extreme

strategie e soluzioni per la resilienza delle infrastrutture critiche

EXTREME NATURAL EVENTS

Call for proposals for strategic development plans carried out in collaboration between associations for the development of Emilia-Romagna's Smart Specialisation Strategy - S3

INTER CLUST-ER CALL FOR PROPOSALS

CLUST-ER BUILD
CLUST-ER INNOVATE
CLUST-ER TOURISM
CLUST-ER URBAN

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NATURAL ENVIRONMENTAL RISKS

Landslides, floods and flooding. For experts, 'it's the new normal.'

Following the climatic events of 2024 in the Parma and Reggio Emilia areas, which followed the even more severe events of 2023 in Romagna, questions are being asked about what will be a trend and no longer an exception, with all that this will entail in terms of repercussions on the territory and infrastructure management, with particular reference to critical infrastructure, which could harm the entire regional economic system if interrupted or severely limited.

Meteorologist Luca Lombroso told Rai, "We have not had exceptional events. We have had events that are part of a new normal. So we have to deal with it".

Torrential rains, swollen rivers, flash floods, sudden hailstorms and flooding even in summer. This state of facts inevitably highlights the problem from the point of view of the technical soil protection system, namely:

- **monitoring of instability**
- **monitoring of watercourses**
- **emergency management**

MAIN VULNERABILITIES

- *INFRASTRUCTURE: weather events not dealt with by the watercourse and sewerage systems increase the risk of soil instability, worsening geotechnical conditions and triggering landslides that inhibit the infrastructure system;*
- *ECONOMIC 1: Post-event intervention entails high restoration costs for the competent authorities and losses due to lost production;*
- *ECONOMIC 2: Critical economic activities are penalised and tend not to locate in areas at risk of flooding or isolation, leading to the risk of relocation.*
- *SOCIAL: The community faces inconveniences that create discontent and impact reputation, as well as encouraging the shutdown of local retail businesses.*

Appropriate programming and planning are needed to ensure protection against natural disasters, in order to minimise the risk to life, citizens and the production system in dangerous situations.

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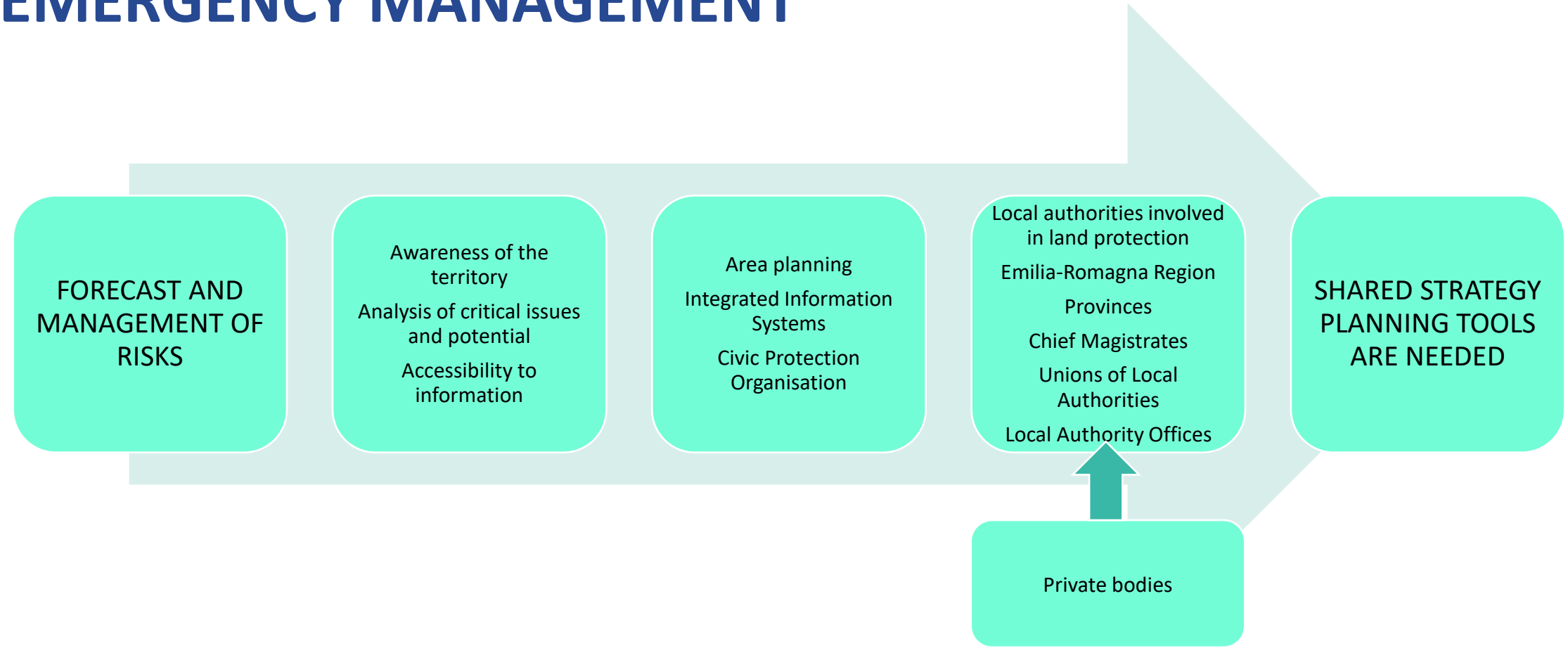
EMERGENCY MANAGEMENT



OBJECTIVES

The main objectives of the project Task Force are to:

- *ensure security and operational continuity*
- *strengthen the capacity to respond to physical and digital risks*
- *manage infrastructure in a sustainable and resilient manner*

Services such as the following are also of great importance:

- *keeping existing services active and preventing abandonment*
- *keeping the territory well maintained and prepared for extreme events*
- *strengthening the resilience of digital infrastructure*
- *keeping local economies active*
- *initiating and promoting dialogue and cooperation with other International Countries*

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ENGAGEMENT OF ASSOCIATES PROCESS

In order to clearly define the specific objectives to be addressed and validate the implementation of individual projects, it was decided to proceed as follows:

- *meeting with members of the four Clust-ERs and discussing critical issues, potential and specific skills*
- *identifying horizontal themes that represent the required characteristics of effectiveness, efficiency, cost-effectiveness and ease of implementation*
- *classifying associates and identifying those with specific experience to contribute to the launch of projects*
- *preparing the launch report*
- *involving members interested in contributing to individual activities*

ASSOCIATES WITH RELEVANT EXPERIENCE ENGAGED:

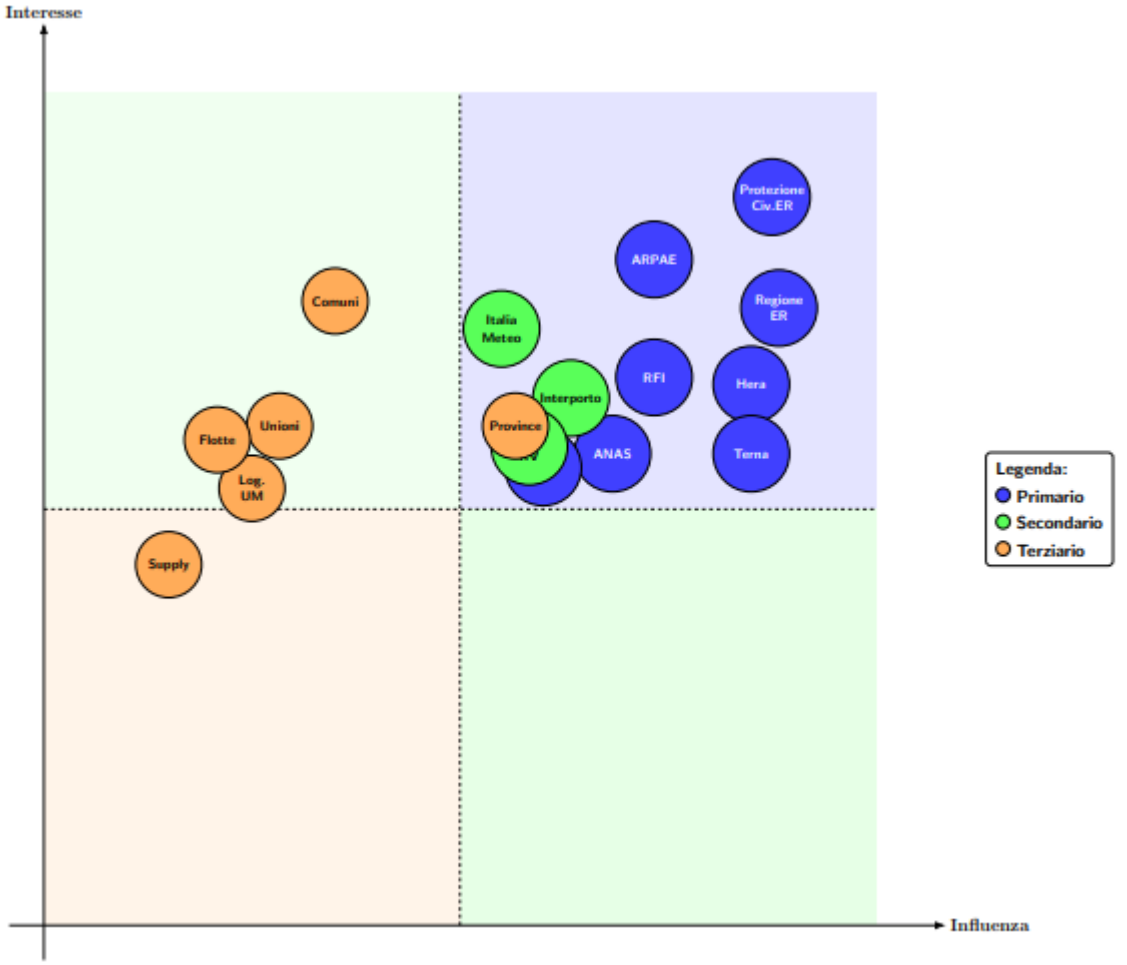
- *CIRI ICT*
- *CICCREI*
- *Unimore Urban*
- *Proambiente*

STAKEHOLDER ENGAGEMENT PROCESS

The ecosystem of actors interacting with the EXTREME project includes internal components (Clust-ER, tech-science centres, project partners) and external ones (local and national institutions, infrastructure managers, logistics and supply chain operators).
The integrated analysis of interest, perceived usefulness and expected benefit highlights how each group derives different benefits depending on its role, information flows and alignment with operational responsibilities.

The combination of interest, usefulness and benefit for each group is the lever for transforming knowledge into action, ensuring both system robustness and solution scalability.

To ensure a consistent and comparable assessment of stakeholders, an interest-influence matrix is adopted for each dimension (Interest, Perceived Utility, Expected Benefit), in order to distinguish more granularly the levels of involvement of each stakeholder.



KEY AREAS

Sea and Ports

Coastal monitoring and protection services will be needed, with particular reference to ports and coastal transport routes, in order to reduce the risk of strong winds and flooding and to be prepared in the event of extreme weather events. The interruption of logistics services in large port areas can bring the entire regional economy to a standstill.

Plains and low Hills

It will be essential to keep an eye on the ridges close to inhabited areas and areas at risk of flooding from rivers in order to implement measures aimed at promoting the resilience of these areas. Bridges and critical industrial areas will be among the main targets of the measures.

Mountains

In addition to the considerations outlined for the plains, it is important to protect the area from perceptions of inadequacy and isolation, factors that would reduce its attractiveness to companies providing critical services and further feed the trend of depopulation. Projects such as analysis of the state of landslides, territorial IT systems and coordination with National Civic Protection at the central and regional levels will be required..

IMPLEMENTATION STRATEGIES

OB1 – PRE-CRISIS ENVIRONMENTAL MONITORING

Development of sensor and monitoring systems, integrated into existing, easy-to-read platforms, which, together with data analysis and predictive risk assessment systems, can warn of extreme scenarios and support surveillance, as well as provide valid alternative access options in advance in the event of disruption to emergency and logistical services.

OB2 - COMMUNICATION DURING THE EMERGENCY

Development and implementation of non-expensive solutions that allow essential communication services to remain active during emergencies, thereby facilitating the timely and prompt intervention of rescue workers and reducing the risk of isolation.

OB3 – RESILIENT INFRASTRUCTURES

Deployment of rapid assessment solutions for buildings used for critical activities and strategic transportation infrastructure, and integration of the results into IT operational tools, in order to understand the vulnerabilities inherent in infrastructure and generated in a cascade effect on the local and regional context, making the entire socio-economic system more resilient to extreme events.

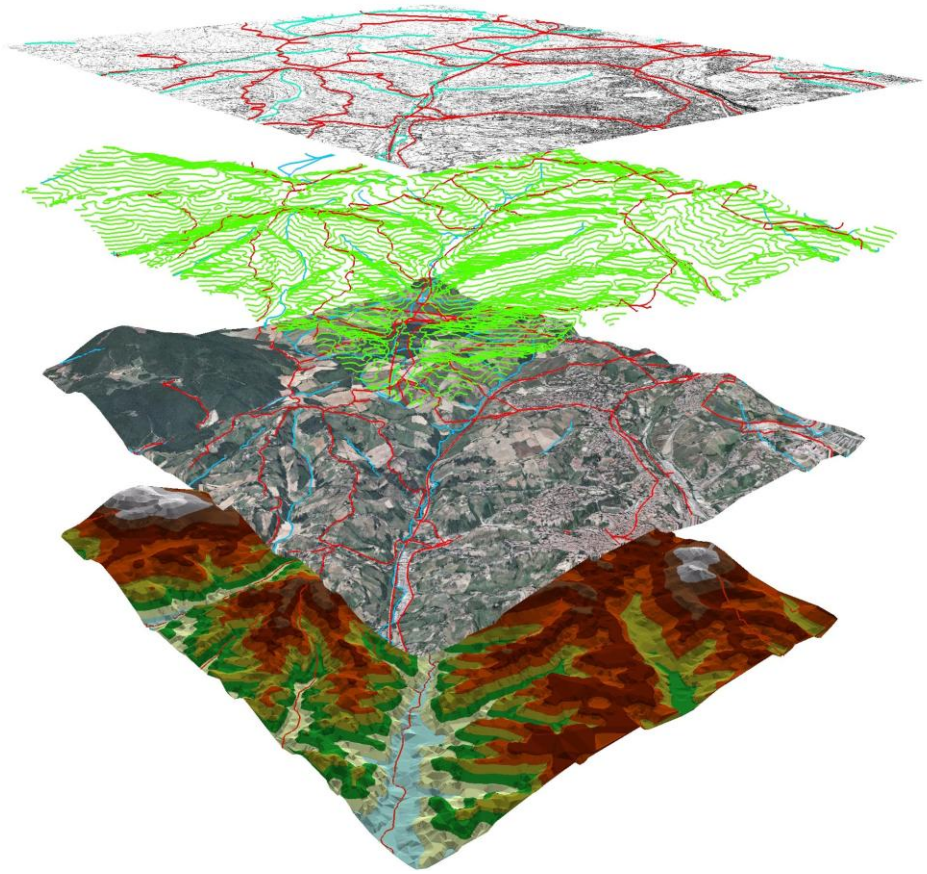
OB 1 - PRE-CRISIS MONITORING

Territorial surveillance is a fundamental practice for strengthening resilience and promoting a faster and more focused response to critical events.

The main tools already at our disposal are as follows:

- *Early Warning Systems: these monitor environmental variables in real time and activate alert thresholds.*
- *GIS platforms: used to display maps and operational information, these are widely used by local authorities.*
- *Digital Twin: dynamic digital representations of territories and infrastructure, powered by real data and simulation models.*

Overall, territorial surveillance is still fragmented and predominantly reactive, making it necessary to evolve towards a predictive, interoperable and continuous model, integrated with logistics planning and emergency management.

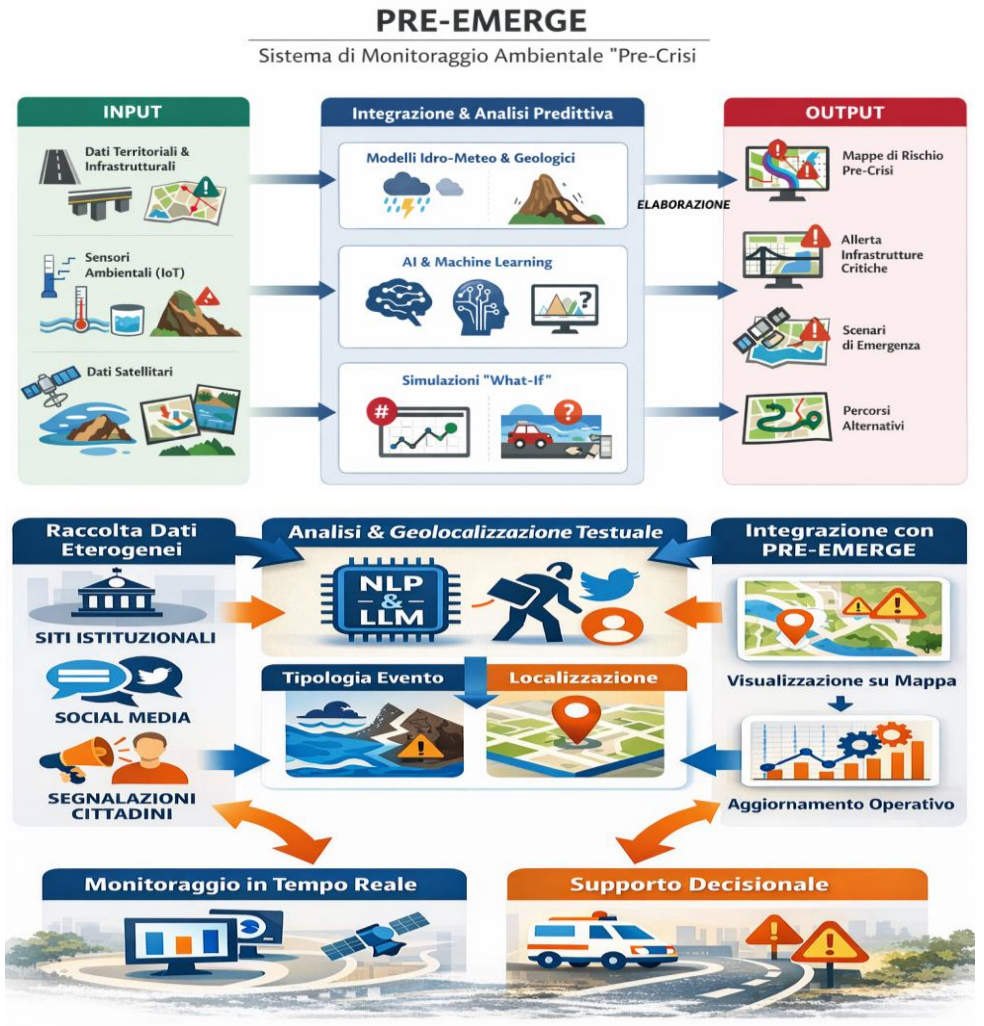


OB 1 - PRE-CRISIS MONITORING

The solutions described above are the result of important studies and experiments and should be valued and exploited as a starting point for the development of even more integrated solutions capable of providing ready-to-use responses by public and private entities responsible for monitoring, assessing and responding to emergency events that could compromise the performance of activities essential to the proper functioning of the regional socio-economic system.

Examples of integrated monitoring systems from our associates:

- *PRE-EMERGE: a predictive environmental monitoring system that integrates data from sensors, satellites and environmental models, allowing critical issues to be anticipated and supporting emergency logistics with dynamic maps and scenario simulations.*
- *CITTADIN-AI: a platform that collects and analyses reports from citizens and administrations using artificial intelligence and NLP techniques, transforming unstructured information into georeferenced data useful for monitoring and operational response.*



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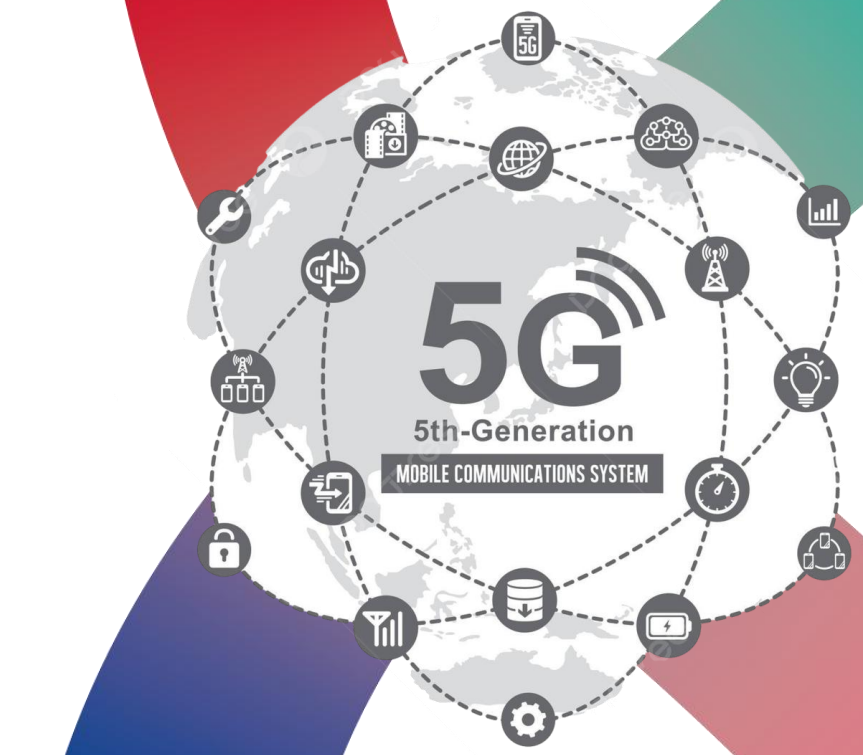
OB 2 – RESILIENCE OF COMMUNICATION

A key aspect is the resilience of communication infrastructures, which are essential for ensuring coordination during emergencies. Traditional networks (such as 5G) are optimised for normal conditions but are fragile in the event of a crisis.

It is necessary to supplement them with "secure" and decentralised infrastructures, such as mesh networks and low-energy technologies (LoRa, NB-IoT), which allow essential services to remain active even in degraded conditions. Technological heterogeneity and complementarity between different communication systems are considered key strategies for increasing resilience.



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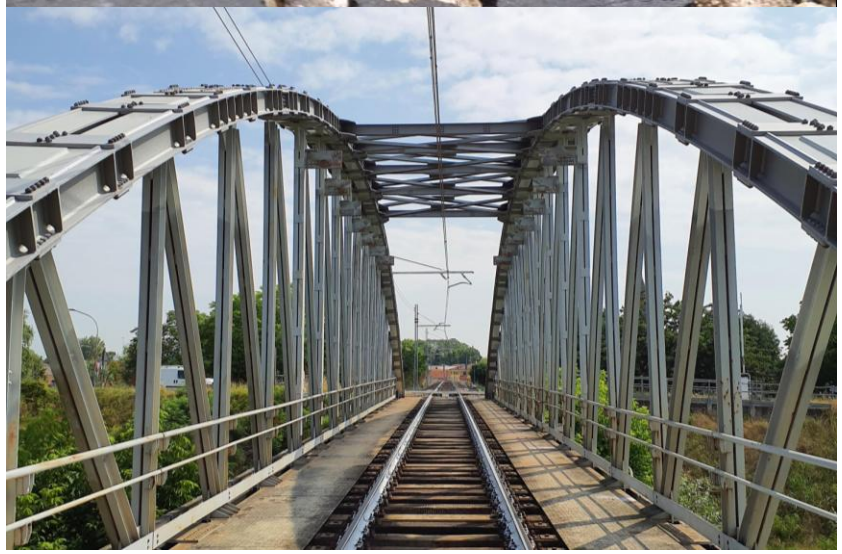
OB 2 – RESILIENCE OF COMMUNICATION

Implementation proposals in this area involve the deployment of existing, non-expensive technologies, such as low-cost mesh technologies which, thanks to the new possibilities enabled by 5G, can absorb emergency peaks, assuming that the cellular network does not completely fail, extending the remaining active signal across the entire territory and creating a bridge between areas that are no longer covered due to power loss (e.g. due to flooding) and the network that is still functioning (but no longer accessible from the affected areas).

In this context, it is necessary to exploit economical and already available solutions, which would not be sufficient if taken individually. In fact, it is necessary to integrate the technologies with the procedures for managing and activating them.

OB 3 – RESILIENCE OF INFRASTRUCTURE

The last objective identified, and probably the most challenging, involves an approach dedicated to strengthening infrastructure, with priority given to those whose damage would have serious repercussions on the socio-economic system, such as buildings used for critical activities and major transport infrastructure connecting populated and productive areas.
The approach to be implemented involves a series of assessments at the territorial level, through the interpolation of databases and environmental information, in order to understand local vulnerabilities and make buildings and critical road infrastructure more resilient to extreme events. This integration of information, which can also be made available through the use of Territorial Information Systems, can help public decision-makers and private entities to define intervention strategies and business plans to mitigate any risks from events.



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CLUST-ER BUILD
EDILIZIA E COSTRUZIONI

CLUST-ER INNOVATE
INNOVAZIONE NEI SERVIZI

CLUST-ER TOURISM
TURISMO E TERRITORIO

CLUST-ER URBAN
ECONOMIA URBANA

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