GUIDELINES

ON SUSTAINABLE NEW TECHNOLOGIES IN DISASTER RISK MANAGEMENT FOR EMPLOYEES OF THE CIVIL PROTECTION DIRECTORATE

Project:
Enabling new INVESTments for Disaster Risk Management in Croatia – INVEST for DRM

Contracting authority:
Ministry of the Interior of the Republic of Croatia
Civil Protection Directorate

Author:
Associate Professor Robert Mikac, PhD

Co-funded by the European Union

GUIDELINES

ON SUSTAINABLE NEW TECHNOLOGIES IN DISASTER RISK MANAGEMENT FOR EMPLOYEES OF THE CIVIL PROTECTION DIRECTORATE

CIVILNA ZAŠTITA
RH
MUP

Co-funded by
the European Union

Project:
Enabling new INVESTments for Disaster
Risk Management in Croatia – INVEST for DRM

Project number: 101192781

Contracting authority:
Ministry of the Interior of the Republic of Croatia
Civil Protection Directorate

Author:
Associate Professor Robert Mikac, PhD

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission. Neither the European Union nor the granting authority can be held responsible for them.

Zagreb, 2026.

Content

1

INTRODUCTION AND STRATEGIC FRAMEWORK

This section establishes the fundamental context of the **Guidelines on Sustainable New Technologies in Disaster Risk Management for the Employees of the Civil Protection Directorate** (hereinafter referred to as "the Guidelines") and explains their purpose, objectives and methodological framework. It also outlines their links to the INVEST for DRM project, relevant national and European strategic documents and the concept of the EU Disaster Resilience Goals (DRGs) which is used in the Guidelines as one of the key reference frameworks for evaluating the contribution of new and sustainable technologies to disaster risk management.

1.1. Purpose of the Guidelines

The Guidelines on sustainable new technologies in disaster risk management have been developed as part of the **INVEST for DRM (Enabling new INVESTments for Disaster Risk Management in Croatia)** project. The project is being implemented under the **Union Civil Protection Mechanism** and aims to strengthen the capacities of the Civil Protection Directorate of the Republic of Croatia for strategic planning, prevention and preparedness in disaster risk management.[1]

The INVEST for DRM project aims to enhance the civil protection system in the Republic of Croatia by promoting a systematic and strategic approach to investments in disaster risk reduction with a particular emphasis on new technologies, sustainability and strengthening institutional capacities. In this context, the development of the Guidelines represents one of the key project activities intended for the employees of the **Civil Protection Directorate (CPD)** as support in planning and implementing future technological and organizational improvements.

The Guidelines constitute the **main document** developed as a result of the preliminary analysis and study visits. They build upon previously developed analytical and research documents within the project, including current state analysis, conclusions, and findings. In this respect, they are the next logical step – a transition from needs analysis and identification to structured recommendations and guidelines for future investments and the practical technology implementation.

1.2. Objectives of the Guidelines

The objective of the Guidelines is to contribute to improving disaster risk management through the systematic consideration and encouraging the application of **sustainable new technologies** in the work of the Civil Protection Directorate. The Guidelines focus on strengthening resilience of the civil protection system across all phases of risk management with particular emphasis on prevention and preparedness, as well as on a more effective emergency response.

Particular emphasis is put on linking technological solutions with current strategic frameworks at both national and European level, as well as on the role they play in the green and digital transition. The Guidelines aim to provide a structured overview of relevant technologies, facilitate understanding of their advantages and limitations and foster a planned and phased approach to their application, including the development of the necessary competencies and provision of sustainable sources of funding.

1.3. Methodological approach to the development of the Guidelines

The development of the Guidelines is based on a **combined and interdisciplinary methodological approach** aimed at ensuring that the recommendations are scientifically based, professionally relevant, and operationally applicable within the context of the civil protection system of the Republic of Croatia. The starting point for the development of the document is the results of previous activities carried out within the framework of the INVEST for DRM project, including a preliminary analysis of technologies and equipment, identified challenges and the conclusions and findings resulting from these analyses.

The development of the Guidelines involved a **review of scientific literature** available through relevant academic databases, as well as an **analysis of expert studies**, **special reports and strategic documents** pertaining to disaster risk management, new and innovative technologies, system resilience and the green and digital transition. Particular attention was paid to sources of knowledge available through the Union **Civil Protection Knowledge Network** which brings together current European practices, recommendations and Member States' experience in the field of civil protection.[2] The methodological framework was further strengthened by using results and approaches developed within the TRACE – Technologies and Risk Assessment of Critical Events project, in particular with respect to risk assessment, data integration, development of situational awareness and decision support in complex emergency situations[3].

A valuable contribution to the development of the Guidelines was provided by the results of **two study visits** conducted within the framework of the INVEST for DRM project. During the study visits to Portugal and Germany, examples of good practice, organisational models and technological solutions applicable to civil protection systems were analysed. The gained insights enabled a deeper understanding of the integration of new and sustainable technologies within different institutional and operational frameworks (a more detailed overview is provided in Annex 1).

In addition, the development of the Guidelines encompassed insights into the **development and application of new technologies presented at international trade fairs and conferences** held in 2024 and 2025, as well as announcements of those planned for 2026 and 2027. This approach enabled following the latest trends in digital solutions, sensor systems, unmanned platforms, energy solutions and communication technologies relevant to disaster risk management along with an assessment of their maturity and potential applicability within the civil protection system (a list of relevant events is provided in Annex 2).

This methodological approach enables the Guidelines to bring together theoretical knowledge, international experience and practical insights, thus creating a balanced basis for defining recommendations, priority investments and further steps in the development of sustainable new technologies within the civil protection system of the Republic of Croatia.

1.4. The Union disaster resilience goals

The Guidelines use the concept of the **Union disaster resilience goals** as one of the key reference frameworks which in the European context is applied to steering policies and measures aimed at strengthening resilience to disasters. The DRG concept encompasses five strategic goals for enhancing resilience to disasters: *anticipation* (anticipate and plan for risks), *preparedness* (increase awareness and preparedness), *alert* (enhance early warning systems), *response* (enhance response capacities) and *security* (ensure robust civil protection systems).[4]

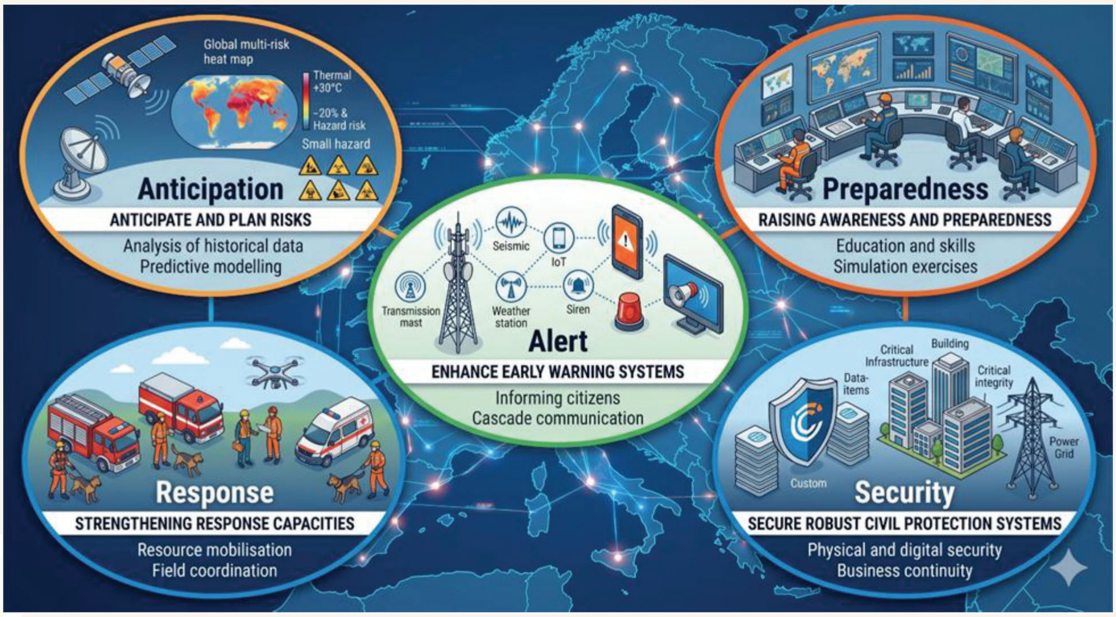

Figure 1.1 Visualisation of the five Union disaster resilience goals (DRGs)

Source: Interpretation by the author

Within the framework of these Guidelines, the DRGs are used as an **analytical tool** to assess the contribution of individual new and innovative technologies. For each technological area, its potential contribution to achieving resilience goals is assessed, thus enabling a more systematic and comparable approach to identifying technological priorities and planning future investments.

1.5. Links with national and EU strategic documents

The Guidelines have been developed in line with key national and European strategic documents that define the framework for disaster risk management, sustainable development and resilience to climate change. At national level, they are coherent with the **Disaster Risk Management Strategy up to 2030**, **Climate Change Adaptation Strategy for the period up to 2040 with a view to 2070**, **National Development Strategy of the Republic of Croatia up to 2030 and Disaster Risk Management Action Plan for the period up to 2024**. These documents provide the basis for a systematic approach to risk reduction and strengthening resilience in the Republic of Croatia.

At European and international levels, the Guidelines rely on both the objectives and principles of the **European Green Deal** and the **Sendai Framework for Disaster Risk Reduction (2015–2030)** which emphasizes the importance of understanding risks, strengthening risk management, investing in risk reduction and enhancing preparedness and resilient recovery.[5]

The Guidelines are also linked to operational and development activities of the **Union Civil Protection Mechanism (UCPM)** and the **Union Civil Protection Knowledge Network**, which provide a platform for sharing knowledge, experience and best practices among the Member States of the European Union.

2

STRATEGIC OVERVIEW OF THE CURRENT STATE

This section provides a strategic overview of the current state of the civil protection system in the Republic of Croatia with particular emphasis on the role and responsibilities of the Civil Protection Directorate. The analysis examines the current level of technological and operational capacity, as well as the key challenges affecting the effectiveness of disaster risk management. The overview is based on the results of a preliminary analysis conducted within the INVEST for DRM project and serves as a starting point for considering the need to introduce sustainable and innovative technologies which are discussed in detail in the following chapters.

2.1. Role and responsibilities of the Civil Protection Directorate in disaster risk management

The Civil Protection Directorate plays a central role in the disaster risk management system in the Republic of Croatia acting as a coordinating and operational body connecting national authorities, local and regional self-government units, civil protection operational forces and other relevant stakeholders. Its tasks cover all phases of the risk management cycle from assessment and prevention through preparedness to response to emergencies and support for recovery.

In the prevention and risk assessment phase, the CPD participates in preparing and updating disaster risk assessments, developing planning documents and monitoring of climate-related and other hazards that may have a significant impact on the safety of the population and infrastructure. During the preparedness phase, key roles are played by early warning systems, capacity planning, education and training of personnel and operational forces, as well as maintaining the readiness of communication and information systems.

During disaster response, the Civil Protection Directorate ensures the coordination of actions among various stakeholders and operational forces, manages information and communication, supports real-time decision-making and enables efficient data exchange between field operations and command structures. Such a complex role requires reliable, interoperable and technologically cutting-edge support, particularly in the context of increasingly frequent and complex emergencies.

2.2. Current state of CPD's technologies and equipment

The analyses conducted within the INVEST for DRM project indicate a **heterogeneous level of technological capacity** within the Civil Protection Directorate. Individual organisational units have access to different levels of equipment and technological solutions which is partly due to the specific nature of their tasks, but also to the historical development of the system and the availability of financial resources.

There are functional and proven solutions that enable day-to-day operational activities in certain segments, particularly in communication systems, early warning systems and specific digital tools. At the same time, the results of online questionnaires, interviews, and written feedback from CPD employees indicate that a large number of organisational units use equipment of varying age and technical performance, including equipment that no longer meets contemporary technological standards.

The average assessment of the state of technology and equipment based on a survey conducted among CPD employees implies moderate satisfaction, but also a clear room for improvement. This state suggests that the system is currently operational, but at the cost of increased effort of the employees, limited analytical capabilities and a reduced level of resilience in the event of more complex or prolonged emergency situations.

2.3. Key challenges

One of the dominant challenges identified in the conducted analyses relates to the **obsolescence of certain equipment and technologies**, particularly in the segment of information and communication systems, laboratory equipment and specialised testing and intervention devices. Obsolete equipment often requires increased maintenance, has limited upgrade potential and does not support the implementation of modern digital solutions, including advanced analytical tools.

Another significant challenge is the **lack of integration and the fragmentation of systems**. Different applications, databases and communication channels are often insufficiently interoperable thus hindering the exchange of information in real-time and slowing down decision-making, particularly in situations requiring rapid coordination among multiple stakeholders. An additional challenge is the lack of single and up-to-date records of operational forces, material resources and equipment within the civil protection system. Existing data are often distributed across different records and systems making it difficult to obtain a consolidated overview, ensure timely updates and use the data effectively in operational decision-making. In emergencies, such fragmentation can delay the mobilisation of resources, hinder the assessment of available capacities and reduce the effectiveness of coordination among different stakeholders.

The analyses have also identified **shortcomings in software support**, as well as limited capacities for processing and analysing large volumes of data. In such an environment, the potential of modern technologies, such as artificial intelligence and advanced GIS (Geographic Information Systems) tools, remains underutilised. An additional challenge relates to the **need for continuous education and training of employees** as the introduction of new technologies requires appropriate knowledge and skills at all levels of the system.

2.4. Need for sustainable and innovative technologies

Addressing climate change, the increasing frequency of extreme weather events and the growing complexity of risks clearly indicates the need for a **strategic shift in the application of technologies within the civil protection system**. The existing challenges identified by analyses and research cannot be resolved in the long term solely by maintaining the status quo, but require the planned introduction of new, innovative, and sustainable solutions.

Sustainable new technologies offer the potential to simultaneously enhance operational efficiency, reduce dependency on conventional energy sources, improve analytical capacities and strengthen the overall resilience of the system. In this context, digitalisation, the application of artificial intelligence, the integration of sensor and communication systems and the development of energy-efficient and self-sufficient solutions represent key directions for further development.

However, the successful deployment of new and sustainable technologies depends not only on their availability, but also on the existence of corresponding preconditions within the civil protection system. Analyses indicate that several interrelated areas need to be improved simultaneously to ensure effective implementation.

At **strategic and governance level**, it is essential to ensure a clear vision for technological development, define investment priorities and coordinate technological initiatives with national and European strategic frameworks. Without such an approach, there is a risk of fragmented and uncoordinated investments that do not contribute to the long-term resilience of the system.

At **technological and data level**, key prerequisites include the development of interoperable information and communication systems, the standardisation of data and the establishment of a reliable data infrastructure. It is particularly important to ensure the availability of high-quality and up-to-date data as without them advanced technologies, such as artificial intelligence and analytical tools, cannot reach their full potential.

At **organisational and process level**, procedures, protocols and working methods need to be improved to enable the effective integration of new technologies into day-to-day operational activities. This includes clearly defined responsibilities, standardised information exchange processes and regular system testing through exercises and operational scenarios.

Finally, **one of the most important prerequisites relates to the development of human capacities**. The introduction of new technologies requires continuous education and training of personnel, the development of digital competences and the ability to understand and apply advanced tools in an operational environment. Without the appropriate knowledge and skills, even technologically advanced systems remain underutilised.

3

SUSTAINABLE TECHNOLOGIES AND PRIORITY INVESTMENTS

This section provides an analytical overview of key technological solutions relevant to disaster risk management and are structured into four thematic areas **(digital and analytical technologies; communication and management; field operations and supervision; sustainability and logistics)**. The analysis is focused on understanding the functionality and potential of individual technologies, as well as their positioning in relation to disaster risk management (DRM) goals with an emphasis on where they deliver the **greatest value within the DRM cycle**. Based on this analysis, the following chapter formulates concrete recommendations for their implementation.

Figure 3.1 illustrates the relationship between the identified technological solutions and key disaster resilience goals (DRG), that is, their contribution to the phases of anticipation, preparedness, alert, response and security. It is evident that certain technologies play a horizontal role and contribute to multiple objectives simultaneously, while others are specifically focused on particular phases of risk management. Such a representation facilitates a clearer understanding of investment priorities and the identification of technologies that have the greatest impact on strengthening the resilience of the civil protection system.

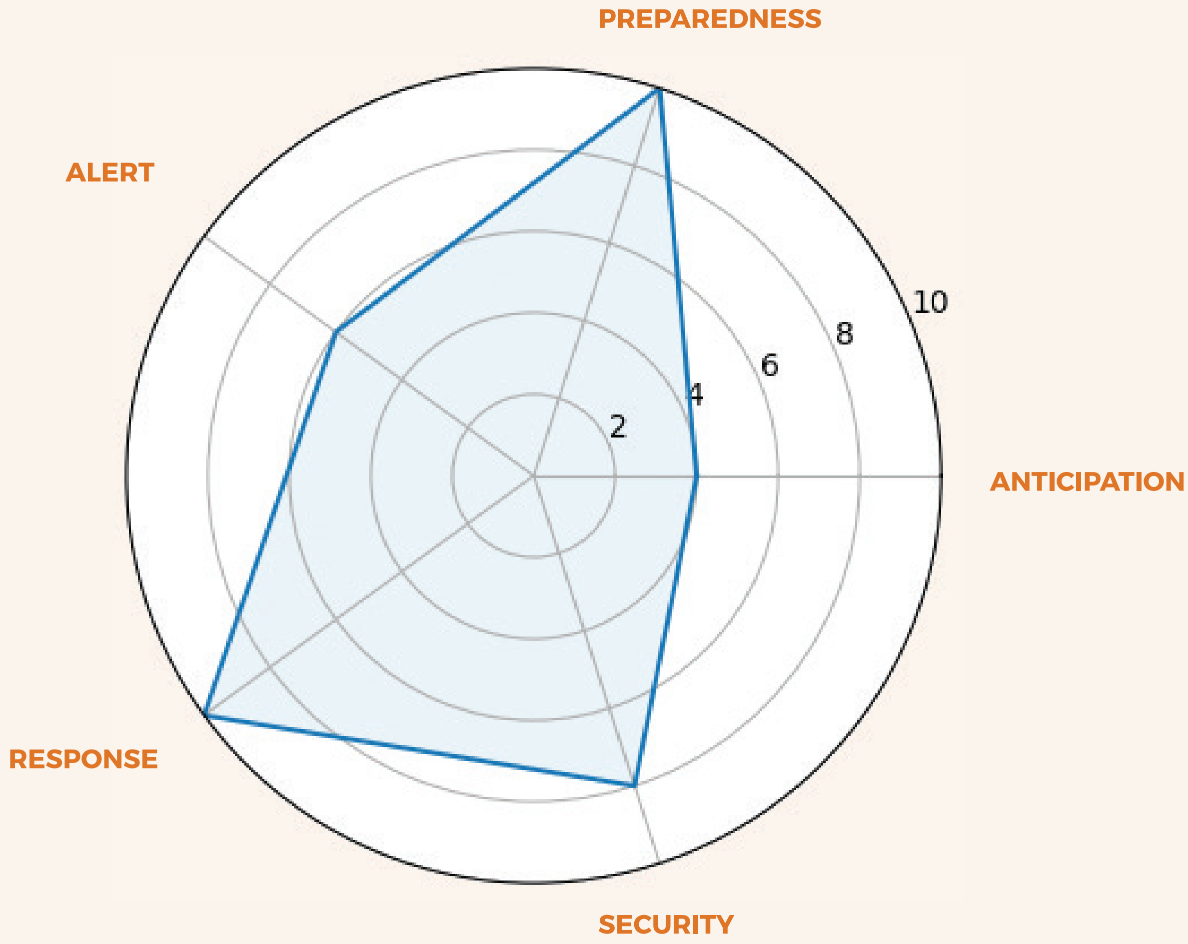

Figure 3.1 The role of technologies in disaster resilience goals (DRG)

Source: Interpretation by the author

3.1. Digital and analytical technologies

Digital and analytical technologies enable significant improvements in disaster risk management through more efficient data processing, the development of advanced analytical models and support for real-time decision-making. Their application contributes to a better understanding of risks, strengthens **anticipation**, **preparedness** and **alert** and enables a more effective **response** in emergency situations. These technologies play a horizontal role as they connect various data sources, operational systems and risk management processes.

Artificial intelligence in disaster risk management

Artificial intelligence (AI) in disaster risk management is increasingly recognized as a technology that enhances the system's ability to understand risks in a timely manner, process large volumes of information and support decision-making under conditions of uncertainty. In the European context, the emphasis is not on AI replacing experts, but rather on acting as a "capacity multiplier," particularly through faster analytics, more reliable image and text processing and improvements in early warning and impact assessment. Such positioning of AI is directly in line with the logic of the **Union disaster resilience goals** as it contributes to anticipation and preparedness, while also strengthening an effective response when a disaster is already developing.

The application of artificial intelligence is particularly significant for strengthening **anticipation** as it enables the development of models that identify patterns in historical and real-time data and contribute to the early detection of potential threats.[6] By integrating diverse data sources, including meteorological, satellite and geospatial information, a more accurate understanding of risks and their potential development is enabled (**alert**).[7]

Artificial intelligence delivers additional value in the context of **preparedness** through data analysis and the modelling of possible scenarios of event development. Such an approach enables the identification of critical points of the system and the optimization of response plans, while the automation of analytical processes increases the efficiency of preparedness activities.[8]

Artificial intelligence contributes to a more effective **response** in emergencies by processing large volumes of information in real-time, including images, videos and textual data. This speeds up the flow of information, facilitates the identification of priorities and supports decision-making. The effectiveness of such systems, however, depends on the quality and availability of data, as well as on both the reliability and transparency of the models[9].

Integrated situational awareness and smart field systems

Integrated situational awareness (ISA) represents a **single operational picture** that brings together data from multiple sources in real-time — from satellite imagery and field sensors to information reported by the very responders. A key element of ISA is its data fusion capability which enables commanders to see not only the position of their teams, but also dynamic changes in the environment, such as the spread of a wildfire front or the concentration of hazardous gases. European research projects are focused on developing platforms that ensure that all stakeholders from local to national level have access to the same up-to-date situational picture.

The integrated situational awareness provides a consolidated real-time view of data from various sources, including sensor systems and early warning systems (**alert**), geospatial data and on-site information. Such an approach enables the creation of a single operational picture that connects field conditions, available resources and the development of events, thus significantly enhancing the decision-making process.[10]

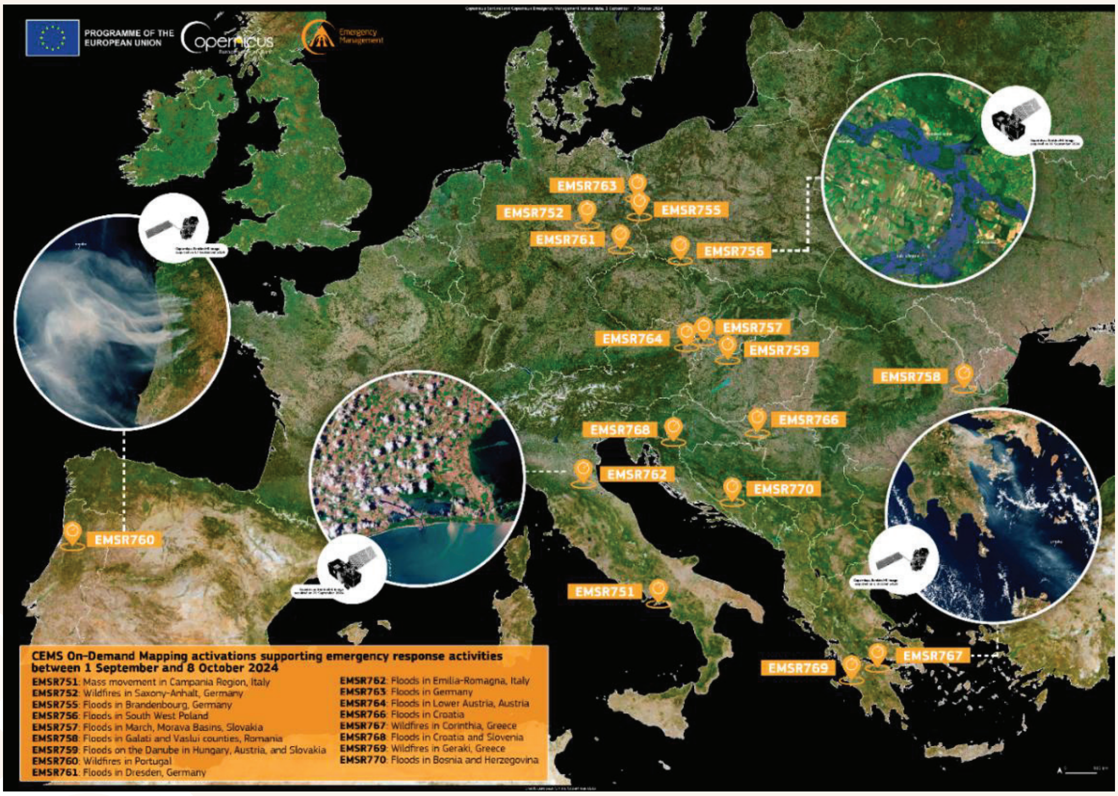

Figure 3.1: Example of Geospatial Mapping and Crisis Situation Analysis (Copernicus Emergency Management Service – EMS)

Source of the figure: https://www.copernicus.eu/en/media/image-day-gallery/copernicus-emergencies

Through their functionality, these systems play a key role in strengthening **preparedness** as they enable continuous situational monitoring and a better understanding of the operational environment. In the context of **response**, they enable the rapid exchange of information and the coordination of operations which is particularly important in dynamic emergency situations.[11]

Additional value is achieved in the area of **security** through the application of smart field systems which include wearable devices, sensors and localization technologies for monitoring the condition of personnel and field conditions.[12]

Digital simulations and digital twin models

Digital simulations, including virtual reality (VR) and augmented reality (AR) technologies, enable the modelling of crisis scenarios in a controlled environment, thus enhancing training and preparedness without exposure to real risks. These technologies allow for the repeatability of scenarios, the analysis of actions taken and the evaluation of different approaches to crisis management.[13]

The concept of a digital twins refers to the creation of an **equivalent digital replica** of critical infrastructure or entire urban areas for testing disaster scenarios. These models use real-time data from IoT sensors to simulate, for example, the movement of a flood wave through a city or to assess the impact of damage to a key bridge on evacuation routes. Within the EU, such models are becoming a standard for planning the resilience of cities, critical infrastructure and various systems enabling decision-makers to visualize the outcomes of different response strategies before they are implemented in the field.

The application of these technologies particularly contributes to strengthening anticipation as it allows for the simulation of various scenarios and the assessment of their impacts prior to actual events. This improves the understanding of potential risks and enables the development of more effective response strategies.[14]

In the context of **preparedness**, digital twin models and simulations enable the testing of plans and the optimization of responses within a virtual environment, thus increasing the overall level of system readiness.[15]

Table 3.1: Overview of digital and analytical technologies and their contribution to DRM goals

TECHNOLOGY	FUNCTIONAL DESCRIPTION	KEY USE IN DRM	KEY ADVANTAGES	KEY LIMITATIONS	CONTRIBUTIONS TO DRGs
Artificial intelligence	Data analysis and predictive analytics for decision-making	Risk analysis; early warning; real-time data processing	Faster processing; earlier threat detection; advanced analytics	Data dependency; need for standardization; model reliability	Anticipation; preparedness; alert; response
Integrated situational awareness and smart systems	Integration and visualization of data from multiple sources in real-time	Operations management; coordination; monitoring the situation on the ground	Enhanced situational awareness; increased security; more effective decision-making	System complexity; interoperability; communication requirements	Preparedness; alert; response; security
Digital simulations and digital twin models	Scenario simulation and digital models of systems and infrastructure	Training; planning; scenario testing	Safe training; improved preparedness; decision optimization	Need for high-quality data; technical complexity	Anticipation; preparedness

3.2. Communication and management

Technologies in the field of communication and management play a key role in ensuring the timely exchange of information, coordination of operations and effective decision-making. Their application is particularly important in areas that require reliable communication, interoperability and continuous system availability, thus directly contributing to the effectiveness of disaster risk management.

Enhancement of information and communication systems

Information and communication systems represent the core infrastructure of modern disaster risk management as they enable the collection, exchange and processing of information across all phases of civil protection system operations. In the European context, information and communication systems are not viewed merely as technical support, but as a **critical capability** that directly affects the effectiveness of coordination, the speed of decision-making and the level of situational awareness. Their upgrade is therefore recognized as one of the key prerequisites for achieving multiple **Union disaster resilience goals**, particularly those related to preparedness, response and the provision of robust civil protection capacities.

In the context of **preparedness**, the development of interoperable systems is based on standards and platforms that enable data exchange between different organizations and countries, including sharing of information for early warning systems (**alert**) through initiatives such as the INSPIRE Directive (Infrastructure for Spatial Information in Europe) and the development of integrated information systems.[16]

In emergency situations, their role in **response** is reflected through coordination and information-sharing systems, such as those operated by the Emergency Response Coordination Centre (ERCC) which enable operational coordination and the exchange of information between Member States.[17]

Their contribution to system **security** is reflected in the development of secure and redundant communication solutions, including satellite communications and initiatives such as GOVSATCOM (Governmental Satellite Communications).[18] This is a European Union programme that provides reliable and secure satellite communication capacities for governmental users and crisis management services, ensuring communication availability even in situations where terrestrial networks are damaged or unavailable.

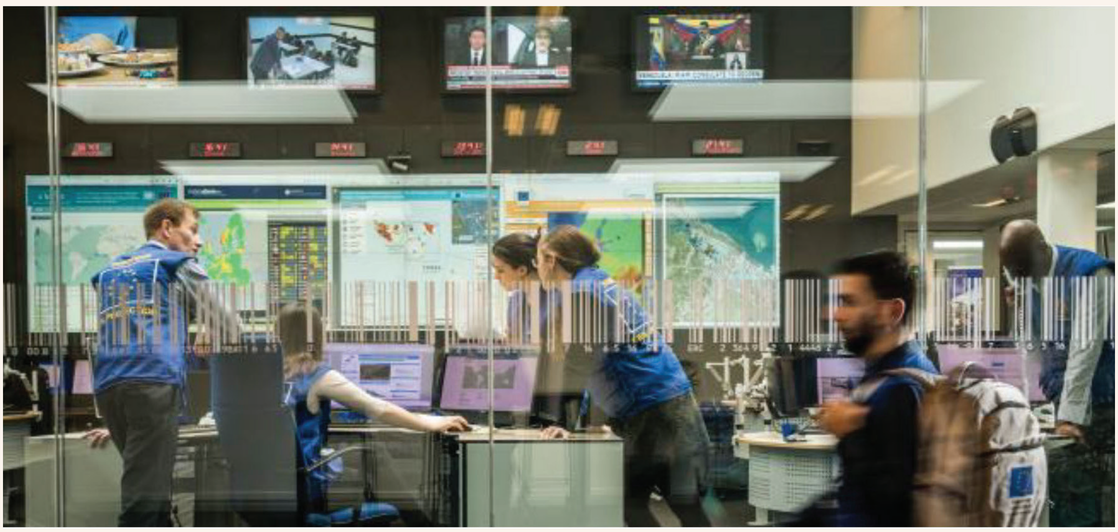

Figure 3.2: Operational activities of the Emergency Response Coordination Centre

Source of the figure: https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/emergency-response-coordination-centre-ercc/10-years-emergency-response-coordination-centre-ercc_en

Real-time video transmission systems

Real-time video transmission represents a key technological solution for enhancing situational awareness in emergency situations, enabling commanders and field teams access to visual data without exposure to danger. European projects use increasingly a combination **of unmanned aerial vehicles (drones), robotic platforms and software protocols optimized for minimal signal delay (low latency)** enabling **direct video transmission** to command centres even when traditional communication networks are partially or completely unavailable. Such technologies enable faster decision-making, improved coordination of response teams and reduced risk for operational personnel.

In the context of **preparedness**, these technologies support the development of operational concepts for using of drones and other platforms in data collection and transmission.[19]

Their application is particularly evident in the **response** phase where they enable real-time video transmission and the integration of data into command systems, thus improving situational awareness.[20]

These technologies further contribute to **security** as they enable the collection of information without direct exposure of operational personnel to hazardous conditions.[21]

Sustainable command and communication systems

Sustainable command and communication systems form the backbone of **effective crisis and disaster management** by enabling on-site information to be rapidly translated into coordinated decisions, while maintaining operational continuity even in conditions where **critical terrestrial infrastructure fails**. Such resilience is achieved through the use of redundant satellite links, systems with independent power supply and solutions for local data processing on the ground. The European practice highlights clear command structures, standardized information exchange protocols and planning of communication capacities as part of operational plans with system resilience considered just as important as its functionality. Such an approach directly supports sustainability by **optimizing** the deployment of forces on the ground, preventing duplication of activities and reducing inefficient use of resources, thus increasing the precision of operations in real-time.

Sustainable command and communication systems are focused on ensuring the long-term functionality and reliability of communication and management capacities, including early warning systems (**alert**) in emergencies.

In the context of **preparedness**, the development of these systems includes business continuity planning, crisis planning and standardized procedures.[22]

Their role in **response** is reflected in emergency situations in the stable functioning of command structures and coordination mechanisms, including European coordination structures (see footnote 17).

Their contribution to **security** is particularly evident through the development of systems that enable the continuation of operations under conditions of infrastructure degradation, including mobile and distributed command systems.[23]

Table 3.2: Overview of communication and command technologies and their contribution to DRM goals

TECHNOLOGY	FUNCTIONAL DESCRIPTION	KEY USE IN DRM	KEY ADVANTAGES	KEY LIMITATIONS	CONTRIBUTIONS TO DRGs
Enhancement of information and communication systems	Interoperable systems for data exchange and communication	Coordination; information sharing; international cooperation	Interoperability; faster information flow; reliability	Integration complexity; standardization	Preparedness; alert; response; security
Real-time video transmission systems	Real-time transmission of images and data	Situational awareness; supervision; operational management	Improved situational insight; faster decision-making; security	Need for a stable network; technical limitations	Preparedness; response; security
Sustainable command and communication systems	Systems for the management and coordination of operations	Crisis management; coordination; operational continuity	Stability; resilience; coordination	Redundancy requirements; investments	Preparedness; alert; response; security

In the context of sustainable command and communication systems, particular importance is given on the development and upgrading of the **Next-Generation Incident Management System** (**NICS**). It is a system already in use within the Civil Protection Directorate enabling the integration of data from various sources into a single operational platform for command and coordination. NICS systems ensure real-time information exchange, monitoring of resources and field activities and support for decision-making through a consolidated situational picture. The application of such systems contributes to increased interoperability, more effective coordination and the overall resilience of the civil protection system in emergency situations.

Figure 3.3: Interdepartmental workshop on the implementation of next-generation incident command system (NICS)

Source of figure: https://civilna-zastita.gov.hr/vijesti/vijesti/u-velikoj-gorici-odrzana-prva-edukacija-u-sklopu-nastavka-nics-projekta/9170

3.3. Field operations and supervision

Technologies in field operations and supervision enable real-time data collection, tracking of field conditions and support for operational decision-making. Their application particularly contributes to strengthening anticipation, response and security through the application of sensors, IoT systems, unmanned platforms and advanced analytical tools.

IoT and sensor technologies

The Internet of Things (IoT) and sensor technologies in disaster risk management are increasingly used as the "extended senses" of the civil protection system enabling continuous monitoring of environmental parameters and infrastructure, as well as faster and more evidence-based situational assessment in real-time. European projects and technology reviews emphasize that the greatest value comes from combining **field sensors**, **remote sensing** (e.g., Copernicus) and **analytics** that transform data into alerts and operational recommendations. This approach increases resilience and reduces the need for routine reconnaissance and unnecessary field deployments, thus directly contributing to sustainability and more efficient resource management.

In the context of **anticipation**, sensor systems enable the early detection of changes and identification of risks, as well as the activation of early warning systems (**alert**) through continuous monitoring of environmental and infrastructure parameters, including use in monitoring fires, floods, and landslides.[24]

Their role in **response** to emergency situations is manifested through the collection and transmission of real-time data, including integration with field systems and operational management platforms.[25]

Figure 3.4: Application of unmanned systems for real-time monitoring

Source of figure: https://fotokite.com/

These technologies also significantly contribute to **security** by enabling monitoring of personnel status and field conditions, including the use of wearable sensors and the integration of sensors on robotic platforms.[26]

Software solutions for risk mapping (drones and artificial intelligence)

The application of unmanned aerial systems (drones) in combination with advanced software solutions and artificial intelligence is increasingly recognized as a key technology for **rapid and accurate risk mapping** in disaster management. In the European context, such solutions enable the collection of high-resolution spatial data immediately after events (e.g., earthquakes, floods, fires), as well as during the prevention and preparedness phases when hazard and vulnerability maps are developed. A particular advantage lies in the ability to automatically process large volumes of data, significantly reducing the time from data capture to the production of operationally usable risk maps.

Software solutions that integrate drone-collected data with artificial intelligence enable advanced risk mapping and analysis of field conditions, including the identification of potential threats and support for early warning systems (**alert**).

In the context of **anticipation**, they enable the development of detailed risk maps and analytical models based on geospatial and sensor data with uses such as those in wildfire management and environmental risk management[27].

These solutions also contribute to **preparedness** through scenario planning and analysis, as well as the development of digital risk models (see footnote 27).

Figure 3.5: Real-time data transmission

Source of figure: https://fotokite.com/

In emergency situations, their role in **response** is manifested through rapid processing of data and the generation of analytical outputs that support operational decision-making.[28]

Table 3.3: Overview of field operations and monitoring technologies and their contribution to DRM goals

TECHNOLOGY	FUNCTIONAL DESCRIPTION	KEY USE IN DRM	KEY ADVANTAGES	KEY LIMITATIONS	CONTRIBUTIONS TO DRGs
IoT and sensor technologies	Systems for continuous collection of environmental and operational data	Early warning; situational monitoring; personnel safety	Continuous data; enhanced safety; timely action	Network dependency; system maintenance; interoperability	Anticipation; alert; response; security
Software solutions for risk mapping (drones and artificial intelligence)	Integration of drone data and AI models for analysis and mapping	Risk mapping; analysis; planning; decision support	Accurate data; improved analysis; situational awareness	Data quality; system complexity	Anticipation; preparedness; alert; response

3.4. Sustainability and logistics

Technologies in the field of sustainability and logistics are aimed at reducing environmental impact, increasing energy independence and ensuring the long-term resilience of operational capacities. Their application particularly contributes to strengthening preparedness, response and resilience through the development of sustainable energy solutions, transport systems and equipment.

Energy-sustainable and autonomous field infrastructure

Energy-sustainable and self-sufficient field infrastructure is increasingly recognized as a key capability of civil protection systems, especially in the context of climate change and the growing frequency of disasters affecting critical infrastructure which directly threatens the continuity of operations. Experiences from major emergency events in Europe and worldwide show that disruptions in electricity supply represent one of the greatest operational challenges for command, communication and the prolonged deployment of units on the ground. Therefore, modern approaches to disaster risk management put increasing emphasis on the development of energy solutions that enable autonomous operation without reliance on external networks.

The development of energy-sustainable and autonomous field infrastructure is aimed at ensuring reliable power supply in emergency situations while reducing dependence on conventional energy systems.

In the context of **preparedness**, the development of such systems includes planning energy-efficient solutions, integrating renewable energy sources and developing autonomous energy systems.[29]

In emergency situations, their role in **response** is manifested through the application of portable and hybrid energy systems that ensure continuous power supply for operational equipment and infrastructure.[30]

These solutions also significantly contribute to system **security** by reducing vulnerability to power supply disruptions and by enabling the development of decentralized energy systems.[31]

Sustainable transport and "green" emergency vehicles

The introduction of **"green" vehicles** and sustainable transport systems into civil protection represents a key step toward both achieving the objectives of the European Green Deal and strengthening operational resilience. Traditional transport systems in emergency situations often depend on fossil fuel supply chains which are among the first to be disrupted during disasters. Therefore, European guidelines advocate a transition to cleaner technologies that in addition to reducing environmental impact ensure greater energy independence. Such sustainable solutions encompass a wide range of technologies from electric and hybrid vehicles to the use of biofuels and advanced logistics models.

Sustainable transport systems and "green" emergency vehicles are aimed at reducing emissions, increasing energy efficiency and ensuring the long-term sustainability of logistical capacities.

In the context of **preparedness**, the development of these systems includes planning the transition to zero- or low-emission vehicles, as well as developing the necessary supporting infrastructure.[32]

In emergency situations, their role in **response** is manifested through the use of electric and alternative vehicles in operational conditions, including pilot projects in emergency services (such as firefighting and medical teams).[33]

Their contribution to **security** is manifested through the reduced dependence on fossil fuels and the development of adaptable power supply systems for mobile units.[34]

Figure 3.6: Use of sustainable and low-carbon vehicles in civil protection activities

Source of figure: https://www.electrive.com/2025/03/18/rosenbauer-delivers-erev-fire-engine-in-hamburg/

Sustainable and circular personal protection equipment

The concept of ecological and circular personal protective equipment (PPE) implies a shift from the linear "take–make–dispose" model to a **sustainable cycle** that uses recycled materials and designs adapted for reuse. In the context of civil protection, this includes the development of protective suits, helmets and footwear made from high-performance polymers that can be fully recycled without losing their protective properties. European trends emphasize the importance of "design for deconstruction," enabling the easy separation of different layers of equipment (e.g., fire-resistant membranes from the outer layer) to facilitate repair or recycling.

The development of sustainable and circular personal protective equipment (PPE) is aimed at reducing waste, extending product lifespans through repair and reuse and utilizing recyclable materials.

In the context of **preparedness**, the development of such equipment includes the application of circular economy principles, eco-design and sustainable production.[35]

In emergency situations, their role in **response** is manifested through ensuring the availability of reliable and functional protective equipment with a reduced environmental impact.[36]

These solutions also contribute to **security** by reducing dependence on supply chains and by promoting the development of circular models of production and recycling.[37]

Table 3.4: Overview of sustainability and logistics technologies and their contribution to DRM goals

TECHNOLOGY	FUNCTIONAL DESCRIPTION	KEY USE IN DRM	KEY ADVANTAGES	KEY LIMITATIONS	CONTRIBUTIONS TO DRGs
Energy-autonomous Infrastructure	Systems based on renewable sources and autonomous	Power supply solutions; field operations; logistics	Energy independence; resilience; sustainability	Initial investment; technical complexity	Preparedness; response; security
Sustainable transport systems	Low- or zero-emission vehicles and new logistics solutions	Mobility; operational transport; logistics	Reduced emissions; efficiency; long-term	Infrastructure sustainability; technological limitations	Preparedness; response; security
Sustainable personal protection equipment	Personal protective equipment based on circular and ecological principles	Protection of personnel; equipment logistics	Waste reduction; sustainability; material innovation	Standardization; cost	Preparedness; response; security

The development of additive technologies, particularly three-dimensional (**3D**) printing, also opens up new possibilities for the sustainable and circular production of personal protective equipment (PPE). Scientific research indicates that 3D printing enables local and decentralized production of protective equipment, while also allowing the use of recycled materials. This approach achieves production with minimal waste significantly reducing the burden on waste management systems. Furthermore, studies show that 3D-printed PPE can be reused multiple times with appropriate disinfection procedures, thus reducing the need for single-use products and increasing overall system sustainability. Such an approach also reduces dependence on supply chains and enables rapid adaptation to needs in emergency situations.

3D printing represents a present-day technology that enables the rapid production of essential items and components directly in the field or within mobile units in the operational zone instead of waiting for delivery from distant warehouses. As an example of the above, it can be highlighted that 900 3D-printed protective face shields for medical staff and other personnel working in direct contact with citizens were produced and assembled by the Faculty of Organization and Informatics of the University of Zagreb, at the beginning of the COVID-19 pandemic in 2020 when there was a shortage of protective equipment.

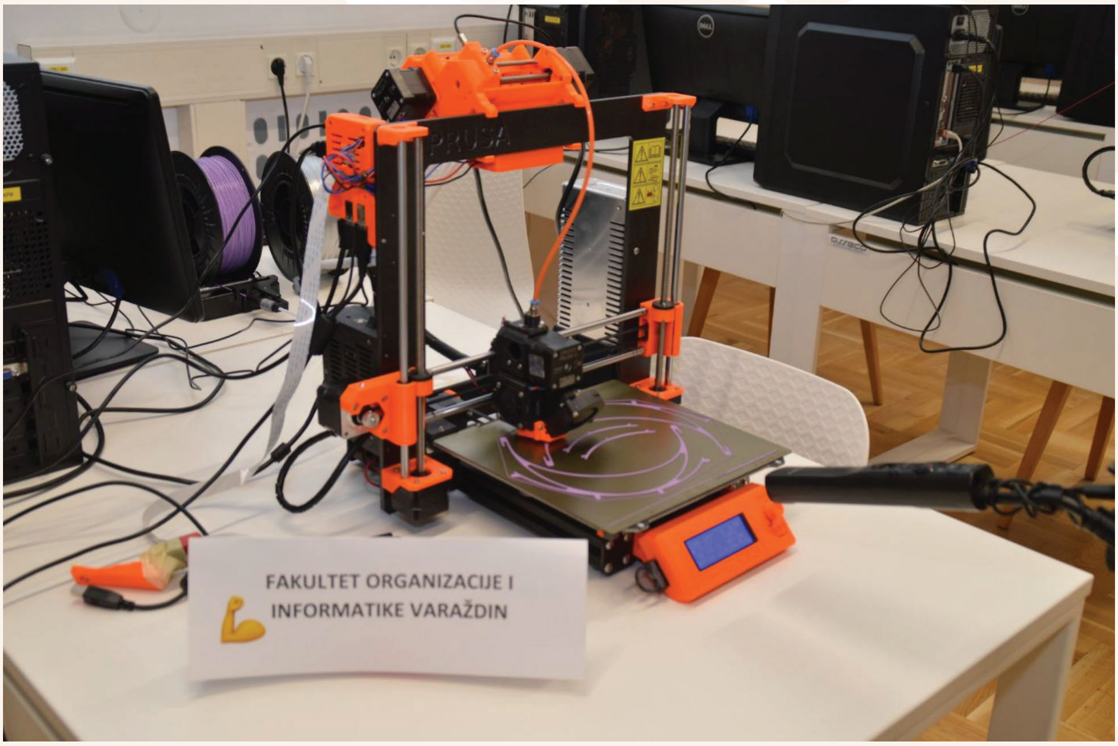

Figure 3.7: 3D printing process at the Faculty of Organization and Informatics, University of Zagreb

Source of figure: https://www.foi.unizg.hr/hr/novosti/foi-isprintao-i-sklopio-gotovo-900-zastitnih-3d-printanih-vizira-za-zastitu-medicinskog#nanogallery/nanoGallery/72157713682700106

4

RECOMMENDATIONS AND BEST PRACTICES

This section provides recommendations for the application of new and sustainable technologies in the civil protection system based on the analysis of technological solutions and their contribution to disaster risk management presented in the previous chapter. The focus is on identifying concrete opportunities for the use of these technologies, taking into account their operational value, level of maturity and experiences from other countries.

The recommendations are structured into three interrelated sections: an **analysis of the possibilities for applying technologies, examples of good practices from other countries and an overview of international experiences in financing.** This approach enables the linkage of technological solutions with their practical use in an operational environment, while a detailed proposal for implementation, sources of financing and cost estimates for the civil protection system of the Republic of Croatia are addressed in the following chapter.

Special emphasis is put on the experiences of European Union Member States and the results of projects funded through European programmes ensuring that the recommendations are based on proven practices and real operational use. This enables the transfer of knowledge and experience into the national context and reduces the likelihood of failure in the adoption of new technologies (so-called technological and operational risk).

4.1. Opportunities for applying technologies

The opportunities for applying new technologies in the civil protection system encompass a range of functionalities that contribute to improving decision-making, coordination and the implementation of activities across all phases of disaster risk management. Their application is particularly evident in data analysis, the development of situational awareness, operations management and the enhancement of operational personnel safety.

The **role of technology in decision-making** is increasingly prominent through the use of advanced analytics, artificial intelligence and integrated information systems which enable faster data processing, better risk assessment and higher-quality support to command structures. At the same time, the effectiveness of these solutions depends on **interoperability and system integration**, i.e., the ability to connect different data sources, platforms and organizations into a single functional framework.

The introduction of new technologies requires **phased implementation and risk management** with clearly defined operational needs, pilot projects and gradual integration into existing systems. Such an approach enables controlled introduction of technology and reduces technical and organizational risks.

An important prerequisite for the successful application of technology is its **coordination with organizational processes**, including existing procedures, management structures and the level of user training in order to ensure real operational value.

Increasing emphasis is also put on **sustainability and the technology lifecycle**, including energy efficiency, maintenance, upgrades and equipment disposal. In this context, the selection of technology should also include an assessment of its long-term environmental impact and operational costs.

The final phase of introducing innovations is based on verifying key criteria: **operational usefulness**, **a high level of reliability** and **environmental sustainability**. Such validation ensures that the selected technology delivers real value to the system, while minimizing financial and organizational risks.

4.2. Examples of good practice from other countries

This section provides recommendations for the application of the analysed technologies along with specific examples of their implementation in European countries and projects. The recommendations are based on the previous analysis of technological capabilities and present ways of their practical use in disaster risk management systems.

4.2.1. Phased implementation of artificial intelligence

A phased approach is recommended in which artificial intelligence is introduced through limited pilot projects focused on specific operational needs, such as data analysis, early warning, communication processing and decision support. Such an approach is in line with the European direction of artificial intelligence development in civil protection where the emphasis is put on testing and validating solutions in real-world conditions.

Examples of countries and projects:

- **Cyprus** — ARTION and AIDERS projects, within which AI-based solutions for risk management and data processing were developed and tested.[38]
- **Greece, Italy, Spain, Ireland, France, Portugal, Sweden, Israel, Luxembourg, Austria and Germany** – AI-based solutions for advanced triage and coordination in crisis situations were developed and validated within the NIGHTINGALE project, including testing in operational conditions.[39]
- **Czechia, Spain, Germany, Italy, Sweden, Finland and Portugal** – AI-based solutions were developed and tested within the "AI Special Project" of the European Emergency Number Association (EENA) for transcription, translation, speech processing and background noise reduction in emergency call centres, including validation in both simulated and operational conditions.[40]

4.2.2. Development of Integrated Situational Awareness

The development of integrated situational awareness is recommended bringing together data from multiple sources, including sensors, drones, geospatial systems and on-site information. Such systems enable improved coordination, more effective operations management and enhanced safety of operational personnel.

Examples of countries and projects:

- **Spain, France, Poland, Netherlands, Sweden, Switzerland, Italy, Germany, Turkey and Greece** — solutions for integrated situational awareness, including the application of drones, robots, and wearable sensors in operational conditions were developed and tested within the ASSISTANCE project.[41]
- **Greece, Germany, Italy and Spain** — a next-generation smart integrated tool for emergency services was developed and tested within the INGENIOUS project aimed at providing a higher level of protection and improved situational awareness by using advanced technologies such as uniform-integrated sensors, drones, and artificial intelligence (see footnote 11).
- **France, Spain, Italy, Greece, Belgium, Germany and United Kingdom —** solutions were developed within the INTREPID project that enable emergency services to rapidly and safely explore inaccessible or hazardous disaster zones (such as collapsed buildings or tunnels) using smart, autonomous robots and drones that generate 3D maps of the terrain and transmit data to commanders in real-time (see footnote 25).

4.2.3. Use of digital simulations and digital twin models

It is recommended that the Civil Protection Directorate (CPD) applies these technologies primarily in training and planning processes as this is where they deliver the greatest benefits with lower operational risk. VR/AR technologies enable the training of complex and hazardous scenarios without real exposure, while digital twin models allow for testing the consequences of different decisions, particularly in the context of fires, floods, and earthquakes. European sources confirm that such tools are already being used for exercises, training, and intervention planning.

Examples of countries and projects:

- **Italy** — the TEMA project in Sardinia uses a digital twin platform for managing wildfire response operations and enhancing situational awareness in the field.[42]

- **France and Italy** — a large-scale exercise was conducted within the NIGHTINGALE project in Villejust to test advanced technologies for response to mass casualty incidents, while in Savona advanced technologies were applied in scenarios involving natural disasters and explosions (see footnote 39).
- **Spain** — the ASSISTANCE project also developed VR/AR components for training first responder organizations (see footnote 41).

4.2.4. Strengthening interoperable communication systems

The development of interoperable communication systems is recommended to enable data exchange between different services and levels of governance through the use of standards and digital platforms.

Examples of countries and projects:

- **Belgium, Czechia, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Ireland, Netherlands, Norway, Poland, Romania, Sweden and Slovenia** — within the BroadEU.Net project, technical, operational and legal preparations have been developed for the establishment of the European Critical Communication System (EUCCS) by 2030 enabling cross-border interoperability and broadband communication for all European emergency services.[43]
- At **EU level (across multiple Member States)** – within the framework of the Union Civil Protection Mechanism and Horizon Europe, models of integrated information systems and data exchange have been developed.

4.2.5. Use of video transmission in operational conditions

The use of real-time video transmission systems is recommended, including the integration of unmanned systems and advanced communication technologies.

Examples of countries and projects:

- **Germany, France, Greece, Italy, Japan, Luxembourg, Netherlands, Spain, Switzerland and United Kingdom** — tools, including miniature tracked robots equipped with sensors for detecting victims in rubble, a drone system for aerial mapping and an integrated platform for real-time information management were developed within the CURSOR project (see footnote 20).
- **Greece, Spain, Italy, France, Finland, Poland, Cyprus, Belgium, Romania, Bulgaria and Japan** — a suite of situational awareness tools, including smartwatches and biometric sensors for monitoring responders' health, autonomous drones for signal transmission in areas without network cover-

age and augmented reality technologies enabling team leaders to visualize hazards in the field was developed within the FASTER project (see footnote 20).

- **France, Greece, Spain, Italy, Germany, Ireland, Portugal, Switzerland and Cyprus** — an open 5G test platform was established within the 5G-EPICENTRE project enabling developers and emergency services to test high-bandwidth applications (such as 4K drone video streaming or remote robotic surgery) with ultra-low latency during mass casualty incidents (see footnote 20).

4.2.6. Development of more resilient command and communication systems

The development of command systems that ensure operational continuity and resilience in crisis conditions is recommended, including coordination at both national and EU levels.

Examples of countries and projects:

- **At EU level (across multiple Member States)** — operational models for coordination and crisis management have been developed through the Emergency Response Coordination Centre system (see footnote 17).
- **Italy, Slovenia, Austria, Turkey and Montenegro** — models of crisis management and command structures were developed within the BORIS2 project. More specifically, the project developed a comparative analysis of national methodologies for assessing seismic and flood risks at city level with the aim of creating a harmonized cross-border framework that enables joint emergency response planning and improves civil protection preparedness across Europe (see footnote 22).

4.2.7. Introduction of IoT and sensor systems for field monitoring

The use of sensor technologies and IoT systems is recommended for the continuous monitoring of the environment, infrastructure, and operational conditions.

Examples of countries and projects:

- **Spain** (wildfire monitoring in rural areas), **South Africa** (development of a smart flood monitoring unit), **India** (landslide monitoring using geosensors) — LoRaWAN technology for crisis management is being successfully applied across different continents (see footnote 24).

- **Greece, Germany, Italy, Netherlands, Sweden, Switzerland and United Kingdom** — a system for rapid assessment of structural damage to buildings using sensors embedded in the structure itself, drone data and satellite imagery to inform rescue services in real-time whether a building is safe to enter or at risk of collapse was developed within the RECONASS project.[44]

4.2.8. Use of drones and AI solutions for risk mapping and operational decision-making

The use of drones and artificial intelligence is recommended for risk mapping, data analysis and real-time decision support.

Examples of countries and projects:

- **Germany, Israel, Spain, France, South Korea, Netherlands, Latvia, Armenia, Greece, Bulgaria, Portugal and Belgium** — emergency response teams were enabled within the ResponDrone project to respond more quickly and effectively to disasters through a fleet of drones providing comprehensive real-time situational awareness and support for search and rescue operations, as well as firefighting (see footnote 28).
- **Poland, France, Sweden, Austria and Greece** — concepts for the use of drones and data analysis in civil protection were developed within the COLLARIS project (see footnote 19).
- **At EU level (across multiple Member States)** — tools for risk mapping and analysis are being developed through the Copernicus Emergency Management Service (see footnote 10).

4.2.9. Development of energy-autonomous field infrastructure

The development of solutions that enable energy independence of operations through the integration of renewable energy sources and autonomous power systems is recommended. Such an approach reduces dependency on centralized energy systems and increases the resilience of operations in crisis conditions.

Examples of countries and projects:

- **At EU level (across multiple Member States)** — guidelines are being developed for the introduction of sustainable and energy-efficient solutions in civil protection operations through analyses and initiatives within the framework of the Union Civil Protection Mechanism (UCPM) (see footnote 29 regarding the *Study on Greening the Union Civil Protection Mechanism*).

4.2.10. Introduction of sustainable transport systems and emergency vehicles

A gradual transition to low- or zero-emission vehicles is recommended, along with the development of infrastructure that enables their operational use in crisis situations.

Examples of countries and projects:

- **Germany** — the fire service in Hamburg is conducting operational testing of electric emergency vehicles (see footnote 33).
- **United Kingdom** — the use of electric vehicles and alternative fuels in emergency services has been tested in pilot projects (see footnote 33).

4.2.11. Use of circular solutions in personal protective equipment

The development and use of personal protective equipment based on circular economy principles is recommended, including recyclable materials and sustainable production processes.

Examples of countries and projects:

- **At EU level (across multiple Member States)** — solutions for sustainable materials and circular production models for protective equipment are being developed within the CISUTAC, BIOMAT and ZeroF projects (see footnote 37)

4.3. Overview of funding sources from other countries

The application of new technologies in civil protection systems across European Union Member States is largely financed through a combination of European research and innovation projects, national and regional investments and targeted procurement of specific equipment and infrastructure. An analysis of publicly available data shows that funding is most often presented in terms of total project budgets and EU contributions, while data on the individual costs of specific technologies are less frequently available and are typically linked to specific investments or pilot projects.

The following section **provides an overview of examples of funding for new technologies** through European projects, as well as a review of publicly available data on the costs of specific technologies and investments in operational capacities.

Table 4.1: Examples of funding for new technologies (EU projects)

TECHNOLOGY AND PROJECTS	COUNTRY (EXAMPLES) AND DURATION	LINK	AMOUNT	SOURCE OF FUNDING
Artificial intelligence in disaster risk management (NIGHTINGALE)	Greece, Italy, Spain, Ireland, France, Portugal, Sweden, Israel, Luxembourg, Austria, Germany 2021 – 2025	https://cordis.europa.eu/project/id/101021957	8 831 477.50 EUR	Horizon 2020
Integrated situational awareness and smart systems (ASSISTANCE)	Spain, France, Poland, Netherlands, Sweden, Switzerland, Italy, Germany, Turkey, Greece 2019 – 2022	https://cordis.europa.eu/project/id/832576	6 393 691.25 EUR	Horizon 2020
IoT and sensor technologies (SEARCH & RESCUE)	Greece, Romania, Italy, Ireland, Spain, Cyprus, Belgium, Germany, Austria, Poland, France 2020 – 2023	https://cordis.europa.eu/project/id/882897	7 890 585.00 EUR	Horizon 2020
Video transmission systems and drones (RESPONDRONE)	Cyprus, France, Germany, Greece, Spain, United Kingdom, Italy, Sweden, Netherlands, Belgium, Bulgaria, Montenegro and Portugal 2020 – 2023	https://cordis.europa.eu/project/id/883371	7 666 225.30 EUR	Horizon 2020
Software solutions for risk mapping (ARTION)	Cypress, France, Italy, Portugal 2021 – 2022	https://civil-protection-knowledge-network.europa.eu/projects/artion#inpage-section-overview	299 928.55 EUR	Union Civil Protection Mechanism
Digital simulations and VR/AR (SHOTPROS)	Austria, Belgium, Netherlands, Romania, Sweden, Germany 2019 – 2022	https://cordis.europa.eu/project/id/833672	5 059 843.75 EUR	Horizon 2020
Communication systems for emergency services (5G-EPICENTRE)	France, Greece, Spain, Italy, Germany, Ireland, Portugal, Switzerland, Cyprus 2021 – 2024	https://cordis.europa.eu/project/id/101016521	7 883 726.25 EUR	Horizon 2020

Table 4.2: Examples of technology costs and investments

COUNTRY/ ORGANISATION	TECHNOLOGY/INVESTMENT	AMOUNT	NOTE
Portugal (Madeira)	Drones, GIS systems, 3D modelling	**≈ 200 000 EUR**	Regional investment for wildfire management
Germany (Hamburg)	Electric vehicles + infrastructure	**≈ 583 000 EUR**	National co-financing
United Kingdom (London)	Electric power infrastructure for electric vehicles	**≈ 4 000 000 GBP**	Estimated cost of transition
United Kingdom (London Firefighting Brigade)	14 light vehicles	**565 400 GBP**	≈ 37 000 GBP per vehicle

Data sources listed in footnote[45]

Analysis of the available data reveals several important patterns:

- EU projects in the field of civil protection and new technologies most often range between **4 million EUR and 9 million EUR per project** with certain countries achieving significant financial and developmental impact through project coordination.
- Individual partner contributions within projects typically range from **100 000 EUR** to **500 000 EUR** depending on their role and scope of activities.
- National and regional investments in specific technologies (e.g., drones, vehicles) are most commonly in the range of **200 000 EUR** to **600 000 EUR** for initial or pilot capacities.
- The costs of infrastructure adaptations (e.g., energy infrastructure for electric vehicles) can reach multi-million euro amounts which highlights the importance of long-term investment planning.

These data confirm that the introduction of new technologies into the civil protection system requires a combination of different funding sources and careful investment planning with a clear distinction between research and development projects and operational investments in equipment and infrastructure.

In a broader context, investments in civil protection technologies and capacities significantly exceed individual projects and investments. At European Union level, the proposed framework for financing civil protection and preparedness reaches approximately **11 billion EUR**, while additional funding of around **11.9 billion EUR** through cohesion funds is directed toward defence and civil preparedness.[46]

The European Defence Fund (EDF) also represents a key instrument for financing the development of advanced technologies at European Union level, with a total budget of approximately **7.9 billion EUR for the 2021–2027 period**. The European Commission regularly allocates around **1 billion EUR per year** within its annual work programmes, to fund research and development of new technologies, including artificial intelligence, unmanned systems, and communication technologies.[47]

At national level, investments in civil protection systems can reach significantly higher amounts in some countries, such as Germany, investing **tens of billions of euros** in the development of civil protection infrastructure and capacities.

5

OPPORTUNITIES FOR THE APPLICATION OF NEW TECHNOLOGIES IN THE CROATIAN CIVIL PROTECTION SYSTEM

This chapter operationalizes the previously discussed sustainable and innovative technologies and translates them into concrete opportunities for the applications within the civil protection system of the Republic of Croatia. Its purpose is to connect strategic objectives, identified needs and technological potentials with the real institutional, organizational and financial framework of the Civil Protection Directorate. The emphasis is put on the phased, sustainable and operationally meaningful introduction of technologies that directly contribute to strengthening system resilience, increasing personnel safety and improving the protection of the population.

When considering the application of new technologies, several fundamental principles are taken into account: (1) the technology must address a clearly identified operational need; (2) it must be interoperable with existing systems and procedures; (3) it must provide added value in terms of sustainability, efficiency or safety; and (4) it must be accompanied by appropriate training and organizational adaptation.

In this context, new technologies are not viewed as isolated solutions, but as an integral part of a broader process of digital and green transformation of the civil protection system.

5.1. Opportunities for the application of new technologies and equipment in the civil protection system

The application of new technologies and equipment in the civil protection system requires a systematic and coordinated approach at the level of the entire Civil Protection Directorate with clearly defined priorities, responsibilities and implementation mechanisms. The introduction of technologies should not be viewed as isolated projects of individual organizational units, but as an integrated process encompassing all levels of management and operational activity.

A key prerequisite for successful implementation is the **establishment of a single strategic framework for the development and application of technologies**, including the definition of priority investment areas, the standardization of technologies and data and the assurance of interoperability between different systems. This enables the development of a functionally interconnected and technologically harmonised civil protection system.

The introduction of new technologies should be carried out through a **phased approach**, including pilot projects, testing in controlled conditions and gradual integration into operational processes. Such an approach makes it possible to reduce risks, adapt technologies to real needs and develop organizational capacities for their effective use.

Particular importance lies **in harmonising technological solutions with existing organizational processes, procedures and capacities**. Technology must serve as support to operational work rather than an additional burden on the system which implies the adaptation of work processes, clearly defined responsibilities and continuous training of personnel.

It is also necessary to ensure the **long-term sustainability of technologies** through lifecycle planning, including maintenance, upgrades and equipment replacement. In this context, investment decisions should take into account not only initial costs, but also the overall operational and environmental impacts.

A **systematic approach** to the application of technologies enables the Civil Protection Directorate to develop an integrated, interoperable and resilient system capable of responding to increasingly complex challenges in disaster risk management.

The introduction of new technologies and equipment in the civil protection system should also be considered through the specific responsibilities and functions of individual organizational units within the Civil Protection Directorate. Although all 11 identified technologies have value for the system as a whole, their use is not uniform across all parts of the organization, but depends on the operational, managerial, analytical or training role of each unit. The following provides an **overview of the possibilities for using technologies** across the key organizational units of the Civil Protection Directorate with an emphasis on their functional justification, areas of application and expected impacts.

Table 5.1: Application of technologies by organizational units of the Civil Protection Directorate

CPD ORGANIZATIONAL UNIT	KEY TECHNOLOGIES	AREA OF APPLICATION	EXPECTED IMPACT
Office of the Civil Protection Directorate	Artificial intelligence; integrated situational awareness and smart systems; digital simulations and digital twin models	Strategic planning, decision support, coordination of development activities, international projects	Improved quality of strategic decision-making, better coordination of system development and more targeted investment planning
112 Sector	Artificial intelligence; integrated situational awareness and smart systems; upgrading information and communication systems; sustainable command and communication systems; IoT and sensor technologies	Receiving and processing information, early warning and alert, communication and coordination	Faster information processing, more efficient alert systems, and increased reliability of communication
Inspection Sector	IoT and sensor technologies; real-time video transmission systems; integrated situational awareness and smart systems	Supervision, inspection supervision, on-site checks of conditions, documentation of findings	More efficient supervision, higher-quality on-site supervision and faster data processing

CPD ORGANIZATIONAL UNIT	KEY TECHNOLOGIES	AREA OF APPLICATION	EXPECTED IMPACT
National Civil Protection Training Centre	Digital simulations and digital twin models; artificial intelligence; real-time video transmission systems	Training, education, crisis scenario simulations, analysis of actions	Improved quality of training, safer exercises and a higher level of preparedness
Disaster Risk Reduction Sector	Artificial intelligence; integrated situational awareness and smart systems; software solutions for risk mapping (drones and AI); digital simulations and digital twin models; IoT and sensor technologies	Risk assessment and analysis, scenario development, planning and modelling	More precise risk assessments, improved spatial analysis and higher-quality planning of risk reduction measures
Radiological and Nuclear Safety Sector	IoT and sensor technologies; integrated situational awareness and smart systems; upgrading information and communication systems; sustainable command and communication systems	Specialized supervision, threat detection, data exchange and coordination	Timely detection, improved data exchange and enhanced system security
Preparedness and Coordination Sector	Integrated situational awareness and smart systems; upgrading information and communication systems; sustainable command and communication systems; digital simulations and digital twin models; energy-autonomous infrastructure	Coordination of operations, preparedness planning, capacity development, resource management	Improved coordination, greater interoperability, more resilient operational capacities, and higher-quality system preparedness
National Civil Protection Intervention Unit	Sustainable transport systems; sustainable personal protective equipment; energy-autonomous infrastructure; IoT and sensor technologies; real-time video transmission systems; software solutions for risk mapping (drones and AI); integrated situational awareness and smart systems	Operational interventions, field operations, personnel safety, mobility, monitoring and data collection	Greater operational autonomy, increased personnel safety, improved situational awareness, and more efficient interventions
Explosive Atmospheres Sector	IoT and sensor technologies; real-time video transmission systems; sustainable command and communication systems	Technical monitoring, specialized supervision, safety in hazardous environments	Greater operational safety, higher-quality technical supervision and reduced exposure to hazardous conditions
Croatian Mine Action Centre	Software solutions for risk mapping (drones and artificial intelligence); IoT and sensor technologies; real-time video transmission systems; integrated situational awareness and smart systems	Mapping, analysis and monitoring of mine-suspected areas, field data collection	More precise mapping, increased safety and more efficient planning of demining activities
County Civil Protection Offices	Enhancement of information and communication systems; integrated situational awareness and smart systems; real-time video transmission systems; IoT and sensor technologies; sustainable command and communication systems	Operational coordination at regional level, communication, supervision, information exchange, and support to interventions	More uniform operational implementation, improved connectivity between central and regional levels and more efficient coordination

5.2. Proposal of funding sources

The successful application of new technologies and equipment within the civil protection system of the Republic of Croatia requires a planned and diversified approach to financing, combining European, national and complementary funding sources. Financing is therefore not viewed solely as a procurement instrument, but as a mechanism to support long-term modernization, capacity building, and institutional resilience of the Civil Protection Directorate.

At European Union level, a key source of funding is the **Union Civil Protection Mechanism** (UCPM), which enables investments in strengthening preparedness, interoperability and disaster response capacities. Calls focused on capacity development, equipment procurement, training and joint exercises are particularly relevant. The UCPM also facilitates the integration of the CPD with other Member States through joint projects further enhancing the transfer of knowledge and best practices.

The **European Regional Development Fund** and the **Cohesion Fund** represent key sources for financing digital infrastructure, equipment modernization, energy efficiency and sustainable solutions. It is possible to finance under these funds the development of information systems, sensor networks, energy self-sufficient solutions, as well as training centres and related infrastructure. Their particular value lies in enabling the implementation of larger, multiannual investments with long-term impact.

The **Horizon Europe** programme provides opportunities for funding research and innovation activities, pilot projects and the testing of new technologies in real operational conditions. Although it is not primarily aimed at operational services, the CPD can participate as an end user, pilot partner or demonstrator ensuring that the developed solutions meet the actual needs of the civil protection system.

The **Recovery and Resilience Facility** and other thematic EU instruments can be used to finance projects that simultaneously contribute to digital transformation, the green transition and strengthening resilience to crises. At national level, **state budget funds, sectoral programmes and financing through programmes of the Ministry of the Interior** remain essential for co-financing, maintenance and the further development of technologies after the completion of EU-funded projects.

It is recommended that the CPD establishes a coordinated funding planning model in which sources for pilot projects, scaling of solutions and long-term system maintenance are clearly distinguished. Such an approach reduces financial risk and ensures the stability of investments.

5.3. Estimation of procurement costs

The estimation of procurement costs for new technologies and equipment **must be based** on a comprehensive and analytical approach resulting from actual needs of the civil protection system rather than market offers or individual manufacturers' catalogues. In this context, any financing **should begin with a due diligence analysis** of operational, organizational and technical requirements as it is not possible to define the true value of a technology in advance without understanding the context in which it will be used. Simply adopting catalogue solutions and assigning them financial value without such analysis carries a high risk of inadequate investments, limited usability and increased long-term costs.

Each procurement of new technology **must be considered** in relation to the specific working conditions in which civil protection services operate, including work in emergency situations, bad weather conditions, infrastructure disruptions and increased system load. In addition, **it is essential to analyse** the entire lifecycle of the technology—from initial procurement and integration through maintenance, upgrades and user training to its eventual replacement or retirement. Such an approach **enables a realistic assessment** of the total cost of ownership and prevents situations in which seemingly cost-effective procurements prove financially and operationally unsustainable in the long term.

It is equally important to **assess the level of connectivity and interoperability** of a new technology with existing systems and other planned investments. Technology that operates in isolation without the ability to exchange data and integrate into a broader system can rarely achieve its full operational impact. Therefore, each procurement must be viewed as part of a broader technological ecosystem of civil protection in which different solutions complement each other and strengthen the overall resilience of the system. Such an approach ensures that financial investments are directed toward solutions that deliver real long-term added value, rather than only short-term technical improvements.

In the context of the civil protection system of the Republic of Croatia, it is **particularly important to plan for costs** arising from operations in demanding and unpredictable conditions where equipment must be robust, reliable and available at all times. Although sustainable and advanced technologies often involve higher initial costs, they generate long-term savings through reduced resource consumption, fewer failures and a longer operational lifespan.

It is recommended to **implement phased procurement** processes starting with pilot projects. The pilot phase enables testing of technologies in real conditions, assessment of actual maintenance costs and adjustment of specifications before wider deployment. This approach reduces the risk of inadequate investments and increases the efficiency of public spending.

When planning costs, it is also **necessary to allocate resources** for interoperability and cybersecurity as digital systems are increasingly exposed to technical and security challenges. Systematic cost planning ensures that technological modernization does not place a long-term burden on the CPD budget, but instead contributes to its financial and operational sustainability.

5.4. Employee training plan

Education and human capacity development are a key prerequisite for the successful and sustainable implementation of new technologies in the civil protection system of the Republic of Croatia. Given the diversity and complexity of the technologies covered by these Guidelines, it is necessary to move away from a universal approach to training and establish **specific, targeted training models for each individual technology**. Each of the eleven technologies addressed has a different purpose, level of complexity, operational context and user group and therefore requires a separately designed training programme.

A **dedicated training programme** should be developed for every new technology clearly defining learning objectives, target groups of employees, required competencies and the level of proficiency to be achieved. Such programmes should cover not only the technical use of equipment or systems, but also an understanding of their role within the broader operational and command context of the civil protection system. This ensures that the technology is properly integrated into existing procedures and that personnel understand its limitations, risks, and capabilities.

Training models for individual technologies should be structured by levels. At the basic level, training should be provided for a broader group of users, focusing on understanding functionality and the correct use of the technology in everyday work. The advanced level of training should be intended for specialized users and technical staff responsible for system management, data analysis and maintenance. The third level intended for command and managerial staff should focus on the strategic application of technology, decision-making supported by technological tools and the integration of new solutions into plans and operational procedures.

Particular importance lies in the fact that training must be developed **in parallel with the introduction of technology** rather than retrospectively. During the pilot project phase, it is recommended to conduct initial training sessions and practical exercises in order to adapt training content and methods based on real experience. This ensures that final training programmes are based on actual operational conditions and the needs of the civil protection system of the Republic of Croatia.

Given the number and diversity of technologies, it is recommended to develop a **modular training framework** in which each technology has its own dedicated module, while at the same time being connected to other modules through common topics such as interoperability, cybersecurity, data management and safety of employees. Such an approach enables flexibility, adaptation to different user groups and the gradual upgrading of knowledge in line with technological developments.

Within the further development of competencies of employees, it is also necessary to put additional emphasis on strengthening knowledge related to the application of sustainable and so-called **"green" solution in the civil protection system.** Green solutions and nature-based solutions enable more efficient, long-term sustainable and often more cost-effective approaches to risk reduction, complementing conventional technological measures. Understanding their use allows employees to better assess, plan and implement disaster risk management measures, particularly in the context of climate change. This further strengthens the capacity of the civil protection system to apply modern approaches that integrate technological solutions with the principles of sustainability and resilience.

An important role in the development and implementation of these programmes is played by the **National Civil Protection Training Centre**, which can act as a central institution for the standardization of training programmes, certification of knowledge and monitoring of acquired competencies. By introducing digital learning platforms, simulations and practical scenarios, the continuous availability of training and the development of the system's institutional memory could be ensured.

In the context of further development of competencies of employees, particular emphasis should be put on upgrading knowledge in the **application of dual-use technologies (military-civilian purposes)** which are increasingly used in crisis management. Such technologies include, among others, unmanned systems, advanced communication technologies, artificial intelligence and satellite systems, all of which have broad applications in civil protection as well as in the security and defence sector.

At the same time, it is necessary to strengthen the capacities of employees for **effective cooperation with the private sector**, particularly in the areas of development and application of new technologies, logistics and data management. Public-private cooperation is becoming an increasingly important element of the civil protection system as it enables faster access to innovation, more flexible use of resources and an overall increase in system resilience.

Finally, training programmes for individual technologies should be **regularly evaluated and updated** in line with technological developments and changes in the operational needs of the CPD. This ensures that investments in training are accompanying investments in technology and that the civil protection system of the Republic of Croatia maintains a high level of readiness, safety and efficiency in the long term.

5.5. Short-term and long-term investment priorities

Based on the analysis of technological areas and their potential application within the civil protection system, it is necessary to define clear time-based investment priorities. Such a phased approach enables more efficient resource planning, reduces the risk of unsuccessful investments and allows for the gradual introduction of new technologies into the operational system.

Investment priorities in new technologies are structured according to the implementation timeframe into **short-term, medium-term and long-term categories** in order to ensure the gradual and sustainable strengthening of civil protection system capacities. **As the highest priority and the basis for all future planning and development of systems, the establishment of a comprehensive digital resource database is highlighted.** This classification, presented in detail in Table 5.2, serves as a framework for planning the sequence of investments and enables their alignment with budget cycles and the operational needs of the CPD, particularly in the context of the multiannual financial framework for the period 2028–2034.

Short-term priorities

In this period, the focus is on solutions that deliver immediate operational benefits and form the basis for further upgrades:

- **Establishment of a single digital record of operational forces, equipment and resources:** A key prerequisite that serves as the foundation for all further planning, mobilization and crisis management.

- **Enhancement of information and communication systems:** Ensuring basic interoperability and the modernization of network infrastructure.
- **Real-time video transmission systems:** Implementation of solutions for real-time visual insight from the ground to enable faster decision-making.
- **IoT and sensor technologies:** Establishment of sensor networks for continuous monitoring of environmental parameters and early warning.
- **Sustainable personal protection equipment:** Procurement of equipment made from recyclable materials, applying the principles of the circular economy.

Medium-term priorities

They relate to the systematic upgrading of infrastructure, strengthening resilience and the broader implementation of advanced solutions at national level:

- **Integrated situational awareness and smart field systems:** Integration of all data sources into a single interface for visualizing the operational situation.
- **Sustainable command and communication systems:** Development of robust solutions that ensure continuity of operations even in the event of critical infrastructure disruptions.
- **Energy-autonomous infrastructure:** Introduction of systems with independent power supply for prolonged field presence and operations.
- **Sustainable transport systems:** Transition to "green" emergency response vehicles and supporting infrastructure for sustainable mobility.

Long-term priorities

They are focused on the strategic transformation of the system through the application of high-level autonomy technologies and complex analytics:

- **Artificial intelligence:** Full integration of AI tools into data analysis processes, process automation and decision support.
- **Digital simulations and digital twin models:** Application of advanced models for testing disaster scenarios and planning preventive measures.
- **Software solutions for risk mapping (drones and AI):** Use of autonomous systems for precise hazard modelling and real-time damage assessment.

Table 5.2: Short-term, medium-term and long-term investment priorities in new technologies

TECHNOLOGICAL AREA	TECHNOLOGY	TIME-FRAME	PRIORITY LEVEL	KEY REASON FOR PRIORITIZATION
Digital and analytical technologies	**Artificial intelligence**	Long-term (5+ years)	HIGH	Rapid use in data analysis and decision support
Digital and analytical technologies	**Integrated situational awareness and smart systems**	Medium-term (3 do 5 years)	HIGH	Key for operational management and coordination
Digital and analytical technologies	**Digital simulations and digital twin models**	Long-term (5+ years)	MEDIUM-HIGH	Enhancement of planning, training and scenario testing
Communication and management	**Enhancement of information and communication systems**	Short-term (1 do 2 years)	HIGH	Foundation of interoperability and data exchange
Communication and management	**Real-time video transmission systems**	Short-term (1 do 2 years)	HIGH	Enhancement of real-time situational awareness
Communication and management	**Sustainable command and communication systems**	Medium-term (3 do 5 years)	MEDIUM	Increased system resilience and reliability
Field operations and monitoring	**IoT and sensor technologies**	Short-term (1 do 2 years)	HIGH	Continuous monitoring and data collection
Field operations and monitoring	**Software solutions for risk mapping (drones and artificial intelligence)**	Long-term (5+ years)	HIGH	Enhancement of risk analysis and situational assessment
Sustainability and logistics	**Energy-autonomous Infrastructure**	Medium-term (3 do 5 years)	MEDIUM-HIGH	ensures operational autonomy in emergency situations
Sustainability and logistics	**Sustainable transport systems**	Medium-term (3 do 5 years)	MEDIUM	High costs and the need for infrastructure
Sustainability and logistics	**Sustainable personal protection equipment**	Short-term (1 do 2 years)	MEDIUM	Compliance with EU regulations and long-term sustainability

The listed priorities are grouped in such a way that investments in basic technologies (information and communication systems, IoT, personal protective equipment) are considered first, followed by infrastructure (energy systems, transport, integrated situational awareness) and finally the most advanced tools (artificial intelligence, digital twin models). It is important to emphasize that the specified timeframes represent phases of full operational implementation. This means that **preparations for medium- and long-term priorities need to begin already at an early stage**. Due to the complexity of technological solutions, the need to adapt the legislative framework and the requirement to secure multiannual funding sources, timely planning and the development of expert capacities are essential for the successful integration of these systems.

6

CONCLUSION

These Guidelines confirm that sustainable and innovative technologies represent a key element of the further development of the civil protection system of the Republic of Croatia, particularly in the context of increasingly complex and frequent risks associated with climate change, technological development and societal challenges. The analysis of technological areas has shown that new technologies have a different but complementary role across all phases of disaster risk management and that their true value becomes evident through an integrated approach to their use.

By applying the analytical framework of the Union disaster resilience goals (DRG), it has been clearly identified how individual technologies contribute to the key functions of the system: **anticipation, preparedness, alert, response** and **security**. Particular emphasis is placed on technologies that enable early threat detection and the development of early warning systems (alert), where sensor technologies, artificial intelligence and integrated information systems play a key role. At the same time, digital platforms, communication systems and analytical tools enable more efficient coordination and decision-making, while sustainable infrastructure and logistics solutions ensure the continuity and resilience of operations in crisis conditions.

The results of the analysis indicate that technologies do not operate in isolation, but as interconnected elements of a single system. Their effectiveness depends on the level of interoperability, the quality and availability of data, as well as the ability to integrate them into existing operational and organizational processes. In this context, the development of an integrated situational awareness, the interconnection of sensor and communication systems and the application of artificial intelligence represent the foundation for transforming the civil protection system toward a data-driven and timely decision-making model.

At the same time, it is clear that the successful implementation of new technologies does not depend solely on their technical availability, but requires a systematic and phased approach to their introduction. This includes the implementation of pilot projects with clearly defined operational objectives, the gradual integration of technologies into existing systems, continuous evaluation of their effectiveness and the development of the necessary knowledge and skills of personnel. Without the parallel development of organizational capacities, process standardization and strengthened interoperability, the potential of these technologies remains only partially utilized.

Additionally, the Guidelines emphasize the importance of aligning technological investments with the principles of sustainability and long-term system resilience. The development of energy-autonomous infrastructure, sustainable transport solutions and circular personal protective equipment contributes to reducing operational risks, increasing safety and decreasing dependence on external resources, thus further strengthening system stability in emergency situations.

In the context of financing and investment planning, the need for the strategic use of available national and European funding sources has been recognized along with clearly defined priorities and a phased approach to investments. Such an approach enables more efficient use of resources, reduces the risk of unsuccessful investments and supports the gradual transformation of the system in line with its actual needs and capacities.

In conclusion, these Guidelines provide a structured framework for understanding, planning and implementing sustainable new technologies within the civil protection system. Their value lies not only in identifying individual technological solutions, but in establishing a clear link between technology, operational needs and strategic resilience goals. Through the systematic and planned application of the proposed approaches, the Civil Protection Directorate can significantly enhance its capacity for anticipation, preparedness, alert, response and security, thus ensuring a more efficient and resilient civil protection system in the Republic of Croatia.

Annex 1

SUMMARY REPORT ON BEST PRACTICES FROM STUDY VISITS

This report provides an overview of the activities carried out and the key findings from two study visits by employees of the Civil Protection Directorate to authorities responsible for disaster risk management. The study visits were conducted with the aim of exchanging knowledge and best practices, as well as gaining insight into the possibilities for applying new technologies and equipment within the civil protection system.

They were carried out as part of the development of the Guidelines on sustainable new technologies in disaster risk management based on previously conducted analyses.

First study visit – Lisbon (Portugal)

The objective of the study visit was to gather information on the possibilities of use new technologies within the disaster risk management system with a particular focus on the operation of emergency call centres. Special attention was given to the application of artificial intelligence in the context of international projects aimed at improving the efficiency and quality of 112 centres, including automated call processing, triage and enhanced communication.

During the visit to the National Authority for Emergency and Civil Protection in Lisbon, the Portuguese civil protection system was presented, including its organizational structure and territorial arrangement at the subregional, regional, and national levels. Digital tools and the FEB Monitorização platform were also presented, enabling situational monitoring through the integration of data from various sources and supporting more efficient resource management, particularly in the case of wildfires.

Photo: INVEST for DRM project

Employees of the Civil Protection Directorate were presented with the organization and functioning of the Portuguese civil protection system at the headquarters of the National Authority for Emergency and Civil Protection in Lisbon.

The study visit programme also included a tour of the 112 operational centre in Lisbon. The 112 centre system is organized to ensure continuous reception and forwarding of calls to the competent emergency services with the capability for call transfer between centres. Ongoing activities are focused on the further development of system functionalities, including improving communication with persons with disabilities and introducing new communication channels using a gradual and controlled approach to implementation.

The application of artificial intelligence in operational work has not yet been fully implemented, but it is being developed through cooperation with the academia, particularly in the field of analysis and forecasting of wildfires.

The study visit provided an insight into organizational and technological solutions highlighting the importance of integrated information systems and the gradual introduction of new technologies into operational work.

Second study visit – Bonn (Federal Republic of Germany)

The objective of the study visit was to gather experience and information on the application of digital technologies and artificial intelligence in crisis management with a focus on geoinformation systems, sensor networks, training and logistical support.

During the visit, which took place at the premises of the Federal Agency for Technical Relief (Technisches Hilfswerk – THW), THW representatives presented the organization's structure with particular emphasis on the role of volunteers as a key operational force supported by a high level of training and standardized operations. Logistical capacities and models of their organization were also presented, aimed at ensuring an efficient response to crisis situations.

Photo: INVEST for DRM project

THW representatives delivered a series of expert presentations on system organization, the application of artificial intelligence, digital command systems, risk mapping and digital simulations at the THW premises in Bonn.

Particular attention was given to the use of advanced technologies, including the development and testing of artificial intelligence models through projects such as the AI Living Lab, the use of unmanned systems and the application of digital simulations and virtual reality in training. Systems for digital communication, data analysis and risk mapping were also presented, along with concepts of digital support through the engagement of specially trained VOST teams.

Key challenges in the application of new technologies were also identified, including the need to ensure system interoperability, reduce gaps in digital readiness between institutions and adapt public procurement procedures to the dynamics of technological development. It was emphasized that in operational conditions, reliable and proven solutions are still used, particularly in the field of logistics.

Photo: INVEST for DRM project

BBK representatives delivered lectures on the German civil protection system, RescEU CBRN decontamination capacities and the application of data analytics and geoinformation systems at the THW premises in Bonn.

Representatives of the Federal Office of Civil Protection and Disaster Assistance (BBK) further highlighted that advanced solutions are being developed in the areas of data analytics and geoinformation systems enabling the integration of various data sources, including satellite and other available sources, thus improving situational monitoring and supporting decision-making.

In conclusion, the study visit confirmed the importance of further development and application of digital technologies within the civil protection system, as well as the need for continuous investment in knowledge, capacities and international cooperation. The gained experience provides a relevant basis for improving the national system.

Annex 2

LIST OF SELECTED RELEVANT FAIRS AND CONFERENCES (2024–2027)

NUMBER	EVENT NAME	DATE AND PLACE	TECHNOLOGIES PRESENTED	IMPORTANCE FOR THE CPD
1	**Disasters Expo Europe**	15 to 16 May 2024, Frankfurt, Germany https://www.disasterexpoeurope.com/	Crisis management systems, GIS integrations, communication networks, emergency equipment	Focus on the interoperability of digital systems and emergency equipment relevant to the operational capabilities of the CPD
2	**AFAC24 Conference & Exhibition**	3 to 6 September 2024, Sydney, Australia https://globalfireevents.com/	Mobile sensors, unmanned platforms, and equipment for field teams	Relevant for drones, sensors, and field equipment in the context of response to large-scale fires and disasters
3	**International Security Expo**	29 to 30 September 2025, London, UK https://www.internationalsecurityexpo.com/	Video surveillance, cybersecurity, communication and robotic platforms	Covers security ICT technologies and cybersecurity relevant to the CPD's command and communication systems
4	**Crisis & Safety Forum**	18 to 20 March 2025., Warsaw, Poland https://safetyrescueexpo.com/	Crises management software, simulation tools and mobile communication	An event focused on crisis management and the integration of simulation and ICT solutions

List of selected relevant fairs and conferences

NUMBER	EVENT NAME	DATE AND PLACE	TECHNOLOGIES PRESENTED	IMPORTANCE FOR THE CPD
5	**EU Science for Preparedness Conference**	4 to 6 November 2025, Bruxelles, Belgium https://joint-research-centre.ec.europa.eu/events/eu-science-preparedness-conference-2025-11-04_en	Risk models, predictive tools and GIS analytics	Relevant for strategic analytics and the development of predictive risk models
6	**European Defence Innovation Days**	13 to 16 May 2025, Krakow, Poland https://edfnetwork.eu/events/european-defence-innovation-days-2025-14/	AI systems, autonomous robots, communication systems	Innovations with dual-use potential for civil protection, particularly in AI and autonomous systems
7	**Indo Pacific Int'l Maritime Exposition**	4 to 6 November 2025, Perth, Australia https://www.indo-pacific-exposition.com/	Drones, autonomous systems, maritime robots, IoT systems	Relevant in the context of autonomous systems, sensors, and broader crisis
8	**Critical Communi-cations World (CCW)**	16 to 18 June 2026, London https://www.critical-communications-world.com/	Communication systems (TETRA, 5G), interoperability, alerting systems	Development and application of communication systems for emergency services
9	**AI for Good Global Summit**	7 to 10 June 2026, Geneva https://aiforgood.itu.int/summit26/	Artificial intelligence, big data, analytics	Application of AI in crisis management and decision-making
10	**INTERGEO**	15 to 17 September 2026, Munich https://dvw.de/intergeo/de	GIS, geospatial data, mapping, digital twins	Key for the development of risk mapping systems and situational awareness
11	**Milipol**	16 to 19 November 2027., Paris https://www.milipol.com/en	Security technologies, equipment for emergency services and surveillance systems	Overview of advanced equipment and technologies for operational forces

Annex 3

LIST OF USED REFERENCES

1. INVEST for DRM: Enabling new INVESTments for Disaster Risk Management in Croatia, https://civil-protection-knowledge-network.europa.eu/projects/invest-drm
2. EU Civil Protection Knowledge Network, https://civil-protection-knowledge-network.europa.eu/knowledge-library
3. TRACENET – Training Centre Network on 3D and VR, https://tracenet.fbk.eu/home
4. European Disaster Resilience Goals, https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/european-disaster-risk-management/european-disaster-resilience-goals_en
5. Implementing the Sendai Framework, https://www.undrr.org/implementing-sendai-framework/what-sendai-framework
6. AI as a new frontier in disaster risk management, https://civil-protection-knowledge-network.europa.eu/ai-new-frontier-disaster-risk-management; Artificial Intelligence approaches for disaster risk management, https://www.preventionweb.net/media/108040/download
7. Artificial Intelligence applied to disasters and crises management, https://civil-protection-knowledge-network.europa.eu/system/files/2024-12/jrc138914_jrc138914_ai_report_revision-3_pubsy.pdf; Guiding disaster risk reduction investments through AI powered tools, https://iddrr.undrr.org/news/guiding-disaster-risk-reduction-investments-through-ai-powered-tools-0
8. Integrating AI into Civil Protection; https://civil-protection-knowledge-network.europa.eu/system/files/2024-04/Integrating%20AI%20into%20Civil%20Protection.pdf; Workshop Report: Artificial Intelligence for Disaster Risk Management, https://civil-protection-knowledge-network.europa.eu/system/files/2024-10/workshop-report.pdf
9. ARTION – DELIVERABLE 2.1 Review of Existing AI Tools, https://civil-protection-knowledge-network.europa.eu/system/files/2024-03/D2.1_AI%20for%20disaster%20management.pdf; Artificial Intelligence approaches for disaster risk management, https://www.preventionweb.net/media/108040/download
10. From common operational picture to common situational understanding: An analysis based on practitioner perspectives, https://doi.org/10.1016/j.ssci.2021.105381; Copernicus Emergency Management Service (EMS), https://emergency.copernicus.eu/
11. Communications and Networking Technology for Public Safety, https://publicsafety.ieee.org/wp-content/uploads/2025/05/PST-Comms-Networking-White-Paper_Final_April2025-2.pdf; EU project INGENIOUS (The Next Generation Integrated Toolkit for Collaborative Response), https://ingenious-first-responders.eu/
12. Wearable sensors for health monitoring: Current applications, trends, and future directions, https://doi.org/10.1016/j.biosx.2025.100727; EU project SIXTHSENSE (Smart Integrated eXtreme Environment Health Monitor with Sensor Excellence), https://sixthsenseproject.eu/

13. EU Project SHOTPROS: VR-based training for first responders in high-stress environments, https://shotpros.eu/; Training Firefighters In Virtual Reality, https://www.researchgate.net/publication/347253113_Training_Firefighters_In_Virtual_Reality

14. EU project DIGITWIN4CIUE (Digital Twins for Complex Infrastructures and Urban Ecosystems), https://www.digitwin4ciue.eu/; Initiative of the European Commission Destination Earth (DestinE), https://destination-earth.eu/

15. EU project DUET (Digital Urban European Twins), https://www.digitalurbantwins.com/; EU project PRECINCT (Horizon Europe), https://www.precinct.info/

16. INSPIRE Directive, https://knowledge-base.inspire.ec.europa.eu/legislation/inspire-directive_en; Disasters Interoperability Concept Development Study, https://www.ogc.org/initiatives/disasters-cds/; Compendium of Good Practices on Integrated Risk Information Systems, https://civil-protection-knowledge-network.europa.eu/system/files/2024-09/cadri-good-practices-integrated-risk-information-systems_2020.pdf

17. Emergency Response Coordination Centre (ERCC), https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/emergency-response-coordination-centre-ercc_en.

18. GOVSATCOM | Satellite Communications, https://defence-industry-space.ec.europa.eu/eu-space/govsatcom-satellite-communications_en.

19. EU project COLLARIS, https://civil-protection-knowledge-network.europa.eu/system/files/2025-03/d3.2-recommendations-towards-interoperability_library.pdf; EU project HEIMDALL, https://arquivo.pt/wayback/20210223141041/https://heimdall-h2020.eu/; TRACENET – Training Centre Network on 3D and VR, https://tracenet.fbk.eu/home

20. EU project CURSOR (Coordination and Rescue System for Response to Urban Catastrophes). https://www.cursor-project.eu/; EU project FASTER (First responder Advanced Technologies for Safe and Efficient Resilience), https://www.faster-project.eu/; EU project 5G-EPICENTRE (5G Experimentation Infrastructure for First Responders), https://www.5gepicentre.eu/

21. EU project INGENIOUS (The Next Generation Integrated Toolkit for Collaborative Response), https://ingenious-first-responders.eu/

22. Emergency Planning Guidelines, https://civil-protection-knowledge-network.europa.eu/system/files/2025-01/emergency-planning-guidelines.pdf; EU project BORIS2 – D2.1 Comparison of existing schemes and methods for emergency management, https://civil-protection-knowledge-network.europa.eu/system/files/2025-02/boris2_d2.1-comparison-of-existing-schemes-and-methods-for-emergency-management.pdf

23. Shaping a disaster-resilient Union: Charting a path for the future of European civil protection, https://civil-protection-knowledge-network.europa.eu/system/files/2024-11/cpf_final-report_final.pdf; European Crisis Management Laboratory, https://joint-research-centre.ec.europa.eu/laboratories-z/european-crisis-management-laboratory_en

24. Sendra, S., García, L., Lloret, J., Bosch, I., & Vega-Rodríguez, R. (2020). LoRaWAN Network for Fire Monitoring in Rural Environments. https://doi.org/10.3390/electronics9030531; Lopes, I. R., Coelho, P. R. d. S. L., Pasquini, R., & Miani, R. S. (2025). Evaluating the Performance of LoRa Networks: A Study on Disaster Monitoring Scenarios, https://doi.org/10.3390/iot6010014; Development of a smart sensing unit for LoRaWAN-based IoT flood monitoring and warning system in catchment areas, https://www.sciencedirect.com/science/article/pii/S2667345223000263; Chaulya, S.K., Mishra, P.K., Kumar, N. et al. Landslide monitoring and anticipation system using geosensors and wireless sensor network. Discov Geosci 2, 6 (2024), https://doi.org/10.1007/s44288-024-00007-3

25. EU project RECONASS, https://projects.research-and-innovation.ec.europa.eu/en/projects/success-stories/all/sensors-drones-and-satellites-watch-buildings-save-lives; EU project INTREPID, https://intrepid-project.eu/the-intrepid-project
26. CBRN Sensor Integrated on Robotics Platform (CSIRP), https://www.draper.com/media-center/featured-stories/detail/25394/cbrn-sensor-integrated-on-robotics-platform-csirp.
27. Copernicus Emergency Management Service (EMS), https://emergency.copernicus.eu/; EU projekt COLLARIS, https://civil-protection-knowledge-network.europa.eu/system/files/2025-03/d3.2-recommendations-towards-interoperability_library.pdf
28. EU project RESPONDRONE (Horizon 2020): Situational awareness through fleet management. https://respondroneproject.com/
29. Study on Greening the Union Civil Protection Mechanism, https://civil-protection-knowledge-network.europa.eu/system/files/2024-04/study%20on%20greening%20the%20union%20civil%20protection%20mechanism-KR0723039ENN.pdf; Li et al. (2023), Integrating sustainable and energy-resilient strategies into emergency shelter design, https://www.sciencedirect.com/science/article/pii/S1364032123008262
30. Sutikno et al. (2025), Portable solar photovoltaic systems for post-disaster emergency power supply: a comprehensive review, https://doi.org/10.11591/ijape.v14.i4.pp1071-1084; Solar-Powered Emergency Shelters: Life-Saving Power When Disaster Strikes, https://www.eurosolar.com.au/resilience-and-emergency-preparedness/solar-powered-emergency-shelters-life-saving-power-when-disaster-strikes/; Muensuksaeng et al. (2022), Portable solar-powered dual storage integrated system: A versatile solution for emergency, https://doi.org/10.1016/j.solener.2022.10.030; Tapping into solar energy to power emergency response, https://www.doctorswithoutborders.org/latest/tapping-solar-energy-power-emergency-response
31. Xu et al. (2024), Quantifying cascading power outages during climate extremes considering renewable energy integration, https://arxiv.org/abs/2407.01758; Amine et al. (2023), Designing and Analysing a PV/Battery System via New Resilience Indicators, https://www.mdpi.com/2071-1050/15/13/10328
32. Study on Greening the Union Civil Protection Mechanism, https://civil-protection-knowledge-network.europa.eu/system/files/2024-04/study%20on%20greening%20the%20union%20civil%20protection%20mechanism-KR0723039ENN.pdf; Sobczuk, Sebastian, and Anna Borucka (2024), Recent Advances for the Development of Sustainable Transport and Their Importance in Case of Global Crises: A Literature Review, https://doi.org/10.3390/app142210653
33. An Introduction to Zero Emission Fire & Rescue Fleets, https://www.cenex.co.uk/app/uploads/2023/04/FireRescue.pdf; Ambulance service trials electric rapid response cars for emergency calls, https://www.independent.co.uk/news/uk/east-of-england-ambulance-service-vauxhall-nhs-england-england-essex-b2113928.html; Hamburg Fire Department begins trial operation with electric emergency vehicles, https://www.now-gmbh.de/en/news/pressreleases/hamburg-fire-department-begins-trial-operation-with-electric-emergency-vehicles/
34. E-mobility deployment and impact on grids, https://smart-networks-energy-transition.ec.europa.eu/system/files/2022-12/ETIP%20SNET%20E-Mobility%20White%20Paper_pdf.pdf; Mosayebi, M., Fathollahi, A., Gheisarnejad, M., Farsizadeh, H., & Khooban, M. H. (2022), Smart Emergency EV-to-EV Portable Battery Charger. Inventions, https://doi.org/10.3390/inventions7020045.

35. EU strategy for sustainable and circular textiles, https://environment.ec.europa.eu/publications/textiles-strategy_en; Ecodesign for Sustainable Products Regulation (ESPR), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781&qid=1719580391746
36. Sustainability in the PPE and Safety Equipment Industry, https://safetyequipment.org/wp-content/uploads/2023/09/PPE-Sustainability-Study.pdf; Rendeki, S.; Nagy, B.; Bene, M.; Pentek, A.; Toth, L.; Szanto, Z.; Told, R.; Maroti, P. An Overview on Personal Protective Equipment (PPE) Fabricated with Additive Manufacturing Technologies in the Era of COVID-19 Pandemic. Polymers 2020, 12, 2703. https://doi.org/10.3390/polym12112703
37. EU project CISUTAC (Circular Innovation and Sustainable Textile Assembly): https://www.cisutac.eu/; EU project BIOMAT, https://www.biomat-testbed.eu/; EU project ZeroF, https://www.zerof.eu/project; Beyond PFAS: safer coatings for EU consumer products, https://cordis.europa.eu/article/id/457676-beyond-pfas-safer-coatings-for-eu-consumer-products
38. Project ARTION, https://www.kios.ucy.ac.cy/ARTION/; project AIDERS, https://civil-protection-knowledge-network.europa.eu/projects/aiders.
39. EU project NIGHTINGALE, https://www.nightingale-triage.eu/.
40. European Emergency Number Association (EENA 112), AI Special Project Final Report, https://eena.org/document/ai-special-project-final-report/.
41. ASSISTANCE project, https://assistance-project.eu/.
42. TEMA's Digital Twins: A Game-Changer for Fire Field Operations in Sardinia, https://civil-protection-knowledge-network.europa.eu/news/temas-digital-twins-game-changer-fire-field-operations-sardinia.
43. David Lund (2024), EUCCS Preparation (BroadEU.Net) Realising the European Critical Communication System (EUCCS), https://docbox.etsi.org/Workshop/2024/10_SECURITYCONFERENCE/17OCTOBER/D42_LUND_PSCE.pdf; projekt web, https://euccs.eu/
44. EU project RECONASS, https://projects.research-and-innovation.ec.europa.eu/en/projects/success-stories/all/sensors-drones-and-satellites-watch-buildings-save-lives
45. Madeira, https://www.madeira.gov.pt/srem/pesquisar/ctl/ReadInformcao/mid/8207/InformacaoId/252192/UnidadeOrganicaId/28/LiveSearch/Preven%C3%A7%C3%A3o%20Rodovi%C3%A1ria_STFP?utm; Hamburg, https://www.now-gmbh.de/en/news/pressreleases/hamburg-fire-department-begins-trial-operation-with-electric-emergency-vehicles/; London, https://www.london-fire.gov.uk/media/t2dfbkgl/lfc-23-072-cnz-increasing-electrical-provision-at-fire-stations-signed.pdf; London fire-fighting brigade, https://www.london-fire.gov.uk/media/t2dfbkgl/lfc-23-072-cnz-increasing-electrical-provision-at-fire-stations-signed.pdf.
46. Enhanced preparedness and emergency response: Strengthening the EU Civil Protection Mechanism combined with ambitious health funding, https://civil-protection-humanitarian-aid.ec.europa.eu/news-stories/news/enhanced-preparedness-and-emergency-response-strengthening-eu-civil-protection-mechanism-combined-2025-07-17_en; Questions and answers on the cohesion policy's reallocation of funds, https://ec.europa.eu/commission/presscorner/detail/en/qanda_26_710
47. European Defence Fund, https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-defence-fund_en

Co-funded by
the European Union

CIVILNA ZAŠTITA
RH
MUP