# RIGID: A Workspace-Based Geospatial System for Multi-Hazard Crisis Coordination

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## ABSTRACT

Crisis management increasingly relies on geospatial information systems that integrate diverse datasets and support coordination across multiple agencies operating under time pressure. However, fragmentation across existing platforms continues to limit cross-hazard analysis and coordinated decision-making. This paper introduces the Rapid Intelligent Geospatial Integrated Disaster Management (RIGID) platform, a web-based geospatial environment that brings together multi-hazard forecast indicators and regional and municipality-level operational data within persistent, role-sensitive workspaces. The platform was evaluated through a structured workshop with civil protection stakeholders, focusing on usability and perceived operational value. The findings provide exploratory indications that participants perceived the platform as helping to reduce data fragmentation, supporting shared situational awareness, and facilitating coordinated interpretation across governance levels. By emphasising operational workspaces as shared reference points, the study highlights how integrated geospatial platforms may contribute to collaborative decision-making in complex emergency management contexts.

### Keywords

Crisis Information Systems, Geospatial Decision Support, Multi-Hazard Integration, Situational Awareness, Civil Protection Coordination

## INTRODUCTION

Contemporary crisis response unfolds within complex, multi-level governance environments where diverse actors must coordinate under time pressure and uncertainty. Such environments are characterised by distributed actors, time-critical constraints, and dynamic information flows, making information management a central operational challenge rather than a peripheral support activity. The Sendai Framework for Disaster Risk Reduction 2015–2030, adopted at the Third UN World Conference on Disaster Risk Reduction, explicitly emphasises the role of accessible risk information, knowledge sharing, and technology-enabled coordination in strengthening disaster governance (UNDRR, 2015).

In operational environments, however, data availability alone does not ensure effective coordination. Research on team situational awareness in crisis settings reveals that when responders rely on multiple disconnected platforms, limited interoperability can lead to miscommunication and misunderstanding during high-pressure operations (Sørensen et al., 2025). More broadly, field-exercise research on multi-agency disaster response shows that limited information sharing and coordination across autonomous agencies can negatively affect collective decision-making and action (Bharosa et al., 2010). Disaster response typically involves multiple agencies with distinct mandates, terminologies, and decision logics. Under time pressure, fragmented information flows and disconnected digital infrastructures can undermine shared situational awareness and delay coordinated action. Research on disaster management information systems indicates that when datasets cannot be effectively integrated into shared operational environments, coordination can fragment into localised "bubbles" while information becomes missing, inaccessible, or uncertain under time pressure and information overload (Nespeca et al., 2020). The challenge is therefore not simply technological capacity, but socio-technical alignment between data structures, organisational roles, and decision contexts. Recent empirical work further shows that socio-technical patterns, such as differing roles, information needs, and collaboration barriers, significantly influence how teams interpret and act on shared information during crisis exercises (Rustenberg et al., 2024).

Moreover, disaster scenarios are often characterised by uncertainty, cascading effects, and rapidly evolving conditions. Crisis information systems must therefore support dynamic reconfiguration of information as incidents develop. Static dashboards or single-purpose monitoring portals are insufficient when operational questions shift from early warning to resource allocation, evacuation planning, or cross-jurisdictional coordination. Research in geospatial disaster decision support stresses that systems should enable iterative integration of multiple spatial data sources into task-oriented configurations that adapt as the incident progresses (Fang et al., 2023).

Crisis information systems therefore need to do more than display maps or publish data. They must help stakeholders construct and maintain a shared operational understanding, while also allowing different users to tailor information to their role and task. Inter-organisational crisis response continues to face persistent challenges in information and expertise sharing, alongside a lack of standardised coordination mechanisms across agencies (Munkvold, 2016). A practical implication is that platforms should enable (a) rapid discovery and assembly of multi-source data into coherent operational visual configurations, (b) reuse of those configurations as an incident evolves, and (c) controlled dissemination beyond organisational boundaries.

Within this context, the RIGID platform is introduced as a web-based geospatial crisis-management solution designed to strengthen preparedness and response through integrated data access, operational map configurations, and multi-stakeholder coordination. Rather than presenting the platform solely as a technical system, this work-in-progress paper investigates how a workspace-based web Geographic Information System (GIS) architecture can support multi-level civil protection coordination in a multi-hazard environment and reports initial evaluation findings from expert end-users in an operational pilot setting.

## BACKGROUND

### Crisis Information Systems and Coordination Needs

Crisis information systems are deployed in socio-technical environments where multiple organisations must coordinate under time pressure, uncertainty, and rapidly evolving conditions. Disaster information systems research emphasises the importance of coordination mechanisms that support distributed actors operating under dynamic and uncertain conditions (Li et al., 2023).

Beyond technology, coordination depends on how roles, responsibilities, and information needs align across teams. Taken together, the literature suggests that effective crisis IT must support shared operational views while remaining adaptable to evolving roles and coordination structures.

### Geospatial Decision Support, Integration, and Interoperability

Because hazards, exposed assets, and response resources are spatially distributed, geospatial decision support is a core component of many crisis-management information environments. However, the operational challenge is not the absence of geospatial data; it is integration (Valachamy et al., 2020). In our context, this implies the need for platforms that help users rapidly assemble multi-source information into task-oriented configurations that can evolve with the incident.

Interoperability standards such as the Open Geospatial Consortium's Web Map Service (WMS) support integration across systems, but operational value also depends on meaningful interaction with spatial information that enables actionable interpretation.

### Competitors and State of the Art from the Geo-Experience Synthesis

The crisis-relevant geospatial ecosystem includes both large-scale monitoring platforms and full-featured GIS environments. Prominent monitoring and data-dissemination platforms include NASA Worldview, the Copernicus Emergency Management Service (CEMS), the Fire Information for Resource Management System (FIRMS), the Group on Earth Observations System of Systems (GEOSS) Portal, and the European Space Agency's (ESA) Rapid Action on COVID-19 and Earth Observation (RACE) Dashboard. In parallel, widely adopted GIS environments such as QGIS and ArcGIS by Esri provide advanced spatial analysis, data management, and customisation capabilities for professional users. While these systems offer powerful visualisation and analytical functions, they are not primarily designed as integrated, role-sensitive operational coordination platforms for multi-stakeholder crisis management contexts.

In parallel, numerous hazard-oriented decision support systems (DSS) have been developed for domains such as flood risk management, wildfire monitoring, and weather-related hazard analysis. While these tools can offer specialised analytics for specific hazard contexts, the DSS literature still reports limited coverage of multi-hazard approaches, indicating that many solutions remain primarily developed and deployed within single-hazard problem framings (Newman et al., 2017). This limitation motivates platforms that can support multi-hazard information integration and coordination across stakeholders rather than treating hazards in isolation.

Design research on the above-mentioned ecosystem highlights recurring baseline capabilities expected in map-centric platforms (e.g., layer management and comparison, legends, basemap selection, measurement tools, temporal controls, and export/sharing). In this landscape, many competitors excel at providing access to authoritative datasets and near-real-time monitoring. However, they often emphasise observation and dissemination rather than operational collaboration and persistent incident workspaces.

A complementary line of applied work demonstrates that operational crisis support typically requires more than a map viewer. Case-based WebGIS implementations show how crisis-support tools can operationalise evacuation-focused decision support through service-oriented architectures and standardised web mapping services (such as WMS and Web Feature Service (WFS), enabling continually updated layers and combined spatial/tabular tools (Netek et al., 2014). Recent work on interfaces for first responders similarly reflects the ongoing push toward modular, multi-platform approaches that can be customised for situational awareness needs (Oregui et al., 2024).

### Synthesis and Positioning Gap

Across crisis informatics and geospatial decision support, three state-of-the-art requirements recur:

- **Shared operational views** that support coordination across organisations,
- **Integration** of heterogeneous geospatial resources into coherent task-oriented configurations, and
- **Secure dissemination** of operationally meaningful information beyond organisational boundaries.

Monitoring-oriented platforms address parts of this space well (visibility, discovery, broad dissemination), while GIS-centric environments address other parts (analysis and configuration). The gap remains in unified solutions that combine multi-source geospatial integration with role-sensitive collaboration and reusable operational configurations that can be shared in controlled ways. This is the gap the paper addresses by positioning RIGID as an operationally oriented geospatial crisis-management platform, bridging data-rich monitoring environments and coordination-focused crisis workflows.

In addition, regional and municipality-level civil protection datasets are often fragmented across institutional silos and accessed through separate systems. Operational assets such as shelters, traffic restrictions, local infrastructure, and responsibility boundaries are often managed independently from multi-hazard forecast indicators and early warning information. This separation constrains cross-hazard preparedness and coordinated response, particularly in multi-level governance contexts where local, regional, and national actors must operate within shared timelines.

Importantly, these challenges are reflected in both the literature and operational practice. During the conceptualisation of the platform, civil protection stakeholders highlighted persistent difficulties related to fragmented data access, the need to consult multiple systems, and challenges in constructing a shared operational picture. These practitioner insights directly informed the design objectives of the RIGID platform.

RIGID represents a specific operational deployment of a broader geospatial intelligence platform architecture, implemented to address this gap by providing a unified, web-based environment that integrates heterogeneous operational datasets, hazard indicators, and role-sensitive collaboration mechanisms within persistent, configurable workspaces. By enabling curated local data layers to coexist with multi-hazard forecasts and shared coordination views, the platform moves beyond hazard-siloed systems and monitoring-oriented portals toward an operationally integrated crisis management environment.

The primary target users of the platform are regional and municipal civil protection authorities, emergency coordination units, and operational stakeholders responsible for monitoring, preparedness, and response activities, capturing the multi-level governance context in which the identified coordination and data integration challenges emerge.

## SYSTEM ARCHITECTURE & OVERVIEW

### Design Objectives and Operational Context

The RIGID platform is implemented as a web-based IT solution for crisis management, designed to support incident monitoring, situational awareness, and coordinated decision-making across multiple hazard domains. It integrates heterogeneous geospatial datasets, dynamic forecast products, and role-sensitive collaboration mechanisms within a unified operational interface, allowing users to assemble distributed information into coherent operational views as conditions evolve. The platform is designed to provide timely access to relevant information, support structured information sharing, and facilitate iterative risk assessment in response to changing hazard conditions and forecast updates.

### Architectural Structure and System Components

The architectural design of RIGID reflects a coordination-oriented and integration-driven logic, where system components are structured to support multi-hazard data interoperability, persistent operational configurations, and role-sensitive collaboration across institutions. Technically, the platform is implemented as a modular web-based system composed of a browser-based user interface, an application backend, geospatial service components, and a persistent data layer. The web-based user environment is illustrated in Figure 1.

The user interface functions as the primary operational workspace, where users activate layers, navigate spatial information, configure scenario-specific views, and access coordination tools. The map-centric design supports visualisation of hazard indicators and forecast products alongside infrastructure and exposure datasets.

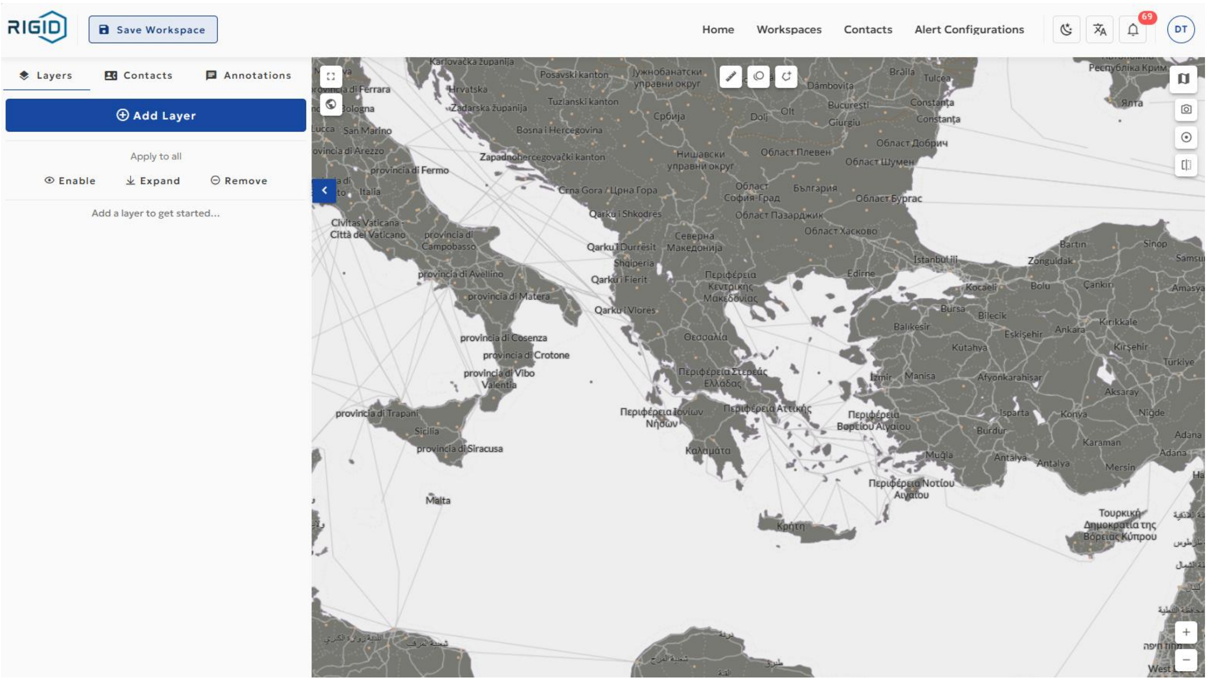


**Figure 1. Web-based user interface of the RIGID platform. The interface supports map-based interaction, layer management, and access to core tools such as workspaces, contacts, and alerts.**

Behind the interface, the backend manages authentication, role-based access control, workspace persistence, and alert logic. Operational configurations created by users are stored and restored across sessions, ensuring continuity of situational awareness during prolonged or evolving incidents.

Geospatial datasets are integrated through standards-based map services, enabling interoperability with external data providers. Hazard maps, meteorological forecasts, and infrastructure datasets originating from different institutional sources can be retrieved and displayed within the same environment. The architectural relationship between user interface, backend logic, geospatial services, and data storage components is presented in Figure 2.

This architecture supports the integration of additional hazard domains and datasets through administrative configuration, allowing the system to be adapted to different regional or institutional contexts.

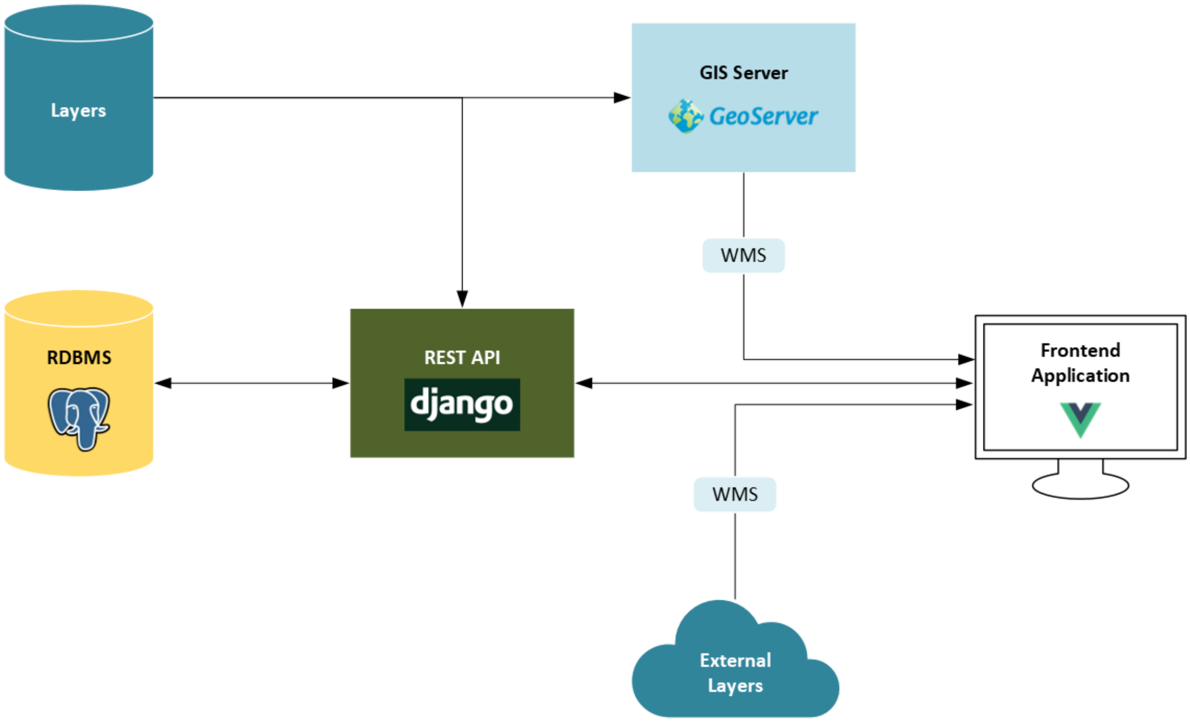


**Figure 2. High-level system architecture of the RIGID platform. The diagram shows the interaction between the user interface, backend, geospatial services (e.g., WMS, WFS), and data storage, with arrows indicating data exchange.**

### Workspace-Based Operational Configuration

A key architectural component of the RIGID platform is the workspace mechanism. Workspaces function as persistent operational containers in which users assemble hazard layers, forecast products, infrastructure datasets, annotations, and relevant contacts into a single scenario configuration.

During monitoring or preparedness activities, users may combine forecast precipitation layers, flood hazard zones, road networks, and shelter locations within a defined administrative boundary. This configuration can be stored as a workspace and revisited as conditions change.

Workspaces can be duplicated and refined to represent alternative operational assumptions or evolving risk scenarios. This feature supports structured decision-making workflows, where situational understanding is progressively updated rather than reconstructed from scratch.

The platform also enables the generation of read-only share links for each workspace. This mechanism allows structured operational views to be disseminated across agencies without transferring modification rights, supporting coordination while preserving governance constraints.

### Access Control, Security, and Data Sharing

Access to the RIGID platform is governed through a role-based access control mechanism that structures user interaction according to operational responsibilities and system administration needs. Administrative users manage layer entries, metadata, and service registrations, while operational users interact with map layers, workspaces, annotations, and alerts within the operational interface. This separation of responsibilities supports controlled system configuration while enabling flexible use during monitoring and response activities, ensuring alignment between system functionality and institutional roles.

Authentication and authorisation are implemented through a dedicated OAuth2/OpenID Connect (OIDC) authorisation server (Keycloak), with all backend endpoints requiring valid access tokens. This ensures that system services are accessible only to authenticated users and that access permissions are consistently enforced across components.

In addition to authenticated access, the platform supports controlled data sharing through read-only workspace links. These links are generated using Universally Unique Identifier (UUID) v4 identifiers embedded in the URL, allowing users to disseminate operational views across agencies without requiring recipients to maintain system accounts. This mechanism facilitates inter-agency collaboration while preserving governance constraints, as shared workspaces remain non-editable. The use of high-entropy (i.e., practically unguessable) identifiers further reduces the likelihood of unauthorised access while maintaining usability in time-critical coordination contexts.

## DATA & FUNCTIONALITIES

### Layer Catalogue Structure and Risk-Oriented Organisation

The Layer Catalogue provides the organisational framework through which spatial datasets are exposed to users within a given RIGID platform deployment. The specific thematic folders and datasets may vary depending on regional priorities and data availability.

The configuration presented in this paper, corresponds to the Attica regional deployment used for evaluation. Table 1 summarises the thematic organisation and indicative content of this specific configuration, where heterogeneous geospatial resources, originating from different institutional providers, are organised within a unified operational environment. Importantly, the platform does not impose a fixed hazard taxonomy or predefined folder hierarchy. Administrative users can register, categorise, and reorganise layers according to local operational needs.

**Table 1. Layer catalog – Structure and content focus.**

| Catalog Folder | Sub-Structure / Content Logic | Indicative Layer Content | Civil Protection Use |
|---|---|---|---|
| **Fire Risk** | Hazard, exposure, vulnerability, risk, and use-case layers | Fire hazard indices, exposure and vulnerability indicators, fire risk layers, areas of interest, road network | Wildfire preparedness, monitoring, and operational situational awareness |
| **Flood Risk** | Hazard, risk, exposure, vulnerability, and use-case layers | Flood hazard maps, exposure zone values, flood risk layers, infrastructure | Flood risk assessment, preparedness, and response planning |
| **Earthquake Risk** | Hazard- and exposure-oriented layers | Seismic hazard indicators and exposure-related layers | Earthquake preparedness and risk awareness |
| **Forecasts** | Hazard-specific, time-dependent forecast products and derived indices | Meteorological variables (e.g. precipitation, temperature, humidity, wind), air quality indicators, and hazard-oriented indices (e.g. probability of fire, vapor pressure deficit, hot-dry windy index, EFI wind gusts, EFI maximum temperature) | Early warning, monitoring evolving conditions, hazard-specific preparedness, anticipatory decision-making |
| **Climate Projections** | Scenario- and indicator-based datasets | Long-term climate variables and projections | Strategic planning and climate adaptation |
| **Infrastructures** | Asset-based thematic layers | Roads, critical facilities, operational infrastructure | Response coordination, accessibility, and logistics |
| **Shelters** | Location-based operational layers | Emergency shelter locations and attributes | Evacuation planning and population protection |
| **Traffic Ban** | Operational restriction layers | Road closures and mobility restrictions | Traffic and mobility management during emergencies |
| **Administrative Boundaries** | Reference and responsibility layers | Administrative units and zones of responsibility | Coordination, reporting, and institutional |

| Catalog Folder | Sub-Structure / Content Logic | Indicative Layer Content | Civil Protection Use |
|---|---|---|---|
| | | | alignment |

Within hazard domains, layers are organised according to components commonly used in risk assessment, including hazard intensity, exposure, vulnerability, and composite risk indicators. This organisation reflects the way civil protection assessments are typically structured during preparedness and response activities.

The layer management panel used to activate and combine these datasets during operational use, is shown in Figure 3 on the left side of the map.

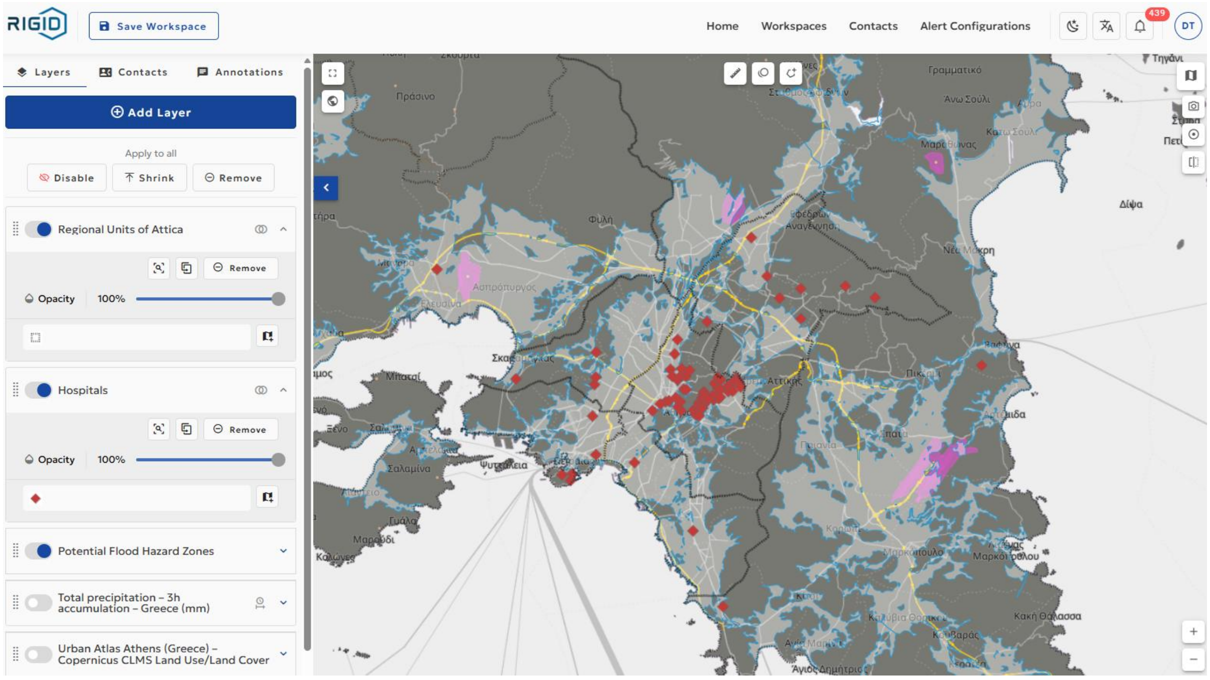


**Figure 3. Layer management panel and thematic organisation. Users can browse, enable, and combine geospatial layers to create task-oriented map views.**

### Infrastructure, Reference Layers, and Operational Context

Infrastructure and contextual layers provide the operational and institutional context required for coordinated action. These include transportation networks, critical facilities, shelters, traffic restrictions, and administrative boundaries (Table 1). When combined with hazard and forecast datasets, these layers support the interpretation of risk information within logistical and governance contexts, enabling coordinated decision-making across responsible authorities.

### Forecast Products and Temporal Navigation

The RIGID platform integrates time-dependent forecast products used during monitoring and early warning activities, including meteorological variables and derived hazard-related indices (Table 1). Temporal navigation controls (Figure 4) allow users to explore forecast time steps and observe projected spatial changes. Forecast layers can be examined in relation to exposure and infrastructure datasets within the same operational environment, supporting anticipatory assessment.

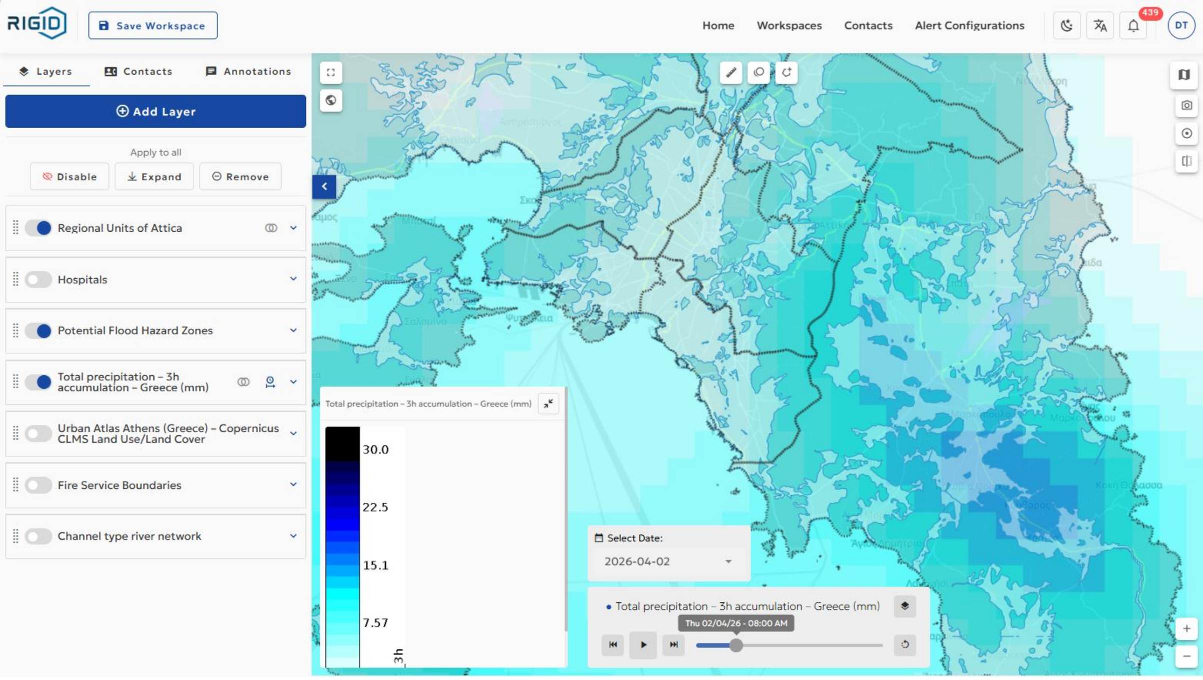


**Figure 4. Layer legend and temporal navigation controls. Users can interpret active layers and explore time-dependent data through forecast time steps.**

### User Interaction and Analytical Support

The RIGID platform incorporates interaction tools that support the interpretation and communication of spatial information within the map interface. Annotation tools enable users to mark areas of concern and share spatial observations within workspaces, supporting coordinated situational awareness and inter-agency discussion.

Measurement and comparison tools (Figure 5, Figure 6) support spatial assessment and analysis. Users can evaluate distances and spatial relationships, as well as visually compare datasets across time steps or between different layers, facilitating the identification of evolving hazard conditions and their relation to exposure and infrastructure.

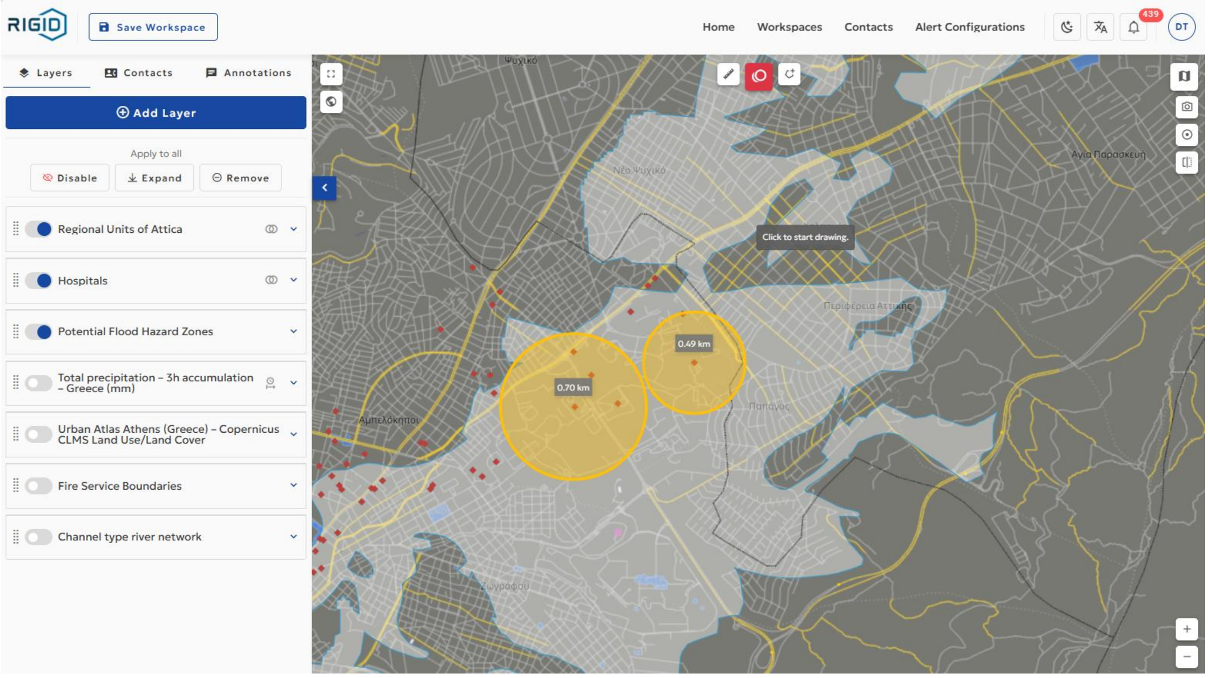


**Figure 5. Measurement tools for spatial analysis. Tools for calculating distances, areas, and buffer zones support spatial assessment within the map interface.**

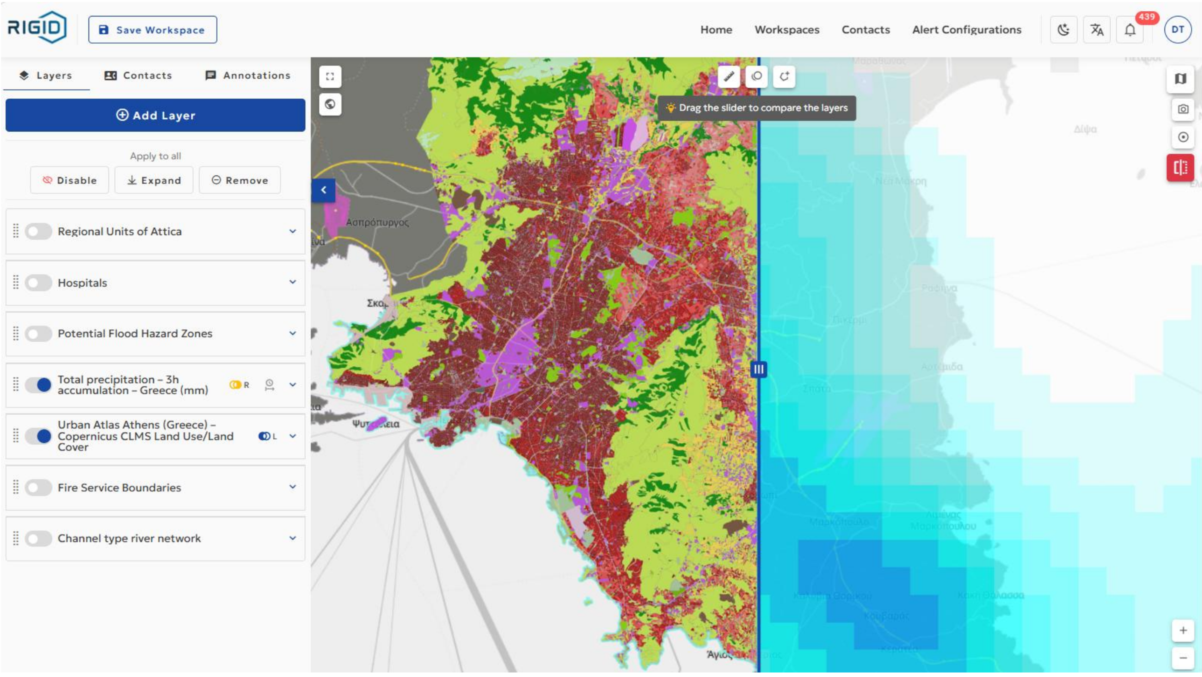


**Figure 6. Layer comparison using swipe functionality. Enables visual comparison between two layers to identify spatial or temporal differences.**

### Alert Mechanisms and Monitoring Workflows

The RIGID platform includes rule-based alert mechanisms linked to selected forecast layers (Figure 7). Alerts are triggered when predefined thresholds are exceeded within specified geographic areas and time windows.

Notifications are displayed within the map interface and summarised in a table format, where user-defined messages can be configured during alert rule setup to support operational interpretation and response. Alerts can be examined in relation to hazard, exposure, and infrastructure layers, supporting anticipatory monitoring by highlighting emerging risks within their operational context.

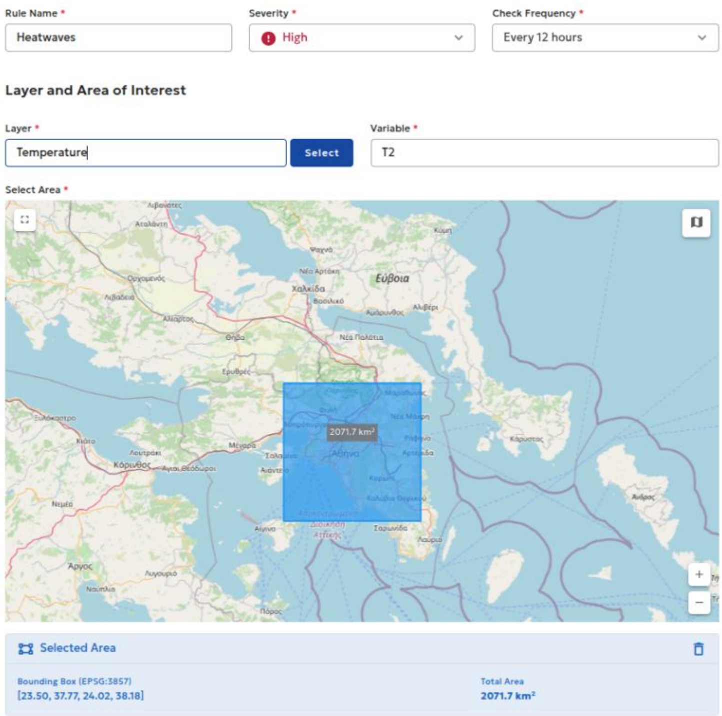


**Figure 7. Alert configuration interface. Rule-based alerts are defined based on forecast thresholds and displayed with user-defined messages.**

### Integrated Contacts and Coordination Support

The RIGID platform includes a structured contact registry, accessible through the Contacts menu in the header as shown in Figure 8, enabling users to retrieve stakeholder information directly within the operational interface. Entries include role, institutional affiliation, administrative responsibility, and communication details. Contacts can be associated with specific workspaces and operational scenarios, allowing relevant stakeholders to be directly linked to the spatial context under analysis.

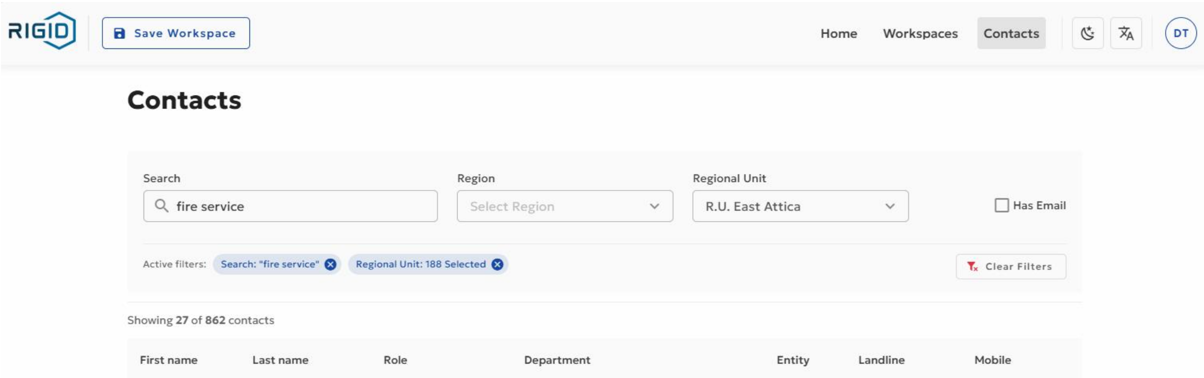


**Figure 8. Contacts directory interface. Users can access stakeholder information and link contacts to operational contexts within workspaces.**

By linking institutional actors to hazard layers, administrative boundaries, and scenario configurations within a workspace, users can identify responsible authorities in relation to a given situation. This enables faster stakeholder identification and supports coordination by providing immediate access to role-specific contact information within the same operational view. Rather than functioning as a static directory, the module integrates communication-relevant information into the situational awareness workflow, reinforcing the platform's coordination-oriented design.

## USE CASE & PRELIMINARY OBSERVATIONS

### Workshop-Based Operational Use Case

The RIGID platform was evaluated in a structured workshop session involving civil protection stakeholders and operational users from the Region of Attica (Greece). Participants represented key institutional roles responsible for monitoring, preparedness planning, and operational coordination at regional and municipal levels.

The objective of the session was to assess the platform's usability, perceived operational value, and potential to support coordination within a multi-hazard civil protection context. The workshop was organised as a guided, hands-on evaluation in which participants interacted directly with the platform using workflows relevant to their day-to-day responsibilities.

Participants explored core functionalities of the platform, including activating and combining hazard, exposure, infrastructure, and administrative boundary layers within a unified map environment. Time-enabled forecast layers were used to examine projected spatial variations of meteorological variables and hazard-related indicators. Users also created annotations, measured distances and areas, and compared layers to support spatial interpretation.

In addition, participants created and managed persistent workspaces that combined selected datasets, map views, and annotations. These workspaces were saved, duplicated, and shared through read-only links to simulate how structured operational views could be disseminated across institutions while preserving governance constraints.

This structured interaction allowed participants to explore how the platform supports integrated situational awareness by enabling the simultaneous examination of hazard conditions, exposure elements, infrastructure assets, and administrative responsibilities. Several of these datasets (e.g., shelter inventories, traffic restrictions, administrative boundaries) are typically maintained by different institutions and are not available through a single interface.

### Questionnaire Design

The evaluation instrument consisted of three components: participant profiling, structured usability assessment, and open-ended feedback. The usability assessment was based on the Post-Study System Usability Questionnaire

(PSSUQ) developed by IBM, a widely used and validated instrument for measuring user satisfaction and perceived system usability (Lewis, 1995). The questionnaire was adapted to the context of geospatial decision-support systems while retaining the original structure and scale of the original PSSUQ framework.

The first section collected background information, including demographics, professional role, digital literacy, prior experience with similar platforms, and familiarity with Decision Support Systems, to contextualise participant responses. The second section included Likert-scale items (1 = Strongly Agree, 7 = Strongly Disagree) assessing interface pleasantness, clarity of organisation, ease of understanding information, overall satisfaction, functional adequacy, and perceived effectiveness in supporting operational work. The final section comprised three open-ended questions asking participants to identify the most useful features, challenges encountered, and suggested improvements. The questionnaire primarily measured perceived usability and system adequacy, while broader coordination-related interpretations discussed later derive from qualitative feedback and workshop discussion.

#### Structured Usability Feedback Results

The questionnaire responses provide structured insights into participants' perceptions of usability and system performance. Given the small number of participants (n = 5), the results are interpreted qualitatively, focusing on response patterns rather than statistical aggregation. Table 2 summarises individual responses and serves as a structured reference for identifying these patterns.

**Table 2. Questionnaire results (n = 5, Likert 1=Strongly Agree, 7=Strongly Disagree).**

| Usability Statement | P1 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|
| Overall, I am satisfied with how easy it is to use this system | 1 | 1 | 2 | 2 | 3 |
| It is simple to use this system | 1 | 2 | 2 | 2 | 3 |
| I can effectively complete my work using this system | 1 | 2 | 2 | 2 | 3 |
| I am able to complete my work quickly using this system | 1 | 2 | 2 | 2 | 3 |
| I am able to efficiently complete my work using this system | 1 | 2 | 2 | 2 | 4 |
| I feel comfortable using this system | 1 | 2 | 1 | 2 | 2 |
| It was easy to learn to use this system | 1 | 2 | 1 | 1 | 2 |
| I believe I became productive quickly using this system | 1 | 2 | 3 | 1 | 3 |
| The system gives error messages that clearly tell me how to fix problems | 2 | 3 | 3 | 1 | 4 |
| Whenever I make a mistake using the system, I recover easily and quickly | 2 | 3 | 3 | 1 | 4 |
| The information provided with this system is clear | 2 | 2 | 2 | 2 | 4 |
| It is easy to find the information I need | 1 | 1 | 2 | 2 | 5 |
| The information provided with the system is easy to understand | 1 | 2 | 2 | 2 | 4 |
| The information is effective in helping me complete my work | 1 | 2 | 3 | 2 | 4 |
| The organisation of information on the system screens is clear | 1 | 1 | 1 | 1 | 2 |
| The interface of this system is pleasant | 1 | 1 | 1 | 1 | 1 |
| I like using the interface of this system | 1 | 1 | 1 | 1 | 2 |
| This system has all the functions and capabilities I expect it to have | 2 | 2 | 2 | 1 | 4 |
| Overall, I am satisfied with this system | 1 | 2 | 2 | 1 | 3 |

Overall, participants expressed consistently positive perceptions of the platform. Responses indicate strong agreement regarding interface pleasantness, clarity of organisation, and ease of use. Participants reported that the system was easy to learn and that they felt comfortable interacting with it, suggesting a low barrier to entry across users with varying levels of technical expertise.

Participants also indicated that they were able to complete tasks effectively, quickly, and efficiently within the platform. These responses suggest that the system supports core operational workflows without introducing significant usability constraints.

At the same time, responses were more varied in items related to error handling and information clarity. While these items did not indicate broadly negative perceptions, they suggest areas where responses were more variable across participants. In particular, responses concerning error messages, recovery from mistakes, and information clarity point to aspects of the interface where additional guidance and contextual support could further improve user experience, especially for first-time or non-expert users.

These findings should be interpreted as exploratory indications of usability and perceived operational value rather than as statistically generalisable results. Their relevance lies in highlighting consistent user perceptions and identifying areas for refinement, which are further elaborated through the qualitative feedback from participants' open-ended responses and observations recorded during the workshop.

### Preliminary Observations

#### *Integrated Geospatial View and Reduction of Data Fragmentation*

Participants consistently highlighted the integrated map-centric interface positively. The ability to combine hazard, exposure, infrastructure, administrative boundaries, and forecast layers within a single operational view was identified as one of the platform's most valuable features.

Participants emphasised that prior workflows required switching between multiple systems, often resulting in delayed synthesis and inconsistent interpretations. In contrast, the integrated environment allowed them to evaluate hazard dynamics, exposure, and institutional responsibility simultaneously, supporting a more coherent understanding of the situation.

#### *Workspace Functionality and Scenario Continuity*

The workspace mechanism was consistently highlighted as a valuable feature during the workshop. Participants highlighted:

- Preservation of scenario-specific configurations
- Ability to duplicate and refine alternative operational hypotheses
- Controlled sharing through read-only links

Participants noted that, in current practices, situational understanding often needs to be reconstructed as conditions evolve. The ability to store and revisit configurations was therefore perceived as reducing the effort required to rebuild operational views.

#### *Multi-Hazard Forecast Integration*

Participants highlighted that the temporal navigation controls were generally easy to use within the workshop scenario and did not present major usability challenges. The ability to explore forecast time steps and observe projected changes in hazard-related indicators was described as useful during monitoring activities.

Users highlighted that examining forecast layers alongside exposure and infrastructure datasets within the same map interface supported their understanding of how projected hazard conditions relate to assets and operational context.

In addition, participants noted that the platform allowed them to move between different hazard domains without switching to separate tools. This was described as beneficial compared to existing workflows, where hazard-specific information is often accessed through different systems.

#### *Usability and Accessibility*

Participants highlighted positive usability perceptions, noting that the system was easy to learn and interact with. Users with varying levels of technical expertise were able to complete the assigned tasks, and the organisation of the layer catalogue was described as intuitive and aligned with existing civil protection practices.

Feedback from open-ended responses and workshop discussion also identified areas for improvement, including legend readability, alert visualisation, and the need for additional onboarding support, indicating that while the system is accessible, further refinement is required to support first-time or non-expert users.

#### *Coordination and Governance Implications*

Participants indicated that the platform supports shared situational awareness across institutional levels. In particular, they noted that administrative boundaries clarified areas of responsibility, while the combination of hazard, infrastructure, and exposure layers supported joint interpretation of evolving situations. Shared workspaces were also described as facilitating communication through structured operational views.

Participants further highlighted that the integrated contact registry supports faster identification of relevant stakeholders by linking contact information to the operational context.

## DISCUSSION

### Addressing Coordination and Fragmentation Gaps

The findings suggest that integrated geospatial environments may contribute to addressing persistent data fragmentation in civil protection contexts. By enabling the combination of hazard indicators, exposure data, infrastructure, and administrative boundaries within a single operational view, such platforms may reduce interpretive fragmentation across agencies and support shared interpretation across institutional actors. This aligns with prior research emphasising the importance of shared operational views for coordination across distributed actors.

### Socio-Technical Implications

From a socio-technical perspective, the workspace mechanism can be seen as a way to support coordination by allowing operational configurations to be saved and reused over time. This persistence can help maintain shared reference points across users, supporting continuity in how the system is used. It also reflects a broader idea that effective coordination is shaped not just by having access to data, but by how that information is organised, maintained, and shared among users with different roles and responsibilities.

More generally, bringing together diverse datasets into unified, task-oriented views highlights the need to support cross-domain understanding, especially in multi-hazard contexts. Instead of approaching hazards as separate issues, this kind of environment allows users to build connections between hazard behaviour, exposure, and operational constraints.

At the same time, the variation in responses related to error handling and information clarity suggests that crisis information systems need to go beyond simply providing access to data. They should also offer clear guidance to help users interpret what they see. This becomes particularly important in situations involving uncertainty or complex configurations, where users rely on meaningful feedback and context to act with confidence. The contrast between relatively consistent usability scores and more variable feedback on error handling and information findability indicates that challenges tend to arise during more complex or less guided interactions, rather than in the initial use of the system

### Limitations and Future Directions

The evaluation took place during a structured workshop with a limited group of expert participants. This setting allowed for an initial look into usability and coordination aspects of the system. However, the results should be seen as preliminary insights rather than conclusions that apply broadly.

Moving forward, it would be valuable to assess how the system performs in real-world or simulated operational scenarios involving a wider range of institutional roles and further explore ways to enhance feedback mechanisms and user guidance to better support practical use.

Aspects related to data security, controlled sharing, and resilience against cyber threats were not explicitly evaluated in this study. Given the sensitivity of crisis management data, these remain important considerations for future releases.

## CONCLUSION

The RIGID platform suggests that an operationally oriented WebGIS environment can help bridge the gap between data-rich monitoring systems and coordination-focused crisis workflows, while addressing the fragmentation of regional civil protection data**.**

The workshop-based evaluation provides exploratory indications that integrated geospatial views can support situational awareness and reduce the need to navigate multiple systems. Workspace persistence appears to facilitate iterative risk assessment and scenario continuity, while controlled sharing mechanisms may support inter-organisational coordination. The integration of regional and municipality-level datasets with multi-hazard forecasts further highlights the potential for cross-hazard operational coherence.

Usability was generally experienced as straightforward and easy to navigate, but the findings also highlight the need for clearer system feedback and better guidance to support users along the way. Moving forward, the focus will be on testing these insights in real-world conditions and continuing to improve both usability and coordination support.

Future development efforts will focus on improving alert visualisation, strengthening user onboarding and guidance, and refining information clarity to better support effective system use.

This work contributes to crisis informatics by framing RIGID as a socio-technical coordination infrastructure grounded in actor-centered design principles. In line with prior work on coordination challenges in disaster response, the platform illustrates how persistent, role-sensitive workspaces may function as shared operational references, supporting alignment across institutional domains. In this way, the study contributes to exploring coordination-oriented design approaches that extend beyond data integration toward structured, reusable operational configurations.

## ACKNOWLEDGMENTS

This research has been financially supported by the European Commission (EC) and is part of the GOBEYOND project (Grant Agreement No. 101121135), funded under the European Union's Horizon Europe programme for research and innovation.

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