



Joint European Research Infrastructure network for Coastal Observatory –
Novel European eXpertise for coastal observaTories - **JERICO-NEXT**

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1. Executive Summary

Three visualisations have been built to display data sets and products generated by JERICO-NEXT. The aims of the visualisations were to contribute to the assessment of the health and status of marine ecosystems and understanding the complexity of coastal processes. The visualisations targeted mainly Environment Agencies / Monitoring Programs (e.g. OSPAR, other Policy Makers/ environmental managers) but also scientific community to share knowledge and best practices. The three visualisations were: an interactive map showing the large coverage areas where the partnership collects the data and two R shiny applications highlighting the innovative way to collect biological data in collaboration with private sector and using new technologies (Benthic Non Native Species Tool and PHYTO-OPS). The chosen visualisations are flexible and can be implemented easily. R shiny is widely supported by the fact that R has well-developed and used by a lot of scientists. It allows to visualise very rapidly new sets of data and share codes which are freely available in repository hosting service (ex: GitHub, Inc) at the organisation level. Additionally, links to Pan-European platforms such as EMODnet biology was made to display the applications increasing the visibility and accessibility of the data at the European level.





2. Introduction

D8.3 relates to the “*production of three compelling visualisation products that inform and engage on topics of priority to research and policy end-user groups*”. It is a part of Task 8.3 which aims to communicate new scientific knowledge derived from JERICO-NEXT for maximising societal benefit in policy, research and operational (including industry) sectors. It also promotes uptake of Trans National (tasks 8.8) and Virtual Access Services (tasks 8.9). Interactive map is the most common tool to visualise the data. It has been used by different Pan European platforms such as EMODnet and NOOS and other H2020 projects (ex: FixO3). However, the last 5 years, R platform becomes an increasingly popular way to make science accessible, reproducible, scalable, and replicable. It is ideally suited for this purpose because it presents a high number of packages for data exploration, visualisation, modelling and statistical analysis. In addition, the creation of web tools can be performed by the R ‘Shiny’ package, allowing users to interact with science outputs and methods, without any requirement for software or a need to understand complex code (Lowndes *et al.* 2017). R Shiny also allows scientists to directly create web tools without having to rely on a 3rd party programmer, thereby minimising costs and avoiding problems around communication and interpretation of the science.

In this task, we focused on improving the visibility of the data and products available in the JERICO-NEXT in collaboration with WP6, WP8 and WP5. Mainly used by the scientific community (D8.14), they can also contribute to elaborate new tools for achieving Good Environmental Status (GES) defined as *The environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive*” (https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm). To help Member States interpret what GES means in practice, the Directive sets out, eleven qualitative descriptors which describe what the environment will look like when GES has been achieved. The virtual infrastructures in JERICO-NEXT provide data and products to feed some of the descriptors such as Biodiversity is maintained (D1), Non-indigenous species do not adversely alter the ecosystem (D2), Elements of food webs ensure long-term abundance and reproduction (D4), Eutrophication is minimised (D5), The sea floor integrity ensures functioning of the ecosystem (D6), Permanent alteration of hydrographical conditions does not adversely affect the ecosystem (D7). In Task 8.3, an interactive map related to virtual infrastructures of JERICO-NEXT (WP6) has been built and displayed on the virtual access webpage. It complements the JERICO-RI catalogue (D5.2) and the description of the 15 virtual infrastructures in WP6 with their operational link for accessing data and products (Virtual access activity). Two R-shiny applications have also been developed (Benthic Non Native Species Tool, PHYTO-OPS) making more visible archived and non-real time data for the biological data which is still underrepresented in products and services in European platforms such as CMEMS.



3. Main report

Three visualisations were built to provide new data and products to Environment Agencies / Monitoring Programs (e.g. OSPAR, other Policy Makers/ environmental managers) and to the scientific community. The targeted areas were driven by the lack of visibility of available data virtual infrastructures (WP6). The visualisations were:

1. An interactive map including in the virtual access page where the JERICO-NEXT virtual infrastructures were displayed as well as the coverage areas for their data (<http://www.jerico-ri.eu/virtual-access/>).
2. Benthic Non Native Species Tool (https://openseience.cefas.co.uk/invasive_species/) showing the spatial distribution and the abundance of 20 non native benthic species in the UK coastal areas.
3. PHYTO-OPS (Phytoplankton - Observation, Products, Services) giving access to phytoplankton biomass and diversity (pigments and functional types) measured by FerryBox, HPLC and flow cytometry (https://openseience.cefas.co.uk/phytoops_tool/) during surveys.

Benthic Non Native Species Tool and PHYTO-OPS are R-shiny applications based on data collected for monitoring purposes by governmental agencies or by industries, and for scientific purposes.

3.1. Interactive map of JERICO-NEXT virtual infrastructures (WP6).

An interactive virtual access coverage map was designed and developed. The map is available to public users of the JERICO-NEXT project website (<http://www.jerico-ri.eu/virtual-access/>) and is primarily targeted at potential Virtual Access user groups.

The map is interactive. Users have the ability to turn map layers (Figure 1). Users can also click on any of the services for more detailed information that appears in a pop-up box. From the pop-up box, users can go to the full Virtual Access page where each virtual infrastructure is listed. Contrary to other interactive maps found in EMODnet websites, the interactive map in JERICO-NEXT gives the possibility to have access to other types of data than near real time ones for each virtual access providers (Figure 2).

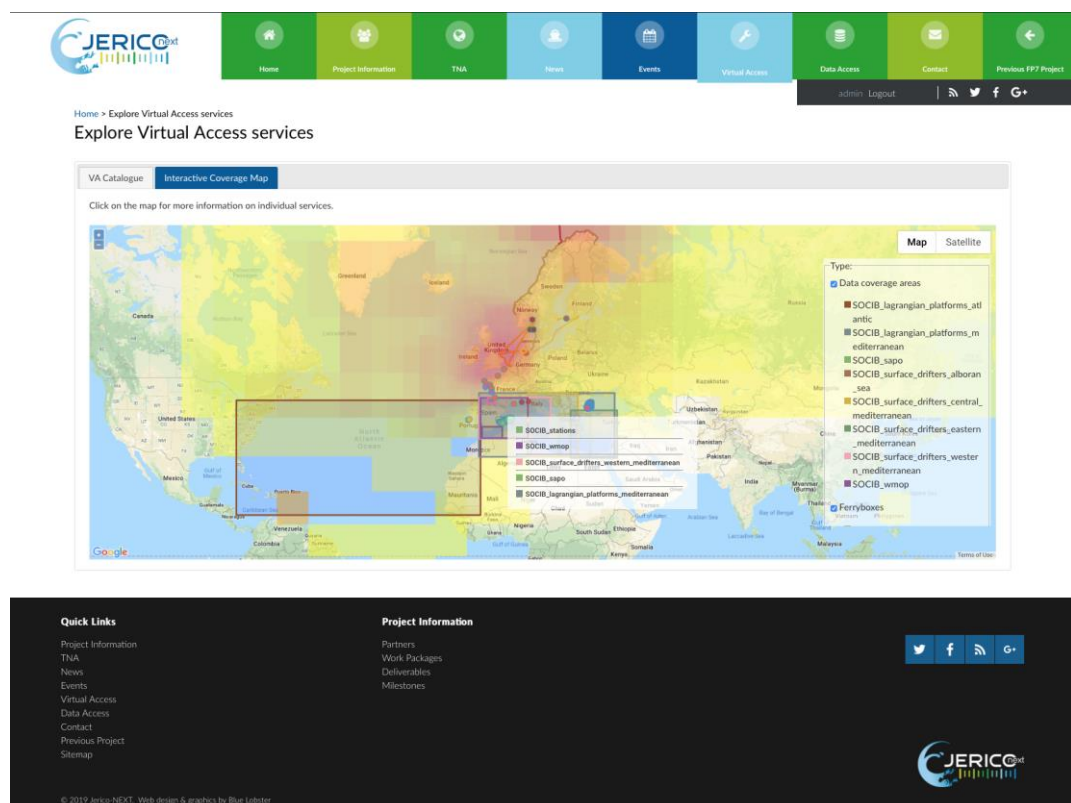


Figure 1: Screenshot of the Interactive Virtual Access (VA) coverage map.

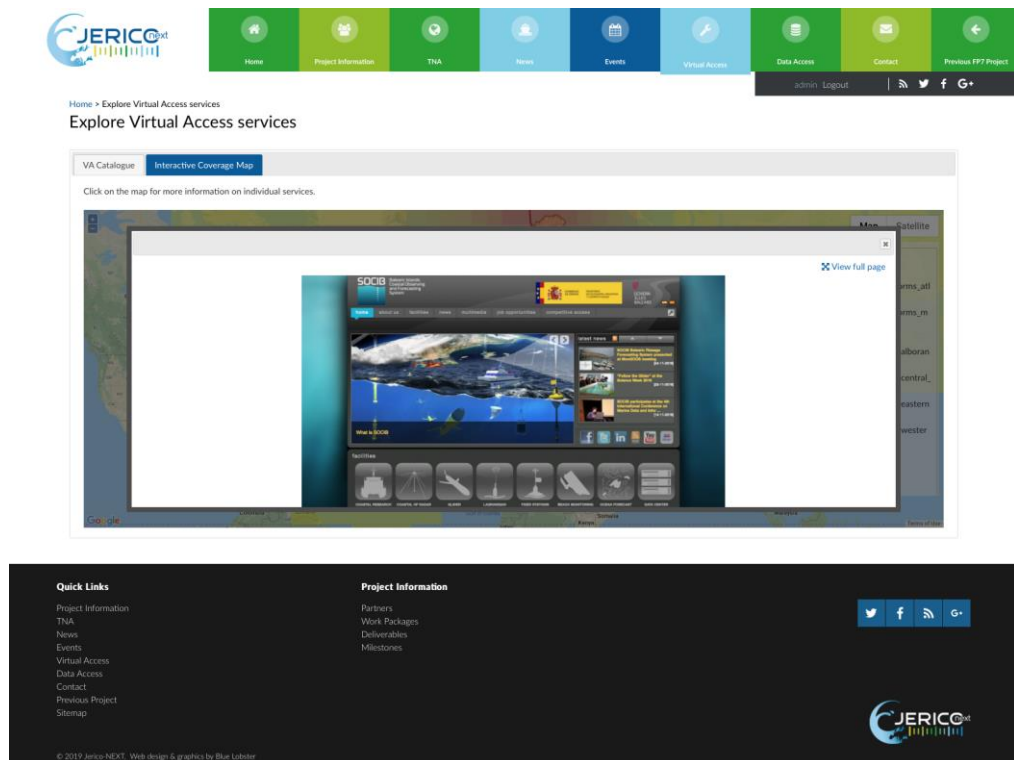


Figure 2: Screenshot of the Interactive Virtual Access (VA) coverage map showing pop up box providing more information on individual services. Users can scroll down the page within the pop-up box or click “view full page” to visit the full individual service page

3.2. Benthic Non Native Species Tool.

Non-indigenous species are species whose introduction or spread threaten biodiversity. Non-indigenous species are species introduced outside their natural past or present range, which might survive and subsequently reproduce. These species are introduced in situations where exchange of people or goods takes place between countries and continents, by shipping for example. In certain cases, non-indigenous species can become “invasive” species and have enormous and long-lasting impacts on the region. The Marine Directive states that non-indigenous species should be at levels that do not adversely alter the ecosystem (Descriptor 2). There are already few initiatives to collect the data on non native species at the European level such as European Alien Species Information Network (<http://alien.jrc.ec.europa.eu/SpeciesMapper>), or national level (<https://portal.medin.org.uk/>).

The Benthic Non Native Species Tool (https://openscience.cefas.co.uk/invasive_species/) is built from a R platform and uses a R-shiny application which displays the data. Easy to reproduce, the codes are available in <https://github.com/CEFAS> (on request) to the partnership for visualising their data at the institution level. The Benthic Non Native Species Tool has been adapted from another application (https://openscience.cefas.co.uk/ma_tool/) established for assisting with marine licence application and compliance monitoring focusing but can also be used for the Descriptor 6. It shows occurrence records for non-native species sampled in benthic grabs between 1969 and 2016. All records fall within the area: 62.47850N to 48.75353N and 3.32080E to 10.00783W, corresponding to different UK coastal areas (Cooper & Barry, 2017). The tool uses standardised dataset for benthic macrofauna and sediments through integration of data (33,198 samples) from 777 grab surveys including the data from UK marine aggregate dredging industry. A website (<http://www.marinedataexchange.co.uk/>) provides access to survey data and reports collected by our offshore renewable and marine aggregates customers. The tool (Figure 3) provides twenty benthic species distribution

range (min and max latitude and longitude) by year, providing an indication of possible spread. All positions are in decimal degrees latitude and longitude (WGS84).

The screenshot shows the 'Benthic Non Native Species Tool' interface. On the left, a dropdown menu is set to 'Crepidula fornicata', with a red circle around it and the label 'Species name'. Below it, a 'Key Features' section includes a photograph of the species, with a red circle around it and the label 'Description of species'. The central part of the interface is a map of Europe with yellow dots indicating the geographical distribution of the species. On the right, there are two data tables. The top table shows a list of records for 'Crepidula fornicata' with columns for Species, Latitude, Longitude, Year, and Abundance. The bottom table is a zoomed-in view of the same data. A red circle around the 'Download' button at the bottom right is labeled 'Download data'.

Figure 3: Screenshot of the Benthic Non Native Species Tool showing the functionality such as the description of the species, the geographical distribution and button for downloading the data.

3.3. PHYTO-OPS: PHYTOplankton-Observation, Products, Services.

According to the MSFD, plankton must be monitored towards GES and must be considered in several descriptors. Phytoplankton finds favourable conditions for development when the nutrient level, light availability and temperature increase. It is considered as a proxy for eutrophication (D5). Phytoplankton is also grazed and is at the base of the aquatic food web providing an essential ecological function for all aquatic life (D4). Finally, the Descriptor 1 (biodiversity) which aims to ensure that biodiversity is "maintained", and kept in line with the natural state appropriate to the area in question, must take into consideration all life-forms (including, bacteria, viruses and plankton) and their behaviours, the environments or habitats in which they live. Sensitive to any change, they can be used as indicator in climatic and physical oceanographic conditions and human activities impact in coastal areas.

Traditionally, phytoplankton samples are collected at fixed location (ex: L4 (England), Stonehaven (Scotland)). The chlorophyll is used as a proxy for the biomass and measured by spectrophotometry or fluorometry after acetone extraction. The diversity is based on taxonomy relying on expert network and personal knowledge. The last 15 years, technologies have been developed for measuring automatically and in high frequency phytoplankton biomass and diversity as well as physical and biogeochemical data. PHYTO-OPS displays data collected at high frequency on board the RV Cefas Endeavour from FerryBox, flow cytometer as well as discrete sampling for pigment determination. The tool shows separate pages for each, for fluorescence and for phytoplankton functional types (Figure 4) calculated from pigment and flow cytometry analyses. Each page has tabs for quality control of the data, plots and data download (Figure 5a, b, c). For a same survey, physical, biogeochemical and biological information can be found and combined in an ecosystem approach for monitoring.

Built from a R platform and R-shiny application which displays the data. Easy to reproduce, the codes are available in <https://github.com/CEFAS> (on request) to the partnership for visualising their data at the institution level.



Figure 4: Screenshot of the PHYTO-OPS showing the functionality: the methods used to determine the biomass and the biodiversity (HPLC, Flow Cytometry, FerryBox) as well as the fluorescence and the functional types.

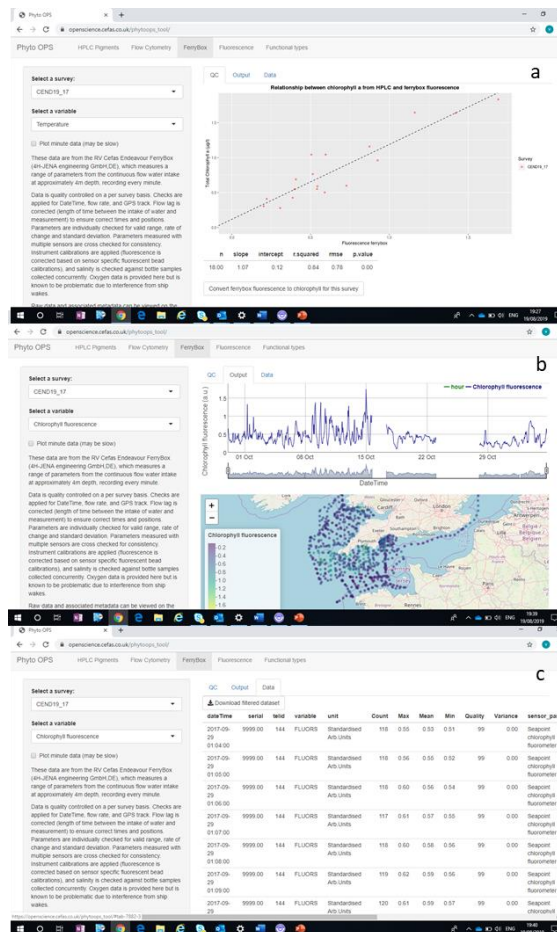


Figure 5: a: QC: Relationship between chlorophyll a (pigment HPLC) and chlorophyll fluorescence (Seapoint-FerryBox); b: Output: Distribution of chlorophyll fluorescence during the survey; c: data: download filtered data for chlorophyll fluorescence.

The tool only presents data from 3 surveys: Cend12_16 (*Nephrops Camera Survey*) in the North Sea in June 2016, Cend04_17 (*Winter Ground Fish Survey*) in Channel and Celtic Sea in March-April 2017, Cend19_17 (*Pelagic trawling*) in Channel and Celtic Sea in October 2017. Plans to add other surveys and other types of data such as microscopical counts and remote sensing information have been discussed. Additionally, the link (https://openscience.cefas.co.uk/phytoops_tool/) is also available on EMODnet Biology and the tool has been well perceived by the UK policy makers for further developments.

3.4. Short news in JERICO-NEXT website.

With the collaboration of WP8, short news were published between November 2017 and June 2019 (<http://www.jerico-ri.eu/news/>) about new technologies, new softwares (Figures 6, 7) ready to be used for GES assessments as well as new visualisations of environmental data for the public (Figure 8).

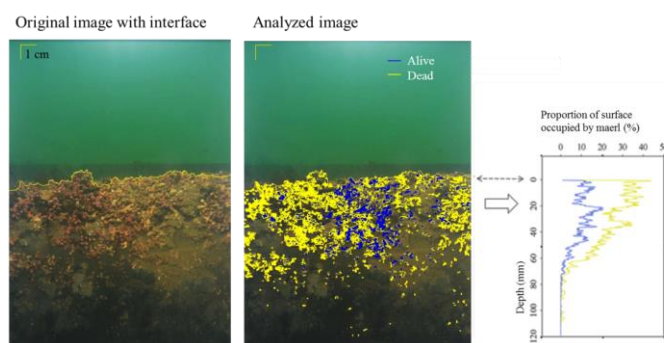


Figure 6: New version of SpiArcBase (V2.0) (<https://spiarcbase.epoc.u-bordeaux1.fr/>) to assess maerl beds while measuring different features



Figure 7: Deployment of Gliders in Mediterranean Sea. SOCIB provides tools to process data to glider community (https://github.com/socib/glider_toolbox)



Figure 8: Digital touchscreen consoles developed by NIVA to promote ocean literacy for educational information and near real-time ocean data collected by FerryBoxes.



4. Conclusions

In this task 8.3, we promoted the visibility of data and products which are not in Pan European platforms such as EMODnet, SeaDataNet or CMEMS but available in JERICO-RI and can contribute to the assessment of the GES for national marine waters. Rich in valuable data, JERICO-NEXT needs to communicate to the policy makers and other scientists the outcomes of the programme. Generally used as the main way of communication, scientific publications require a knowledge that policy makers or private sector do not have or little. On the contrary, visualisation is so powerful at representing conditions in an area, that it can help policy makers understand issues more clearly, and lead to policies that address reality in rational ways" (Rabinowitz 2013).

One of the most widely used visualisation tool is the Interactive mapping (ex: EMODnet, NOOS, FixO3). It has the advantage to improve the display of a large amount of complex data. It can be used in the design, implementation and evaluation of interventions. It can provide evidence to be used in planning and implementation decisions. Interactive maps are also flexible because information and design elements can be changed, reorganised, and manipulated, creating each time a new representation that can clarify conditions and relationships. In JERICO-NEXT, an interactive map displays specific areas where data and products provided by the partners of WP6 can be found. It allows to investigate other sets of data and products when they are not in Pan European data platforms and highlight the scientific work at the institutional level. During the last few years, an alternative tool has been developed. R Shiny is a web application framework for R, suitable for both desktop and mobile devices. The choice for using this R based approach is supported by the fact that R has well-developed, powerful, high level functions for data processing and visualisation. Since R is broadly accepted as open source programming language for data analysis in biodiversity and ecosystem studies, the developed scripts can be made available and re-used by scientists. Another added value of this tool is to speed up the accessibility of controlled quality data by sharing our expertise, develop common tools for generating products which could be adapted to local use (important for each organisation for business interests), innovate in the way to share the data processes particularly for new technologies. In JERICO-NEXT, 2 R Shiny applications have been created. *Benthic Non Native Species Tool* demonstrates that the collaboration with the industry is possible and beneficial for the scientific community as well as the private sector. This collaboration has increased the number of the datasets available in marine coastal environments for a better knowledge of the species distribution of species and potential spread and consequently facilitate the delivery of the marine licensing for industry activities such as building and renewable energy companies. *PHYTO-OPS* combines biological (related to phytoplankton), physical and biogeochemical information collected from interdisciplinary surveys in contrast to other platforms displaying data per category from fixed stations (EMODnet, NOOS) or well-known routes (COSYNA). In addition to current way of monitoring phytoplankton (CTD samples), *PHYTO-OPS* shows the outputs of new technologies (flow cytometry, FerryBox) which allows a measurement at high temporal and spatial coverage of the phytoplankton variability in the marine waters. The concern of the data reliability expressed by some user panel members has been addressed by adding a page containing the quality processes and the outputs. This application represents a step forward in the FAIR data principle for new technology outputs. It also fills the need of the ground proof data for remote sensing (ex: chlorophyll *a* and phytoplankton functional types) and modelling (ex: ERSEM ecosystem modelling) which will be more widely used in an ecosystem based approach monitoring in the near future.

By developing and sharing expertise and scientific knowledge, JERICO-RI can be a creative platform for new visualisation tools to advertise its products developed according specific needs and marine areas. These tools can combine outputs of different technologies which allow an ecosystem based approach for monitoring and create new services for blue growth economy. However, the development of its own services should not decrease the strong and well established link with Pan European Platform to bring higher visibility, accessibility to data and products outside of the partnership and increase the sustainability of the JERICO-RI.





5. References

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