Interreg Co-funded by the European Union

Italy – Croatia

Digital Plan

Project DIGITAL PLAN

Activity 1.5 Development of Internet of Things Decision Support System Platform

Deliverable n. D.1.5.1 IoT DSS Platform

LP1 GAL Molise

Project Acronym	Digital Plan
Project ID Number	ITHR0200430
Project Title	Civil Protection Plan Digitalization through Internet of Things Decision Support System based Platform
Priority Axis	2 - Green and resilient shared environment
Specific objective	SO 2.1 - Climate change adaptation
Work Package	WP1 Digitalization model of civil protection plans and IoT EDSS Platform Development
Activity	A.1.5 Development of Internet of Things Decision Support System Platform
Deliverable	D.1.5.1 IoT DSS Platform
Partner in Charge	LP GAL Molise
Status	Final
Distribution	Public

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About Digital Plan Project

The main objective of the project is the digitalization of civil protection plans, already operatives in the territorial areas of competence of the PPs, to improve the capacity of local authorities to investigate the risks present, to define common operational methods of action in the event of a disaster and in particular to share all the emergency planning with other bodies and agencies in charge of rescue, for compress intervention times, and with the population.

Project Relevance

The selected theme of digitalization of CP Plans represents a common interest for Italian and Croatian territories that present similar problems and demand common transnational solutions. Fragmentation of the area and different status of civil protection systems create heterogeneity in hazard handling. Yet, risks and disasters, sure enough, do not recognize state borders and other boundaries imposed by human conventions and treaties. Common risks affect the whole area and the need for a homogeneous, interoperable, and EU-integrated approach is a necessity. This means both homogenizing plans and procedures in the area and presenting common tools for civil protection plan digitalization.

Further to homogenization, such a plan, its accompanying capacity building and training, and its adoption by partners will strengthen the administrative and technical capacities of local authorities in managing hazardous and emergencies. Moreover,

partners will benefit from the transnational process of exchange of know-how and from a common basis of knowledge and experience, which will help individual solutions for enhancing resilience in uniformly dealing with natural and man-made hazards within the involved territories. By empowering territorial resilience, the project reduces overall Italian and Croatian programme area vulnerability through extensive information interchange in both vertical and horizontal directions.

The Digital Plan project will contribute to disaster risk reduction, and management efficiency both in the planning phase and in emergencies, collaborating in the building of resilience in the Adriatic region, through the strengthening of cross-border territorial cooperation with the help of innovative technologies both through DSS (Decision Support System) and through the integration of IoT (Internet of Things) sensors.

A poor sharing of emergency planning and management tools and the effects of forecast and ongoing climate change such as extreme weather events, floods, droughts, increased temperatures, and major snow events are a "powder keg" in the world of risk management and the emergency.

The cooperation between the territories of Italy and Croatia, with this project, supports the strengthening of resilience in all sectors of activity in the field of civil protection; then the focus risks of the project, chosen by the PPs, identify innovative technological tools and to support decisions, also with climate adaptation actions.

The territories of the PPs, given the short distances, also share the impacts of multiple extreme phenomena with meteorological or seismic forcing, for which it is essential to

share knowledge, skills, and equipment in the event of disaster response, but also during the other phases of the resilience-building and contingency planning cycle.

Until now, the world of extreme events and climate change has been seen as two separate entities, but this is not correct. The main challenge derives from the assumption that good emergency response planning also makes it possible to identify and apply tools and climate adaptation actions.

This cross-border initiative is particularly needed while the entire Adriatic region is preparing to manage events related to climate change and the management of any emergency crises. Climate change mitigation and adaptation can only be achieved through an integrated approach of territorial cooperation and resilience building by endorsing the entire resilience cycle: planning and preparedness, prevention, response, mitigation, recovery, and adaptation towards a new equilibrium. The Deming cycle, the reference point of emergency planning (planning, execution, control, and adjustment), can be perfectly integrated into this cycle.

Finally, in the Sendai Framework for Disaster Risk Reduction (2015-2030), the project's actions support the ultimate goal of achieving results.

The 2015 Sendai Document and the United Nations International Strategy for Disaster Reduction emphasized the need to address disaster risk reduction and climate change adaptation in setting sustainable development goals.

The project with its actions goes precisely in this direction and specifically aims to improve the understanding of disaster risk, improve disaster preparedness for effective

response and rebuild better in the recovery phase by setting some overall objectives in the project actions such as increasing entities with their disaster risk reduction strategies and increasing the availability of and access to multi-hazard early warning systems and disaster risk information and assessments.

WP1: Digitalization model of civil protection plans and IoT EDSS Platform Development

WP1 aims to develop a cross border model for civil protection plan digitalization. It will be based on a set of activities, starting from collection of data from civil protection plans, selecting the risks affecting the plans, the emergency flow charts, open data sources like public and private platforms, websites and webcams, to carry out at preliminary analysis of the needs of each individual PPs and to study the local civil protection plans. Furthermore, WP1 also focuses on the development of a scalable and capitalizable IT platform that can achieve several goals: (i) digitization of civil protection plans; (ii) access to geolocated open data sources and IoT sensors; (iii) manage synthetic georeferenced environmental data. Given the ongoing impact of climate change and its potential to increase the frequency and severity of extreme weather events, a key component of the platform will involve conducting multivariate statistical analyses.

Activity 1.5 Development of Internet of Things Decision Support System Platform:

Starting Period: Period 1, 01.03.2024 - 31.08.2024

Ending period: Period 5, 01.03.2026 - 31.08.2026

LP1 will coordinate activity relates to develop a series of software modules, which firstly will be developed and tested individually then integrated into a single web enabled platform based on functional and technical specifications (WP2). The platform will be also tested applying pilot actions with IoT sensors. Subcontracted by public procurement managed by LP1, software houses will carry out the entire process of development and testing. The platform will include modules such platform willator, cartographic representation of risk scenarios & hazardous event, elements of emergency planning included in DB plan of activity 1.1, 1.2 and 1.2, user graphic interfaces. The web interface will have layered components that will be accessible by different users with different roles (public and private); the access privileges will define the components that each user can see and eventually modify.

The software architecture of the DSS will be based on a cloud micro-services approach. LP will produce the technical and user manuals of the platform. PP7 will make a training set (training contents and tutorials) to staff of local authorities that will use the platform to manage civil protection plans digitalized.

Layers and IoT DSS Platform:

The main objective of the web platform is to provide a back-office interface that simplifies data entry for partners. It enables both partners and experts to input the parameters required for the proper functioning of Decision Support Systems (DSS).

Platform architecture

The platform is organized into three main layers:

1. **Presentation Layer**

   This is the user interaction layer. It includes the front-end interface with maps, as well as the back-office area for managing data.
2. **Application Layer**

   This layer contains the business logic. It handles all operations related to data management, performs calculations, and integrates with the IoT system.
3. **Data Layer**

   This is the data storage layer. It consists of databases and object storage systems used to store both structured data and binary files.

Carthographic data: Vector and raster

When working with cartographic data, it's important to distinguish between vector data and raster data:

- **Raster data** is made up of a grid of cells or pixels, where each cell contains a value (e.g., temperature).
- **Vector data** represents geographic features using geometries such as points, lines, or polygons, and is generally more accurate since it's not limited by grid size.

Data analysis from questionnaires

Based on the questionnaires completed by partners during activity and 1.3, two main geographical categories were identified:

- **Area of Interest**
  These are the pilot areas defined by each partner (e.g., municipalities, river basins), including points of interest, reference data, and other relevant information.
- **Risk Areas**
  These refer to specific areas that must be monitored for each identified risk, including relevant points of interest and reference data.

All the data collected through the questionnaires are associated with vector geometries (points, lines, polygons).

This means the data must be stored in a database using a shared standard, with uniform table structures (e.g., same column names and formats). To ensure proper functionality of the web platform and allow for consistent data filtering and map visualization, the database structure requires standardization across all partners. This

includes defining common fields and formats for both the area of interest and for each identified risk and its associated resources.

Compilation Guidelines and Thematic layer questionnaire for digitalization of civil protection plans:

To gather and determine the data necessary for the digitisation of the Civil Protection Plan available within the civil protection/emergency plan to be digitalized in each partner territory LP GAL Molise administered to the partners a questionnaire containing guidelines and questions relevant to fulfil and gather the necessary geographical layers and data.

Geographical Information overview

The partnes have to determine geographical information that refers to data that include geographic coordinates. These data can be represented in various forms, including:

- **Point**
- **Line**
- **Polygon**
- **Raster**

Common file formats for geographic data include: .shp, .kml, .kmz, .dwg, .geojson, .geotiff, among others.

Each question in the thematic layer section offers the following answer choices:

- **The data is available**

  The information is already included in the civil protection/emergency plan and stored in the partner's database.

- **The data does not exist / is not applicable**

  The risk or resource is irrelevant in the area (e.g., avalanche risk in a non-mountainous municipality).

- **The data exists but is unavailable or not yet identified**

  The risk is present but lacks formal identification or accessible datasets (e.g., a known hazard not yet officially mapped or certified).

- **The data cannot be retrieved**

  The information is currently inaccessible due to lack of knowledge, expertise, or resources within the responsible authority.

Thematic Data Categories (Reference to Questionnaire Topics):

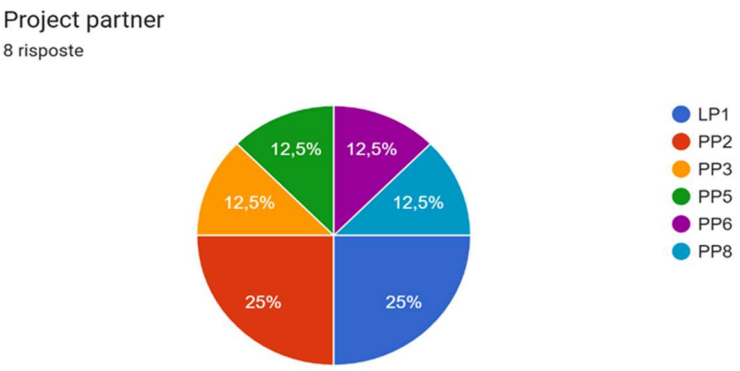
The questionnaire focuses on identifying the availability of key geographic data layers needed for civil protection planning, including:

- **Strategic and Operational Facilities**: Hospitals, emergency operation rooms, civil protection offices, police/fire stations, voluntary organization headquarters.
- **Critical Infrastructure**: Roads, access routes, essential service networks (electricity, water, gas, telecom), mobility hubs (ports, airports).
- **Risk Zones**: Seismic, flood, hydraulic, hydrogeological, forest fire, wildfire-urban interface, avalanche, volcanic, and tsunami risk areas.

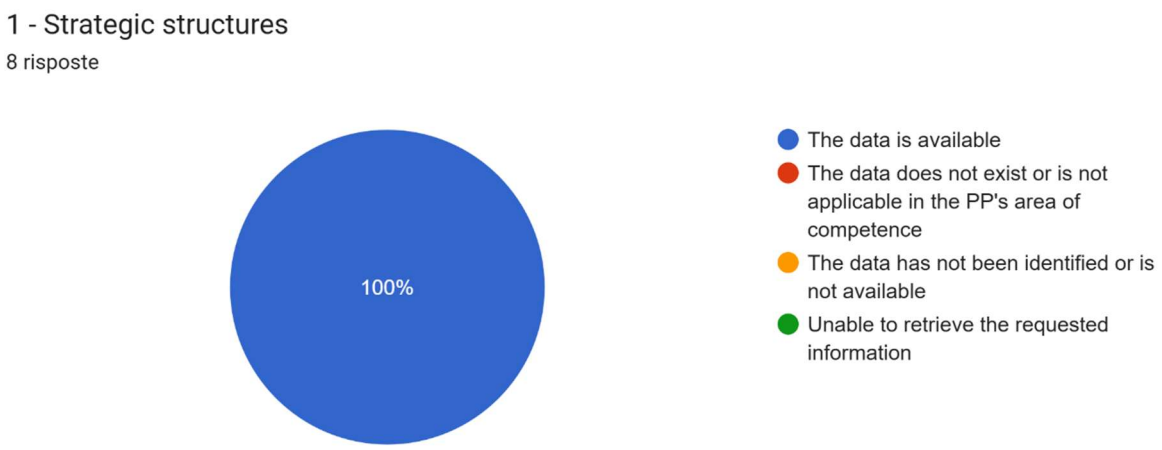
- **Environmental and Protected Areas**: Green zones, wooded areas, conservation areas.
- **Emergency Management Sites**: Assembly areas, arrival and assistance zones, semi-permanent settlements, helicopter landing zones.
- **Monitoring and Support Systems**: Sensor systems, radio and telecommunications infrastructure, observation points.
- **Resources and Supplies**: Fire hydrants, first aid supplies, material and equipment storage facilities.
- **Other Relevant Locations**: Livestock and agricultural facilities, production sites, emergency waste management areas, closure points, and critical locations highlighted in local CP plans.

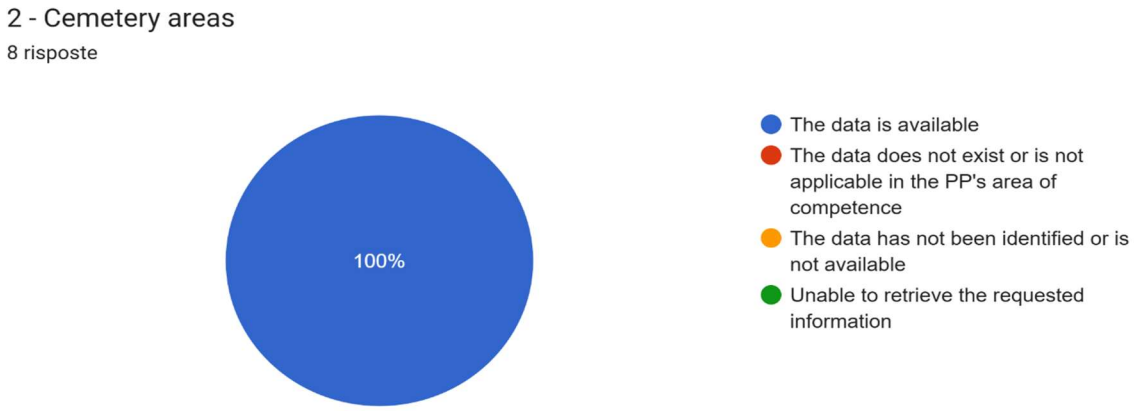
Partners involved and questionnaire results:

The project partners involved and that answered the questionnaire are: LP1 - GAL Molise, PP2 - AGRRA, PP3 - Parco Maiella, PP5 - Municipality of Dubrovnik, PP6 - RERA, PP8 - Municipality of Fermo.



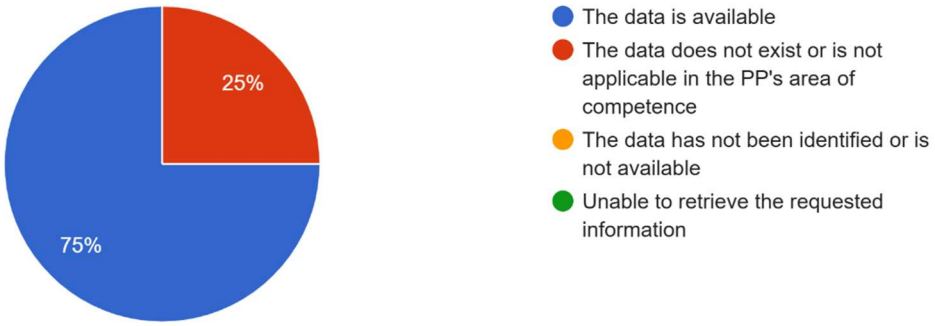
Following the visual and graphical analysis of each question's results in the





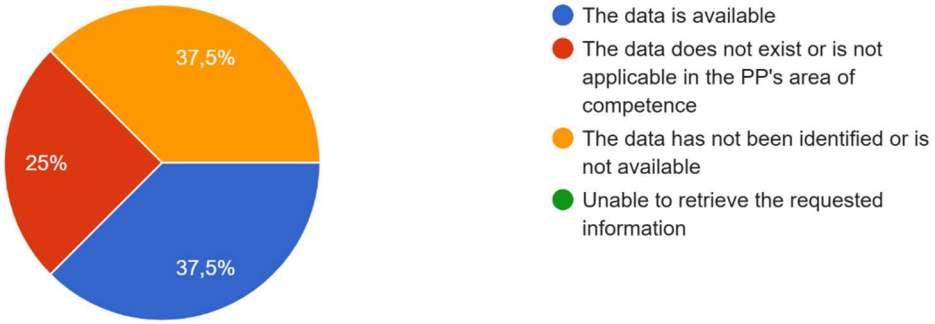
3 - Production facilities

8 risposte



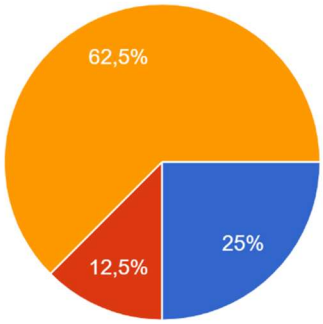
4 - Livestock facilities

8 risposte



5 - Animal shelters

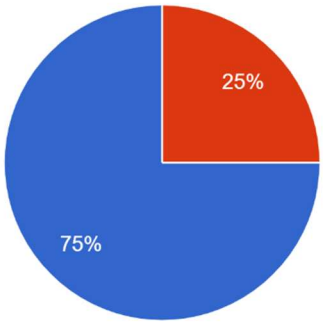
8 risposte



- The data is available
- The data does not exist or is not applicable in the PP's area of competence
- The data has not been identified or is not available
- Unable to retrieve the requested information

6 - Mobility infrastructure

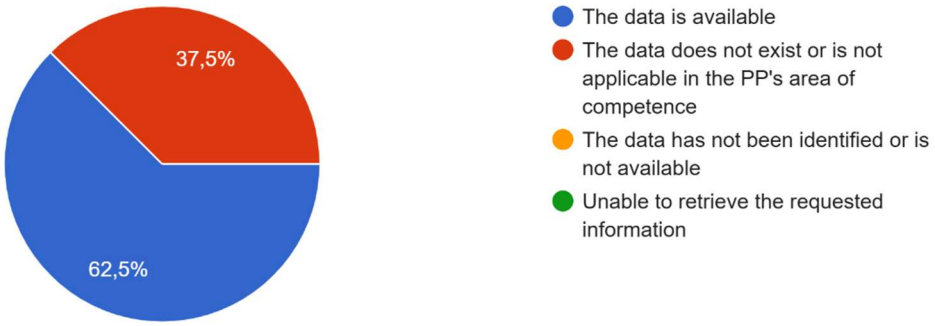
8 risposte



- The data is available
- The data does not exist or is not applicable in the PP's area of competence
- The data has not been identified or is not available
- Unable to retrieve the requested information

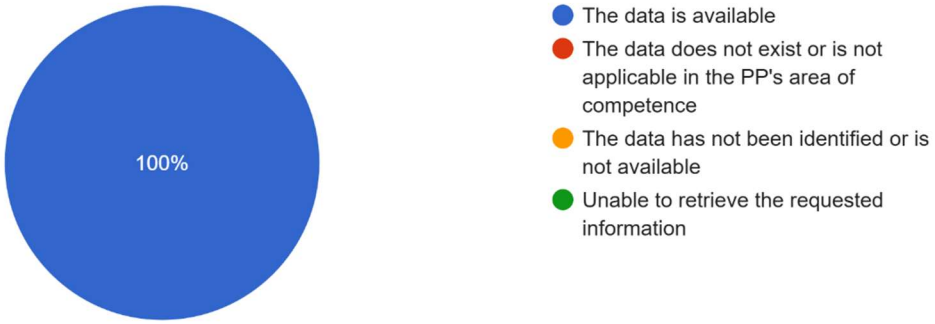
7 - Essential service networks

8 risposte



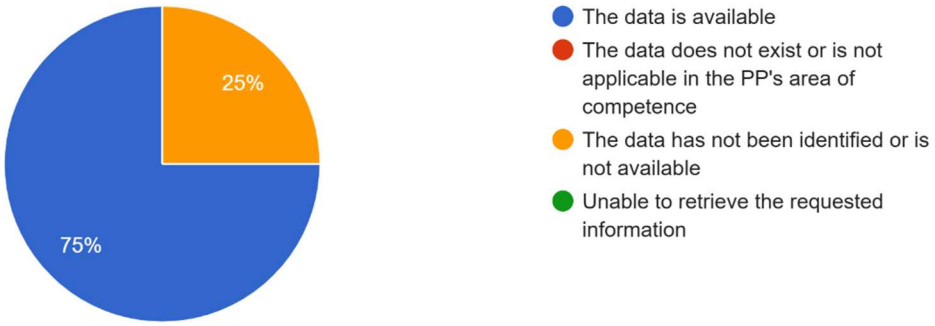
8 - Green wooded and protected areas

8 risposte



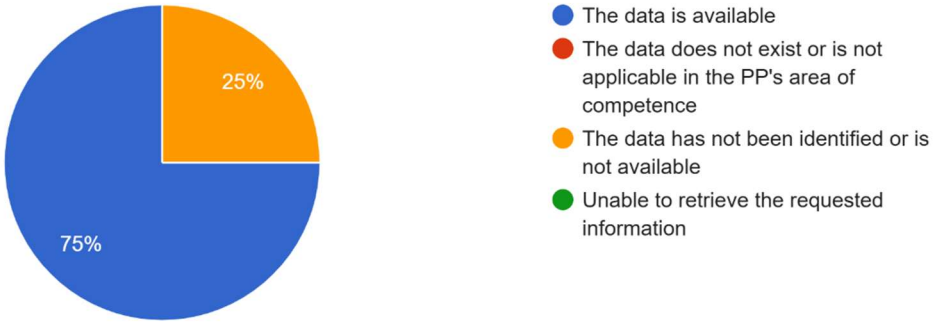
9 - Hydraulic risk areas

8 risposte



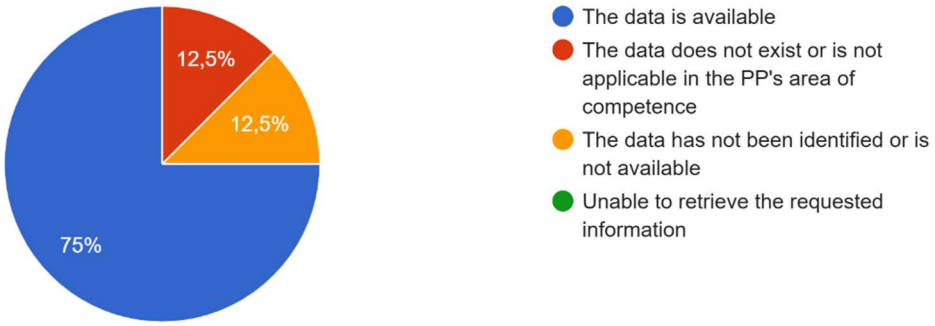
10 - Hydrogeological risk areas

8 risposte



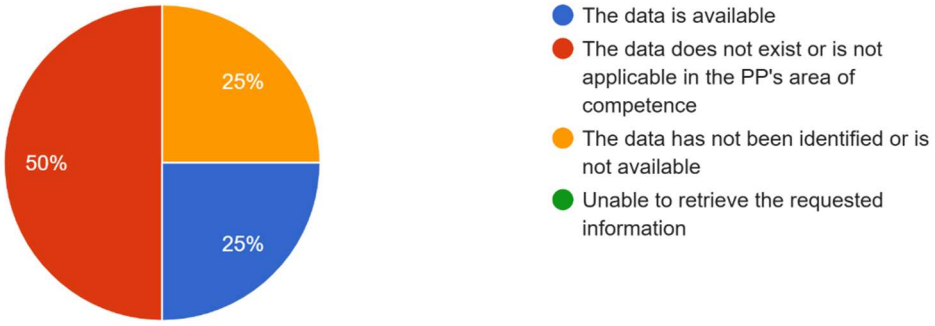
11 Critical points

8 risposte



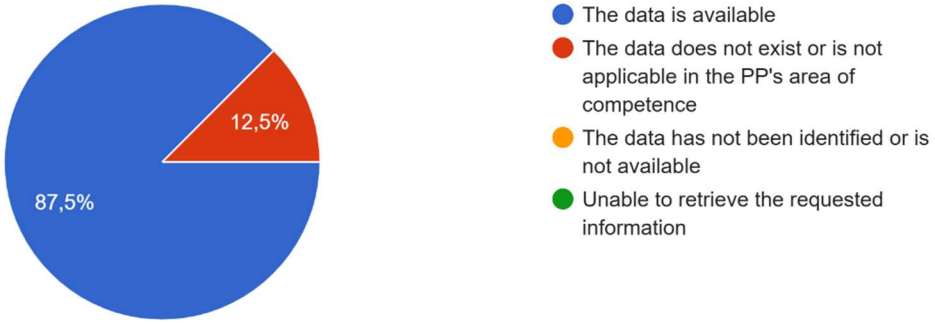
12 - Floodable areas due to dam collapse and rapid run-off of water

8 risposte



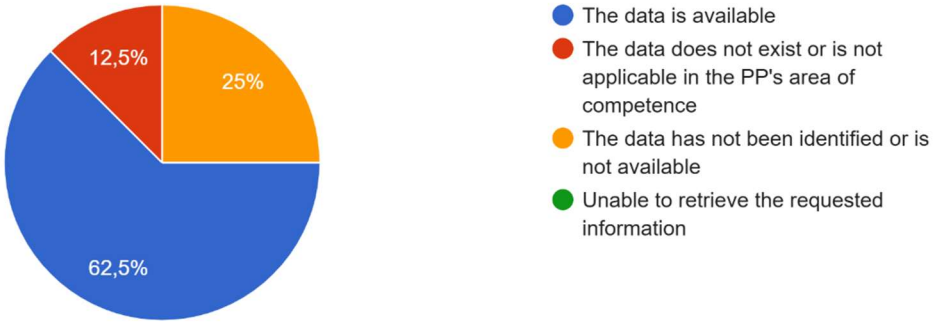
13 - Forest fire hazard areas

8 risposte



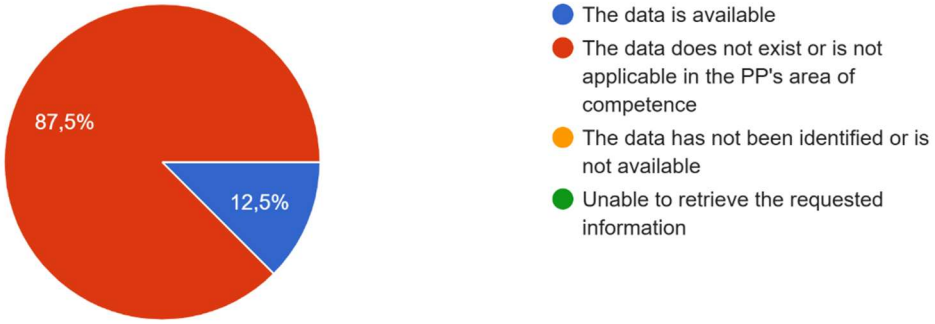
14 - Interface fire hazard areas

8 risposte



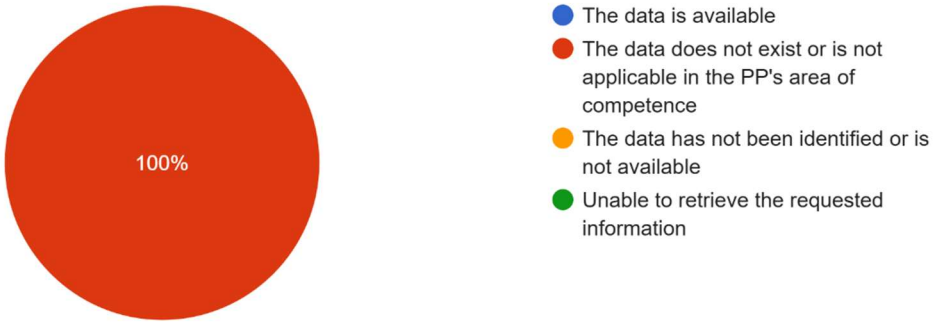
15 - Avalanche hazard areas

8 risposte



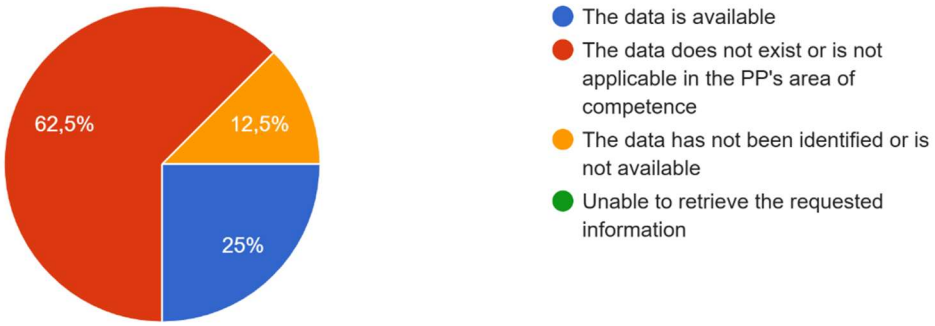
16 - Volcanic hazard areas

8 risposte



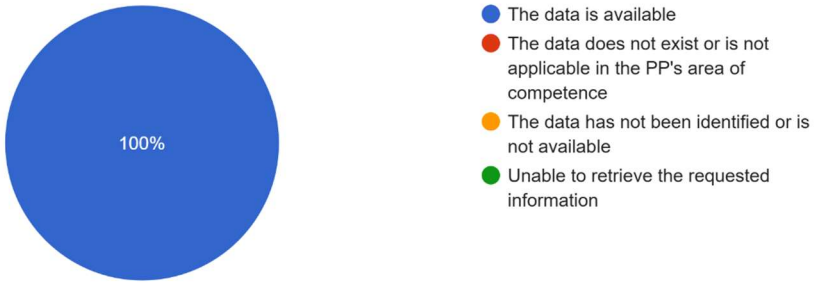
17 - Earthquake-induced tsunami hazard areas

8 risposte



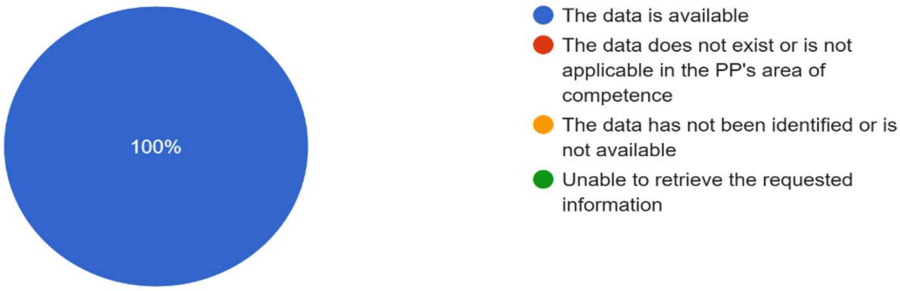
18 - Seismic hazard

8 risposte



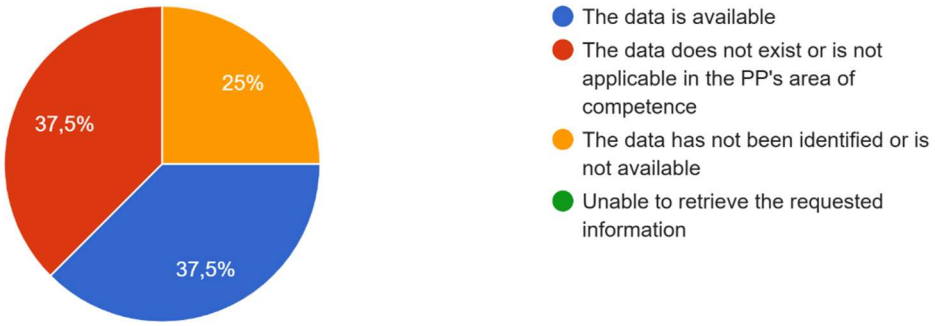
19 - Municipal Civil Protection Offices

8 risposte



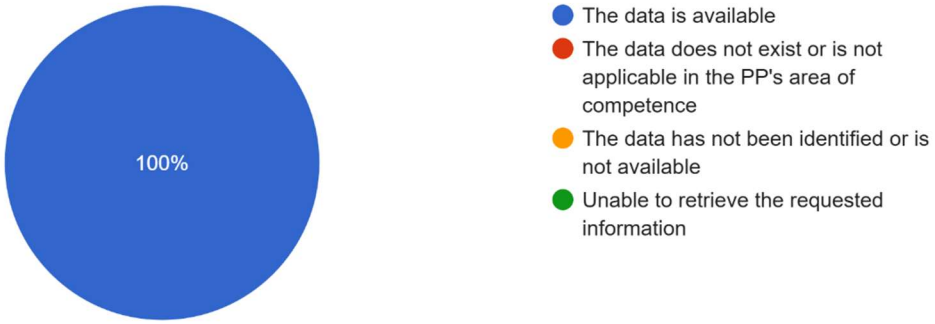
20 - Monitoring network

8 risposte



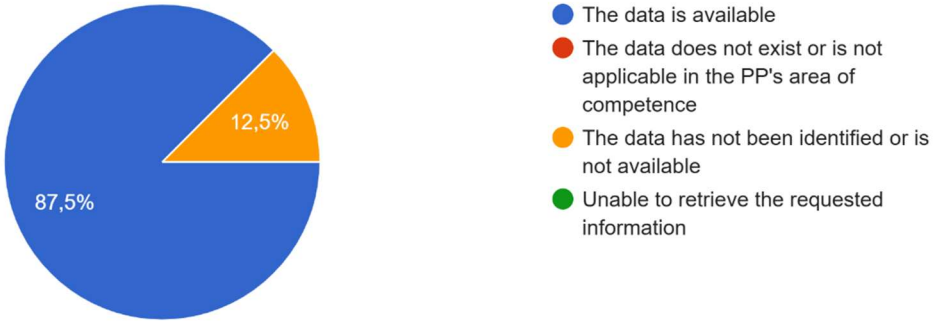
21 - Municipal Operations Center

8 risposte



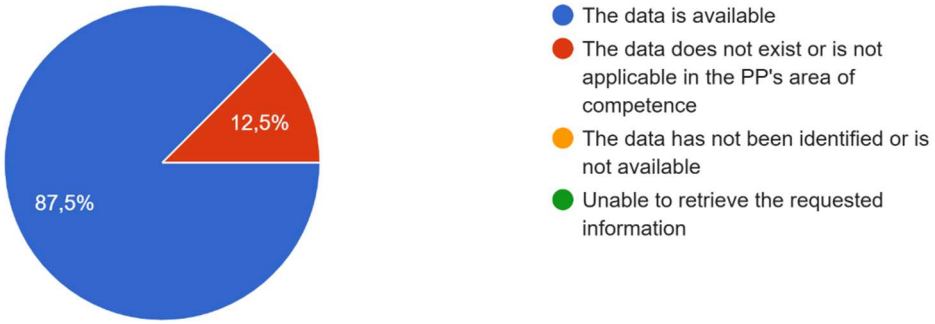
22 - Joint Operations Center

8 risposte



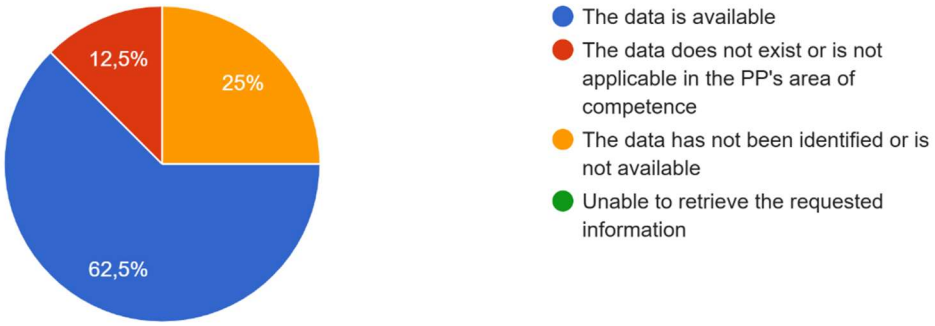
23 - Arrival point areas or population assistance areas

8 risposte



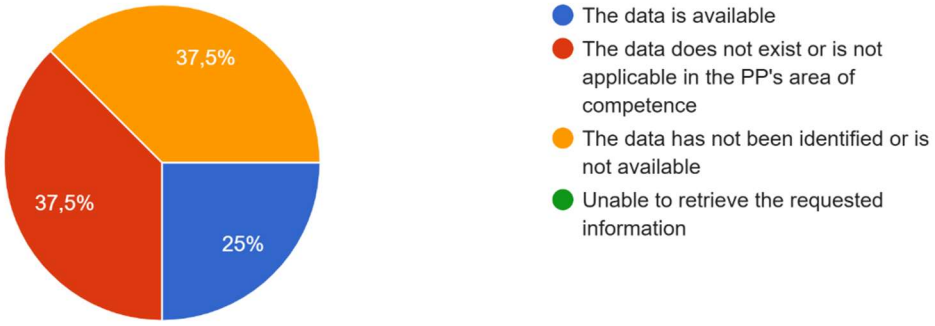
24 - Areas for gathering rescuers and for sheltering/assisting the population for field camps

8 risposte



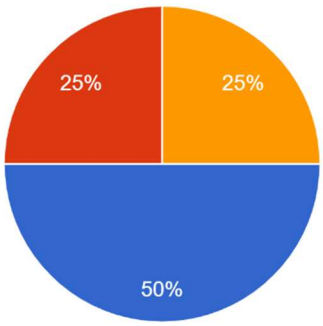
25 - Population Housing Assistance Centers

8 risposte



26 - Accommodation facilities

8 risposte



- The data is available
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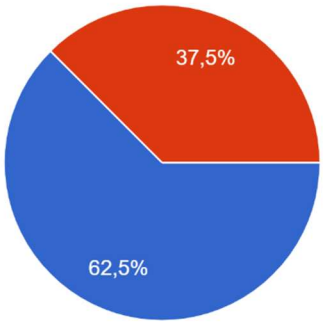
- The data has not been identified or is not available
- Unable to retrieve the requested information

27 - Helycopter landing areas

8 risposte



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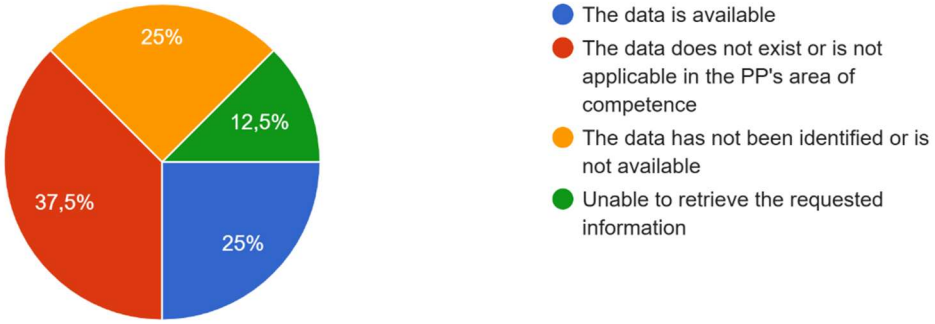
- The data does not exist or is not applicable in the PP's area of competence
- The data has not been identified or is not available
- Unable to retrieve the requested information

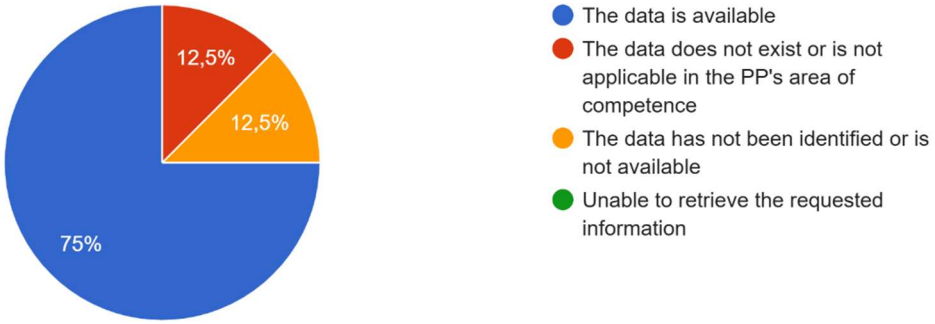
28 - Areas for semi-permanent settlements

8 risposte



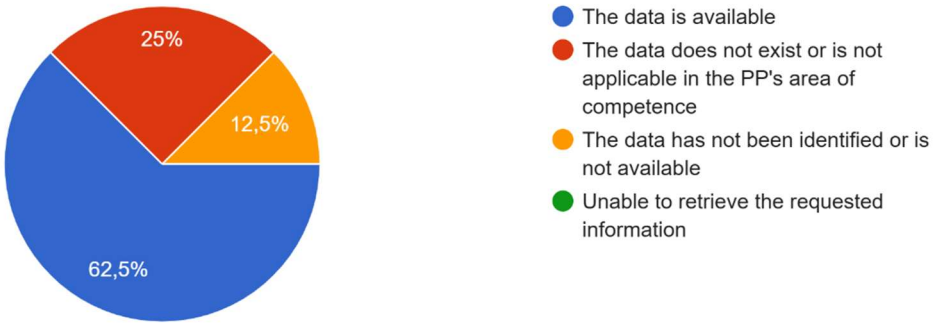
29 - Emergency waste management

8 risposte



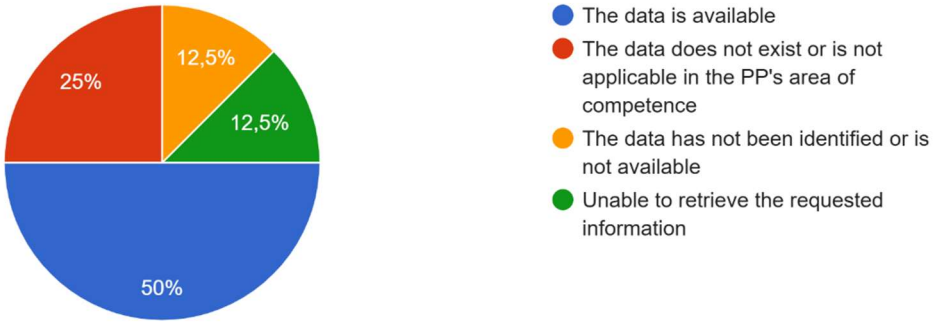
30 - Telecommunications system

8 risposte



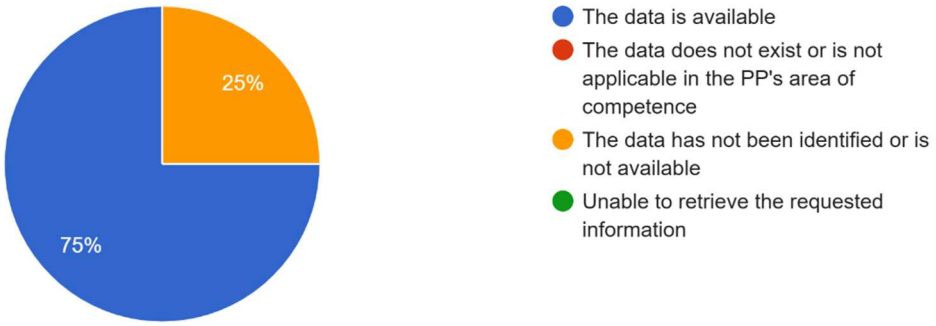
31 - Base Radio Stations

8 risposte



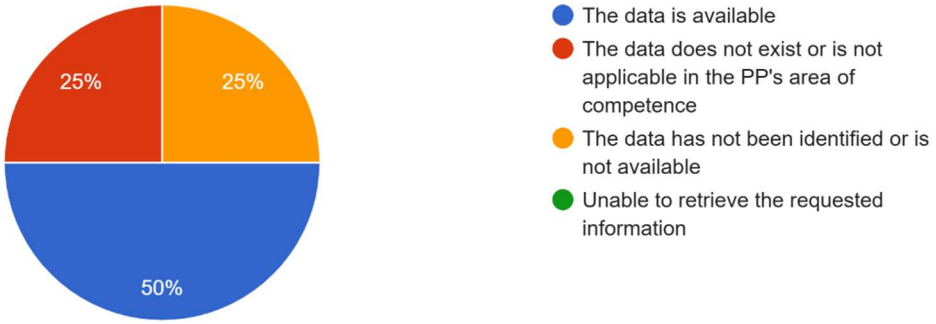
32 - Main accesses to the municipal territory

8 risposte



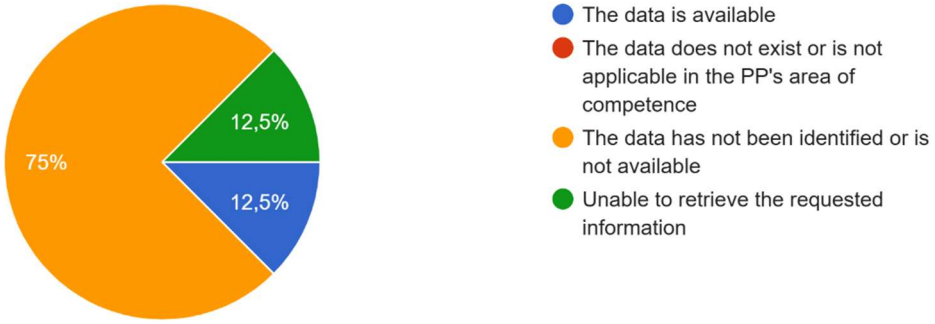
33 - Gates

8 risposte



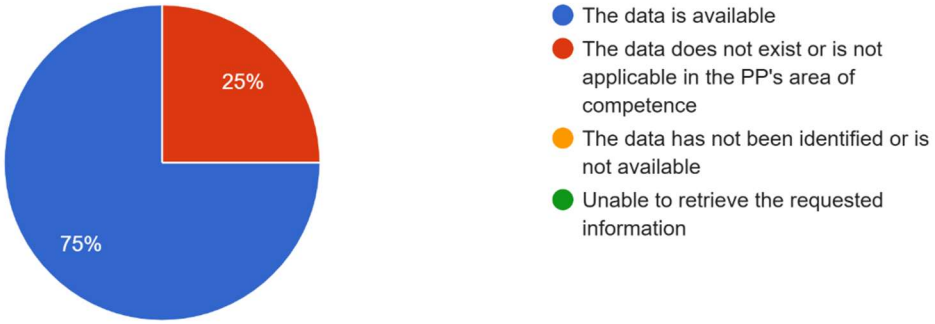
34 - Observation point

8 risposte



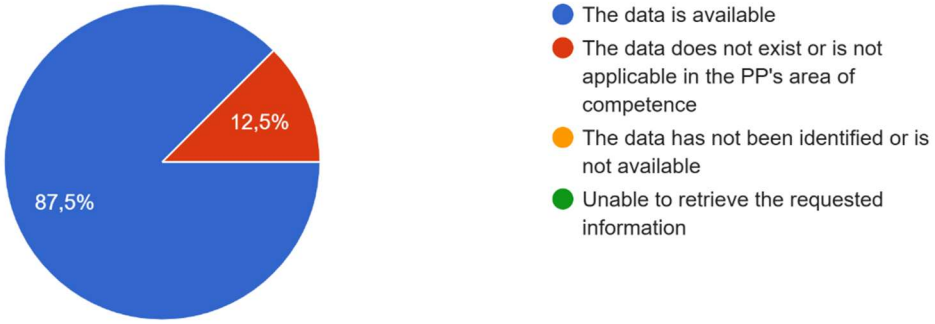
35 - Hospital and social-healthcare facilities

8 risposte



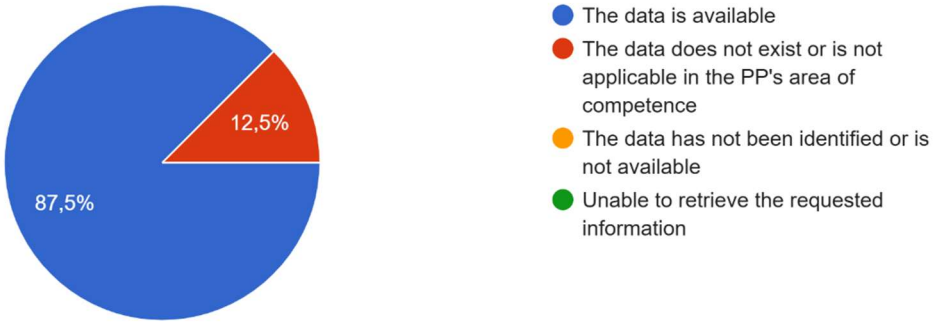
36 - Operational structures

8 risposte



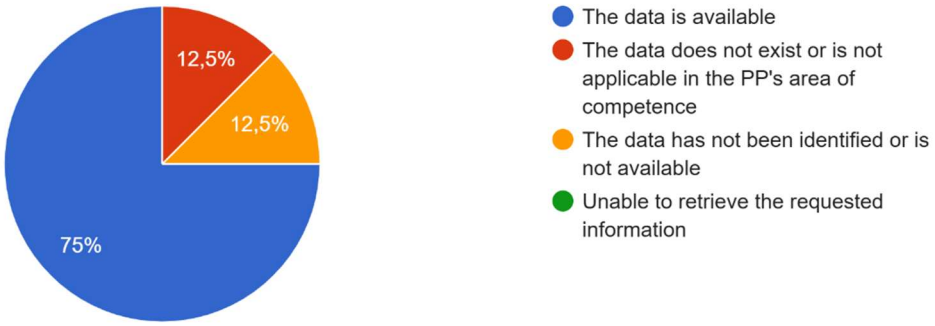
37 - Volunteer organizations

8 risposte



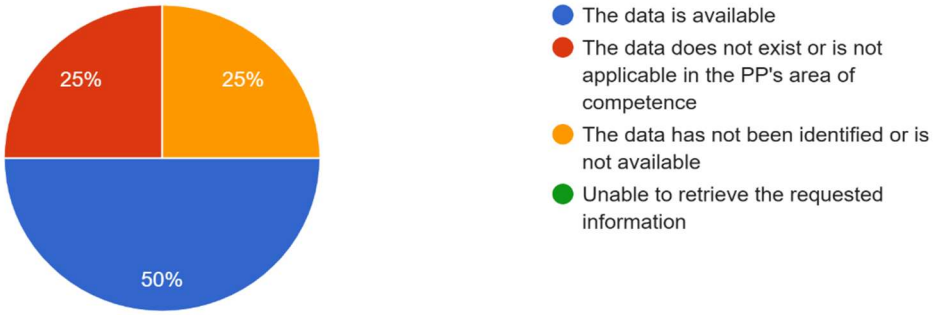
38 - Fire hydrant systems

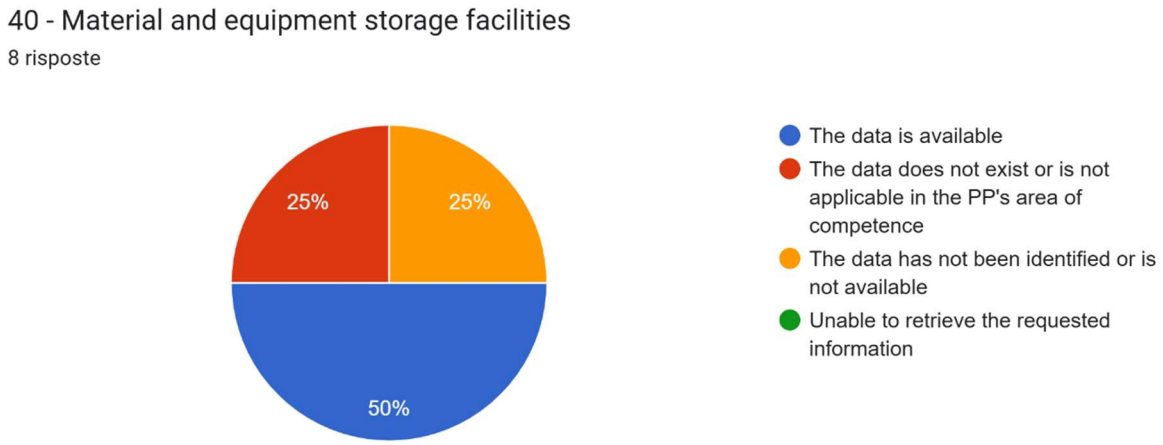
8 risposte



39 - First aid supplies

8 risposte





Introduction to the platform

The platform is organised into two main areas: a public section, accessible without authentication, and a private section, available only to authorised users after login. The public section allows users to consult information and geographic data in read-only mode, while the private section provides the tools required to create, edit and manage content.

Public Section

The public section provides open access to the main information available on the platform. Its purpose is to allow users to explore geographic data, civil protection plans and related documents without requiring authentication. All content in this area can be consulted but not modified. The interface follows a two-panel layout. The left panel contains navigation tools such as thematic filters and document lists, while the right

panel displays either the interactive map or the document viewer depending on the selected content. Through this interface users can explore the geographic layers of the civil protection plans and consult the associated documentation.

When monitoring alarms are generated by the system, they are also displayed on the public map. Each alarm appears at the geographic position of the sensor that triggered the threshold breach, allowing users to quickly identify the affected location.

Although the public section allows broad consultation of the available information, all editing and management functions are restricted to authenticated users.

Private Section

After authentication, users access the private area of the platform, where operational tools for managing plans and data are available. The default entry point is the Digitise Plan section. The interface maintains the same two-panel layout used in the public area but includes additional capabilities for editing and data management. Navigation between sections takes place through the main menu, which displays only the entries available according to the user's role. Standard partner users can access Digitise Plan, Plan Documents, and Catalogue Management**,** while users with higher privileges can also manage Users**,** Partners, and the Thematics and Classes classification system.

Digitise Plan

The Digitise Plan section is the core operational environment for partner users. Here the digitisation of civil protection plans is performed through the insertion, modification and deletion of geographic elements. The interface consists of a left panel containing the plan selection controls, filters, the plan index and available actions, and a map on the right where geometries are displayed in real time.

Before starting any activity, the user selects the relevant civil protection plan from a dropdown list. The plan index can then be refined using thematic filters, class selection or a text search. Active filters are clearly indicated and can be reset at any time. The plan index is presented as a hierarchical tree organised into three levels: thematics, classes and geographic elements. Thematics represent the main categories of the plan, such as hydrogeological risk, road network or reception points. Each thematic contains classes describing specific element types, and each class contains the geographic elements inserted by the user. Every element in the tree is displayed with a map icon and a contextual action menu that allows the user to edit the attribute data, locate the geometry on the map or delete the element.

To insert a new element, the user selects the Add command in the action bar. A guided modal window opens and leads the user through three steps: selecting the thematic, choosing the class and defining the geometry type to be drawn on the map (point, line or polygon). Once confirmed, the platform enters drawing mode and the user can trace the geometry directly on the map. After the drawing is completed, the panel displays a summary of the operation and, when required, a form for entering the element's attribute information. The element can then be saved or the operation cancelled.

Existing elements can be edited through the contextual menu. The edit option opens the attribute form with the current values, while the view option centres the map on the element and highlights it. The delete option permanently removes the element from the plan after confirmation.

Catalogue Management

The Catalogue Management section is used to manage the cartographic layers that support the digitisation process. These layers are GIS files uploaded in batches and used as reference datasets for interpreting the territory.

The interface again follows the two-panel layout. The navigation panel on the left contains filters and a catalogue tree organised by thematics and classes, while the map on the right displays the selected layers. Each layer is associated with a visual status indicator showing whether it is being processed, published or in error. Only layers in the published state can be activated and displayed on the map. New layers can be added through the Add Layer function, which opens a modal form where the user specifies the layer name, description, thematic and class. Thematic and class follow a cascading selection logic similar to the Digitise Plan section.

The file can then be uploaded through drag-and-drop or file selection. Supported formats include zipped shapefiles, GeoJSON, TIFF raster files and GeoPackage datasets, with a maximum file size of 2 GB. Uploads are processed asynchronously and the layer appears in the catalogue tree while validation is performed.

Users may update the layer name or description, view a detailed information card containing metadata and the system identifier, or delete layers they own after

confirmation. Clicking a published layer in the catalogue tree adds it to the map, and multiple layers can be displayed simultaneously.

Environmental Monitoring within the Digitalised Plan

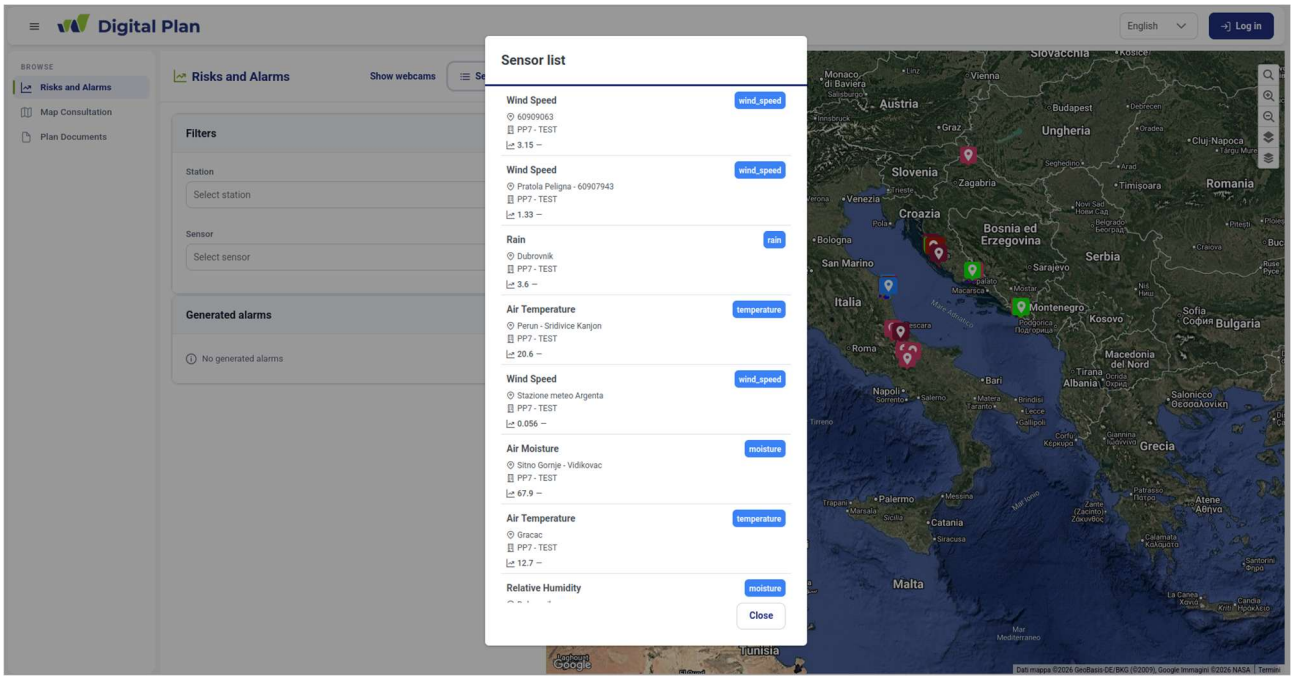
Digitalising a civil protection plan establishes where a hazard could occur, which elements of the territory are exposed to it, and which resources are available to respond. It does not, on its own, establish when conditions on the ground have begun to deteriorate. A plan that is consulted only after an event has been reported delivers a fraction of the value it is capable of delivering; the same plan, coupled to a continuous reading of the physical parameters that precede an event, becomes an instrument of anticipation rather than of reconstruction.

The Decision Support System, generally abbreviated as DSS, and the IoT sensor infrastructure the DSS depends on, supplies this coupling. It observes the territory continuously through a network of field sensors, compares what those sensors report against thresholds that each partner organisation defines for its own territory in terms meaningful to its own plan, and, when a reading crosses a threshold, raises an alarm and notifies the parties and the equipment configured to respond to it. The same information is simultaneously made available, in simplified form, to the public. The result is a single system in which the static content of the plan, its hazard zones, its strategic buildings, its area of application, and the dynamic condition of the territory are consulted on the same map, by the same users, at the same moment.

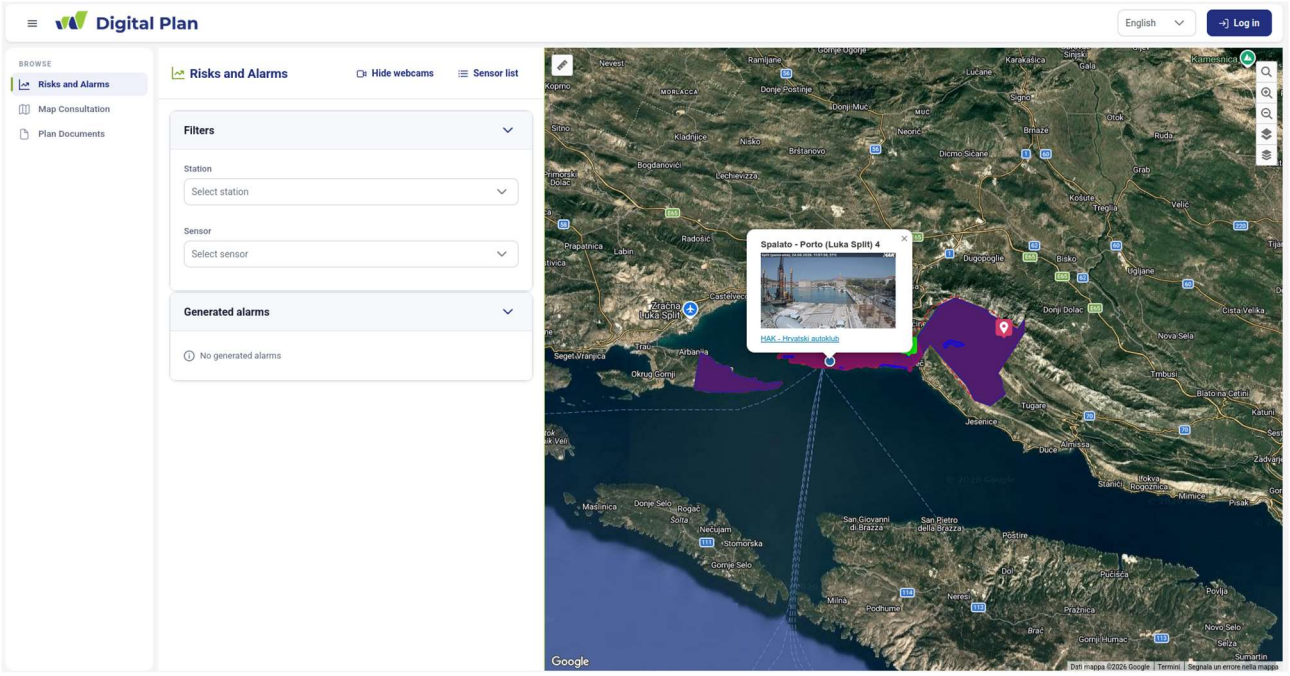
The Project Sensor Network and the Acquisition of Field Data

The monitoring capability rests on an integrated group of field devices installed across the pilot territories, each measuring several physical parameters continuously and transmitting its readings at a standard interval. The parameters observed by the project network are air temperature, atmospheric pressure, relative humidity, wind, hydrometric level and snow depth. Between them these cover the hazard families that the pilot territories are most exposed to: the combination of high temperature, low relative humidity and strong wind that precedes wildfire; the rainfall accumulation and rising water levels that precede hydraulic and hydrogeological criticality; and the accumulated load that makes heavy snowfall a structural concern.

Devices are grouped into monitoring stations, and each sensor is registered on the platform with its identifier, its name, the parameter type it measures, its geographic position and the partner organisation responsible for it. A station therefore functions as the physical and cartographic unit of the network, while the individual sensor functions as the unit against which a threshold is configured. Readings arriving from the field are aggregated by the DSS and made available to the platform as a continuously updated feed, from which the platform draws both the current state of each sensor, the last value recorded and the moment it was recorded, and the sequence of values over which a threshold calculation is performed.



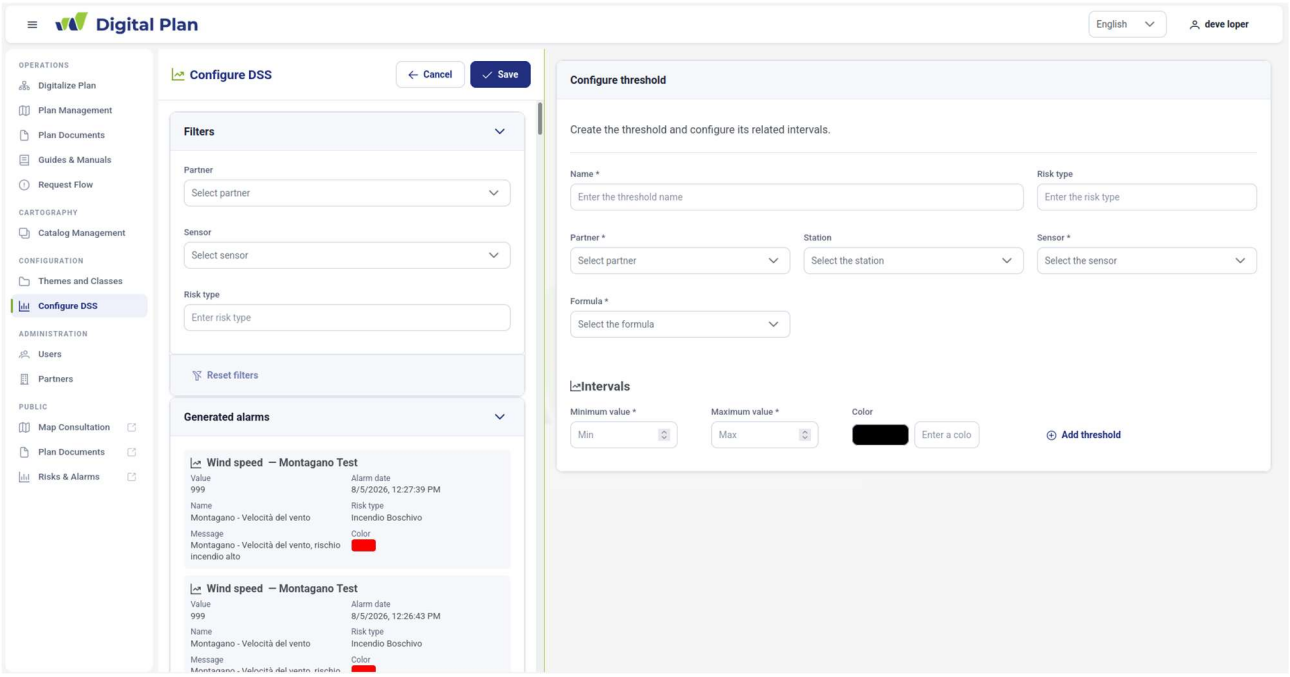
Alongside the instrumented sensors, the platform makes an additional layer of field webcams available on the risk and alarm map, which can be switched on and off at will. Direct visual observation complements instrumental readings in precisely the situations where instrumental readings are hardest to interpret in isolation, and it allows an operator to corroborate a threshold crossing against the visible state of the territory before acting on it.



Configuration of Risk Monitoring: Thresholds, Value Ranges and Alarm Notifications

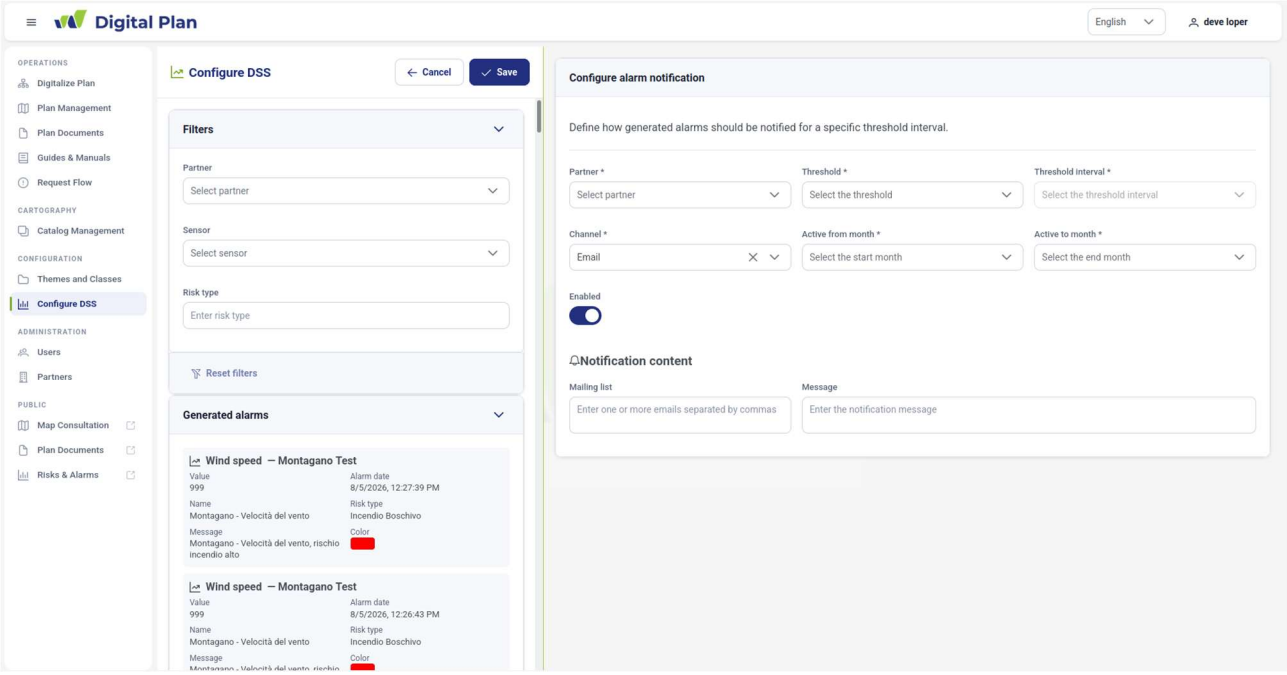
A sensor reading acquires meaning only against a stated expectation of what constitutes a normal, an elevated and an unacceptable value, and that expectation is territorial: the rainfall accumulation that is unremarkable in one catchment is critical in another. The platform therefore does not impose a fixed catalogue of hazard categories or a fixed set of trigger values. It provides, instead, a configuration module in which each partner organisation expresses its own monitoring policy for its own territory, and it is this configuration, rather than any assumption built into the software, that determines what the system treats as a cause for concern.

A threshold is configured against a single sensor and carries a name and, optionally, a risk type entered as free text, so that a hazard may be described as a hydrogeological risk from intense rainfall, a wildfire risk or a snow load risk in the vocabulary the organisation's own plan already uses. A calculation formula is then selected from the options the platform provides, which determines how the sensor's raw readings are transformed into the value actually compared against the threshold; this is what allows the same instrument to serve a rule expressed as an instantaneous reading and a rule expressed as an accumulation over a stated window, such as the one, three, six, twelve, twenty-four, forty-eight and seventy-two hour.



The threshold is completed by one or more value ranges, each defined by a minimum, a maximum and a colour. The colour is not decorative: it is the visual language in which the state of the territory is subsequently rendered on every map and in every list where

that threshold appears, and it is what allows a severity gradient, absent, low, medium, high, to be read at a glance rather than inferred from numbers. The platform validates that a range's minimum remains below its maximum and that no two ranges of the same threshold overlap, so that any given reading resolves to exactly one range and therefore to exactly one unambiguous severity.



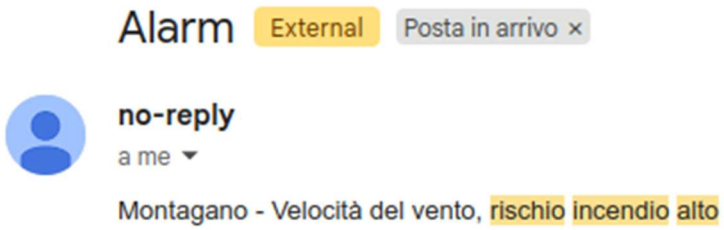
Each value range may in turn carry one or more alarm notifications, which state how the platform is to react when a reading falls within that range. A notification is bound to a single channel, either electronic mail or a connected actuator, and carries a free text message for inclusion in the notification itself, together with the list of recipient addresses when the channel is electronic mail. Because hazard exposure is seasonal, a notification also carries a period of activity defined by a starting and an ending month, so that a snow load notification is silent through the summer and a wildfire notification

through the winter without either having to be deleted and recreated as the seasons turn. A notification can additionally be switched off and on at any time while retaining its full configuration.

When a reading does fall within a configured range, the resulting alarm is recorded with the value that was computed and the moment it was triggered, and remains available thereafter against the range that produced it. The configuration and the alarm history are consequently held together: an operator examining a threshold sees the ranges defined for it, the notifications attached to each range, and the alarms those ranges have actually raised, without leaving the screen.

Alarm Notification and Physical Actuation

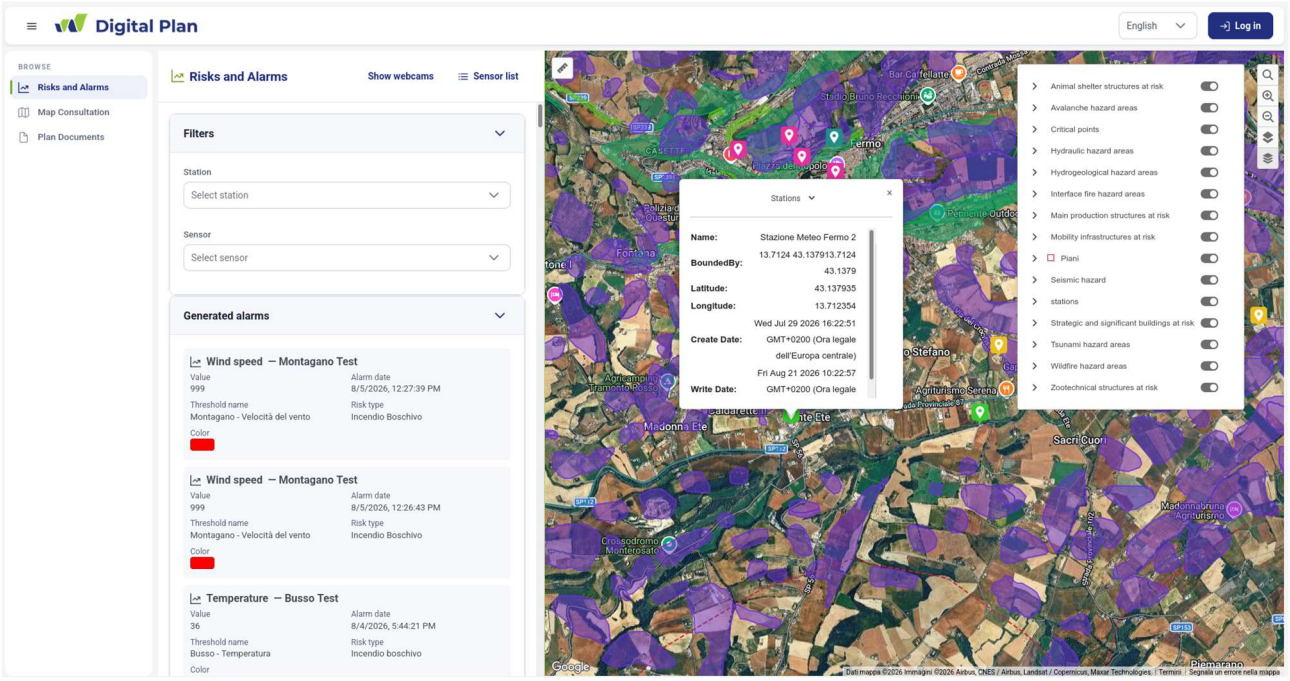
Two forms of response follow from a threshold crossing. The first is informational: a message is dispatched to the recipients that the responsible organisation has designated, carrying the text configured for that notification.



The second is physical. Where a notification is configured against an actuator rather than an electronic mail address, the crossing of the threshold acts directly on connected equipment in the field. This closes the loop between observation and intervention without a human step in between, which matters most in precisely those circumstances where the interval available for a human step is shortest.

Cartographic Representation of Risk Scenarios and Hazardous Events

The platform renders monitoring information cartographically rather than as a data table with a map attached to it. The monitoring stations relevant to the displayed territory appear on the map in their true positions, together with the boundary of the corresponding civil protection plan, so that a reading is always read against the area it applies to and against the plan content already digitalised for that area. The colour assigned to the value range a station's current reading falls into is what conveys its state, which makes the severity distribution across a territory legible before any individual station has been interrogated. Selecting a station, or any other element on the map, opens its details.



The map maintains this picture continuously. Station positions and states are kept up to date as new information arrives from the field, without the page being reloaded and without the person watching it doing anything at all, which is the behaviour an operator monitoring an evolving situation requires: attention is spent on the territory rather than on the act of refreshing a screen. The same live channel drives the alarm list presented alongside the map, so that an alarm raised in the field appears in the interface as it occurs.

Because the same cartographic base carries the digitalised plan content, a hazardous event is represented in relation to what it threatens rather than in isolation. A station reporting an elevated hydrometric level is displayed within the plan boundary, among the hazard zones, strategic buildings and other elements that the organisation has already recorded for that area, which is what allows an operator to move from the

observation that a threshold has been crossed to the question of which elements of the plan are exposed as a consequence.

The Public Risk and Alarm Interface

The monitoring configured by each partner organisation is published to the public through a dedicated page of the platform's public application, which requires no account and no familiarity with the platform's administrative side. The page presents the live map described in the preceding section alongside a sidebar in which the current situation can be narrowed and examined: a filter panel restricting what is shown by monitoring station and by sensor, a panel listing the alarms generated, and, on request, a paginated list of the monitoring sensors relevant to the displayed area, giving for each one its name, the parameter it measures, the station it belongs to, the partner organisation responsible for it, and the value most recently recorded together with the moment of recording, with sensors lacking recent data indicated as such.

Publishing this information without authentication is a deliberate choice with two distinct beneficiaries. For the population of an exposed territory it provides an early warning instrument and, outside an emergency, an ongoing awareness of local environmental conditions. For the staff of the responsible authority it provides the same view of conditions that the public is seeing, which is a necessary reference during an active event, when the authority's communication needs to be consistent with what citizens are already able to observe for themselves.

Layered Components and Access Privileges

The platform's interface is layered, and the layer a given person reaches is determined by the role held by their account. Applied to risk monitoring, the layering resolves into three levels.

A visitor without an account reaches the public risk and alarm page described in the preceding section: the live map, the alarms generated, the sensor readings, in read only form and without any means of altering what is being monitored or how.

An account holding the Administrator role for a partner organisation additionally reaches the configuration module, exercised over that organisation's own monitoring: it defines and revises the thresholds, value ranges and alarm notifications that govern the organisation's territory, and consults the alarms those thresholds have raised. The organisation an Administrator belongs to is fixed, and the module presents that organisation's configuration only, so a threshold defined for one territory cannot be altered from another.

An account holding the Super Administrator role is bound to no single organisation and exercises the same configuration capability across every partner registered on the platform, selecting the organisation whose thresholds and notifications are to be displayed or amended, and assigning a newly created threshold or notification to the organisation it belongs to.

Access is enforced rather than merely reflected in the interface. Authentication is delegated to a dedicated identity management application, so the platform itself never receives a user's credentials, and the role carried by an authenticated session determines both which sections of the interface are offered and which are reachable at all: an attempt to reach a section without the corresponding role is refused rather than served. This is what allows a single platform to hold the monitoring configuration of multiple independent authorities alongside a page addressed to the general public without the boundaries between them depending on the discretion of the people using it.

Integration with the Emergency Planning Elements

Risk monitoring on this platform is not a self-contained instrument bolted onto a plan repository; it is expressed in the same terms as the plan database produced under Activities 1.1 and 1.2 and is consulted on the same cartography.

Three points of integration establish this. The first is the plan's area of application, defined when the plan is registered and drawn on every map the platform presents: monitoring stations are displayed within the boundary of the plan they pertain to, so a reading is situated in the planning unit that will have to act on it. The second is the shared classification of themes and classes, maintained centrally for the whole platform, under which every digitalised plan element and every geographic layer is filed; because the plan's hazard zones and strategic buildings are classified under this common vocabulary, the elements exposed by a hazardous condition can be identified

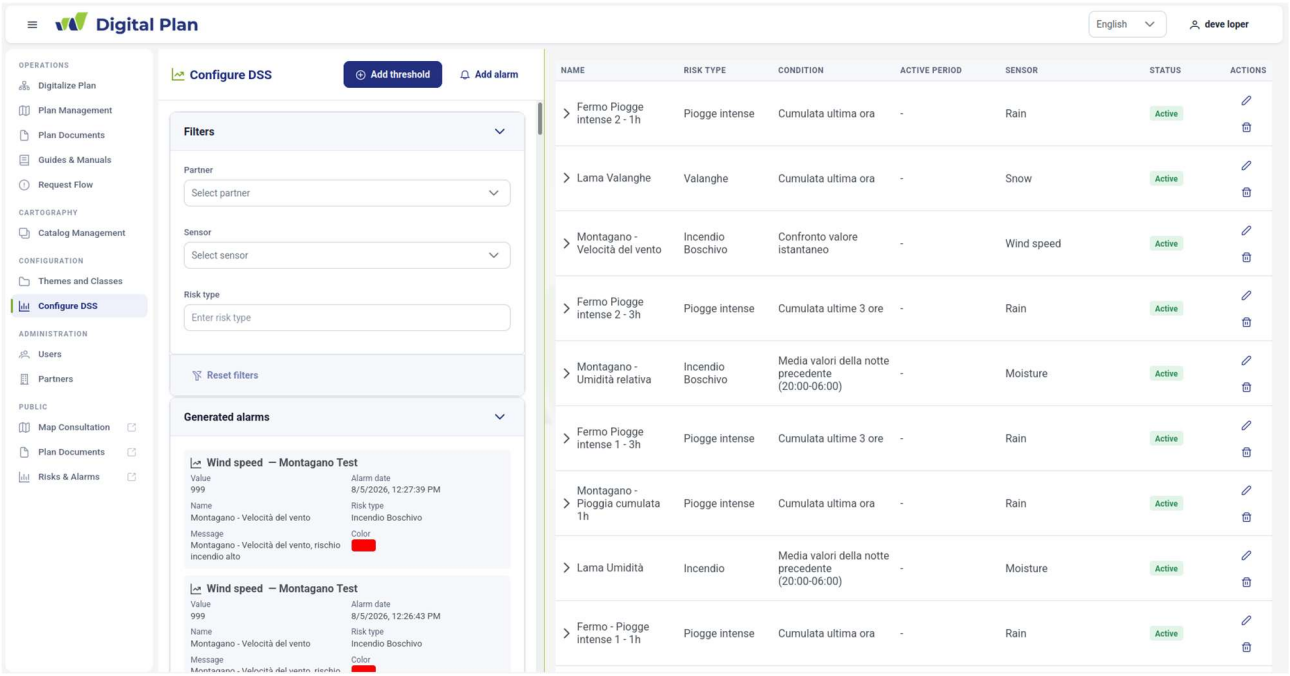
in the same terms across every participating organisation rather than in terminology each has invented for itself. The third is the digitalised plan content itself, the hazard areas, strategic buildings and related elements recorded on the interactive map, which is the layer against which an alarm acquires operational meaning: the question raised by a threshold crossing is which of these elements is now at stake.

Graphical User Interfaces

The interfaces through which the monitoring capability is operated were built to the same conventions as the rest of the platform, and their design responds to two requirements that pull in opposite directions: the configuration of a threshold is intrinsically layered, a threshold containing ranges containing notifications and alarms, while the situation an operator monitors must be legible immediately.

The configuration module resolves this through progressive disclosure. Its principal screen is a summary table of every configured threshold, showing its name, its risk type, the sensor it monitors and whether it is active; expanding a threshold reveals the value ranges configured for it, each with the colour that represents it on the map; expanding a range in turn reveals the alarm notifications attached to it and the alarms already raised against it. The hierarchy is therefore navigated in place, at whatever depth the task requires, rather than through a sequence of separate screens. A filter panel narrows the list by sensor and by risk type, with a further filter over partner organisations presented to the Super Administrator, and active filters are indicated and can be reset in a single action. Creation and revision take place through forms that

validate their input as it is entered, refusing an inverted or overlapping value range at the point of entry rather than on submission.



The monitoring interfaces are map centred, the cartography occupying the working area and the panels arranged beside it, so that consultation begins from the territory. Lists that may grow without bound are paginated, and confirmation is required before a threshold or a notification is deleted.

Conclusions

The graphical analysis provides a comprehensive overview of how project partners evaluated the availability and accessibility of thematic data layers required for the digitalisation of Civil Protection Plans. The results are based on questionnaires

circulated among partners and offer an overview of the current level of preparedness across the territories involved. In addition to highlighting existing datasets, the analysis also reveals structural gaps in data accessibility and standardisation that are relevant for the development of the project's digital infrastructure.

Data Availability and Readiness

The responses collected through the questionnaires were categorised into four main classes describing the status of each dataset. These include data already available and structured in existing databases; data that does not exist or is not applicable to the territory; data that exists but is not yet accessible in a structured format; and data that cannot currently be retrieved due to institutional, technical or resource limitations.

The graphical results show that, despite differences between partners, a significant share of the required information is already available. This provides a solid basis for interoperability and for the development of the digital platform supporting Civil Protection planning. At the same time, the presence of datasets classified as existing but unavailable indicates that many resources are recognised but not yet organised or validated within accessible information systems.

Differences Across Thematic Categories

The analysis also highlights important variations between thematic categories. Data related to strategic and operational facilities, such as hospitals, civil protection offices and command centres, generally shows a high level of availability, as these infrastructures are typically mapped and managed by public institutions. Information

concerning critical infrastructure, including road networks, ports and airports, tends to be more fragmented. In many cases the data exists but is distributed across different institutions, which complicates integration and accessibility.

Greater variability emerges for risk-related datasets, such as seismic hazards, flood risk, wildfire risk and hydrogeological instability. While some territories maintain detailed and updated risk maps, others report that the risks are known but the related datasets are not yet structured or accessible. This situation highlights the need for harmonisation and shared data standards. Environmental datasets, including protected areas and environmental monitoring information, are generally available due to the existence of national and European data frameworks. Conversely, information related to emergency management infrastructure, such as assembly points, shelters or helicopter landing areas, varies widely between municipalities, reflecting different levels of preparedness.

Similarly, monitoring infrastructures and support systems, such as sensor networks and communication towers, are often reported as existing but not yet integrated into structured databases. Data on operational resources, including fire hydrants or emergency supply depots, is frequently dispersed across several local departments, which contributes to inconsistencies in data availability.

National and Local Differences

The graphical results also reveal differences between Italian and Croatian partners, as well as variations within each country. These discrepancies can largely be explained by

differences in territorial characteristics, the maturity of local civil protection systems and the institutional frameworks governing data collection and sharing.

Geographical conditions, such as mountainous versus coastal environments or urban versus rural contexts, strongly influence the relevance and availability of specific datasets. At the same time, municipalities exposed to similar hazards sometimes report very different levels of data readiness, indicating uneven administrative practices and different levels of technical capacity.

Implications for the IoT DSS Platform

The heterogeneity highlighted by the analysis confirms the need for a platform capable of integrating and harmonising diverse sources of information. The project therefore requires not only technological integration but also the adoption of common standards for file formats, database structures and metadata definitions.

In this context, the IoT DSS (Decision Support System) module represents a key component of the platform's operational capabilities. The module introduces real-time monitoring functions through IoT sensors deployed across partner territories. By continuously collecting environmental data, the system can identify situations where measured values exceed predefined thresholds and automatically generate alerts. Within the DSS module, users can define the conditions that trigger alarms through the Threshold Management system. Each threshold is associated with a specific sensor, a data-processing function and limit values that determine when an alert should be activated.

Thresholds can also be limited to specific periods of the year, allowing seasonal risks - such as snow or wildfire hazards - to be monitored only when relevant. When a threshold is exceeded, the platform generates an alarm that becomes visible on the public map. A coloured label appears at the geographic location of the sensor, enabling users and authorities to quickly identify the monitoring point involved. At the same time, the system can send automatic notifications via email to designated recipients or activate connected actuators, depending on the configuration defined by the user. Custom messages and visual identifiers further support the interpretation of alerts.

The integration of the DSS monitoring system with the platform's geospatial datasets strengthens the overall decision-support framework. While the availability of thematic data layers supports planning and risk assessment, the real-time sensor monitoring capabilities provide dynamic information that can assist authorities during emergency situations.

Strategic Value of the Analysis

The graphical results therefore represent more than a simple technical inventory of datasets. They provide a strategic tool for guiding the next phases of the project. By identifying areas where information is already available and standardised, the analysis highlights the existing strengths on which the digital platform can be built. At the same time, the identification of missing or inaccessible datasets offers a roadmap for future actions, including targeted data collection, institutional coordination and capacity-building initiatives. These efforts will contribute to improving data accessibility and ensuring that the IoT DSS platform can effectively support both civil protection planning

and real-time emergency management. More broadly, the analysis reinforces the importance of transnational cooperation.

Establishing shared standards, improving interoperability and integrating monitoring technologies will be essential for building a unified system capable of supporting risk management across all participating territories.