

VETERINARIA RIVISTA DI SANITÀ PUBBLICA VETERINARIA **ITALIANA**

Special Issue GeoVet2023



The “Working Group Land of Fires” Platform for emergency management, data sharing and dissemination

Susanna Tora^{1*}, Alessio Di Lorenzo¹, Gianluca Ragone², Amedeo D’Antonio³, Claudio Marro², Annamaria Conte¹, Stefania Cavallo⁴, Americo Bonanni¹, Monica Bucciarelli¹, Elio Malizia¹, Angelo Ciavarella¹, Giacomo Migliorati¹, Lara Savini¹, Terra dei Fuochi Working Group[#]

¹Istituto Zooprofilattico Sperimentale dell’Abruzzo e del Molise “G. Caporale”, Italy - IT

²Campania Regional Agency for Environmental Protection, Italy - IT

³Directorate Generals for Environment, Agriculture and Health of the Campania Region, Italy - IT

⁴Istituto Zooprofilattico Sperimentale del Mezzogiorno, Italy - IT

*Corresponding author at: Istituto Zooprofilattico Sperimentale dell’Abruzzo e del Molise “G. Caporale”, Italy - IT

E-mail: s.tora@izs.it

Veterinaria Italiana, 2024: Special Issue GeoVet23 DOI: 10.12834/VetIt.3527.25903.2

Abstract

Over the last decades, the Campania Region in Italy has faced an environmental crisis due to the widespread illegal dumping and burning of waste. This has led to the area being notoriously known as the *Land of Fires* (Terra dei Fuochi - TdF), sparking serious concerns about public health and threatening the region’s agricultural sector, one of its economic mainstays. In such a context, a timely, accurate, and reliable flow of information, aimed both at the population and at stakeholders, is crucial for establishing a proper dialogue between institutions and people, driving the empowerment of citizens.

To address this crisis, the Italian Government introduced Law 6 of 2014, establishing a multidisciplinary Working Group tasked with identifying and mapping the sites affected by spills and illegal disposal in the territory. The TdF-WG defined a scientific methodology for classifying these sites in terms of prohibition on the cultivation of specific crops, consequently allowing the adoption of appropriate clean up and restoration measures for the impacted sites. This paper describes the data collection process and the IT platform commissioned by the Government to the IZS-TE and used by the TdF-WG to exchange data, knowledge, and technology, thereby fostering efficient and effective crisis management.

Keywords

Campania Region, environmental emergency, geodata, land of fires, web-GIS

Introduction

The widely accepted framework of Emergency Management for all types of emergencies and disasters consists of four phases linked by time and function: reduction, readiness, response, and recovery (Drabek and Hoetmer 1991). All phases heavily rely on the quality of collected data, gathered from various sources. Data must be meticulously collected, organized, and logically presented to determine the scale and scope of emergency management programs and to facilitate prompt and appropriate actions (Gerbino 2020, Ierardi 2020).

Over the past decades, the Campania Region in Southern Italy, particularly in the provinces of Naples and Caserta, has experienced a number of waste management crises due to the illegal disposal of refuse across the territory. These waste materials were often intentionally set on fire, leading the involved area to be dubbed *Land of Fires* (Terra dei Fuochi - TdF) (Legambiente Ecomafie Report 2003, Legambiente Reports 2013 and 2015).

In 2014 the *Land of Fires* included 57 municipalities between Naples and Caserta. Subsequently, it was expanded to include 90 municipalities, 56 in the province of Naples and 34 in the province of Caserta (Ministerial Directives of 23/12/2013 and 16/04/2014 and Interministerial Directive of 10/12/2015), covering an area of approximately 1,487 km², with an exposed population of 2,912,337 (source: ISTAT 2022) (Siniscalchi 2022) and a used agricultural

surface equal to 809.34 km² (ISTAT Agricultural Census, 2010). The illegal burning of tires, plastics and other special waste poses significant problems of environmental pollution and public health (Senior and Mazza 2004, Diletti *et al.* 2008, Nature Editorial 2014, Lambiase *et al.* 2017).

In this area, excess mortality and significant increases in the incidence of various cancers have been observed, suspected to be linked to environmental pollution by various chemicals and contaminants also in consideration of the high conurbation of the area (Comba *et al.* 2006, Martuzzi *et al.* 2009, Fazzo *et al.* 2011, Alberti 2022). Studies on the breast milk of mothers living in the Naples and Caserta areas have revealed contamination by dioxins and PCBs. The levels of dioxins found were significantly positively correlated with the age of the sampled women and their proximity to toxic waste disposal sites (Rivezzi *et al.* 2013, Giovannini *et al.* 2014) with the values measured in *Land of Fires* being on a par with those collected in other industrialized areas of Italy (Ulaszewska *et al.* 2011). SEBIOREC biomonitoring study by De Felip and Di Domenico (2010) and De Felip *et al.* (2014), as well as the Study of Exposure on Susceptible Population (SPES) in 2021, have shown that serum samples analyzed in the *Land of Fires* area had high levels of dioxins and PCBs compared to samples from areas with lower waste-related environmental pressure (Marfella 2021, SPES 2021, Alberti 2022). By contrast, studies like those conducted by Esposito *et al.* 2016 and 2018, which investigated the presence of trace elements in food products of crops cultivated in the *Land of Fires*, showed that the average content of toxic metals, such as cadmium and lead in fruit and vegetables, was significantly lower than in other areas with high environmental impact, where there are industrial plants, and well below the maximum limits set by European regulations (Esposito *et al.* 2016 and 2018). Additionally, other studies, including those referenced in Pierri *et al.* 2021 and Ducci *et al.* 2017 suggest that the levels of contaminants in that area may not be as high as presumed at early stages (Pierri *et al.* 2021, Ducci *et al.* 2017).

In such complex crisis contexts, it is crucial to acknowledge the ongoing debates surrounding the findings. Despite efforts to understand the true extent of the environmental challenges in the *Land of Fires* region, inconsistencies in data interpretation persist. Furthermore, persistent media coverage, especially between 2013 and 2016, drew public attention to Campania products, causing widespread distrust and huge damage to the agri-food sector in the region (Cembalo *et al.* 2018, Pierri *et al.* 2021).

This crisis prompted special intervention by the Italian government, involving the Ministries of Health, Agriculture, Food, and Forestry Policies, and Environment and Protection of the Territory and the Sea, which established an *ad hoc* multidisciplinary inter-ministerial task force (from now on referred to as TdF-WG) (Decree-law 136/2013 converted into Law No. 6, February 2014). The TdF-WG was tasked with identifying and mapping the sites affected by spills and illegal disposal in the territory, defining a scientific reference model for the classification of land, and determining all the information necessary for the execution of the model based on the different types of site or contaminant agents, and finally predisposing technical/scientific reports on the achieved results. Contextually, the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise "G. Caporale" (IZS-TE) was tasked with developing a digital platform known as the WG TdF Platform, designed to gather, disseminate, and visualize standardized data, knowledge and technologies. Within this collaborative effort, the Carabinieri Command of Environmental and Agri-Food Forestry Units, which has specialized units of agro-environmental teams, has been assigned a high-level inter-ministerial and institutional coordination role. It was pivotal in operational field activities, including inspections conducted with the Campania Regional Agency for Environmental Protection technicians, and surveys performed using geomagnetometers.

Amidst a complex crisis, a timely, accurate, and reliable flow of information is crucial for establishing a proper dialogue between institutions and people, driving the empowerment of citizens. Such a goal requires an interdisciplinary perspective in order to integrate data from different scientific fields and at multiple levels of analysis. This helps in understanding complex phenomena and implementing methods of an in-depth analysis aimed at supporting policies to solve critical territorial problems (Gong *et al.* 2004, Zang and Li 2005, Gerbino 2020, Ierardi 2020).

The collaboration within the TdF-WG is a notable example on a national level, where technical-scientific institutes, universities, and specialized police forces share information and expertise. This collaboration involves authoritative representatives from the Council for Agricultural Research and Economics (CREA), the Institute for Environmental Protection and Research (ISPRA), the Italian National Institute of Health (ISS), the Directorate Generals for Environment, Agriculture and Health of the Campania Region, the Campania Regional Agency for Environmental Protection (ARPAC), the Department of Agriculture of the University of Federico II, the Agency for Agricultural Payments (AGEA), the Istituto Zooprofilattico Sperimentale del Mezzogiorno (IZSM), the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise (IZS-TE), and the National Institute of Geophysics and Volcanology (INGV).

Ten years have passed since the publication of decree-law 136/2013, and during this timeframe the TdF-WG collaborative effort has produced a significant amount of knowledge and achieved major milestones in its dissemination, aiming to empower the citizens of the territory.

Detailed findings from the collaborative efforts of the TdF-WG are published in five technical reports endorsed by

Interministerial and MITE Decrees (Decrees 12/02/2015, 07/07/2015, 26/02/2016, and 03/04/2017, as well as MITE Decrees 238 and 239 of 01/06/2021). These reports delineate the environmental and vegetable matrices investigated, the methodologies employed and the criteria used for land evaluation and classification for agricultural purposes. As of 2023, 641 sites have been analyzed and classified. Of these, only about 25% have been banned from agri-food and silvo-pastoral production and subjected to periodic checks by the Forestry Corps, while the majority have been deemed suitable for production.

In summary, this paper aims to detail the WG TdF Platform, showcasing it as the result of collaborative and cooperative efforts in crisis management and data dissemination. Specifically, it highlights how the WG TdF Platform facilitates timely communication with stakeholders and the community, providing a shared workspace for the TdF-WG and enabling the rapid exchange of data and resources for throughout analysis and effective solutions. This aspect, and its ability to promote effective communication, could serve as a reference point for defining a model of communication and collaboration that can be replicated and adapted in different domains, at both national and international levels.

Materials and methods

This section will illustrate the data processing and publication workflow covering data storage and its subsequent publication as OGC and REST services. Additionally, the design and infrastructure behind the WG TdF Platform and the 'GIS Dashboard' will be highlighted.

Data collection and flow

The WG TdF Platform shares data contributed by all the components of the TdF-WG. The data provided were collected, analyzed and harmonized by IZS-TE in collaboration with the TdF-WG members.

This dataset includes a variety of geographical and non-geographical elements, providing a comprehensive overview of the environmental situation in the area of interest. Components such as orthophoto mosaics, administrative divisions of municipalities, and potentially polluted cadastral parcels provided by AGEA, with the addition of laboratory results on soil and crops provided by ARPAC and IZSM respectively, have been key in identifying and defining a classification map of the investigated lands. The dataset is detailed in five publicly available technical reports, approved by inter-ministerial and MITE decrees (12/02/2015, 07/07/2015, 26/02/2016, 03/04/2017, MITE Decrees 238 and 239 of 01/06/2021). These reports detail the environmental and vegetation matrices studied, the methodologies utilized, the criteria applied for land evaluation and classification, as well as analytical results for soil and crop assessments. For each investigated cadastral parcel, the dataset includes the following metadata:

- Parcel identification code: a unique code that identifies each cadastral parcel.
- Municipality: the municipality where the parcel is located.
- Presumed risk class: the risk classification associated with the parcel, based on preliminary assessments.
- Soil suitability for use: the evaluation of the soil's capability to be used for specific purposes (the classified cadastral parcels), such as agriculture.
- Sampled matrix: the specific type of environmental matrix sampled, belonging to soil or vegetation.
- Critical and borderline soil parameters: the soil parameters that are close to or exceed safety limits and may pose a risk.
- Prescriptions: the recommendations or corrective actions suggested based on the analysis results.
- Geomagnetometer result: the results of geomagnetic surveys used to detect anomalies in the soil, such as the presence of underground waste.
- Presence of waste: the indication of the presence of waste materials or contaminants found in the parcel.

- Relative ministerial decree: the reference to the ministerial decree that approved the investigations and analyses conducted on the parcel.

Laboratory results on soil and crops include: parcel identification code; sampling code; matrix; analyte name; analysis result value; threshold exceedance.

The principal analytes considered in the soil and vegetation analyses are as follows:

1) Soil Parameters:

- Heavy Metals Analysis: Parameters for each soil sample include concentrations of antimony, arsenic, beryllium, cadmium, cobalt, total chromium, manganese, mercury, nickel, lead, copper, selenium, tin, thallium, vanadium, zinc, etc. These parameters are crucial for assessing soil contamination levels and potential risks to human health and the environment.
- Hydrocarbon and Solvent Analysis: Includes parameters on aromatic solvents (benzene, toluene, p-xylene) and various hydrocarbons (C>12, PAHs), aiding in the identification and quantification of organic pollutants in the soil.
- Aliphatics and Phenols: Parameters on carcinogenic and non-carcinogenic chlorinated aliphatics, halogenated compounds, and phenols provide insights into chemical pollution levels in the soil.
- Dioxins, Furans, and PCBs (Polychlorinated Biphenyls): Parameters on PCDDs (Polychlorinated Dibenzodioxins), PCDFs (Polychlorinated Dibenzofurans), total PCBs, and dioxin-like PCBs provide insights into chemical pollution levels in the soil.

2) Vegetation (Crops) Parameters:

- PCDD/F and PCB Analysis: Parameters on dioxins (PCDD/F) and dioxin-like PCBs (PCB-dl) in vegetation highlight the accumulation of persistent organic pollutants within the food chain.
- Non-dioxin-like PCBs (PCB-ndl) and PAHs: The analysis of specific PCB congeners and polycyclic aromatic hydrocarbons (PAHs) in vegetation monitors environmental contamination levels.
- Heavy Metals in Vegetation: Parameters on regulated metals (arsenic, cadmium, mercury, lead) and other non-regulated metals (beryllium, cobalt, chromium, manganese, molybdenum, nickel, copper, selenium, tin, strontium, thallium, uranium, vanadium, zinc) assess plant uptake and potential risks to consumers.
- Specific chemicals and isotopes: This include specific chemicals such as alaclor, cobalt, and chromium, as well as isotopes like cesium-133 and uranium-238.

The data were formatted as ESRI shapefiles and Excel spreadsheets, then processed and normalized to fit the database structure (Figure 1). This ensures compatibility and usability with applications and services offered by the WG TdF Platform, like the 'GIS Dashboard' and the OGC WMS (<https://www.ogc.org/standard/wms/>) and REST standard web geoservices (<http://geoservices.github.io/>). Moreover, the entire data set has been made accessible under a Creative Commons license (CC-BY-4.0, <https://creativecommons.org/licenses/by/4.0/>) in a dedicated GitHub repository (<https://github.com/IZSAM-StatGIS/TdF-data>) in a dedicated GitHub repository (<https://github.com/IZSAM-StatGIS/TdF-data>), facilitating dissemination and promoting open collaboration. The data are regularly updated and processed in line with the ongoing work of the TdF-WG, ensuring that the information remains current and accurate.

Updates are verified and validated by TdF-WG members to maintain the integrity and reliability of the data.

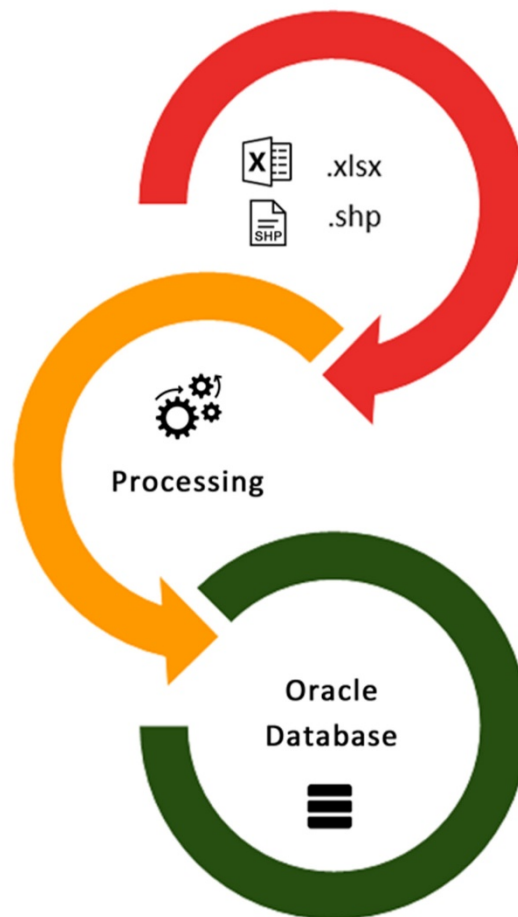


Figure 1. The WG TdF data flow.

WG TdF Platform design

WG TdF Platform, accessible at <https://terradeifuochi.izs.it>, has been developed using Java Server Pages (JSP) for the server side and the Twitter Bootstrap HTML/CSS framework for the user interface. It addresses security aspects and provides an interface for user authorization, enabling access to private content. Figure 2 depicts the conceptual map of the WG TdF Platform, illustrating its two main areas and features:

Public Area

Users have access to informative content about the *Land of Fires* through menu items such as 'Home', 'Working Group', 'Results', 'Regulations', 'Publications', and 'In Evidence'. Additionally, a dedicated 'GIS Dashboard' item, reachable from the 'Home' menu and the 'Results' menu, enables access to a 'GIS Dashboard' for visualizing and querying data sets shared by the web services. The 'GIS Dashboard' provides the users with a strictly selected set of tools designed to navigate and query the underlying spatial database (Di Lorenzo *et al.* 2016, Di Lorenzo *et al.* 2023) through an interactive map, featuring filters and interactive charts (that also function as filters) that summarize information about the cadastral parcels, their distribution, and classification. These tools are seamlessly integrated, providing the user with a cohesive and accessible environment, enabling the public and professionals to fully utilize the system to increase awareness thanks to its ease of use nature. Additionally, the 'GIS Dashboard' enables access to analytic results for crop and soil samplings by clicking on the "show the detail sheet" link provided for each cadastral parcel (on the map, in the popup window, or in the list on the right side of the Dashboard user interface). This action launches the 'Details Viewer' application, a custom-built module, developed through JavaScript open-source libraries. This module uses the unique cadastral parcel code as a parameter to retrieve the corresponding analysis results from the database. The 'GIS Dashboard' features a clean and user-friendly interface, making it accessible even for non-technical users. At the heart of the application, the interactive map displays the administrative boundaries of the surveyed municipalities and the cadastral parcels, color-coded according to permitted agricultural use. In addition to

the interactive map, the 'GIS Dashboard' includes various interactive widgets organized in different sections:

- a toolbar at the top, featuring a widget that allows for the search of cadastral parcels. Parcels can be selected either by their identification code, which consists of the Site ID, Sheet number, and Cadastral parcel code, or by their presumed risk (Summary of the technical report referred to in Art. 1, Paragraph 3, Letter C of Ministerial Directive 23/12/2013);
- a counter widget positioned in the upper left part of the user interface, which dynamically updates every time a filter is applied;
- an interactive histogram on the left, beneath the counter widget, reporting the number of cadastral parcels per municipality;
- a tab panel on the right side, featuring tabs reporting the cadastral parcel's interactive list, the map legend, the notes explaining the prescriptions and criticalities of the contamination, and the URLs of the WMS and REST web services made available;
- an interactive pie chart in the lower right corner, displaying the number and percentage of cadastral parcels for each class of agricultural use allowed.

Private Area

This section grants exclusive access to the 'Workspace GdL', serving as a centralized repository for secure document management, archival, and data sharing of supporting collaborative work accessible only to members of the TdF-WG. This includes large spatial datasets. Users are assigned one of two roles: consultation or administration. Users with consultation access can view, search, and download data and documents. Meanwhile, those with administration access have additional privileges, including uploading data and organizing document storage. Documents shared in this workspace can also be accessed and edited online simultaneously, fostering real-time collaboration and interaction. In addition, the file sharing feature is customizable, allowing users to work on a file exclusively with a select group of team members, thus ensuring privacy and focused collaboration within designated work-groups. These actions are facilitated by a user-friendly step-by-step guide.

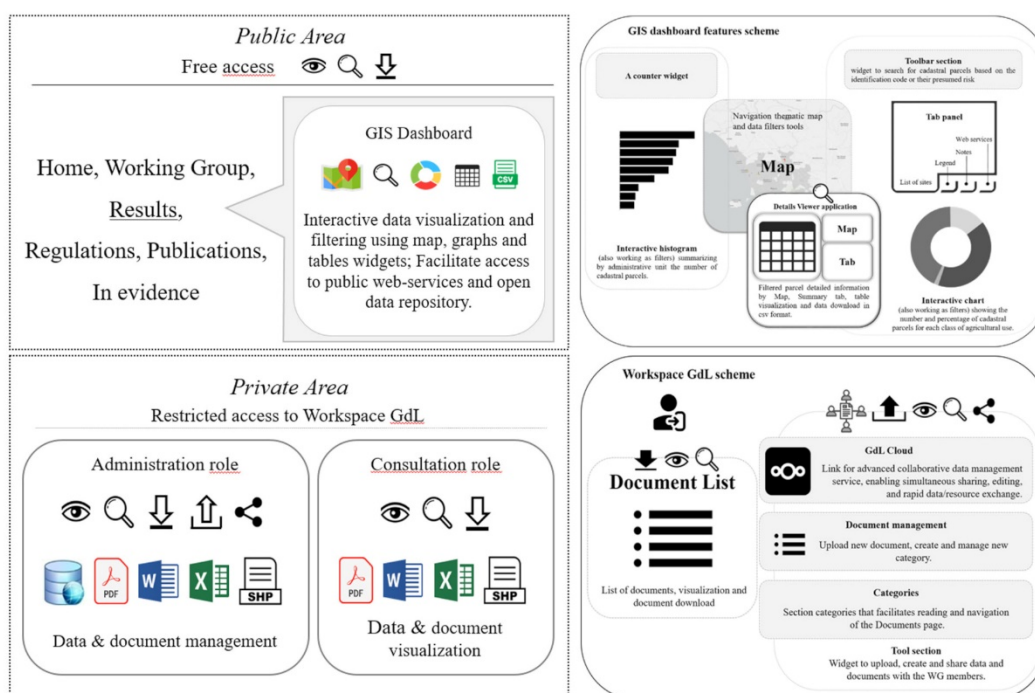


Figure 2 - WG TdF Platform Conceptual Map.

Spatial Data management Infrastructure

The technological foundation of the 'GIS Dashboard' consists of Oracle 12g Database Management System (DBMS) and ESRI ArcGIS Server 10.8.1 (ESRI® Inc., Redlands, CA). The data collected are stored in the Oracle 12g database and connected to the ArcGIS Server to be exposed on a REST and WMS interface. The 'GIS Dashboard' was created by combining the ArcGIS Online Operations Dashboards SaaS with a custom application (the 'Details Viewer') developed using the OpenLayers (<https://openlayers.org>) and Tabulator (<https://tabulator.info>) JavaScript open source libraries. This combination enables the display and downloading of analyses results from crop and soil samplings. The custom module was designed to overcome some functional limitations imposed by the Operations Dashboards platform on tabular data management at the time the WG TdF Platform design was conceptualized. It has been deployed on premises on an IZS-TE server running Apache Tomcat 9. The described stack and the involved application modules are displayed in Figure 3.

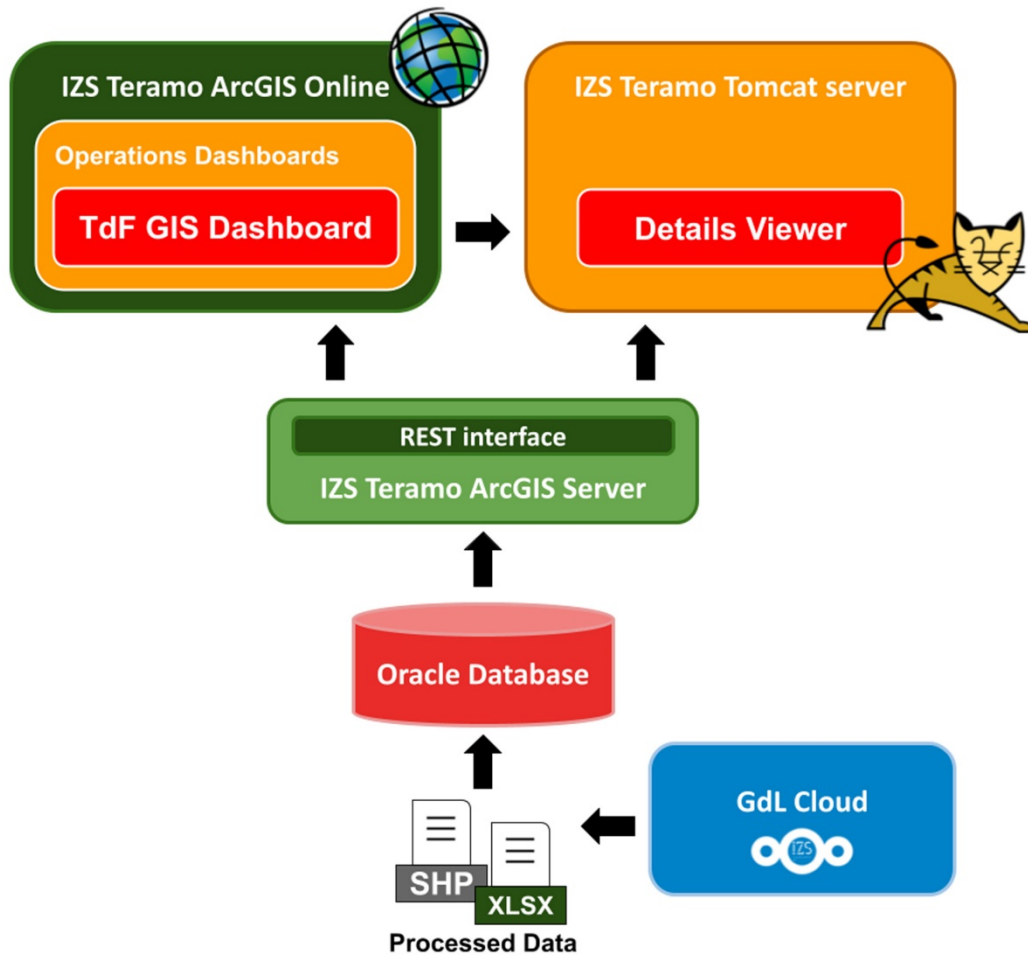


Figure 3 - the 'GIS Dashboard' stack and data flow.

Results

The WG TdF Platform serves as the central hub for accessing and sharing data and outcomes from TdF-WG activities, offering a wide array of content, applications and services to users. Accessible at <https://terradeifuochi.izs.it>, the portal features both public and private areas. The distinction lies in the inclusion of an additional menu item, 'Workspace GdL', which is reserved for authorized users to facilitate collaborative work within the TdF-WG (Figure 4).



Figure 4 - WG TdF Platform home page.

WG TdF Platform as a Gateway for Accessing and Sharing TdF-WG Data and Results

The 'Results' page on the WG TdF Platform serves as the primary gateway for accessing publicly available data and outcomes from the decade-long activities of the TdF-WG, providing a platform for data sharing, consultation, and services to a broad audience. Users have one main avenue for accessing information through the 'GIS Dashboard', as illustrated in Figure 5. The 'GIS Dashboard' provides various tools for sharing geographical and analytical data, facilitating interoperability, and enabling experts in the field to reuse the data in GIS software for further analysis. Specifically, the 'Web Services' tab offers:

- Web Services: Data on cadastral parcels and analytical results accessible via web services (WMS and REST) for integration and reuse into proprietary or open GIS software, including online platforms like Google Earth, and data are downloadable in KMZ format.
- Public Repository on GitHub: The repository is available at <https://github.com/IZSAM-StatGIS/TdF-data> and contains machine-readable data in CSV/Excel format and geographical data in GeoJSON and Shapefile formats.

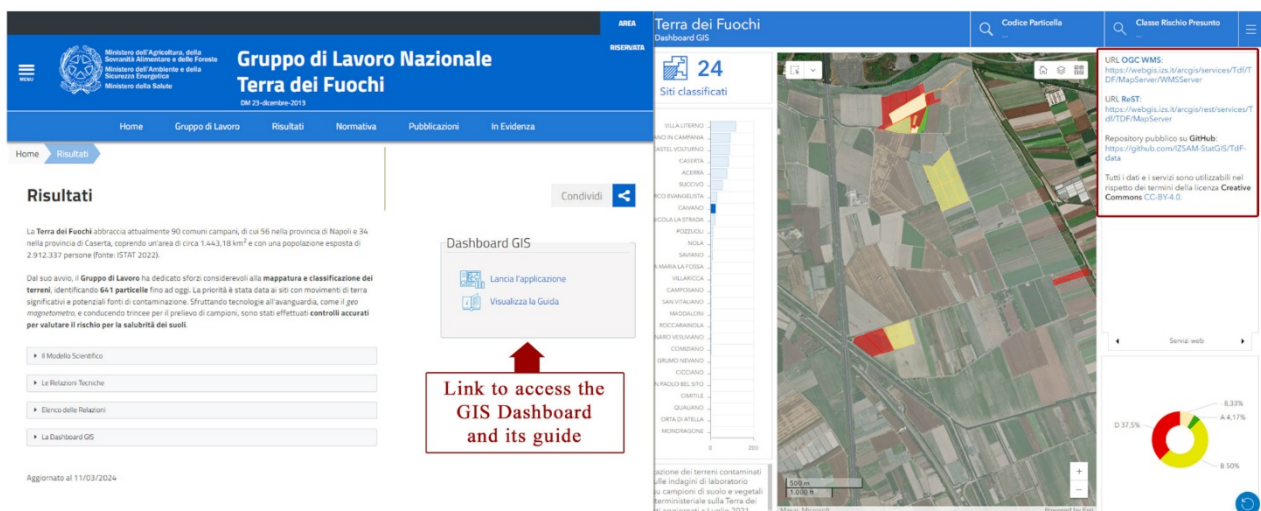


Figure 5 - Data Access Pathways on the 'WG TdF Platform Results' page.

In addition, the 'GIS Dashboard' provides an intuitive user interface (Figure 6) that highlights the interactive map along with various other interactive widgets, such as charts, list, cadastral parcel counter, and toolbar filters, facilitating the querying and visualization of information. When a cadastral parcel is selected (either by clicking on the map, using the toolbar filters, or clicking on the parcel list), a popup window displays detailed information about it. Contextually, the bar corresponding to the municipality containing the selected parcel is highlighted in the interactive histogram, and the counter widget is updated as depicted in Figure 7. Additionally, the popup window includes a link at the bottom which launches in a new browser tab the 'Details Viewer' application. It displays the analysis conducted on soil and vegetable samples in a table format (downloadable as CSV files), provides a view of the selected cadastral parcel on an orthophoto background, and presents all available information on it, as illustrated in Figure 8. The 'Details Viewer' can also be accessed by clicking on the link present in the list on the right side of the 'GIS Dashboard' user interface. This structure allows an efficient access to and utilization of TdF-WG data and results, thereby promoting transparency and collaboration.

All the datasets used and shown by the 'GIS Dashboard' are also accessible via a GitHub repository, under a Creative Commons license (CC-BY-4.0). The Basemap throughout figures were created using ArcGIS® software by Esri.

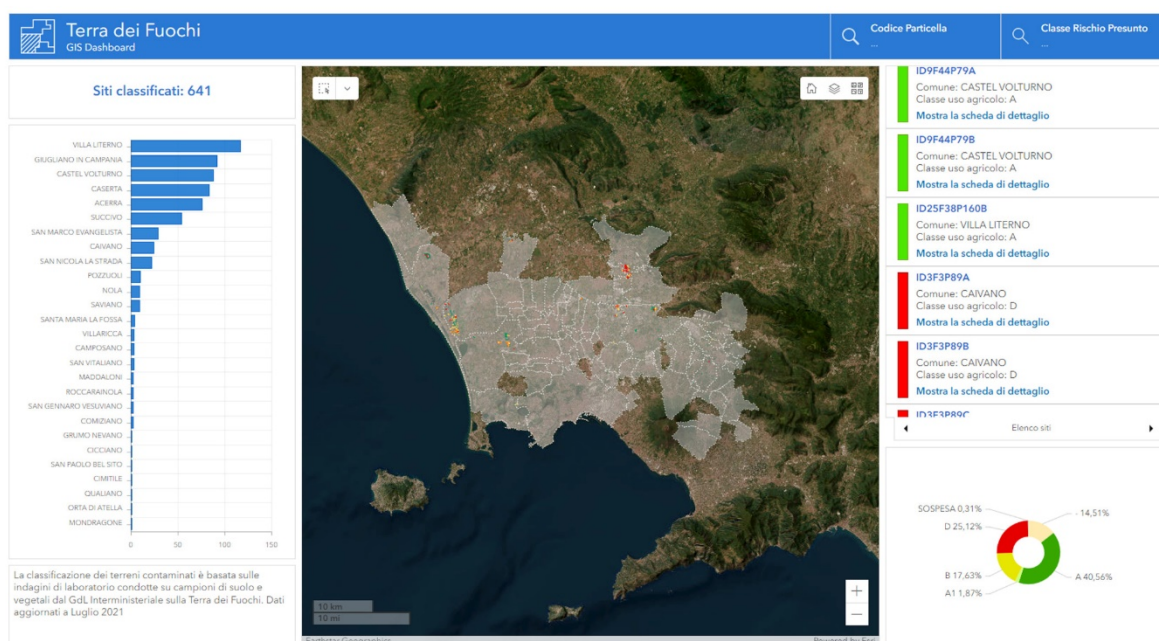


Figure 6 - the 'GIS Dashboard' user interface.

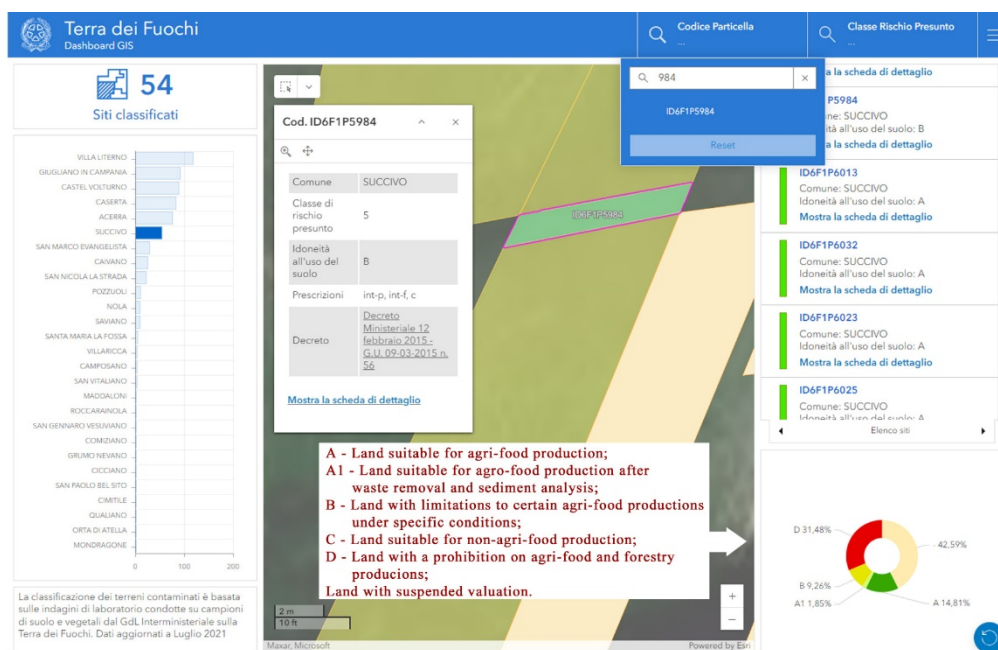


Figure 7 - the popup window on classified cadastral parcels (Technical report approved with Decree 12/02/2015), also filtered by municipality.

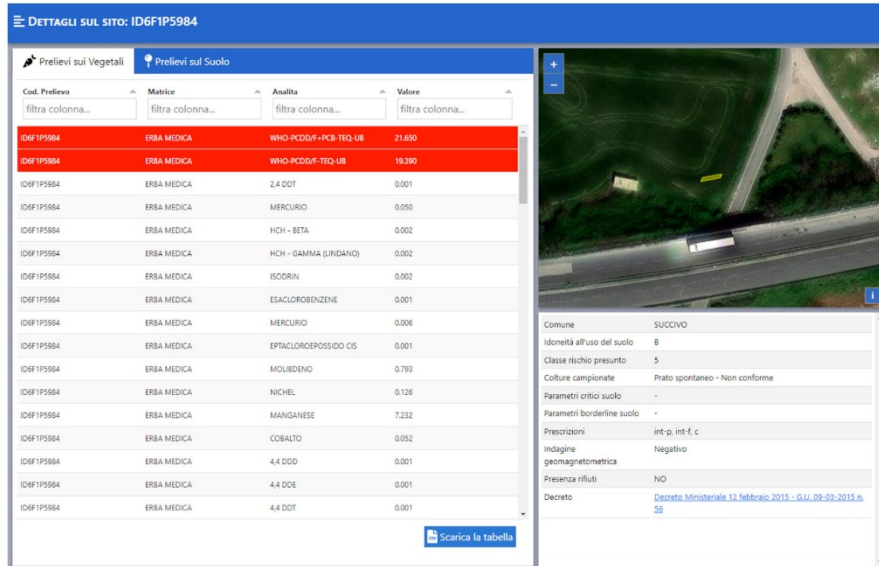


Figure 8 - The 'Details Viewer' application displays the results of the analysis conducted on soil and vegetable samples taken from the selected cadastral parcel. Exceedances of analytes sought for samples collected in the cadastral parcel under review are highlighted in red.

Collaborative Workspace: Empowering TdF-WG Collaboration and Data Management

Figure 9 illustrates the layout of the 'Workspace GdL' page, specifically designed for managing work documents within the dedicated area for the TdF-WG. This session is developed to facilitate the rapid exchange of data and resources, enabling in-depth analysis and effective solution formulation by TdF-WG members.

The user interface of this section displays archived documents via cards or lists and organizing them into categories. It also provides tools for locking, editing document information, deleting and downloading. Moreover, the 'Document' section allows users to upload new documents and assign them to one or more categories, facilitating storage and retrieval. Furthermore, for seamless collaboration and data management, the 'GdL Cloud' service allows for the sharing and management of files in different formats, including large datasets (e.g., orthophotos). These files can be selectively shared with specific subgroups of the TdF-WG to facilitate collaboration on ongoing, non-finalized work. Access to the system is secured with two-factor authentication (2FA), ensuring enhanced security and control over file access and sharing.

This platform currently contains public and confidential working documents from 2013 to 2024 and it is constantly updated in accordance with new information available. The informative nature of this portal is enhanced by the regular updates on news, new publications, regulations, and data results.

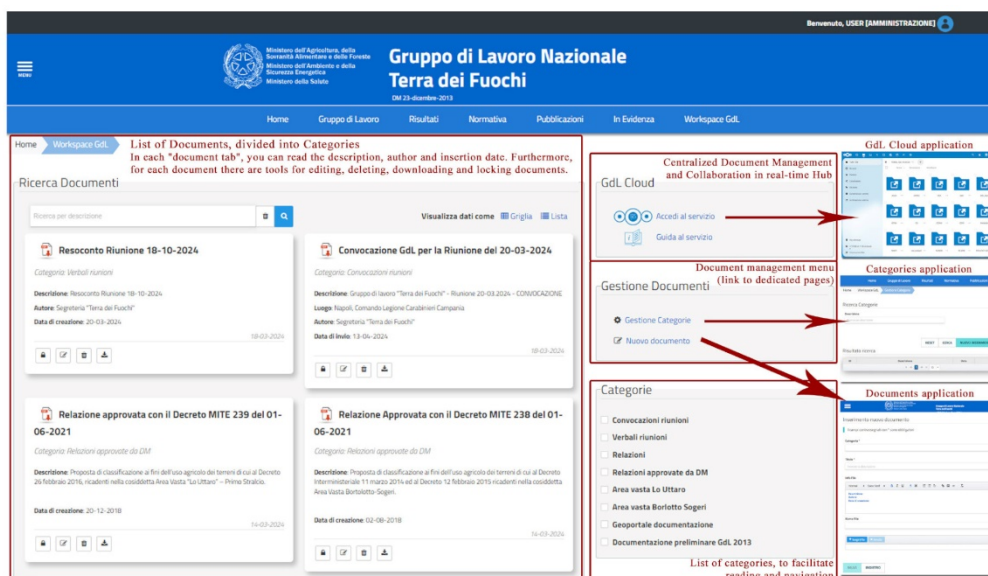


Figure 9 - Layout of 'Workspace GdL' Page and Document Management Application.

Discussion and Conclusion

In a crisis management process, there is a strong need to make decisions and transform measures into actions. Informed decision-making at any stage of a crisis, from reduction to recovery, requires a considerable volume of data and information. However, the data required for such actions are generally voluminous, diverse in coverage and quality, not always up-to-date and, above all, provided by different research areas and organizations.

Although access to existing data is a fundamental pillar for rapid crisis response, the effective sharing and manipulation of various sources is a major concern to public authorities who, in a crisis, are looking for technologies that facilitate the harmonization and integration of these data. One of the most strategic components for efficient and effective crisis management is the availability of an infrastructure to support information sharing.

In this context, the principal focus of the WG TdF Platform is to transfer and disseminate standardized data, knowledge, and technologies to develop strategies for the *Land of Fires* crisis and facilitate the authorities in the decision process. The 'GIS Dashboard' is an example of effective georeferenced information visualization and sharing on the World Wide Web. The platform's basic and analytical applications help in revealing trends, patterns and relationships that might be more difficult or obscure to discover in tabular or other formats.

Moreover, the dedicated workspace for the TdF-WG (Workspace GdL) serves as a central hub for collaboration, data collection and management, and decision support within the crisis management framework. This workspace provides TdF-WG members with the tools and resources necessary to exchange information, coordinate efforts, and formulate effective strategies in response to crises. Through this collaborative environment, users can access, analyze and share critical data in real time, enhancing the overall efficiency and effectiveness of crisis response efforts.

Given the extremely sensitive nature of the subject, potential issues regarding data sharing and dissemination were anticipated. Concerns mainly stemmed from the perception of data ownership, privacy and public access, unclear policies on sharing agreements, and liability (Mathys and Boulos 2011). These issues have been clarified and addressed through various consultations, roundtable discussions, and meetings within the TdF-WG. Currently, the classified cadastral parcels and the analytical results available on the platform stand as the real answer to the initial perception of possible concerns. The activities of the TdF-WG are still ongoing and the platform continuously integrates data as they become available.

Furthermore, from the perspective of transparency, embracing collaborative technologies and open licensing, as evidenced by the publicly accessible GitHub repository, promises to enhance the dissemination and reuse of data generated by the TdF-WG. This approach has the potential to improve the efficiency of public service operations, promote transparency in innovation creation, and foster collaborative endeavors aimed at addressing public challenges (Mergel 2015). TdF-WG offers an approach to information and expertise sharing among technical-scientific institutes, universities, and specialized police forces. This collaborative model serves as a pioneering framework that could be replicated in other regions and at a national as well as international scale. Not only does it enhance the efficacy of immediate responses, but also contributes to a sustainable strategy for long-term crisis preparedness and mitigation, showcasing a blueprint for enhancing communication and collaboration models in diverse contexts of crisis, both nationally and internationally. The TdF-WG platform is continuously evolving to become more portable and accessible. Utilizing advanced tools and technologies to simplify installation, the platform can be easily implemented and customized by various stakeholders. The ongoing improvements aim to enable regional, national, and international entities to adapt the platform to their specific needs, enhancing operational efficiency and strategic capacity. Despite potential challenges, this versatile framework provides a strong foundation for improving communication and collaboration in diverse crisis scenarios worldwide. In the future, the portal is poised to evolve into a dynamic workspace for active collaboration and dissemination among institutions tasked with the autonomous organization and management of public content, according to their specific expertise or institutional roles. This forward-thinking approach will enhance the operational efficiency and strategic capacity of each participating entity.

Conflict of interest statement

No potential conflict of interest was reported by the authors.

#TdF-Working Group

Gen. C.A. Andrea Rispoli, Gen. B. Ciro Lungo, Col. Antonio Zumbolo, Ten. Col. Pasquale Starace and Ten. Col. Sandra Martinelli (The Command of the Forest, Environmental and Agri-food units of the Carabinieri, CUFAA); Rita Aromolo and Silvia Socciarelli (Research Centre for Agriculture and Environment, CREA); Vincenzo Fiano and Fabio Pascarella (Institute for Environmental Protection and Research, ISPRA); Eleonora Beccaloni (Italian National Institute

of Health, ISS); Angelo Ferraro and Paolo Sarnelli (Directorate Generals for Environment, Agriculture and Health of the Campania Region); Massimo Fagnano (Department of Agricultural Sciences of the University of Naples Federico II); Luigi Brillo and Francesco Sofia (Paying Agency for Agriculture, AGEA); Antonio Limone (Istituto Zooprofilattico Sperimentale del Mezzogiorno, IZSM); Marco Marchetti (National Institute of Geophysics and Volcanology, INGV).

References

A toxic legacy. 2014. Nature Editorial, 508, 431, doi:10.1038/508431a.

Alberti P. 2022. The 'land of fires': epidemiological research and public health policy during the waste crisis in Campania, Italy. *Heliyon.*; 8(12):e12331. doi: 10.1016/j.heliyon.2022.e12331.

Cembalo L., Caso D., Carfora V., Caracciolo F., Lombardi A., Cicia G. 2018. The “Land of Fires” Toxic Waste Scandal and Its Effect on Consumer Food Choices. *International Journal of Environmental Research and Public Health*, 16 (1).

Comba P., Bianchi F., Fazzo L., Martina L., Menegozzo M., Minichilli F., Mitis F., Musmeci L., Pizzuti R., Santoro M., Trinca S., Martuzzi M. 2006. Health Impact of Waste Management Campania Working Group. Cancer mortality in an area of Campania (Italy) characterized by multiple toxic dumping sites. *Ann N Y Acad Sci.* 1076, 449-61.

De Felip E. & Di Domenico A. 2010. Studio epidemiologico sullo stato di salute e sui livelli d'accumulo di contaminanti organici persistenti nel sangue e nel latte materno in gruppi di popolazione a differente rischio d'esposizione nella Regione Campania. SEBIOREC. (<https://speciali.espresso.repubblica.it/pdf/sebiorec2010.pdf>, accessed on 18 January 2024).

De Felip E., Bianchi F., Bove C., Cori L., D'Argenzio A., D'Orsi G., et al. 2014. Priority persistent contaminants in people dwelling in critical areas of Campania Region, Italy (SEBIOREC biomonitoring study). *Sci. Total Environ.* 487, 420-435.

Decree-law n. 136 of 10 December 2013. Disposizioni urgenti dirette a fronteggiare emergenze ambientali e industriali ed a favorire lo sviluppo delle aree interessate. *Gazzetta Ufficiale della Repubblica Italiana* n. 289 of 10/12/2013.

Decree of 11 March 2014, Indicazione dei terreni della regione Campania da sottoporre ad indagini dirette, ai sensi dell'articolo 1, comma 6, del decreto-legge 10 dicembre 2013, n. 136, convertito, con modificazioni, dalla legge 6 febbraio 2014, n. 6, nonche' interdizione dalla commercializzazione di prodotti agricoli. *Gazzetta Ufficiale della Repubblica Italiana* n. 75 of 31/03/2014.

Decree of 12 February 2015, Indicazione dei terreni della regione Campania da interdire alla produzione agroalimentare, da destinare esclusivamente a colture diverse in considerazione delle capacità fitodepurative, ovvero solo a determinate produzioni agroalimentari, nonché di quelli da sottoporre ad indagini dirette, con contestuale interdizione dalla commercializzazione di prodotti agricoli, ai sensi dell'articolo 1, comma 6, del decreto-legge 10 dicembre 2013, n. 136, convertito, con modificazioni, dalla legge 6 febbraio 2014, n. 6. *Gazzetta Ufficiale della Repubblica Italiana* n.56 of 09/03/2015.

Decree of 7 July 2015, Decreto interministeriale ai sensi dell'articolo 1, comma 6, del decreto-legge 10 dicembre 2013, n. 136, convertito, con modificazioni, dalla legge 6 febbraio 2014, n. 6. *Gazzetta Ufficiale della Repubblica Italiana* n. 191 of 19/08/2015.

Decree of 3 April 2017, Individuazione, a seguito delle indagini dirette, di terreni agricoli della Regione Campania, ai sensi dell'articolo 1, comma 6, del decreto-legge 10 dicembre 2013, n. 136, convertito, con modificazioni, dalla legge 6 febbraio 2014, n. 6. *Gazzetta Ufficiale della Repubblica Italiana* n. 88 of 14/04/2017.

Decree of 1 June 2021 - MITE n. 238, Adozione della classificazione ai fini dell'uso agricolo relativamente all'Area vasta Bortolotto-Sogeri. *Gazzetta Ufficiale della Repubblica Italiana* n. 168 of 16/07/2021.

Decree of 1 June 2021 - MITE n. 239, Adozione della Classificazione ai fini dell'uso agricolo relativamente all'Area Vasta Lo Uttaro – Primo Stralcio. Gazzetta Ufficiale della Repubblica Italiana n. 168 of 16/07/2021.

Di Lorenzo A., Di Sabatino D., Cioci D., Conte A., Bruno R., Sauro F., Calistri P., Savini L. 2016. The Arbo-zoonet Information System. *Veterinaria Italiana*, 52 (2), 161-168.

Di Lorenzo A., Zenobio V., Cioci D., Dall'Acqua F., Tora S., Iannetti S., Rulli M., Di Sabatino D. 2023. A web-based geographic information system monitoring wildlife diseases in Abruzzo and Molise regions, Southern Italy. *BMC Vet Res*, 19 (183).

Diletti G., Ceci R., Conte A., De Benedictis A., Migliorati G., Scortichini G. 2008. Milk contamination from dioxins in Italy: source identification and intervention strategies. In: Mehmetli E, Koumanova B, (eds). *The fate of persistent organic pollutants in the environment*. NATO Science for Peace and Security Series. Springer, Dordrecht.

Drabek, T.E. & Hoetmer, G.J. 1991. *Emergency management: principles and practice for local government*. International City Management Association.

Ducci D., Albanese S., Boccia L., Celentano E., Cervelli E., Corniello A., Crispo A., De Vivo B., Iodice P., Langella C., Lima A., Manno M., Palladino M., Pindozi S., Rigillo M., Romano N., Sellerino M., Senatore A., Speranza G., Fiorentino N., Fagnano M. 2017. An Integrated Approach for the Environmental Characterization of a Wide Potentially Contaminated Area in Southern Italy. *International Journal of Environmental Research and Public Health*. 14(7):693. <https://doi.org/10.3390/ijerph14070693>.

Esposito M., Cavallo S., Rosato G., Chiaravalle E., Miedico O., Pellicanò R., Soprano V., Baldi L. 2016. Levels of trace elements in the fruits and vegetables from the so-called Land of fires in Campania Region (Southern Italy). *Epidemiologia&Prevenzione*, <https://epiprev.it/3458>.

Esposito F., Nardone A., Fasano E., Scognamiglio G, Esposito D., Agrelli D., Ottaiano L., Fagnano M., Adamo P., Beccaloni E., Vanni F., Cirillo T. 2018. A systematic risk characterization related to the dietary exposure of the population to potentially toxic elements through the ingestion of fruit and vegetables from a potentially contaminated area. A case study: The issue of the "Land of Fires" area in Campania region, Italy. *Environ Pollut*. 243(Pt B):1781-1790. doi: 10.1016/j.envpol.2018.09.058.

Ministerial Directive of 23 December 2013. Indicazioni per lo svolgimento delle indagini tecniche per la mappatura dei terreni della Regione Campania destinati all'agricoltura di cui all'articolo 1, comma 1, del decreto-legge 10 dicembre 2013, n. 136.

Ministerial Directive of 16 April 2014. Definizione, ai sensi dell'articolo 1, comma 5, secondo periodo, del decreto-legge 10 dicembre 2013, n. 136, convertito, con modificazioni, dalla legge 6 febbraio 2014, n. 6, degli ulteriori territori da sottoporre alle indagini tecniche per la mappatura dei terreni della Regione Campania destinati all'agricoltura di cui all'articolo 1, comma 1, del medesimo decreto-legge. (<https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/7585#main>, accessed on 15 February 2024).

Interministerial Directive of 10 December 2015. Individuazione, ai sensi dell'articolo 1, comma 6.1, del decreto-legge 10 dicembre 2013, n. 136, convertito, con modificazioni, dalla legge 6 febbraio 2014, n. 6, degli ulteriori terreni agricoli da sottoporre alle indagini tecniche per la mappatura dei terreni della Regione Campania destinati all'agricoltura di cui all'articolo 1, comma 1, del medesimo decreto-legge e variazione della composizione del gruppo di lavoro di cui all'articolo 1, comma 2, della direttiva del 23 dicembre 2013. (<https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/9558>, accessed on 15 February 2024).

Fazzo L., De Santis M., Mitis F., Benedetti M., Martuzzi M., Comba P., Fusco M. 2011. Ecological studies of cancer incidence in an area interested by dumping waste sites in Campania (Italy). *Ann Ist Super Sanita*. 47 (2), 181-91.

Gerbino C. 2020. Emergenza COVID-19: dati, standard ed interoperabilità o solo dashboard? *GEOmedia*, 24 (1) (<https://mediageo.it/ojs/index.php/GEOmedia/article/view/1719> accessed on 19 January 2024).

Giovannini A., Rivezzi G., Carideo P., Ceci R., Diletti G., Ippoliti C., et al. 2014. Dioxins levels in breast milk of women

living in Caserta and Naples: assessment of environmental risk factors. *Chemosphere*, 94, 76-84.

Gong J., Shi L., Du D., de By R.A. 2004. Technologies and standards on spatial data sharing. In ISPRS 2004: proceedings of the XXth ISPRS congress: Geo-imagery bridging continents, 12-23 July 2004, Istanbul, Turkey. Comm. IV WG IV/2. pp. 118-128. International Society for Photogrammetry and Remote Sensing (ISPRS). http://www.itc.nl/library/Papers_2004/peer_conf/deby.pdf.

Ierardi M. 2020. La piattaforma Esri come supporto essenziale alla fase 2 dell'emergenza Covid-19. *GEOmedia*, 24 (1). (<https://ojs.mediageo.it/index.php/GEOmedia/article/view/1717> accessed on 19 January 2024).

Lambiase S., Serpe F.P., Cavallo S., Rosato G., Baldi L., Neri B. & Esposito M. 2017. Occurrence of polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) in eggs from free-range hens in Campania (southern Italy) and risk evaluation, *Food Additives & Contaminants: Part A*, 34 (1), 56-64.

Law No. 6 of 6 February 2014, Conversione in legge, con modificazioni, del decreto-legge 10 dicembre 2013, n. 136, recante disposizioni urgenti dirette a fronteggiare emergenze ambientali e industriali ed a favorire lo sviluppo delle aree interessate. *Gazzetta Ufficiale della Repubblica Italiana* n. 32 of 08/02/2014.

Legambiente. 2003. Rapporto Ecomafia 2003. L'illegalità ambientale in Italia e il ruolo della criminalità organizzata, Rome, p. 27.

Legambiente. 2013. Terra dei fuochi: radiografia di un ecocidio - I numeri, le responsabilità, le conseguenze sulla salute dei cittadini e le proposte di Legambiente. Roma 18 settembre 2013. (<https://dokumen.tips/documents/terra-dei-fuochi-radiografia-di-un-orlando-a-ribadire-in-una-lettera-indirizza.html?page=1> accessed on 11 January 2024).

Legambiente Dossier. 2015. Terra dei Fuochi, a che punto siamo? Caserta 10 febbraio 2015. (<https://legambiente.campania.it/wp-content/uploads/2015/02/TdF-a-che-punto-siamo.pdf> accessed on 11 January 2024).

Marfella A. 2021. Terra dei Fuochi, lo studio Spes ha rilevato elementi tossici nel siero dei volontari. Ma nessuno li ha avvertiti. *Il Fatto Quotidiano*. (<https://www.ilfattoquotidiano.it/2021/05/07/terra-dei-fuochi-lo-studio-spes-ha-rilevato-elementi-tossici-nel-siero-dei-volontari-ma-nessuno-li-ha-avvertiti/6188565/> accessed on 18 January 2024).

Martuzzi M., Mitis F., Bianchi F., Minichilli F., Comba P., Fazzo L. 2009. Cancer mortality and congenital anomalies in a region of Italy with intense environmental pressure due to 15 waste. *Occup. Environ. Med.* 66, 725-732.

Mathys T. & Kamel Boulos M.N. 2011. Geospatial resources for supporting data standards, guidance and best practice in health informatics. *BMC Res Notes*. 4 (19).

Mergel I. 2015. Open collaboration in the public sector: The case of social coding on GitHub. *Government Information Quarterly*, 32 (4), 464-472.

Pierrri B., Buonerba C., Pierrri A., Pizzolante A., Ferro A., Crispo A., Bollati V., Sanchez T. R., Grazia Andreassi M., Esposito M., Cerino, P. 2021. Exposure study on susceptible people - SPES: An integrative biomonitoring approach. *Environment International*, 158, 106931.

Rivezzi G., Piscitelli P., Scortichini G., Giovannini A., Diletti G., Migliorati G., Ceci R., Rivezzi G., Cirasino L., Carideo P., et al. 2013. A General Model of Dioxin Contamination in Breast Milk: Results from a Study on 94 Women from the Caserta and Naples Areas in Italy. *International Journal of Environmental Research and Public Health*. 10 (11), 5953-5970.

Senior K. & Mazza A. 2004. Italian "Triangle of Death" linked to waste crisis. *Lancet Oncol.* 5 (9), 525-527.

Siniscalchi S. 2022. The "Terra dei Fuochi" in Campania. *Belgeo* [En ligne], 4 | 2022, mis en ligne le 24 avril 2023, consulté le 22 janvier 2024. URL: <http://journals.openedition.org/belgeo/58750>. DOI: <https://doi.org/10.4000/belgeo.58750>.

SPES 2021. Studio di Esposizione sulla Popolazione Suscettibile. (<http://spes.campaniatrasparente.it/> accessed on

18 January 2024).

Summary of Ministerial Directives of 23 December 2013. Indicazioni per lo svolgimento delle indagini tecniche per la mappatura dei terreni della Regione Campania destinati all'agricoltura di cui art. 1, comma 1 DL 10.12.2013 n. 136. (https://www.salute.gov.it/imgs/C_17_pubblicazioni_2131_allegato.pdf accessed on 20 February 2024).

Ulaszewska M.M., Zuccato E., Capri E., Iovine R., Colombo A., Rotella G., Generoso C., Grassi P., Fanelli R., Melis M. 2011. The effect of waste combustion on the occurrence of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs) in breast milk in Italy. *Chemosphere*, 82 (2011), pp. 1-8.

Zhang C. & Li W. 2005. The Roles of Web Feature and Web Map Services in Real-time Geospatial Data Sharing for Time-critical Applications. *Cartography and Geographic Information Science*, 32 (4), 269-283.