AdriaClim

Climate change information, monitoring and management tools for adaptation strategies in Adriatic coastal areas

Project ID: 10252001

D 3.1.1 Design Plan of Installation of devices and measurement campaigns

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1. Introduction

The EU Strategy for the Adriatic Ionian Region (EUSAIR) is a macro-regional strategy adopted by the European Commission and endorsed by the European Council in 2014. The Strategy was jointly developed by the Commission and the Adriatic-Ionian Region countries and stakeholders, which agreed to work together on the areas of common interest for the benefit of each country and the whole region.

As part of the implementation plan of the Strategy, the strategic Interreg Italy-Croatia AdriaClim Project will improve the climate change information, monitoring, and management tools for adaptation strategies in the Adriatic coastal areas.

Reliable and quality information is at the basis of the Sustainable Development Goals targets and the Disaster Risk Reduction framework which, among others, recommend the strengthening of the monitoring and modelling capacity across different space-time scales. This deliverable is mainly concerned with the observational components of the climate monitoring system.

1.1 International framework

The Global Climate Observing System (GCOS), a joint activity between WMO and UNESCO IOC, is dedicated to defining and setting standards for climate monitoring. GCOS has recently defined the Essential Climate Variables (ECV) that are physical, chemical and biological variables or a group of linked variables that critically contribute to the characterization of the Earth's climate. GCOS currently specifies 54 variables that are represented in Fig. 1. The variables are identified in all the major earth system compartments.

AdriaClim will try to overview and analyze the present ECV monitoring from the Italian and Croatian partners and increase the capabilities in the monitoring from the different Institutions. AdriaClim is focusing on the ocean ECVs but also would like to understand the gaps in other compartments when possible.

Fig. 1. The 54 Essential Climate Variables that are recommended for climate monitoring

1.2 European framework

In the past twenty years, Europe has started many initiatives in support of climate monitoring of ECVs. Here we mention only few of them. The European Space Agency (ESA) initiated the programme Global Monitoring of ECVs (ESA Climate Change Initiative). ESA Climate Change Initiative (CCI) provides an adequate, comprehensive and timely response to the extremely challenging set of requirements for highly stable long-term satellite-based products for climate, that have been addressed to Space Agencies via GCOS and the Committee for Earth Observation Satellites. Recently the CCI initiative has developed a Climate data portal (https://climate.esa.int/en/) where the longest, multi-satellite and multi-sensors time series of satellite data are made available in an open and free manner. The Copernicus Climate Change Service (C3S) combines climate system observations with the latest science to develop authoritative, quality-assured information about the past, current and future states of the climate in Europe and worldwide. The European Centre for Medium-Range Weather Forecasts (ECMWF) operates C3S on behalf of the European Union and will bring together expertise from across Europe to deliver the service. C3S will provide key indicators on climate change drivers such as carbon

dioxide and impacts, for example, reducing glaciers. The aim of providing these indicators will be to support European adaptation and mitigation policies in a number of sectors.

The Copernicus Marine Environment Monitoring Service (CMEMS) has developed in the past 6 years a combination of satellite, in situ and numerical model reconstructions of the ocean state for the past thirty years on large scale grids, such as 3-4 km for the Mediterranean and Adriatic Sea. All the data are freely available from the CMEMS product portal and they will serve as a basis data set for validation. The European Marine Observation and Data Network (EMODnet) provides a unique gateway to retrieve real time and historical data sets in European regional Seas (https://emodnet.eu/en). The product portfolio consists of bathymetric data, biology, chemistry, geology, physics, human activities and seabed habitats at different resolution and level of processing depending on the available data. For climate archived data, the European SeaDataNet research infrastructure is collecting and quality controlling all the data sets for physics available from 1900 in the Mediterranean and Adriatic Sea. SeaDataNet provides aggregated datasets (ODV collections of all unrestricted SeaDataNet measurements of temperature and salinity by sea basins) and climatologies (regional gridded field products). Each SeaDataNet product is described in a Product Information Document (PIDoc) that can be accessed from the product's landing page. Recently a new historical data collection has been released with higher quality control than previously. The data span between -9.25 and 37 degrees of longitude, thus including an Atlantic box and the Marmara Sea. It covers the time period 1900- 2019. Data have been quality checked using ODV 5.3.2 software. Quality Flags of anomalous data have been revised using basic QC procedures. The dataset format is ODV binary collections. You can read, analyse and export from the ODV application provided by Alfred Wegener institute at http://odv.awi.de/

1.3. Adriatic Sea monitoring

The EMODnet database contains several marine monitoring stations from the Adriatic Sea, as illustrated in Fig. 2. The ECV considered are only physical state variables. All the other biogeochemical/biological and ecosystem ECVs are monitored in the coastal areas by some of the governmental Institutions that have as a mission the monitoring of the national coastal waters as defined by the EU Marine Strategy Framework Directive (MSFD) and EU Water Framework Directive (WDF). In the Adriatic Sea, the Italian national waters for MSFD are considered to extend west of the middle of the Adriatic Sea basin while the eastern part is subdivided among the Balkan countries and Slovenia.

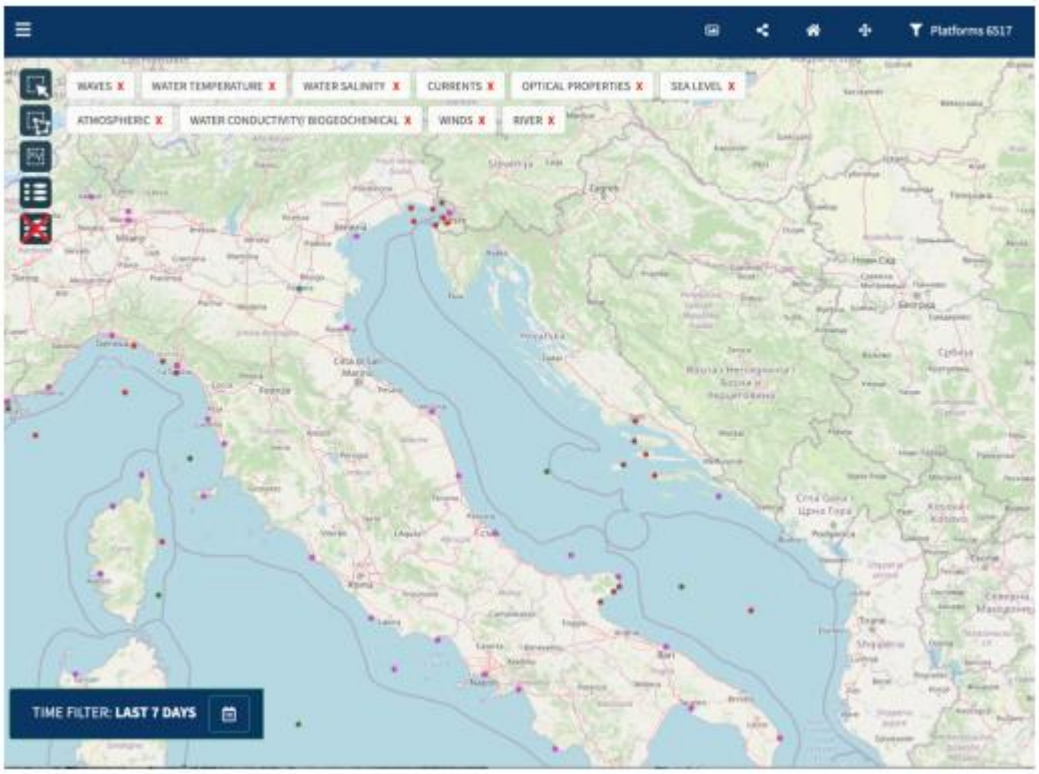

Fig. 2 The last 7. days station data from Feb. 21, 2021 available in real time from EMODnet Portal. The red dots indicate wave stations, the green dots the ARGO profilers for temperature and salinity data, the brown dots the currents stations (radars and buoy), the red dot in the central part of the southern Adriatic Sea a multi-disciplinary open ocean buoy (so-called E2M3A) where also optical properties of the water column are measured, the purple dots are tide gauges.

Almost all the Italian Environmental Protection Agency monitoring stations are missing from the EMODnet database and it might be worth to check if AdriaClim could help to start the transmission of these data sets to EMODnet. The regional Italian Environmental Protection Agency observing Networks are overviewed in the next chapters. Withing the framework of the Interreg I-STORMS project, a data collection and visualization portal (I-STORMS Web System, IWS, https://iws.seastorms.eu/) was developed with the aim of sharing sea level and wave data acquired in the Adriatic and Ionian seas. The IWS allows the public historical and real-time (or near real-time) time series of observations from fixed- point sensor networks to be explored over the internet through the use of share maps, dashboards, graphics, tables and other interactive geo-visualization tools. IWS has been designed to foster the data dissemination in according to the community-based

paradigm and to the Open Data principles (i.e. open format, open licensing), while respecting each countries' data policies.

The Italian Long TERm Ecological Research Network (LTER-Italy; www.lteritalia.it) is one of the twenty-six national networks of the LTER-Europe Network (LTER-Europe) with a focus on ecological observations at the multi decadal scale. LTER-Italy comprises marine and coastal ecosystems in the Adriatic Sea are: Valli di Comacchio, Sacca di Goro, Golfo di Trieste, Golfo di Venezia, Delta del Po e Costa Romagnola, Transetto Senigallia-Susak. CNR-ISMAR is the coordinating institution of LTERItaly and has the direct responsibility of two marine sites: the Northern Adriatic Sea and the Lagoon of Venice (http://www.ismar.cnr.it/infrastructures/observational-systems/lter-italy).

Information about LTER sites, facilities and parameters measured are part of the DEIMS-SDR catalogue (Dynamic Ecological Information Management System - Site and dataset registry).

1.4 Objectives of this deliverable

The overall objectives of AdriaClim Activity 3.1. 'Design and implementation of the observing systems'under WP 3 'Climate Change Monitoring (Observing and Modelling) Systems' of the AdriaClim project are: To contribute to the development of the Adriatic Sea integrated regional observing infrastructure and monitoring network system focused on the hydro-meteo-marine climatological dimension; To set up, improve and harmonize cross-border methodologies and standard operating procedures on coastal and marine monitoring through implementation of Ocean Best Practice Systems (OCBS) ; to improve accessibility and dissemination of observing data and products; Deliverable D.3.1.1 is part of AdriaClim Activity 3.1. 'Design and implementation of the observing systems'.

The specific objectives of D.3.1.1 are: to describe the present state of ECV Observing sub-regional infrastructure and monitoring network systems at Adriatic basin scale and in the AdriaClim Pilot areas; to describe the planning and deployment of new observing system components and their integration into the existing ECV Observing sub-regional infrastructure and monitoring network systems in the AdriaClim project Pilot areas;

To describe the present state of the marine and coastal monitoring networks for water quality in the Pilot areas; to describe the planning of coastal ocean sampling campaigns for biogeochemical components on the basis of Pilot areas sensitivity.

2. Observing national and sub-regional infrastructure

In the previous chapter we overviewed the ECV monitoring at the basin scale level from European databases and initiatives. In this section, we present the coastal oriented observing infrastructure and monitoring network at sub-regional level and in so-called Pilot areas of AdriaClim project (Fig. 3).

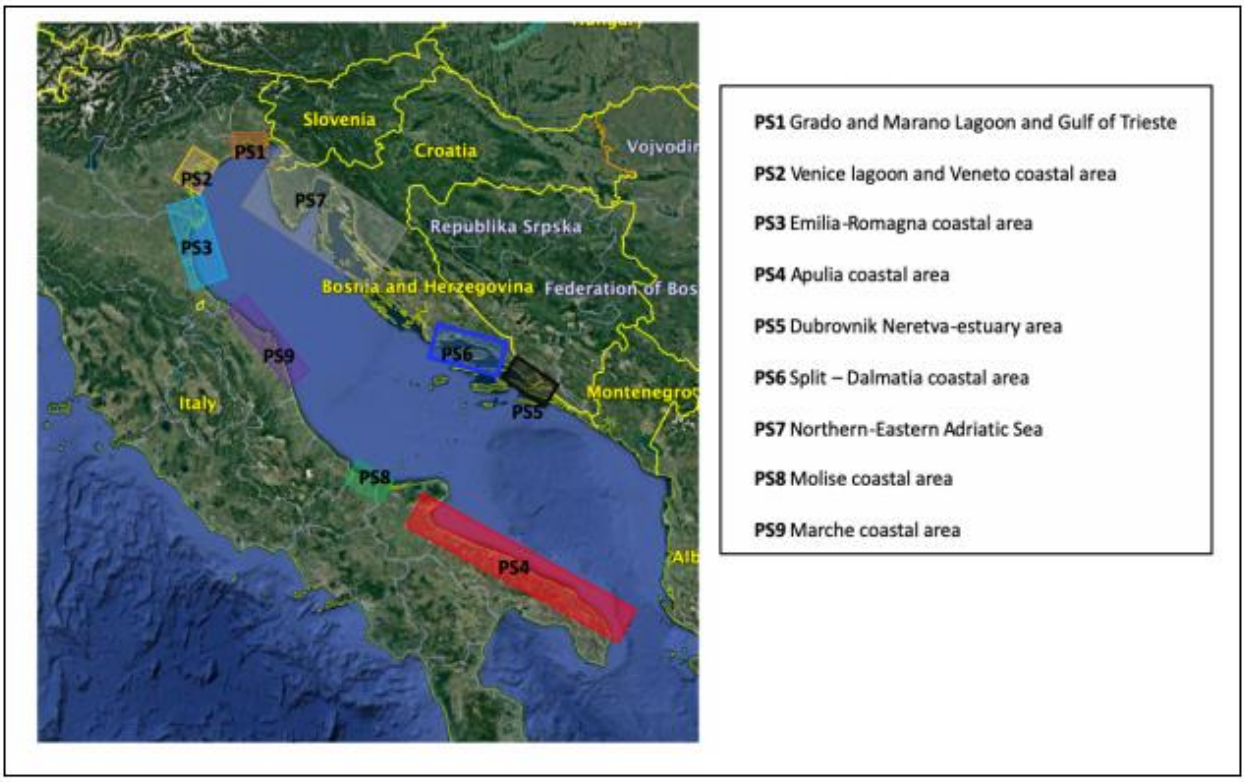

Fig. 3. The marine pilot areas in the Adriatic basin.

2.1 Overall Adriatic Sea

2.1.1 Monitoring network

Along Italian coasts, there are three monitoring networks managed by ISPRA:

– National Sea Level Monitoring Network (RMN);

– National Wave Measurement Network (RON);

North Adriatic and Venice Lagoon Measurement Network (RMLV), focused on the monitoring of meteo-marine parameters in the Northen Adriatic Sea and lagoons (see Veneto and FVG pilot sites). Moreover 3 stations are co-localized with GNSS instruments (Punta della Salute, Lido Diga Sud, Grado). The RMN is composed of 10 stations distributed along the Adriatic coasts (Fig.2.1.1 yellow circle) and providing sea level and meteo-marine parameters (Table 2.1.1).

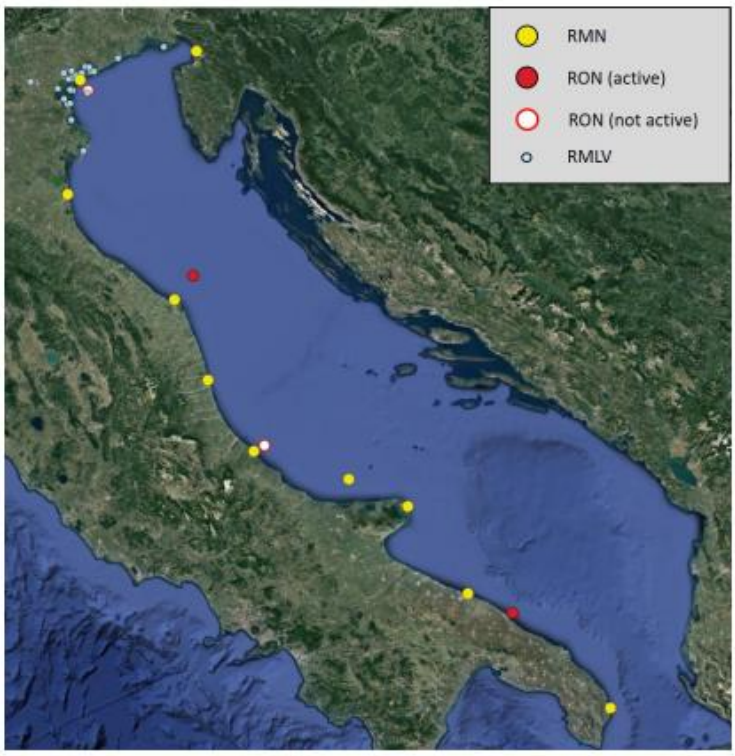

Fig. 2.1.1 RMN, RMLV, RON stations on the Adriatic coasts

Table 2.1.1. Parameters provided by RMN stations in the Adriatic Sea

STATION	PARAMETERS
Trieste	LEV, WT, AT, AP, WS, WD, RH
Venezia	LEV, WT, AT, AP, WS, WD, RH
Ravenna	LEV, WT, AT, AP, WS, WD, RH
Ancona	LEV, WT, AT, AP, WS, WD, RH
San Benedetto del Tronto	LEV, WT, AT, AP, WS, WD, RH
Ortona	LEV, WT, AT, AP, WS, WD, RH
Isole Tremiti	LEV, WT, AT, AP, RH
Vieste	LEV, WT, AT, AP, WS, WD, RH
Bari	LEV, WT, AT, AP, WS, WD, RH
Otranto	LEV, WT, AT, AP, WS, WD, RH

LEV: Sea Level

WT: Water Temperature

AT: Air Temperature

AP: Atmospheric Pressure

WS: Wind Speed

WD: Wind Direction

RH: Relative Humidity

The RON is composed of 4 directional wave buoys (Fig. 2.1.1, red circle active stations, white circle red rounded for not active stations) deployed along the Adriatic coasts and providing waves and meteo-marine data. The four buoys provided data until 2015, however two of them, located at Monopoli and Ancona, will be moored again in 2021 (Tables 2.1.2 – 2.1.3).

BUOY CODE	SHORE STATION	LATITUDE	LONGITUDE	Depth (meters)
61207	CATANIA	37°26'24'N	15°08'48'E	90
61208	MAZARA	37°31'05'N	12°32'00'E	85
61209	PALERMO	38°15'30'N	13°20'00''E	145
61210	CROTONE	39°01'25'N	17°13'12'E	80
61211	CETRARO	39°27'12'N	15°55'06'E	100
61212	SINISCOLA	40°37'00'N	09°53'30'E	130
61213	ALGHERO	40°32'55'N	08°06'25'E	85
61214	PONZA	40°52'00'N	12°57'00'E	115
61215	MONOPOLI	40°58'30'N	17°22'40'E	85
61216	CIVITAVECCHIA	42°14'41'N	11°33'14'E	62
61217	ORTONA	42°24'24'N	14°32'12''E	72
61218	ANCONA	43°49'26'N	13°43'10'E	70
61219	LA SPEZIA	43°55'45'N	09°49'40'E	85
61220	VENEZIA	45°20'00'N	12°31'00'E	17
61221	CAGLIARI	39°06'54'N	09°24'18'E	150

Table 2.1.3. Meteo-marine parameters provided by RON buoys in the Adriatic Sea

WAVE BUOY	PARAMETERS
Venezia	Hs, Dir, Mp, Pp, WS, WD, WT, AT, AP, RH
Ancona	Hs, Dir, Mp, Pp, WS, WD, WT, AT, AP, RH
Ortona	Hs, Dir, Mp, Pp, WS, WD, WT, AT, AP, RH
Monopoli	Hs, Dir, Mp, Pp, WS, WD, WT, AT, AP, RH

Hs: Significant Wave Height

Dir: Wave Direction

Mp: Wave Mean Period

Pp: Wave Peak Period

WS: Wind Speed

WD: Wind Direction

WT: Water Temperature

2.1.2 Data sharing facilities

Historical time series are freely downloadable by ISPRA website (www.mareografico.it). In the framework of ADRIACLIM project, data could be shared in very flexible way, such as SPARQL endpoint, answering to AdriaClim project requirements.

2.2 Grado and Marano Lagoon, Gulf of Trieste

ARPA FVG: Dario Giaiotti, Claudia Orlandi, Denis Guiatti, Alessandro Acquavita and Nicola Bettoso
CNR-ISMAR: Christian Ferrarin

2.2.1 Monitoring network

In the Gulf of Trieste, CNR-ISMAR is managing:

- the Meteorological-marine station at Molo F. Bandiera (since 1986). Observed variables: 10 m air temperature and wind, sea temperature at 0.4, 2 and 6 m depths.
- the tide-gauge station al Molo Sartorio (since 1859). Observed variables: sea-level height, atmospheric pressure at 2.5 m.
- PALOMA mast (45°37.097'N, 13°33.913'E), 12 km offshore, bottom depth 25 m. Data: sea temperatures (0.4, 2, 15, 25 m below s.l.), wind speed and direction, air temperature, relative humidity, precipitation, solar radiation, air pressure. Data acquisition and elaboration every 5 minutes. Data transmission in real time (every 3 hours).

Along the shore of the Gulf of Trieste, ARPA FVG is collecting:

- atmospheric measurements of main air variable, namely: precipitation, wind speed and direction, temperature, relative humidity and global solar radiation. Data are available from four costal meteorological station: Trieste, Fossalon di Grado, Grado and Lignano Sabbiadoro, with hourly resolution, for the last twenty years.
- In the Gulf of Trieste and the Grado and Marano lagoon, ARPA FVG, since 2001, has developed an active monitoring network with the aim to define the quality of transitional, coastal and marine waters of the Friuli Venezia Giulia region. Taking into consideration the coastal waters, the current network consists of:
- 16 sampling stations located in the Italian side of the Gulf of Trieste. In these stations, chemical and physical parameters (i.e., temperature, salinity, dissolved oxygen, turbidity and chlorophyll-a) are monthly measured in situ on the whole water column by means of a CTD. In parallel, water samples for nutrient determination (dissolved nitrogen forms, dissolved.

Fig. 2.2.1 Monitoring network for the quality of coastal and marine waters (dismissed stations in red).

Regarding the transitional waters:

- 16 water bodies of the Marano and Grado Lagoon are monitored monthly (from 2012 to 2016) and seasonally (since 2017) and the related dataset is characterized by the parameters aforementioned for coastal waters (Fig. 2.2.2);
- a set of measurements on benthos characteristics have been carried on according to specific monitoring objectives since 2010.

Fig. 2.2.2 Monitoring network for the quality of transitional waters in Grado and Marano Lagoon

2.2.2 Data sharing facilities

CNR-ISMAR data acquired in the Gulf of Trieste are collected in the private ISMAR Meteomarine unified network (http://rmm.dati.ismar.cnr.it/

Real time sea level data are available without authentication through the data portal of the I-STORMS project (https://iws.seastorms.eu/). ARPA FVG meteorological data are available on demand sending a request to the PP11 Project Partner or directly on line at https://www.osmer.fvg.it/archivio.php?ln=&p=dati CTD profiles are stored on the private ARPA network and available on demand upon request to the PP11 Project Partner. Chemical data can be found on the regional Open Data portal at the web page https://www.dati.friuliveneziagiulia.it/en/Ambiente/Acqua-Acque-di-classificazione-Superficialimarino/qcsf-bwk5 , or available on demand Measurements on benthos are available on demand upon request to the PP11 Project Part

2.3 Venice lagoon, City of Venice and Veneto coastal area

ARPA Veneto: Fabio Dalan

ISPRA: Sara Morucci, Gabriele Nardone, Andrea Bonometto

CNR-ISMAR: Christian Ferrarin

2.3.1 Monitoring network

ISPRA manages the Tide Gauges Measurement Network for the North Adriatic and the Venice Lagoon (RMLV) composed of 26 observing stations (Fig. 2.3.1) and providing sea level and meteo-marine parameters (Table 2.3.1).

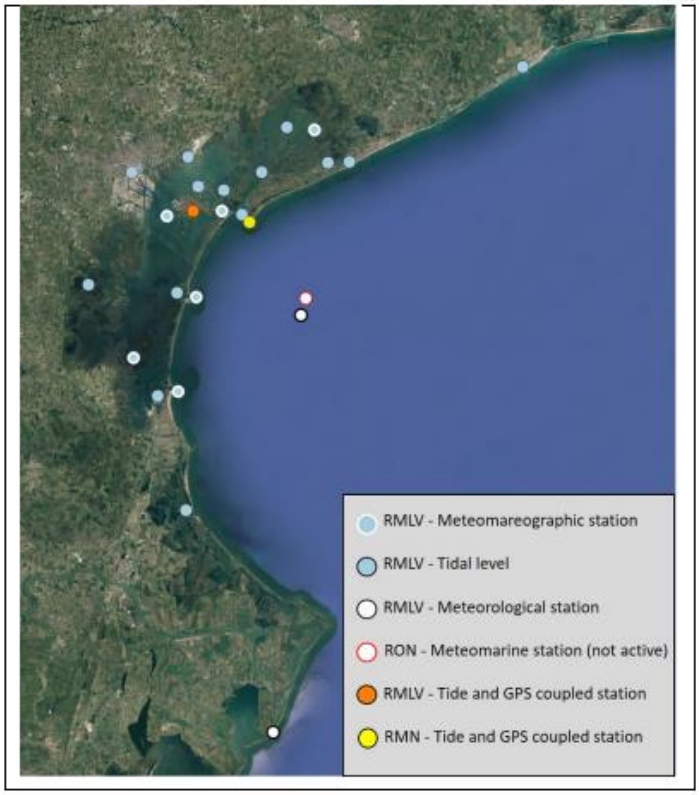

Fig. 2.3.1: RMLV stations in the North Adriatic Sea and the Venice lagoon.

Table 2.3.1. Sea level and meteo-marine parameters provided by RMLV measurement stations

	Progr.	Stazione	Idrometro a galleggiante	Idrometro Radar	Anemometro	Barometro	Pluviometro	Termometro aria	Igrometro	Radiometro
Stazioni della nuova RMLV	1	Padova meteo			1	1	1	1	1	
	2	Canal dell'Ancora	1							
	3	Caorle	1							
	4	Cavallino centro	1							
	5	Cavallino darsena	1							
	6	Chioggia Diga Sud	1		1					
	7	Chioggia Vigo	1							
	8	Faro Rocchetta	1							
	9	Foce Po'			1	1				
	10	Grado	1							
	11	Grassabò	1		1		1			
	12	Lido Meteo			1	1	1	1	1	1
	13	Malamocco Diga Nord	1		1					
	14	Marghera	1							
	15	Meda	1							
	16	Murano	1							
	17	Petta de Bò	1		1		1			
	18	Piattaforma CNR		1	1	1	1	1	1	
	19	Porto Caleri	1							
	20	Punta della Salute	1							
	21	San Giorgio in Alga	1		1		1			
	22	San Nicolò		1						
	23	Sant'Erasmo	1							
	24	Tessera	1							
	25	Treporti		1						
	26	Valle Averto	1							
		TOTALI	20	3	9	4	6	3	3	1

The Sea and Lagoon Quality Organizational Unit of ARPA Veneto, manages three monitoring networks. The first (Fig. 2.3.1) is the environmental quality network of Veneto coastal and marine waters. This network aims at determining the ecological and chemical quality of the marine and coastal environment in accordance with Directive 2000/60/EC. It consists of 76 sampling stations and field analysis (multiparametric probe, nutrients, phytoplankton, chemical analysis of the water and sediment and biota matrix) uniformly distributed in the 6 water bodies (4 coastal and 2 marine). Every year, seven monitoring campaigns are carried out on this network.The second one (Fig. 2.3.2) is the Marine Strategy network monitors the marine environment in accordance with the European directive 2008/56/EC. On behalf of the Ministry (MET, ex MATTM), six monitoring campaigns with sampling and analysis are carried out in the field on different matrices (water, sediment, biota).

The third network (Fig. 2.3.3) is the environmental quality network of the Venice lagoon. This network has the aim of determining the ecological quality of the Venice lagoon in accordance with Directive 2000/60/EC. It consists of 30 sampling stations and field analysis. On this network, four

monitoring campaigns are carried out every year.

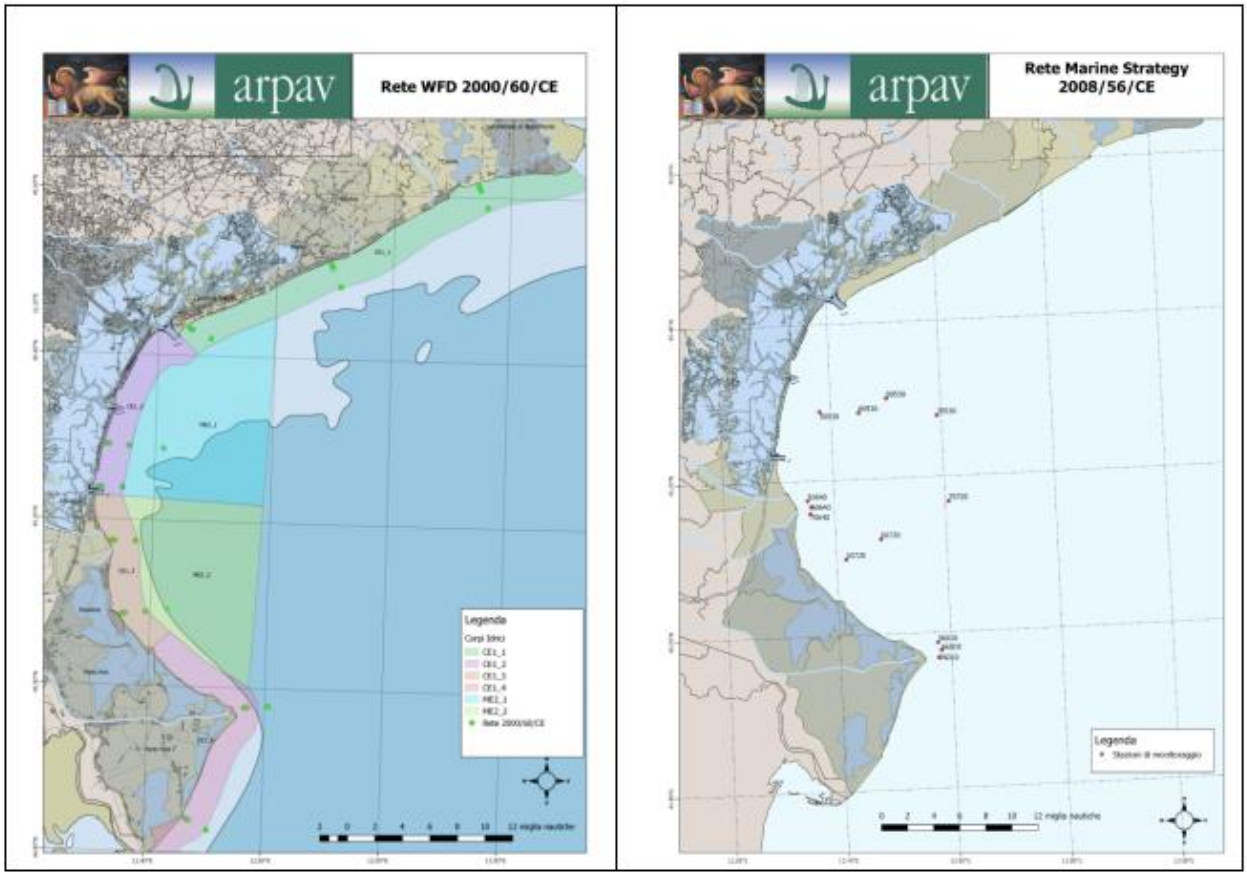

Fig. 2.3.1 Environmental quality network of Veneto coastal and marine waters (left panel), and Fig. 2.3.2 Marine Strategy network (right panel).

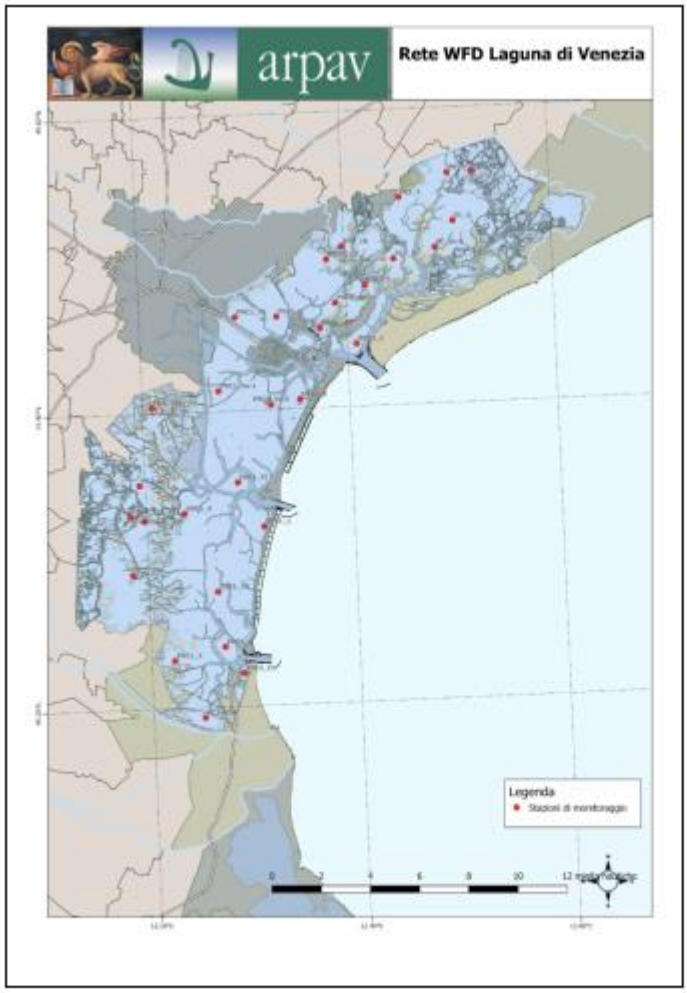

Fig. 2.3.3 Environmental quality network of the Venice lagoon.

Meteorological coastal network

CNR-ISMAR is managing the Acqua Alta oceanographic platform (45° 18.83’ N, 12° 30.53’E), 15 km offshore the Venice Lagoon, bottom depth 16 m. Meteorological data: wind speed and direction, air temperature, humidity, solar radiation, precipitation. Oceanographic data: sea temperature, sea level, ADCP currents, waves.

The ARPAV meteorological network along the coastlines in Veneto is shown in Fig. 2.3.4. While the spatial coverage is sufficient, its density needs to be improved if we are to detect early warnings of

heavy and localized storms and tornadoes that have already hit the area. Additionally the network is not complete, i.e. some stations do not measure certain meteorological parameters. Lastly certain stations have been shielded by the growing surrounding vegetation and needs to be relocated in more suitable areas.

For these reasons, ADRIACLIM will contribute to upgrade the meteorological network as described in section 3.3

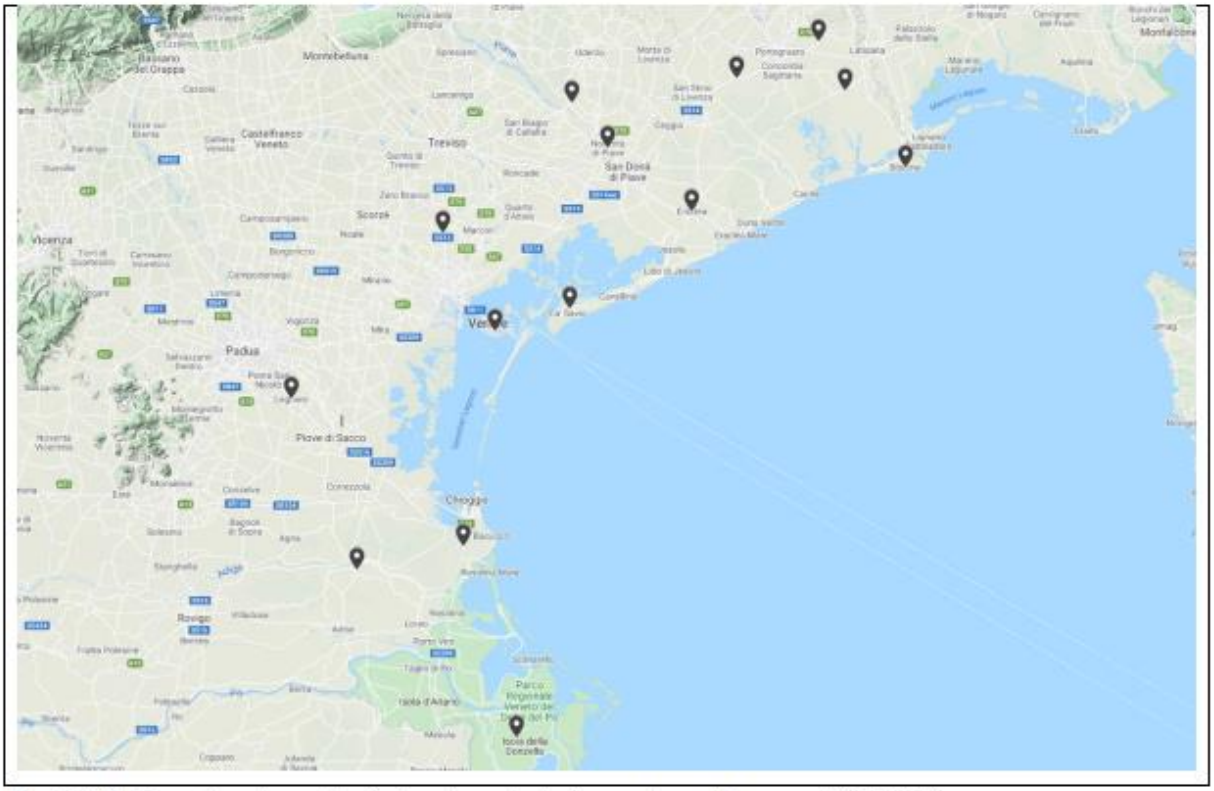

Fig. 2.3.4 Map of metereological network stations along the coast (ARPAV)

2.3.2 Data sharing facilities

Concerning meteorological data as well as the WFD (Water Framework Directive) Coastal and Marine Network and WFD Venice Lagoon Networks, all data are periodical published on ARPAV web site – open data section with Creative Common licence 3.0, in CSV format.

https://www.arpa.veneto.it/dati-ambientali/open-data/ Meteorological data are updated annually although ARPAV is implementing in 2021 a system to extract data directly from the database as soon as they are validated. For marine data, multiparameter probe files data are updated quarterly, all the other files are updated annually. The Marine Strategy network (Fig 2.3.2) data are published after validation by the MET (ex MATTM) on the following link: http://www.db-strategiamarina.isprambiente.it/app/#/. CNR-ISMAR data acquired the Acqua Alta oceanographic tower are collected in the private ISMAR Meteomarine unified network (http://rmm.dati.ismar.cnr.it/). Real time sea level and wave data are available without authentication throught the data portal of the I-STORMS project (https://iws.seastorms.eu/). Historical time series are freely downloadable by ISPRA website (www.venezia.isprambiente.it). In the framework of ADRIACLIM, data could be shared in very flexible way, such as a dedicated ftp, answering to AdriaClim project requirements

2.4 Emilia-Romagna coastal area

ARPAE: Andrea Valentini, Cristina Mazziotti, Silvia Unguendoli, Luis Germano Biolchi

UNIBO: Roberta Guerra, Nadia Pinardi

ISPRA: Tommaso Petochi, Giovanna Marino, Antonello Bruschi IZSLER: Silva Rubini

The coast of Emilia-Romagna, between the mouth of the Po di Goro, on the northern border with the Veneto Region, and the mouth of the Torrente Tavollo, between Cattolica and Gabicce, on the southern border with the Marche Region, is characterized by a low and almost continuous sandy coast, with wide beaches from a few meters to over 200 m, or in some cases without a beach, such as inside the Sacca di Goro or in some stretches subject to strong erosion. Behind the coastal system there are, in particular in the northern sector of Ravenna and Ferrara, wide reclaimed territories, with altitudes below sea level, partly occupied by wet areas of high naturalistic importance. A greater anthropization characterizes the southern part of the Cesena and Rimini areas, which has widespread urbanization and infrastructures. The coastal strip is a highly vulnerable territory characterized by a high risk for the natural systems, settlements and human activities present in a concentrated and widespread way. The causes of vulnerability common to the whole regional coastal area, such as the low slope of the submerged beach, the low altitude of the emerged coast, the phenomenon of subsidence, the limited circulation of the Adriatic, the influence of the Po river flows and the quantity and the quality of local river inputs, are added, to a greater level in the southern sector, by the anthropogenic pressures linked to the intense urbanization, infrastructures and marine-coastal tourist use of the territory. The Emilia-Romagna further represents a major national and Adriatic production pole of bivalve shellfish (farms and natural banks). Production

areas (about 60 classified areas, 180 licenses), are located in both transitional and marine waters, from the shore line to offshore. These areas are particularly vulnerable to anthropogenic pressure and climate changes, with implications on shellfish ecosystem services, public health and seafood quality. 2.4.1 Monitoring network Along the about 120 km coastline stretch of Fig.2.4.1a, several marine monitoring stations are present and managed by the Hydro-Meteo-Climate Service and by the Daphne Oceanographic Structure of the Regional Agency for Prevention, Environment and Energy of Emilia-Romagna, Italy (ARPAE). The Regional Meteo-Marine Monitoring Network (Fig 2.4.1b) is subdivided into 2 subnetworks: the real time coastal and marine waters monitoring network (https://www.arpae.it/it/temi-ambientali/mare/dati-e-indicatori/rete-di-monitoraggio-meteomarina) and the regional monitoring network for the quality of coastal and marine waters (https://www.arpae.it/it/temi-ambientali/mare). Regarding the real time coastal and marine network, along the regional coastal towns ARPAE operates and provides maintenance to eight stations where multiparametric probes are available (four stations in the Goro and Sacca di Goro Area and other four located in the Valli di Comacchio). Dissolved oxygen, pH, salinity and temperature are the parameters measured on an hourly basis.

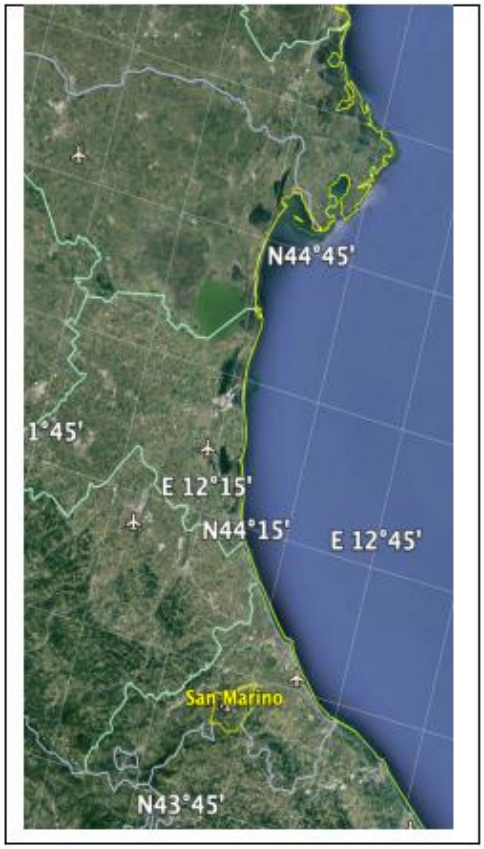

Fig. 2.4.1a The Emilia-Romagna coastal area and its four coastal towns, Ferrara, Ravenna, Forlì and Rimini starting from the north.

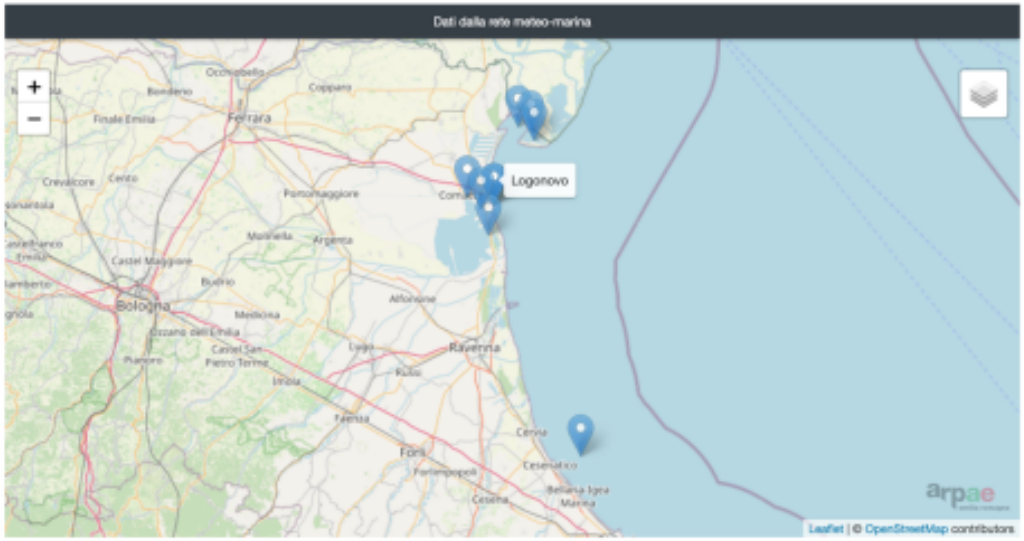

Fig. 2.4.1b The real time coastal and marine waters measurement stations of ARPAE Emilia-Romagna.

During summertime, ARPAE proceeds with equipment maintenance every seven days, while during the winter the maintenance campaigns occur every 15 days. Additionally, from June to September, point specific monitoring occurs along 20 stations in Sacca di Goro with the aforementioned parameters being measured in the whole water column. Online publications as well as reports are sent containing the data acquired in the campaigns.

Among the coastal stations, the reference and most important is the Integrated station of Porto Garibaldi. Since 2009, the station measures sea level, water quality, meteorological, and vertical land movement parameters. For sea level, the station is equipped with a radar tide gauge and a mechanical one, while for water quality the measurements are from a multiparametric probe as mentioned earlier in this subsection. In what refers to meteorology, air temperature and humidity, wind direction and velocity, atmospheric pressure and pluviosity are prone to be measured in-situ. A high-resolution GPS is also installed at the station to verify land vertical movements mostly related to subsidence whether naturally occurring or anthropogenically driven. Moreover, the GPS-GNSS system also allows for a high-quality measurement of local sea-level and substantiates further applications in which the finest possible data is necessary.

In addition to the coastal stations that measure sea level, meteorological parameters, and vertical land variation, ARPAE -SIMC also operates a buoy deployed just offshore the town of Cesenatico at about 10m depth. It was installed in 2007 and it is equipped with a directional waverider, sending

the data collected every half an hour through radar (HF channel) and/or satellite (GSM) devices. The receiving stations are part of the Daphne oceanographic structure. Topo-bathymetric profiles and bathymetric mapping are also among the measurements conducted by ARPAE. ARPAE Emilia-Romagna takes care of the Regional Topo-Bathymetric Coastal Network composed by more than 1000 km of along-shore and cross-shore beach profiles distributed along the entire Emilia-Romagna littoral. The surveys are carried out with an interval of about 5-6 years in the context of the regional plans of nourishment involving the coastal areas more affected by erosion. The monitoring activities covering the entire regional coast, from Cattolica to the Po di Goro mouth. The entire area of the emerged beach is surveyed until the last point towards the land while the bathymetry surveying extended up to the bathymetric depth of 8-10 m. Moreover, morphological variations in Sacca di Goro are analyzed through specific topo-bathymetric profiles produced normally from single beam campaigns for the subaqueous portion while GPS and satellite derived elevation is used for the subaerial part. Besides, seasonal measuring campaigns for 16 regional cross-shore sections in 8 coastal sites occur to have an updated topo-bathymetric profile that accounts for winter-summer variations (e.g. due to winter dune building, storm impacts, dredging) and are subsequently implemented in the regional coastal Early Warning System (EWS) based on the morphodynamic model XBeach. The marine-coastal network is part of ARPAE's monitoring system covering both inland as well as coastal localities. Rain gauges (233), hydrometric levels (182), temperature (176), relative humidity (67), wind (36), solar radiation (27), snow depth (18), radars (2), and an automatic radio sounder (1) are among the measured parameters (with a variety of sensors) and equipment disposed in the region. As regards the regional monitoring network for the quality of coastal and marine waters, the Daphne Oceanographic Structure (Emilia-Romagna Regional Environmental Protection and Energy Agency, ARPAE) monitors the coastal area of Emilia-Romagna region since 1981. The monitoring area is located close to the Po river Delta (transect of Lido di Volano) and the southern part of the region (Cattolica). The monitoring grid considers 35 sampling stations located along eight transects perpendicular to the coast, between 0,5 to 20 km distance from the coastline (Fig. 2.4.2). 33 stations are coastal, extending from 0,5 km to 10 km offshore, while 2 stations (2004, 2014) are at a 20 km distance, sampling an open shelf regime. Generally the monitoring area is divided into three subareas (areas A, B and C) on the basis of hydrological and trophic conditions. Area A (from the transect of Lido di Volano to Casalborsetti) is located immediately south of the Po Delta and is directly affected by river runoff and nutrient load. It is therefore characterized by enhanced primary production. Area B (from Ravenna port toCesenatico) is a transitional area. Area C (from Bellaria to Cattolica) is located in the southern part of the coastal area of Emilia-Romagna region and is characterized by hydrological conditions mainly governed by the large-scale basin circulation. Physical (temperature, salinity, dissolved oxygen, pH) and biological (chlorophyll-a) parameters along the water column are monitored two times a month in all the sampling stations using CTD (IDRONAUT 316 PLUS) and fluorimeter (Turner Design 10 AU). During the summer period (from June to September) the samplings are carried out weekly, to monitor the frequent

phytoplankton blooms often connected to low oxygen concentration. Nutrients (nitrate, phosphate and silicate) and phytoplankton communities are monitored two times a month. Qualitative and quantitative analysis of phytoplankton are generally carried out at the surface level (- 0,5 m) and at the depth corresponding to the maximum chlorophyll concentration, identified using a fluorimeter placed on the CTD

Fig. 2.4.2. Daphne Monitoring Network

An additional coastal monitoring network of Emilia-Romagna is in place for the classification of shellfish production areas. It is based on 61 sampling stations (Fig. 2.4.3) identified, according to EU Regulations (625/2017; 627/2019) and National classification Guidelines, as the most representative sampling stations for each production area.

Fig. 2.4.3. Environmental and sanitary monitoring network of shellfish production areas of Emilia Romagna (data source: Regional resolution n. 47/2021)

Environmental and sanitary data are collected through surveys carried on weekly/monthly/yearly by sanitary services (ASL), collecting data from water column and/or shellfish to assess the concentrations of heavy metals, PAHs, PCBs, dioxins, fecal bacteria (e.g. Escherichia coli; Salmonella spp.), viruses, biotoxins in the sampling station, and to analyse seasonality and alerts. The number and location of monitoring stations may thus undergo some variations over the years based on the number of classified production areas and changes in environmental conditions. The above microbial, chemical and toxicological parameters are collected in each sampling station, together with chemical-physical (salinity, oxygen, pH, water and air temperature) and biological (toxic phytoplankton) parameters.

The monitoring network of shellfish production areas is further implemented by the Daphne Oceanographic Structure of ARPAE for the purpose of monitoring the quality of water bodies designated for shellfish life and productions (Legislative Decree 152/2006, art. 87, 88. Annex 2 part III/C). Monitored parameters include: pH, T°, oxygen, salinity, suspended solids, colour, metals, hydrocarbons, organ halogenated substances, fecal coliformes and saxitoxin and other substance which can influence the flavor of shellfish). Most of the sampling stations correspond to those monitored for the classification of the trophic status of coastal marine waters.

2.4.2 Data sharing facilities

Data from ARPAE -SIMC real time monitoring network is available in several formats (.xls, .csv, and .pdf) and it can be consulted in the: https://simc.arpae.it/dext3r/. Additionally, through contacting different services it is possible to request specific data that is not yet available online and/or require specific legal arrangements. Depending on the parameter and relative field of expertise associated, the covered timespan might vary strongly, hence a consultation of the database portal is strongly encouraged as means to have an initial idea on time coverage, download character limitations, and possible incomplete time series. Data related to the regional monitoring network for the quality of coastal and marine waters can be requested contacting the Daphne Oceanographic Structure. Data from the sanitary monitoring network of shellfish areas will be entered in a geodatabase under development by ISPRA and IZSLER

2.5 Apulia coastal area

CMCC: Viviana Piermattei, Giorgia Verri

2.5.1 Monitoring network

The Apulia pilot site is characterized by the presence of the Torre Guaceto Marine Protected Area (MPA), delimited by a very varied coastline and characterized by the existence of Posidonia oceanica meadows. The MPA offshore boundaries are marked by a series of signal buoys, useful as protection measures necessary for the conservation of the area (Fig. 2.5.1). Fig. 2.5.1. Apulia pilot site, Torre Guaceto Marine Protected Area Buoy One of the buoys was made available to be integrated with different kind of sensors and technologies based on low-cost philosophy. The activities foreseen by the project were the update of the basic instrumentation already mounted onboard the buoy and the upgrade of the transmission system.

2.5.2 Data sharing facilities

Data from CMCC real time Apulia Buoy is available in .csv format. Given its highly experimental feature, the data are available on request contacting CMCC personnel

2.6 Slano Bay

DNC: Iva Slade, Vicko Grkeš

IBR: Ana Baricevic, Martin Pfannkuchen

IOF: Gordana Beg Paklar

2.6.1 Monitoring network

Slano bay pilot area is a part of the monitoring network of the Croatian National Reference Center for the Sea. It is included in the Marine Strategy Framework Directive so its obligations are to monitor, report and research the Adriatic Sea. Regular monitoring within the national projects included seasonal salinity, temperature and bacterial analysis (Escherichia coli, Enteroccus). Samples are collected on three different locations within the Slano bay area (Fig. 2.6.1). Besides regular monitoring within the national projects there has been individual research from the Public Institution for the Management of Protected Natural Areas of Dubrovnik-Neretva County. The main goal of the research was to satisfy project task, so measurements were done occasionally in a short period of time. The research monitored existing situation of the Posidonia oceanica meadow within the Slano bay and recommendations for future monitoring (Fi. 2.6.2).

Fig. 2.6.1. Sample locations for the salinity, temperature and bacteria analysis.

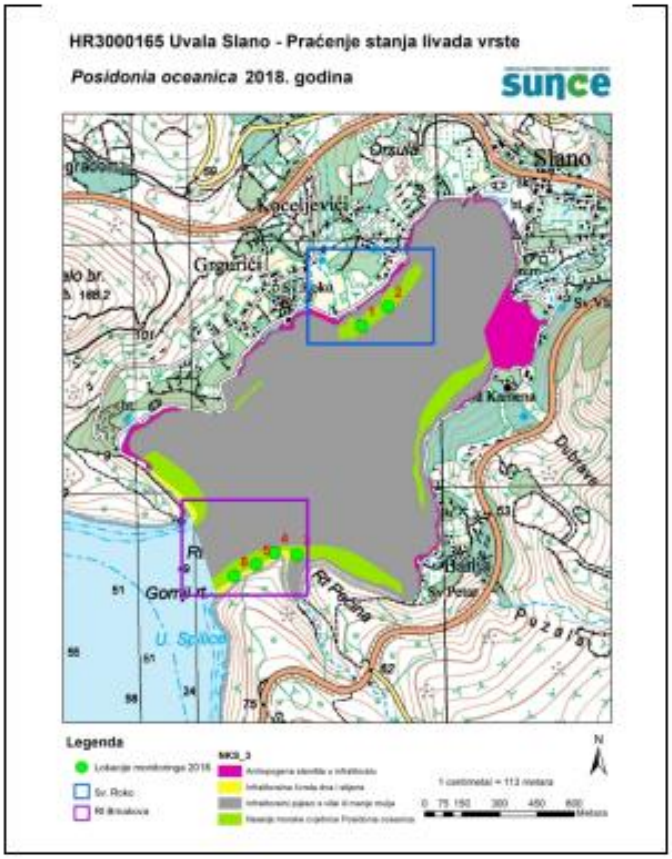

Fig. 2.6.2. Map of the Posidonia oceanica meadow.

2.6.2 Data sharing facilities

Monitoring activities were financed through Ministry of Economy and Sustainable development of the Republic of Croatia and Dubrovnik Neretva Region. Data accessible from the Baltazar web pages are shared (integrated) with the European Environment Agency. Please find down below links with described data resources.

http://baltazar.izor.hr/portal/pocetna

https://www.zastita-prirode-dnz.hr/

https://water.europa.eu/marine/policy-and-reporting/implementation-and-reports

2.7 Dubrovnik Neretva- estuarine area

IOF: Gordana Beg Paklar, Branka Grbec, David Udovičić

2.7.1 Monitoring network

Institute of Oceanography and Fisheries started monitoring in the Neretva River estuary (Fig. 2.7.1) in 1976 within national project Vir-Konavle. In an effort to harmonize compliance with European regulations oceanographic measurements and samplings in the area of transitional and coastal waters of the eastern Adriatic coast have been gradually upgraded following the EU Water Framework Directive (WFD) protocols since 2012.

The main task of the current national project is to propose a plan and program for monitoring transitional and coastal waters, and to start to implement the monitoring of the thermohaline, chemical and ecological status of water according to the requirements of the Water Framework Directive. Permanent oceanographic stations in the Dubrovnik Neretva pilot area currently included in the national monitoring are denoted in Fig. 2.7.1. With continuous monitoring in the area of the Neretva estuary, we are able to warn of possible harmful effects and exceeding the permitted ecological limits. In situ measurements are carried out monthly or seasonally, depending on the measuring area, by a research vessel BIOS DVA (Fig. 2.7.2).

Recently monitored parameters are the following:

§ 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

Besides regular monitoring within the national projects, in the past there have been several institutional projects focused on the Neretva area. As their main goal was to satisfy the project tasks, measurements and samplings were carried out sporadically, which gives us modest spatial-temporal data sets.

Recent monitoring has been financed by legal entity for water management - Hrvatske vode and Ministry of Economy and Sustainable Development of the Republic of Croatia. In accordance recent datasets are property of the mentioned entities. Project reports are available online on the following links:

- https://www.voda.hr/hr/godisnji-planovi-izvjesca-o-provedenom-monitoringu-za-plansko-razdoblje-2016-2021
- http://baltazar.izor.hr/portal/pocetna

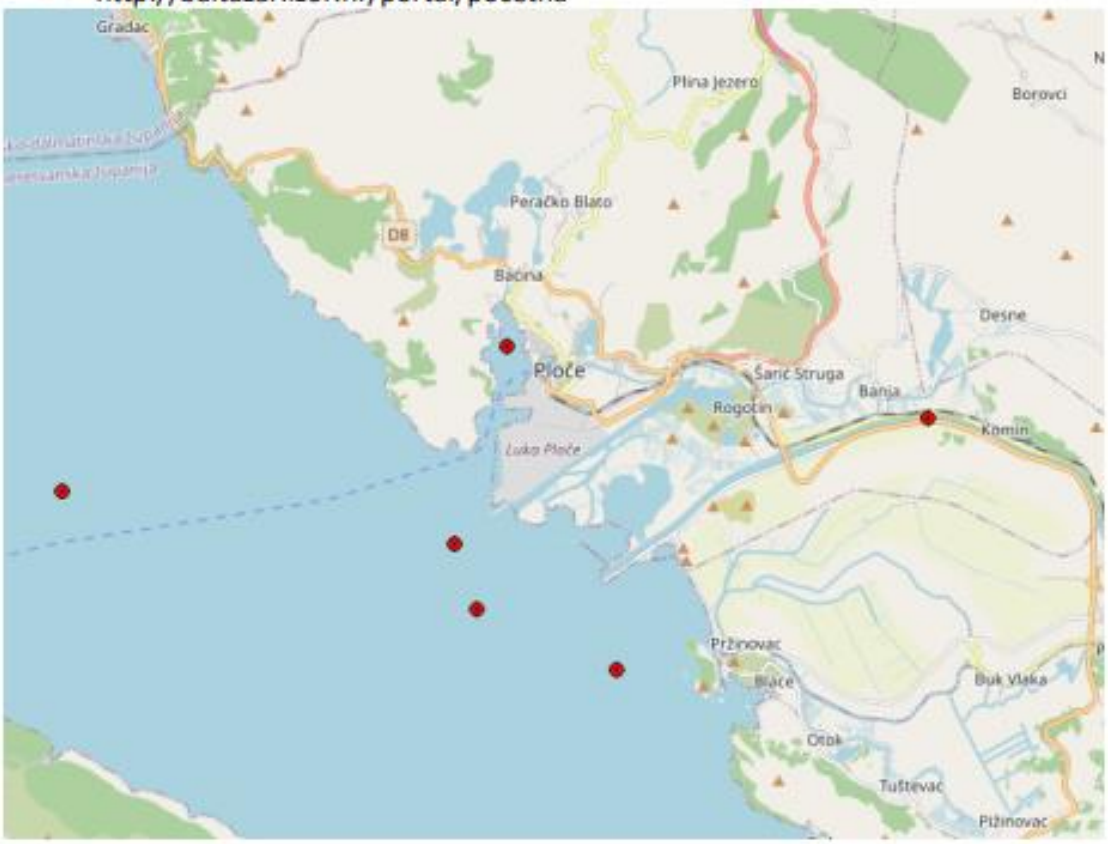

Fig. 2.7.1. Permanent stations included in national monitoring

Fig. 2.7.2. Research vessel BIOS DVA

Besides regular monitoring within the national projects, in the past there have been several institutional projects focused on the Neretva area. As their main goal was to satisfy the project tasks, measurements and samplings were carried out sporadically, which gives us modest spatial-temporal data sets.

2.7.2 Data sharing facilities

Recent monitoring has been financed by legal entity for water management - Hrvatske vode and Ministry of Economy and Sustainable Development of the Republic of Croatia. In accordance recent datasets are property of the mentioned entities. Project reports are available online on the following links:

https://www.voda.hr/hr/godisnji-planovi-izvjesca-o-provedenom-monitoringu-za-plansko-razdoblje-2016-2021

http://baltazar.izor.hr/portal/pocetna

2.8 Split- Dalmatia coastal area

IBR: Ana Baricevic, Martin Pfannkuchen IOF: Gordana Beg Paklar, Branka Grbec, David Udovičić, Danijela Bogner, Stefanija Šestanović, Živana Ninčević

2.8.1 Monitoring network

Intensive long-term temperature and salinity measurements in the middle Adriatic Sea, (Fig. 2.8.1) started in the early 1950s as a part of investigations performed by Institute of Oceanography and Fisheries. This area is under permanent scientific research and in situ measurements along the water column and at the sea bottom have been carried out monthly in the coastal and open sea areas. IOF historical data sets represent repository that today contains over 80% of all data from various measurement in the Adriatic. The longest IOF datasets (covering more than 50 years) are from the Split – Vis transect (Fig. 2.8.1) and the most numerous measurements and samplings have been conducted at Stončica station which is included in this project (Fig. 2.8.2 and 2.8.3). An example of CTD measurements at Stončica station are shown in Fig. 2.8.2, while mean annual temperature and salinity cycles from the same station are in Fig. 2.8.3. Recently monitored parameters are the same as those listed for Dubrovnik Neretva pilot area, along with the microbial food web parameters. Same as in Neretva area Split-Dalmatia pilot area has been almost regularly monitored since 1976 within Vir – Konavle project. The project ended in 2012 but most of the research stations are included in ongoing projects and are still regularly monitored following the EU Water Framework Directive (WFD) protocols in the coastal, and Marine Strategy Framework Directive (MSDF) protocol in the open waters.

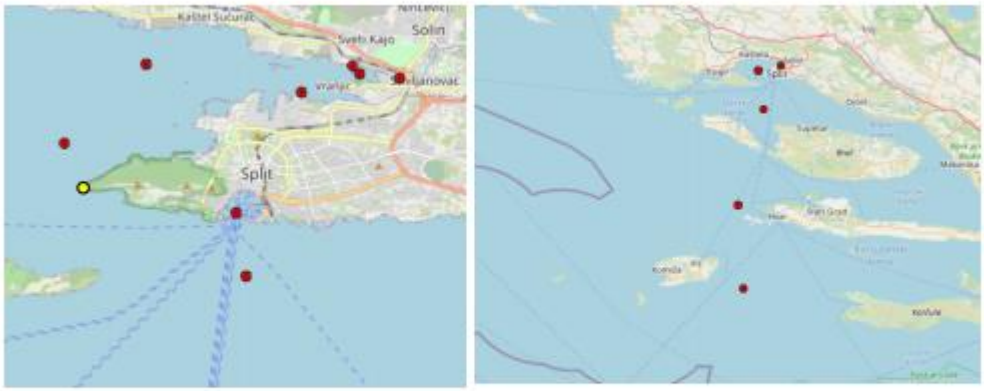

Fig. 2.8.1. Monitoring stations in Split – Dalmatia area.

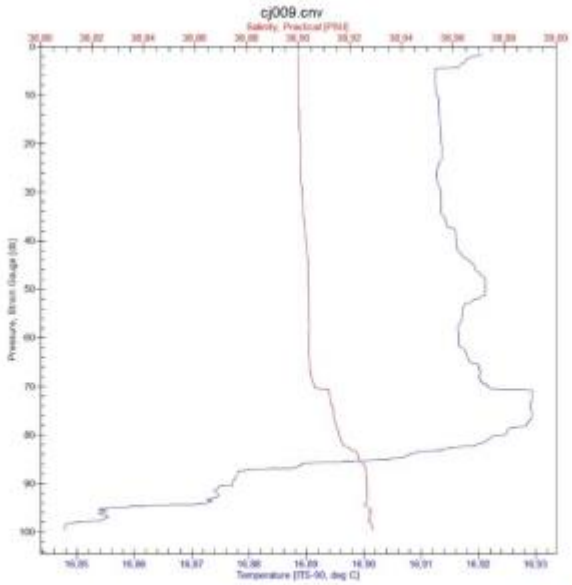

Fig. 2.8.2. Temperature-salinity diagram example from Stončica station CJ009.

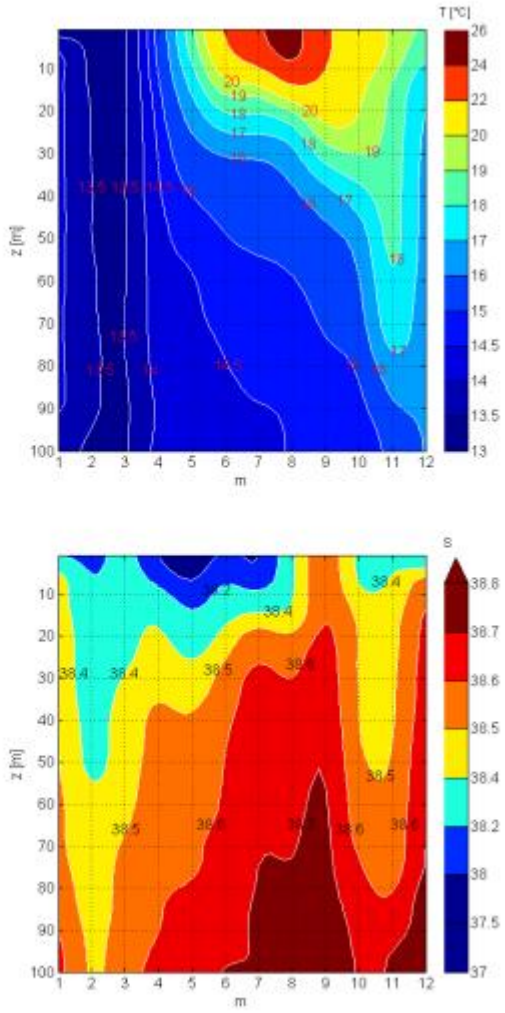

Fig. 2.8.3. Mean annual temperature and salinity cycles at Stončica station.

In addition to CTD measurements plankton community at stations in Kaštela Bay and Stončica were analyzed for many years and time series data of primary production, chlorophyll a concentration, picoplankton, phytoplankton and zooplankton community structure were collected. Namely, primary production was measured since 1962, phytoplankton community structure was determined since 1956, data for picoplankton community are available from 1980, zooplankton community structure since 1959 and concentration of chl a was measured since 1977. These data are an invaluable tool for assessing the impact of climate change on planktonic communities.

Regular sediment samplings at the permanent stations in the Split Dalmatia pilot area have also been carried out within national monitoring. The grain size composition, content of organic matter (loss of ignition) and carbonates were determined at all stations, while content of N and P in surface subsamples 2 cm thick and the content of org C were determined at a reduced number of stations.

Besides monthly and seasonal measurements and samplings at permanent stations, the tide gauge at Jurana station has been in operation since 1949 (marked as a yellow dot on Fig. 2.8.1; Fig. 2.8.4).

Fig. 2.8.4. Meteo - oceanographic station Punta Jurana with tide gauge housing.

2.8.2 Data sharing facilities

Recent monitoring has been financed by legal entity for water management - Hrvatske vode and Ministry of Economy and Sustainable Development of the Republic of Croatia. In accordance recent datasets are property of mentioned entities. Project reports are available online on the following links: https://www.voda.hr/hr/godisnji-planovi-izvjesca-o-provedenom-monitoringu-za-planskorazdoblje-2016-2021 http://baltazar.izor.hr/portal/pocetna Data for the purpose of MSFD are collected at authentication-required IOF network and are reported electronically to the European Commission. The European Environment Agency maintains the electronic platform used for the Reporting (ReportNet), as well as hosts the central database where the reported data are stored (https://water.europa.eu/marine/policy-and-reporting/implementation-and-reports).

2.9 Northern-Eastern Adriatic Sea

IBR: Ana Baricevic, Martin Pfannkuchen IOF: Gordana Beg Paklar

2.9.1 Monitoring network

Northern-Eastern Adriatic Sea pilot area is part of the monitoring network of the Croatian National Reference Centre for the Sea that is tasked with the monitoring, reporting and research obligations in the framework of the Marine Strategy Framework Directive.

2.9.2 Data sharing facilities

RBIs Center for Marine Research (CMR) holds oceanographic buoys as part of the integrated monitoring system and research vessels for operating a network of long term observation sampling stations across the northern Adriatic. In the framework of AdriaClim project, all data from the Northern-Eastern Adriatic Sea pilot area will be stored and processed in the Center for Marine Research, RBI and available on request in CSV format. The intent is also to share data in publicly available databases, either organized through Regional Operational Oceanographic Systems(ROOS)(https://eurogoos.eu/regional-operationaloceanographic-systems/) or directly through SeaDataNet(https://www.seadatanet.org/)as soon as possible

2.10 Marche coastal area

Regione Marche: Patrizia Giacomin

ARPAM: Milena Brandinelli

2.10.1 Monitoring network

The Regional Civil Protection and Local Security System (SPCSL) has created an extensive system for real-time monitoring of the main meteorological parameters (precipitation, temperature, humidity, wind, etc.), hydrogeological (hydrometric level of watercourses). The Agency for Services in the Agri-food Sector of the Marche (ASSAM) manages other meteorological stations: http://www.assam.marche.it/servizi/agrometeorologia IRBIM-CNR manages some marine stations: http://www.irbim.cnr.it/it/index.php ISPRA manages data: - Wave network and associated meteorological data and - Mareographic network and associated meteorological data (real time) A mia conoscenza ci sono inoltre i dati della Rete Ondametrica Nazionale : http://dati.isprambiente.it/il-progetto/ Integrated Coastal management plan has developed a management and information system of coastal erosion based on areal variations in the period 1999-2015: https://www.regione.marche.it/Regione-Utile/Paesaggio-Territorio-Urbanistica-GenioCivile/Difesa-della-costa#Sistema-Informativo-Territoriale The Regional Agency for Prevention, Environment of Marche, Italy (ARPAM) manages the following monitoring network: § The algal surveillance program as a bathing water management activity (L.185 / 93, D.L.vo 11 July 2007 n. 94, and D.Lgs 116/2008). Microalgae with possible hygienic-sanitary implications and any toxic microalgal blooms are monitored § The monitoring of water bodies provides an overall picture of the ecological and chemical status of the coastal marine environment and allows the classification of water bodies in order to verify their actual status. Algal surveillance monitoring in coastal marine waters The monitoring network, used to control eutrophication processes in the marine-coastal environment, consists of 35 stations, 24 of which are located on 12 coast-wide transepts perpendicular to the shore located at a distance of 500 m and 3000 m from the coast, the other 11 are located on the shore, in correspondence with the bathing areas (Fig. 2.9.1). The monitoring program includes monthly samplings during the year, for the execution of analyzes on the phytoplankton component (composition, density, reporting of blooms of potentially toxic

species), on the presence of nutrients (soluble inorganic nitrogen and total phosphorus) and other chemical and chemical-physical parameters (temperature, salinity, pH, dissolved oxygen, concentration of chlorophyll "a", reactive silica and transparency), measured along the water column at every meter of depth.

Monitoring of coastal marine water bodies

The monitoring program of the coastal marine waters (Legislative Decree 152/06) provides for the classification of the 12 water bodies identified by the Marche Region with DGR 2105/2009.

Within the water bodies, 12 transepts have been identified, each consisting of 2 stations one at 500 m from the coast, the other at 1800 m for the monitoring of phytoplankton and physico-chemical elements, in analogy to algal surveillance monitoring. Furthermore, 2 stations for monitoring the macrobenthonic component are identified on each water body, one in correspondence with the sandy bottoms and one in correspondence with muddy bottoms. The following map shows the stations included in the monitoring networks provided for the two monitoring systems.

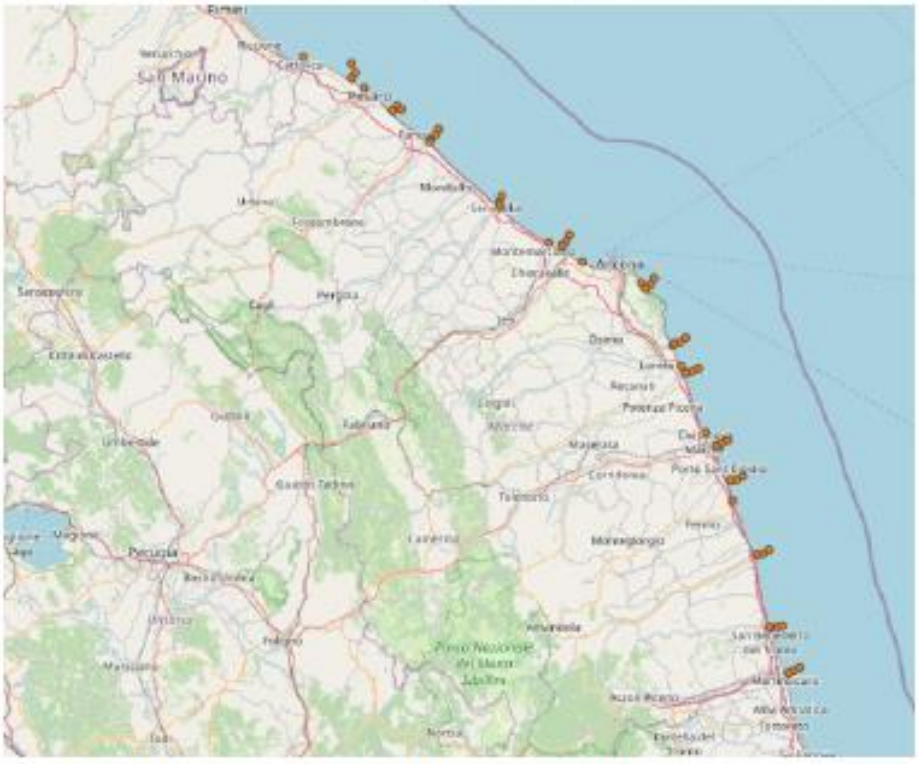

Fig. 2.9.1 Monitoring network of Marche coastal marine waters.

2.11 Molise coastal area

Molise Region – Civil Protection – CFD Molise: Antonio Cardillo

2.11.1 Monitoring network

The Molise Region - Civil Protection Service manages a monitoring network for hydrometeorological data (Fig. 2.10.1). The monitoring network represents the indispensable element to guarantee the "Regional alert system for the hydraulic and hydrogeological risk of the Molise Region", approved with DGR n. 152 of 27 February 2009, implementing the operational guidelines for the organizational and functional management of the national alert system, issued with the PCM Directive of 27 February 2004 and subsequent amendments.

The sensors present in the monitoring network are:

P - Rain gauge - measure of equivalent precipitation;

I - Hydrometer - measurement of the hydrometric level;

T - Thermometer - measurement of the air temperature at 2 meters above the ground;

U - Hygrometer - measurement of the relative humidity of the air;

A - Anemometer - measurement of the scalar and vector speed and of the wind direction both average and gust;

R - Radiometer - measure of the intensity of solar radiation;

N - Snow gauge - measure of the height of the snow cover;

B - Barometer - measurement of normalized pressure at sea level

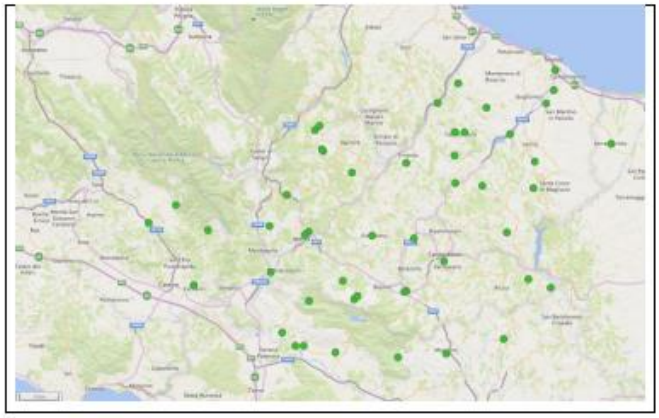

Fig. 2.10.1. Monitoring network of Molise Region in real time.

On the coastal area there are no off shore measurement points available. The station closest to the coast line is that of Termoli which has a rain gauge (P) and a thermometer (T) (Fig. 2.10.2).

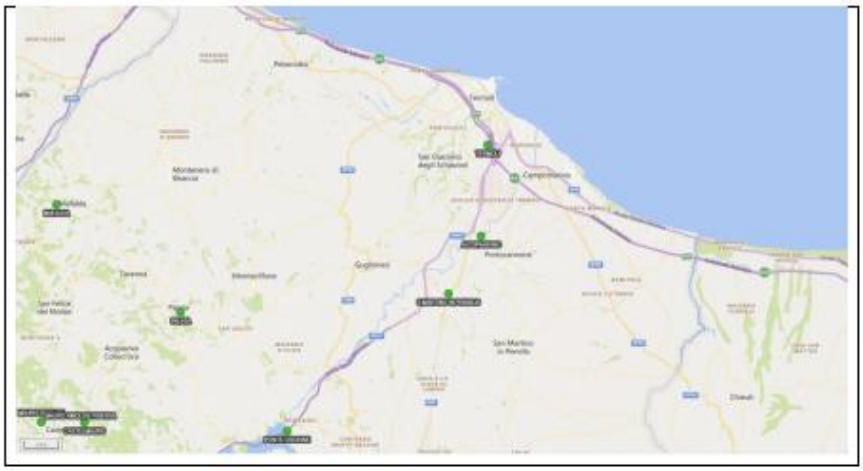

Fig. 2.10.2 Monitoring network of Molise Region – close to the costal line

2.11.2 Data sharing facilities

The data of the monitoring network are available on request through the form downloadable this link: https://www.protezionecivile.molise.it/centro-funzionale/la-rete-meteo-idro-pluviometrica.html https://www.protezionecivile.molise.it/images/modulo_richiesta.pdf and according to the procedures established by the regional regulation (https://www.protezionecivile.molise.it/images/regolamento_richiesta.pdf): free access for public and research bodies, paid for private individuals. According to the regional regulation, a price list was also identified for requesting data. Data are usually sent in cvs format.

3. Planned upgrade of the existing observing infrastructure

To meet the overall objectives of AdriaClim Activity 3.1. 'Design and implementation of the observing systems' under WP 3 'Climate Change Monitoring (Observing and Modelling) Systems' of the AdriaClim project and the specific objectives of deliverable D. 3.1.1 (Section 1.4), in this section we describe the planning and deployment of new observing system components and their integration into the existing ECV Observing sub-regional infrastructure and monitoring networks.

3.1 Overall Adriatic Sea

3.1.1 Monitoring plan/survey

In the framework of ADRIACLIM project, ISPRA activities will be especially focused on meteo-marine monitoring, data analysis and validation (sea level and meteorological related parameters) since it is deeply experienced in managing the national observing systems (RMN, RMLV, RON).

It is going to plan the integration and the acquisition of new technical resources in order to update and to implement the meteo-marine observing systems, with 3 new tide gauges (see Friuli Venezia Giulia and Veneto Pilot area) and 4 co-localized GNSS stations, also to monitor the station references changes and highlight sea level trend (in the future) in the Adriatic Sea. This is a very crucial aspect when managing the validation and the analysis of tide gauge station references, local ones and with respect to national datum IGM.

Moreover, this information is needed handling with modelling systems and data assimilation algorithms. In particular it has been planned to acquire 4 GPS to co-localize with 4 tide gauge stations: Trieste, Ortona, Bari and Otranto.

3.1.2 Dissemination plan

AdriaClim tide gauges and GNSS data, acquired by ISPRA, will be made available on the AdriaClim Geoportal and on ISPRA official website. Especially sea level data would be distributed also in LOD format. The dataset will be identified by a DOI and will be published in several scientific journals.

3.2 Grado and Marano lagoons, Gulf of Trieste

ARPA FVG: Dario Giaiotti, Claudia Orlandi, Denis Guiatti, Alessandro Acquavita and Nicola Bettoso
CNR-ISMAR: Christian Ferrarin

3.2.1 Monitoring plan/survey

Within the framework of the AdriaClim project, new atmospheric and marine sensors and new data transmission will be installed at the Molo F. Bandiera meteorological-marine station, and a new digital tide gauge with built-in data transmission will be installed at the Molo Sartorio tide-gauge station. Atmospheric measurements at the four costal meteorological station of Trieste, Fossalon di Grado, Grado and Lignano Sabbiadoro, are going to be maintained during the AdriaClim project period. With reference to coastal and transitional waters ARPA-FVG will collect chemical and physical parameters bimonthly for 12 stations in the Gulf of Trieste and seasonally for 16 stations in the Grado and Marano Lagoon. Parameters will cover at least temperature, salinity and nutrients.

3.2.2 Dissemination plan

Availability of measurements, that are going to be carried on during the project, will follow the same access type as described in section 2.2, for the already available time series.

3.3 Venice lagoon, City of Venice, Veneto coastal area

ARPA Veneto: Fabio Dalan

ISPRA: Sara Morucci

CNR-ISMAR: Christian Ferrarin

3.3.1 Monitoring plan/survey

An improvement of the meteorological monitoring in the Veneto coastline and in the neighbouring areas is planned. The planned actions are:

§ increasing the monitoring sites in the coastline;

§ moving an existing coastline station to a more representative place;

§ measuring variables currently are not available in Veneto.

The first action will increase the density of the network of coastline stations, by installing two new stations for measuring the surface significant variables for climate changes: temperature, rainfall, wind. Such measures, over the time, will allow to evaluate how the climate changes influence the coastline temperature trend.

Furthermore the availability of denser measures of rainfall and wind will increase the chance to detect and to monitor the development of intense events (like intense rainfall, wind gusts), that usually occur on very small spatial and time scales. The second action provides the displacement of the Chioggia station in a more open area not far from the current location. This action will improve the representativeness of the variables currently measured (the thermometer and the radiometer are partially shielded from plants) and it will allow to restore the 10 meter wind measurement.

Finally, at two currently already present in meteorological regional network stations, inland and less than 20 km away from the coast, three new instruments will be installed to measures the cloud cover and of the height of cloud base (by a ceilometer), the visibility and of type of precipitation (by a present-weather sensor) and of net radiation (by a net radiometer). Furthermore, at two other already present stations, one in the central coastline, and the other in southern inland, the presentweather sensor will be installed. This arrangement will give information on the weather status along the coastline and its evolution towards the inland part of the Region allowing to draw a complete picture of the weather in the area and its evolution.

No changes are foreseen to the marine station networks. Three temporary tide gauges (Fig. 3.3.1.) will be installed inside Po Delta lagoons (North Adriatic Sea), in order to acquire sea level information for downscaling analysis (e.g numerical model calibration and validation)

Two out three new tide gaudges will be placed in the inner area of Sacca degli Scardovari and Porto Caleri lagoons, in order to measure the contribute of the wind induced set up to the total sea level during storm surge events. The location of this stations was settled also considering the tide gauges already available in the Po Delta area (managed by ISPRA and ARPA Veneto). The third station will be placed in the Sacca del Canarin lagoon, for supporting the analysis of water circulation and salinity variability.

Fig. 3.3.1. New tide gauges locations

3.3.2 Dissemination plan

New meteorological stations and observations from AdriaClim project will be made available on the AdriaClim Geoportal. The datasets will be available to ARPAV website in the open data section in .csv format or contacting the relevant service for more specific data needs. A presentation of the upgrade of the costal network will be given towards the end of the project in a couple of coastal municipalities.

Data acquired in the framework of ADRIACLIM will be made available in LOD format and published on the AdriaClim Geoportal and in several scientific journals. Moreover, data could follow the same access type as described in section 2.1 and 2.3 for the already available time series.

3.4 Emilia-Romagna coastal area

UNIBO-CIRSA: Roberta Guerra

3.4.1 Monitoring plan/survey

The regional monitoring network for the quality of coastal and marine waters will be integrated and upgraded to adopt a randomized sampling design at 18 stations in place of the 35 stations (ARPAE, 2020). The core structure of the AdriaClim oceanographic surveys consists of a series of parallel transects that run west-east, from 0.5 km to approximately 20 km offshore (Fig. 3.4.1). The AdriaClim sampling stations are placed at the inshore (0.5 m depth) and offshore ends (20 m) bounding the survey area. Moving offshore, sampling occurs at the 3, 6, 10 and 20 m isobaths (Fig. 3.4.1).

Physical (temperature, salinity, dissolved oxygen, pH) and biological (chlorophyll-a) parameters along the water column are measured twice a year – in Autumn and Spring occupying 18 stations using CTD (IDRONAUT 316 PLUS) and a Seapoint Chlorophyll Fluorometer placed on the CTD. Particulate matter is filtered through precombusted acid-washed GF/F filters using water from Niskin bottles and analyzed for particulate organic carbon (POC) and total particulate nitrogen (TPN), stable carbon isotopic and nitrogen isotopic composition (δ13C and δ15N), particulate phosphorus (PN) and particulate inorganic phosphorus (PIP). Between three and five water depths are sampled at 2 stations at a 20 km distance, sampling an open shelf regime. Sediments are collected by means of a Van Veen (0.112 m2) grab in tandem with physical and biological water parameters during the oceanographic surveys occupying the same 18 stations.

The surficial 0-2 cm representing the active sedimentation layer is scooped or spooned out of the grab sampler. Samples are temporary stored at 4°C onboard, and immediately transferred to the UNIBO-CIRSA laboratories for analysis. Sediments physical and biogeochemical parameters are the following:

- water content (%)
- porosity and bulk density
- grain size
- organic carbon (TOC), total nitrogen (TN)
- stable carbon and nitrogen isotopic composition (δ13C and δ15N)

• total phosphorus (TP) and inorganic phosphorus (IP)

A summary of the sampling scheme including field sampling methods, target coordinates, analyses, sampling compositing scheme, and sample nomenclature are provided in Table 3.4.1. Water content, porosity and bulk dry density are determined according to (Berner, 1971). Grain size is determined after the removal of organic matter by hydrogen peroxide and wet sieving at 63 µm to separate sand from silt and clay fractions. Isotopic analysis (δ13C and δ15N) is performed with an elemental analyzer coupled online via a Stable Isotope Ratio Mass Spectrometer using air nitrogen and PDB standards for N and C, respectively. The δ13C and δ15N values are reported relative to the VPDB (Vienna Pee Dee Belemnite) and air nitrogen standards international reference materials using δ (delta) notation and parts per thousand (‰). The TP and IP content is determined using a modification of the combustion method and HCl extraction procedure according to the procedures of Solórzano and Sharp (1980) and Aspila et al., 1980. The orthophosphate concentrations in extracts are measured using the standard ascorbic acid molybdate blue spectrophotometric method (Strickland & Parsons, 1972). A selection of naturally occurring P compounds (i.e. phosphoesters, polyphosphates) and Certified Reference Materials (CRMs) are analyzed for quality assurance.

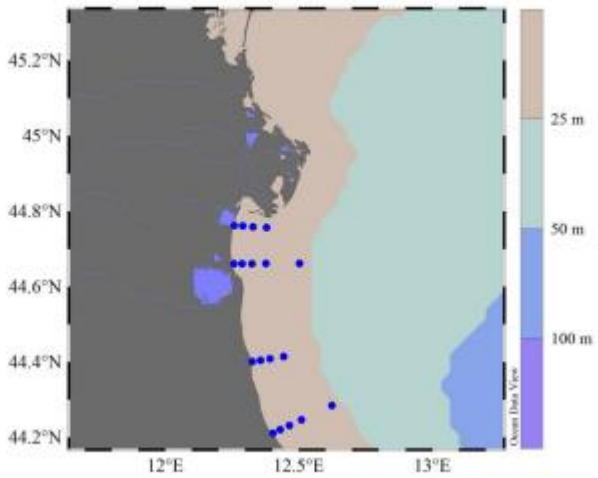

Fig. 3.4.1. Map of AdriaClim monitoring stations for water, suspended particulate and sediment.

Table 3.4.1. AdriaClim station list for CTD deployments, particulate matter and sediment. The station numbers are according to the regional monitoring network for the quality of coastal and marine waters.

Station ID	Area	water depth (m)	distance from coast (km)	latitude (N)	longitude (W)
2	Lido di Volano	3.9	0.5	44.45766	12.15513
4	Porto Garibaldi	3.7	0.5	44.39687	12.15423
9	Lido Adriano	5.4	0.5	44.24075	12.19539
14	Cesenatico	3.1	0.5	44.12723	12.24152
302	Lido di Volano	6.7	3	44.45688	12.17409
304	Porto Garibaldi	9.1	3	44.39693	12.17289
309	Lido Adriano	9.4	3	44.24309	12.21387
314	Cesenatico	8.3	3	44.13263	12.25844
602	Lido di Volano	7.8	6	44.45574	12.19689
604	Porto Garibaldi	12	6	44.39705	12.19497
609	Lido Adriano	11.4	6	44.24549	12.23559
614	Cesenatico	10.2	6	44.13941	12.2786
1002	Lido di Volano	10.1	10	44.45436	12.22749
1004	Porto Garibaldi	14.8	10	44.39718	12.22569
1009	Lido Adriano	15.1	10	44.24903	12.26595
1014	Cesenatico	12.3	10	44.14859	12.30596
2004	Porto Garibaldi	26.5	20	44.3973	12.30129
2014	Cesenatico	22	20	44.17109	12.37388

Arpae-SIMC

The foreseen upgrades in Arpae's monitoring network relative to AdriaClim involve the acquisition of a wave buoy with a current meter to replace the one currently deployed just offshore the town of Cesenatico. At first, a coastal radar was intended but due to technical limitations, a wave buoy has been chosen instead as coupled with a current meter it will enhance the current wave monitoring system and it will provide an in-situ real-(near real-)time source of current data that is not yet available inside Arpae's network.

In addition to the wave buoy coupled with the current meter, the upgrade of the Regional Coastal Geodetic Network through the acquisition of two Global Navigation Satellite System (GNSS) highprecision apparatus intends to increase the vertical land movement quantification. Likewise, this new boost will provide better sea-level evaluation that, associated with improved land movement assessments, increases significantly the analysis and predictions of future sea-level rise impacts facilitating and augmenting the resources available to decision-makes to produce sound adaptation plans.

It is important to emphasize the importance of the aforementioned equipment not only for the network monitoring system but also to the currently implemented forecasting systems maintained by Arpae. In-situ measurements are crucial on modelling calibration and validation steps as well as for constant quality control assessments as well as necessary corrective procedures to allow for a skillful representation of the observed/measured conditions on a long-term basis.

For the focus on shellfish aquaculture in EMR Pilot, the risks of diffusion of microbial pathogens in CC scenarios will be modeled in target/critical production areas taking advantage of environmental high-resolution data provided by other AdriaCLIM partners, historical data (2005-2020) from sanitary surveys provided by IZSLER. In the identified shellfish target areas, additional sampling campaigns will be carried out for calibration and validation of the diffusion model.

3.4.2 Dissemination plan

AdriaClim physical and biological water parameters, particulate matter, and sediment physical and biogeochemical parameters will be made available on the AdriaClim Geoportal. The dataset will be identified by a DOI and will be published in several scientific journals.

3.5 Apulia coastal area

CMCC: Giorgia Verri, Viviana Piermattei

3.5.1 Monitoring plan/survey

This section specifies both the underway activities and the planned ones. The underway activities involve the acquisition of electronic components, the acquisition of mechanical components for instruments assembly onboard the buoy and the improvement of laboratory calibration system also by the acquisition of high-quality reference Conductivity and Temperature sensors. A series of in situ tests of low-cost sensors were carried out in a lab-coastal fixed site in order to verify the functioning and stability of electronic boards for sensors management and data transmission. The procedures for laboratory sensors calibration are going to be planned as well as a series of test of a low-cost transmission system based on LoRa.

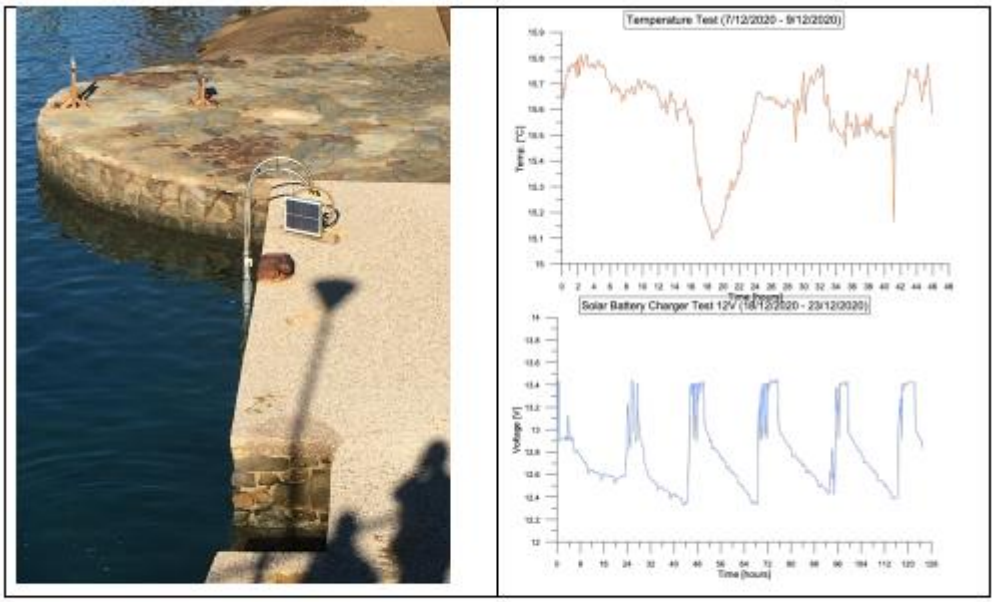

Fig. 3.5.1. Lab-coastal fixed site and first tests of the system

Moreover, a first prototype of a new developed low-cost multispectral radiometer (18 channels) is under test in order to be integrated in the future instrumentation onboard the buoy.

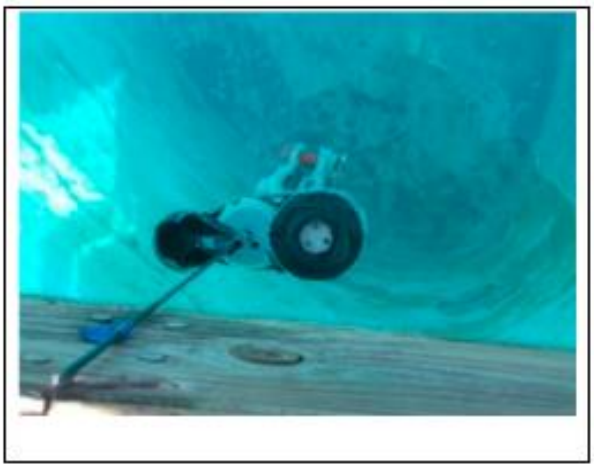

Fig. 3.5.2. Prototype of a new low-cost multispectral radiometer

3.5.2 Dissemination plan

The new data collected from the updated buoy will be made available on the AdriaClim Geoportal. The dataset will be identified by a DOI and could be used for scientific journals publications.

3.6. Slano Bay

DNC: Iva Slade, Vicko Grkeš

IBR: Ana Baricevic, Martin Pfannkuchen

3.6.1 Monitoring plan/survey

Monitoring in the Slano bay area will be upgraded with the installation of the device which will measure sea level, tide and meteorological parameters that will include temperature, humidity, air pressure, wind speed and direction, solar radiation and precipitation. This device has an option of upgrading for additional sensors. Device installed in Slano bay will contain not only the required instruments, but also a GPRS-enabled datalogger, a backup battery and a solar panel to provide continuous power on remote locations. The data collected will contribute to the overall sea measures in order to get the complete pictures of the climate change indicators. It will help for the future research of the climate change processes on the Adriatic Sea and ultimately adaptation plans as a result. 3.6.2 Dissemination plan Data (delayed mode and near real time) will be available from the operational oceanography server at www.irb.hr .

3.7 Dubrovnik Neretva- estuary area

IOF: Gordana Beg Paklar, Branka Grbec, David Udovičić, Danijela Bogner

3.7.1 Monitoring plan/survey

Monitoring in the Dubrovnik Neretva pilot area will be upgraded by deployment of autonomous sensors for temperature, salinity and dissolved oxygen along the Neretva River estuary and part of the riverbed and by installation of automatic station with meteo (wind speed and direction, air temperature, air humidity, air pressure) and marine (sea level, sea temperature, salinity) sensors. The upgraded observing system is design mainly to study the dynamics of salt wedge intrusions. Sediment samplings in the Dubrovnik Neretva area are planned to coincide with deployment of meteo-marine equipment, its inspection and recovering campaign.

3.7.2 Dissemination plan

Data obtained within AdriaClim project by IOF team will be available on the AdriaClim Geoportal

3.8 Split- Dalmatia coastal area

IBR: Ana Baricevic, Martin Pfannkuchen

IOF: Gordana Beg Paklar, Branka Grbec, David Udovičić, Danijela Bogner, Stefanija Šestanović, Živana Ninčević

3.8.1 Monitoring plan/survey

Sediment samples will be collected at three additional stations in the Kaštela Bay and at the Stončica station near the island of Vis. In order to improve sediment sample analysis it is planned to purchase laser diffraction particle size analyzers, for particles smaller than 0.063 mm. Until now sediment fraction<0.063 mm have been determined using hydrometer method according to Cassagrande

(STRMAC, 1952). Although mentioned method is reliable, new method using the laser diffraction particle size analysers will give more accurate values, especially for fraction less than 0.001 mm.

Also getting results will be accelerated.Within the framework of the AdriaClim project, it is planned to introduce a new molecular method based on DNA microarray technology with aim to improve monitoring program of harmful algae at shellfish farms and shellfish harvesting area. Because the current monitoring program is based on light microscopy that does not allow the identification of all harmful species down to the species level, the microarray method will be introduced in order to increase the reliability of the monitoring program. Microarray technique offer faster and more accurate detecting and monitoring species. Method is based on the labeling of the target nucleic acids, which then are hybridized to the probes on the microarray. The laser in a microarray scanner scans the slides and recognizes the hybridization pattern according to fluorescent excitation and identifies present species. DNA microarrays, or phylochips as they have been termed, have been used to identify phytoplankton, toxic algae, bacteria, eggs and larvae from fish species (Medlin, 2017). We did a market research related to the microarray scanner and started preparing the procurement documentation.

For the microbiological investigations two stations with different trophic status are chosen: one is located in the center of the Kaštela Bay (central part of Kaštela Bay, 43°51'N; 16°38'E, depth 38 m) and the other one is Stončica station near the island of Vis (central Adriatic Sea, 43°N; 16°33'E, depth 103 m). The structural and functional features of microbial food web will be studied by observing the following parameters: abundance and production of heterotrophic bacteria (with different DNA content, i.e. High- DNA bacteria and Low- DNA bacteria), abundances of two cyanobacteria groups, i.e. Prochlorococcus and Synechococcus, abundances of pico-eukaryotic algae and abundances of protistan grazers (heterotrophic nanoflagellates). The sampling for microbial community will beconducted on the monthly basis and at least 9 sampling dates will be covered. Samples will be collected vertically at 5-8 different depths.

The microbiological investigations will be improved by upgrading laboratory equipment. A new CCD camera that will be mounted on existing epifluorescent microscope will improve research capacities by enabling a better view of fluorescence microscopy images, higher resolution and finer sensitivity. The existing flow cytometer will be improved with automatic plate loader that will help to optimize sample processing by time reduction.

3.8.2 Dissemination plan

Data obtained within AdriaClim project by IOF team will be available on the AdriaClim Geoportal.

3.9 Northern-Eastern Adriatic Sea

IBR: Ana Baricevic, Martin Pfannkuchen

3.9.1 Monitoring plan/survey

Fig 3.9.1 shows the spatial distribution for the planned delayed mode monitoring stations. Sampling frequency will be between 2 and 8 samplings per year, depending on the station and the sea conditions. Samples will be taken from research vessels. Parameters will cover at least temperature and salinity. At latitude 45.1, two in situ observatories will be installed at 1 and 4 miles off the Croatian coast, that will deliver near real time data on SST, salinity, wind (direction and speed) surface current (direction and speed), waves (height, frequency), visibility, air temperature, precipitation and humidity

Fig. 3.9.1 Delayed mode monitoring stations in the north-eastern Adriatic Sea

3.9.2 Dissemination plan

Data (delayed mode and near real time) will be available from the operational oceanography server at www.irb.hr

3.10 Marche coastal area

Regione Marche: Patrizia Giacomin

ARPAM: Milena Brandinelli

No monitoring survey, instrument deployment and dissemination plan are foreseen within the AdriaClim Activity 3.1 Activity.

3.11 Molise coastal area

Molise Region – Civil Protection – CFD Molise: Antonio Cardillo

3.11.1 Monitoring plan/survey

The monitoring plan provides for the installation of a complete station for monitoring the sea level and some environmental quality parameters. We plan to place the station in the harbor bay with the following sensors: Data logger, Radio module + Antenna (data in real time), Thermo-hygrometer, Barometer, Rain gauge, Anemometer (mechanical), Wave meter, Multi-parameter probe for quality (electrical conductivity meter, pH, water temperature) The observed data are transmitted in real time to the Decentralized Functional Center of Molise (CFD Molise) for registration and processing. The installed station will have the same characteristics as a monitoring station used for weather and network alerts.

3.11.2 Dissemination plan

The monitoring data can be part of the national network RON and RMN by ISPRA. AdriaClim data observation will be made available on the AdriaClim Geoportal. The dataset will be identified by a DOI and will be published in several scientific journals. The collected data will be distributed to the Molise environmental protection agency (ARPA Molise) and published in the Molise region bulletin issued every day by the CFD Molise on the website www.protezionecivile.molise.it

4 Outlook

This report is an overview of the status of the coastal oriented observing infrastructure and monitoring network for marine and coastal water quality at sub-regional level and in the AdriaClim Pilot Areas in the Adriatic Sea. The sustainability of this core infrastructure at the Adriatic Sea basin level requires a larger and more intensive framework of collaboration between research groups and research institutes, researching organizations, agencies and regional/local authorities to be established over the next decade. There is a need to strengthen the existing monitoring and infrastructure by complementing or upgrading it with innovative monitoring technologies and harmonized methods.

Annex

List of Acronyms used in this Report

AT Air Temperature

AP Atmospheric Pressure

ARPA FVG Environmental Protection Agency of Friuli Venezia Giulia

ARPAE Regional Agency for Prevention, Environment and Energy in Emilia Romagna

ARPAE –SIMC Hydro-Meteo-Climate Service of ARPAE

ARPAV Regional Agency For Environmental Protection And Prevention Of Veneto

CCI Climate Change Initiative

CMCC Euro-Mediterranean Center on Climate Change Foundation

CMEMS Copernicus Marine Environment Monitoring Service

CNR-ISMAR National Research Council - Institute for Marine Sciences

CTD Conductivity, temperature, depth

Dir Wave Direction

DOC Dissolved organic carbon

ECV Essential Climate Variables

ECMWF European Centre for Medium-Range Weather Forecasts

EMODnet European Marine Observation and Data Network

ESA European Space Agency

EUSAIR EU Strategy for the Adriatic Ionian Region

EWS Early Warning System

GCOS Global Climate Observing System

GNSS Global Navigation Satellite System

Hs Significant Wave Height

IOF Institute of Oceanography and Fisheries

ISPRA Italian National Institute for Environmental Protection and Research

IZSLER Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia Romagna

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