



D5.7 Report on the state of the art of integrated data products for Good Environmental Status, Good Ecological Status, and Ecosystem Integrity assessment; and modelled products provision



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Author(s) (Partner-OU):	Francesca De Pascalis, Debora Bellafiore, Alessandra Puggnetti, Emilio Urbinati (CNR-ISMAR Venezia), Caterina Bergami, Simone Toller (CNR-ISMAR Bologna/Milano)
Reviewed by:	ITINERIS WP 5 Leader
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1. INTRODUCTION

This deliverable presents the content of the first year of activities 5.17 and 5.19. It provides the context, assumptions and state of the art of the ongoing work related to the delivery of integrated data products and, specifically, integrated model products developed by the ITINERIS RIs. In this deliverable, we consider three main aspects of integration: the merging and fusion of different sources of data for a given parameter, a collection and analyses of different variables to produce a derived information, or, particularly within ITINERIS, an effort to put in synergy the different RIs to complement a given information. Each of these requires focused actions to be achieved.

Activity 5.17 tries to tackle the need for a wider use of modelling products, specifically designed for the investigation of transitional and coastal environments including the integration of available data from in-situ and remote sensing. The focus is on the physical component, to build on the quite extensive previous effort developed by the ITINERIS partners in investigation of extreme events, coastal dynamics, effects of changes on the systems. The full activity aims at providing, at the end of the project, prototypes of integrated model products for the pilot area of the Northern Adriatic Sea, empowered by the inclusion of data from new ITINERIS equipment, exploiting as much as possible the contribution of the different RIs (e.g. DANUBIUS, JERICO, ICOS, eLTER). The integration of data from different tools/sources (modelled, in-situ and remote sensing data), particularly concerning the physical processes, is the core action of activity 5.17.

Activity 5.19 specifically focusses on the identification and delivery of integrated data products to provide information on selected processes, which may affect ecosystem structure and functioning (e.g. trophic state changes, biodiversity alteration). The selected approach aims to integrate different conceptual schemes of variables such as the Ecosystem Integrity (EI; Müller et al., 2000; Müller, 2005) and the Essential Variables (EVs) frameworks, also to support and inform the main EU policies and strategies that deal with coastal and marine management (i.e. Marine Strategy Framework Directive – MSFD; EC 2008; Water Framework Directive – WFD; EC 2000). In particular, data products based on merged selected oceanographic and biological/ecological parameters will provide a contribution useful for the assessment of the Good Environmental Status (GENS; MSFD), Good Ecological Status (GEcS, WFD) and EI, in selected areas, where different RIs insist.

In this deliverable, we provide a definition of the three frameworks (MSFD, WFD, EI), an analysis on the main correspondences among the three and, finally, an assessment on how the available EVs from the various RIs can be linked to the main requirements of the three frameworks.

After the overview on the state of art and the contextualization of integrated data products and integrated model products, some pathways that will be explored in the proceeding of the project will be drawn, to reach tangible exemplars of integration done by RIs to reduce gaps. A definition of integrated data products is provided in the following section.

1.1 Definition of integrated data products and modelled products

To ensure a common understanding with stakeholders, policy makers and the academic community, it is vital that all parties can agree on what constitutes a data product.

The definitions of data and data product can be multiple and dependent on their final scope and users. In the context of this deliverable, the following general definitions provided by Peng et al. 2018 are listed:

“**Data** can refer to anything that is collected, observed, or derived and used as a basis for reasoning, discussion, or calculation. Data can be either structured or unstructured, and can be represented in quantitative, qualitative, or physical forms. Scientific or research data is defined as: “the recorded

factual material commonly accepted in the scientific community as necessary to validate research findings” (OMB 1999).”

“**Dataset** is an identifiable collection of physical records, a digital rendition of factual materials, or a product of a given version of an algorithm/model. A dataset may contain one or many physical samples or data files in an identical format, having the same geophysical variable(s) and product specification(s), such as the geospatial location or spatial grid.”

“**Data product** refers to “a product that facilitates an end goal through the use of data,” usually with a well-thought-out algorithm or approach. Data products tend to be structured and can be raw measurements or scientific products derived from raw measurements or other products. Products can also be statistical or numerical model outputs, including analyses, re-analyses, predictions, or projections. Earth Science data products may be further categorized based on their processing levels” (e.g. EMODnet or COPERNICUS EO). **Geospatial data products** organize and provide physical, spatial, and temporal relevance to raw digital measurements or physical samples.

In the EU context, the EU Horizon 2020 funded ENVRI Plus project sought to develop a common, cross-Research Infrastructure approach within the environmental science domain. Central to this is a standard Reference Model, where a data product is defined as “an instance of persistent [meta]data which has been processed to be offered to external users.” (Nieva et al., 2017).

As a single definition this is adequate, however the range of potential data and data products required within the marine community requires a tiered approach to describing a data product. As cited before, EMODnet has developed a series of categories defining data and data products based on the amount of processing and/or analysis that has taken place to come to a particular level. These categorizations align with the suggestions for EBV data products as outlined in Kissling et al., 2018. In the case of EMODnet, each data category (from 0 to 4) implies an increased amount of processing and quality control with regards to the previous level(s), ranging from raw data to harmonized collections of thematic quality controlled (QC'd) data. Additionally, two categories of data products (from 5 to 6) are also defined according to the complexity of the processing needed. Data products of Level 5 (a,b and c) display the distribution of a single parameter (e.g. species occurrence or abundance, chlorophyll), built upon QC'd data from levels described previously. Data products of Level 6 are the result of multi-variate analysis that may include both data and data products as inputs (e.g. predicted seabed habitats) (Lear et al., 2020).

Also, in the framework of eLTER-RI there is an ongoing effort to define data products and the workflows necessary to build them. In general, data products are created through synthesis of different datasets and/or modelling of single observations. This will include spatial interpolation of different site data to form contiguous spatial coverages.

More in detail, as part of the eLTER-RI activities, prototypical data products (Science Cases) have been implemented and organized along four research challenges covering (a) Biodiversity loss (BDL), (b) Biogeochemical processes (BGC), (c) Climate-Water-Food Nexus (CWF), and (d) Socio-Ecological Systems (SES).

In the context of the ITINERIS Project there was the need to identify a specific typology of data products, called “integrated data products” (IDP) because based on harmonized and validated datasets of parameters, coming from the various RIs, to provide information on selected processes, which may affect ecosystem structure and functioning (e.g. trophic state changes, biodiversity alteration).

1.2 The Water Framework, Marine Strategy and Ecosystem Integrity frameworks

The Water Framework Directive (WFD; EC 2000) and the Marine Strategy Framework Directive (MSFD; EC 2008) are the two main legal frameworks, established by the EU policy, for the

protection and management of our freshwater and marine resources with an ecosystem-based, holistic approach. The Ecosystem Integrity (EI) framework (Müller et al., 2000; Müller, 2005) has been adopted by the European node of eLTER and it has now been recommended for the entire (International) ILTER network as the conceptual framework for indicator selection, data integration and upscaling for individual sites (Haase et al., 2018).

1.2.1 WFD and GEcS

The WFD was conceived mainly as an instrument for addressing the ecological quality of water, considered as a common and fundamental good, threatened by the increasing pressure for the growing human-derived demand and impacts and it establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. Its jurisdictional action extends up to 1 nautical mile from the coastline; member States are requested to draw up river basin management plans, based on natural geographical river basins, as well as specific programs of measures to achieve the objectives. Central to the WFD is the achievement of the Good Ecological Status (GEcS) defined as “the values of the biological quality elements for the surface water body type which show low levels of distortion resulting from human activity but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions”. By addressing the ecological status of the whole aquatic environment and thus considering the structure and functioning of aquatic ecosystems, the WFD adopts a pioneering approach, going beyond the protection of single species and habitats. Moreover, the ecological concept behind WFD (and, later, MSFD) consists in comparing the current state of an area with that which would be expected under minimal or sustainable human use and, in case of degradation, intervening to bring it back to the desired good status. (Manea et al., 2021) In the WFD the Quality Status (QS) of a water body can be determined based on the evaluation of Biological Quality Elements (BQE), for example phytoplankton, macroalgae, macro-invertebrates and fish (only in transitional waters), which are supported by chemical, physico-chemical quality elements (e.g., transparency, thermal and oxygen conditions, salinity and nutrients). The evaluation of these latter aims at supporting the achievement of the second target of the directive, which is the Good Chemical Status (GCS). The GEcS and the GCS are used as environmental indicators of system performance, since they show the distance between the current state and the desired one of the defined quality elements that are subjected to monitoring. For each quality element (biological, hydro-morphological, and physico-chemical) the value of high, good, moderate, poor, bad quality is assessed, following normative definition, to quantify the ecological status. The approach adopted by WFD can be defined as a “deconstructing structural approach” (Borja et al 2010), since (i) it separates the ecosystems into several quality elements and districts, then (ii) it compares their structure individually and, finally, (iii) it combines them to assess the overall conditions. List of quality elements for WFD is the following,

QE1 - Biological quality elements

- QE1-1 – Phytoplankton
- QE1-2 - Other aquatic flora
 - QE1-2-1 – Macroalgae
 - QE1-2-2 – Angiosperms
 - QE1-2-3 – Macrophytes
 - QE1-2-4 – Phytobenthos
- QE1-3 - Benthic invertebrates
- QE1-4 - Fish

QE2 - Hydromorphological quality elements

- QE2-1 - Hydrological or tidal regime
- QE2-2 - River continuity conditions
- QE2-3 - Morphological conditions;

QE3 - Chemical and physico-chemical quality elements

- QE3-1 - General parameters
 - QE3-1-1 - Transparency conditions
 - QE3-1-2 - Thermal conditions
 - QE3-1-3 - Oxygenation conditions
 - QE3-1-4 - Salinity conditions
 - QE3-1-5 - Acidification status
 - QE3-1-6 - Nutrient conditions
 - QE3-1-6-1 - Nitrogen conditions
 - QE3-1-6-2 - Phosphorus conditions
 - QE3-3 - River Basin Specific Pollutants.

1.2.2 MSFD and GEnS

The MSFD (EC 2008) represents the most updated and comprehensive policy instrument that addresses the protection and conservation of the marine environment in its entirety. MSFD establishes European marine regions (the Baltic Sea, the North-east Atlantic Ocean, the Mediterranean Sea and the Black Sea) and sub-regions within the geographical boundaries of the existing Regional Sea Conventions. The objective of the MSFD is to reach ‘Good Environmental Status’ (GEnS) of the EU’s marine waters. GEnS is defined as “the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations”. GEnS might be considered as an overall performance indicator, which can be valued as good or not good based on several biotic and abiotic parameters that must be included in the monitoring programs (Manea et al., 2021). It shall be determined at the level of the marine region or subregion based on eleven qualitative descriptors:

- Descriptor 1. Biodiversity is maintained;
- Descriptor 2. Non-indigenous species do not adversely alter the ecosystem;
- Descriptor 3. The population of commercial fish species is healthy;
- Descriptor 4. Elements of food webs ensure long-term abundance and reproduction;
- Descriptor 5. Eutrophication is minimized;
- Descriptor 6. The sea floor integrity ensures functioning of the ecosystem;
- Descriptor 7. Permanent alteration of hydrographical conditions does not adversely affect the ecosystem;
- Descriptor 8. Concentrations of contaminants give no effects;
- Descriptor 9. Contaminants in seafood are below safe levels;
- Descriptor 10. Marine litter does not cause harm;
- Descriptor 11. Introduction of energy (including underwater noise) does not adversely affect the ecosystem.

The EC, in 2017 (EC, 2017), indicated criteria, instead of descriptive indicators, related to each descriptor, which should be monitored for the achievement of the set environmental performance.

The approach adopted by the MSFD has been defined as “holistic and functional” (Borja et al 2010), since marine regions are not defined based on geopolitical boundaries, and because it considers functional objectives related to the ecosystems, concentrating on the 11 descriptors that together ensure the whole ecosystem integrity and entail ecological connectivity aspects. The MSFD delivers monitoring in even a more structured way than WFD, it considers and integrates the existence of other monitoring and management programs and foresees, when possible, synergies among them.

1.2.3 Comparison between MSFD and WFD

Each directive was conceived for addressing different conservation and monitoring targets, despite being forged for the common achievement of a better quality of the environment and of its natural components. The two directives can be considered as complementary to each other, since all together provide an overall normative context for conservation priority objectives at different spatial and ecological levels. Explicitly or implicitly, the ecosystem-based approach is commonly adopted, and the human dimension is always present, since all aim at contributing to the sustainability objectives, highlighting the tight interconnections between nature and humans. Complementarity is also present when considering the spatial scale of application of the directives. The WFD and the MSFD apply within different jurisdictional boundaries, the WFD being focused on internal and coastal waters and the MSFD extending from the coast to offshore areas. If appropriately coordinated, these two instruments can cover the entire water territories. Natural goods and services are mentioned, more or less explicitly, in all these jurisdictional instruments, and the need to preserve and manage them is recognized as critical. While the WFD mentions the human activities only generically, the MSFD makes an ad hoc analysis of the human-derived pressures and impacts that can negatively affect the marine environment, highlighting the need of addressing all of them through ecosystem-based management measures.

1.2.4 Ecosystem Integrity

The conceptual EI framework (Müller et al., 2000; Müller, 2005) focuses on the ability to sustainable self-organization of ecosystem. According to the framework, the main components to describe the pressures on, and state of, ecosystems are their structures and processes. Ecosystem structures are well characterized by biotic diversity (of flora and fauna) and abiotic heterogeneity (of soils, sediments, water, air) forming habitats. Ecosystem processes (cycling of energy, matter and water) are characterized by indicators of inputs, storages and outputs. The indicators of EI are represented by parameters accessible by conventional methods of ecosystem quantification ending up in a set of parameters recommended to be calculated or measured in many local instances. This set is based on the focal parameters of ecosystem research which can be provided by LTER networks. This approach facilitates one of the major challenges for LTER trans-domain indication, aiming at comparability of measurements for terrestrial, freshwater and marine sites, trying to find suitable indicator-parameter sets from all sites. By combining biotic and abiotic aspects of ecosystems with ecosystem structures and processes, the framework differs from the traditional approach of investigating individual components of ecosystems separately. Essentially, EI represents the self-organizing capacity of ecosystems (e.g. during succession or after disturbance) and reflects the idea of sustainability from an ecological perspective (Müller et al., 2000).

Ecological integrity has been defined as a political target for the preservation against non-specific ecological risks; it can therefore be considered as a wider framework, able to also include the different descriptors and quality elements of the two directives, WFD and MSFD.

2. Available parameters to deliver data products and contribution to EI, GEnS and GECS

2.1 Available parameters to deliver data products

In the framework of the WP5 of the ITINERIS project, two deliverables (D5.3 and D5.5) were already produced to provide a preliminary analysis on the available parameters collected from the

facilities belonging to the different RIs, considered within the WP5. D5.3 aims to provide the landscape of available facilities, equipment, analysis of the related measured Essential Ocean and Climate Variables (EOV and ECV) for eight RIs considered in WP5 (DANUBIUS-RI, eLTER-RI, EMSO-ERIC, ICOS-ERIC, JERICO-RI, Euro-Argo ERIC, LNS, GeoSciences), allowing to identify bottlenecks and gaps; D5.5 is focused on the available observations of biogeochemical and biological EOVs (bio-eco EOV) and Essential Biodiversity Variables (EBV) for four selected RIs (eLTER-RI, JERICO-RI, EMSO-ERIC and Euro-Argo-ERIC).

From D5.3 it emerged that the majority of EOV/ECV are measured by many RIs, with few exceptions, in those connected with the atmospheric composition (e.g., ozone, aerosol) covered by other RIs not involved in WP5. It is clear how certain EOVs/ECVs are considered relevant for a wide range of studies, intercepting activities of many RIs. This particularly applies to all the ECV – Ocean, Physical (Temperature, Salinity and Currents), to the EOV – Biology and Ecosystem: Phytoplankton Biomass and diversity, ECV – Ocean Biogeochemical: Oxygen and to the full category ECV – Atmosphere, surface (see Figure 1 for details).



Figure 1 - Number of RIs contributing to the measurement of specific EOVs/ECVs (from D5.3)

Looking at the results from D5.5, only two variables, namely the “EOV - Biology and Ecosystems: Phytoplankton Biomass and Diversity” and the “EBV - Ecosystem function: Marine primary productivity”, are measured by all the four RIs considered in the deliverable. It must be noted that the two variables are related, as some measures of primary productivity may rely on phytoplankton biomass estimates. Only three EVs are measured by three RIs (EOV - Zooplankton biomass and

diversity, EBV - functional diversity of phytoplankton and EBV - phenology of marine spring phytoplankton blooms), while the “EOV - Biology and Ecosystems: Fish abundance and Distribution” is the only variable measured by two RIs.



Figure 2 – Total number of RIs measuring specific bio-eco EOVs and EBVs (from D5.5)

2.2 Contribution to EI, GEnS and GEcS

Based on the previous deliverables (D5.3 and D5.5; Figures 1 and 2), which reported the EVs provided by the different RIs, we selected those which are most measured by all the RIs. In table 1, we evidence the contribution and the connections between each EVs, the EI components, the MSFD descriptors and criteria, and the WFD quality elements. This table represents the foundation for the implementation and delivery of the integrated data products, according to the scheme in Fig. 3.

RI ECVs	RI EOVs	RI EBVs	Source	EI component	MSFD DC	WFD BQE
ECV - Ocean, Physical: Sea Surface Salinity			Sensor based	Ecosystem structure/abiotic heterogeneity/water	D1C6	QE3-1-4 Salinity Conditions
ECV - Ocean, Physical: Sea Surface Temperature			Sensor based	Ecosystem structure/abiotic heterogeneity/water	D1C6, D5C4, D7C1	QE3-1-2 Thermal Conditions; Temperature
ECV - Ocean, Biogeochemical: Oxygen			Sensor based	Ecosystem structure/abiotic heterogeneity/water; Ecosystem processes/matter budget	D5C5, D6C3, D6C5, D7C2	QE3-1-3 Oxygenation Conditions
	EOV - Biology and Ecosystems: Phytoplankton	EBV - Community composition: Functional diversity of	Sample based	Ecosystem structure/Biotic diversity/flora diversity	D1C1, D1C4, D2C2, D4C4,	QE1-1 Phytoplankton

	Biomass and Diversity	marine phytoplankton (based on traits)			D5C2, D5C3	
	EOV - Biology and Ecosystems: Zooplankton Biomass and Diversity	EBV - Community composition: Functional diversity of marine zooplankton (based on traits)	Sample based	Ecosystem structure/Biotic diversity/fauna diversity	D1C1, D1C3, D1C4, D2C1, D2C2	-
	EOV - Biology and Ecosystems: Phytoplankton Biomass and Diversity	EBV - Ecosystem function: Phenology of marine spring phytoplankton bloom	Sample based	Ecosystem structure/Biotic diversity/flora diversity	D1C1, D1C4, D2C2, D4C4, D5C2, D5C3	QE1-1 Phytoplankton
		EBV - Ecosystem function: Marine primary productivity	Sensor and sample based	Ecosystem processes/energy and matter budget	D5C2, D5C5	QE3-1-3 Oxygenation Conditions

Table 1. Connections between each EV (ECV, EOV and EBV), the EI components, the MSFD descriptors and criteria (DC), and the WFD quality elements (BQE)

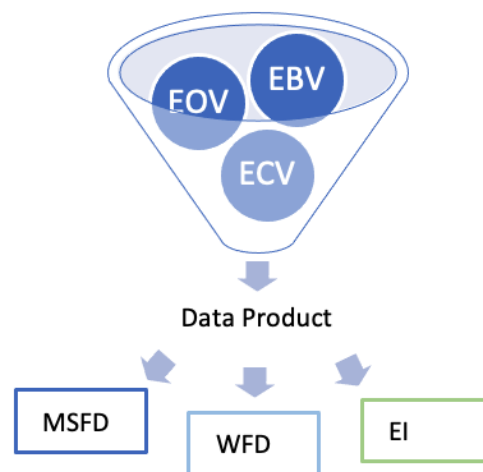


Fig. 3 Scheme for the implementation of the integrated data products contributing to the MSFD, WFD and EI and based on EVs from the different RIs

3. Review of the Italian offer in terms of modelled products on coastal and transitional environments

In addition to the integrated data products for GENs, GEcS and EI, to fulfill the activities planned in Activity 5.17 increasing the offer of modelled products in the coastal environments and transitional zones, here we present an overview of the state of the art of the modeling offer for the physical component. The focus is on the North Adriatic that is chosen as test to demonstrate how the

ITINERIS will enhance the observative capability, from a modelling perspective, along the Italian coasts.

Concerning the state of art of modelling offer, it must be mentioned that specific model code characteristics are needed to properly reproduce the dynamics at the coastal and transitional environment scale. The highly complex morphology of these environments leads to the use of those modelling tools able to adapt their resolution such as the unstructured grid models. One of the most used codes applied in the North Adriatic and in several transitional environments worldwide is SHYFEM.

On the other hand, at the subbasin scale, the North Adriatic as a whole, is modelled with a wider range of tools, both using finite differences, finite volumes and finite elements. Some of the relevant models to mention are MITGCM, NEMO, ROMS, etc. A quite complete overview of modelling in the Adriatic Sea is presented in Umgiesser et al. (2022).

These models have a 3D hydrodynamic core and, in some cases, coupled to modules, such as those for waves, sediment transport or lagrangian dispersion, as well as the biogeochemical modules.

The modelling effort devoted in the North Adriatic addresses the reproduction of tides, storm surges, baroclinic circulation, waves, at the scale of basin, coasts, lagoons, deltas and estuaries.

The typology of applications spans from specific limited in time applications, focused on processes, extreme events, dispersal dynamics and sediment transport to operational systems developed by the combined effort of research institutions and agencies and other stakeholders.

Among the several modelling implementations in the area, here we present a general overview of them, probably not being exhaustive but trying to track those relevant for the purposes of the ITINERIS project. At this stage we keep together products from projects, specific initiatives from institutions, services of regional or local agencies the partners of ITINERIS relate to. This choice is because this is the set of applications that would more easily be affected by the improvements planned by RIs in ITINERIS. This overview gives the flavor of what potentially can be put in connection in the pilot area, shows gaps to be filled and suggests on what kind of modelling application a higher potential in improving results can be achieved through the increased observational effort planned in ITINERIS.

The modelling initiatives/applications are:

- Storm surge forecasting system for the Adriatic Sea and the coastal lagoons (ISPRA, ICPSM – Venice Municipality); 3D baroclinic circulation operative system for the Venice Lagoon (ISSOS, CNR);
- Coupled storm surge, tide and wave forecasting system for the Mediterranean Sea (Kassandra CNR);
- 3D oceanographic forecasting for the Adriatic Sea and coastal lagoons (Tiresia CNR);
- 3D oceanographic and wave forecasting systems for the Adriatic Sea (ARPAE)
- 3D oceanographic forecasting system for the ER coast and Po Delta (ARPAE);
- Applications for saltwater intrusion, both present state and climate scenarios on the Po River Delta and approaching coastal areas (Change We Care INTERREG Project , CNR);
- Lagrangian dispersal application on the Po River delta for marine litter studies (CNR);
- 30-year hincast of sea levels and waves over the Adriatic Sea (CNR);
- MITgcmBFM (operational chain integration physics- biogeochemistry, connects to CMEMS and satellite, in-situ data) OGS;

- LTRANS-Zlev-MITgcm integration physics-lagrangian approach with oil spill module and larval dynamics (Not operational, for tailored applications, Connects to satellite and in-situ measurements) OGS;
- SHYFEM-Hg Venice Lagoon (physics and pollutants - Hg. Not operational, for tailored applications, Connects to CMEMS data and sin-situ data) OGS;
- Circulation application for the Lagoon of Goro (Interreg CASCADE ARPAE);
- Marine litter Model-Satellite application – langrangian Po River (CNR – Trace);
- Marine litter Model application – langrangian Adriatic Sea (CNR – Maelstrom);

As evident, there is a wide range of modelling products but, from a first check, those directly accessible for use are a limited part. In some cases those data are used for services from agencies but are not accessible to end users, in other, datasets are accessible upon request and according to data policies of the projects which financed the production.

In this broad modelling context, the DANUBIUS-RI Modelling Node component has the aim at reducing gaps and harmonizing approaches for the investigation at coast and in the river sea systems, namely the Po Delta area, North Adriatic Lagoons and surrounding coasts.

DANUBIUS-RI already recognizes the importance of modelling as a fundamental tool to complement the field observative effort. The DANUBIUS-RI SIA (Science and Innovation Agenda¹) suggests the need to further develop services to support studies in the following three cores:

- Water sufficiency
- Sediments and their Management
- Ecosystem health

Therefore, modelling tools to cover the water coastal and lagoons dynamics, the dispersal processes and biogeochemical dynamics, particularly in the transitional environments are part of the modelling offer already in place.

DANUBIUS-RI, through the work in the Po Delta and North Adriatic Lagoons Supersite and the Modelling Node component, already developed specific datasets ready to be accessed within the RI service offer. Those cover:

- Hindcast of Adriatic Sea Hydrodynamics: SHYFEM hydrodynamic model applies to a domain that cover the whole Adriatic basin together with the lagoons of Marano-Grado, Venice and Po Delta (CNR).
- Model dataset for reproduction of saltwater intrusion and derived maps for the identification of the maximum extension and persistence in a climate change perspective (CNR).

¹ DANUBIUS-RI Science and Innovation Agenda DOI 10.5281/zenodo.3712901

3.1 Gap Analysis

The above mentioned list of operational modelling systems, singular hindcasts or datasets connected with on purpose applications show the variety of production, which does not correspond with a broad access or a certified quality check.

Gaps can be identified in the lack of modeling products covering geographically and temporally all the basic variables, but, as well, are in the provision (or production without access) of data with low level of robustness (not quality checked or not validated).

Moreover, gaps are also in defined procedures to fully integrate modeling results with available observations (from in-situ or remote sensing), applying extensively data assimilation, data fusion, or producing derived quantities/maps/indices relying on more than one data source.

4. Requirements and plan to deliver integrated and modelled data products

Despite the importance of modeling in the area is well recognized both by the research community and stakeholders and even the application and systems already mentioned represent a robust baseline for the investigation of the area and the production of useful services for citizen, further efforts are needed to reach higher level of accuracy, a better coverage and improvement of the information produced from models.

In the development of the 5.17 activity, some of the planned new equipment located particularly in the North Adriatic will be used to improve modelling. As examples: Oxigen, turbidity, Chl-A from new CTDs located at the inlets of Venice Lagoon will support the determination of exchange flows between lagoons and the sea, to establish boundary conditions for the biogeochemical model of the Grado and Marano Lagoon. As well other equipment like coastal webcams would be used to support and integrate the information from models for flooding characterization. Other possible model integrations are under evaluation.

For what regards activity 5.19, the integrated data products (IDP) to be developed and delivered in the following phase of the project, will be grounded on the scheme of table 1 and Figure 3, which could be enriched by new variables made available by the acquisition of new sensors and instrumentations, within the ITINERIS project. Just as examples of possible IDP, we could mention visual representation of long-term trends of phyto and zooplankton, their spatial variability, the phytoplankton bloom frequency.

Even if the above plan is under development, there is the need to do a disclaimer: all the possible demonstrators on novel integrated data products and integrated model products are directly dependent on the timely acquisition of the new equipment, since before developing new products based on new data, there should be enough time to verify installation and proper data transfer.

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