D.3.3.2 – Sensor Data Web

Document Control Sheet

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1. INTRODUCTION

The WQIS network was applied and implemented for each study area and focused on urban area in sewers, riverine and rivers. The sensor data collected by meteorological/hydrological network and by bacteriological analyses were stored into a geographic database freely accessible on a dedicated web page. Once generated the alert system, the user (watercare partner) is enabled to access the output resulting from the models, which will provide a simulation and forecast of bacterial dispersion in the coastal waters to identify the critical areas for the bathing.

In the D3.1.1 Software Utilities and D3.1.2 WATERCARE WQIS deliverables, design, test and preparation of the WQIS have been described.

After this preparatory phase, the WQIS was implemented in the Fano pilot site as described in the deliverable *D.3.3.1 - WATERCARE WQIS implementation* and *4.1.2– Implementation/realization of the WQIS in the pilot site.*

The experience gained in the implementation phase of the WQIS in the pilot site has been transferred to the various partners of the project. In particular, the connection diagrams of the equipment, the sampling strategies, and an operating manual regarding the use of the entire WQIS "ecosystem" were shared. In this regard, the authors of this deliverable would like to thank Alan Blažekovic, PROMOTRONIC (Zagreb) for testing and implementation of the equipment in all Croatian sites and Dr. Roberto d'Andrea and Ing Lucia Bergia, ACA (Pescara) for testing and implementation of the equipment of the Pescara site. CNR IRBIM provided continuous remote support from the testing phase in the laboratory to the complete installation in the field and subsequent launch of the Watercare site to the production of valid data. During this operational phase CNR IRBIM also updated both the centralized database and the dashboards designed for data visualization as shown in chapter *4 WEB presentation of sensor data* of this deliverable.

2. Sensor Data flow

The conceptual model of the management of the acquired sensor data is composed of different levels (Figure 1).

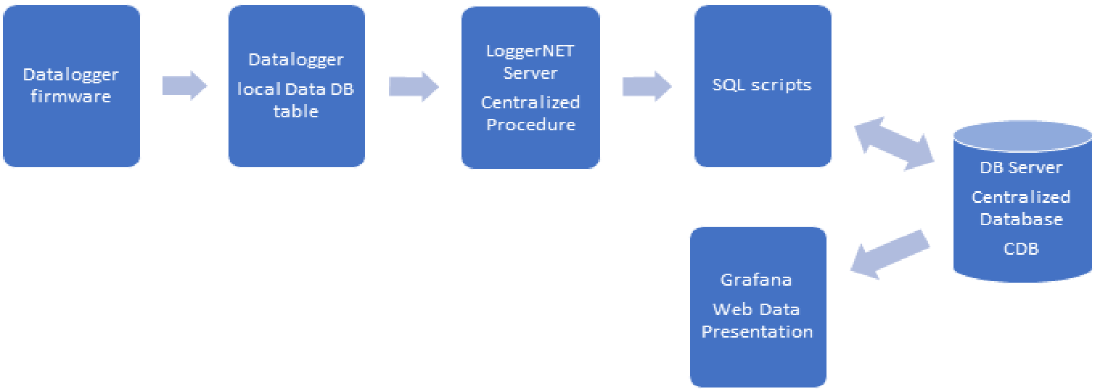


Figure 1. Data flow diagram showing the procedure for acquiring, storing, and displaying data.

The datalogger firmware is responsible for interfacing with the sensors (Figure 2) and it manages the reading of the signals (analog and/or digital) output from the sensors. Data are processed and inserted into a pre-configured table in an internal DB.

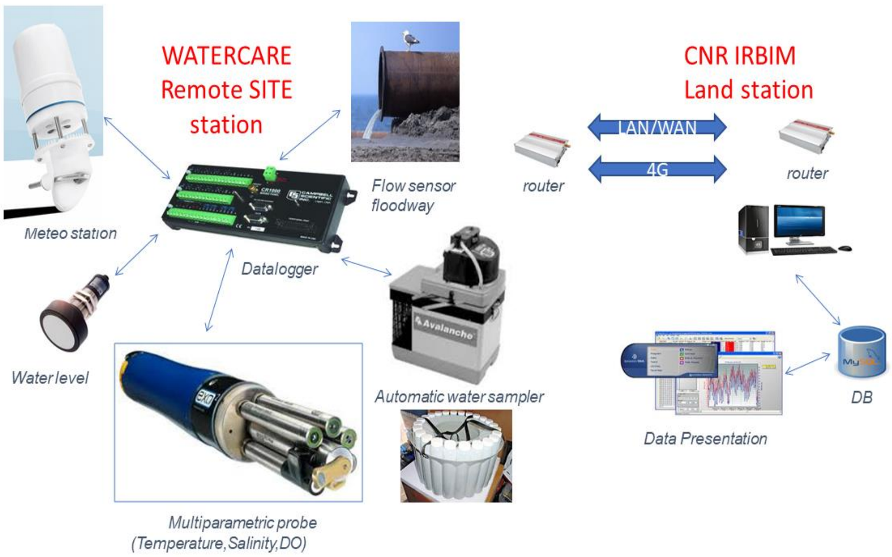


Figure 2. The Block Diagram shows the datalogger connections with sensors, communication stage, centralized database, and web data presentation.

The Campbell Scientific’s LoggerNet software retrieves in real-time raw data from remote dataloggers and inserts it into the WQIS Centralized Database (CDB, Figure 3).

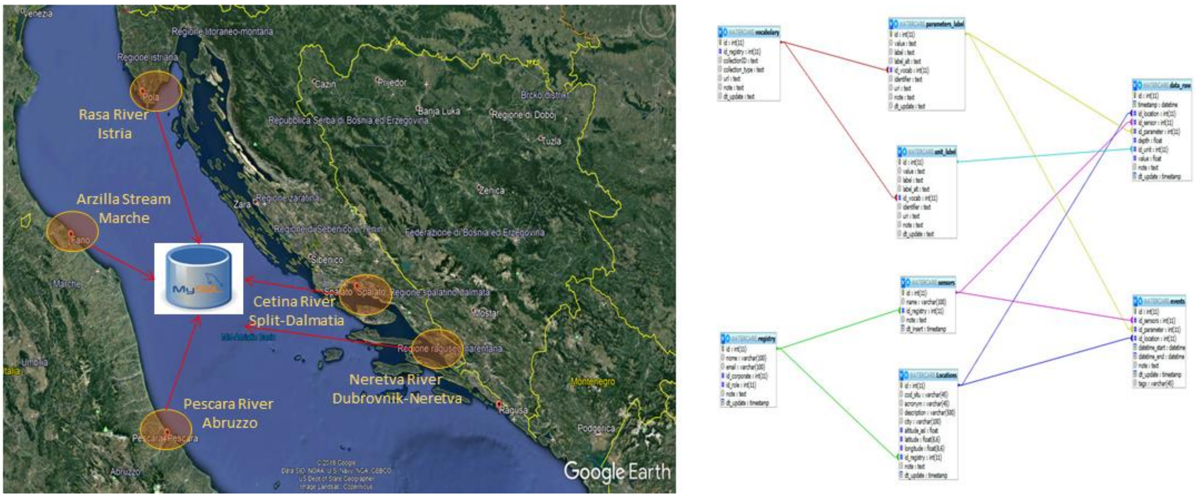


Figure 3. WQIS Centralized Database (CDB).

In order to ensure interoperability, a dedicated python script saves the data with a suitable formatting in specific tables of the WQIS CDB (Figure 4). The Web data presentation (see chap. 4 WEB presentation of sensor data) is provided by a Grafana Web Server (installed at the CNR Institute) programmed to interface directly with the WQIS CDB.

id	timestamp	id_location	id_sensor	id_parameter	id_registry	depth	id_unit	value	note	dt_update
46636933	2021-09-14 16:00:00	20	10	102	20	NULL	12	0.5	NULL	2021-09-14 18:03:06
46636932	2021-09-14 16:00:00	20	10	101	20	NULL	12	-0.6	NULL	2021-09-14 18:03:06
46636931	2021-09-14 16:00:00	20	11	99	20	NULL	37	449...	NULL	2021-09-14 18:03:06
46636930	2021-09-14 16:00:00	20	11	100	20	NULL	32	194.61	NULL	2021-09-14 18:03:06
46636929	2021-09-14 16:00:00	20	11	64	20	NULL	16	8.1	NULL	2021-09-14 18:03:06
46636928	2021-09-14 16:00:00	20	13	88	20	NULL	35	-27.58	NULL	2021-09-14 18:03:06
46636927	2021-09-14 16:00:00	20	12	89	20	NULL	19	-3	NULL	2021-09-14 18:03:06
46636926	2021-09-14 16:00:00	20	10	85	20	NULL	34	0.00...	NULL	2021-09-14 18:03:06
46636925	2021-09-14 16:00:00	20	10	84	20	NULL	33	0.064	NULL	2021-09-14 18:03:06
46636924	2021-09-14 16:00:00	20	6	62	20	NULL	15	3	NULL	2021-09-14 18:03:06
46636923	2021-09-14 16:00:00	20	11	59	20	NULL	20	11.33	NULL	2021-09-14 18:03:06
46636922	2021-09-14 16:00:00	20	11	61	20	NULL	16	1.15	NULL	2021-09-14 18:03:06
46636921	2021-09-14 16:00:00	20	11	60	20	NULL	26	33.29	NULL	2021-09-14 18:03:06
46636920	2021-09-14 16:00:00	20	11	58	20	NULL	19	0	NULL	2021-09-14 18:03:06
46636919	2021-09-14 16:00:00	20	11	55	20	NULL	14	74.62	NULL	2021-09-14 18:03:06
46636918	2021-09-14 16:00:00	20	11	54	20	NULL	25	6.84	NULL	2021-09-14 18:03:06
46636917	2021-09-14 16:00:00	20	11	56	20	NULL	14	74.62	NULL	2021-09-14 18:03:06
46636916	2021-09-14 16:00:00	20	11	57	20	NULL	25	0	NULL	2021-09-14 18:03:06

Figure 4. WQIS DB. Extract of the data table.

3. SENSORS INSTALLED AT THE WATERCARE PILOT & TARGET SITES

Meteorological/hydrological sensors as remote stations were installed in 5 different Watercare sites and they are shown in the section below.

FANO - ARZILLA OUTFALL (Pilot site)

Figure 5. Position of sampling stations: WQIS box (yellow house), sea (blue pin) and river (green pin).

Meteo station (real time): wind (speed, gust, direction), Air temperature, relative humidity, atmospheric pressure, solar radiation, rain gauges, lightning.

Multiparametric probe, river water monitoring(real-time): level, temperature, salinity, conductivity, Optical Dissolved Oxygen (concentration and saturation), turbidity. Not installed: pH and redox (measured with portable CTD probe) flow rate

Datalogger for data collecting and sharing.

Energy source: 230 VAC

The web data flow started on 26 August, 2019.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/BSOnDb1Zs/fano-arzilla-outfall

Figure 6. Equipment and sensors installed at Arzilla River outfall (Fano Pilot Site).

FANO - ARZILLA UPSTREAM (Pilot site)

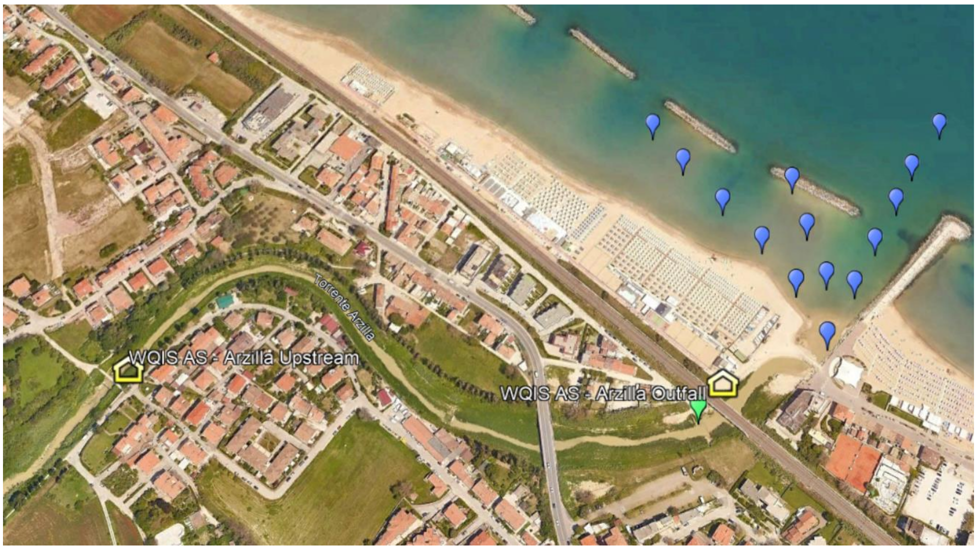


Figure 7. Position of sampling stations: WQIS box (yellow house), sea (blue pin) and river (green pin).

Multiparametric probe, river water monitoring(real-time): temperature, salinity, conductivity, Optical Dissolved Oxygen (concentration and saturation), turbidity. Not installed: pH and redox (measured with portable CTD probe).

Datalogger for data collecting and sharing

Energy source: 230 VAC

The web data flow started on 28 May 2020.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/X7A84QsZz/fano-arzilla-upstream

Figure 8. Equipment and sensors installed at Arzilla River upstream (Fano Pilot Site).

POLA - RAŠA river

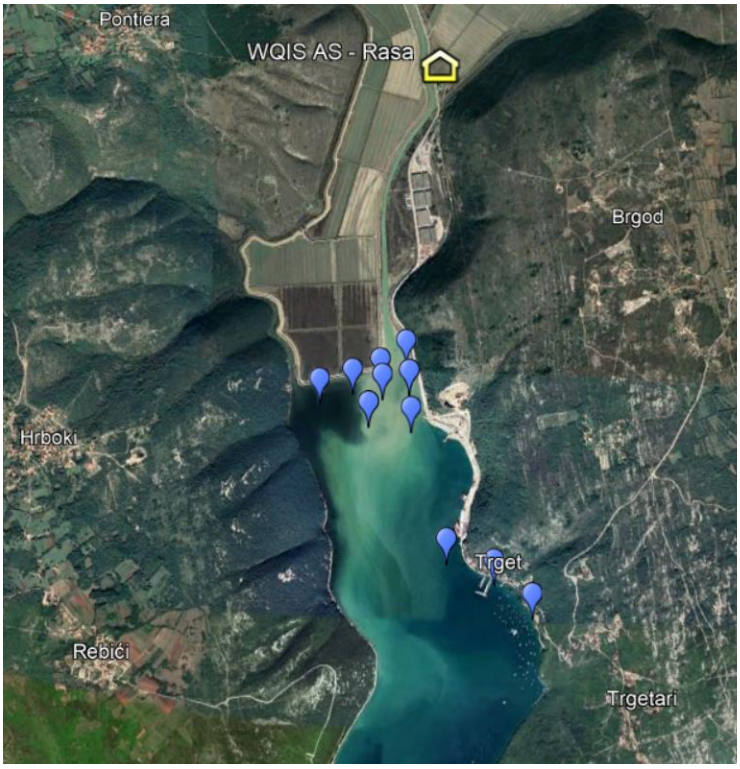


Figure 9. Position of sampling stations: WQIS box (yellow house), sea (blue pin).

Meteo station (real time): wind (speed, gust, direction), Air temperature, relative humidity, atmospheric pressure, solar radiation, rain gauges, lightning.

Multiparametric probe, river water monitoring(real-time): temperature, salinity, conductivity, Optical Dissolved Oxygen (concentration and saturation), turbidity, pH, redox.

Datalogger for data collecting and sharing.

Energy source: 230 VAC

The web data flow started on 4 March 2020.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/CP2A-EQWk/pola-rasa-river

Figure 10. Equipment and sensors installed at Raša River.

SPLIT - CETINA River Main (Upstream)

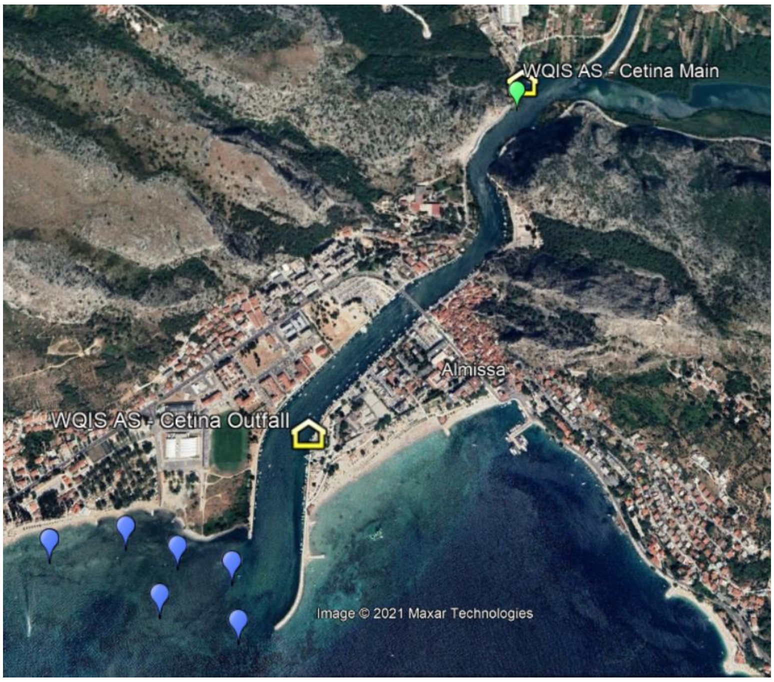


Figure 11. Position of sampling stations: WQIS box (yellow house), sea (blue pin).

Meteo station: (real time): wind (speed, gust, direction), air temperature, relative humidity, atmospheric pressure, solar radiation, rain gauges, lightning.

Multiparametric probe, river water monitoring(real-time): salinity, water temperature, redox potential, pH, conductivity, turbidity, dissolved oxygen, oxygen saturation.

Datalogger for data collecting and sharing.

Energy source: solar panel and batteries

The web data flow started on 6 May 2021.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/2gO-v5rGz/split-cetina-main

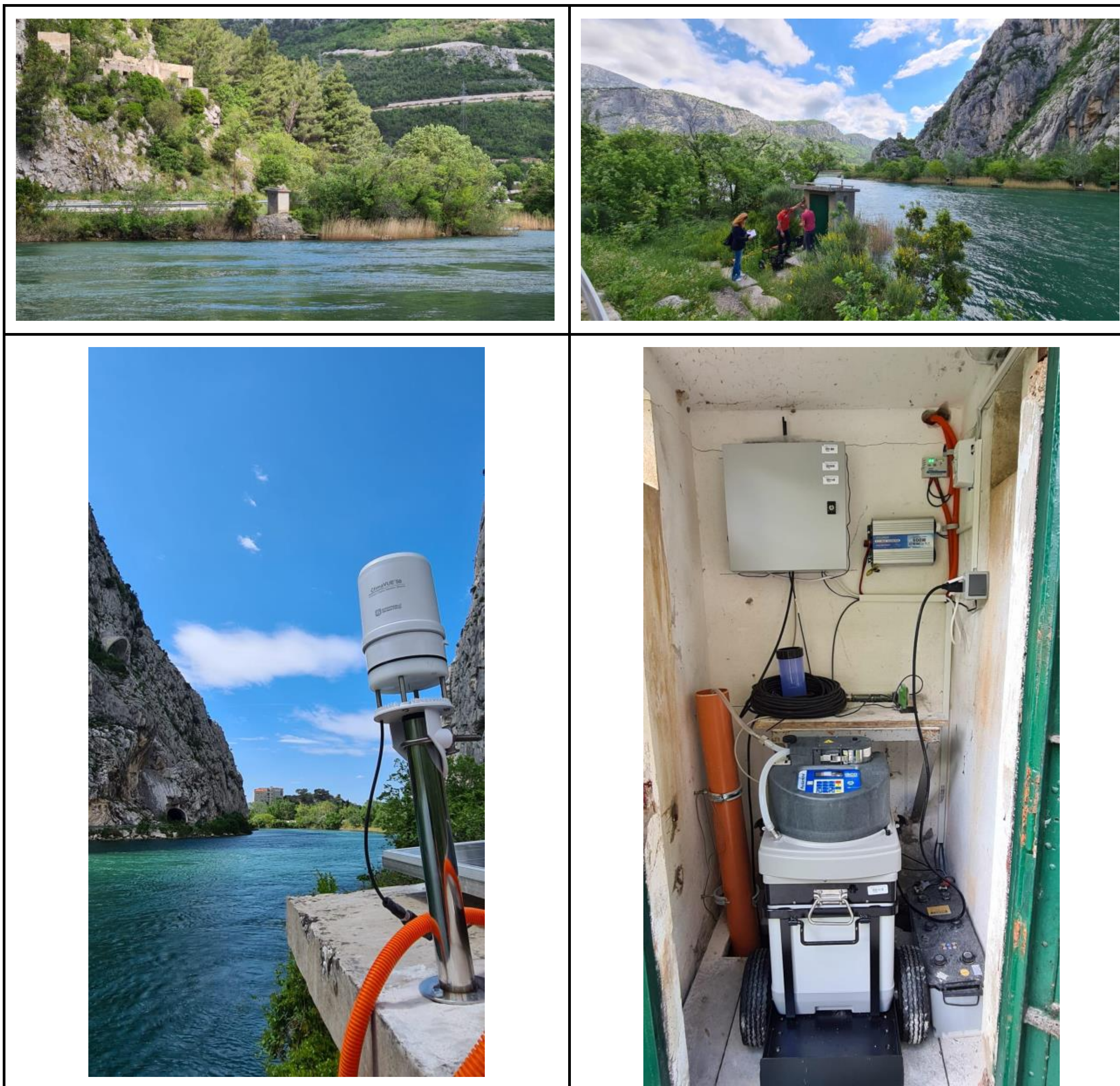


Figure 12. Equipment and sensors installed at CETINA River Main (upstream).

SPLIT - CETINA River Outfall

Figure 13. Position of sampling stations: WQIS box (yellow house), sea (blue pin).

Automatic sampling station AVALANCHE which takes samples during sunny and rainy period for laboratory analysis of microbiological parameters of river water.

Datalogger for data collecting and sharing.

The web data flow started on 06 May 2021.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/I_BVmEknz/split-cetina-outfall

Figure 14. Equipment and sensors installed at CETINA River Outfall.

DUBROVNIK - NERETVA River

Figure 15. Position of sampling stations: WQIS box (yellow house), sea (blue pin) and river (green pin).

Meteo station (real time 0-24): wind (speed, gust, direction), air temperature, relative humidity, atmospheric pressure, solar radiation, rain gauges, lightning.

Multiparametric probe sonde river water monitoring (real-time 0-24): temperature, salinity, conductivity, redox potential, Optical Dissolved Oxygen (concentration and saturation), turbidity, pH.

Datalogger for data collecting and sharing.

Energy source: solar panel and batteries

The web data flow started on 23 March 2021.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/TUbesxQGz/dubrovnik-neretva-river

Figure 16. Equipment and sensors installed at NERETVA River.

PESCARA - PESCARA River

Figure 17. Position of sampling stations: WQIS box (yellow house), sea (blue pin) and river (green pin).

Meteo station (real time 0-24): wind (speed, gust, direction), air temperature, relative humidity, atmospheric pressure, solar radiation, rain gauges, lightning.

Multiparametric probe sonde river water monitoring (real-time 0-24): temperature, salinity, conductivity, redox potential, Optical Dissolved Oxygen (concentration and saturation), turbidity, pH.

Datalogger for data collecting and sharing.

Energy source: 230 VAC

The web data flow started on 27 May 2021.

Data visualization link: https://watercare.irbim.cnr.it/grafana/d/OQBudPznz/pescara-pescara-river

Figure 18. Equipment and sensors installed at PESCARA River.

4. WEB presentation of sensor data

Concurrently the development of the data acquisition system, the centralized database (WQIS CDB) and the data visualization tools were created. The database was developed using the relational database management system (RDBMS) MySQL. It is the heart of the data collection of the Watercare project, storing sensors data, analysis results, ancillary data, geolocation sampling points, etc allowing to project partners to be accredited, access and easily recover information.

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 graphs and visualizations.

After implementing the pilot sites dashboard, CNR IRBIM staff replicated the same structure on all the other project sites.

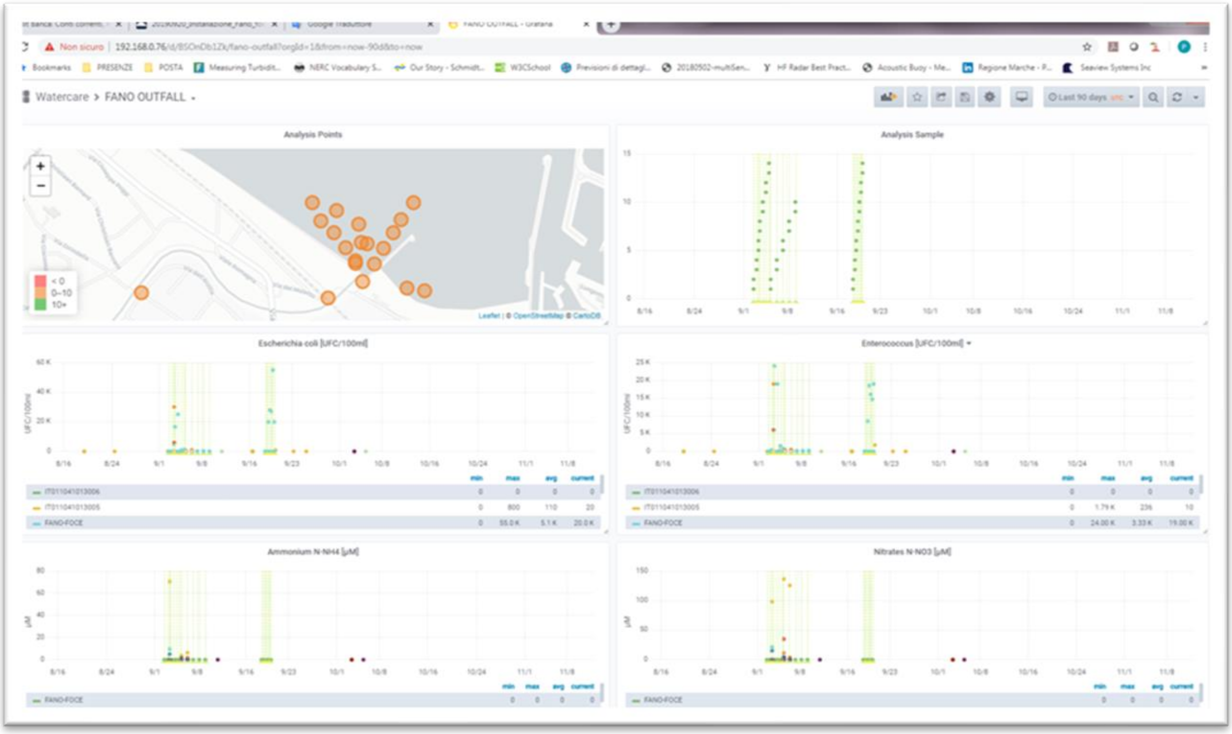
To have a unique access point and an overview of all the stations foreseen by the project, a web page called Watercare Sites Map has been developed (Figure. 19). Clicking the markdown corresponding to the site of interest leads to a card (Figure. 20) with the link to access the data visualization, site management (for setting and managing the automatic sampling) and Samples and Analysis (for inserting the results of sample analyses).

Figure 19. Watercare Sites Map. The unique access point helps project partner to data access.

Figure 20. Direct Links to Web Data Visualization, Site Management and Samples Analysis.

The screenshot shows links to the Cetina River outfall site.

The data visualization site was updated at the beginning of 2021: Grafana was updated to the latest major release and the dashboards were upgraded with more attractive graphics, cool and easy to consult (Figures 21-23).



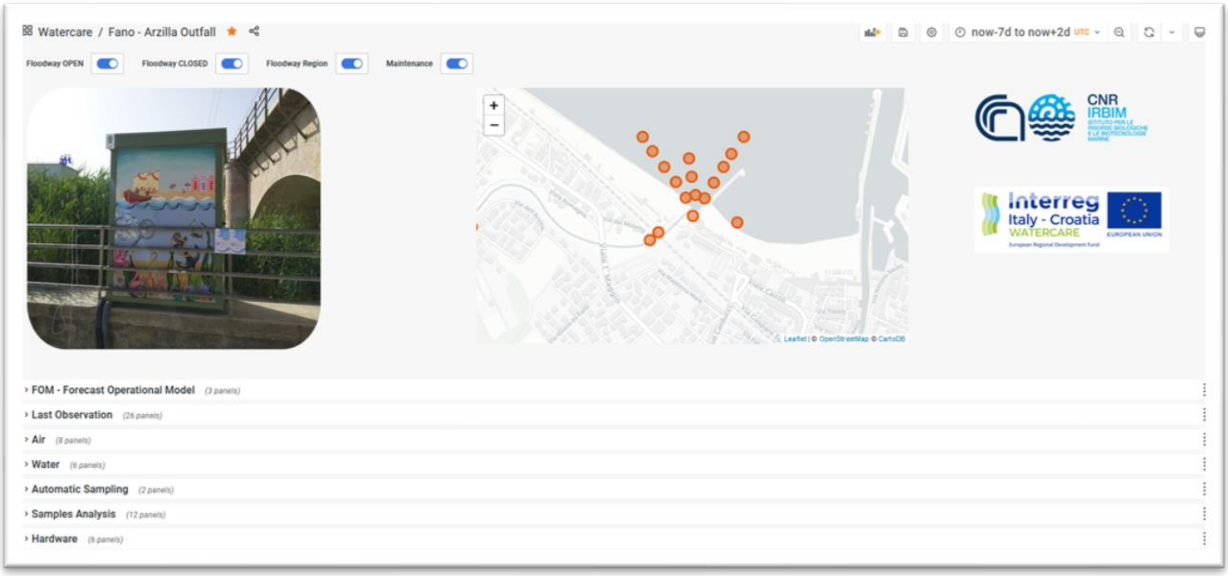


Figure 21. Dashboard’s upgrade. Before (image above) and after (image below) the website restyling.

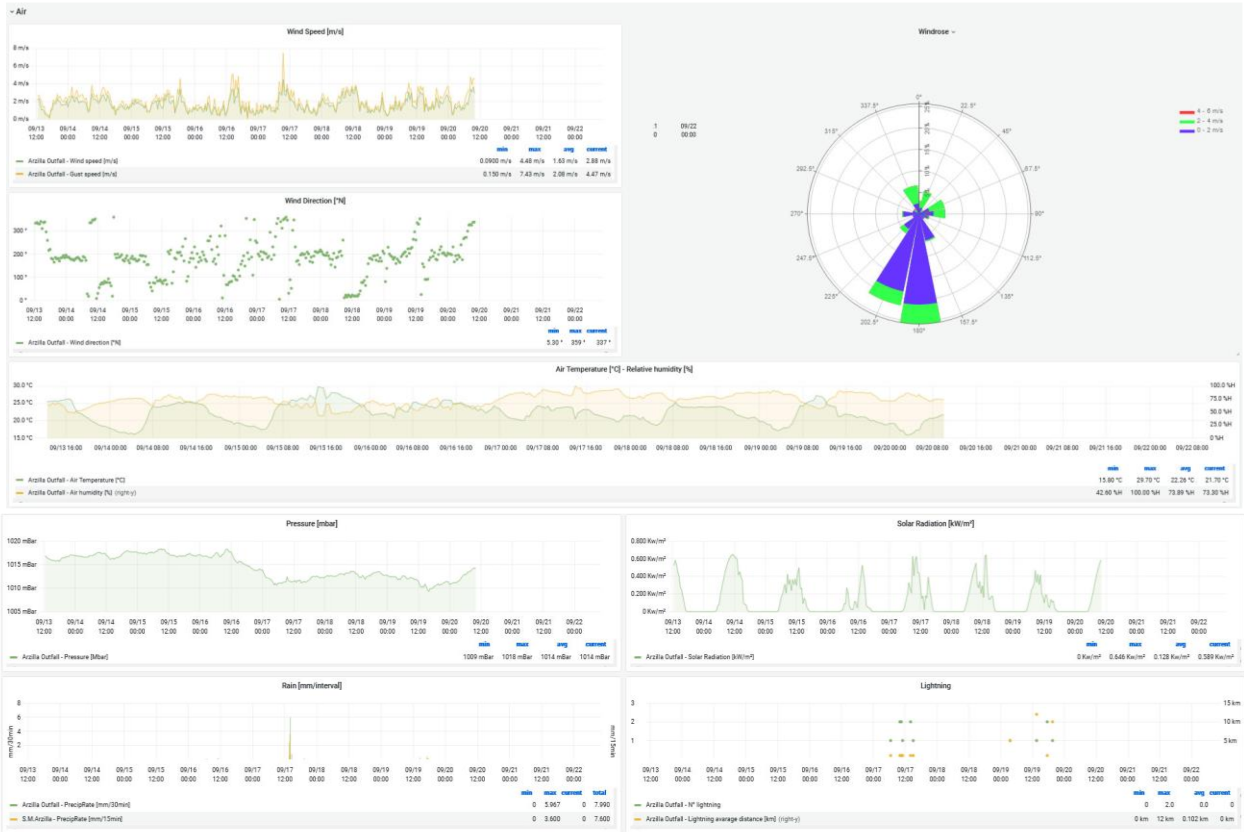


Figure 22. The new Sensor data web visualization. Example of the Air section.

Figure 23. The new Sensor data web visualization. Example of the Water section.

In addition, an intuitive section, named Last observation (Figures 24-30), has been added for viewing the latest data received.

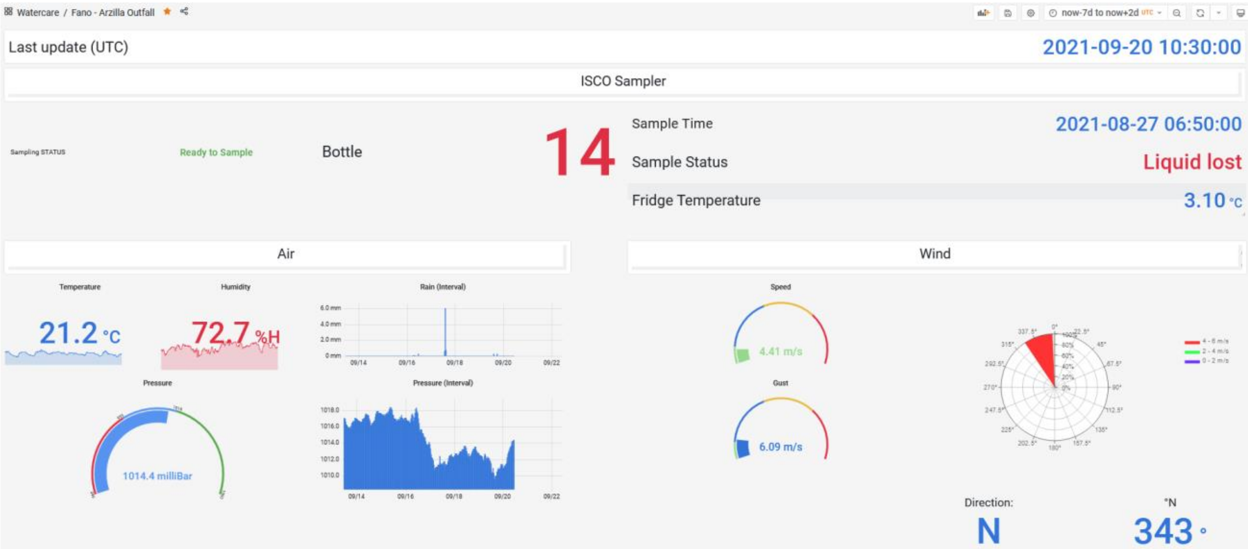


Figure 24. Last observation - Fano Outfall.

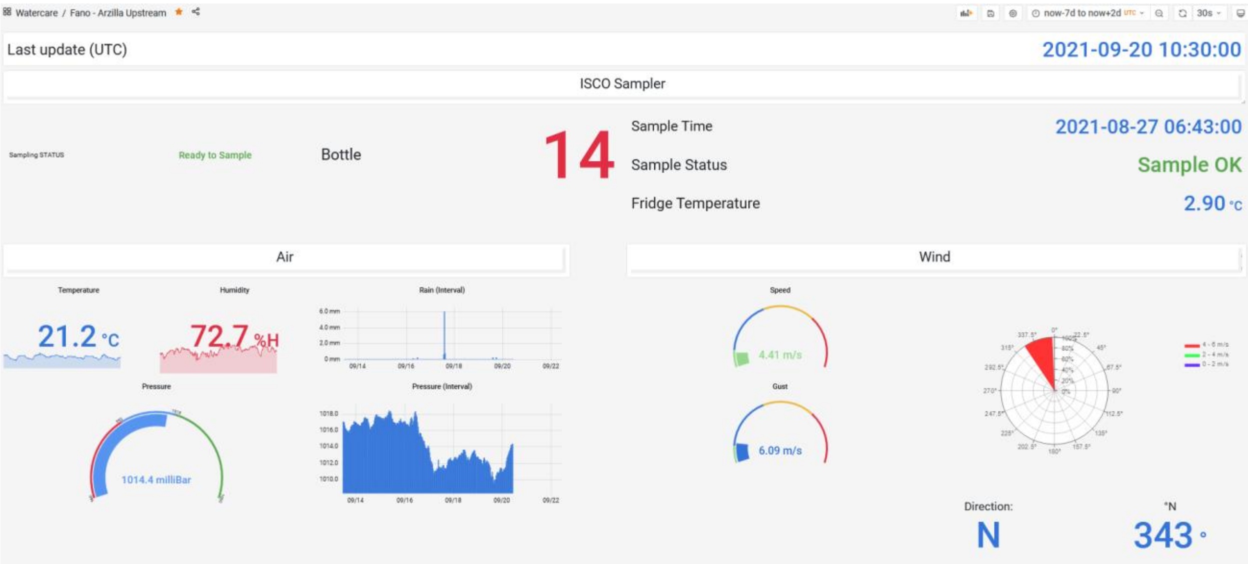


Figure 25. Last observation - Fano Upstream.

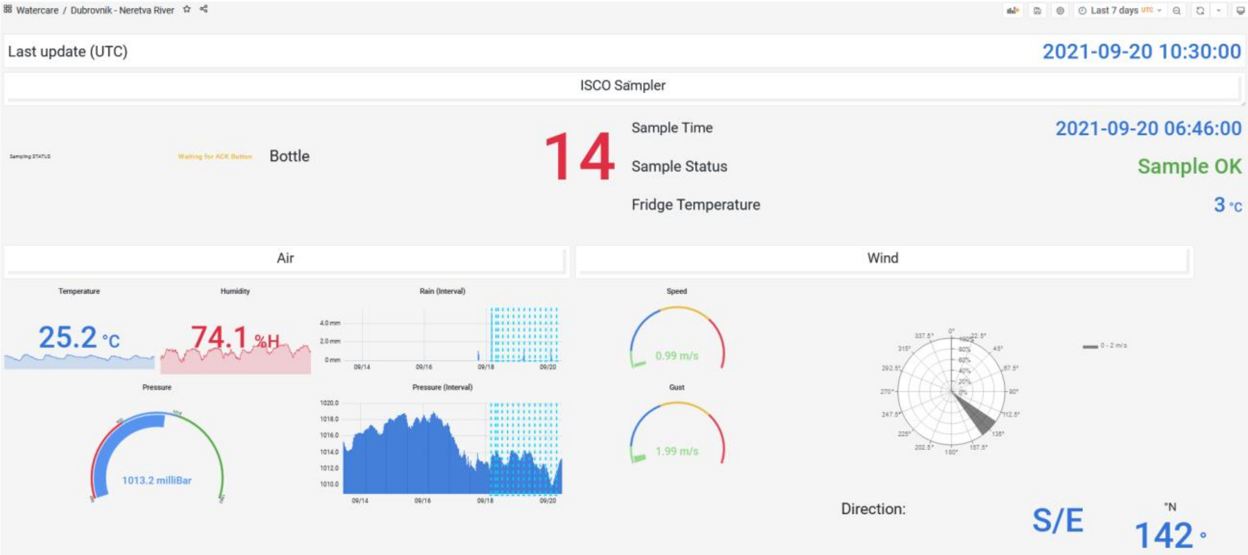


Figure 26. Last observation - Neretva River.

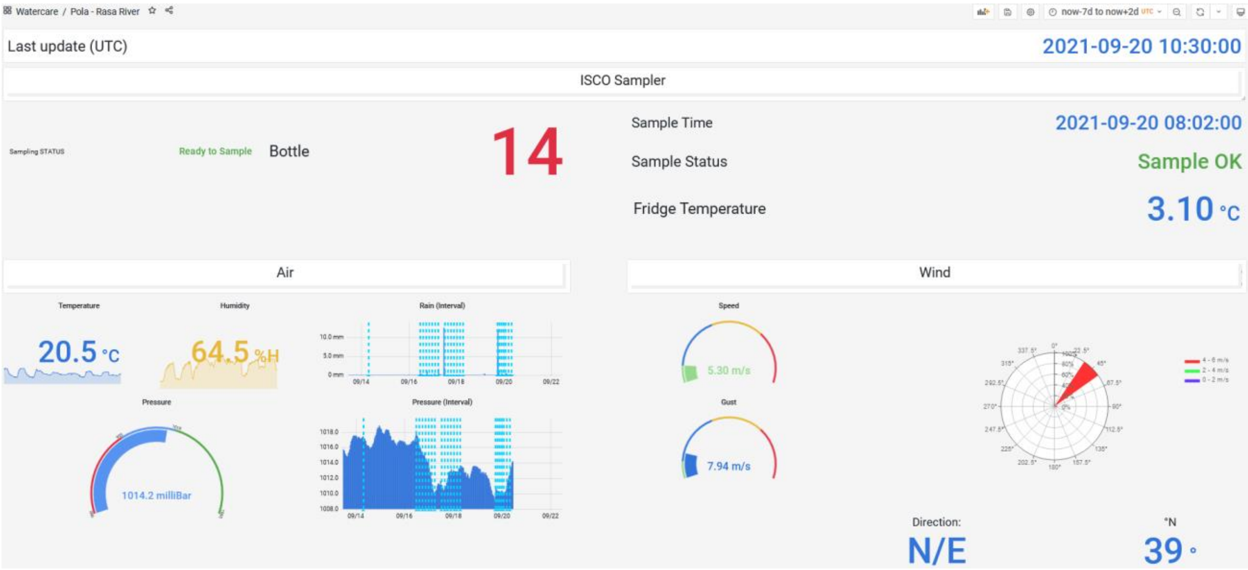


Figure 27. Last observation - Raša River.

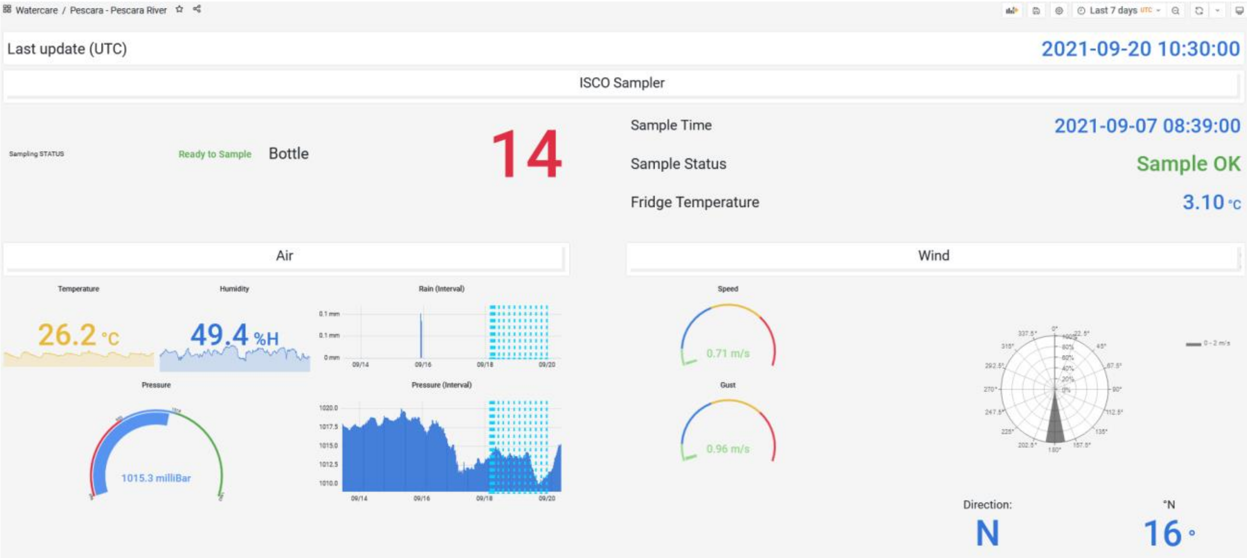


Figure 28. Last observation - Pescara River.

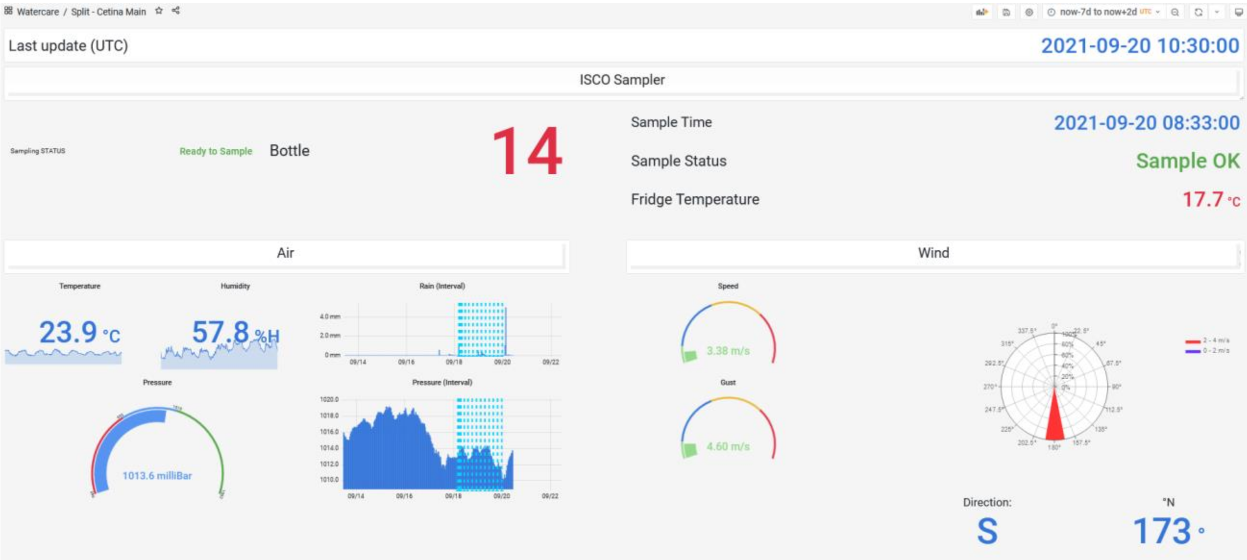


Figure 29. Last observation - Cetina River Main.

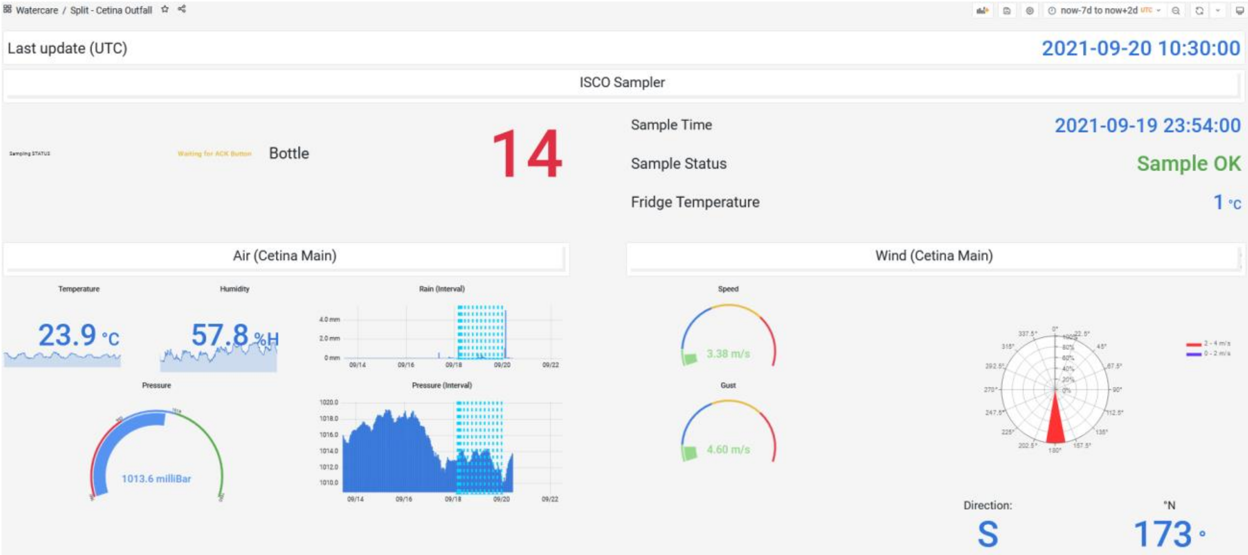


Figure 30. Last observation - Cetina Outfall.