Business Intelligence (BI) and Geographic Information Systems (GIS) tools in a coordinated strategy for handling and controlling outbreaks of African Swine Fever

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ABSTRACT

African Swine Fever (ASF), a severe swine disease with potential zoonotic implications, historically limited to Sardinia in Italy since 1978, made its mainland debut in January 2022, raising concerns. The genotype found in northwest Italy (genotype II) differs from the Sardinian strain (genotype I). By January 2024, the epidemic had escalated, with 1435 wild boar cases and 21 domestic pig outbreaks reported [6]. The Epidemiology department of

the "Istituto Zooprofilattico Sperimentale delle Venezie" (IZSVe) responded with innovative tools. These included a comprehensive data warehouse, integrating farm, processing centre, and slaughterhouse data with Laboratory Information Management Systems and geospatial information. Additionally, an "African Swine Fever/Manager" (ASF-Manager) tracked outbreak specifics, while "IZSVe GIS African Swine Fever" (IZSVeGIS-ASF) provided real-time monitoring and support for control measures. IZSVeGIS-ASF facilitates spatial analysis and filtering of data, offering insights into animal demographics and premises characteristics. Currently exclusive to IZSVe's Epidemiology department, efforts are underway to expand access to local and regional veterinary services, fostering collaborative ASF management. Ongoing enhancements aim to optimize functionality and broaden utilization during ASF outbreaks.

Keywords: Emergency, Geographic Information System, Business Intelligence (BI), African Swine Fever, Contingency plan

1. BACKGROUND

African Swine Fever (ASF) is a hemorrhagic disease caused by a DNA virus from the *Asfarviridae* family, spreading globally and affecting domestic pigs and wild boars. It often leads to high mortality rates, up to 100%, causing severe socioeconomic consequences in the affected countries, especially in those with a major share in pig farming. The virus is highly resilient in the environment, persisting on various surfaces for several months. Currently, no effective treatment or vaccine is available, therefore the control of the disease strictly relies on the adoption of stringent biosecurity measures.

In January 2022, the ASF virus (ASFV) was identified for the first time in a wild boar population in North-Western Italy (Piedmont region) [5]. Before this, ASF had been limited to the Sardinia region since 1978, with the rest of the country considered disease-free. Due to the ongoing European wave of ASFV outbreaks since 2020, the Italian Ministry of Health has implemented a national surveillance plan to prevent the spread of ASFV in domestic pigs and wild boars.

The surveillance plan involves various actions, including passive measures applied to carcasses, aimed at early virus detection and prompt control strategies. According to the ASF national passive surveillance plan [2], local veterinary services across Italian regions must weekly collect samples from at least two deceased domestic pigs and all wild boars found dead. Collected data are recorded in an official database hosted by the national portal of the animal information system (VETINFO) [3].

The Italian pork industry, a significant player in the national agri-food market, mainly focuses on producing Protected Designation by Origin dry-cured raw ham and constitutes almost 6% of the value of the national agriculture sector. As of January 2023, Italy had nearly 8.5 million farmed pigs and 105,500 pig holdings, with Veneto ranking fourth in the number of reared heads [4]. Ensuring the correct and efficient application of ASF surveillance measures is crucial for animal health and welfare and for safeguarding pork producers from substantial economic losses.

Although in the territory of competence IZSVe, which is the Veneto Region, Autonomous Province of Trento, Autonomous Province of Bolzano, and Friuli Venezia Giulia Region, has no cases of ASF, IZSVe has already started the development of a computer system for the management of possible outbreaks of ASF for the territory of competence. This system integrates data from various sources and databases, allowing for quick production and visualization of maps and close to real-time monitoring of the status of each outbreak. [1] These tools are still under development and are now only available for the veterinarians of the epidemiology laboratory of IZSVe. Still, they will be available for regional and local veterinary services and stakeholders with different profiles and viewable information.

This paper outlines the components and practical application of the information system in managing ASF data emergency in Veneto, emphasizing its vital role in supporting epidemiologists, veterinary services, and competent regional bodies in implementing animal health policies and optimizing animal disease emergency preparedness.

2. INVOLVED ACTORS

Since 1994, the Veneto Region has been actively developing the Regional Information System (RIS), a collaborative initiative involving various Public Health Organizations. Among these organizations, IZSVe serves as the system's central information hub. Situated in Legnaro (PD), IZSVe is a veterinary public health institute engaged in diagnostic and research activities spanning animal health and welfare, food safety, and environmental protection. In the Veneto Region's Animal Health contingency plan and emergency management network context, IZSVe plays a pivotal role.

Specifically related to the African Swine Fever (ASF) emergency management, IZSVe is the official laboratory responsible for conducting virological tests on samples gathered from domestic pigs and wild boars by local veterinary services in Veneto collaborating with the national reference centre for the PSA (IZSUM), based in Perugia [7]. Additionally, the IZSVe Epidemiology Department is tasked with organizing and analyzing data related to sampling and ASF emergency activities. This involves meeting the specific technical and managerial requirements of Competent Authorities (CAs). IZSVe also participates in the central and regional crisis units in case of outbreaks and as the technical body for the choice of management decisions by regional and national veterinary services.
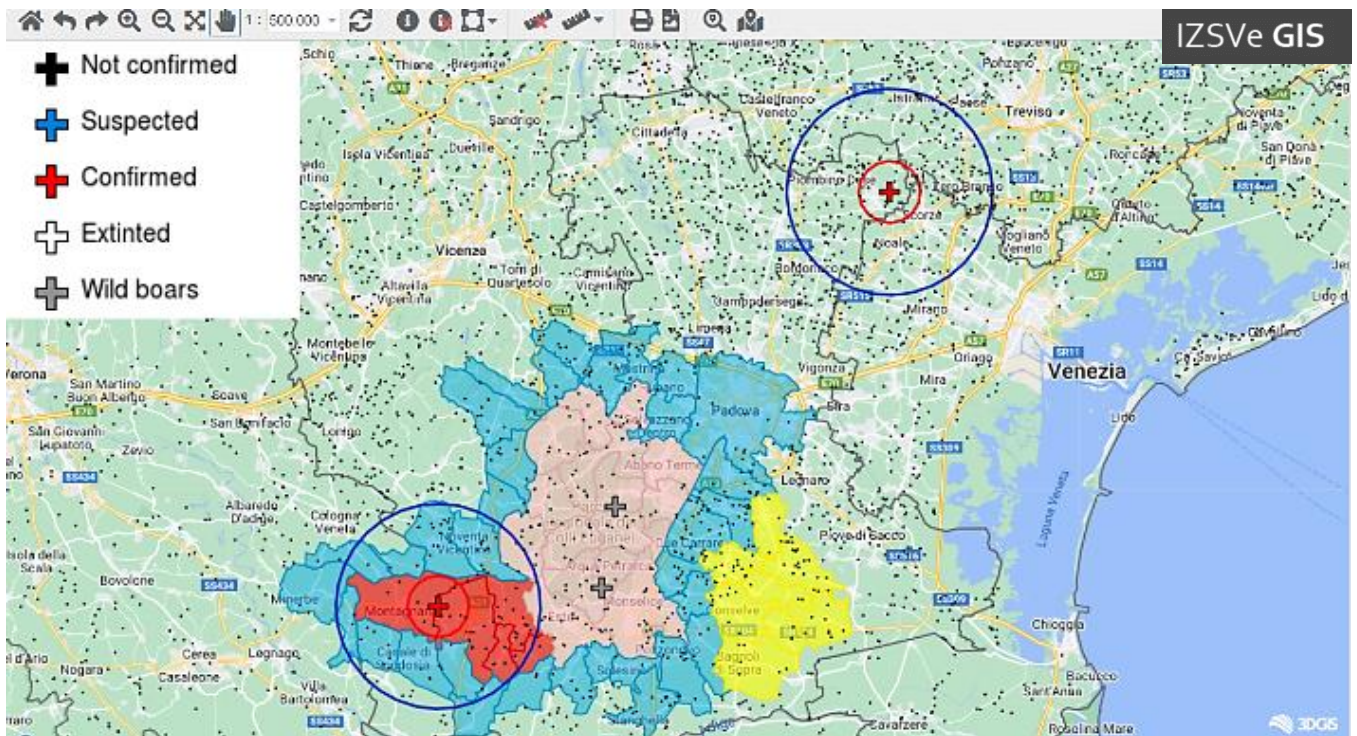
Figure 1. A display example of IZSVeGIS-ASF: On the left, the change in status of each outbreak (not confirmed, suspected, confirmed, extinct and wild boars); in the map the buffers around the outbreak and the different restriction zones of different colours according to the selected layers.

3. SYSTEM COMPONENTS & METHODOLOGY APPLIED

With the technical assistance of IZSVe, the Veneto Region has developed three tools for the management of possible ASF outbreaks: a data warehouse (IZSVe DWH), an "African Swine Fever/Manager", and a WebGIS called "IZSVe GIS African Swine fever" (IZSVeGIS-ASF).

IZSVe DWH developed using Oracle® 11g integrates data from two sources: the National Data Registry (NDR) for animals, farms, and related industries with the LIMS and geospatial information.

African Swine Fever/Manager (ASF-Manager), developed with HTML, JavaScript, and PHP/Java technologies and enabling visualizing data stored on PostGreSQL® RDBMS, is an outbreak data manager dedicated to managing ASF outbreak data, e.g. date of the suspect, date of cleaning and disinfection, number of dead animals.

IZSVeGIS-ASF (Fig.1) is a web GIS that collects information from the other two information systems, exposing them in a web GIS system aimed at real-time monitoring of the epidemiological situation in Italy and at supporting the definition of control and emergency measures. It also allows the display of specific farm information such as the method of housing (free range system or indoor system), the number of animals, the age of the animals, the type of production (reproduction, fattening, familiar). This system, drawing on data provided by IZSVe DWH and ASF Manager, is able to view and map pig farms in Veneto, assess the epidemic trend based on the variation between confirmed and extinct suspicion status of any outbreaks, display different maps by selecting and activating different layers. By selecting different layers, it is also possible to view the infected areas, restrictions, surveillance zones and buffers prevented by European Community regulations in the event of an outbreak.

4. CONCLUSIONS

Information systems and GIS are of fundamental importance for monitoring and managing serious epidemic emergencies, such as ASF seals. They allow veterinary services to more effectively evaluate decisions to learn in emergencies, enabling a more comprehensive view of the situation on the territory. For this reason, with the support of all veterinary services and technical expertise of the epidemiology lab of IZSVe, IZSVeGIS-ASF is being further developed to give the possibility to all stakeholders, supply chains, companies and local and central veterinary services personalized access with different information viewable according to the profile.

5. ACKNOWLEDGEMENTS

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