Technische Hochschule Georg Agricola

PoMHaz

USER MANUAL

for the sDSS API

Annex B to POMHAZ deliverable D3.3

https://dss.fzn.thga.de/

Research Fund for Coal & Steel

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Introduction

Welcome to the **Spatial Decision Support System (sDSS) API** User Manual. This API has been developed as part of the **POMHAZ Project** (Post-Mining Multi-Hazards evaluation for land-planning).

POMHAZ focuses on improving hazard assessment and risk management strategies in abandoned coalmines. The project aims to enhance the methodological framework for conducting multi-hazard analyses at the scale of mining basins, correlating with the primary post-mining hazards.

The sDSS API provides an intuitive platform to evaluate risk in post-mining areas by incorporating expert knowledge, hazard interaction, and vulnerability analysis. It allows users to assess various scenarios and visualize results through interactive maps. This user manual details the steps for using the API effectively.

The sDSS API is part of the POMHAZ Project funded by the **Research Fund for Coal and Steel (Grant Agreement No 101057326)**. It aims to bridge the gap between theoretical methodologies and practical applications in post-mining hazard assessment and risk management.

Note: This document is intended for expert users of the sDSS system.

Administrators have a separate manual with additional details on system management and data handling (Annex C).

Main API

Initial API Launch

1. Open the SDSS API application via https://dss.fzn.thga.de/
2. Click “Go to sDSS API” in the field “Explore the sDSS API”
3. After lauching the sDSS API, the platform establish two entry options: Private access (for admin users) and Public access (for general users)
4. **Public Access:** Without login the user could start working with the case studies in PoMHAZ API
5. **Admin Access**: A login window will appear (see Figure 1). Enter your credentials (username and password) to access the system. If you do not have credentials yet, contact Vinicius.Inojosa@thga.de or Benjamin.Haske@thga.de

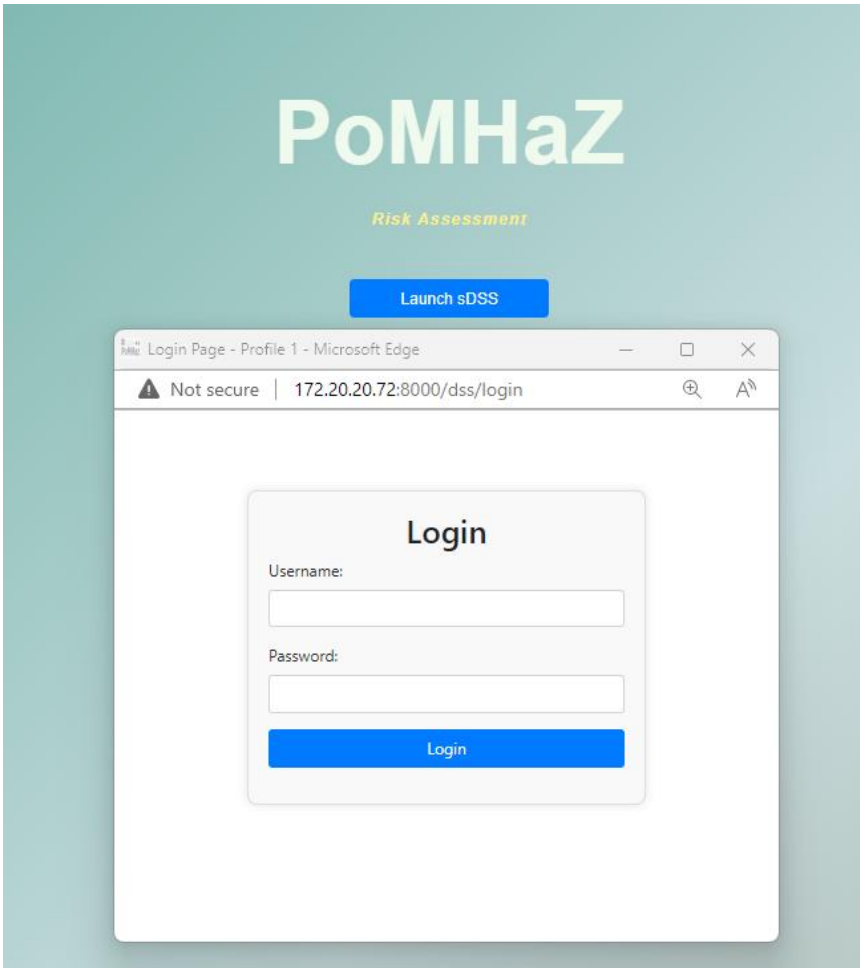

Figure 1: Login window to input credentials

Work with Study Cases

This option allows users to explore the data available for multi-risk management cases for specific post-mining locations presented in the POMHAZ project:

- **Southern Ruhr area, Germany**
- **Megalopolis, Greece**
- **Wałbrzych, Piekary Śląskie and Sosnowiec, Poland**
- **Peypin and Fuveau, France**

Upon selecting this option, a map with highlighted countries will appear (see Figure 2). Click on a location to proceed with the risk assessment for the location desire.

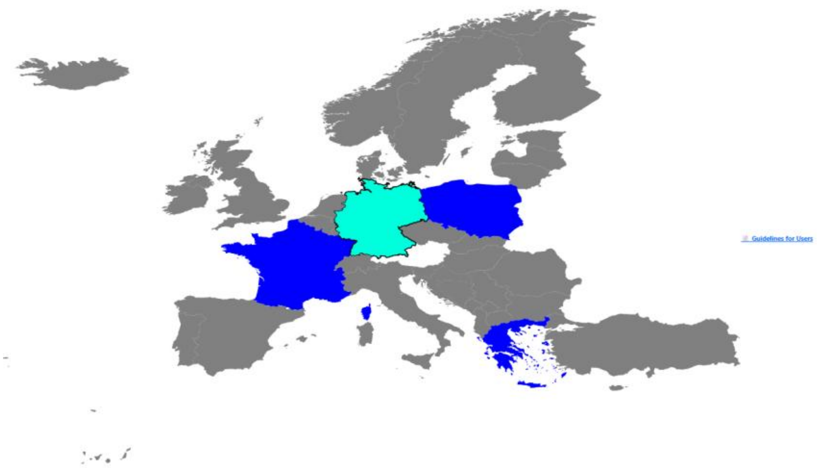

Figure 2: Site selection for loading the study cases

Data Preparation

Users can contribute additional data to the sDSS by contacting the admin assigned to their site. To ensure the data is correctly structured and compatible with the system, users should follow these steps:

1. Hazard Data

To perform multi-hazard assessments, hazard data must be structured according to the sDSS database requirements:

- **File Identification:** Each hazard file must follow the naming convention ID_Site, where Site corresponds to one of the predefined locations:

- **Germany**: Refers to the Ruhr area.
- **Poland**: Refers to Sosnowiec or other mine locations in Poland.
- **Greece**: Refers to Western Macedonia Lignite Centre and Megalopolis Lignite Centre mines.
- **France**: Refers to Peypin and other mine locations in France.

The *ID* refers to the type of post-mining or natural hazards that are defined for the PoMHAZ project (see Table 1 for valid IDs).

Table 1: Post-mining and natural hazards with corresponding ID for uploading in sDSS

N°	Post Mining Hazard	ID	N°	Natural Hazards	ID
1	Subsidence	subsidence	1	Natural Subsidence	natural_subsidence
2	Settlement	settlement	2	Localised collapse (sinkhole)	localised_collapse
3	Slope movement (slope stability) –Generalized scale	slope_general	3	Dissolution (e.g., gypsum, chalk or salt)	dissolution
4	Slope movement (slope stability) –	slope_local	4	Clay shrinkage or settlement	clay_shrinkage
5	Rock falls	rockfalls	5	Deep-seated landslide	deep_landslide
6	Induced seismicity	induced_seismicity	6	Shallow landslide	shallow_landslide
7	Sinkhole	sinkhole	7	Erosion	erosion
8	Crevice	crevice	8	Mudflow	mudflow
9	Environmental water pollution	water_pollution	9	Rockslide	rockslide
10	Environmental pollution from spoils	pollution_spoils	10	Rockfall	rockfall
11	Environmental pollution from tailings dams	pollution_tailings	11	Avalanche	avalanche
12	Hydrological disturbances, mining induced floods	floods_surface	12	Earthquake	earthquake
13	Hydrological disturbances, mining induced floods	floods_underground	13	Forest fire (wildfire)	forest_fire

14	Hydrological disturbances, mining induced floods	floods_pitlake	14	Settlement, consolidation	settlement_consolidation
15	Ionizing radiation emissions	radiation	15	Lowland flooding, as opposed to torrential flooding	lowland_flooding
16	Gas emissions linked to mining	gas	16	Flooding by runoff and mudslides	flooding_runoff
17	Combustion and overheating of mine waste	combustion	17	Flooding by rising groundwater	flooding_rising

- **Hazard Polygon Creation:** Use Shapefiles or GeoJSON to create hazard polygons with intensity levels ranging from 1 (no hazard) to 5 (high intensity). Examples include:
  - Flood hazards, where intensity increases with occurrence intervals.
  - Sinkholes near old shafts, where intensity increases with proximity to the shaft.
- **Export and Submission:** Export the hazard polygons and send them to the admin user of the site.
- **Metadata:** Ensure all data includes proper metadata, such as CRS (Coordinate Reference System).
- **Validation Support:** Provide original datasets (e.g., maps, shaft coordinates) to validate the hazard data and contribute to the Relational Database.
- **Rasterization and Analysis:** Rasterization, weighting, and analysis will be handled by the sDSS.

2. Exposed Element at Risk data

The sDSS uses open-source Sentinel-2 Land Use/Land Cover (LU/LC) data from ESA imagery at a 10m resolution. The LU/LC data is categorized according to the predefined classes in Table 2.

- **Data Submission Guidelines:** Users may submit additional LU/LC data, but submissions must:
  - Follow the naming convention: LULC_site.

- Contain raster files with pixels labeled according to the predefined ID values stated in Table 2
- Ensure compatibility with the DSS for reclassification and analysis. The system will only accept the files that are proper structure with the LULC nomenclature

Table 2: Classes defined for the LU/LC layer in the sDSS

ID	Class	Description
1	Water	Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.
2	Trees	Any significant clustering of tall (~15 feet or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).
4	Flooded vegetation	Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.
5	Crops	Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.
7	Built Area	Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.
8	Bare ground	Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.
9	Snow/Ice	Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, snow fields.
11	Rangeland	Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures. Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

3. Vulnerability Indicators

The vulnerability index is calculated as described in the vulnerability module and requires data from cities within the study site.

- **Index Structure:** The sDSS calculates the vulnerability index using four weighted categories, divided into 10 subclasses. Each subclass is normalized on a scale from 1 to 9. The categories include:
  - **Socioeconomic Status:** Indicators like unemployment rate and GDP per capita.
  - **Household Composition:** Factors such as the percentage of the population under 15 or over 64 years old, and population density.
  - **Environment:** Metrics like settlement area and agricultural land.
  - **Infrastructure:** Attributes such as building age, material, geometry, and traffic areas.
- **File Format and Submission:** Data for each city must be uploaded in a .zip file containing a Shapefile with the vulnerability categories for the cities in the study site:
  - Naming Convention: vulnerability_site.
  - Shapefile Columns:
    - **Socioeconomic Status:** socioeconomic.
    - **Household Composition:** household.
    - **Environment:** environmental.
    - **Infrastructure:** infrastructure.
- **Metadata Requirements:** As with hazard data, ensure proper metadata accompanies the Shapefile.

Modules Overview

The SDSS API establishes four interactive modules that correspond with the calculation of the risk assessment of each area.

Module I: Multi-Hazard Assessment

This module enables users to evaluate the risk of selected hazards and analyze their interactions. The polygons for the hazards have to be prepared according to the methodology shown in D3.3 and uploaded by the admin user (see Annex C). Expert users can create between 1 to 5 scenarios for assessment and select the hazards relevant to each site.

The interaction between different post-mining, technical or natural hazards is defined by assigning interaction levels (Low = 1, Medium = 2, High = 3) and positioning hazard boxes to represent these interactions. Once the configuration is complete, a map with the normalized Multi-Hazard Index (values from 1 to 9) is generated, indicating the level of risk in the area. As part of the PoMHaZ project, the consortium designed an interaction matrix that captures dependencies between post-mining hazards and between post-mining and natural hazards. This matrix serves as a practical guideline for formulating hazard scenarios and for assigning consistent interaction levels. In the interface, these recommendations are revealed by overlaying the recommendation box.

Export Options: After completing the Multi-Hazard Assessment, users can export the generated hazard map as a .TIF file using the "Download" button.

Step-by-step procedure (see Figure 3).

1. **Select Scenarios**:
    - Choose between 1 to 5 scenarios you want to assess in the sDSS.
    - Based on the different scenarios, choose the hazards to evaluate.
2. **Hazard Interaction**:
    - For each hazard, indicate its interaction with others by assigning interaction levels:
        - 1 (Low)
        - 2 (Medium)

- 3 (High)

- Drag and position hazard boxes to define the chain of interactions (from left to right).

3. **Submit**:
   - Once hazards and interactions are defined, submit the configuration.
   - A map with the normalized Multi-Hazard Index (values from 1 to 9) will be generated, indicating the level of risk in the area (see Figure 4).

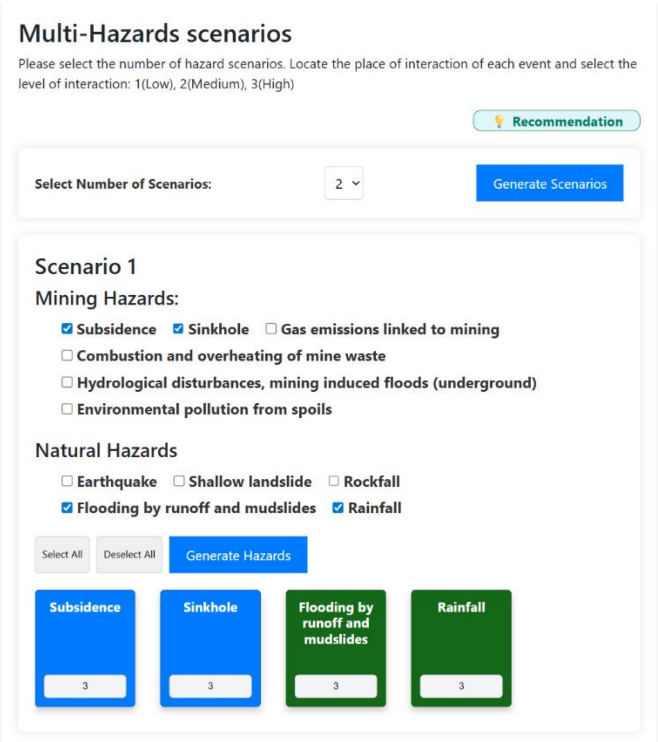

Figure 3: Example of generation of hazard scenarios with Ruhr study case

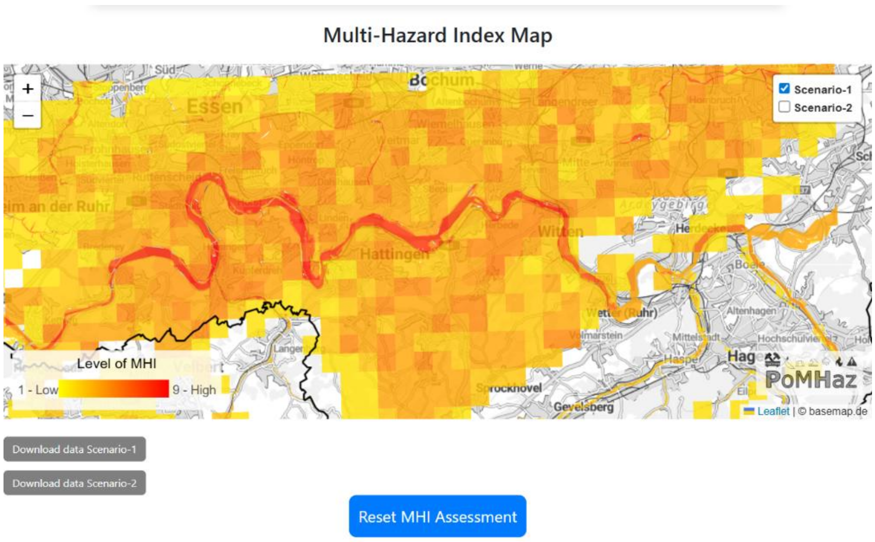

Figure 4: Visual representation of the selected hazards on the case study map

Module II: Exposure Assessment

This module assesses the elements at risk within the selected area base on different classes of the Land Use/Land Cover (LU/LC) 10x10m map derived from Esri's global map ESA Sentinel-2 imagery.

The expert user can assign significance levels to each class, ranging from low to very significant (1 to 9), and submit these weights to reclassify the LU/LC map. The system then generates a risk map indicating the level of exposure from very low to very high.

Export Options: The reclassified land use/land cover risk map can be exported as a .TIF or .SHP file by clicking the "Download" button provided in the module.

Step-by-step procedure (see Figure 5).

1. **Generate Matrix**:
   - View available classes of the Land Use/Land Cover (LU/LC) 10x10m map developed by derived from an Esri global map ESA Sentinel-2 imagery. This data is uploaded by an admin user (see Annex C).
2. **Weight Classes**:
   - Assign a significance level to each class (1 = Low significance, 9 = Very significant).
3. **Submit**:
   - Submit the weights to reclassify the land use/land cover map.
   - The system generates a map displaying the level of risk (1 = Very low risk, 9 = Very high risk) and the base LU/LC, see Figure 6.

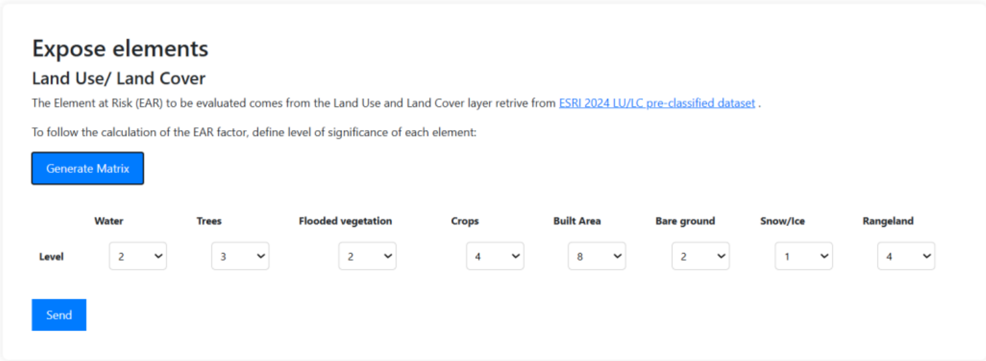

Figure 5: Example of reclassification of LU/LC classes to assess expose element at risk

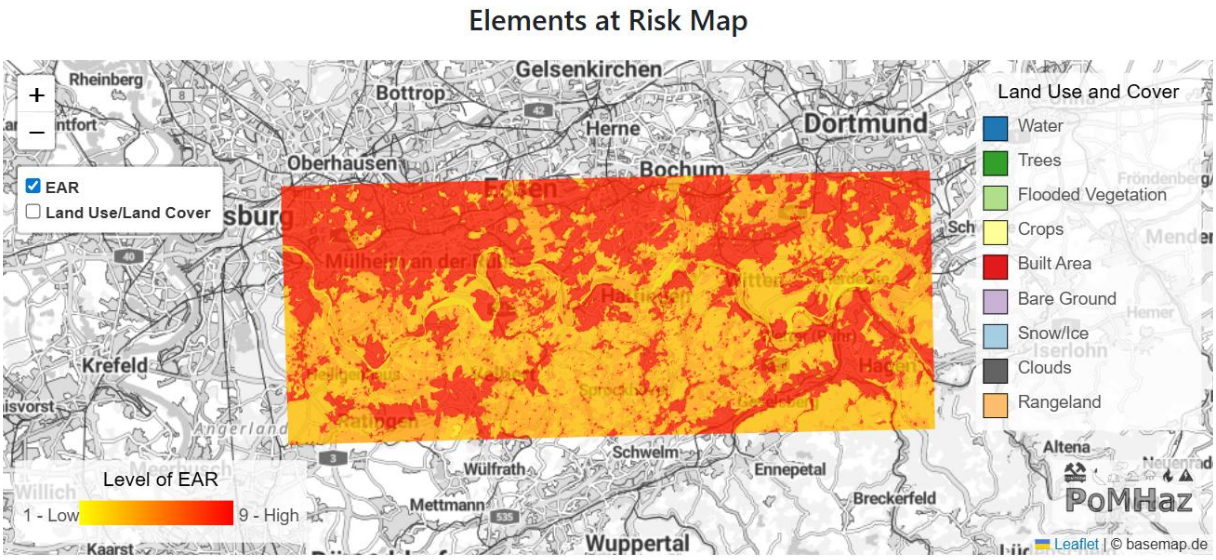

Figure 6: Example of Exposed Elements at Risk (EAR) in the Southern Ruhr area case, screenshot without scale

Module III: Vulnerability Evaluation

Module III focuses on assessing the vulnerability within the study area. Because of the scale of the data available for the socio-economic datasets (Socioeconomic status ,Household composition, Environment) in the Vulnerability Index (VI) calculation (see Annex A), this is done on city-level. The data is prepared by the expert user in the excel spreadsheet (Annex A) and uploaded by the admin user (Annex C).

Users define weight factors by assigning importance levels to each vulnerability indicator (0.1 = Low importance, 1 = High importance). After defining these weights, users can calculate the Vulnerability Index (VI), which is then displayed on an interactive map for easy visualization of vulnerable areas.

Export Options: The calculated Vulnerability Index map can be exported in .TIF or .SHP format by using the "Download" button located within the module.

Step-by-step procedure (see Figure 7).

1. **Define Vulnerability Factors**:
    - Click on "Weight VI Factor" to generate a matrix to assign the importance levels (0.1 = Low importance, 1 = High importance) of each vulnerability indicator.
2. **Calculate Vulnerability Index**:
    - Click "Calculate" to compute the Vulnerability Index for cities in the study area.
    - Results are displayed on an interactive map, see Figure 8.

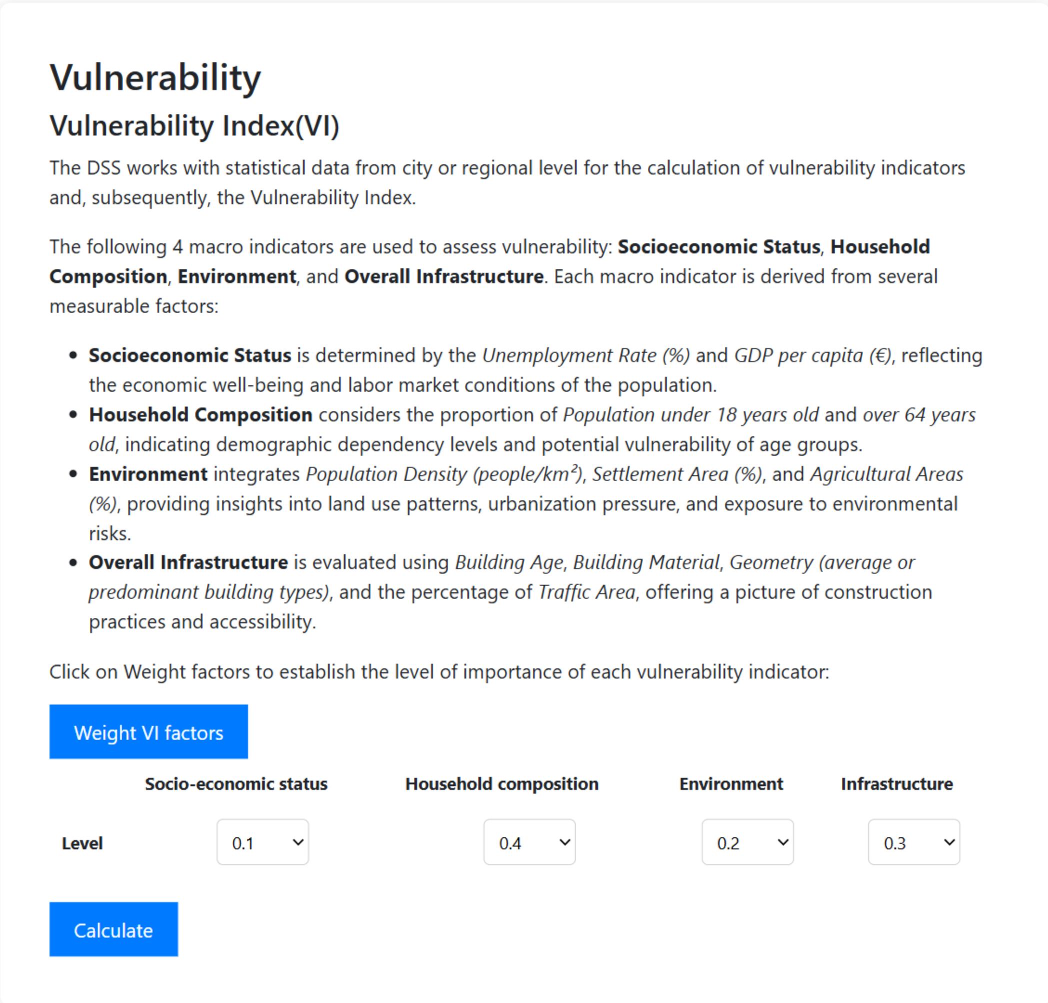

Figure 7: Weighting vulnerability indicators

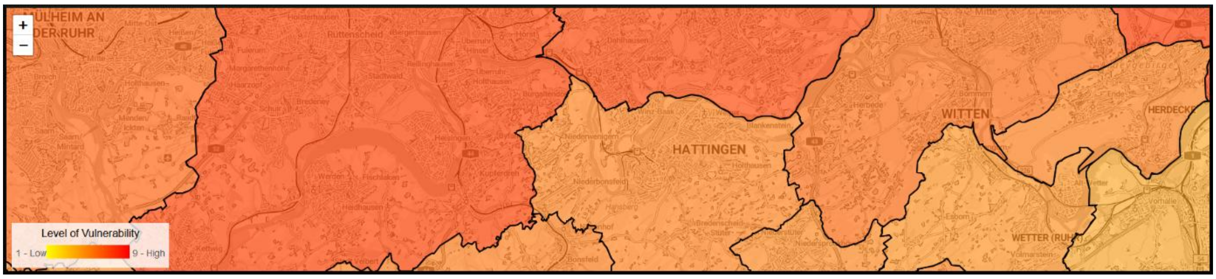

Figure 8: Example of Vulnerability Index in the Southern Ruhr area case, screenshot without scale

Module IV: Integrated Risk Assessment

This module (IV) integrates the outcomes of the previous modules to calculate the overall risk of the selected study case. Users can view the maps corresponding to each multi-hazard scenario, adjust risk levels using sliders (Low, Medium, High), and generate final results. The system then produces downloadable .TIFF files for each scenario with the overall risk results, allowing for further analysis.

Export Options: The spatial risk assessment results for each scenario can be exported as .TIFF files for further analysis by using the "Download" button available in the module.

Additional pages with suggestions for risk evaluation strategies are provided for each risk level. For low-risk areas, monitoring techniques are recommended. Medium-risk areas are addressed with risk mitigation strategies, while for high-risk areas, a guide for land planning approaches is given.

1. **Risk Scenarios**:
    - The risk results are based on the numbers of scenarios defined in the MHI module. Hence, for each MHI scenario, a multi-risk scenario will be calculated.
2. **Definition of Risk Levels**:
    - The definition of risk is established by the integration of the normalized MHI, EAR, and VI factors and classified using a likelihood–impact risk matrix aligned with NIST SP 800-30 into Low, Medium, High classes.

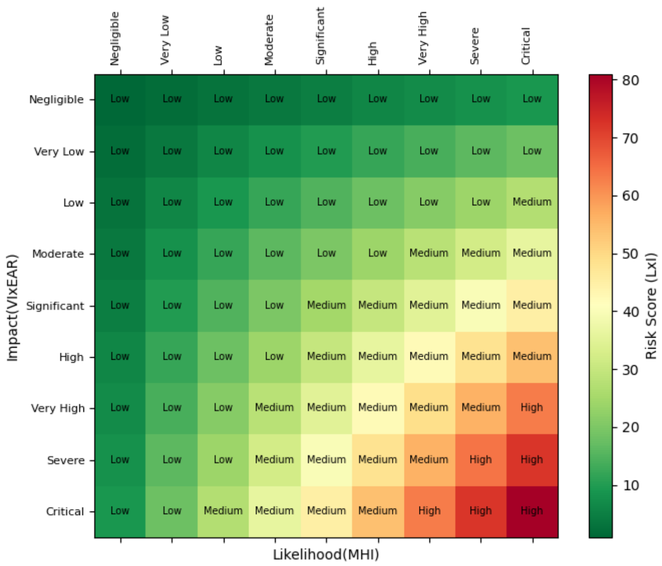

Figure 10. Likelihood-impact risk matrix defining the risk level based on previously normalized factors

3. **Generate Results**:
   - The results of the integration will appear in the map where the user could trigger each scenario and performed a visual inspection.
   - Additional pages with suggestions for risk evaluation strategies are provided for each risk level. For low-risk areas, monitoring techniques are recommended. Medium-risk areas are addressed with risk mitigation strategies, while for high-risk areas, a guide for land planning approaches is given.

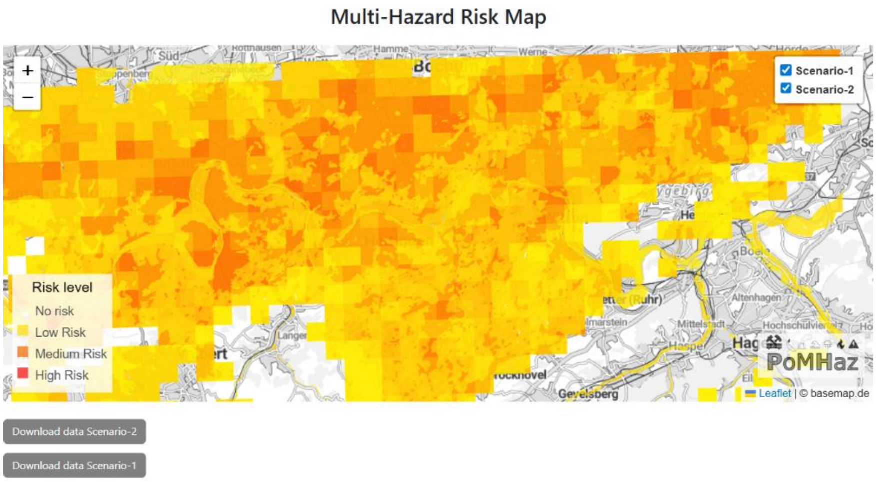

Figure 11: Risk Assessment module with example of Ruhr case

4. **Interactive dashboard**
   - Specific class view: A deeper inspection in each of the risk classes by selecting the corresponding scenario dashboard.
   - Custom risk polygons: Users could draw polygons to evaluate the risk level for any location within the study area.
   - Bring your own data: Upload additional layers by zipping the Shapefile and importing the .zip. The dashboard can then count how many features from the new layer fall inside your risk polygon.

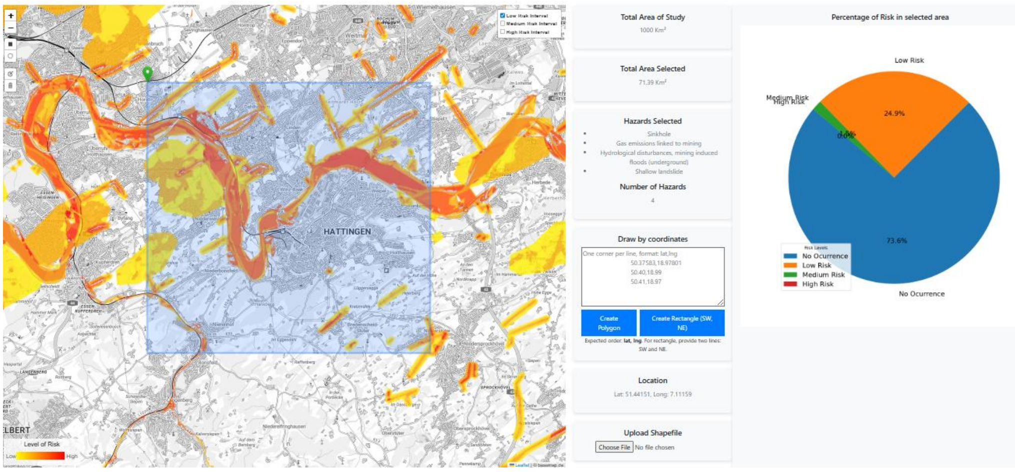

Figure 12: sDSS Interactive dashboard example in Southern Ruhr area

5. Automatic report

For each scenario, you can download an automatic report. It includes a general description of the study area, details of the user-selected hazards, and module-specific outputs based on your selections. The report is designed to make cross-scenario comparison easy and provides deeper calculations with quantitative values for each factor in every module.

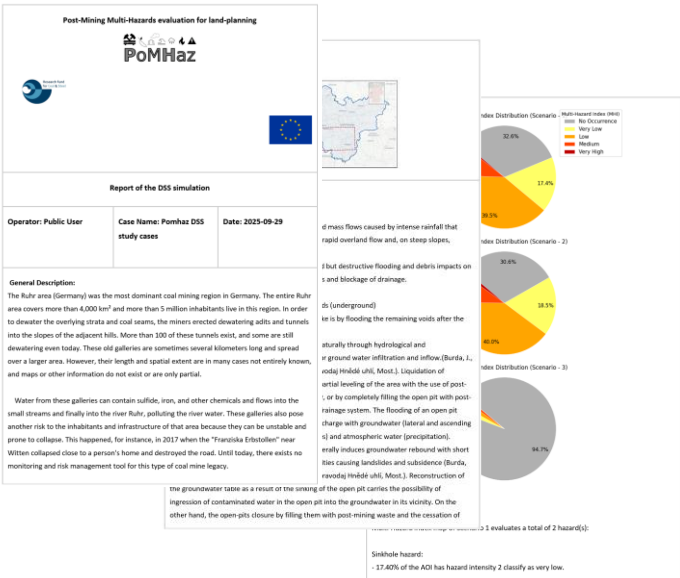

Figure 13. Automatic Report generation based on User's selection

Start New Risk Management Process

This option allows users to initiate a custom risk management analysis with the possibility to upload data for the current studies location of the available study cases or upload a new area of interest to work in a different region (see the Admin Manual). Option available for admin and expert users of sDSS. Please contact your admin of your site study or the technical administrators of the sDSS (vinicius.inojosa@thga.de or benjamin.hazke@thga.de)

Additional Features

Reload Server

- Provides users with the ability to restart the API. This option is located at the end of the API

Interactive Maps

- Visualize results dynamically across all modules.
- Adjust parameters and immediately see the impact on risk assessment for each one of the scenarios

Download Options

- Export maps and raster results of each module in forma .TIF or .SHP using the download buttons

FAQ

This chapter aims to assist users in solving common problems and challenges encountered while using the SDSS API. Below are some frequently encountered issues and their solutions:

1. **Login Problems**
   - **Solution**: Ensure your credentials are correct. If the issue persists, contact the system administrator.
2. **Module Not Loading**
   - **Solution**: Verify your internet connection and try reloading the server using the "Reload Server" button.
3. **Exporting Maps or Results**
   - **Solution**: If export options do not work, ensure that all required inputs are correctly defined in the module.
4. **Risk Assessment module not being performed**
   - **Solution:** The Risk Assessment module is only executed if all preceding risk factor modules are completed successfully. This is because the final risk assessment integrates information from all these modules to generate comprehensive results. Ensure that each module is processed correctly before proceeding to the Risk Assessment module.