New online tools for the data visualization of bivalve molluscs' production areas of Veneto Region

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ABSTRACT

The current European Food Hygiene Legislation makes the control and monitoring of all bivalve molluscs (BM) classified production areas mandatory in order to ensure the compliance of the product. Whenever the results of the controls highlight non-compliance, the Local Veterinary Competent Authority (LVCA) issues a measure to limit or suspend harvesting activities in the involved production area. Therefore, it is essential for LVCA accessing to updated information in near real time on sanitary status, laboratory test results and spatial distribution of production areas. In the framework of a project financed by the European Maritime and Fisheries Fund (n. 04/INP/20/VE), three Information Technology (IT) tools have been developed to aid the LVCA in their daily control activities. The developed IT tools also indirectly help to ensure a safe product for the end consumer, because they support food safety control activities. Moreover, the open access to information regarding these systematic controls will enhance the consumers' trust in the local product increasing its value on the market.

Keywords: Information Systems, Health Status, Shellfish Production Areas, Bivalve molluscs, Veterinary Authority, IT tools

1. BACKGROUND

As filter feeding organisms, bivalve molluscs (BM) can accidentally accumulate substances potentially harmful to humans, such as pathogenic microorganisms, chemical contaminants and toxins producing microalgae.

To be able to implement the actions useful to prevent, eliminate or reduce to acceptable levels the risks to the consumer, the Local Competent Veterinary Authority (LCVA) implements hygienic and sanitary monitoring and surveillance of BM's chain, in compliance with the European legislation on microbiological [1], biotoxicological [2] and chemical [3] risks.

BM harvesting activities can take place only in classified production areas. These are parts of the sea, lagoon or estuary whose location and boundaries are fixed by the LVCA. Classifying an area, to allow farming or harvesting of BM, means

carrying out a sanitary survey, which is a documentary study to identifying the potential pollution sources (especially faecal contaminants such as *Escherichia coli*) for the site under investigation and their possible impact and, therefore, the geographical points to be used for the following sampling activities (fixed points of samplings as described below). If the results of these activities show compliance with the legal requirements, the area is considered classified at different levels ("A", "B" or "C") depending on the average amount of *E. coli* detected, which then determines the treatment to which BM should be subjected (A: harvested molluscs may go directly for human consumption; B: harvested molluscs must be purified before human consumption; C: harvested molluscs must undergo to a long relaying or depuration procedure). Every mollusc species farmed or harvested in an area for human consumption shall be classified in the Veneto Region.

The official monitoring activities such as inspection and sampling in production areas are mandatory and performed at regular intervals. Whenever the results of the controls highlight non-compliance with the regulatory requirements, the LVCA issues a measure changing the sanitary status of the involved production area, thus limiting (e.g. requirement for depuration treatment) or suspending harvesting activities until further controls certify the re-establishment of the compliance with legal requirements.

To plan, manage and verify the correct performance in the above-mentioned monitoring activity, it is essential to set up suitable tools that allow a quick data collection and validation of information generated during sampling activities. To carry out this set of activities effectively, it is necessary to equip LVCA with integrated information systems, capable of properly managing and organising the acquired data displaying the processed information in analytic and summary reports, presenting the data on maps and information dashboards. It is also important to disseminate information on these controls in order to promote knowledge about the various actors involved in the bivalve mollusc chain to the consumers.

Considering that Italy is the third European producer of marine bivalve molluscs (~93.000 t), after Spain (~287.000 t) and France (~145.000 t) [4], and the national production is concentrated mostly in the north-eastern part of the country [5], the Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe), whose laboratories are statutory designated for official controls of this area, decided to support LVCA activities in data management and reporting.

The Epidemiological Unit of the IZSVe implemented two online tools entirely dedicated to the LVCA, and enhanced the website "Ambiti bivalvi Veneto" developed in the frame of another project activity [6] where several information regarding controls activities on BM are available to the general population.

All these activities were performed in the framework of a project financed by the European Maritime and Fisheries Fund (EMFF) (n. 04/INP/20/VE).

2. THE DATA ACQUISITION AND ORGANISATION

As a first step in the project, a conceptual scheme was drawn up for data acquisition and visualisation on different websites. Then a study was carried out to describe the technical specifications necessary for the implementation of the information system for the management of information of veterinary interest regarding BM production areas.

The data sources identified were first of all the national zootechnical databank (https://www.vetinfo.it/) where it is possible to find data describing each farm (e.g. owner and type of farming) with their location and also the data of the production areas (geography of the polygons, coordinates, species present). The second source was the IZSVe Laboratory Information Management System (LIMS), which stores the results of laboratory tests performed in the framework of the LVCA official controls.

The last data source was the software named QVeNet [7], which has been in use since 2013 and allows the collection of data related to the official controls performed in the Veneto Region by the LVCAs' network. From this web, application was possible to acquire date, species, coordinates and more over of the molluscs samples collected.

Data of interest were integrated and organised within the IZSVe Data Warehouse i.e. an infrastructure that aggregates data from different sources into a single, centralised and coherent data repository, which supports statistical/epidemiological analyses. Integration of data arising from the above-mentioned management information systems was implemented by means of ETL (Extract Transform Load) processes, which allow data to be collected from several sources, processed and brought together for reuse in specific datasets.

An Information Technology (IT) private company specialised in the development of information systems, implemented specific modules for the Data Warehouse, with the aim of managing and organising the data required by the project.

Based on the various ETL processes, individual datasets were created, in order to make available the information in the visualisation software and maps. Based on the datasets, a series of logical views were then developed, i.e. virtual tables used for the integration of information both for the web portal dedicated to the management of business intelligence implemented through dedicated dashboards, and in the system dedicated to the presentation of dynamic maps.

In particular, the views realised were:
- CLASSIFICATION: the view shows the list of species and their classification present in the production areas;
- ZONES: the view shows the list of production areas with their name;
- FARMS: the view shows the list of existing production sites, also the geometric data where it is present;
- SAMPLES: the view shows the list of samples carried out from January 2021 to date. For each sample, the reference report number, the sampling production area, the analyses and sub-analyses carried out are specified.

Three different websites were than set up to make available data collected using the data warehouse by the epidemiological Unit of IZSVe and the IT private company.

3. THE THREE WEBSITES

3.1 "Bivaclass"
The first online tool produced was installed in the production environment https://bivaclass.izsvenezie.it. It has restricted access to the LVCA and the IZSVe staff involved in the BM's chain and official controls. Bivaclass is a dashboard that allows the LVCA to visualise and download, for each BM production area, the list of classified species, information on the number and characteristics of farms in it, results of sampling activities and other data necessary for the sanitary management of shellfish production. This information can also be visualised in maps through a viewer. It was realised by using the ArcGIS, a scalable and secure SaaS (Software-as-a-Service) model hosted by the company ESRI.

The description of each section of the management information system are written below:
- Homepage: Page for the login with credentials into the reserved area.

- List of production areas: A list of all the production areas of Veneto Region where BM are farmed or harvested. Each record detailed the name of the production area and its code, as well as a series of counters summarising the type of analysis performed in the different production sites, species classified and the identified geographical sampling points within the production area. Some research filters have been implemented to select specific information of interest.
- List of farms belonging to a precise production area: Selecting a single production area the list of the production sites belonging to the area is displayed together with specific information describing them, such as the unique identification code, the type of production (e.g. fattening) and the species kept.
- Map of production areas: All farms in the production areas of the Veneto region are represented on the map. The map is interactive so it is possible to click on the elements represented and a pop-up window appears giving relevant information. Moreover marine and lagoon area in which molluscs harvesting is prohibited are also displayed.
- List of samples and results: In this section a list of information concerning sampling activities carried out for food safety purposes in production areas are made available: date of sampling, the species sampled and the reason for the investigation requested i.e. routine monitoring or surveillance in case of abnormal sanitary problems. The type of analysis requested (e.g. algal biotoxins or *E. coli spp.*), the sub-analysis (in the case of biotoxins whether okadaic acid or yessotoxins, etc.) and the analytical method used by the laboratory, are specified in detail. At last, the geographical characteristics of the area (temperature, tide, etc.) and the start and end dates of the analysis are also reported.
- Fixed points of samplings: According to the regulations, the sanitary survey, performed before the classification of a production zone, provide an overview of pollution sources and thus a scientific basis for subsequent establishment of representative sampling points. They are points geographically fixed and represent the area where the product's health parameters should be the worst. If at these points the parameters are good then all shellfish in the area are fit for human consumption. This page shows the list.

3.2 "Geomolluschi"

A webGIS dedicated to present dynamic maps regarding BM production areas and farms was implemented, also this website was realised using ArcGIS. Through this web-oriented system, it is possible to visualise and query master data (e.g. production sites, monitoring areas), health data (e.g. type of zone classification and classified species, fixed sampling points) and geographical data (e.g. regional fish map).

This system is available, with restricted access, to the LVCA referring to the bivalve mollusc production areas, as well as to the IZSVe staff following the mollusc sector.

After logging in, the site presented a dynamic map showing all the production areas of the Veneto region (Figure 1). On the map, it is possible to distinguish the various elements by different colours and shapes, which are defined by a legend on the right of the page. It is possible to visualise the classified zones, the fixed sampling points, the molluscs' farms, no-breeding areas and pollution spots. A label with its name or identification code identifies each element. In addition, if selected in the map, the elements respond with the appearance of a window with various information about it.
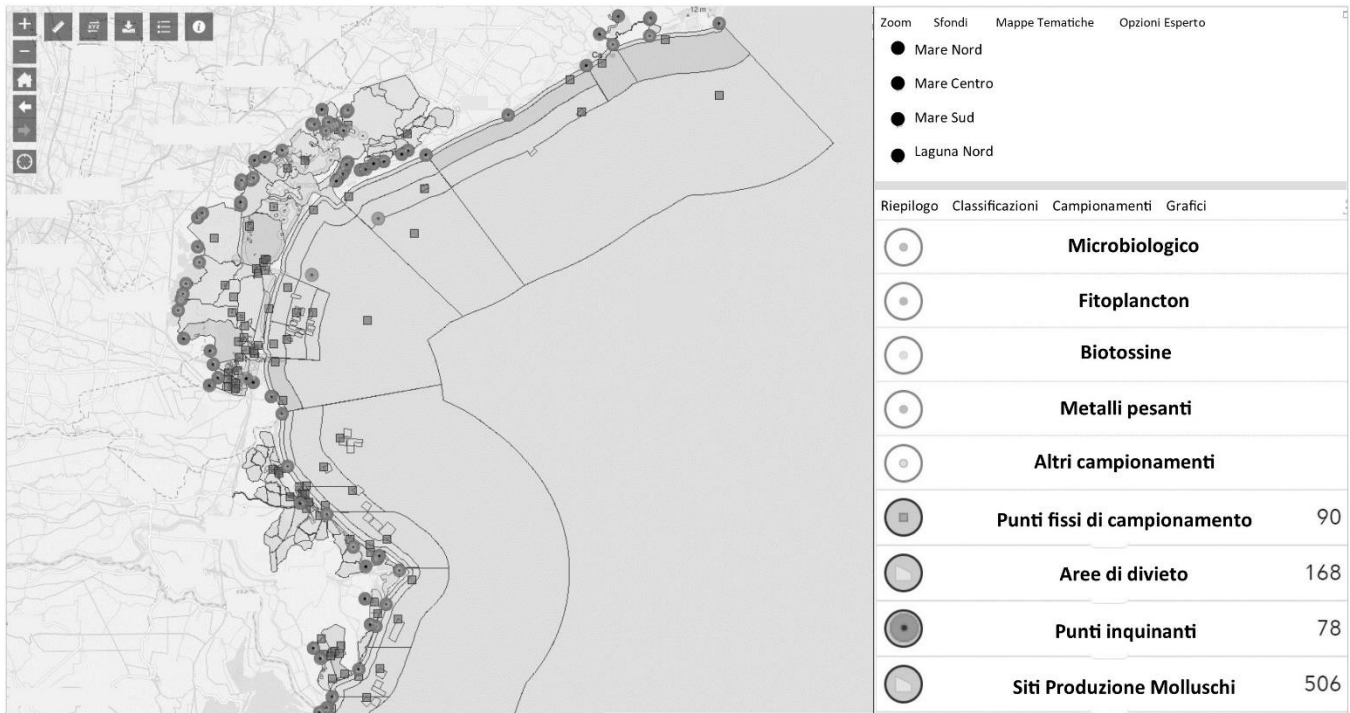

Figure 1 – The webGIS "Geomolluschi", the core of the site is the dynamic map with all the elements represented, on the right side of the page there is the interactive menu and the legend of the elements on the map (updated on 31st January 2024 – Italian language).

Also listed in the menu in the right-hand column are the types of sampling carried out for official food safety controls of shellfish. They are divided into macro-categories (microbiological, phytoplankton, biotoxins, heavy metals and others) and if selected, counters appear on the map in the various production areas so that you know how many samples were taken and where. The site also gives the possibility to produce graphs from the displayed data, e.g. you can automatically produce a pie chart of the percentage of samples run for biotoxins.

Also in the right-hand menu, there are various tabs:

- Zooms: allows you to select specific zooms that show specific areas on the map of your choice;
- Backgrounds: provides the possibility of varying the map background;
- Thematic Maps: You can also choose to view other data sources besides the IZSVe data; here you can find the geographic data for the regional fish map from https://idt2.regione.veneto.it/portfolio/webgis-della-carta-ittica webpage.

3.3 "Ambiti bivalvi Veneto" upgrade

One of the outputs of a previous EMFF project n. 22/SSL/2017 had been the creation of a website open to the public (https://ambiti-bivalvi-veneto.izsvenezie.it/) where the health status of bivalve molluscs' production areas could be viewed [6]. As part of the new project, additions and upgrades to this website were planned. In particular, a page called "Classification of zones" (Figure 2) was added to the site where, through an interactive map, it is possible to view the production zones coloured differently according to the type of classification attributed to the species harvested/farmed (Table 1).

Table 1 - Meaning of the colours on the map on the "Classification of zones" page

Colour	Meaning
Light green	Production areas where all harvested or farmed species are classified as A
Dark blue	Production areas where several species are present that have been assigned a different classification, specifically one or more as A and one or more as B
Dark green	Production areas where all harvested or farmed species are classified as B
Light grey	Zones not classified
Dark grey	Forbidden zones

Thanks to search filters, it is possible to search in the map for the code and name of the area, the classified species, the LVCA to which it belongs, the type of area (lagoon or sea) and the type of classification of the area (A, A-B, B, not classified or forbidden).

Figure 2 - Part of the page "Classification of zones" of the Website "Ambiti Bivalvi Veneto". The dynamic map shows the classification of Veneto region's MB production areas, through a different colouring. On the right side, you can see the available search filters (updated on 31st January 2024 – Italian language).

The map is interactive and have a tooltip function, i.e. you can simply pass over a zone with your mouse to see the zone code and how many species are classified in it. By clicking on it, a table appears below the map with some information: the code and name of the zone, the type of zone, the classified species, the type of classification and whether there are farms in it or only harvesting or both. It was realised by using the Qlik Sense analytic engine system (https://www.qlik.com/us/products/qlik-sense).

In the already existing page of the website dedicated to the detailed description of the project, a split was made, creating two sub-pages, one dedicated to the previous project and one to the project whose output is described in this article. Also the actors involved were made explicit on the same page.

4. CONCLUSIONS

Due to their support in the daily control activities, the tools need to be as efficient as possible, so they are constantly monitored and amended according to the needs of regional authorities or LVCA. The tools provide, through the aggregation and rationalisation of data, aid in the periodic review of the classification of production areas and in all the evaluations necessary to guarantee a safe product for the end consumer. Moreover, the open access to information regarding these systematic control activities guarantee transparency and that will enhance the consumers' trust in the local product increasing its value on the market.

ACKNOWLEDGEMENTS

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