JRC 142778

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SCIENCE FOR POLICY BRIEF

SPRINT – Policy brief

AI approaches for disaster risk management

TAKEAWAYS

- Artificial Intelligence (AI) models and applications can play a crucial role in enhancing the EU's ability to anticipate and prepare for disasters. However, it is essential that these models are interpretable and maintain a "human-in-the-loop" approach to support accountable decision-making.
- The Joint Research Centre (JRC) explores AI capabilities to support the EU's Prevention, Preparedness, and Resilience-building strategies, including the Preparedness Union Strategy. Efforts focus on enhancing information and image processing, advancing AI-driven risk assessment, and strengthening early warning systems.
- The JRC's AI-powered approaches to disaster risk management can aid Member States by offering timely, data-informed, scientific decision support. Combined with collaborative workshops, this can boost national preparedness and response strategies.

THE JRC'S INNOVATIVE APPROACH TO DISASTER RISK MANAGEMENT

Artificial Intelligence (AI) is transforming the world, creating opportunities for faster and better decisions — also in the field of disaster risk management (DRM). New approaches based on AI allow us to rethink the foundations of existing early warning systems, situational awareness tools and crisis management practices. However, the adoption of new tools comes with risks that affect people's lives. Therefore, it is essential to explore AI solutions with care. They should be tested in a scientific environment closely connected to policy and operations, with a human-controlled approach, and rolled out only when there is added value.

It is also worth noting that, while today the focus is on generative AI and large language models (LLMs), AI itself is a much broader field. It comprises a wide range of models and approaches, either novel or more consolidated, dealing with different specific types of processes and tasks. Each specific class of AI models may have its own potential uses, challenges and limitations in terms of policy support. The Joint Research Centre (JRC) is actively exploring novel AI applications (e.g. deep learning models) to enhance data processing, analysis, and early warning capabilities for DRM. In doing so, the JRC builds on the expertise obtained by its past work with state-of-the art statistical and numerical models.

Recent technological advancements are critical for improving efficiency and effectiveness in all the DRM phases. The JRC has successfully tested new AI models in various disaster-related projects and is also experimenting with integrating these new approaches into early warning systems.

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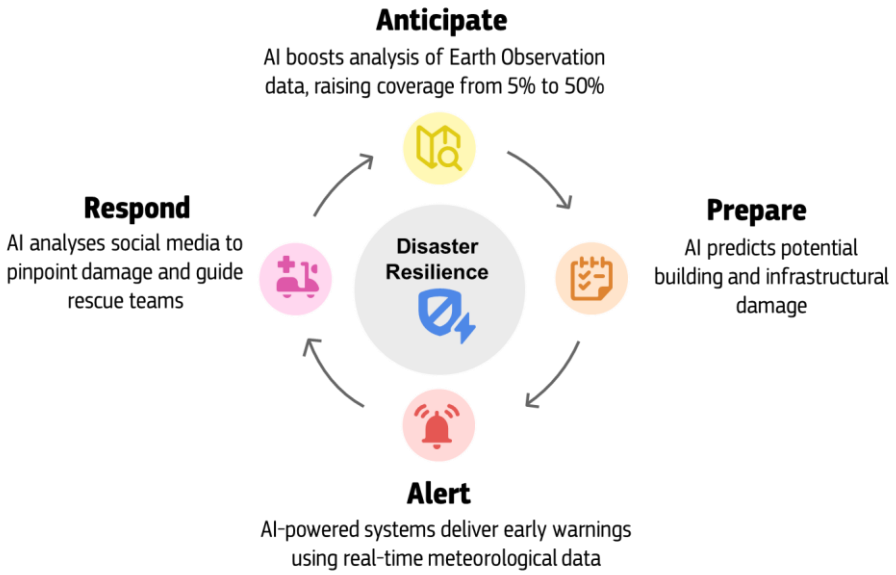
Figure 1 – AI applied to Disaster Risk Management



Source: Own illustration

WHAT WE HAVE ALREADY ACHIEVED

Enhanced anticipation, preparedness and response

Anticipation, preparedness, and response are critical areas where the JRC has tested and observed how AI capabilities can add significant value to human efforts. The challenges of effectively preparing for disasters are compounded by complex data and limited human resources: the sheer volume of historical data can be overwhelming, making it difficult to identify trends. AI, particularly machine learning, can enhance these efforts. For instance, Earth Observation platforms (such as Copernicus) generate extensive data, with hundreds of active Earth Observation satellites continuously collecting information. However, only about 5 % of this data can currently be analysed due to its overwhelming volume [1]. AI can increase the percentage of analysed data substantially from 5 % to at least 50 % [1]. Hence, AI assistance allows analysts to process hundreds of thousands of square kilometres daily, in contrast to only a few hundred square kilometres with declining quality over the course of a day without AI assistance. This capability allows disaster managers to have increased lead time to prioritise and implement mitigation activities.

Better understanding of human settlements

The JRC's Global Human Settlement Layer (GHSL) project aims to improve our understanding of human settlements worldwide. The project uses AI, specifically Symbolic Machine Learning (SML), to analyse satellite images [2]. This method is transparent and open about how it makes decisions, creating simple rules that experts can understand and check. Using SML, the project can derive directly from the satellite data information such as the extent of built-up land, the presence of permanent water, and whether built areas are used for homes or businesses. This project demonstrates the capability of AI to map informal settlements such as slums, refugee camps, or camps for internally displaced people, and estimate potential building and infrastructural damage caused by natural hazards [2].

Explainable AI for agriculture risk assessment

Explainable AI (xAI) is important for assessing and predicting risks associated with natural hazards such as droughts. For example, the JRC has developed an expert-driven xAI model that integrates expert knowledge with large datasets to identify areas of concern for EU agriculture related to climate hazards [3].

WHAT WE ARE TESTING RIGHT NOW

Strategic early warning

The EU Preparedness Union Strategy underscores the need for improved strategic early warning tools to shift from reactive to proactive crisis management. This includes enhancing alertness, which offers the potential to improve early warning systems. AI can play a role in this enhancement. While still in experimental stages, AI already demonstrates its capabilities in processing large volumes of data. For

example, it can identify unknown patterns, and thus enable faster, more accurate alerts.

AI in Earth Observation

One of the key initiatives addressing this need is the Copernicus Emergency Management Service (CEMS). CEMS is currently rolling out AI-powered models to analyse Earth Observation data, providing critical support for emergency response and management to national authorities. Hence, AI will help to improve CEMS to better respond to crises such as wildfires in the Mediterranean and floods in Central Europe.

Generative AI in crisis communication and situational awareness

Generative AI — AI systems capable of creating new content, such as text and images — has shown promising results in crisis management communication projects. Recently, the European Crisis Management Laboratory (ECML) developed AI functionalities to boost the production of DG ECHO's Daily Flashes, which are bulletins about global disasters and humanitarian crises [4]. This technology supports drafting these daily situational awareness reports by locating, processing, translating, and summarising news articles for analysts. Additionally, AI helps to automatically extract key details, such as affected areas and loss information from the bulletins to build databases. Analysts then use these databases, employing AI and specialised search techniques that combine information retrieval with text generation, to find information for their work.

AI in tropical cyclone preparedness

Similarly, a pilot JRC project aims to increase the anticipation time-window of preparedness measures for tropical cyclones. This is achieved by monitoring and visualising meteorological conditions which may lead to cyclone formation (so-called cyclogenesis) within the Global Disaster Alert and Coordination System (GDACS) [8], before they are explicitly categorised as fully formed tropical cyclones [5]. This pilot project uses AI to automatically process information from text-based weather bulletins issued by meteorological centres. As a next step, AI extracts details about potential tropical cyclogenesis conditions from this unstructured text and converts it into a structured format that GDACS can use to register and announce these developing cyclones for preparedness purposes. This activity aims to provide timely critical information for the earliest stages of tropical cyclone formation.

Real-time (social) media analysis in disaster response

When a disaster occurs, the EU's response should be immediate to help fill critical gaps and prevent further deterioration of the situation, especially when a country's capacity is overwhelmed. During disasters, people often share photos, videos, and their locations in real-time on social media. These posts are a critical data source for enhancing response efforts in the crucial early hours and days of a disaster, particularly in the first 12-24 hours, when Earth Observation images are not available yet.

However, quickly identifying important information is challenging, and that's where AI comes in. For example, during the 2023 earthquakes in Türkiye and Syria, AI tools analysed social media content to identify areas of damage and prioritise rescue operations [6]. The JRC has created open-source software that uses machine learning to scan social media posts in real time. It filters, geolocates, and analyses data to help emergency responders during disasters. For example, it was used after the 2021 Haiti earthquake to assess the situation [7].

The JRC has extensive experience in gathering intelligence and monitoring media to automatically identify potential threats from public sources. For example, the Europe Media Monitor (EMM) is a sophisticated tool that screens information from numerous worldwide sources, providing near real-time insights on current events, trends, and emerging issues. The JRC's EMM technology is also applied in public health through the Epidemic Intelligence from Open Sources (EIOS) system, as well as in conflict anticipation and analysis.

HOW THE JRC SUPPORTS MEMBER STATES

The JRC works at the science-for-policy interface and therefore has a mandate to explore how AI can support EU policy making. Concretely, its work falls in three categories.

First, the JRC creates new AI-based solutions in support of the Commission’s policies. Examples include enhancing the capabilities of the Copernicus Emergency Management Service or creating applications for Destination Earth — a digital twin of the Earth. Its close connection with the policymakers allows for a fast, user-driven innovation cycle.

Second, the JRC keeps track of the fast progress in the field of AI for Disaster Risk Reduction (DRR) through its Disaster Risk Management Knowledge Centre (DRMKC). The JRC ensures everyone has access to state-of-the-art technologies by facilitating an exchange of knowledge across departments of the European Commission, across Horizon Europe research projects and across Member States (in collaboration with the UCP Knowledge Network).

Third, the JRC actively participates in global AI initiatives for DRR. One example is the co-lead of the UN "Global Initiative on Resilience to Natural Hazards with AI" [8] and the strong role in the "AI for Public Good" initiative [9].

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