DELIVERABLE 3.3.3

Report on the existing oceanographic data and improving frequency of measurement (IOF, UNIVPM). In comparison to the existing meteorological networks, active oceanographic observational systems over the Adriatic regions will be examined. Possibilities of the harmonization between existing and planned meteorological and oceanographic observations will be summarized.

Let's be reSEAlient!

Project key facts

Priority:	2. Safety and resilience
Specific objective:	2.1 Improve the climate change monitoring and planning of adaptation measures tackling specific effects in the cooperation area
Acronym:	**RESPONSe**
Title:	**Strategies to adapt to climate change in Adriatic regions**
ID request:	10175714
Lead Partner:	INFORMEST
Duration:	01.01.2019 30.04.2022

Deliverable information

WP 3	Harmonization of the climate exchange analysis and monitoring systems
Act 3.3	Analysis, enhacement and integration of existing climate and oceanographic monitoring systems
Issued by:	**Partner n° 7 – IOF**
Reviewed by:	**Partner n° 3– UNIVPM**
Partners involved:	**IOF, UNIVPM, DHMZ**
Status:	Final
Distribution:	Public
Date:	04.2022.

Document history

Version	Date	Author	Description of changes
V 1.0	28.04.2022	IOF	Final version

Table of contents

1 Introduction

Complexity of the oceanographic states of the Adriatic Sea starts from its geographical orientation, since it is deeply embedded into the European continent and consequently regarded as a transitional zone between the influences of continental Europe and the oceanic effect of the Mediterranean Sea. As the prevailing meteorological conditions over the area are mainly controlled with external forcing via atmospheric teleconnection pattern, the basin-wide Adriatic thermohaline circulation depends on the large-scale atmospheric oscillations. This should be emphasized since Adriatic thermohaline circulation and the environmental conditions in the sea, also change.

According to its topography, it is divided into the northern, middle and southern Adriatic. The northernmost part is very shallow overlaying the continental shelf. This area is under the strong influence of the north Italian rivers, especially the Po River. The middle Adriatic is deeper, reaching 280 m in the Jabuka Pit. It is separated from the southern Adriatic by the Palagruža Sill (180 m depth). The southern Adriatic is much deeper, with the deepest part in the south Adriatic Pit, reaching 1233 m. The whole eastern middle Adriatic is a region of strong thermohaline dynamics, and consequently ecosystem variability, on time scales ranging from synoptic and seasonal to interannual, and attributed to the atmosphere through air-sea interactions, river discharges, mixing, and seasonally dependent circulation.

The thermohaline complexity of the region was documented via intensive long-term measurements of hydrological parameters established in the early 1950 as a part of oceanographic investigations performed by the Institute of Oceanography and Fisheries.

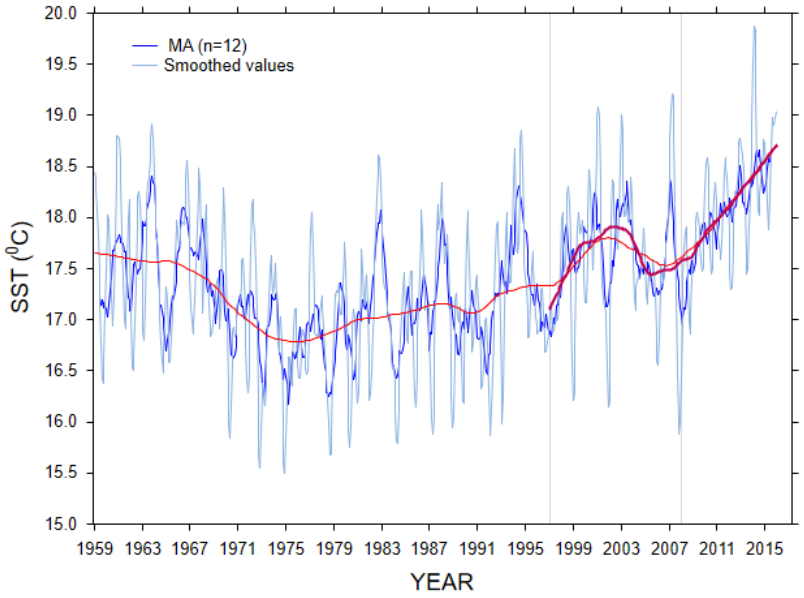


Figure 1. Seasonal decompositions of mean monthly sea surface temperature for the middle Adriatic Sea obtained from moving averages procedure. Non-linear trend for the period 1959–2015 (thin red line) and for the period 1997–2015 (bold red line) are presented as LOWESS spline (obtained from Šolić, Grbec, et all., 2018).

2 Existing measurements in the Adriatic sea

2.1 Vertical profiles

Due to climate change sensitivity, which can be documented by long - term changes in sea surface temperature (Figure 1), research in the Adriatic is still continuing over several predefined profiles in the open sea, and along the coast. In addition to scientific interest, the importance of this research is the preservation of good environmental status prescribed by the Water Framework Directives (WFD), and with the Marine Strategy Framework Directive (MSFD). Long-term sea temperature and salinity measurements started in 2005 under the biological MEDIAS project (former PELMON) during August-September period covering whole Adriatic are still continued (see figure 2). The main goal of the Project is to obtain important biological knowledge about the pelagic ecosystem, with special emphasis on economically important species of small blue fish in the eastern part of the Adriatic Sea.

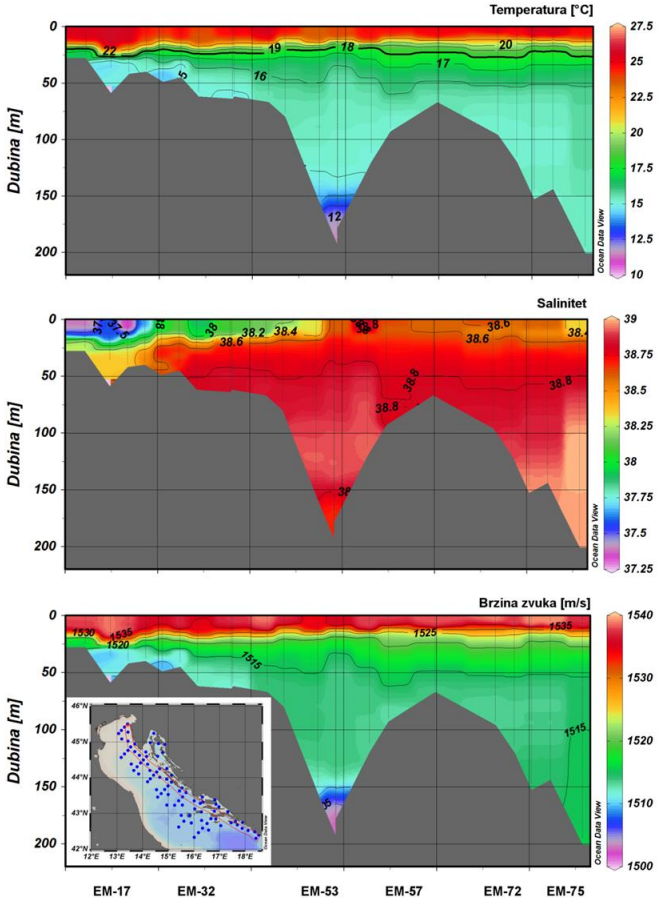


Figure 2. Example of temperature, salinity and sound velocity obtained during MEDIAS oceanography cruise in the autumn 2010.

In an effort to harmonize compliance with European regulations in the area of protection, monitoring and management of water areas, the implementation of the Water Framework Directive and Marine Strategy Framework Directive has started in the Republic of Croatia in 2012. According to the requirements of the Directive, the monitoring of the thermohaline, chemical and ecological status of water bodies in the area of transitional and coastal waters, and open waters of the eastern Adriatic coast is carried out.
The main task of the WFD project was to develop a proposal for a plan and program for monitoring transitional and coastal waters, and to start to implementing the monitoring of transitional and coastal waters. With continuous monitoring in the area of the eastern Adriatic estuaries, we are able to warn of possible harmful effects and exceeding the permitted ecological limits. Oceanographic research in the rivers estuaries began in the last century as part of a complex ecological research of the Institute of Oceanography and Fisheries. Ongoing research activity started through the national project Vir-Konavle (IOR 1976) continues today following the protocols of the EU Water Framework Directive (WFD) in the coastal area, and the protocol of the Marine Strategy Framework Directive (MSFD) in the open waters, as a continuation of intensive long-term measurements of hydrological parameters established in the early 1950s.

Monitored parameters at the WFD and MSFD stations (see stations map/Fig. 4):

- Temperature
- Salinity
- Transparency
- Oxygen
- Copper
- Zinc
- Phytoplankton pigments
- Phytoplankton species
- Nutrient salts
- pH
- DOC (Dissolved organic carbon)
- Priority substances in water, biota and sediment
- Microalgae
- Microzooplankton
- Mesozooplankton
- Marine seagrass
- Benthonic invertebrate

The Marine strategy framework directive established for the EU seas is defined with 11 descriptors, two of which (D5; eutrophication and D7; hydrographical changes) control and monitor, beside chemical-biological parameters, physical changes in the open waters.

Figure 3. Stations established under WFD project in the area of transitional and coastal waters of the eastern Adriatic coast

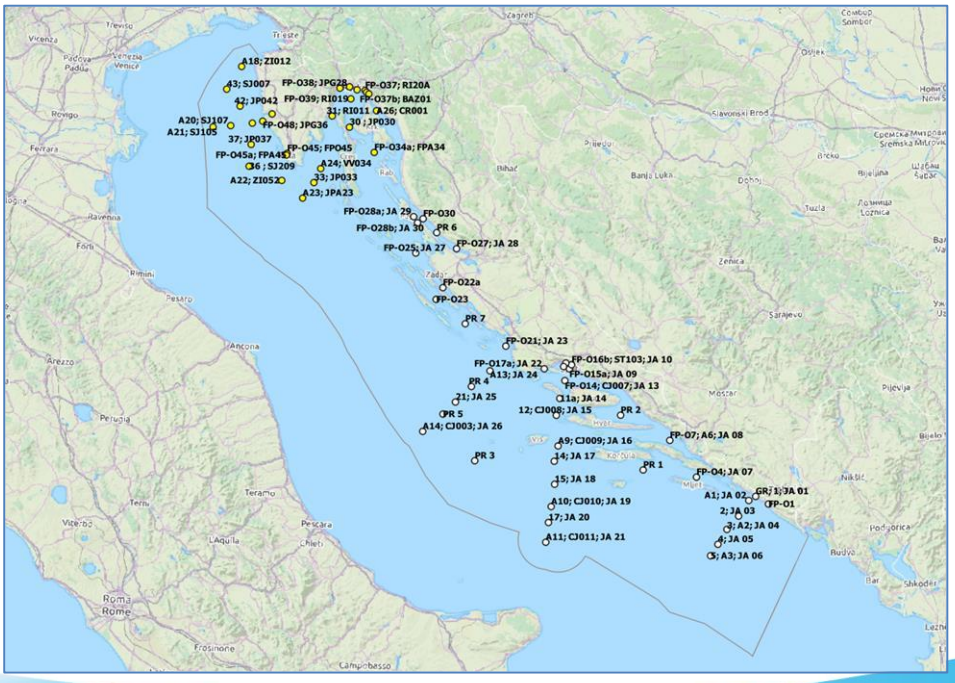


Figure 4. Stations established under MSFD project in the area of open waters of the eastern Adriatic coast for the D5 and D7 descriptors

2.2 Meteorological-oceanographic network under IOF responsibility

Under the Institute's recent programs (MESSI; INTERREGs HR-IT), a network of automatic meteorological-oceanographic stations has been established. Air-sea interaction processes are important factors in changing the dynamic properties of the sea. The establishment of a network of meteorological-oceanographic stations significantly contributes to this.

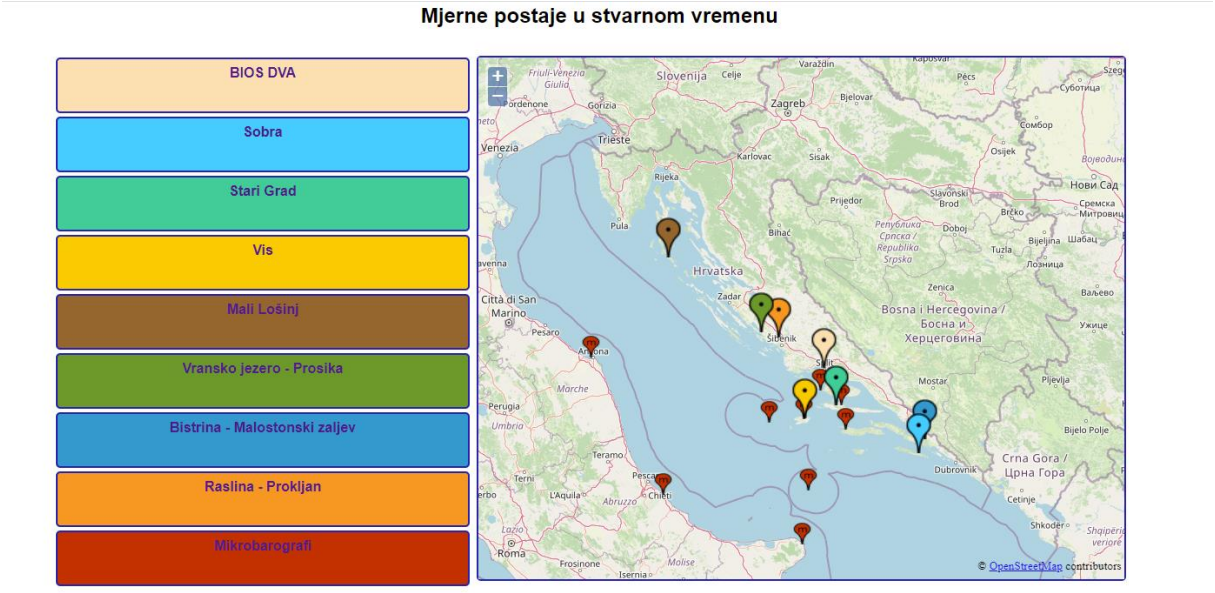
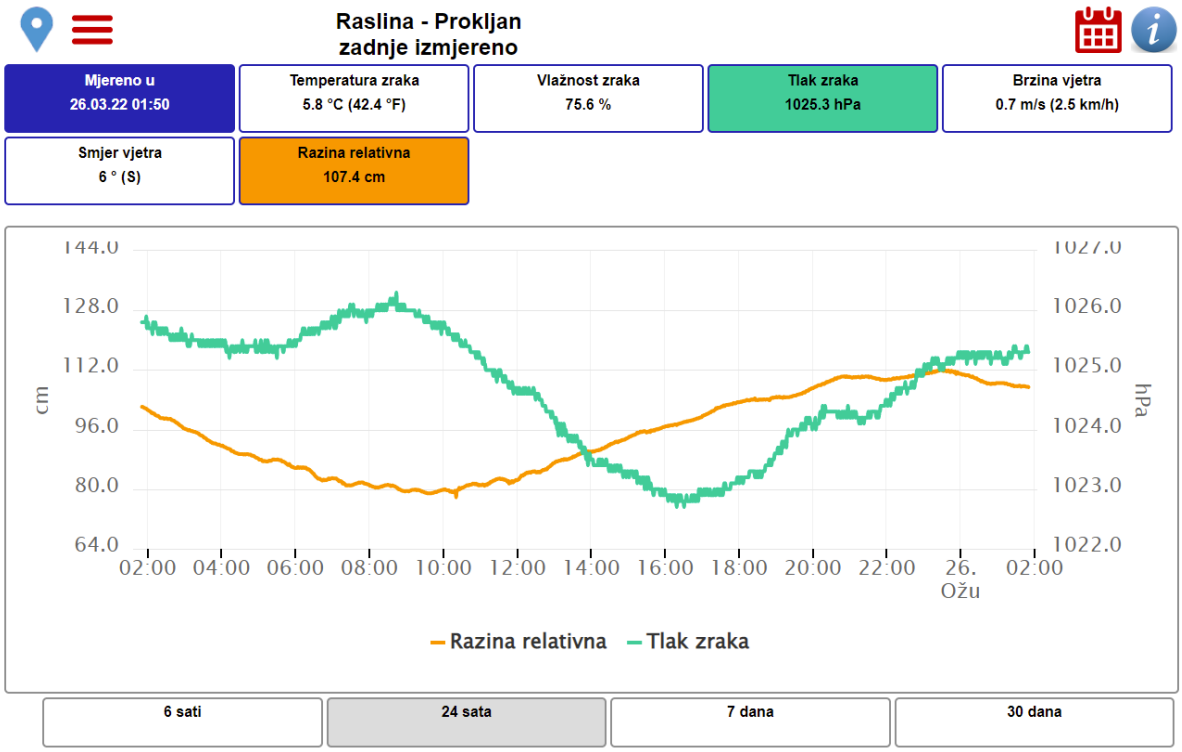


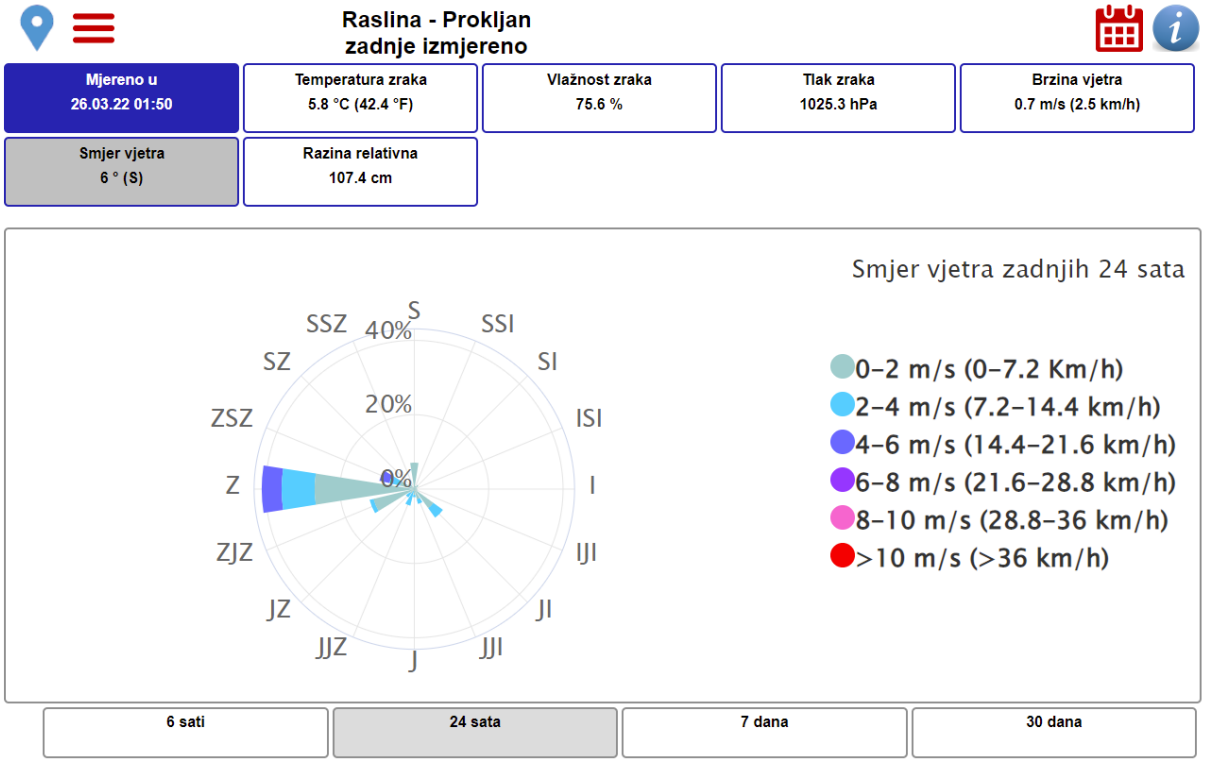
Figure 5. Automatic meteo-ocean stations of the Institute of Oceanography and Fisheries. Station Raslina in the Krka estuary is driven by RESPONSe project

Met-ocean stations along the eastern Adriatic coast have sensors for air temperature, air pressure, wind speed and direction, relative humidity and relative sea level. In the real time, graphs for those measurement parameters are available for the selected period (http://faust.izor.hr/autodatapub/postaje). Microbarographs net station established within the

research project MESSI, precisely measure high-resolution changes in air pressure. As stated on the MESSI web page (http://jadran.izor.hr/~sepic/MESSI/) …*geometry of the network is allowing for the detection of rapid air pressure changes, and enables estimation of their coherency, speed and propagation direction over the middle Adriatic. The network being operational in real-time and enabling the warning, alerting and mitigating of the population and adopting the infrastructure prone to destructive meteotsunamis*

An additional met-ocean station has been set up in the Krka estuary pilot area. The daily variability of the selected meteorological parameters is shown in the figure 6.




Raslina - Prokljan
zadnje izmjereno
Mjereno u
26.03.22 01:50
Temperatura zraka
5.8 °C (42.4 °F)
Vlažnost zraka
75.6 %
Tlak zraka
1025.3 hPa
Brzina vjetra
0.7 m/s (2.5 km/h)
Smjer vjetra
6 ° (S)
Razina relativna
107.4 cm
Smjer vjetra zadnjih 24 sata
S
SSI
SI
ISI
I
IJI
JI
JJI
J
JJZ
JZ
ZJZ
Z
ZSZ
SZ
SSZ
40%
20%
0%
0–2 m/s (0–7.2 Km/h)
2–4 m/s (7.2–14.4 km/h)
4–6 m/s (14.4–21.6 km/h)
6–8 m/s (21.6–28.8 km/h)
8–10 m/s (28.8–36 km/h)
>10 m/s (>36 km/h)
6 sati
24 sata
7 dana
30 dana


Raslina - Prokljan
zadnje izmjereno
Mjereno u
26.03.22 01:50
Temperatura zraka
5.8 °C (42.4 °F)
Vlažnost zraka
75.6 %
Tlak zraka
1025.3 hPa
Brzina vjetra
0.7 m/s (2.5 km/h)
Smjer vjetra
6 ° (S)
Razina relativna
107.4 cm
6.0
5.0
4.0
3.0
2.0
1.0
0.0
m/s
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
26.
Ožu
0...
Brzina vjetra
6 sati
24 sata
7 dana
30 dana

Figure 6. Daily variations of the selected met-ocean parameters for the Mart, 26 2022 from the station Raslina in the Krka estuary

3 Conclusion - Harmonization between existing and planned meteorological and oceanographic observations

Given the availability of real-time data from the met-ocean stations, and in collaboration with the Croatian Meteorological and Hydrological Service, through the METMONIC project, these stations can significantly contribute to the weather forecasts.