SIRIMA – Sinkhole hazard and risk management in Post-mining areas

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General

The SIRIMA project aims to improve the safety and sustainability of lands affected by mining activities by addressing risks such as surface deformations from subsidence and groundwater uplift, which can lead to sinkholes. The project collects both in-situ and historical data from partner countries, enabling the use of machine learning models to predict sinkhole hazards more accurately.

A key outcome is the development of a spatial Decision Support System (sDSS) that integrates Multi-Criteria Decision Analysis (MCDA). This system enhances decision-making by providing stakeholders with accurate, data-driven insights for effective risk management, ensuring safer and more sustainable post-mining environments.

Case Study

Case study in SIRIMA

- **In France**

Thil, located in the Lorraine Iron Basin in eastern France, experienced mining collapses after mines were flooded, particularly in the 1990s and early 2000s.

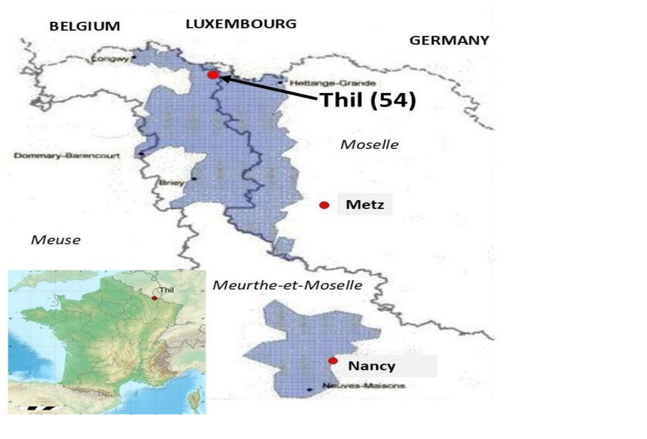

Figure 1: Location of the Thil site (Lorraine Basin, France). In gray, the Lorraine iron basin (adapted from Geoderis, 2020). [1]

- **In Poland**

Kazimierz Juliusz mine in Poland closed in 2016, while Siersza mine was liquidated in 1999. Both mines experienced an extended flooding process which has led to the formation of sinkholes.

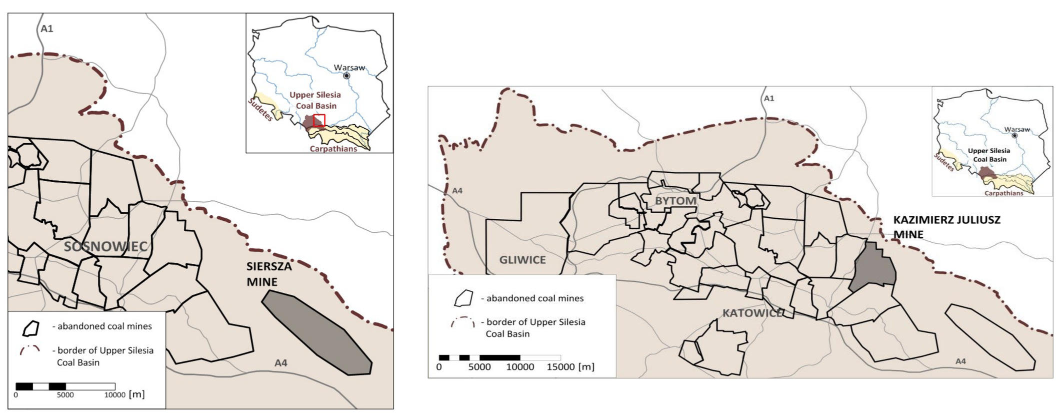

Figure 2: Location of the Siersza mine (left) and Kazimierz-Juliusz mine (right). [1]

Ruhrgebiet in SIRIMA

Ruhrgebiet is known for its intensive mining industry. Although it is not the primary study case in the SIRIMA project, the collection and analysis of data from this region will provide valuable insights, particularly regarding sinkhole hazards, benefiting Ruhrgebiet as well.

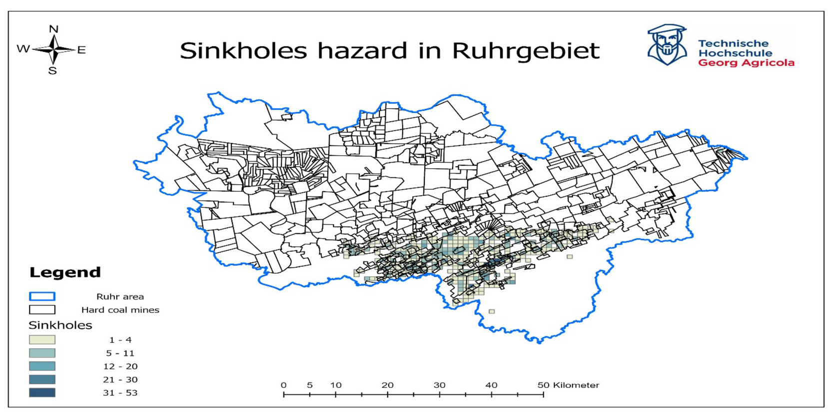

Figure 3: Sinkholes in Ruhrgebiet.

Methodology and Workflow

- Create a large-scale database using advanced tools like multi-regression and multi-criteria analysis
- Developing a website for users
- Applying numerical models to study sinkholes mechanisms
- Creating tools for infrastructure reliability and monitoring
- Employing machine learning to identify new patterns

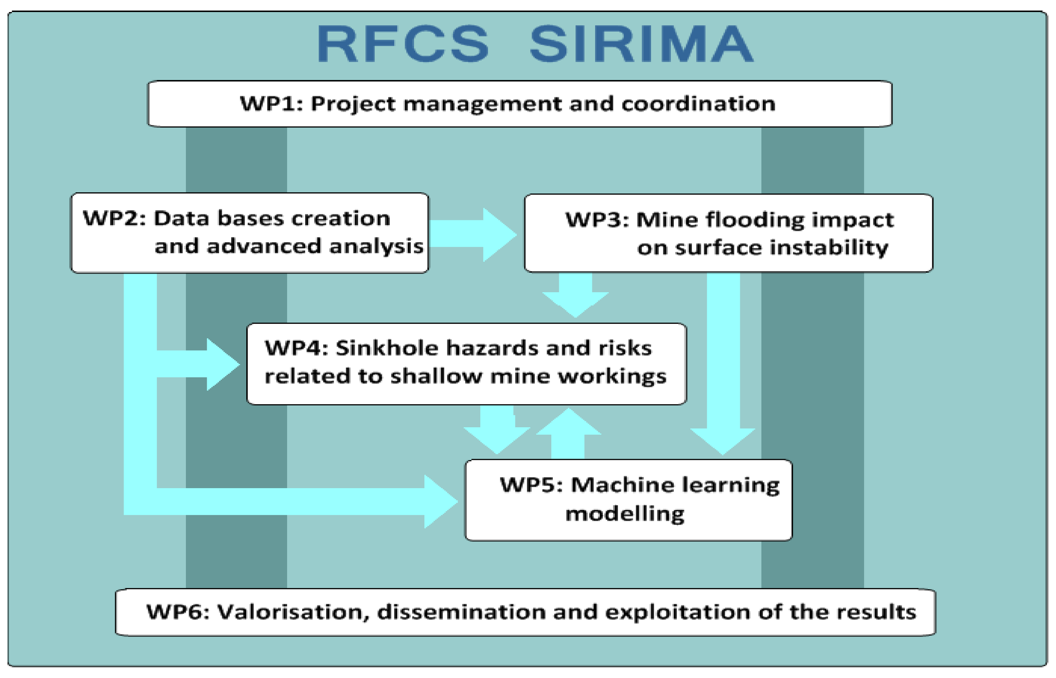

Figure 4: Graphical presentation of the SIRIMA project workflow. [1]

The workflow is designed to follow a logical sequence, where the outcomes of one work package provide the foundation for the next. To ensure a seamless and efficient workflow, each partner is responsible for specific tasks related to their expertise.

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FZN in SIRIMA

Geomonitoring

FZN coordinates key tasks in Geomonitoring. With the goal of developing optical monitoring systems in the test areas , these advanced techniques provide real-time data, strengthening efforts to assess and mitigate risks related to historical mining activity. By continuously monitoring critical parameters, potential sinkhole hazards can be identified, which is crucial for making safer and more informed decisions in risk management. These efforts establish the basis for the subsequent tasks in the SIRIMA project.

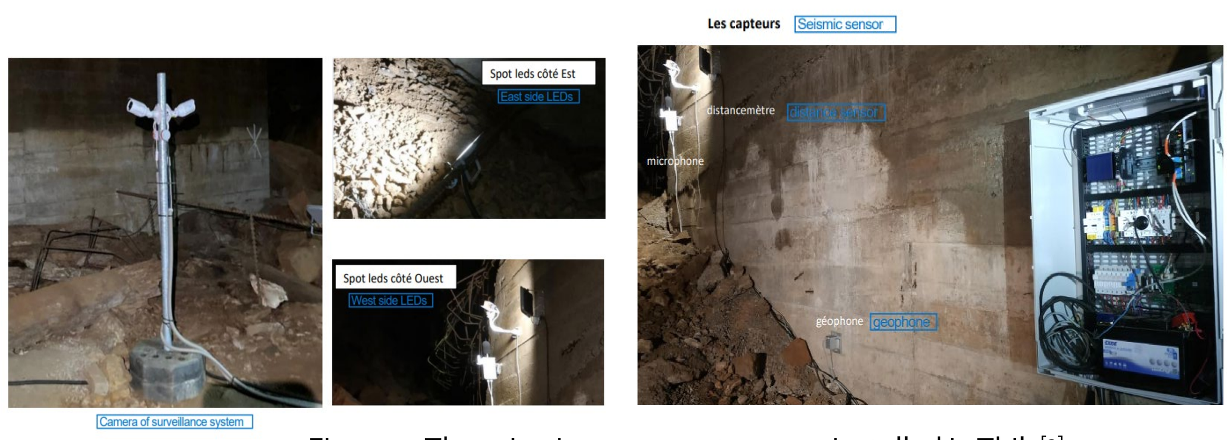

Figure 5: The seismic sensor system was installed in Thil. [2]

Figure 6: The piezometer with automatic measurement capabilities tracks changes in groundwater table, in Kazimierz. [3]

Figure 7 : The drilling work for a piezometer in Siersza. [3] [5]

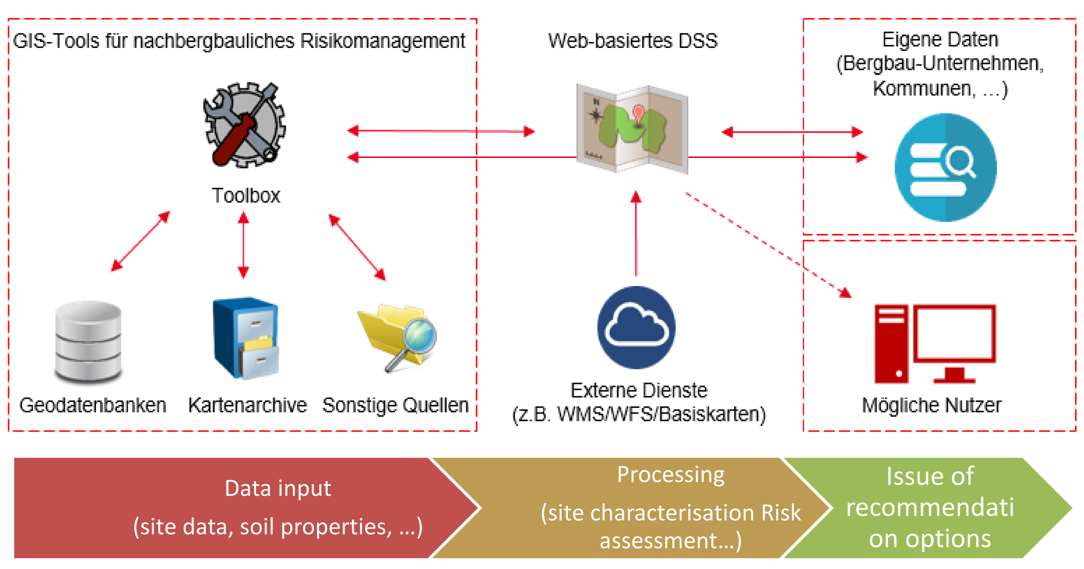

Figure 8: Technical and functional specification of DSS and GIS tools. [4]

sDSS – spatial Decision Support System

As the work package leader of the sDSS, FZN takes primary responsibility for developing the spatial Decision Support System (sDSS). This crucial role involves overseeing the system's design, implementation, and integration, ensuring it provides effective spatial analysis and decision-making support for managing geospatial data and addressing complex environmental challenges.

Expected Goals

The SIRIMA project focuses on increasing knowledge and experience related to the threats of post-mining areas in EU Member States especially related to uncontrolled movements of the earth's surface[1]. By developing new methodologies to evaluate the risk of discontinuous deformations, the project aims to provide insights into how the decommissioning of mining plants and the subsequent changes in geological and physical parameters can influence sinkhole formation.

The Forschungszentrum Nachbergbau (FZN) plays an essential role as a task leader in Geomonitoring and sDSS within the SIRIMA project. FZN's experience and expertise in these fields are highly valuable for the project's success in reducing sinkholes in Post-mining areas.

References:

[1] SIRIMA Project (2025). https://sirima.gig.eu/, accessed on 06 March 2025.
[2] Boullée, H. and Edwards, B. (2023): Seismic sensor system installed in Thil, France, 06 December 2023.
[3] GIG (n.d.): SIRIMA platform, unpublished.
[4] Haske, B. (2023): Ganzheitliches, interdisziplinäres Risikomanagement für europäische Nachbergbauregionen – Das Projekt PoMHaz, presented at Wissenschaftstag FZN 2/2023.
[5] The piezometer is planned to be installed from March 10, 2025 (n.d.), unpublished.

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Project Partners: