ECOlogical observing System in the Adriatic Sea: oceanographic observations for biodiversity

Priority Axis 3: Environment and cultural heritage

Specific Objective 3.2: Contribute to protect and restore biodiversity

D5.1.1 Report on data/information availability and infrastructure/tools requirements

WP5 – Design and implementation of data infrastructure

A5.1 - Design of the data infrastructure

PP3 IZOR / Ivica Vilibić

LP, PP1, PP2, PP4, PP5, PP6, PP7, PP8, PP9

Final

Public

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CONTENTS

1. INTRODUCTION

Within the frame of the Activity 5.1 Design and implementation of data infrastructure of the project ECOlogical observing System in the Adriatic Sea: oceanographic observations for biodiversity (ECOSS), this report aims to identify and analyze existing data infrastructures, portals, observing networks together with specific datasets and spatial information relevant for the project. In the same way, tools and workflows of analysis is identified and described to support WP4 objective.

To collect as much as possible information about data infrastructures, portals and observing networks, a questionnaire has been developed with the aim of collecting prescribed information necessary to build up the deliverable. For this deliverable, the questionnaire included the following information: the name of the data infrastructure or data portal, institutions maintaining the data infrastructure or data portal, ecological parameters stored by the data infrastructure or data portal, web page of the data infrastructure or data portal, accessibility of the data by the data infrastructure or data portal, data policy, and a description of the data infrastructure, portal or observing network.

This deliverable should be jointly analyzed with Deliverable 3.1.1, which contain report on the assessment of existing ecological monitoring programs and observing systems. In fact, a great number of the observing systems require a kind of data infrastructure or portal for visualizing or accessing the data. For that reason, some of the information presented in Deliverable 3.1.1 and relevant for this deliverable, is not presented here.

After presenting data infrastructures, portals and observing networks, all of the information has been assessed and a SWOT (strengths-weaknesses-opportunities-threats) matrix has been created. The SWOT analysis has been continued by assessing requirements for all the quoted items. Finally, a few conclusion is drawn from the presented documents and analysis.

2. EXISTING DATA INFRASTRUCTURES, PORTALS AND OBSERVING NETWORKS

2.1. Reporting system of the Adriatic Sea monitoring for MFSD

The name of the data infrastructure or data portal: Izvještajni sustav monitoringa Jadrana (Reporting system of the Adriatic Sea monitoring) web portal

Institutions maintaining the data infrastructure or data portal: Institute of Oceanography and Fisheries

Ecological parameters stored by the data infrastructure or data portal: Data obtained from "Monitoring and observation system for assessment of the Adriatic Sea state" in accordance with MSFD Monitoring Plan for Croatia (OG 153/2014) are grouped into parameters from physical oceanography, chemical oceanography, biological parameters, marine litter and underwater noise. Parameters are also connected with certain MSFD descriptor or group of descriptors.

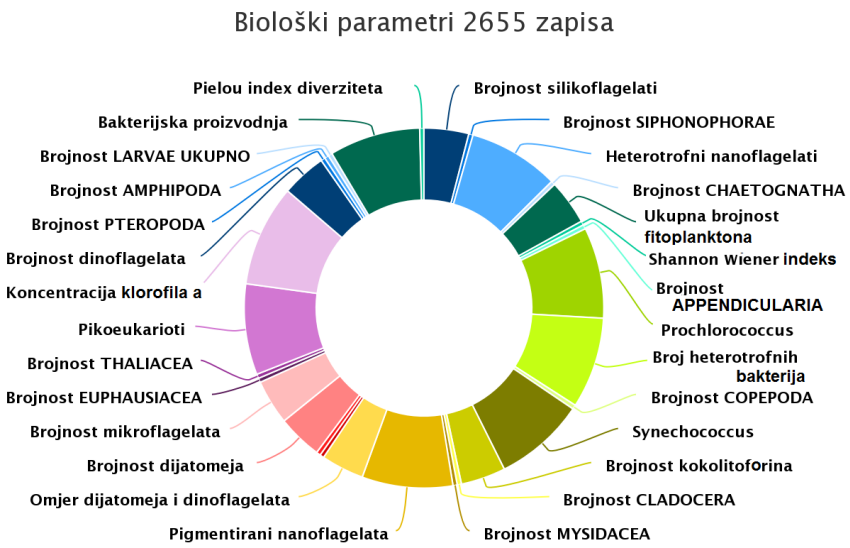
Web page of the data infrastructure or data portal: http://faust.izor.hr/nmon/pocetna, still under development

Accessibility of the data by the data infrastructure or data portal, data policy: Restricted, for now

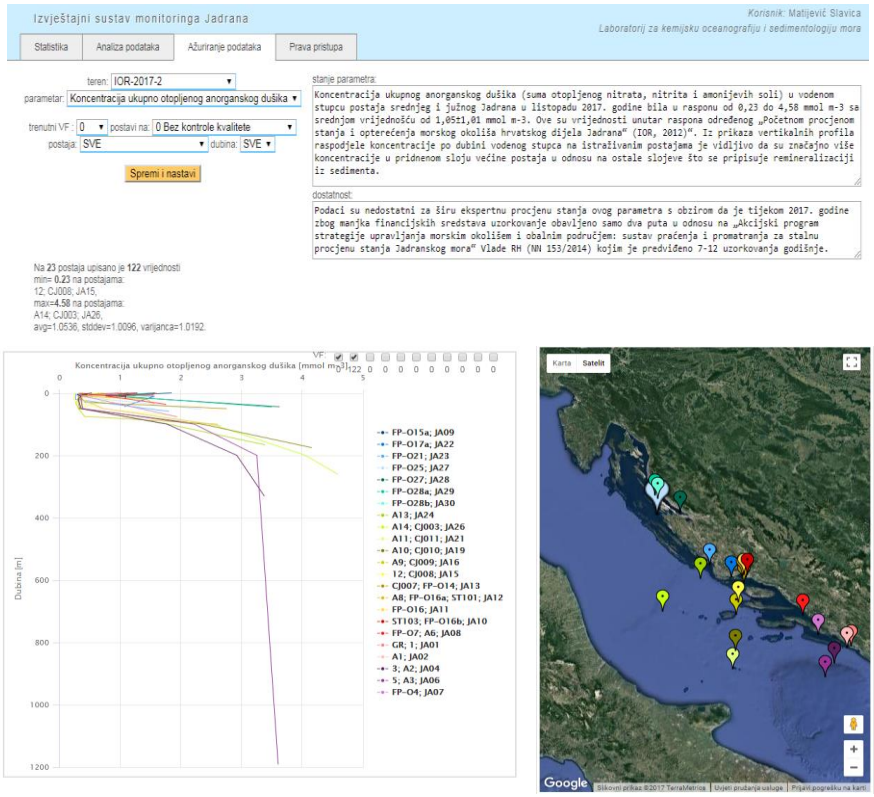
Description: Web portal *Izvještajni sustav monitoringa Jadrana* (*Reporting system of the Adriatic Sea monitoring)* is still under development. Data obtained from "Monitoring and observation system for assessment of the Adriatic Sea state" in accordance with MSFD Monitoring Plan for Croatia (*OG 153/2014)* are grouped into parameters from physical oceanography, chemical oceanography, biological parameters, marine litter and underwater noise (table in Annex). Parameters are also connected with certain MSFD descriptor or group of descriptors. Data obtained for coastal sites derived from monitoring according to WFD demands are also part of data base, considering the parameters that are covered by both directives. Data portal gives metadata presentation, data visualisation with connection between sites and parameters, data

QA/QC as well as “key of expert” through simple interpretation of parameters and processes at investigated sites based on scientific experience.

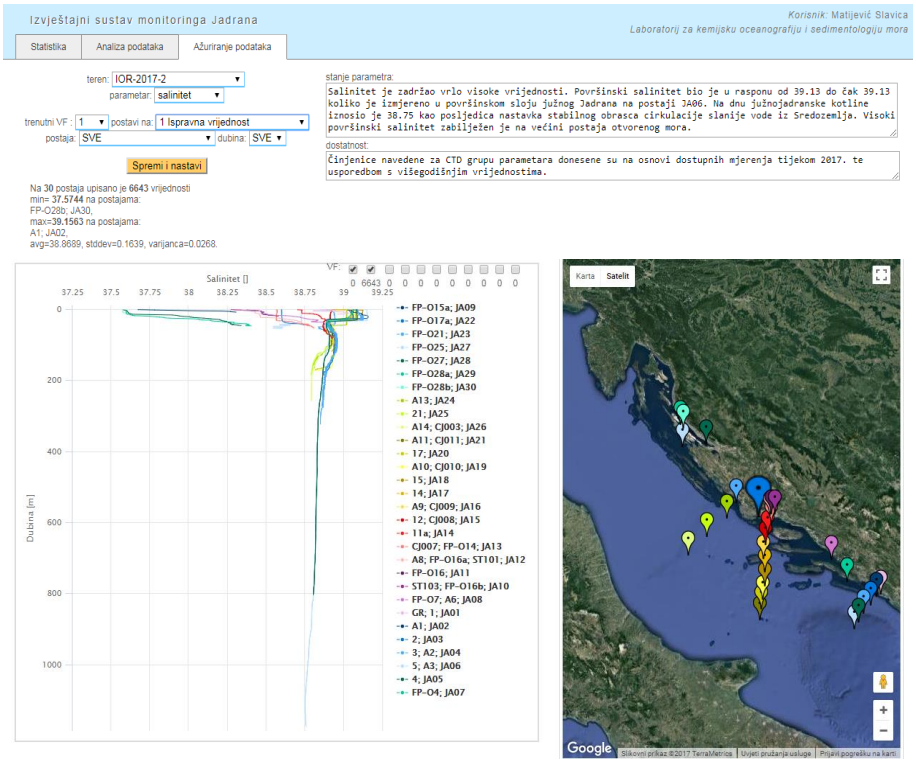
Examples of interpretation of data in web portal under development are shown in Figures.



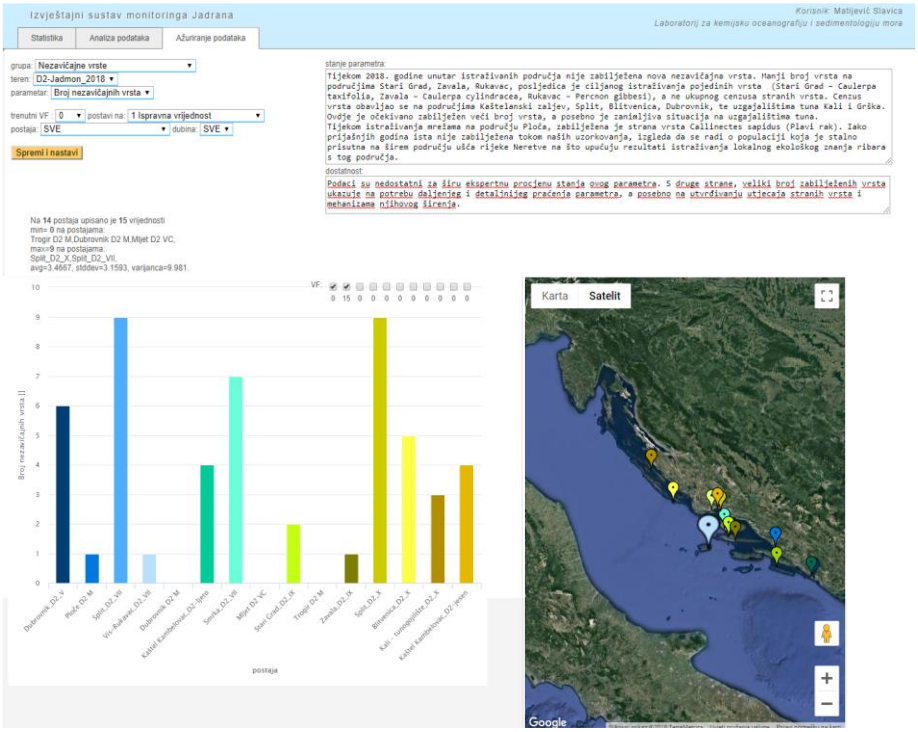
Number of records for biological parameters monitored according to MSFD demands – example of metadata visualisation.



Example of data visualisation as vertical profile of total inorganic nitrogen at sites in middle and south Adriatic.



Example of data visualisation as vertical salinity profiles at sites in middle and south Adriatic.



Example of interpretation of invasive species at 10 sites investigated in middle and south Adriatic.

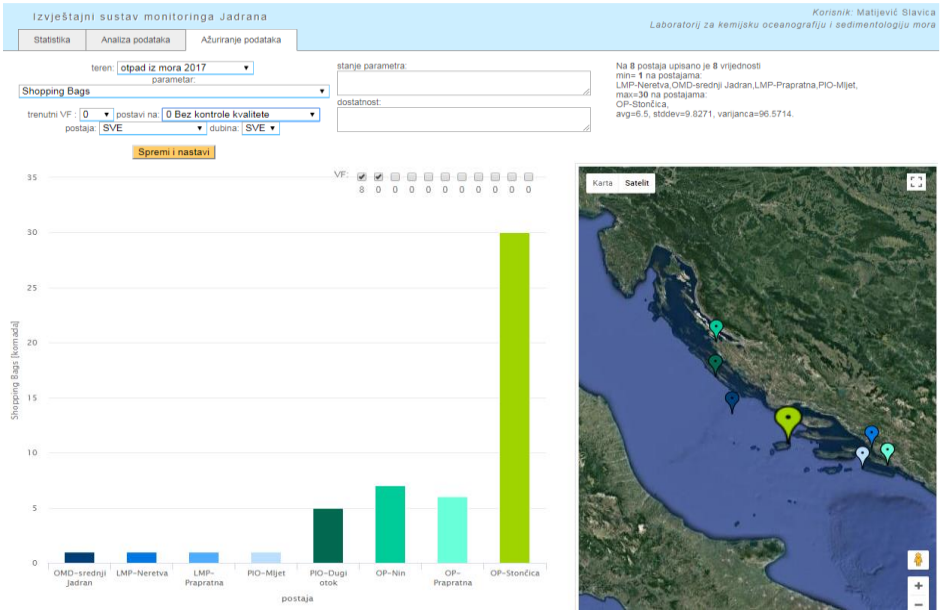


Figure 5. Example of interpretation of plastic bags on beaches at sites investigated in middle and south Adriatic.

2.2. Database and indicators of the state of the marine environment, mariculture and fisheries

The name of the data infrastructure or data portal: Fishery database for demersal, pelagic and coastal fisheries and for aquaculture

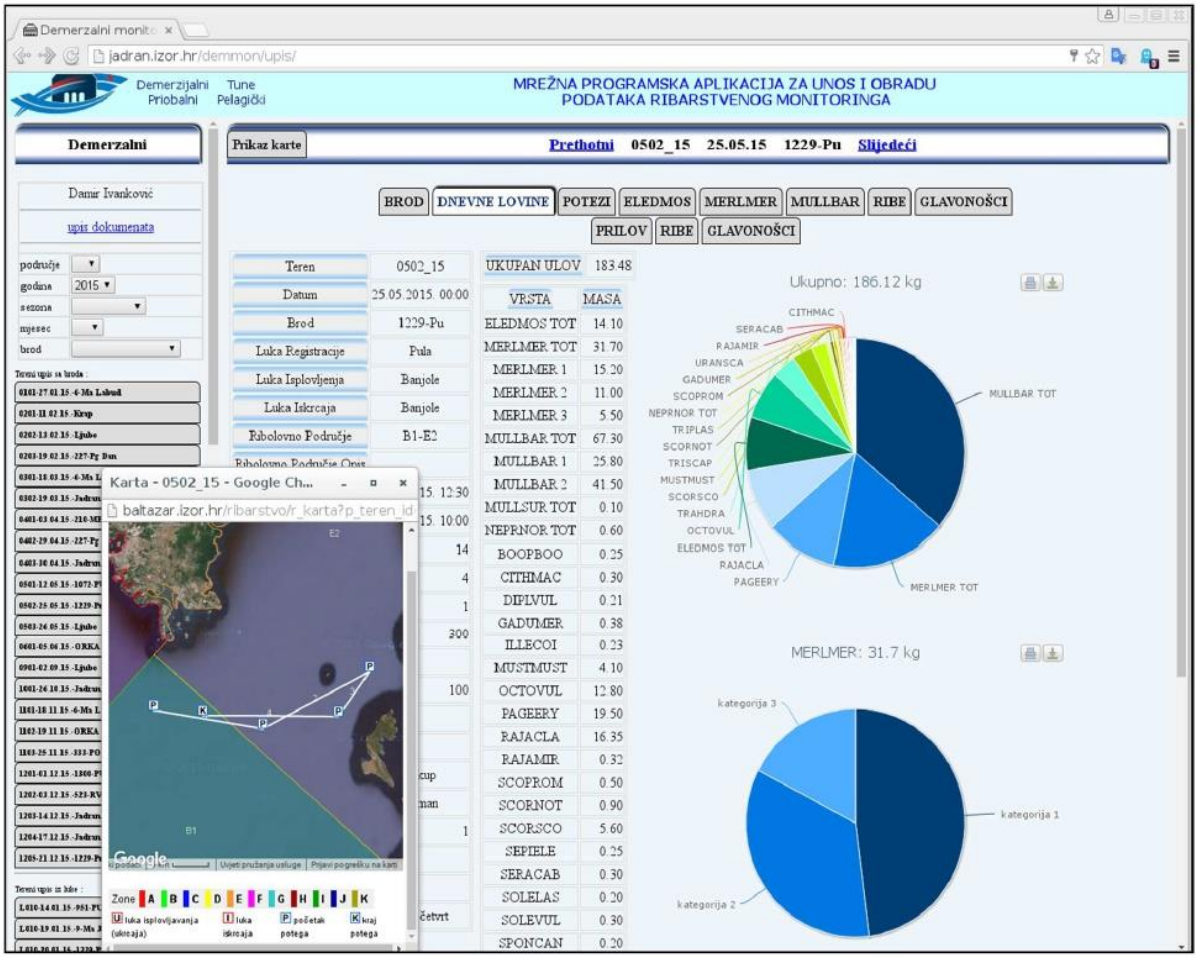
Institutions maintaining the data infrastructure or data portal: Institute of Oceanography and Fisheries

Ecological parameters stored by the data infrastructure or data portal: Temperature, Salinity, Visible pollution, Floating waste matter, Mineral fat, Suspended waste matter

Web page of the data infrastructure or data portal: http://jadran.izor.hr/demmon

Accessibility of the data by the data infrastructure or data portal, data policy: Not available

Description: The database of fisheries data enables the entry and processing of data collected through field activities within the monitoring. Data include metadata (fishing time, place, ship, fishing coordinates, fishing gear) as well as data on long and massive catch frequencies. Based on the data and data obtained from the ministry on the basis of the reported catches, the fish population estimates are being analyzed. These data are also used for reporting to the European Commission.



The example of database record for a cruise.

2.3. MEDAS (Marine Environmental Database of the Adriatic Sea)

The name of the data infrastructure or data portal: MEDAS (Marine Environmental Database of the Adriatic Sea)

Institutions maintaining the data infrastructure or data portal: Institute of Oceanography and Fisheries

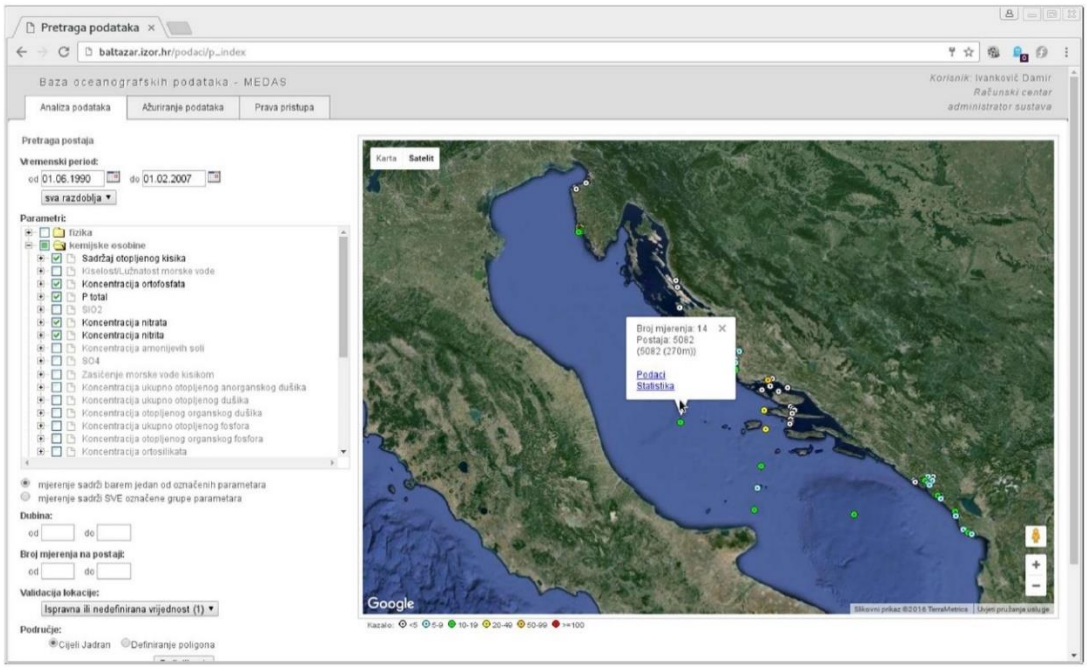
Ecological parameters stored by the data infrastructure or data portal: Temperature, Salinity, Visible pollution, Floating waste matter, Mineral fat, Suspended waste matter

Web page of the data infrastructure or data portal: http://baltazar.izor.hr/podaci/p_index

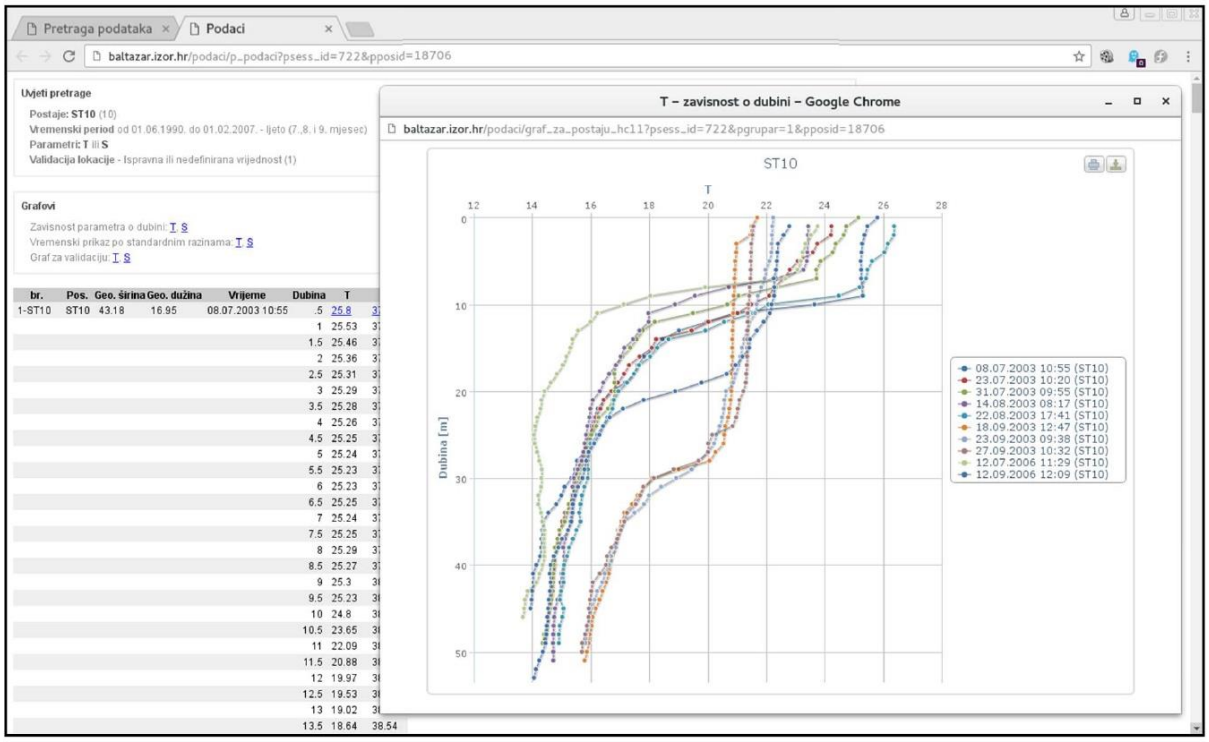
Accessibility of the data by the data infrastructure or data portal, data policy: Not available

Description: The MEDAS database has been measuring since the year 1900 to date. Its modular structure makes it easy to add new parameters. Data can be searched by parameter and metering method, parameter, and by parameter group with time and spatial conditions. The database validates data and statistical and climatological data analysis. This database is still in development.

MEDAS databases with individual thematic subdivisions are included in the distributed database of the SeaDataNet project (EU SF calls FP5, FP6, FP7) whereby certain measured data allowing for unlocked access can be retrieved from the database via the http://www.seadatanet.org located in the Netherlands.



The example of database record for a cruise.



The example of temperature profile record in the database.

2.4. Fishery database for demersal, pelagic and coastal fisheries and for aquaculture

The name of the data infrastructure or data portal: Fishery database for demersal, pelagic and coastal fisheries and for aquaculture

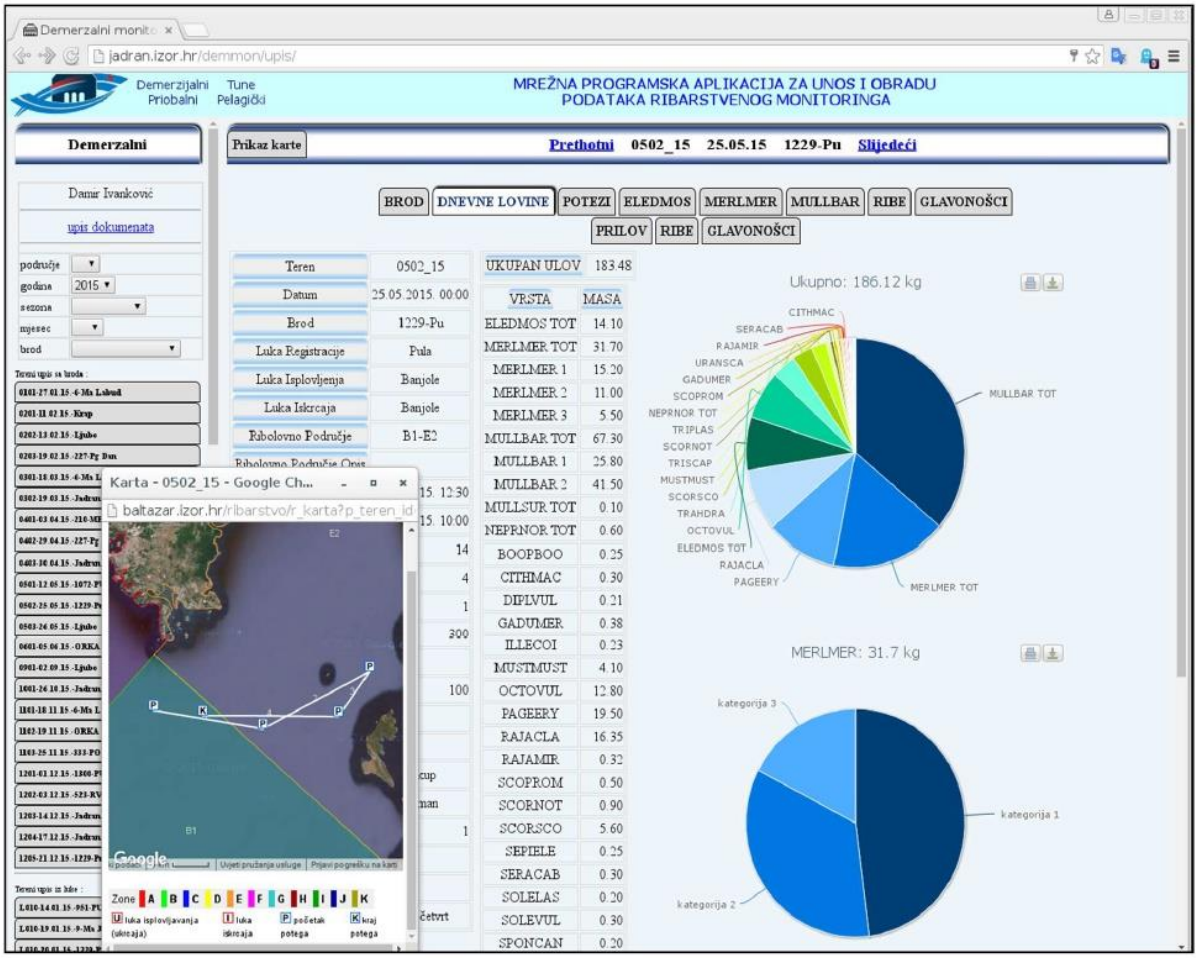
Institutions maintaining the data infrastructure or data portal: Institute of Oceanography and Fisheries

Ecological parameters stored by the data infrastructure or data portal: Temperature, Salinity, Visible pollution, Floating waste matter, Mineral fat, Suspended waste matter

Web page of the data infrastructure or data portal: http://jadran.izor.hr/demmon

Accessibility of the data by the data infrastructure or data portal, data policy: Not available

Description: The database of fisheries data enables the entry and processing of data collected through field activities within the monitoring. Data include metadata (fishing time, place, ship, fishing coordinates, fishing gear) as well as data on long and massive catch frequencies. Based on the data and data obtained from the ministry on the basis of the reported catches, the fish population estimates are being analyzed. These data are also used for reporting to the European Commission.



The example of database record for a cruise.

2.5. OGS-NODC

The name of the data infrastructure or data portal: OGS-NODC

Institutions maintaining the data infrastructure or data portal: National Institute for Oceanography and Seismology - OGS

Ecological parameters stored by the data infrastructure or data portal: OGS as part of the IOC's network of National Oceanographic Data Centres has designated responsibility for the coordination of data and information management at national level. The oceanographic database covers the fields of marine physics, chemical, biological, underway geophysics and general information on Italian oceanographic cruises and data sets.

Web page of the data infrastructure or data portal: http://nodc.ogs.trieste.it

Accessibility of the data by the data infrastructure or data portal, data policy: Data use is permitted upon request by citing the source

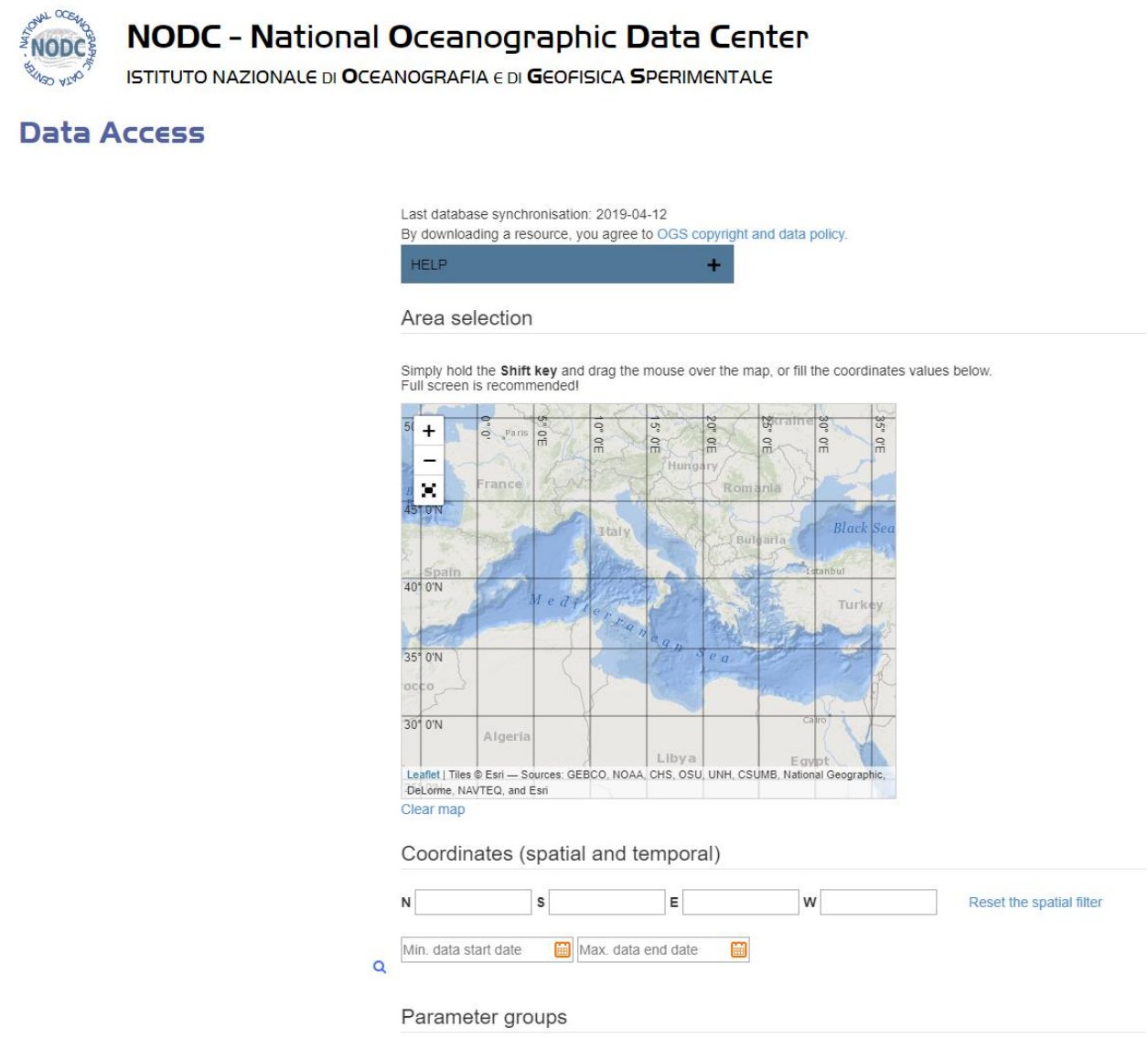
Description: OGS is recognized as the Italian National Oceanographic Data Centre (OGS-NODC) within the International Oceanographic Data Exchange System of the UNESCO Intergovernmental Oceanographic Commission (IOC) since 27/6/2002.

OGS as part of the IOC's network of National Oceanographic Data Centres has designated responsibility for the coordination of data and information management at national level. The oceanographic database covers the fields of marine physics, chemical, biological, underway geophysics and general information on Italian oceanographic cruises and data sets.

The main objectives are (revision IODE-XXII, March 2013):

- Facilitate and promote the discovery, exchange of, and access to, marine data and information including metadata, products and information in real-time, near real time and delayed mode, through the use of international standards, and in compliance with the IOC Oceanographic Data Exchange Policy for the ocean research and observation community and other stakeholders;

- Encourage the long term archival, preservation, documentation, management and services of all marine data, data products, and information;
- Develop or use existing best practices for the discovery, management, exchange of, and access to marine data and information, including international standards, quality control and appropriate information technology;
- Assist Member States to acquire the necessary capacity to manage marine research and observation data and information and become partners in the IODE network;
- Support international scientific and operational marine programmes, including the Framework for Ocean Observing for the benefit of a wide range



Screenshot of the OGS-NODC data access portal.

2.6. Copernicus Marine Service

The name of the data infrastructure or data portal: Copernicus Marine Service

Institutions maintaining the data infrastructure or data portal: Mercator Ocean

Ecological parameters stored by the data infrastructure or data portal: Parameters provided by Copernicus Marine Services are: Temperature, Salinity, Currents, Sea Ice, Sea Level, Wind, Ocean Optics, Ocean Chemistry, Ocean Biology, Ocean Chlorophyll.

Web page of the data infrastructure or data portal: http://marine.copernicus.eu/

Accessibility of the data by the data infrastructure or data portal, data policy: Products of Copernicus Marine Service are available to all registered users.

Description: Satellites and space technologies provide our societies with crucial services; they have a direct impact on your everyday lives, and the space industry is a source of economic growth and jobs.The EU relies on space technology for implementing its policies – protecting the marine and land environment and biodiversity, combating climate change, responding to disasters, managing transport … To achieve this mission, the EU needed its own independent access to space-based services.

COPERNICUS, previously known as GMES (Global Monitoring for Environment and Security), is the European Programme for the establishment of a European capacity for Earth Observation and Monitoring. COPERNICUS encompasses 3 components: SPACE, INSITU and SERVICES.

The Copernicus Space Component:

It includes 1. The ESA's "Sentinels", which are currently being developed for the specific needs of the Copernicus programme and 2. The Contributing Missions, which are operated by national, European or international organisations and already provide a wealth of data for Copernicus services.

The European Space Agency (ESA) is responsible for the space component of the Copernicus programme. The European Organisation for the Exploitation of Meteorological Satellites

(EUMETSAT) is fundamental to the operational remit of Copernicus on account of their unparalleled experience and proven capability as a provider of operational meteorological satellite data, products and services.

The Copernicus InSitu component:

Copernicus services rely on data from in situ monitoring networks (e.g. maps, ground based weather stations, ocean buoys and air quality monitoring networks) to provide robust integrated information and to calibrate and validate the data from satellites.

The in situ networks are managed by Members States and international bodies and make data available to the services by agreement.The European Environment Agency (EEA) is leading work for Copernicus under the FP7 "GISC" project to catalogue the in situ requirements of the Copernicus services, develop frameworks and pilot agreements to ensure access to all the relevant data in a timely and sustainable way.

The Copernicus Service component: Copernicus services address six main thematic areas:

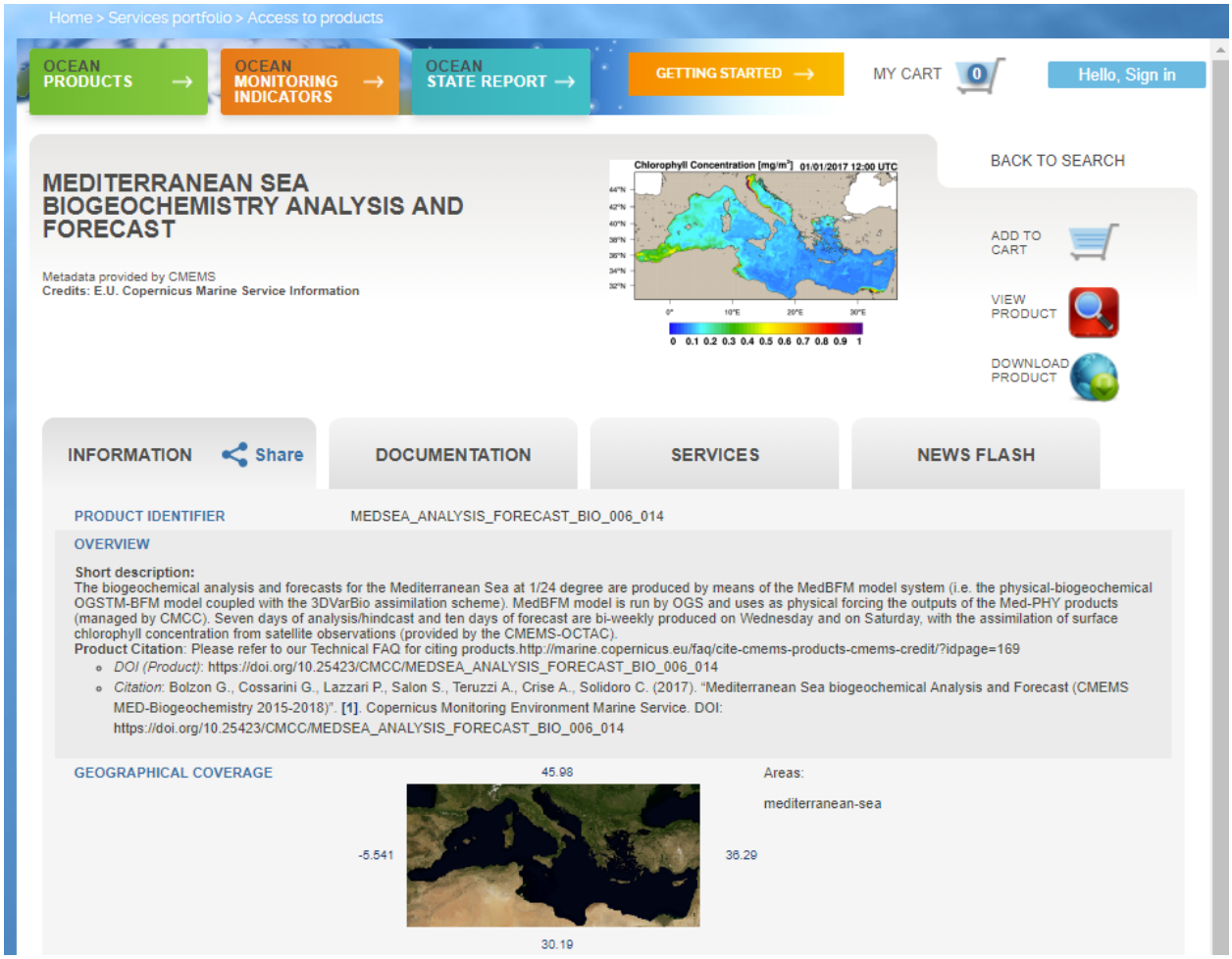
- Land Monitoring
- Emergency Management
- Marine Monitoring
- Atmosphere Monitoring
- Security
- Climate Change

These services have reached different degrees of maturity. Some are already operational (land monitoring and emergency management) while others are still in a pre-operational mode (atmosphere monitoring and marine monitoring), or in a development phase (climate change monitoring and services for security applications).

On November 11th, the European Commission and Mercator Ocean have signed an Agreement to implement and manage the Copernicus Marine Environment Monitoring Service. The latter is operational from early May 2015.

Today, the Copernicus Marine Service is provided on an operational mode by Mercator Ocean to more than 5000 subscribers worldwide.

Screenshot of the Copernicus Marine Service portal.



Copernicus Marine Service web page with the access to the biogeochemistry analysis and forecast product for the Mediterranean Sea.

2.7. Dynamic Ecological Information Management System - Site and dataset registry (DEIMS-SDR)

The name of the data infrastructure or data portal: Dynamic Ecological Information Management System - Site and dataset registry - DEIMS-SDR

Institutions maintaining the data infrastructure or data portal: CNR-IREA, LTER Europe, UBA, ILTER, KLIMETO

Ecological parameters stored by the data infrastructure or data portal: Physical parameters: density, water temperature, water salinity, water transparency, PAR; Chemical parameters: dissolved oxygen, pH, dissolved macronutrient concentration (N-NH4, N-NO3, N-NO2, P-PO4, Si-SiO4); Biological parameter: chlorophyll a, phytoplankton and zooplankton abundance and biomass

Web page of the data infrastructure or data portal: https://deims.org/

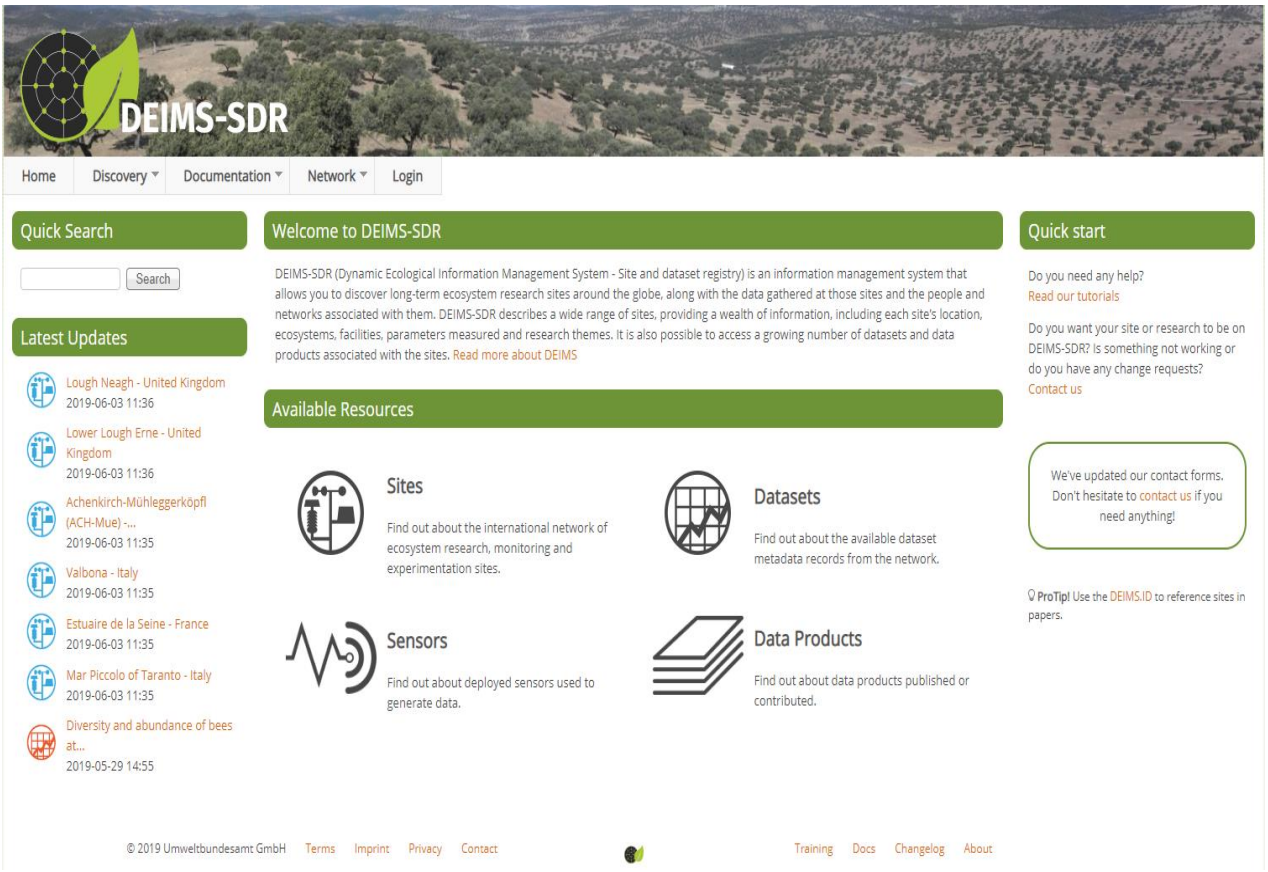
Accessibility of the data by the data infrastructure or data portal, data policy: Creative Commons (CC-BY) license

Description: DEIMS-SDR (Dynamic Ecological Information Management System - Site and dataset registry) is an information management system that allows you to discover long-term ecosystem research sites around the globe, along with the data gathered at those sites and the people and networks associated with them. DEIMS-SDR describes a wide range of sites, providing a wealth of information, including each site's location, ecosystems, facilities, parameters measured and research themes. It is also possible to access a growing number of datasets and data products associated with the sites.

All sites and dataset records can be referenced using unique identifiers that are generated by DEIMS-SDR. It is possible to search for sites via keyword, predefined filters or a map search.

By including accurate, up to date information in DEIMS, site managers benefit from greater visibility for their LTER site, LTSER platform and datasets, which can help attract funding to support site investments.

The aim of DEIMS-SDR is to be the globally most comprehensive catalogue of environmental research and monitoring facilities, featuring foremost but not exclusively information about all LTER sites on the globe and providing that information to science, politics and the public in general.



Screenshot of the DEIMS-SDR portal.

2.8. GET-IT LTER-ITALIA

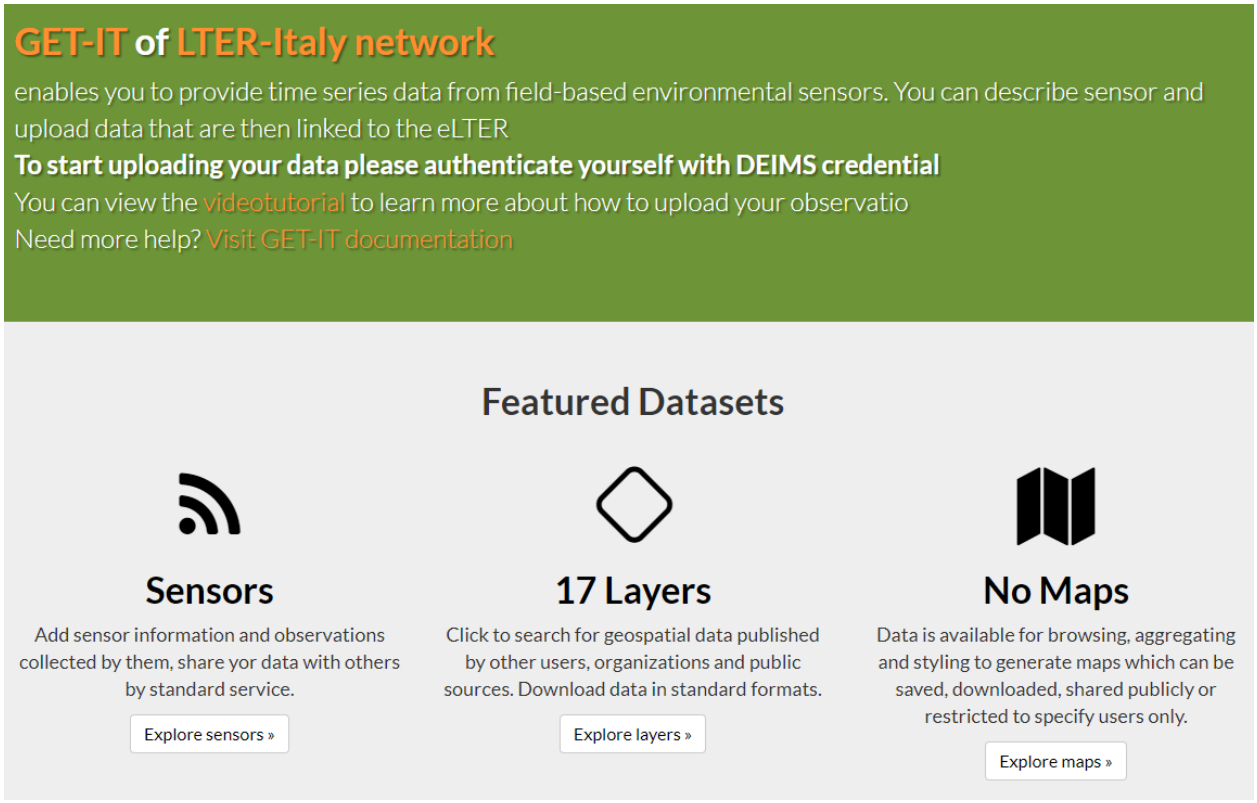
The name of the data infrastructure or data portal: GET-IT LTER-ITALIA

Institutions maintaining the data infrastructure or data portal: CNR-IREA, LTER-Italy

Ecological parameters stored by the data infrastructure or data portal: Physical parameters: air temperature

Web page of the data infrastructure or data portal: http://getit.lteritalia.it

Accessibility of the data by the data infrastructure or data portal, data policy: Creative Commons (CC-BY) license



Screenshot of the GET-IT LTER-ITALIA portal.

2.9. GET-IT ISMAR Venezia

The name of the data infrastructure or data portal: GET-IT ISMAR Venezia

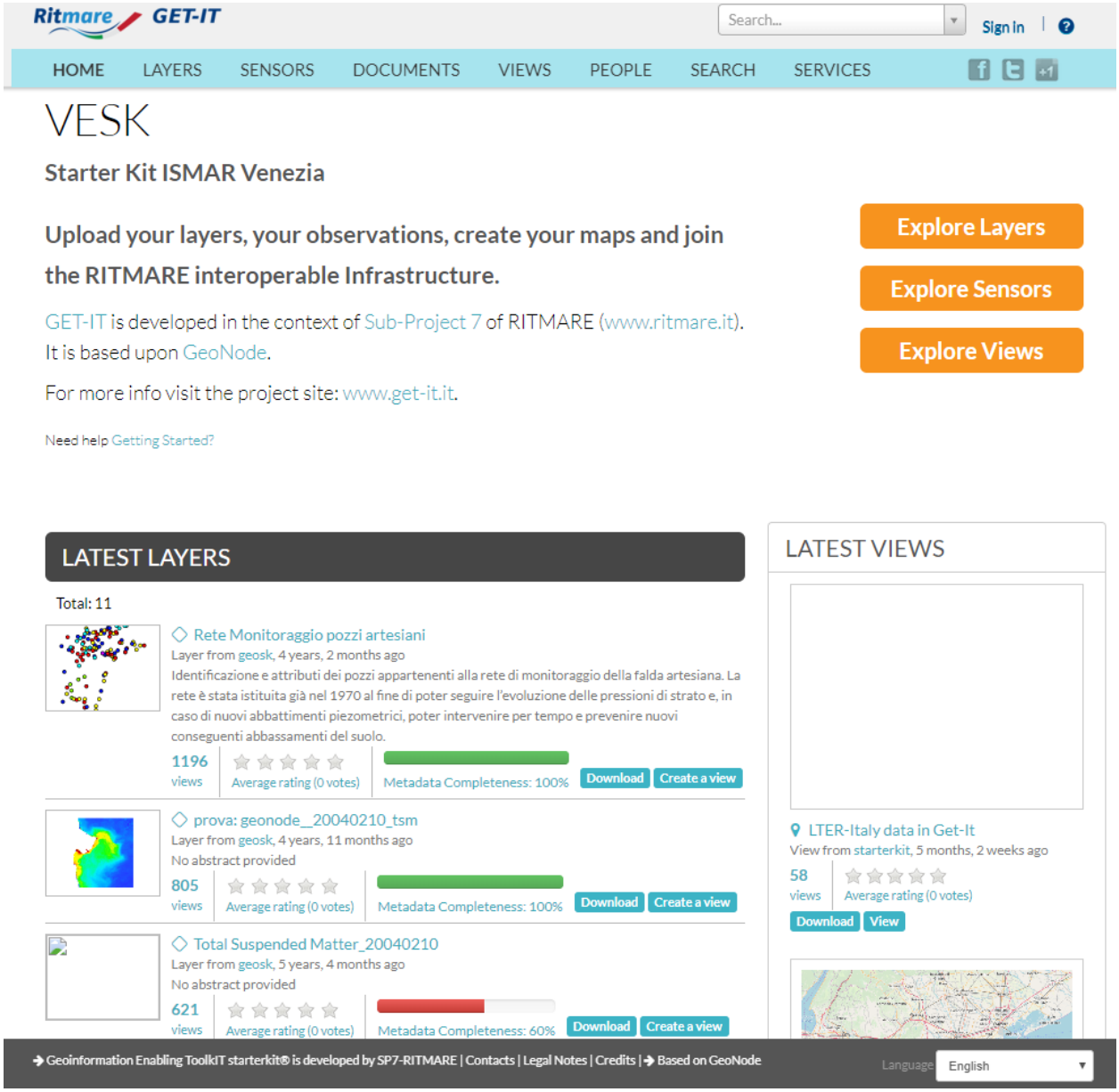
Institutions maintaining the data infrastructure or data portal: CNR-ISMAR

Ecological parameters stored by the data infrastructure or data portal: Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust, precipitation rate, thickness of precipitation amount, solar radiation; pressure, current speed, current direction, wave height, wave period, wave direction, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity; Chemical parameters: dissolved oxygen, pH, dissolved macronutrient concentration ($N\text{-}NH_4$, $N\text{-}NO_3$, $N\text{-}NO_2$, $P\text{-}PO_4$, Si-

SiO_4), partial pressure of carbon dioxide (pCO_2); Biological parameters: chlorophyll a, phyto- and zooplankton abundance and biomass.

Web page of the data infrastructure or data portal: http://vesk.ve.ismar.cnr.it

Accessibility of the data by the data infrastructure or data portal, data policy: Creative Commons (CC-BY) license.



Screenshot of the GET-IT ISMAR Venezia portal.

2.10. IFON - Italian Fixed-point Observatories Network

The name of the data infrastructure or data portal: IFON - Italian Fixed-point Observatories Network

Institutions maintaining the data infrastructure or data portal: CNR-ISMAR, CNR-IRBIM

Ecological parameters stored by the data infrastructure or data portal: Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust, precipitation rate; pressure, current speed, current direction, wave height, wave period, wave direction, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity, CDOM; Chemical parameters: dissolved oxygen, pH, dissolved organic carbon, coloured dissolved organic carbon, inorganic carbon, dissolved macronutrient concentration ($N\text{-}NH_4$, $N\text{-}NO_3$, $N\text{-}NO_2$, $P\text{-}PO_4$, $Si\text{-}SiO_4$); Biological parameters: chlorophyll a, phyto- and zooplankton abundance, and biomass, biodiversity, change in population size over time, community pattern, community structure, underwater video-monitoring of pelagic communities (e.g. fish, megazooplankton), benthic foraminifera abundance

Web page of the data infrastructure or data portal: http://rmm.dati.ismar.cnr.it (will be changed in http://ifon.cnr.it)

Accessibility of the data by the data infrastructure or data portal, data policy: Creative Commons (CC-BY) license.

Description: The Italian Fixed-Point Observatory Network (IFON) integrates well-established coastal and ocean infrastructures (buoys, platforms, moorings, mast platforms, etc.), most of them providing real-time multidisciplinary monitoring for a number of marine and atmospheric variables. Here, we describe the network characteristics and then discuss an example of its operation during the cold spell of winter 2012. One of the goals of the Italian Flagship Project Ricerca Italiana per il mare (RITMARE) is to create a common, validated IFON database able to fulfil both public and private demands, including validation of remotely sensed data and numerical models, environmental planning and management, and time-series analysis of climate and oceanographic data.

2.11. DEXT3R (Arpae-marefe network)

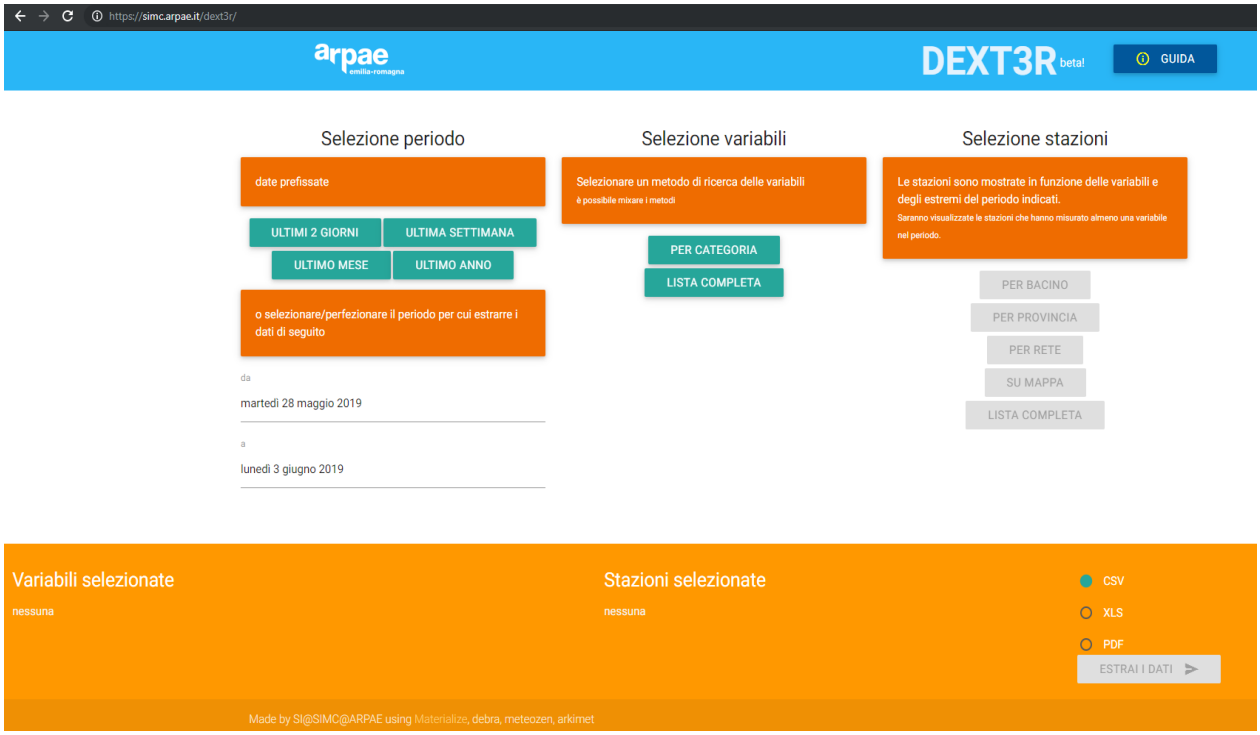
The name of the data infrastructure or data portal: 2.11. DEXT3R (Arpae-marefe network)

Institutions maintaining the data infrastructure or data portal: Arpae

Ecological parameters stored by the data infrastructure or data portal: physical parameters of pH, dissolved oxygen, temperature

Web page of the data infrastructure or data portal: https://simc.arpae.it/dext3r/

Accessibility of the data by the data infrastructure or data portal, data policy: Free access, see https://simc.arpae.it/dext3r/doc/GuidaDext3r.html (only in Italian)



Screenshot of the Arpae-marefe DEXT3R portal.

2.12. NEURAL (neural network based) forecasting suite

The name of the data infrastructure or data portal: NEURAL (neural network based) forecasting suite

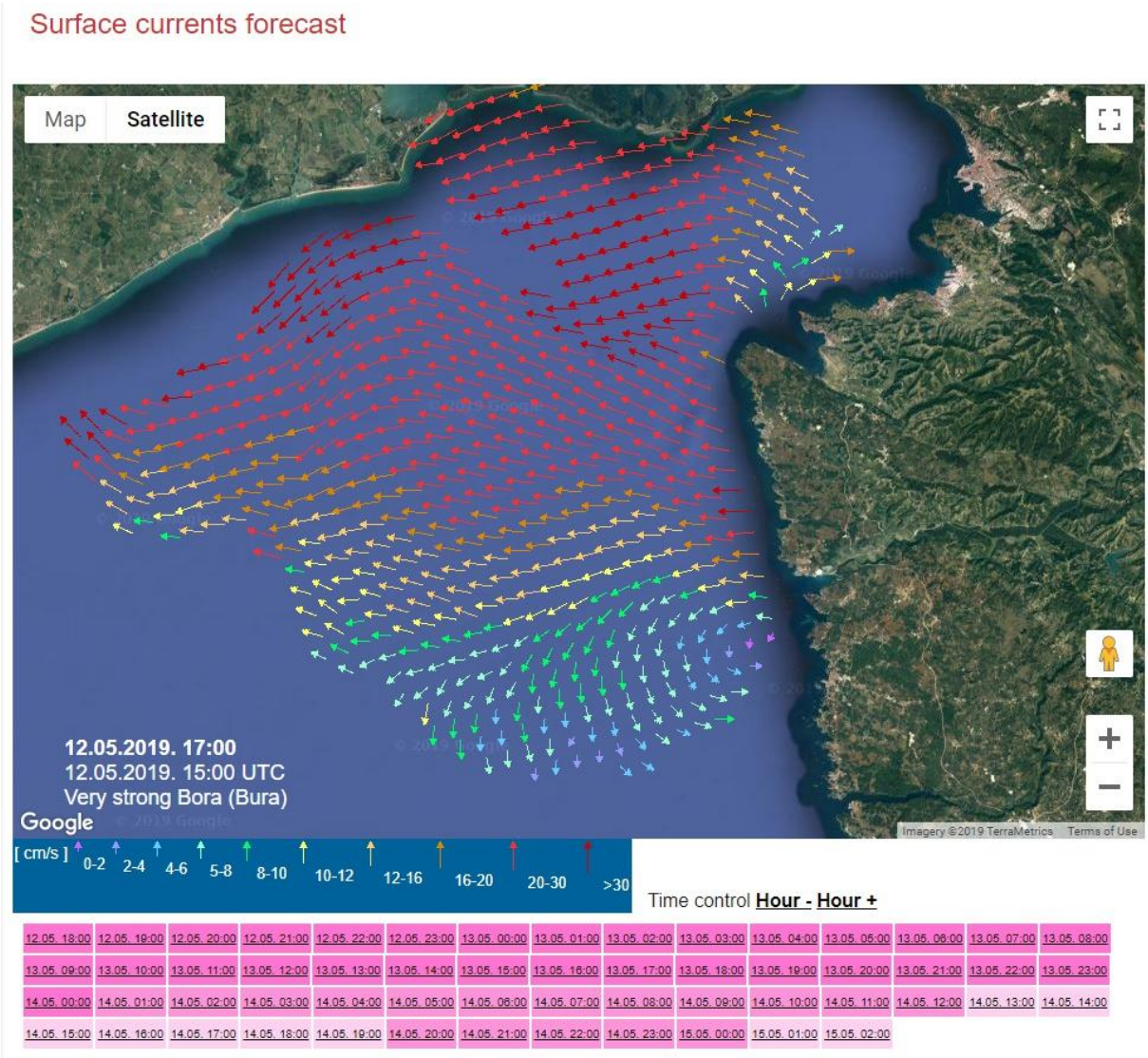
Institutions maintaining the data infrastructure or data portal: Institute of Oceanography and Fisheries

Ecological parameters stored by the data infrastructure or data portal: Currents

Web page of the data infrastructure or data portal: http://www.izor.hr/neural

Accessibility of the data by the data infrastructure or data portal, data policy: Available on demand

Description: An operational oceanography forecasting service still does not exist in Croatia, an unacceptable omission for a country which has been investing major resources into its infrastructure in support to its development as a leading tourist destination, built on its natural beauty, climate and geographical position. The aim of this project is to investigate and to develop a hybrid ocean forecasting system for the eastern coastal regions of the Adriatic Sea based on the neural network approach. The project will use surface current fields measured by high-frequency oceanographic radars and mesoscale surface winds simulated by the high-resolution numerical weather prediction (NWP) models. A state-of-the-art atmospheric hydrostatic model Aladin/HR, which is used for the operational NWP at the Croatian national weather service (Meteorological and Hydrological Service, DHMZ, http://meteo.hr), will be used in the project. In addition, a high-resolution version of the non-hydrostatic research WRF-ARW model nested into the ALADIN model and operating in real time in a research mode will provide a complementary input wind dataset for validation and intercomparison. The models' outputs and the HF radar data will be introduced to the neural network and self-organizing maps algorithms to learn about the wind effects on the ocean and to create characteristic circulation patterns in the Adriatic. Once created through the learning process, the ocean current patterns will be forecasted by using outputs from the meteorological models only. The skill of the forecast will be estimated, and the models will be tuned to reach the best score. The forecast process will be in real-time and automatized, with forecasts published online and thus made available to numerous potential users.



Operational forecast of surface currents in the northern Adriatic derived by the NEURAL operational system.

2.13. AdriSC (Adriatic Sea and Coasts) forecasting suite

The name of the data infrastructure or data portal: AdriSC (Adriatic Sea and Coasts) forecasting suite

Institutions maintaining the data infrastructure or data portal: Institute of Oceanography and Fisheries

Ecological parameters stored by the data infrastructure or data portal: Temperature, Salinity, Currents, Sea level

Web page of the data infrastructure or data portal: http://www.izor.hr/adrisc

Accessibility of the data by the data infrastructure or data portal, data policy: Available on demand

Description: The Adriatic Sea and Coast (AdriSC) Meteotsunami Forecast is a research product that was developed within the framework of two Croatian research projects: (1) project MESSI (http://www.izor.hr/messi), for reproduction and forecast of the Adriatic meteotsunamis, being a part of a pilot meteotsunami early warning system and (2) project ADIOS (http://www.izor.hr/ADIOS), with an ongoing effort to better understand the interactions between the Ionian and Adriatic Seas over interannual to decadal timescale and their potential effects on the ocean circulation along the Croatian coastline and islands.

Two different AdriSC modules have been developed: (1) a basic module using the COAWST model with WRF (3km highest resolution) for the atmosphere and ROMS (1km highest resolution) for the ocean (in blue in the figure) and (2) a dedicated meteotsunami module using WRF (1.5km resolution) for the atmosphere and ADCIRC (between 10m and 5km) for the ocean (in red in the figure).

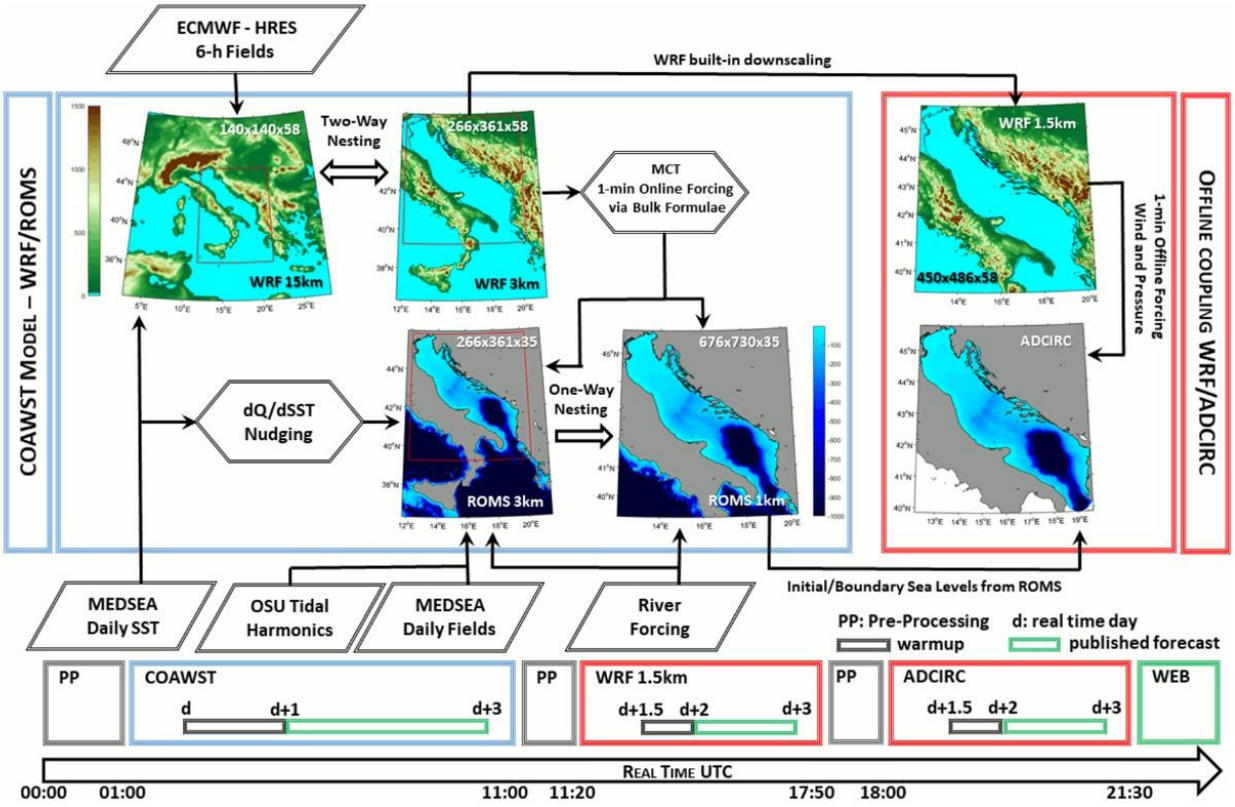
Every day since the 15th of April, the following forecast data are published:

- 48h forecast of hourly atmospheric fields from the WRF model: air temperature at 2m (°C), air temperature at 850 mbar (°C), mean sea level air pressure (hPa), wind at 10m (m/s), wind at 500mbar (m/s), cloud coverage (%) and rain (mm per hour). The WRF results presented in

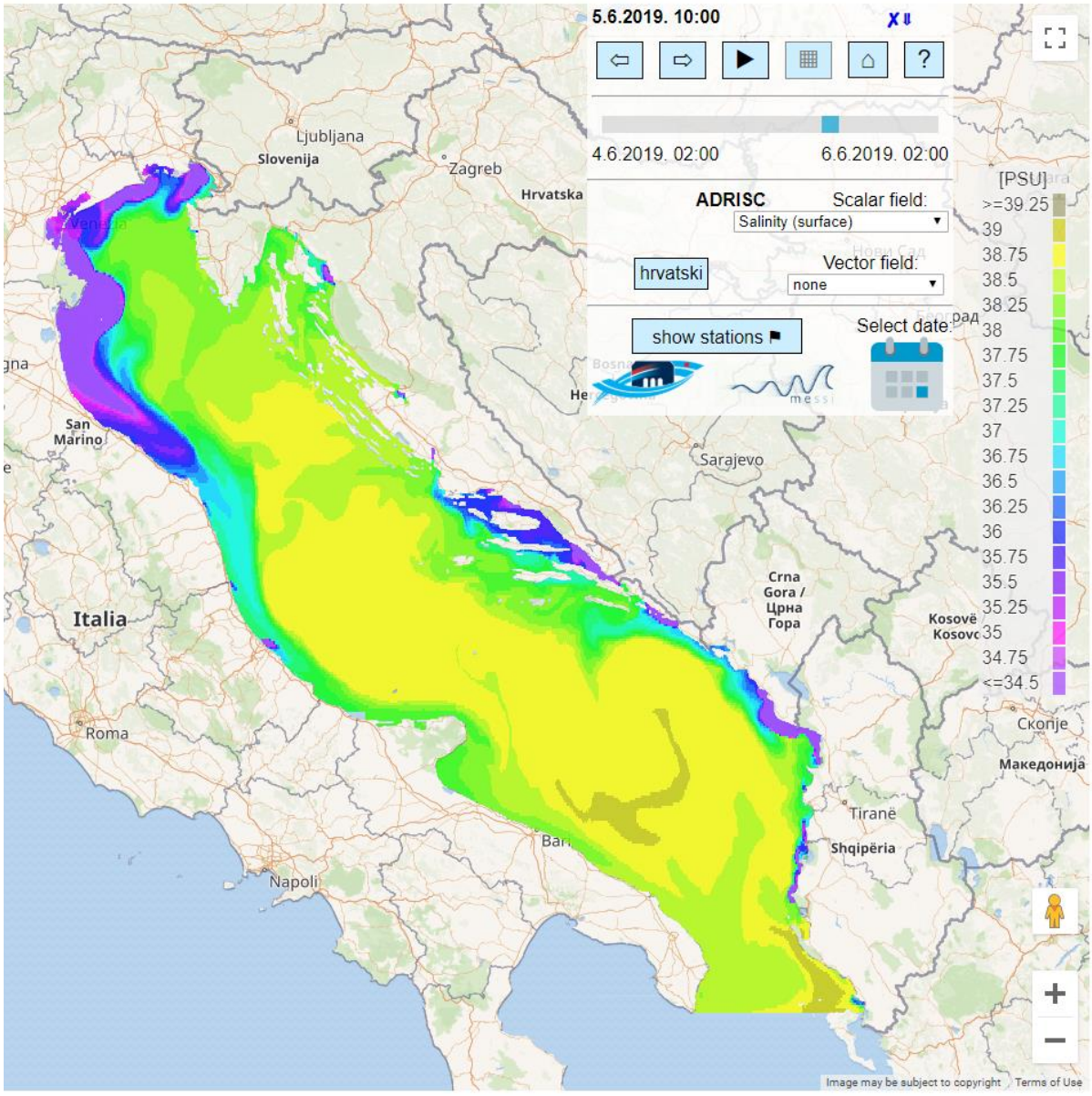
the website have a spatial resolution of 3km and thus cannot provide accurate fields at precise locations.

- 48h forecast of hourly ocean fields from the ROMS model: sea surface elevation (m, including tides), sea surface ocean currents (cm/s), barotropic ocean currents (cm/s, averaged value of the currents over the depth), sea surface ocean temperature (°C), salinity, significant wave height (m), wave period, wave length and wave direction. The ROMS results presented in the website have a spatial resolution of 1km and thus cannot resolve all the geographic features of the numerous Croatian Islands bays and harbors.

Three days after their date of publication on the website, the hourly results of WRF 3km and ROMS 1km are stored and displayed every 6h and the 15-min results of WRF 1.5km and ADCIRC are stored and displayed every hour.



Operational mode of the AdriSC Meteotsunami Forecast component. On the top, the flow chart represents the coupling between the different models (in blue COAWST, in red WRF/ADCIRC), their grids (plotted with topography/bathymetry data) and their forcing. On the bottom the timeline shows the different steps of the operational run starting every day d at 00:00 UTC (real time) and running from day d to day d+3. The forecast data is published on the web (in green) for days d+1 to d+3.



Screenshot of the AdriSC web page (www.izor.hr/adrisc).

2.14. Summary

From the collected information on available existing data infrastructures, portals and observing networks, the following information can be summarized:

- A great portion of the archived data in a data infrastructure is not accessible on the web
- The best accessibility of the data is provided for the established European or international platforms, with precisely-defined data sharing and usage policies (like Copernicus portal and different LTER portals)
- The most of the data infrastructure that are used for forecasting of ecological parameters are developed for forecasting of parameters of physical oceanography (temperature, salinity, currents, etc.)
- The most of the data stored and managed by existing data infrastructures, portals and observing systems is physical oceanography data (like water temperature, water salinity, water density, …), then some chemical and biological parameters which are not so complicated to measure (like dissolved oxygen, pH, nutrients, chlorophyll a, phytoplankton and zooplankton abundance and biomass), while very little on data is available for description of species, i.e. on biodiversity. That is not just the case in the Adriatic Sea, but is a global bottleneck that threats our knowledge on species, i.e. taxonomy
- A great portion of available data infrastructure has incorporated a kind of geo-spatial tools, which in some cases are unexploited in their usage in portals

3. SWOT ANALYSIS

Strengths

- There is a variety of observing networks, data and infrastructure in the Adriatic Sea, maintained by using state-of-the-art IT tools
- The organizations engaged in managing of observing networks, data and infrastructure is participating in a great number of local to international projects, programmes and initiatives, being at the forefront of the knowledge needed for proper monitoring and managing of environmental data and observational infrastructure
- The composition of the ECOSS partnership, from research-performing organizations through regional agencies, is enabling for exchange of ideas and practical procedures for proper maintenance of observing networks, data and infrastructure
- Both observations, numerical modelling tools, including forecasting of the ocean properties, are available for the Adriatic Sea

Weaknesses

- Long-term investment in maintenance of long-term ecological series, observing networks and data infrastructure is a low, and is dependable on short-term resources and projects rather than on a long-term
- Too many measured data in not available, publicly or for the research purposes only, which is a kind of obligation for data collection and monitoring programmes financed by taxpayers
- The collaboration between research groups and research institutes is not at the satisfactorily level
- The collaboration between research-performing organizations, agencies and regional/local authorities is not well established at some parts of the Interreg Italy-Croatia programme area
- The products coming from observing networks, data and infrastructure for the programme area is not well disseminated towards potential users and public

Opportunities

- Composition of the partnership might be used for building an added value in design and implementation of future observing networks, data and infrastructure or development of the existing ones
- Merging the efforts might enable for development of better observational infrastructure and products to the potential users and products
- Collaboration between researchers and staff coming from different research and management systems may allow for new ideas and better performance of both Croatian and Italian systems and allow for their competiveness on the European level
- An integrated platforms and programmes of observing networks, data and infrastructure may allow for boosting the importance of necessity of monitoring of ocean, which at end will results in better operational and forecasting systems following demands of the society
- Transfer of knowledge and information between partners from Croatia and Italy will allow for definition and creation of better environmental protection policies and strategies

Threats

- Underfinancing of long-term activities necessary for proper observation and managements of the Adriatic Sea might lead to a deterioration of the level of protection of marine environment and habitats in the Adriatic Sea, ending with failing in preserving Good Environmental Status of the European seas and thus not fulfilling the European policies (e.g. Marine Strategy Framework Directive)
- Political situation at higher level might have a repercussion to the collaboration and maintenance of the research and other connection established for protection of the Adriatic Sea, and therefore impact a great number of activities related to the common sea
- Brain gain and leakage of competences towards the Western and Northern Europe, in particular present in Croatia, may reflect in a decrease of competences and level of maintenance of long-term ecological series, observing networks and data infrastructure in the future

4. REQUIREMENTS

From the analysis of the existing observational networks, data and infrastructure in the Adriatic Sea, and by acknowledging the state-of-the-art and practices in the European and world level, the following requirements might be seen for the future development of the observational ecological networks, data and infrastructure:

- *What type of information do you need to access in order to support the objective of the project?*:
  - Geospatial maps (coastal geomorphology, bathymetry, digital elevation model, coastal land use/land cover, marine and coastal habitat maps, protected areas, nursery areas for species with commercial importance)
  - Socio-economic data (e.g. tourist arrivals per coastal municipalities, coastal population, road infrastructures in coastal areas)
  - Time series data (storm surge, wave regime, dissolved oxygen, nutrient concentrations, nutrient loads from rivers, meteorological data - wind direction and intensity, currents, rainfall regime, air temperature)
  - Maps of spatial distribution of species, time series data of species diversity and composition.
- *Which environmental parameter are of primary importance for you to describe and manage the Natura 2000 sites?*:
  - Geospatial maps (coastal geomorphology, bathymetry, digital elevation model, coastal land use/land cover, marine and coastal habitat maps, protected areas, nursery areas for species with commercial importance)
  - Socio-economic data (e.g. tourist arrivals per coastal municipalities, coastal population, road infrastructures in coastal areas)

  - Time series data (storm surge, wave regime, dissolved oxygen, nutrient concentrations, nutrient loads from rivers)
  - Species diversity and composition at the Natura 2000 sites

- *What functionalities would be needed more in an infrastructure to access and use that information?*:
  - Visualization and download (including re-analysis)
  - Download of geospatial data (sea temperature, depth, chlorophyl) for analysis in relation to biological data

- *Who would be the main users of this infrastructure?*:
  - Researchers working in ecological/oceanographic fields, decision makers and researchers working on marine spatial planning
  - Scientists and Natura 2000 sites managing authorities
  - Fisherman/sea shell agriculture cooperative and communities

Going through available information on availability of the ecological data for the research, it comes out that a large amount of data is not available and is not accessible. Although the data is not collected exclusively through research projects which demand reproducibility of any research and results, the availability of the data is a demand for increasing quality of the research. Furthermore, open data and open science policy is one of key policies on the European level, as it is widely recognized that making research results more accessible contributes to better and more efficient science, and to innovation in the public and private sectors. That is the reason while open science is addressed in all data collection and research activities for projects financed by European taxpayers, like Horizon 2020 programme (https://ec.europa.eu/research/openscience/index.cfm). At end, better science ends with healthy, productive and sustainable oceans and seas in the Adriatic, Mediterranean and wider, recognized in a number of European and Mediterranean programmes and initiatrives, like JPI-

Oceans (http://www.jpi-oceans.eu/) and BLUEMED Initiative (http://www.bluemed-initiative.eu/).

Therefore, the strong and most relevant requirement that emerge for our analysis is the requirement for data accessibility and availability, in particular for research. I.e. the data sharing and usage policy should be defined and agreed on the Adriatic level.

Another important issue is a variety of non-harmonized information systems and platforms (using different IT tools and concepts) that are collecting ecological data, which normally lower the data usage by users. It is not reasonable that these data infrastructures may be unified on the basin level. However, the development of an Adriatic data portal – one-stop shop for the data – may help users to access the data through a distributed ecological data Infrastructure, for the management of large and diverse sets of data deriving from in situ of the seas and oceans. That will follow global and European approach, as developed through SeaDataNet network (https://www.seadatanet.org/) or Mediterranean Operational Network for the Global Ocean Observing System (MONGOOS) (http://www.mongoos.eu/) or other, for a parts of the observational networks.

5. CONCLUSIONS

The presented review of existing observing networks, data and infrastructure in the Adriatic Sea, enlightens their variability coming from different background and involvement of ECOSS partner organizations in the international projects, programmes and activities. Yet, the diversity between observing and operational networks, physical and ecological instrumentation, real-time and delayed observations, longevity of observations, common-used IT tools vs. the new developments, etc., might be used for providing added value to the management and maintenance of the Adriatic networks and marine-related infrastructure, potentially ending with the increased level of managements of the Adriatic living resources and biodiversity. Hopefully, this deliverable and the ECOSS project will result in such an improvement, and more healthy and productive Adriatic Sea.