTION

This web tool has been designed to remotely activate the sampling cycle and to have a quick look at the events and the progress of the system. It is reserved to Scientific site manager, a core actor of the WQIS system planned for each study site.

In collaboration with project staff, the Scientific Site Manager is in charge of consulting the WQIS and seen the weather-marine forecasts. Then decides the strategy to be applied and is responsible for starting the sampling cycle. It also coordinates all logistic activities related to sample management.

3.2 LOGIN

From the map on Watercare Sites page click on the markdown focused on the your project site (Figure 1) and then press on *Site Management* link (Figure 2).
In the login form (Figure 3) insert the username and password assigned to Scientific Site Manager and then press the *Enter (Accedi)* button.

Figure 1 - Watercare Sites Map.
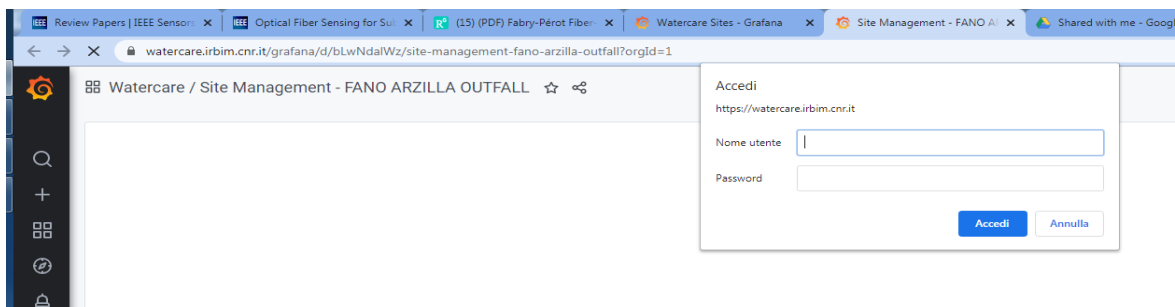
Figure 2 - Popup with Site Management link.

Figure 3 - Site Management, Login form.

3.3 WEB INTERFACE

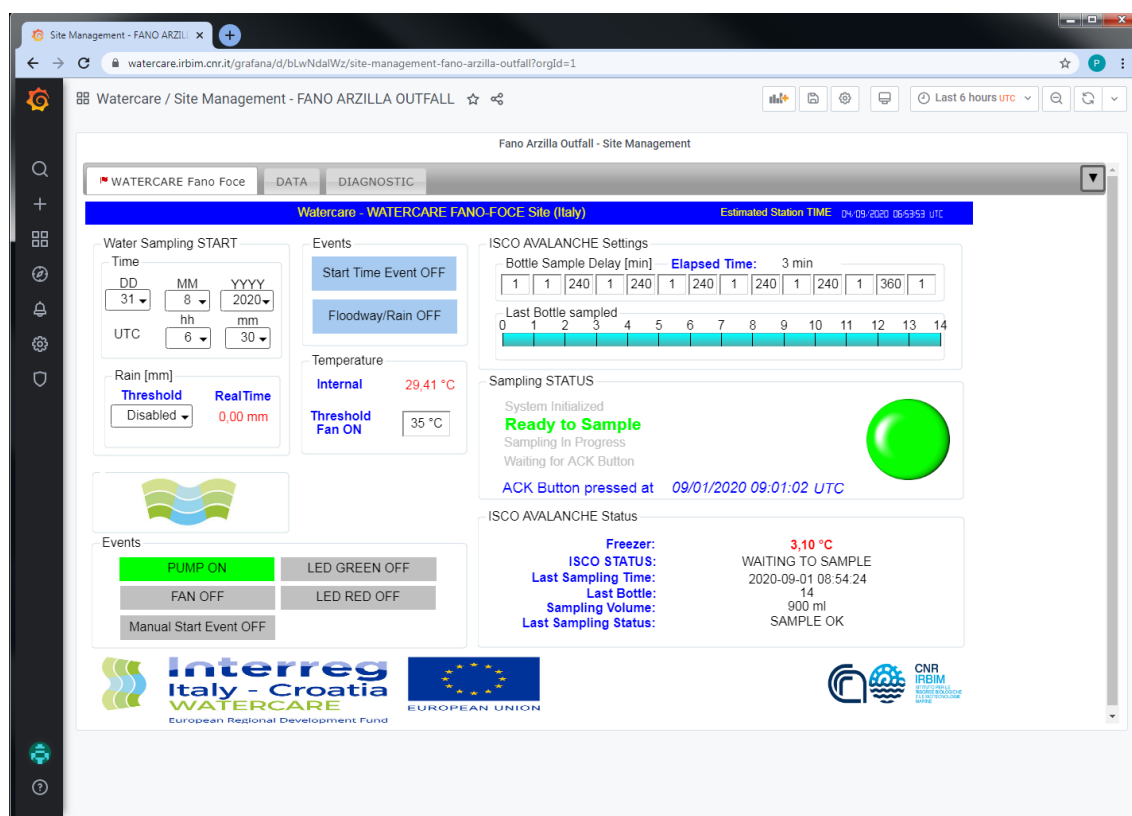After login, you have access to the web interface which is described below.

Figure 4 - Site Management web interface.

3.4 ISCO AVALANCHE SETTINGS

Before starting sampling (or during for subsequent samples), the user has to set the *Bootle Sample Delay (*Figure 5*)*. The value to be set indicates the delay time in minutes between the bottle [n-1] and the bottle [n]. In the example illustrated above, after the time or rain event, the bottle [1] will be filled after one minute. Once the bottle [1] has been sampled, after 1 minute the bottle [2] will be sampled. You will have to wait 240 minutes (4 hours) to sample the bottle [3] and so on up to the bottle [14]. Keep in mind that in the activation times of the automatic sampling it is necessary to consider the times derived from the pumping and purging cycles as well as the length of the suction line of the sampler.

The delay values corresponding to the bottles still to be sampled can be modified during the automatic sampling cycle (except bottle 1 and 2). The site manager can thus better manage the sampling strategy based on weather forecasts or logistics management.

Last Bottle sampled progress bar indicates the last bottle sampled.

Elapsed time indicates the minutes elapsed since sampling the last bottle.
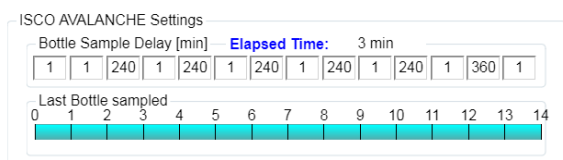
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Figure 5 - Isco Avalanche Settings.

3.5   Water Sampling START

Figure 6 shows the Water Sampling START form which is used to set the start of sampling.

- ***Time***: enter the date and time when automatic sampling is expected to start (Time is in UTC). Example: The sampling will start on 31 August 2020, at 6:30 UTC (8:30 Rome time zone, local time)
- ***Rain [mm]***: the user can set the threshold value expressed in mm / 30min, that is the cumulative value of rainfall in millimeters that has fallen in the last half hour. Once the threshold is exceeded, automatic sampling will start. This function (available only in the sites where the CLIMA VUE50 compact weather unit has been installed) can be switched off by inserting *DISABLED*.
- ***Realtime*** reports the value of rain in real time in millimeters, which fell in the last minute.

Figure 6 - Site management, Water Sampling Start.

3.6   EVENTS

The *Sampling Events group* box (Figure 7) includes The Start Time Event and Floodway/Rain labels. two labels turn green when a trigger event has occurred. For example, when the activation time has been reached or the rainfall threshold has been exceeded.

The labels inside the *Status Events group* box (Figure 8) indicate the status (ON green colour, OFF Gray colour) of the peristaltic pump, of the fan (if installed), and of the status LEDs located in the external panel of the electrical cabinet.

Manual Start Event label: there is the possibility to manually (and remotely) start the sampling cycle, using the keyboard of the ISCO AVALANCHE refrigerated automatic sampler. After

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manually starting the cycle, the data logger will manage the progress in any case, sending information to the WQIS DB. For more information contact the support team.
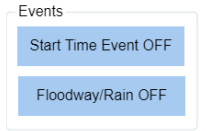

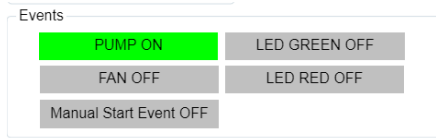*Figure 7 - Sampling Events group box.*

Figure 8 - Status events group box.

3.7　TEMPERATURE

Figure 9 shows the temperature box with the following labels:

- *Internal*: The value indicates the current temperature of the data logger and probably the temperature reached inside the environment in which it is installed (consider that the temperature of the data logger is a little higher than the temperature outside it)

- *Threshold Fan ON:* in the Watercare sites where the fan has been installed, it will be activated when this threshold is exceeded

Figure 9 - Site Management. Temperature box.

3.8　SAMPLING STATUS

This panel (Figure 10) indicates the general progress of the automatic sampling cycle:

- *System initialized*: this state shows when a new firmware version is loaded into the data logger or when it is reset;

- *Ready to Sample*: the system is waiting for some trigger events that start the sampling cycle;

- *Sampling in progress*: there has been a trigger event and sampling are in progress;

- *Waiting for ACK button*: the sampling ended with the filling of the bottle [14]. The system is waiting for the ACK mushroom button to be pressed (see section 4). When the operator has pressed the button, the label ACK Button pressed at will appear and the UTC date and time will also be indicated. The site manager now knows that the bottles

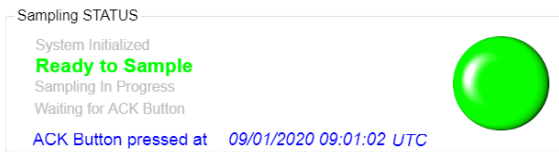have been substituted, the water samples taken, and the system is ready for a new cycle.

Figure 10 - Site Management. Sampling STATUS panel.

3.9 ISCO AVALANCHE STATUS

This panel (Figure 11) indicates the status information of the ISCO AVALANCHE.

- *Freezer*: indicates the internal temperature of the freezer. This value is very important for the management of the water sample already taken. The WQIS continuously stores this value to certify the quality of the sample during the sampling cycle. Attention: ISCO AVALANCHE does not heat the sample to keep it at 3-4 ° C in case of outside temperature <0 ° C

- *ISCO STATUS*: The possible states returned by the sampler are:

> 1 = WAITING TO SAMPLE
>
> 4 = POWER FAILED (for short time after power is restored)
>
> 5 = PUMP JAMMED (must be resolved before continuing)
>
> 6 = DISTRIBUTOR JAMMED (must be resolved before continuing)
>
> 9 = SAMPLER OFF
>
> 12 = SAMPLE IN PROGRESS
>
> 20 = INVALID COMMAND
>
> 21 = CHECKSUM MISMATCH
>
> 22 = INVALID BOTTLE
>
> 23 = VOLUME OUT OF RANGE. (the sample volume requested is outside its range (10-9990 ml)

The site manager will have to check these states because for example states 4,5,6 and 9 require a quick intervention to restore the system. The Alert tool will send these anomaly messages to the staff in charge.

- *Last Sampling Time, Last Bottle, Sampling Volume*: indicates the date and time of the peeled volume in the last bottle sampled. Attention: the date and time showed refer to the automatic sampler clock (It is not the datalogger clock which is continuously synchronized). Check and if necessary, set the clock periodically using the ISCO AVALANCHE keypad

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- *Last Sampling STATUS*: is the results of attempting the most recent sample. The possible results are:

> 0 = SAMPLE OK
>
> 1 = NO LIQUID FOUND
>
> 2 = LIQUID LOST (not enough liquid)
>
> 3 = USER STOPPED (using the Stop Key)
>
> 4 = POWER FAILED
>
> 5 = PUMP JAMMED
>
> 6 = DISTRIBUTOR JAMMED
>
> 8 = PUMP LATCH OPEN
>
> 9 = SAMPLER SHUT OFF (while sampling)
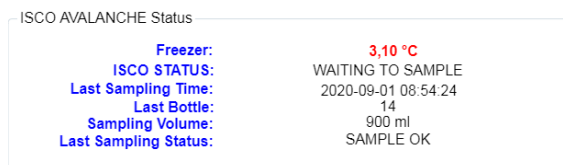>
> 11 = NO DISTRIBUTOR
>
> 12 = SAMPLE IN PROGRESS

ISCO AVALANCHE Status

Freezer:	**3,10 °C**
ISCO STATUS:	WAITING TO SAMPLE
Last Sampling Time:	2020-09-01 08:54:24
Last Bottle:	14
Sampling Volume:	900 ml
Last Sampling Status:	SAMPLE OK

Figure 11 - Site Management. Isco Avalanche Status.

3.10 Other technical information about the system status

Selecting the DATA tab (Figure 12) it is possible to view the real-time data of the general log table and the data generated by the sensors of the acquisition system such as weather data, the multiparameter probe and the level sensor (if provided).

DIAGNOSTIC TAB (Figure 13) shows a graph with the trend of datalogger temperature and battery voltage.

In addition, the status of communications is shown. Each single device (if installed in the Watercare site) is continuous monitored regarding the communications with the data logger. In the event of an anomaly, the panel corresponding to the device turns red.
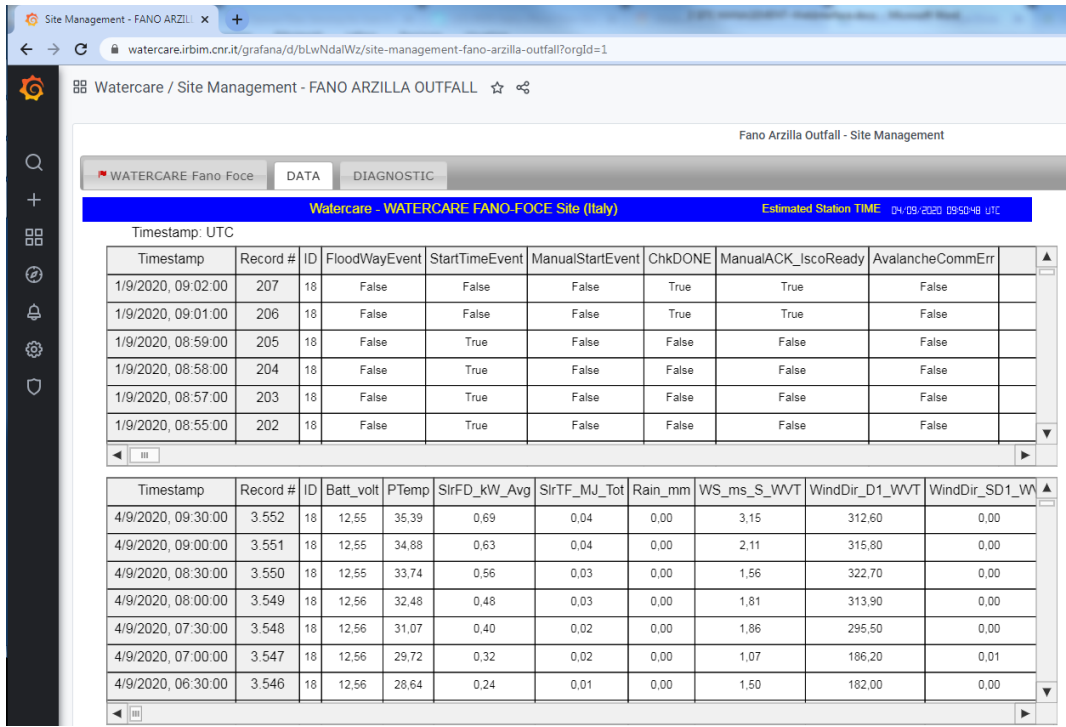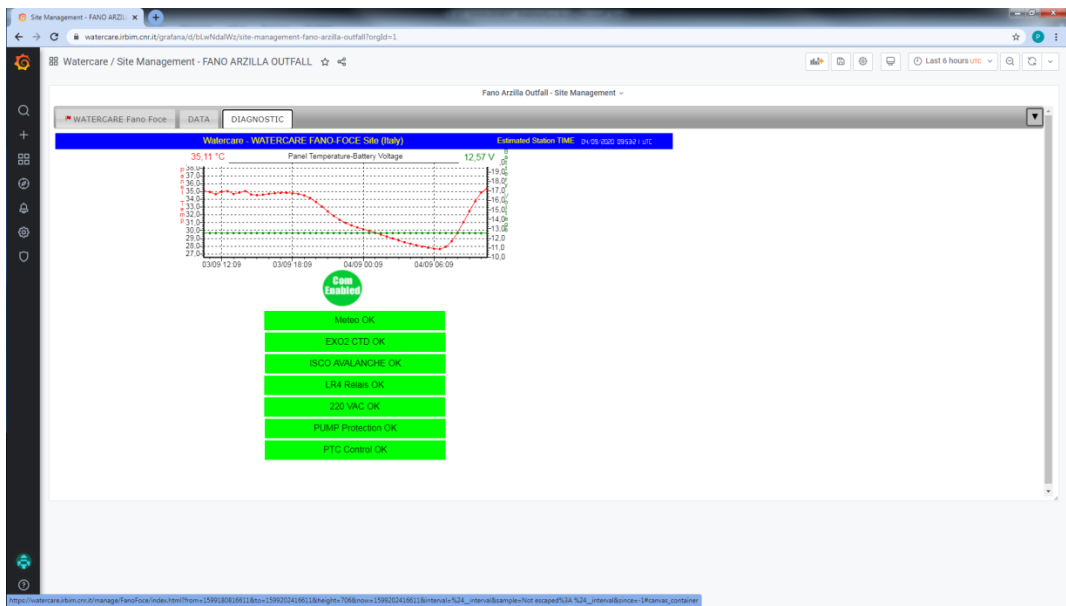
Figure 12 - Site Management. DATA tab.

Figure 13 - Site Management. DIAGNOSTIC tab.

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4   ISCO AVALANCHE SAMPLER
Guidelines for bottle collection after the end of sampling cycle

The following procedure for bottles replacement and sampler preparation comes from on field tests and experiences carried out at the Fano Foce pilot site as part of the EU-INTERREG WATERCARE project.

The source reference of this manual is:

"Avalanche® Installation and Operation Guide", *Part #69-2973-062 of Assembly #60-2974-024, Copyright © 2013. All rights reserved, Teledyne Isco. Revision Y, May 2015*

Figure 14 - Isco Avalanche Sampler

Regarding installation, use and safety regulations, please consult the official Teledyne manual, freely available at the following link https://www.teledyneisco.com/en-us/waterandwastewater/Sampler%20Documents/Manuals/Avalanche%20Transportable%20Sampler%20User%20Manual.pdf (accessed September 2,2020).

This manual does not replace the official manual mentioned above.

1 Strainer

2 Suction Line

3 Stainless Steel Coupling

4 Pump Tube. Routes liquid through liquid detector's intake port, pump, out the detector's discharge port, and over the side of the controller to a bulkhead fitting.

5 Liquid Detector

6 Peristaltic Pump

7 Bulkhead Fitting

8 Discharge Tube

9 Distributor Arm
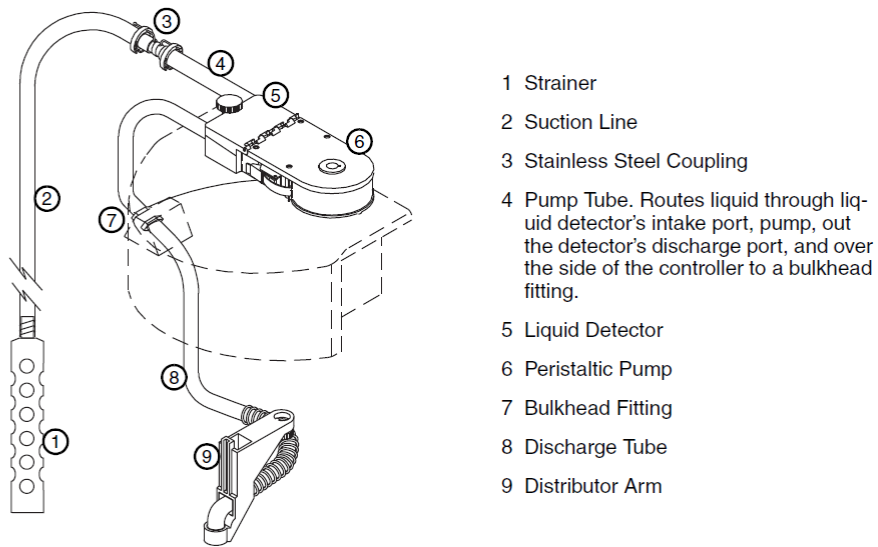
Figure 15 - Identifying sampler components, from ISCO AVALANCHE user manual, page 6-3.


Figure 16 - Bottle Carrier with 14 Bottles 950ml.

Figure 17 - Some keyboard input from the sampler.

Table 1 - Keypad button function. It shows the functionality of each keypad button.

KEY	NAME	FUNCTION
(Standby symbol)	Standby	Turns sampler on or off.
(Stop symbol)	Stop	Stops the pump or distributor. Pauses a running sampling program. In programming screens, returns to a previous screen.
(Enter symbol)	Enter	Accepts a menu choice or number entry and goes to next screen.
?	Help	In programming screens, displays a brief help message.
(Down-Right Arrow symbol)	Down-Right Arrow	Selects the menu option right or below the current choice.
(Up-Left Arrow symbol)	Up-Left Arrow	Selects the menu option left or above the current choice.
0	Numbers	Types a number.
.	Decimal Point	Types a decimal point.
1	Pump Reverse	Press when at the main menu to run the pump in reverse.
3	Pump Forward	Press when at the main menu to run the pump forward.

4.1   Replacement of bottles

Checklist for Replacing bottles:

- Bottle carrier with 14 sterilized bottles;
- Refrigerated container used for transport to the analysis laboratory;
- Sterilized discharge tube (distributor arm);
- Sterilized pump tube;
- 10l tank with water and diluted HCl for cleaning discharge and pump tube;
- 10l tank to recover diluted HCl;
- Fitting for tank tube and discharge tube;
- Cleaning paper, towels and detergents;

The end of sampling cycle event by ISCO AVALANCHE is communicated by the WQIS Alert Tool to the concerned recipients. The progress and possibly the end of the sampling cycle can be seen on the data presentation page (see section 6).

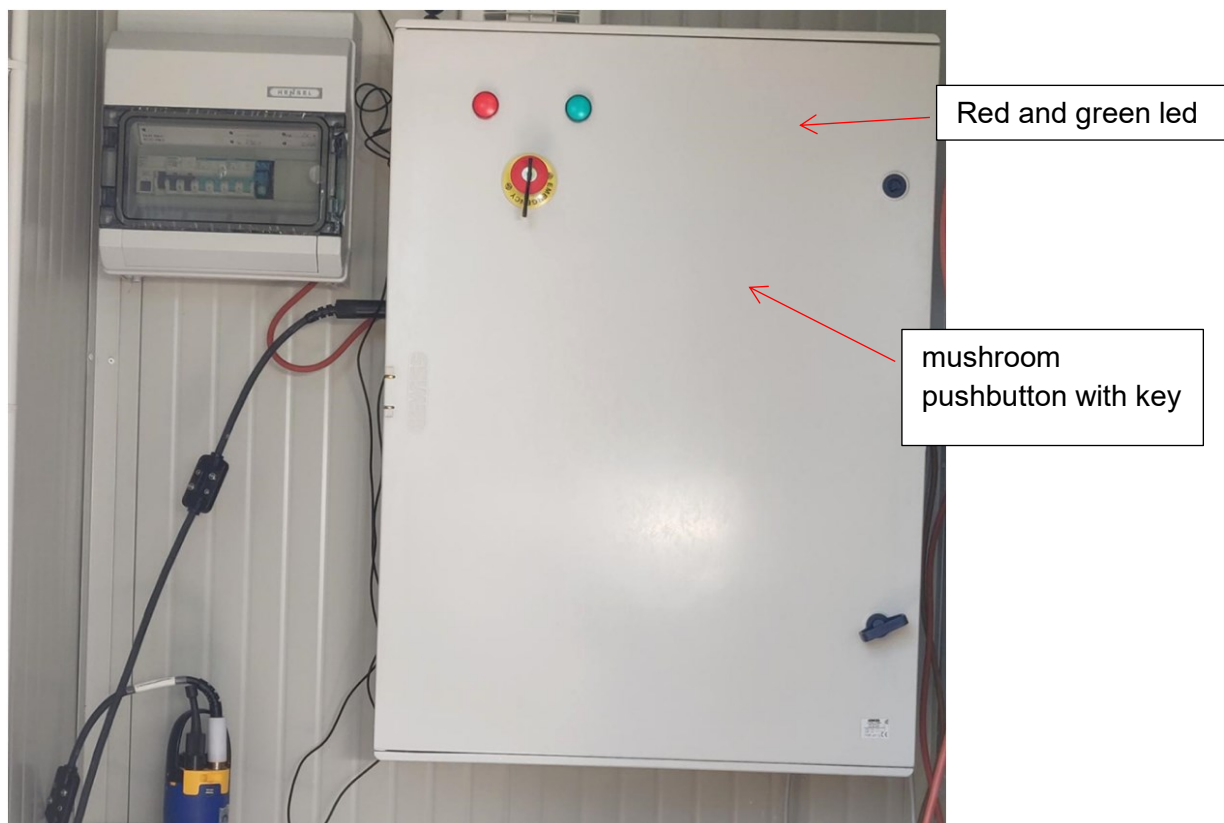At the end of the sampling, the red and green LEDs installed in the main electrical panel flash simultaneously.

Figure 18 - The electrical cabinet installed at Pilot site FANO FOCE.

Bottles Replacement procedure:

1. Release the latches and open the refrigerated compartment
2. Place caps on the bottles
3. Remove the bottles with water sample. You can lift the bottle carrier from the compartment. Attach a label to the bottle(s) detailing the location, date, etc.
4. Place the bottles in a refrigerated container used for transport to the analysis lab
5. Check for water at the bottom. Dry if necessary
6. Clean (defrost) the inside of the refrigerated compartment if necessary
7. Replace or clean/sterilize the distributor tube
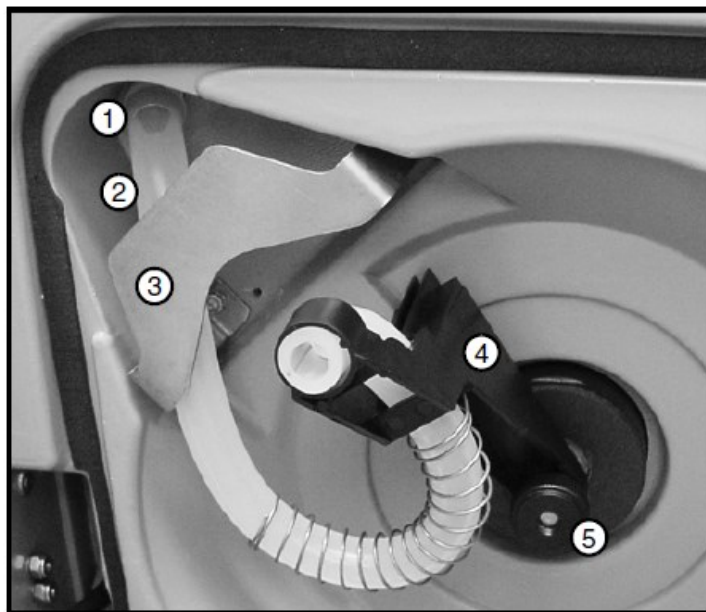
1 Bulkhead Fitting
2 Discharge Tube
3 Tube Holder
4 Distributor Arm
5 Nut

Figure 19 - Attaching the distributor arm and discharge tube, from ISCO AVALANCHE user manual, page 2-6.

- Attach the 13-inch (33 cm) discharge tube to the bulkhead fitting. Route the tube over the stainless-steel tube holder
- Route the other end of the tube through the spring on the distributor arm. Then, place the end of the discharge tube through the opening in the end of the distributor arm. The end of the tube should protrude below the arm 1/16 to 1/8 inch. **If too much tube protrudes from the arm, it can catch on bottles and jam the distributor arm**
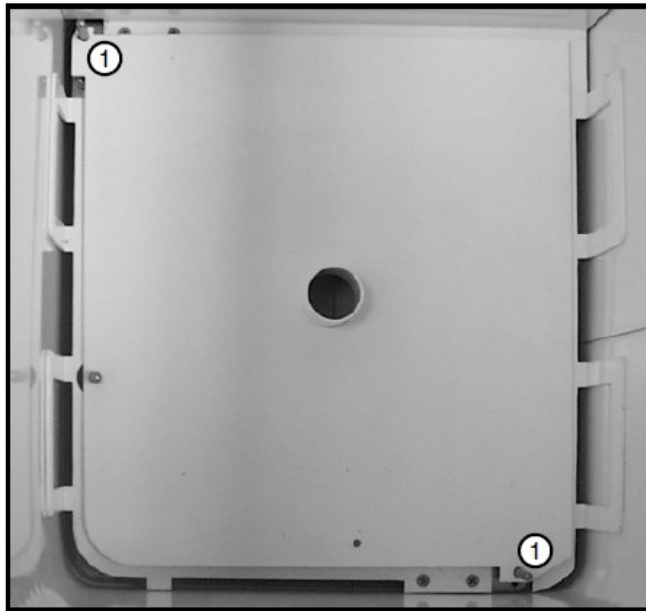
8. Replace or clean/sterilize the pump tube
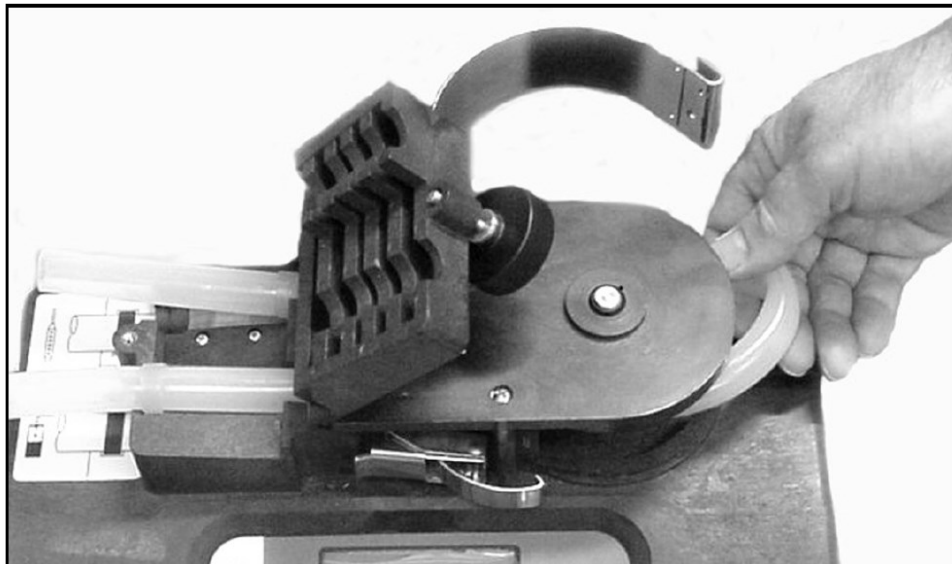
Figure 20 - Pump tube.

Figure 21 - Removing and replacing the pump tube, from ISCO AVALANCHE user manual, page 9-10.

9. The bottom of the compartment has two posts that ensure the adapter plate is oriented correctly
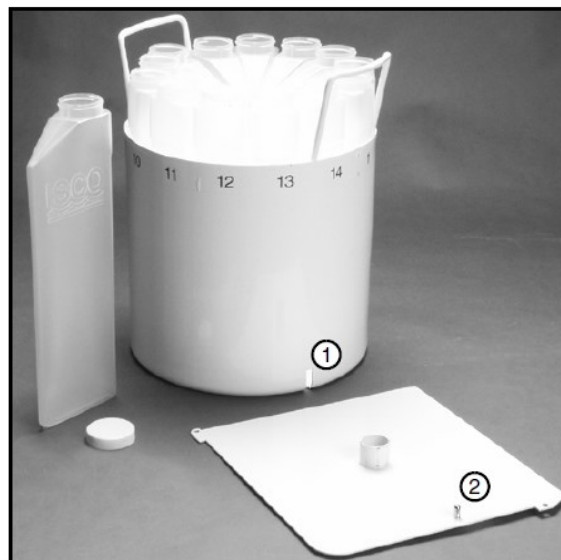
1 Alignment Posts

Figure 22 – 14-Bottle adapter plate, from ISCO AVALANCHE user manual, page 2-7.

10. Load the sterilized bottles into the carrier. Note that the bottles fit between the handles of the carrier. The handles keep the bottles positioned correctly in the carrier

11. Place the carrier into the refrigerated compartment. The carrier must be aligned with the alignment post on the plate. Once it is aligned, it should seat fully against the adapter plate

1 Carrier
   Alignment Hole
2 Carrier
   Alignment Post

Figure 23 - Carrier alignment, from ISCO AVALANCHE user manual, page 2-7.

Figure 24 - 14-Bottle configuration completed, from ISCO AVALANCHE user manual, page 2-7.

12. Close and latch the refrigerated compartment
13. To check the correct positioning of the distributor arm and the carrier alignment and thus avoid the presence of obstacles, proceed as follows:

- Using keypad, select OTHER FUNCTIONS from the Main Menu. Then, select MANUAL FUNCTIONS

```
            RUN
          PROGRAM
        VIEW REPORT
      OTHER FUNCTIONS
```

```
        MAINTENANCE
      MANUAL FUNCTIONS
      PROGRAMMING STYLE
```

```
        GRAB SAMPLE
      CALIBRATE VOLUME
        OPERATE PUMP
      MOVE DISTRIBUTOR
```

- Select MOVE DISTRIBUTOR

```
      GO TO BOTTLE _____
          (1-MAX)
```

- Enter 1 (14 during the first deployment) and press enter
- The distributor arm moves to the selected bottle position then displays

---

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```
NOW AT BOTTLE ____
```

- Press the Stop key to return to the Manual Functions screen
- Repeat the whole procedure described above to return the distributor arm to position 14 (GO TO BOTTLE 14, enter 1 during the first deployment)
- Check for any error messages in the display.
- In case of anomalies, open the refrigerated container, check the correct positioning of the bottles inside the container, close the container and repeat the entire procedure step 13

<u>Distributor drive gears may be permanently damaged if you attempt to rotate the distributor arm by hand or with any tool.</u> Only move the distributor arm through the Manual Functions.

The ISCO Avalanche Sampler is now ready for a new sampling cycle with correctly positioned sampling tubes and sterilized bottles.

14. Press the mushroom button after turning the key. The button is located in the electrical panel (see Figure 18). This acknowledgment function informs the WQIS that the sampler reset procedure has been carried out successfully. The date and time of pressing the button are stored in DB WQIS. The green LED in the electrical panel stays on for 5 seconds.

Here is another method for sterilizing the tubes, avoiding replacing them. This method replaces steps 7 and 8 described above. Proceed as follows:

1. Take a 10l tank with water and diluted HCl (10%). Connect a tube that draws water diluted with HCl with the distributor tube

Connect with the tank
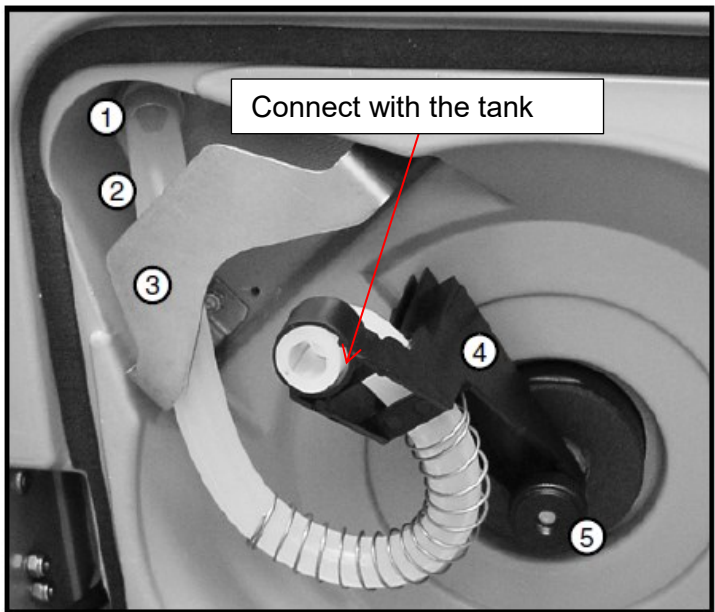
1 Bulkhead Fitting
2 Discharge Tube
3 Tube Holder
4 Distributor Arm
5 Nut

Figure 25 - Tube in the distributor arm.

2. Insert the end of the ISCO Avalanche rinsing tube into a recovery tank
3. Using keypad, select OTHER FUNCTIONS from the Main Menu. Then, select MANUAL FUNCTIONS

```
        RUN
      PROGRAM
    VIEW REPORT
  OTHER FUNCTIONS
```

```
    MAINTENANCE
  MANUAL FUNCTIONS
  PROGRAMMING STYLE
```

4. Select OPERATE PUMP

```
    GRAB SAMPLE
  CALIBRATE VOLUME
    OPERATE PUMP
  MOVE DISTRIBUTOR
```

5. Select PUMP REVERSE

```
  SELECT DIRECTION
    PUMP FORWARD
    PUMP REVERSE
```

6. While pumping, the screen reports PURGING. Press the red stop when the tank with water and HCl is almost empty

```
         PURGING. . .
    PRESS THE RED 'STOP'
      KEY WHEN DONE
```

Suction line, pump and discharge tube are now cleaned and sterilized

4.2   Calibration of sample volume

The sampler delivers accurate sample volumes without calibration. If you find that sample volumes vary significantly from the programmed values, you can calibrate a sample volume following next instructions (see also ISCO AVALANCHE user manual, page 6-10)

1. Disconnect the pump tube from the bulkhead fitting
2. Place the end of the tube over a graduated cylinder for volume measurement. In Watercare project the volume is set to 900ml

Figure 26 - Take a grab sample, from ISCO AVALANCHE user manual, page 6-8.

3. Place the end of the tube over a graduated cylinder for volume measurement. In Watercare project the volume is set to 900ml
4. Using keypad, select OTHER FUNCTIONS from the Main Menu. Then, select MANUAL FUNCTIONS

```
         RUN
       PROGRAM
      VIEW REPORT
    OTHER FUNCTIONS
```

```
      MAINTENANCE
    MANUAL FUNCTIONS
    PROGRAMMING STYLE
```

5. Select CALIBRATE VOLUME

```
GRAB SAMPLE
CALIBRATE VOLUME
OPERATE PUMP
MOVE DISTRIBUTOR
```

6. Enter the sample volume. Insert 900

```
SAMPLE VOLUME:
___ ml (10-9990)
```

7. Place the end of the pump tube over the container and press Enter

```
CALIBRATE VOLUME

PRESS ⏎ WHEN READY!
```

8. The controller will complete a sample collection cycle to deliver the programmed volume. The collection cycle is complete when the controller displays the programmed volume. Measure the actual volume delivered to the collection container and enter the amount here

```
VOLUME DELIVERED:
___ ml
```

9. The collection cycle is complete when the display returns the MANUAL FUNCTIONS screen. Press the Stop key to return to the main menu
10. Reconnect the pump tube to the bulkhead fitting. Remember to clean/sterilize all tubes.

5   SAMPLES ANALYSIS – Web Interface

5.1   INTRODUCTION

Sample Analyses (S.A) is a web interface with the task of acquiring manual monitoring data, such as data from chemical and microbiological analyses performed by the researchers.

The user authorized to insert the results of the analysis, can view and manage the data related to site for which he is responsible. The data can be downloaded into Excel and CSV format and they can be copy to clipboard.

The samples taken by the ISCO Avalanche automatic sampler are automatically added in the database and they are shown directly in the web interface to simplify the insertion procedure of the data and to reduce the risk of human typing error.

The chemical and microbiological parameters included in the S.A are listed in Table 2, Annex section.

Please Note: the sampling points of each monitoring site have already been defined by the site managers and entered in the DB by CNR staff.
<u>Any new sampling point must be previously reported to CNR staff who will proceed to insert it in the DB</u>.

5.2   LOGIN

From the map on <u>Watercare Sites page,</u> click on the markdown focused on your site (Figure 27) and then press the   *Samples Analysis* link (Figure 28). In alternative, go directly to the link <u>https://watercare.irbim.cnr.it/wsa</u>.
In the login form (Figure 29) insert the username and password received by e-mail from the CNR Staff and then press the *Login* button.

Figure 27 – Watercare Sites Map.

Figure 28- Popup with Samples Analysis link.
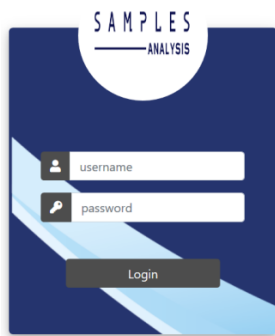
Figure 29 - Login form.

5.3   MAIN PAGE

The main page includes a list of all chemical and microbiological data collected in the studied sites (Figure 30). The main functions and commands are shown in Figure 31 and a brief description is given below:

- *Login information*: it shows the name of the logged in user and the logout key;

- *Search bar by date*: it allows the visualization of the data in the period between the start-date (*From date:*) and the end-date (*To date:*). The start date must be reported in the *from date* form and the end date in the *to date form* (format allowed: YYYY-MM-DD HH:MM:SS);

- *Quick Search Bar*: In the Quick Search bar type the keyword you want to search. The bar can quickly visualize records that include the keyword in one or more fields.

- *Command Bar:* it includes the following buttons:

    • *Reload* - to reload the table after a change.

    • *New Sample Event* - to open the window for inserting a new sample (5.5).

    • *Edit Sample* - to open the window for editing a record/sample (5.4)*.

    • *Copy* - to copy the selected records to the clipboard (5.6).

    • *Excel* - to export the selected records to Excel (5.6).

    • *CSV* - to export the selected records to a CSV format file (comma-separated values) (5.6).

    • *Remove Sample* – to remove the selected records (5.7).

The bottom part of the main page contains the table with all the information relating to the collected samples. The column headers are listed in the Table 2.

The User will have access only to the data of the locations under his responsibility.
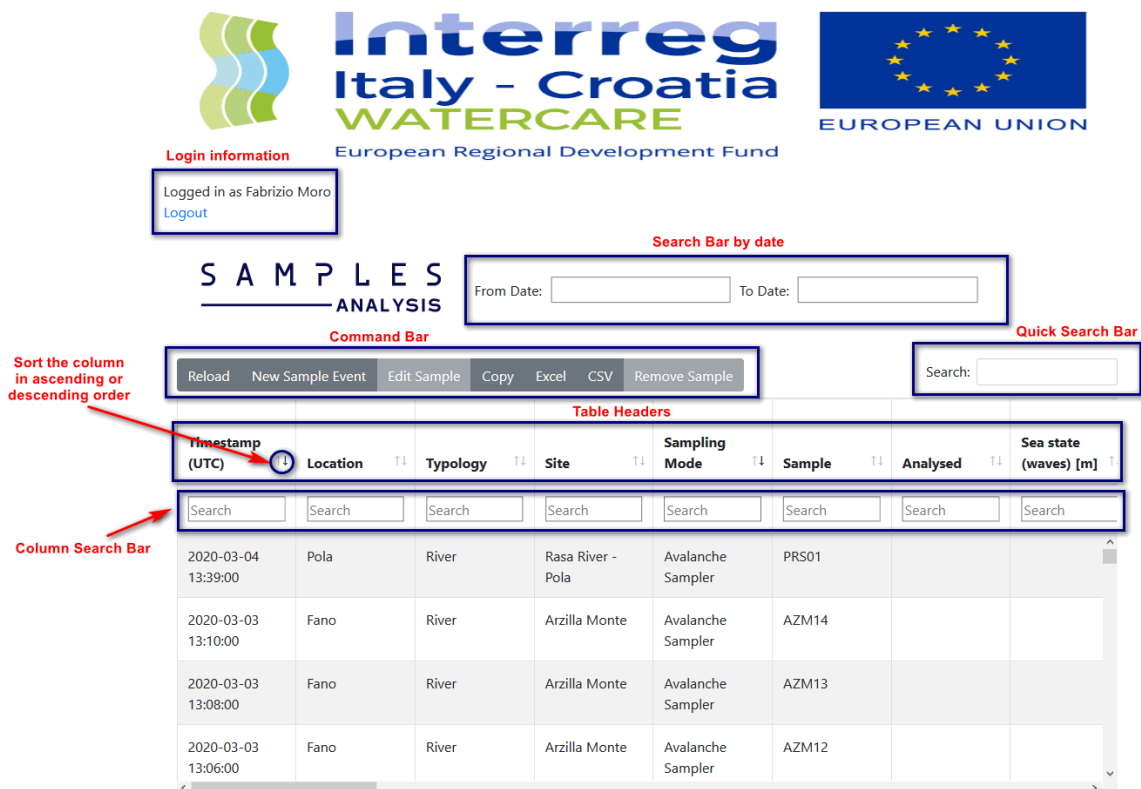
Figure 30 – Main page of the Samples Analysis site.

Figure 31 - Description of the Main Page functions.

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Table 2 - List of table headers

Header	Description	Type / Units
Timestamp	date and time of the sampling event	UTC Time (YYYY-MM-DD HH:MM:SS)
Location	City where the site is installed	Selection form (text)
Typology	Typology of the sampling point (Sea, River)	Selection form (text)
Site	Name of the sampling site	Selection form (text)
Sampling Mode	Reporting the sampling method: Avalanche Sampler, Manual Sampling	Selection form (text)
Sample	Unique code of the sampling point	Automatic setting (text)
Analysed	Report whether the sample has been analysed	Boolean (Yes or No)
Sea state (waves)	Sea wave height (optional)	Numeric (m)
Sea water current	Direction of the sea water current (optional)	Selection form (cardinal points)
Salinity	The amount of salt dissolved in a body of water	Numeric (PSU)
Temperature	Water temperature	Numeric (°C)
Redox	Water reduction–oxidation	Numeric (mV)
pH	Water pH	Numeric
Conductibility	Specific conductance: ability to conduct electricity	Numeric (mS/cm)
BOD$_5$	Biochemical Oxygen Demand	Numeric (mg/L)
COD	Chemical Oxygen Demand	Numeric (mg/L)
Turbidity	The cloudiness or haziness of a fluid caused by suspended	Numeric (NTU)

	solids that are usually invisible to the naked eye	
Dissolved O$_2$ [%sat]	Dissolved Oxygen	Numeric (%)
Dissolved O$_2$ [mg/L]	Dissolved Oxygen	Numeric (mg/L)
Chlorophyll-a	blue/green substance	Numeric (µg/L)
TSS	Total suspended solids	Numeric (mg/L)
TOM		Numeric (mg/L)
Ammonium N-NH4	Ammoniacal Nitrogen	Numeric (µM)
Nitrates N-NO^{3-}		Numeric (µM)
Nitrites N-NO^{2-}		Numeric (µM)
N tot	Total nitrogen	Numeric (µM)
P tot	Total phosphate	Numeric (µM)
Orthophosphate P-PO$_4$		Numeric (µM)
Enterococcus		Numeric (UFC/100ml)
Escherichia		Numeric (UFC/100ml)
Note	Report any comments or notes on the specific sample	Text

5.4   EDIT PROCEDURE

The events recorded by the ISCO Avalanche automatic sampler are inserted in the table automatically and in real time. After each ISCO Sample, a new record will be automatically filled with the following information: timestamp, location, typology, site, sampling mode and sample.

To insert the analysis information, the operator must click on the corresponding record (highlighting it - Figure 32) and then press the *Edit Sample* button in the *Command Bar*.

In the popup window (Figure 33) fields *Timestamp*, *City*, *Location*, *Sampling Mode* and *Sample* are already filled in and it cannot be edited. If the sample has been analysed select *Yes*, if not, press *No* (Figure 34).

If True is selected, all the parameters available for that sample will be displayed (the available parameters also vary according to the type of user logged in). Refer to Table 2 for the description of the parameters. Insert the corresponding value in the text box (Figure 35) respecting the parameter type (column 3 of the Table 2). At the end, check the entered values and confirm by pressing the *Update* button (Figure 36). The data are then automatically compiled and entered the database. When the edit form is closed, the table on the main page is updated.

If False is selected, only the *Note* field can be filled.

N.B. Click outside the Edit form window to exit the edit mode.

N.B. Follow procedure 5.4 even if you want to modify the data previously entered.

Figure 32 - highlighting Sample.

Figure 33 - Edit Form.

Figure 34 - -Edit Form. Analysed select Form.

Figure 35 - Edit Form. Parameters and input of values.

Figure 36 - Edit Form. Update button.

5.5   INSERT NEW SAMPLE EVENT PROCEDURE - MANUAL SAMPLE

If there is the need to insert new manual sample records (e.g. all sampling points not directly connected to the ISCO Avalanche automatic sampler, sea sampling points or all manually collected samples), the user must follow four main steps:

1. insert a new sample event by selecting *New Sample Event* on the command bar (Figure 31). In the popup window (Figure 37), the user can enter the date and time of the sampling in

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Timestamp form (format yyyy-mm-dd hh:mm:ss) or select date and time by using the popup calendar (Figure 38);

2. select from the drop-down list in order *Location* (Figure 39), *Sampling Mode* (Figure 40) (*Avalanche sampler* for a sample collected by the automatic sampler or *Manual Sampling* for a sample collected manually) and *Sample* (Figure 41) (list of a *samples id* that varies according to the selections made previously);

3. save the new sample event by pressing the *Create* button or by pressing the *Close* button to quit without saving;

4. once the sample has been created, proceed with point 5.4 to add the chemical and microbiological values.

Please Note: All selectable values are linked to the logger in use. The user can only see the values associated with the observing sites of competence (e.g. Fano Foce and Fano Monte for CNR staff).

Please Note: the sampling points of each monitoring site have already been defined by the site managers and entered in the DB by CNR staff.
Any new sampling point must be previously reported to CNR staff who will proceed to insert it in the DB.
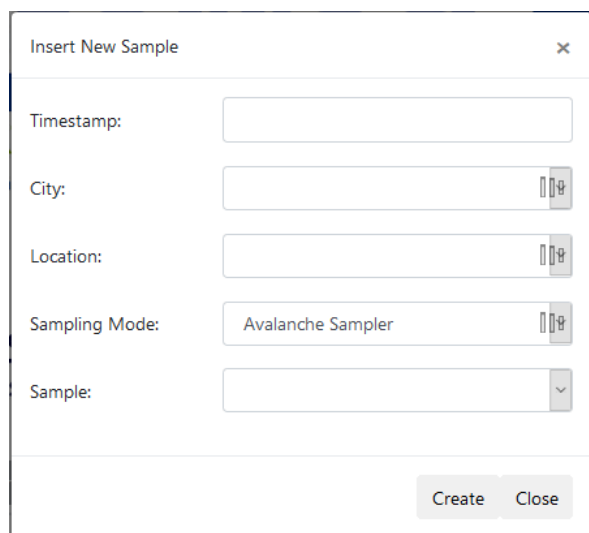
Figure 37 - Insert New Sample form.
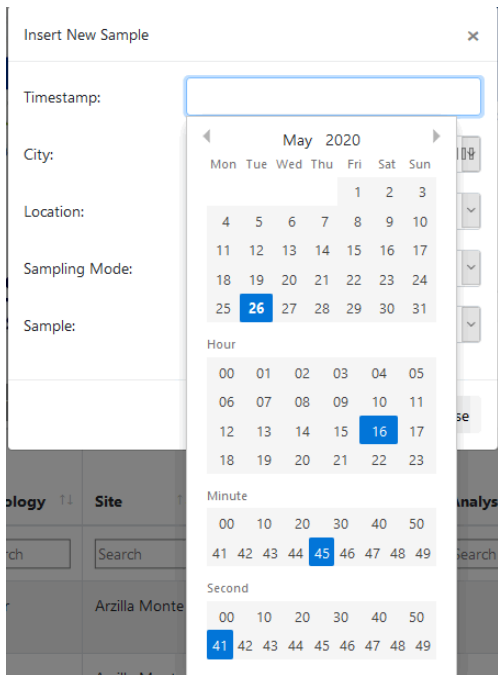
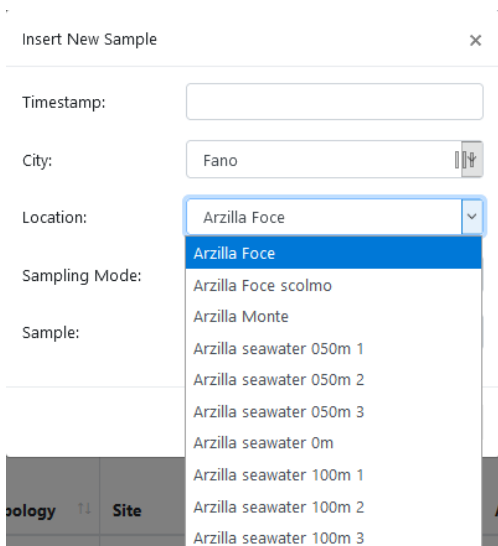*Figure 38 - Insert New sample form. Calendar.*

Figure 39 - Insert New Sample form. Location list.

Figure 40 - Insert New Sample form. Sampling Mode list.

Figure 41 - Insert New Sample form. Sample list.

5.6   EXPORT PROCEDURE

Sample analysis interface provides the possibility to export the data analysis into Excel or CSV files (each line of the file is a data record. Each record consists of one or more fields, separated by commas).

It is possible to export all table records or a selection of data. In the latter case, just click on the records to export (highlighting them) holding down the CTRL key and then press the *Excel (*Figure 42*)* or *CSV* (Figure 43) buttons in the command bar. Eventually, it is possible to use the same procedure to copy records in the clipboard by pressing the *Copy* button.
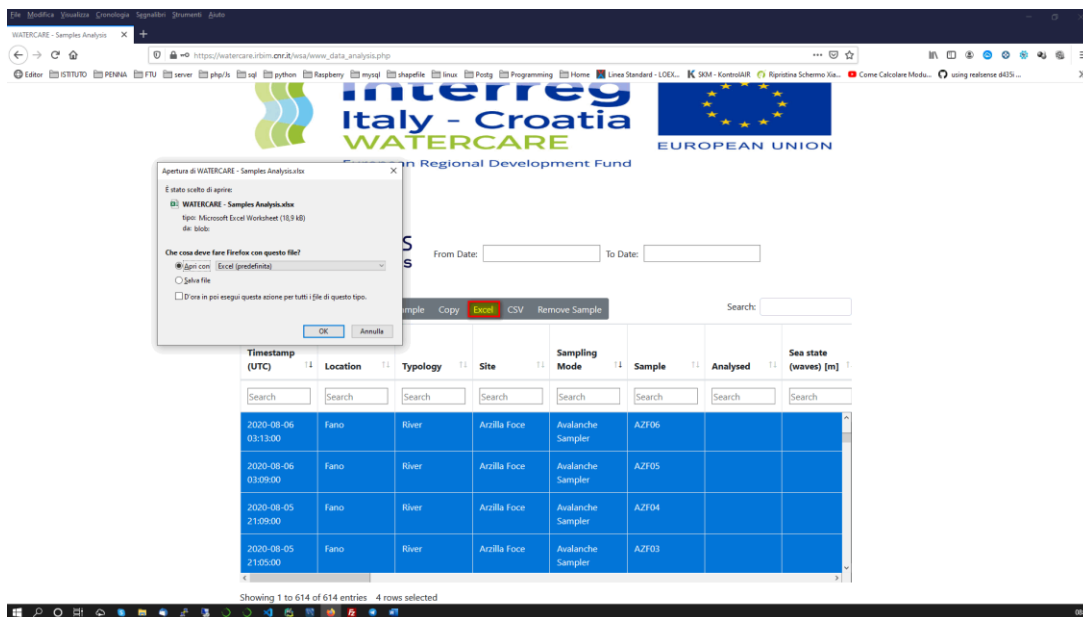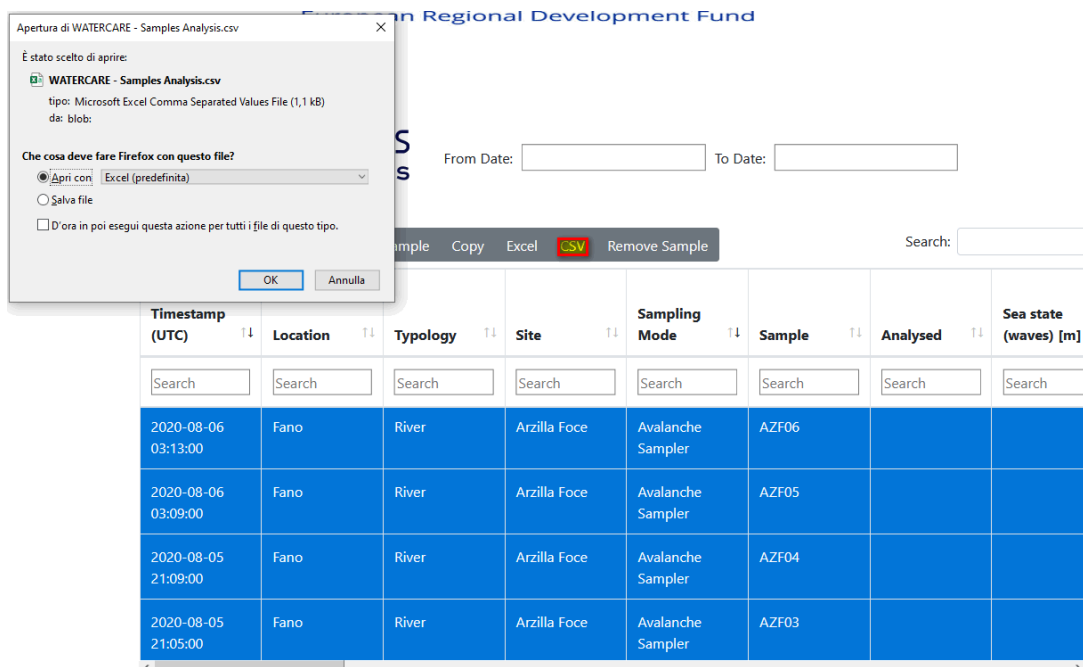

Figure 42 - Export to Excel.

Figure 43 - Export to CSV.

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5.7 REMOVE PROCEDURE

In case of errors, a record can be deleted using the *Remove* button in the command bar. Select the record to delete and press the *Remove* button then confirm (Figure 44).

CAUTION: This function should be used very carefully because it permanently deletes the record. Do not proceed and contact the authors in case of doubt (pierluigi.penna@cnr.it, fabrizio.moro@cnr.it).
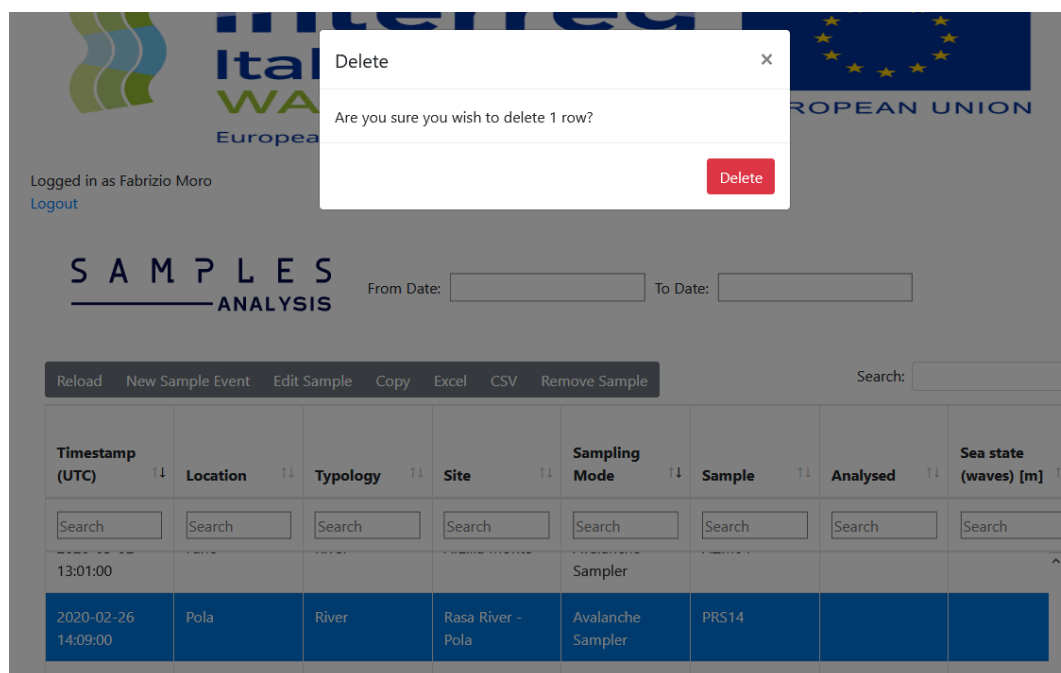

Figure 44 - Delete form.

6 DATA VISUALIZATION – GRAFANA Web Interface

6.1 INTRODUCTION

All physical data received from the stations installed in-situ, analysis data and other ancillary data are collected in a database. To visualize the data, various dashboards were implemented using a web solution provided by Grafana Labs. Grafana is open source visualization and analytics software. It allows you to query, visualize, alert on, and explore your metrics no matter where they are stored. It provides you with tools to turn your time-series database (TSDB) data into beautiful graphs and visualizations.

6.2 LOGIN

The enabling of users to the Grafana portal are managed by the CNR staff. Users will receive an email from support@irbim.cnr.it with the username and a registration link to the portal (also check the spam box). On the registration page enter a new password, confirm it and press the registration button.

Go to https://watercare.irbim.cnr.it/grafana/login and on the login page (Figure 45) enter username and password then press the *Log in* button.

Once logged in, you will be redirected to the *Watercare Sites* homepage with summary map of all the project sites (Figure 27). From the map click on the markdown focused on site of interest and then press on *Data visualization* link (Figure 46) to open the dashboard with site data and information.
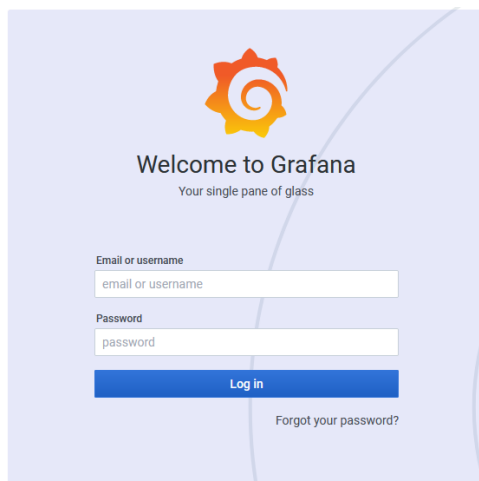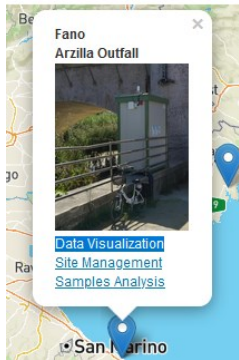

Figure 45 - Grafana login page.

Figure 46 - Popup with data visualization link.

6.3   DASHBOARD

The site dashboard is characterized by a set of panels (the basic data visualization building block). Each panel allows one or more physical parameters to be plotted and correlated versus time.

The source reference of this manual is:
"Grafana documentation" (*https://grafana.com/docs/grafana/latest/?utm_source=grafana_footer*)

6.3.1   TIME RANGES

You can manage the time ranges of data being visualized by acting on the *time range controls* (Figure 47).

NB: Time zone of all dashboard is set in UTC format.

The following time units are supported: s (seconds), m (minutes), h (hours), d (days), w (weeks), M (months), and y (years).

The minus operator allows you to step back in time, relative to now. If you wish to display the full period of the unit (day, week, month, etc…), append /<time unit> to the end.

The plus operator allows you to step forward in time relative to now. You might use this feature to look at predicted data in th.

The current time range, also called the time picker, shows the time range currently displayed in the dashboard or panel you are viewing (Figure 48).

Click on the current time range to change the time range (Figure 49). You can change the current time using a relative time range, such as the last 5 minutes, or an absolute time range, such as 2020-08-31 00:00:00 to 2020-09-03 23:59:59.

Set an absolute time range one of two ways:

- Type values into the *From* and *To* fields. You can type exact time values or relative values, such as now-24h, and then click *Apply time range*.

- Click in the *From* or *To* field. Grafana displays a calendar. Click the day or days you want to use as the current time range and then click *Apply time range*.

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You can also fast change the time by pressing the *zoom* button   .

Click the *Refresh dashboard icon*   to immediately run every query on the dashboard and refresh the visualizations. By default, Grafana does not automatically refresh the dashboard. Queries run on their own schedule according to the panel settings. However, if you want to regularly refresh the dashboard, then click the down arrow next to the Refresh dashboard icon and then select a refresh interval.

Table 3 - Example time range.

Example relative range	From:	To:
Last 5 minutes	now-5m	now
The day so far	now/d	now
This week	now/w	now/w
Week to date	now/w	now
Previous Month	now-1M/M	now-1M/M
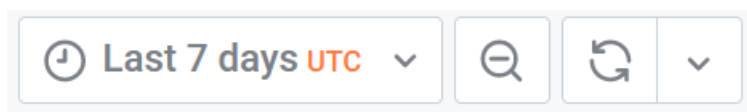
Figure 47 - Time range controls.
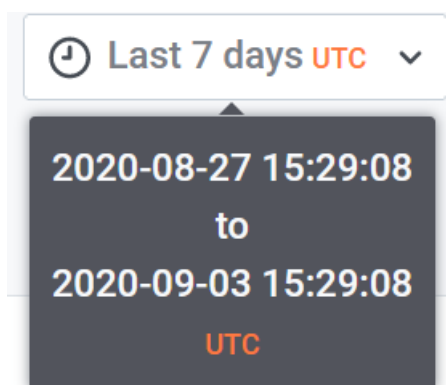
Figure 48 - Current Time range.

Figure 49 - Change time range.

6.3.2   Hover tooltip

The hover tooltip shows all series in the graph. Grafana highlights the series that you are hovering over in bold in the series list in the tooltip.

When you hover your cursor over a graph visualization, information from all other series (graphs) in the same time period is displayed (Figure 50).

Figure 50 - Hover tooltip.

6.3.3   TAGS - ANNOTATIONS

Annotations provide a way to mark points on the graph with rich events. When you hover over an annotation you can get event description and event tags (Figure 51). The tags are replicated on all dashboard panels.

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Annotations are added automatically and include:

- information on automatic (avalanche) and manual samples collected (identified with the sample code Figure 51);

- Trigger events (floodway open, floodway close, rain events, etc.);
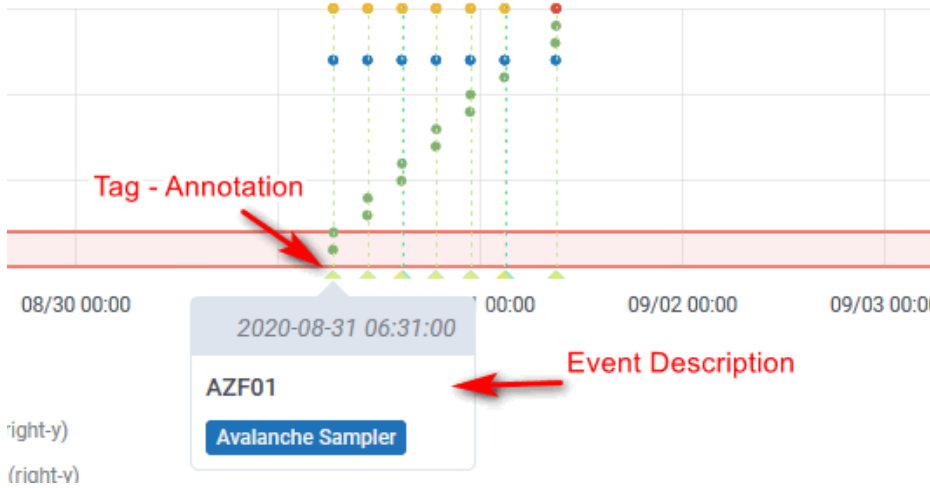
- Relevant notes (lack of data, failures).

Figure 51 - Tags, Annotations. In the example, the event description reports the sample id (AZF01 – Fano Arzilla Foce sample 01 of the avalanche sampler) and the sampling methods (Avalanche sampler, manual sampling, etc.).

6.3.4   ANALYSIS POINTS PANEL

The analysis points panel shows a map with all the sampling points provided for the specific site. The points are georeferenced and are extracted from the database. You can see the sample id by hovering the mouse over the point (Figure 53).

Please Note: the sampling points of each monitoring site have already been defined by the site managers and entered in the DB by CNR staff.
Any new sampling point must be previously reported to CNR staff who will proceed to insert it in the DB.
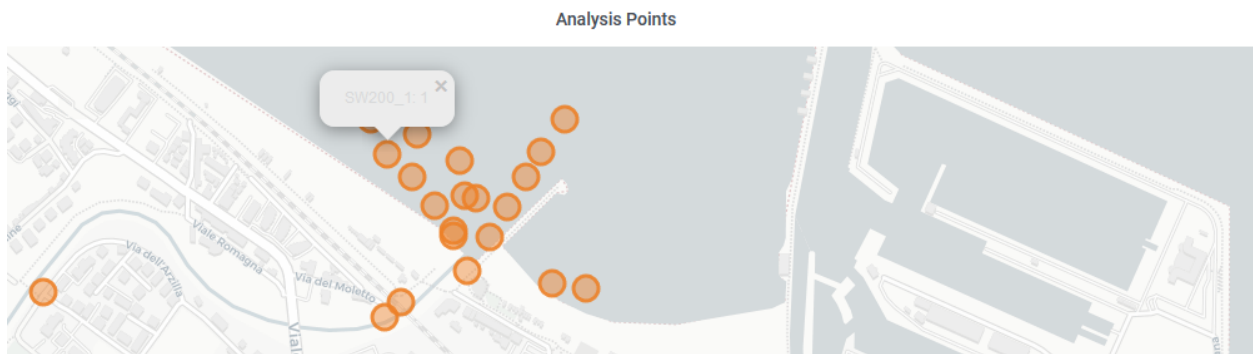

Figure 52 - show the Fano Arzilla Outfall map with the sampling points.

6.3.5 GRAPH PANEL

This visualization is the most used in the Grafana ecosystem. It can render as a line, a path of dots, or a series of bars. This type of graph is versatile enough to display almost any time-series data.

The panels are organized into the following sections (Figure 53):

- *Automatic Sampling;*
- *Air;*
- *Water;*
- *Samples Analysis;*
- *Hardware.*

Each section can be activated or deactivated by clicking on the **>** symbol or on the section name.

> **Automatic Sampling** *(5 panels)*

> **Air** *(7 panels)*

> **Water** *(7 panels)*

> **Samples Analysis** *(10 panels)*
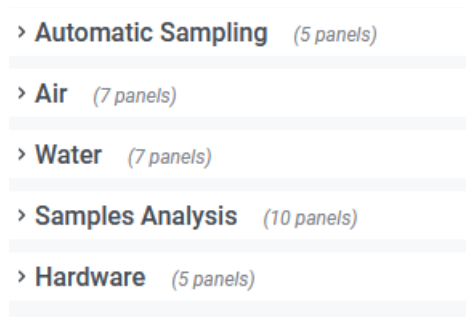
> **Hardware** *(5 panels)*

Figure 53 - Dashboard sections.

6.3.5.1 Automatic Sampling section

Automatic Sampling section includes panels with real-time information of the automatic sampling (Figure 54).

- *Sampling STATUS* reports the status of the sampler:
  - *Ready to Sample* – the sampler is ready and it is possible to start a sampling;
  - *Sampling in Progress* – a sampling was started and is still in progress;
  - *Waiting for ACK Button* – the sampling is finisched, the sampler has collected all the samples. The staff will have to replace the bottle carrier, carry out the required cleaning and then press the ACK button (see 3.4).
- *LAST SAMPLE* show a gauge chart with the last sampled bottle.
- *LAST SAMPLE INFO* displays the real-time sampler information (time, number and status of last sample).
- *ISCO AVALANCHE Automatic Water Sample* graph shows the trend of the sampling status over time.
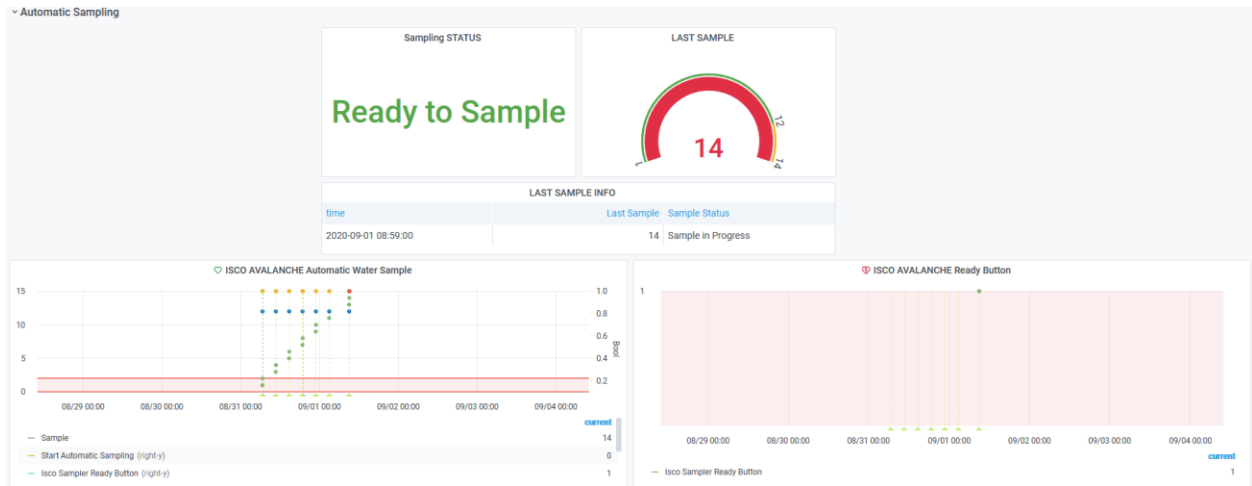
Figure 54 - Automatic Sampling section. Fano Arzilla Outfall.

6.3.5.2   Air section

The AIR section (Figure 55) includes graph panels with weather information collected by the weather station installed on the monitoring site (data are updated every 20 minutes).
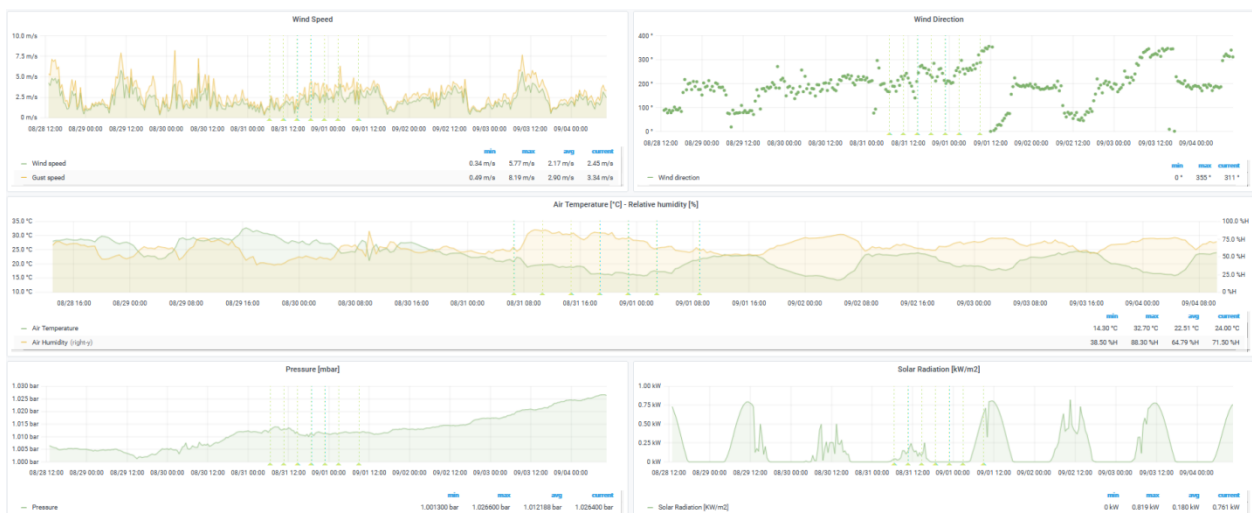

Figure 55 – part of Air section. Fano Arzilla Outfall.

6.3.5.3   Water section

the graph panels inside water section (Figure 56) show the measurements made by the CTD probe, water level and everything related to measurements in water. Data are updated every 20 minutes.

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Figure 56 - part of Water section. Fano Arzilla Outfall.

6.3.5.4   Sample Analysis section

This section (Figure 57) reports the data generated by chemical and microbiological analysis derived from automatic or field sampling at sea (for example, coliforms concentration). If provided, it also shows ancillary analysis data. Data are updated every 20 minutes.
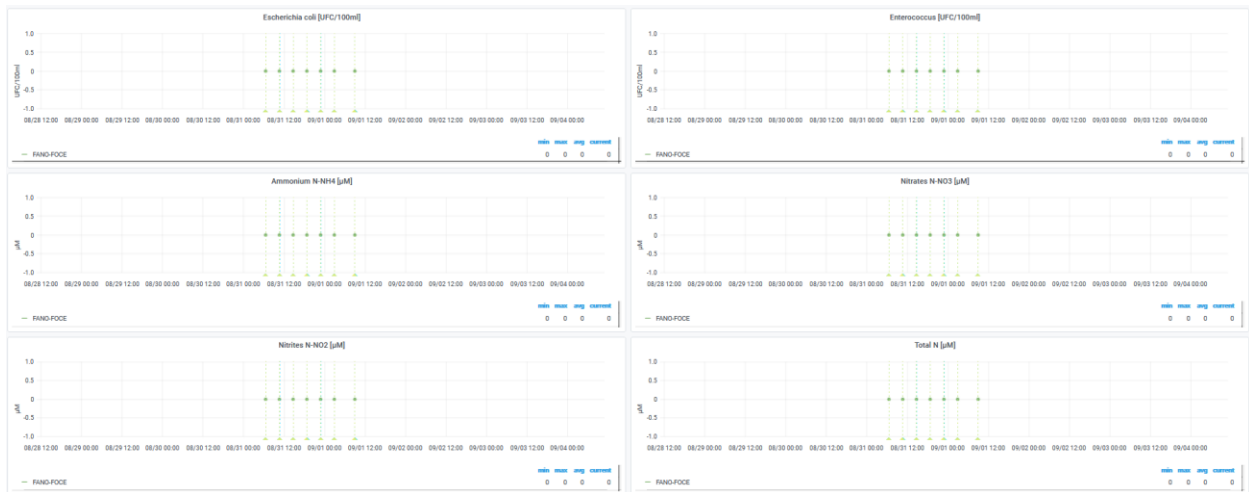

Figure 57 - part of Sample Analysis section. Fano Arzilla Outfall.

6.3.5.5   Hardware section

The Hardware section (Figure 58) includes all important information to analyse the operating status of the systems installed on the monitoring site.
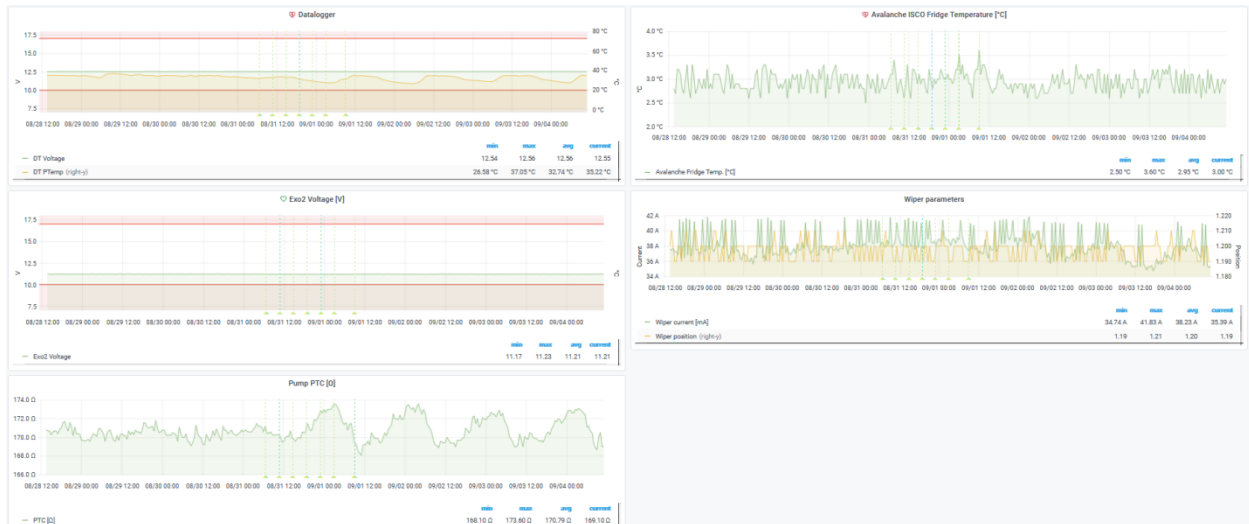

Figure 58 - part of Hardware section. Fano Arzilla Outfall.

6.4   DATA EXPORT – INSPECT PANEL

Inspect allows you to view the raw data for any Grafana panel as well as export that data to a CSV file.

The panel inspector (Figure 59) consists of four tabs:

- *Data tab* - Shows the raw data returned by the query with transformations applied. Field options such as overrides and value mappings are not applied by default.

- *Stats tab* - Shows how long query takes and how much it returns.

- *JSON tab* - Allows you to view and copy the panel JSON, panel data JSON, and data frame structure JSON. This is useful if you are provisioning or administering Grafana.

- *Query tab* - Shows you the requests to the server sent when Grafana queries the data source.

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Not all panel types include all four tabs. For example, dashboard list panels do not have raw data to inspect, so they do not display the Stats, Data, or Query tabs.
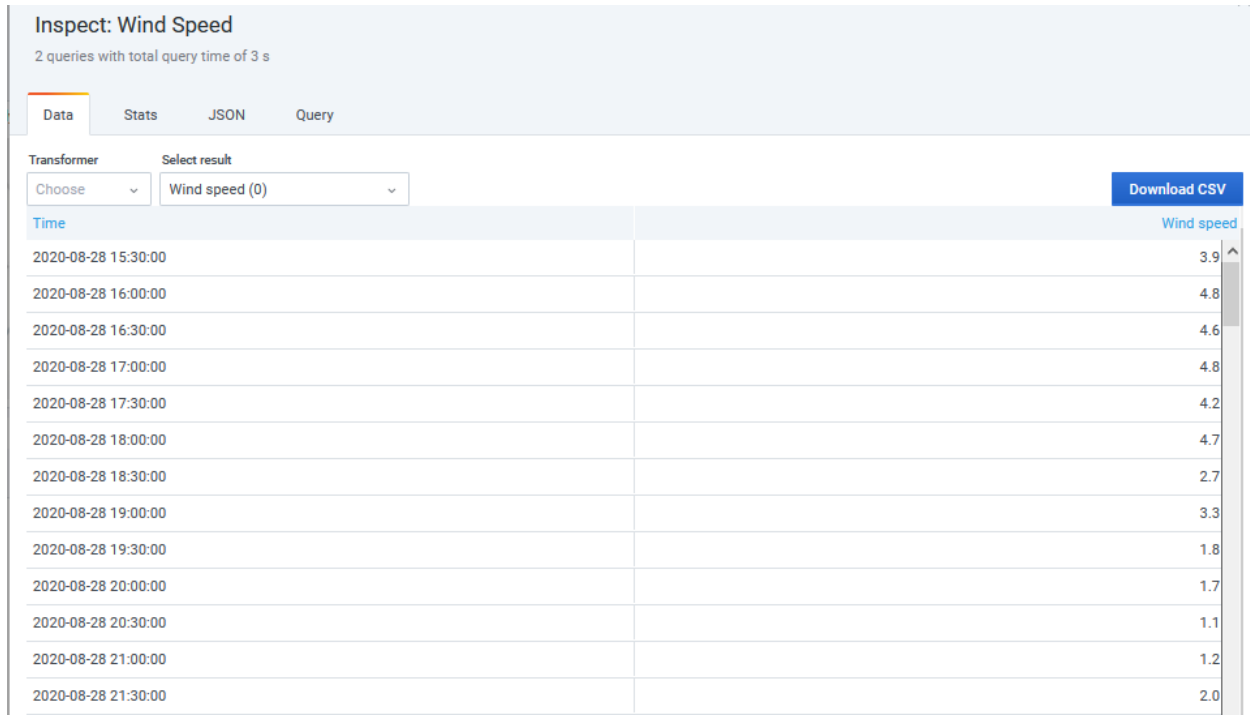

Figure 59 – Panel Inspector.

6.4.1.1   Open the panel inspector

You can inspect any panel that you can view. Navigate to the dashboard that contains the panel you want to inspect. Click the title of the panel you want to inspect and then click *Inspect*. Or Hover your cursor over the panel title and then press *i*. The panel inspector panel (Figure 59) opens on the right side of the screen.
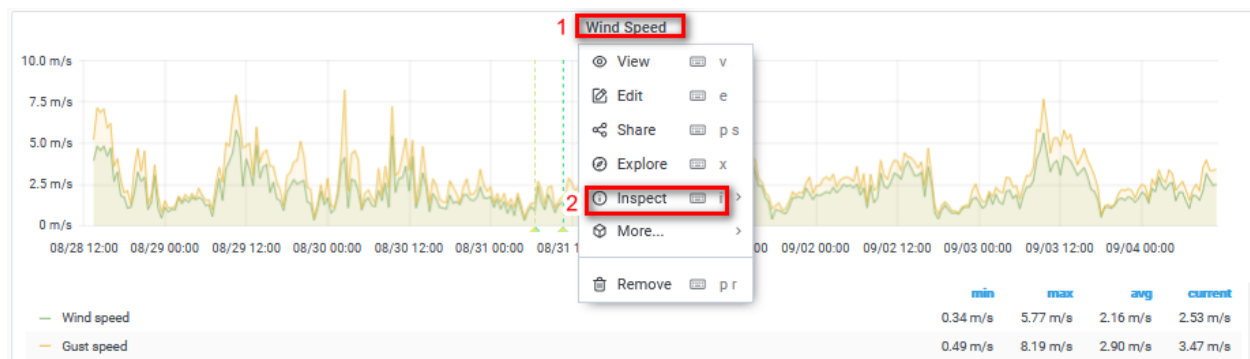

Figure 60 -Open panel inspector.

6.4.1.2 Inspect raw query results

View raw query results in a table. This is the data returned by the query with transformations applied and before the panel applies field options or field option overrides.

1. Open the panel inspector and then click the Data tab or in the panel menu click **Inspect > Data**.

2. If panel contains multiple queries or queries multiple nodes, then you have additional options.

   a. **Select result** - Choose which result set data you want to view.

   b. **Transform data**

      ○ **Join by time** - View raw data from all queries at once, one result set per column. Click a column heading to reorder the data.

   View raw query results in a table with field options and options overrides applied:

      ○ Open the **Data** tab in panel inspector.

      ○ Click on **Data display options** above the table.

      ○ Click on **Apply field configuration** toggle button.

6.4.1.3 Download raw query results as CSV

Grafana generates a CSV file in your default browser download location. You can open it in the viewer of your choice.

1. Open the panel inspector.

2. Inspect the raw query results as described above. Adjust settings until you see the raw data that you want to export.
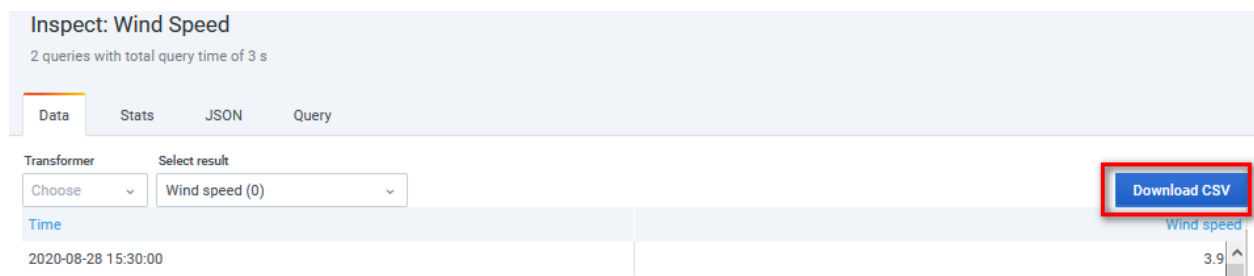
3. Click **Download CSV**.

Figure 61 - panel inspector, download CSV button.

7 ALERT TOOL

The alert tool is a dedicated software that runs continuously in real time using the data stored in the WQIS database (Penna P. et al, 2021). The alert tool provides the notification through a communication channel (email or Telegram).

The alert tool notifies users of:

• system progress.

• any abnormalities in the environmental parameters.

• any hardware abnormalities detected in real time.

The alert tool has been tested and applied to the five pilot sites in the Adriatic Sea.

7.1 Alert Tool Structure

The conceptual model of the Alert Tool is composed of several levels as showed in Figure 62. Block diagrtam showing the operation of the Alert Tool system..

The datalogger firmware checks communication with sensors and data consistence and store these states in LOG table. The Campbell Scientific's LoggerNet software retrieves in real-time raw data from remote dataloggers and inserts it into the WQIS Centralized Database (CDB). In order to ensure interoperability, a dedicated python script saves the data with a suitable formatting in specific tables of the WQIS CDB. Grafana service was programmed to generate the alerts envisaged by the alert tool.
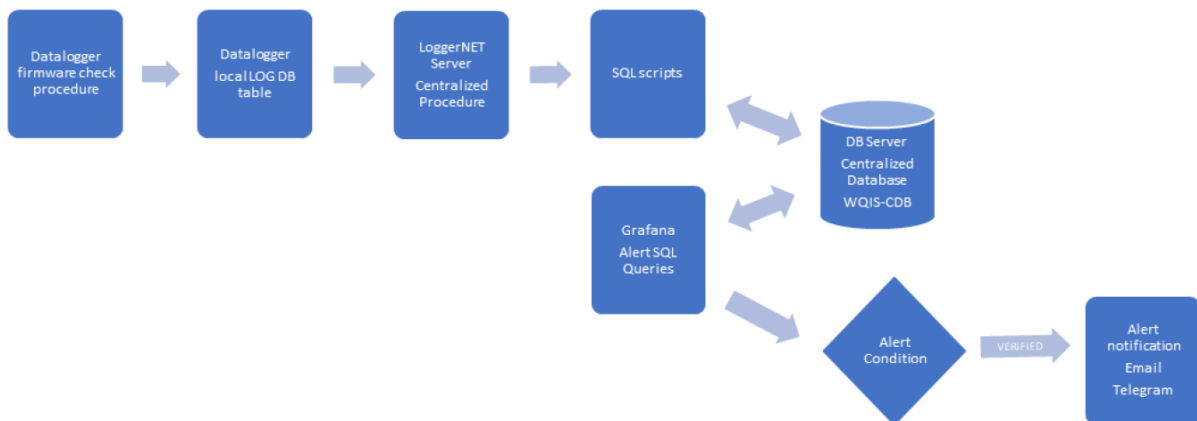

Figure 62. Block diagrtam showing the operation of the Alert Tool system.

7.2 Grafana Alert Service

The Grafana service, in addition to the web data presentation, was programmed to generate the alerts envisaged by the alert tool. Alerts have four main components:

- Alerting rule - One or more query and/or expression, a condition, the frequency of evaluation, and the (optional) duration that a condition must be met before creating an alert.

- Contact point - A channel for sending notifications when the conditions of an alerting rule are met.

- Notification policy - A set of matching and grouping criteria used to determine where, and how frequently, to send notifications.

- Silences - Date and matching criteria used to silence notifications.

For each specific parameter, the alert conditions were generated by programming a series of SQL queries that run at specific intervals.

If the pre-set thresholds (Figure 63) are exceeded, the system sends an email (Figure 64) and/or Telegram notification (Figure 65) to the pre-selected actors/recipients.

Here below a description of the events involved in the Alert Tool (Table 1) is provided:

- Rain trigger: it activates if system detects rain in the previous half hour.

- Floodway: this trigger is based on the real-time information provided by the public water and wastewater service provider (ASET in Fano). It is activated in case of discharge of wastewater in the analysed river.

- River level: It is activated if the river level exceeds a pre-set threshold.

- Sampling Start and Sampling End: it sends an alert at the start and at the end of the automatic sampling.

- Bottle Progress: it allows to know the sampling status; it sends an alert for each new sampling bottle.

- Ready Button: it sends an alert when the sample manager presses the button that the bottles have been replaced.

- No Data: it reports transmission issues between specific remote station and master station or between sensors and datalogger.

- Power Failure, Power Anomaly, Pump failure: it reports hardware anomalies of remote devices.

- Fridge Temperature: it is activated in case of anomalies in the automatic sampler fridge temperature.
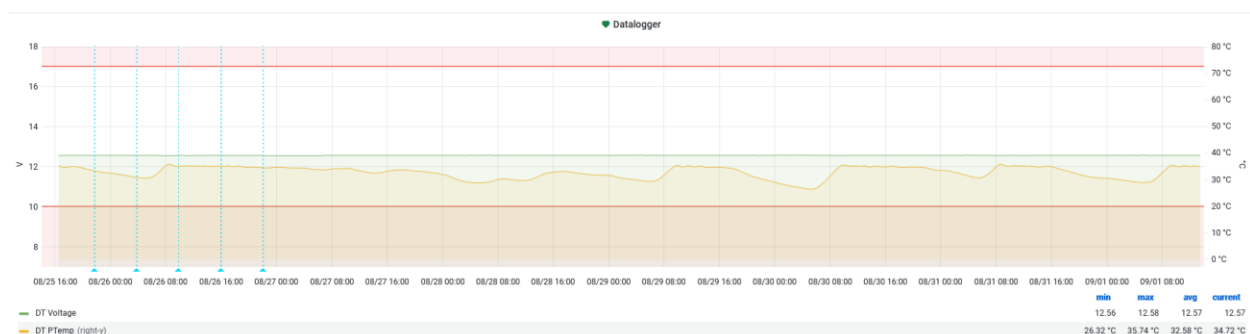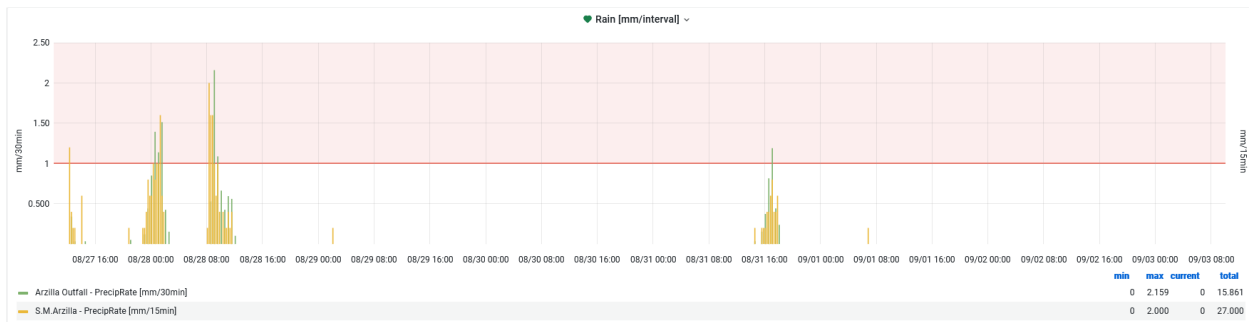
Figure 63.The graph above shows the voltage and temperature values of the CR1000X datalogger. The two red lines represent the minimum and maximum thresholds of the Alert Tool system that sends a Power Anomaly warning if the voltage goes out of the range 10-16.5V. The graph below shows the rain threshold set at 1mm/30min. If the rain that falls in the last 30 minutes exceeds 1mm, a specific alert is sent.
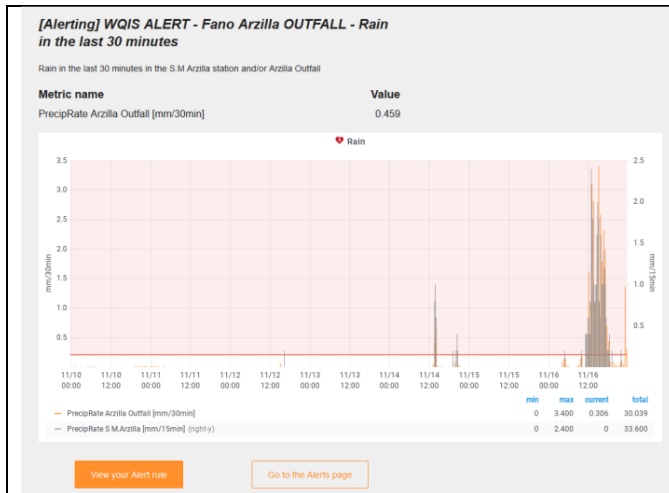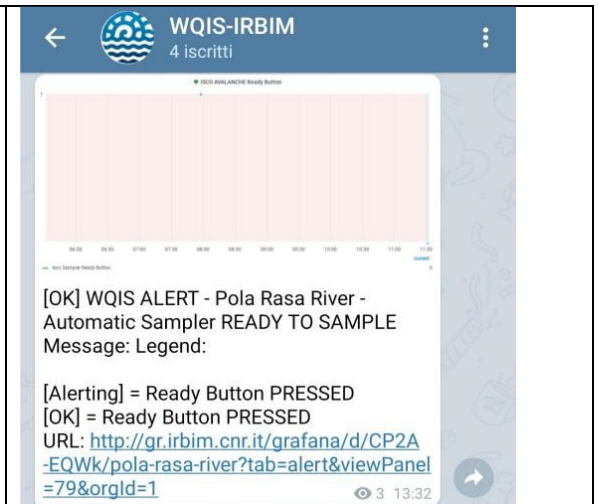

Figure 64. Example of notification: e-mail

Figure 65. Example of notification: Telegram

8   ANNEXES

Table 4 - Real-time physical and chemical parameters collected in WATERCARE PROJECT

Atmosphere	River Water
Air temperature [°C]	Temperature [°C]
Barometric pressure [mbar]	Conductivity [mS/m]
Lightning count and average distance [km]	Salinity [PSU]
Precipitation [mm/h]	Turbidity [NTU]
Relative humidity [%]	Dissolved Oxygen Concentration [ml/l]
Solar radiation [W/m^2]	Dissolved Oxygen Saturation [%]
Tilt [°]	
Wind direction [°N]	
Wind speed [m/s]	

Table 5 - Chemical and microbiological parameters collected in WATERCARE PROJECT.

Enterococcus [UFC/100 ml]	Turbidity [NTU];
Escherichia [UFC/100 ml]	Dissolved O2 [% sat];
Ammonium N-NH4 [μM]	Chlorophylla [μg/L];
Nitrates N-NO3 [μM]	Sea State (waves) [m];
BOD5 [mg/L]	Dissolved O2 [mg/L];
BOD5 [mg/L]	Sea water current;
COD [mg/L]	TSS [mg/L];
Salinity	TOM [mg/L];
Temperature [°C]	Nitrites N-NO2 [μM];
Redox [mV]	Total N [μM];
pH	Total P [μM];
Conductibility [mS/cm];	Orthophosphate P-PO4 [μM];