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D5.4

Software package and user guide for multi-hazard and multi-risk scenario generation

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D5.4/ Software package and user guide for multi-hazard and multi-risk scenario generation

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Abstract

This deliverable presents the MYRIAD-EU Multi-Risk Toolkit - a modular, open-source software platform developed under Work Package 5 to support comprehensive multi-hazard and multi-risk scenario generation.

Designed to address the complexity of systemic risk in a changing climate, the toolkit enables quantitative, semi-quantitative, and qualitative assessments across hazards, sectors, and geographies. Through its web-based interface and integrated QGIS plugin, the software empowers users to explore cascading impacts, test mitigation strategies, and support decision-making with evidence-based risk insights. This was one of the key findings as part of WP5, that only quantitative modelling cannot fully encompass the needs of sectors towards multi-risk.

The toolkit comprises core analytical modules including the Curve Explorer, Exposure at Risk, Scenario Calculator, Scenario Showcase, and the Vulnerability Index Editor. These allow users to visualise vulnerability functions, assess sectoral exposure, simulate risk under concurrent or sequential hazards, and generate spatial vulnerability indices. Complementary observatories, such as the EU Tourism Resilience Observatory, further extend the toolkit's application to destination-specific risk profiling and sectoral solutions, specifically for tourism.

Integration with datasets and concepts from across MYRIAD-EU (WPs 1–4, 6) ensures alignment with state-of-the-art risk science and stakeholder-driven methodologies.

The user guide, included in this deliverable, provides detailed operational support for deploying and applying the toolkit in research and policy settings. It includes setup instructions, methodological background, user workflows, and guidance on future extensibility. Future enhancements will focus on improving sectoral data coverage, dynamic vulnerability integration, and long-term usability. The toolkit is accessible via www.myriad-multirisk.eu and maintained by Risklayer to ensure ongoing relevance beyond the project duration.

Dissemination level of the document

☒Public

☐Restricted to other programme participants (including the Commission Services)

☐Restricted to a group specified by the consortium (including the European Commission Services)
☐Confidential, only for members of the consortium (including the European Commission Services)

Version History

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1 Purpose of the Deliverable and Introduction

1.1 Objective

The **MYRIAD-EU software** developed under **Work Package 5 (Multi-Risk Scenario Modelling and Quantification)** serves as an interactive, modular tool designed to support the **quantification of multi-hazard and multi-risk scenarios**. Its core objective is to enable users—such as scientists, decision-makers, and planners—to model complex interactions between multiple natural hazards and cascading risks, and to evaluate their direct and indirect impacts on society, infrastructure, and the environment.

The software allows users to:

- Use synthetic and historical multi-hazard event sets.
- Quantify risk using probabilistic, exposure-at-risk and scenario-based approaches.
- Incorporate exposure, vulnerability, and hazard data from across MYRIAD-EU work packages.
- Provide quantitative, semi-quantitative and qualitative results for current and future events.
- Visualise results and support evidence-based disaster risk reduction strategies.

The **user guide** provides a comprehensive explanation of the software's functionality, structure, and methodologies. It serves to:

- Assist users in navigating and applying the software effectively.
- Clarify how the software integrates various datasets and modules from other WPs.
- Explain the scientific assumptions, step-by-step workflows, and outputs.
- Support stakeholders and researchers in conducting transparent and reproducible multi-risk assessments.

The **purpose of the WP5 software deliverable** is to provide a functional prototype (and final release) of the MYRIAD-EU multi-risk modelling tool, along with detailed documentation that reflects the scientific framework developed throughout the project.

Specifically, the deliverable:

- Demonstrates the practical implementation of WP5 methodologies in a usable format.
- Supports cross-WP integration by operationalising insights from WP1–WP4 and linking with decision-making processes in WP6.
- Enables piloting of multi-risk assessments in selected case study regions, supporting the co-development of risk-informed pathways.
- Contributes to MYRIAD-EU's broader mission of **transforming Europe's risk management paradigm by enabling holistic, cross-sectoral, and forward-looking disaster risk analysis**.

Ultimately, this deliverable ensures that the scientific innovations of WP5 are translated into actionable tools for researchers, policymakers, and practitioners working at the intersection of climate adaptation, civil protection, and sustainable development.

1.2 Existing work within MYRIAD-EU which interacts with WP5 software

WP1 (Diagnosis and State-of-the-Art)

WP1 underpins the WP5 Software by supplying essential data inputs and state-of-the-art insights that shape the development of realistic multi-hazard scenarios. Information on data availability and

methodological advances from WP1 ensures that the WP5 Software is grounded in current scientific understanding. In particular, the Disaster Risk Gateway developed in WP1 serves as a reference point within the WP5 Software, enabling users and stakeholders to better understand the terminology, methodologies, and analytical tools employed throughout the risk modelling process.

WP2 (Framework and Guidance Protocols)

The WP5 Software directly applies the frameworks and protocols established in WP2 to structure the generation of hazard event sets and risk quantification processes. This ensures consistency with project-wide methodological standards. The software reflects the stepwise structure of WP2's framework, including System Definition, Direct and Indirect Risk Characterisation, Risk Evaluation, and Future System State Assessment. Chapter 5 of the user guide demonstrates how the WP5 Software implements these steps, ensuring alignment with the guidance protocols of WP2.

WP3 (Pilot Studies and Stakeholder Engagement)

Stakeholder feedback and pilot study insights collected in WP3 play a key role in shaping the functionality and usability of the WP5 Software. Tool development is guided by practical needs identified through engagement activities, ensuring that the software outputs are relevant for real-world decision-making. The WP5 Software incorporates feedback mechanisms and has been demonstrated in stakeholder webinars. Additional sessions are planned to gather user input on the interpretability and usefulness of multi-hazard and multi-risk scenario results, including both quantitative and semi-quantitative outputs.

WP4 (Risk Drivers and Dynamic Feedbacks)

The WP5 Software integrates data and insights from WP4 to enrich its modelling capabilities. The Multi-Hazard Events Database informs the software's scenario generation, drawing on historical disaster data and associated risk management responses. The software also embeds dynamic feedbacks and systemic risk drivers identified in WP4, enhancing the realism of simulated hazard interactions and cascading effects. Moreover, the VulneraCity database developed in WP4 is linked within the WP5 Software to provide detailed urban vulnerability information, supporting spatially and thematically refined risk assessments.

WP6 (Disaster Risk Management Pathways Approach)

The outputs generated by the WP5 Software feed directly into WP6, informing the development of adaptive disaster risk management strategies for the pilot regions. Risk scenarios and critical event sequences modelled in WP5 serve as the basis for identifying and evaluating strategic options within the Dynamic Adaptive Policy Pathways for Multi-Risk (DAPP-MR) approach. The storyline-based approach supported by the WP5 Software allows users to explore plausible future trajectories of multi-risk events, linking scenario development with long-term policy planning in WP6.

2 Main Scientific Developments

2.1 Introduction and User Setup

2.1.1 Introduction

The MYRIAD-EU Software Multi-Risk Toolkit is a modular and extensible web-based application that supports integrated multi-risk assessment across diverse hazard types and geographic regions. Designed for researchers, analysts, and policy practitioners, it provides a unified environment for quantifying, visualising, and comparing the impacts of different risk scenarios. The platform allows users to import hazard, exposure, and vulnerability datasets; simulate damages; review spatial results; and export insights for communication and policy use.

By bringing together multiple components into a single interface, the Multi-Risk Toolkit bridges key gaps between hazard data, vulnerability understanding, and exposure mapping. It serves both exploratory and operational workflows, supporting climate adaptation planning, disaster risk reduction, and resilience analysis.

The MYRIAD-EU Multi-Risk Toolkit is built upon an open-source architecture and integrates web-based modules with geospatial analysis tools, backend simulation logic, and external plugin support. Core modules include:

- Curve Explorer: for visualising and comparing vulnerability functions across different hazards and asset types.
- Exposure at Risk: for identifying and quantifying exposed assets under specified hazard thresholds.
- Scenario Calculator: for computing physical and economic damage outputs based on simulated hazard events.
- Vulnerability Index Editor: a QGIS-based tool for constructing spatial composite indices using weighted indicators.
- EU Tourism Resilience Observatory: Semi-Quantitative Tourism Destination Resilience Index (TDRI) and Qualitative TDRI Scorecard looking at dimensions of resilience and drivers of tourism risk.
- Advanced Tools: command-line utilities and scripting support for advanced users and large-scale automation.

This guide is intended for technical users, researchers, and practitioners who wish to deploy and use the Multi-Risk Toolkit in an operational or research context. It provides a comprehensive walkthrough of setup procedures, interface functions, analytical capabilities, and export features. Each section includes illustrative screenshots and detailed instructions for reproducibility, designed to complement the support features in the software/web interface.

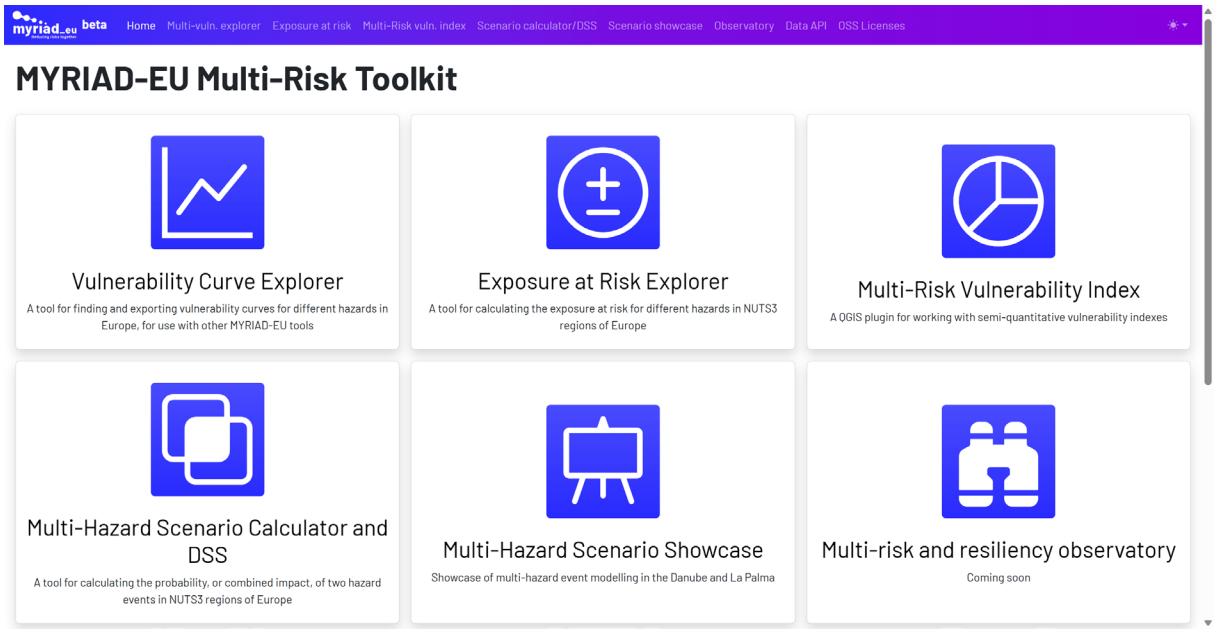


Figure 1: MYRIAD-EU Multi-Risk Toolkit front screen with the various tools.

2.1.2 User Setup

As a first step the MYRIAD-EU Multi-Risk Toolkit, does not need to be set up for users who just want to use the interface. Just go to **www.myriad-multirisk.eu.**

The MYRIAD-EU Multi-Risk Toolkit is also designed for straightforward deployment using Docker, which simplifies setup by packaging all backend services, frontend components, and dependencies into a consistent environment.

For users wishing to work outside Docker (e.g. during development), manual installation is also supported.

Steps (Manual Setup for Development)

Prerequisites

- Docker Desktop (v20.10 or later) and Docker Compose (v1.29 or later)
- Python 3.9+ (if installing manually)
- Node.js and npm (if building frontend manually)
- Git (for cloning the repository)
- QGIS 3.22 or higher (for the Vulnerability Index Editor plugin)

Steps (Docker Deployment)

1. **Clone the Repository**: Run git clone https://github.com/MYRIAD-EU/myriad-Multi-Risk Toolkit.git and change into the project directory using cd myriad-Multi-Risk Toolkit.
2. **Build and Launch the Application**: Run docker-compose up --build to create and start the full system including the API backend, frontend interface, and worker processes.
3. **Access the Application**: Once all containers are running, open a web browser and navigate to http://localhost:3000.

4. **Verify Functionality**: Ensure that key modules (Curve Explorer, Exposure at Risk, Scenario Calculator) are accessible from the interface.
5. **Stopping the Multi-Risk Toolkit**: To shut down the system, use docker-compose down.

Steps (Manual Setup for Development)

1. **Install Backend Dependencies**: Ensure Python 3.9+ is installed and create a virtual environment. Install Python packages from requirements.txt using pip.
2. **Install Frontend Dependencies**: Navigate to the frontend directory and run npm install to fetch required libraries.
3. **Run Services**: Start the backend with python manage.py runserver and run the frontend with npm run dev.
4. **Connect Frontend and Backend**: Ensure both services are running locally and configured to communicate on matching ports.

2.2 Multi-Risk Toolkit Overview

The Multi-Risk Toolkit provides a structured and intuitive interface for navigating between analytical tools. It is designed to accommodate modular use, allowing users to engage with individual components (e.g. Curve Explorer or Scenario Calculator) or conduct integrated workflows.

The main interface consists of a top navigation menu and a dynamic content panel. Modules are loaded into this panel based on the user's selection. The layout is responsive and optimised for wide-screen desktops, although it is functional on tablets.

Each module features specific UI components, such as dropdown selectors, upload fields, filtering sliders, and visualisation canvases. Consistent design principles allow users to quickly adapt to different parts of the platform.

Steps:

1. **Launch the Application**: Open http://localhost:3000 in your web browser after setup. The landing page presents the module selector and welcome interface.
2. **Explore the Navigation Menu**: The topbar (shown in purple) lists all active modules. Click on any module name (e.g., Exposure at Risk) to load the respective interface.
3. **Interact with Interface Components**: Each module includes input panels for selecting or uploading data, control sections for adjusting parameters, and output panels showing maps, graphs, or tables.
4. **Return to Home or Switch Modules**: Use the taskbar/topbar to switch to another module at any time. Modules do not require a full page reload, ensuring a seamless experience.
5. **Inspect Module-Specific Tools**: Each tool provides specialised components such as export buttons, comparison utilities, and filter mechanisms tailored to the module's purpose.

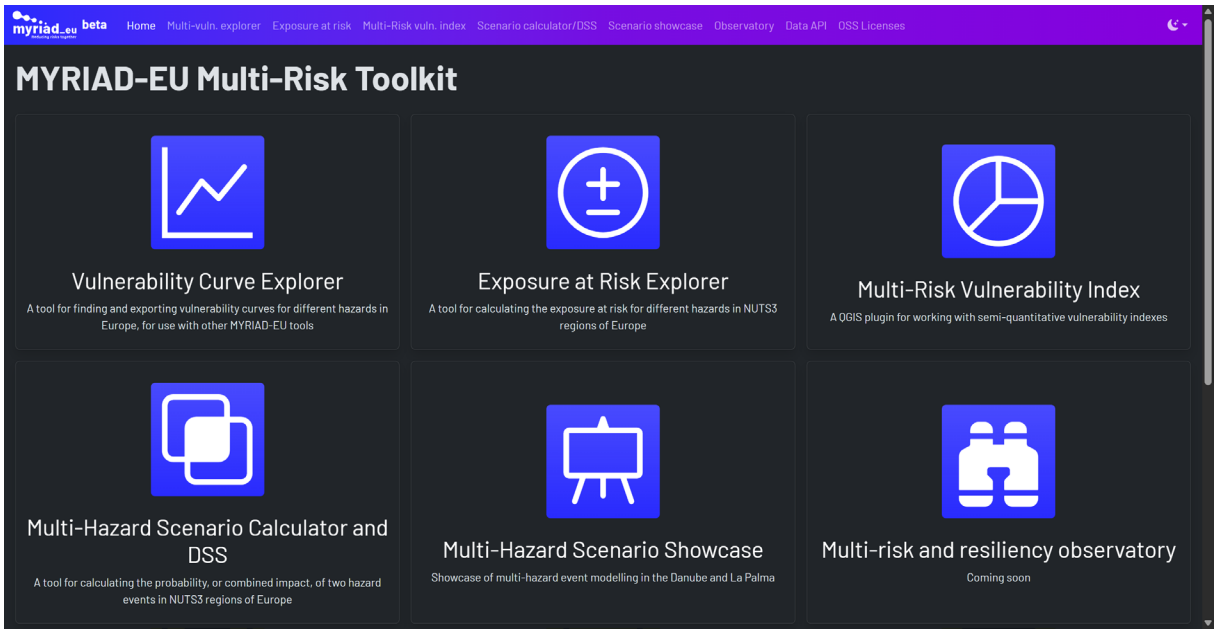


Figure 2: MYRIAD-EU Multi-Risk Toolkit front screen (different colour versions)

The MYRIAD-EU Software Multi-Risk Toolkit provides a customisable environment that allows users to configure settings according to their workflow preferences, data formats, regional standards, and analytical requirements. The platform is designed to adapt to both individual users and institutional deployments, offering configuration options that affect interface language, coordinate reference systems, theming, data persistence, and module behaviour.

This chapter outlines the various user settings available within the Multi-Risk Toolkit, as well as tips for managing personal or organisational configurations efficiently. While many settings can be managed directly through the interface, others may require editing configuration files when deploying a local or institutional version of the platform.

Accessing the Settings Panel

The settings panel can be accessed from the navigation sidebar or the user profile menu located in the top-right corner of the Multi-Risk Toolkit. Upon entry, users will find a series of tabs or collapsible sections that control different aspects of the Multi-Risk Toolkit's appearance and behaviour.

Interface Theme and Display

Users can toggle between a light and dark theme for improved readability depending on their working environment. These preferences are stored in the browser's local storage or user profile, so they persist across sessions.

Additional interface settings include:

- Default zoom extent for maps
- Layer transparency and blending modes
- Sidebar expansion behaviour (collapsed/expanded)
- Tooltip verbosity

Module Defaults and Behaviour

Some modules, such as the Scenario Calculator or Curve Explorer, allow pre-setting default options that streamline repetitive tasks. These may include:

- Preloaded datasets
- Preferred vulnerability curve libraries
- Default hazard intensity units (e.g. water depth in metres, wind speed in m/s)
- Auto-export formats (e.g. GeoJSON, CSV)

Advanced users can configure these defaults in a user profile JSON file or YAML configuration, particularly in institutional deployments.

Saving and Syncing Settings

For users running local instances of MYRIAD-EU, configuration files are typically stored in a settings directory alongside the deployment. In cloud-hosted versions, user preferences are saved in the backend database and associated with login credentials.

Users can export their configuration as a .json or .yml file for backup or sharing. These files can also be loaded during deployment to replicate a familiar environment or deploy consistent settings across an organisation.

Reset and Troubleshooting

If a configuration causes unintended behaviour (e.g. incorrect projections, missing modules), users can reset the Multi-Risk Toolkit to default settings via the Reset button in the settings panel. For persistent errors, manual deletion of stored configurations or server cache may be required.

Administrators deploying MYRIAD-EU for multiple users should also maintain a global settings file that enforces organisational standards while allowing per-user overrides.

In summary, the user configuration system in the MYRIAD-EU Multi-Risk Toolkit ensures that the platform can be tailored to meet the diverse technical, linguistic, and procedural needs of its users. Through thoughtful configuration and profile management, both individuals and teams can optimise the platform for consistent and productive risk assessment workflows.

2.3 Main Parts of the Software

2.3.1 Curve Explorer

The Curve Explorer module is designed for visualising and comparing vulnerability functions used in risk modelling. Vulnerability curves express the relationship between hazard intensity (e.g. flood depth, wind speed) and the expected damage ratio to exposed assets. This module enables users to explore existing curves, add custom functions in the same format, and conduct side-by-side comparisons.

The module supports importing predefined curve libraries or generating curves based on user-specified parameters in the same format. Curves can be customised interactively and saved for use in the Scenario Calculator.

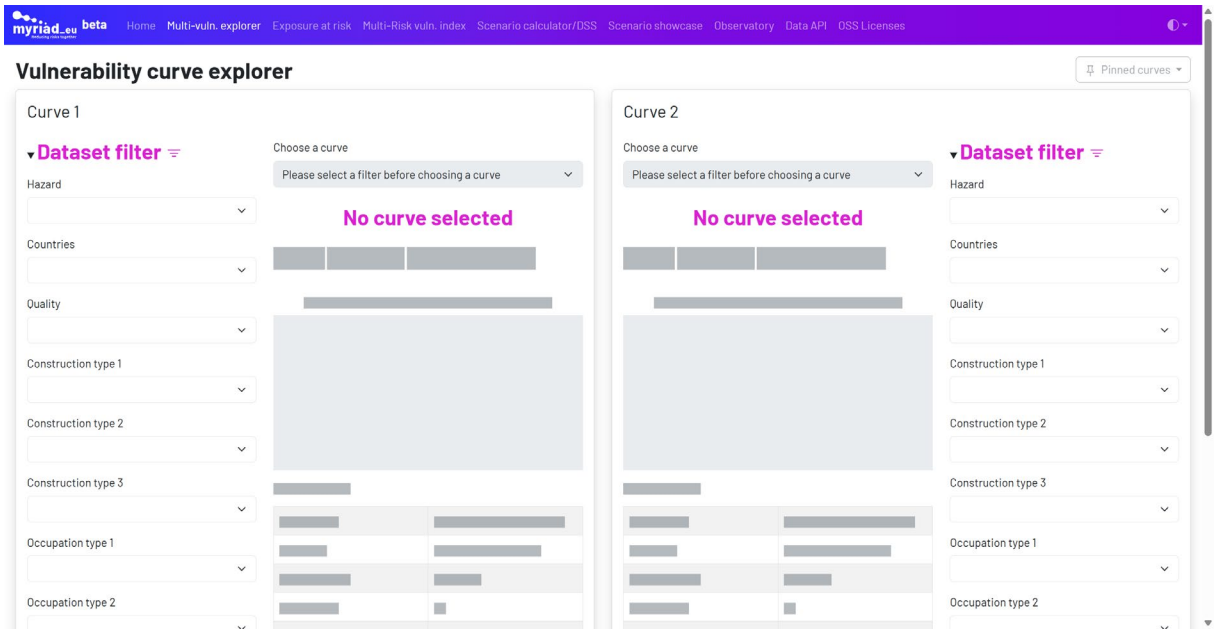


Figure 3: MYRIAD-EU Multi-Risk Toolkit – Vulnerability Curve Editor start screen

Steps:

1. **Open the Module**: From the Multi-Risk Toolkit sidebar, select "Curve Explorer" to load the curve visualisation interface.
2. **Choose Hazard and Asset Types**: Use the dropdown selectors to choose the hazard type (e.g. river flood, coastal surge) and the asset classification (e.g. economic sector or infrastructure).
3. **Load Existing Curves**: Click "Load Curve" to fetch predefined vulnerability functions associated with the selected parameters. The curve appears in the main graph panel.
4. **Add and Compare Multiple Curves**: Use the “Add Curve” button to load additional functions for side-by-side comparison. This helps visualise variation in vulnerability assumptions across sectors or countries.

5. **Edit Curve Parameters**: Modify curve parameters directly via form inputs or sliders. You can adjust thresholds, shape factors, and saturation points to reflect empirical data or theoretical expectations.

6. **Save or Export Curves**: Click “Save Curve” to store your custom curve in the internal library, or use the export function to download it as a JSON or CSV file for integration into the Scenario Calculator or external models.

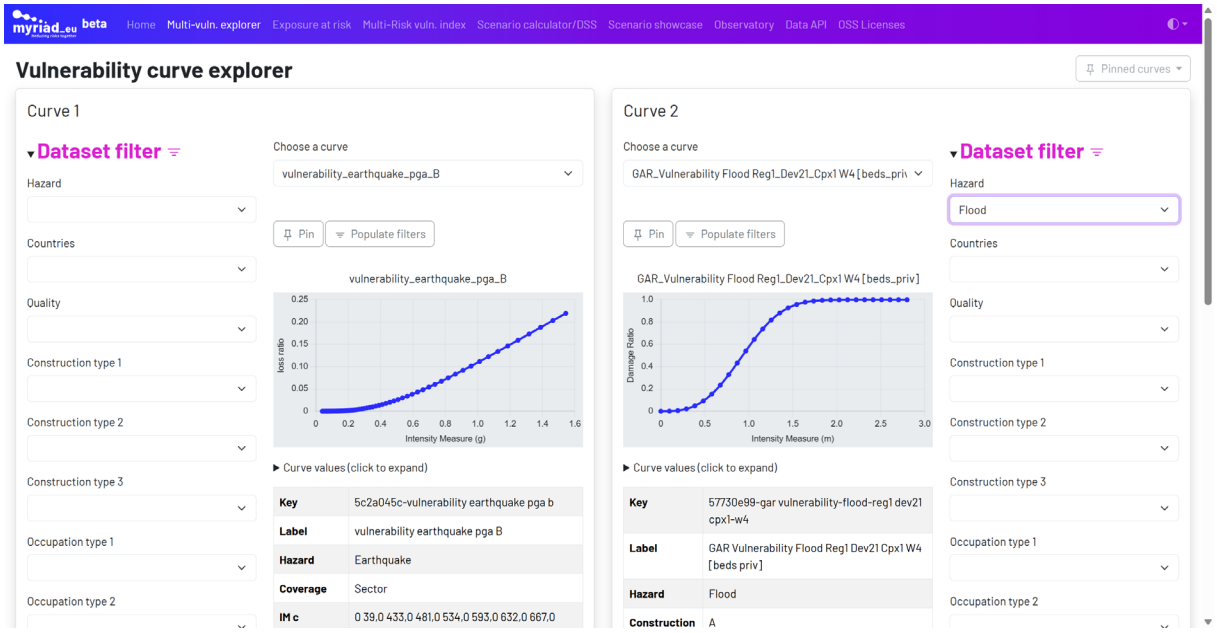


Figure 4: MYRIAD-EU Vulnerability Curve Editor functions

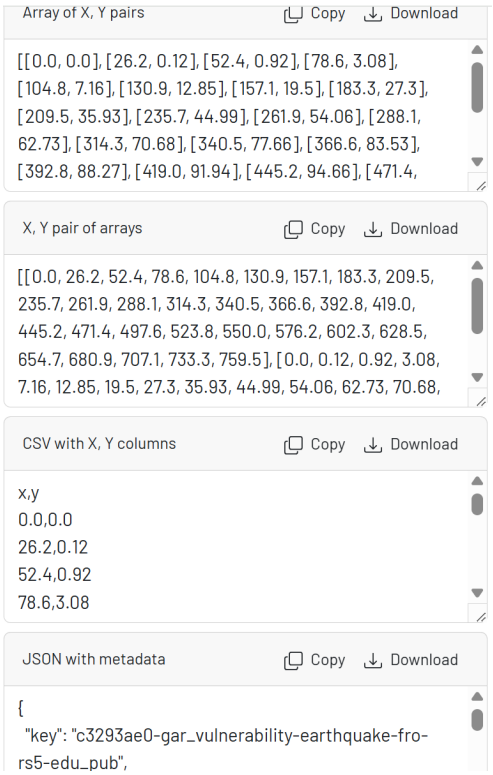


Figure 5: MYRIAD-EU Vulnerability Curve Editor function outputs

2.3.2 Exposure at Risk Module

The Exposure at Risk module allows users to identify and quantify how much of an exposure dataset lies within defined hazard thresholds. This analysis helps determine the scale of assets at risk given a certain event footprint or scenario.

The module supports input layers for exposure (typically buildings, infrastructure, or population datasets) and hazard footprints (e.g. flood depth rasters, wind speed maps). It intersects these spatial datasets using threshold filters to estimate exposed value.

Current or Future scenarios can be explicitly chosen via a click button for temporal choice of indicators.

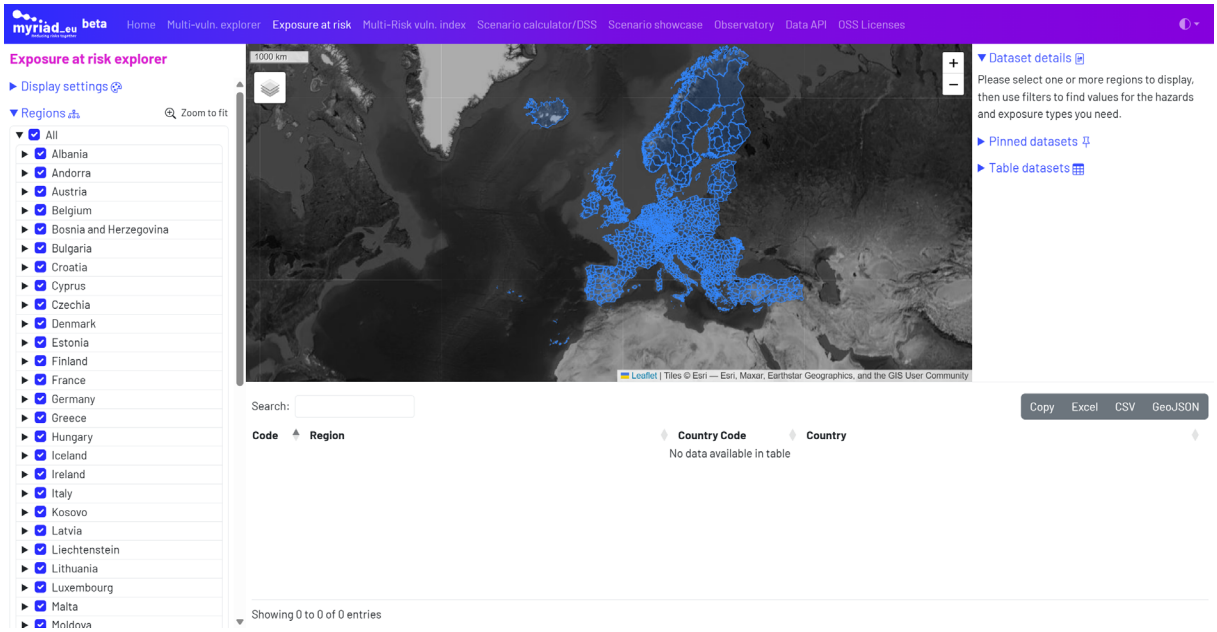


Figure 6: MYRIAD-EU Exposure at Risk starting screen

Steps:

1. **Launch the Module**: Click "Exposure at Risk" in the Multi-Risk Toolkit sidebar. The interface will prompt you to select exposure and hazard layers.
2. **Upload or Select Datasets**: Choose a hazard map and an exposure dataset from the available files or upload your own in supported formats (e.g. GeoTIFF, GeoJSON, Shapefile).
3. **Set Hazard Threshold**: Define a condition for exposure filtering, such as “depth ≥ 0.5m” or “wind speed > 100 km/h.”
4. **Run the Analysis**: Click "Analyse" to intersect the datasets. The system processes the inputs and highlights areas where exposure exceeds the defined threshold.

5. **Review Spatial Output**: View the results on an interactive map with symbology indicating impacted assets or intensity.

6. **Export Results**: Download the filtered exposure layer, summary statistics, or charts in standard formats for reporting or further analysis.

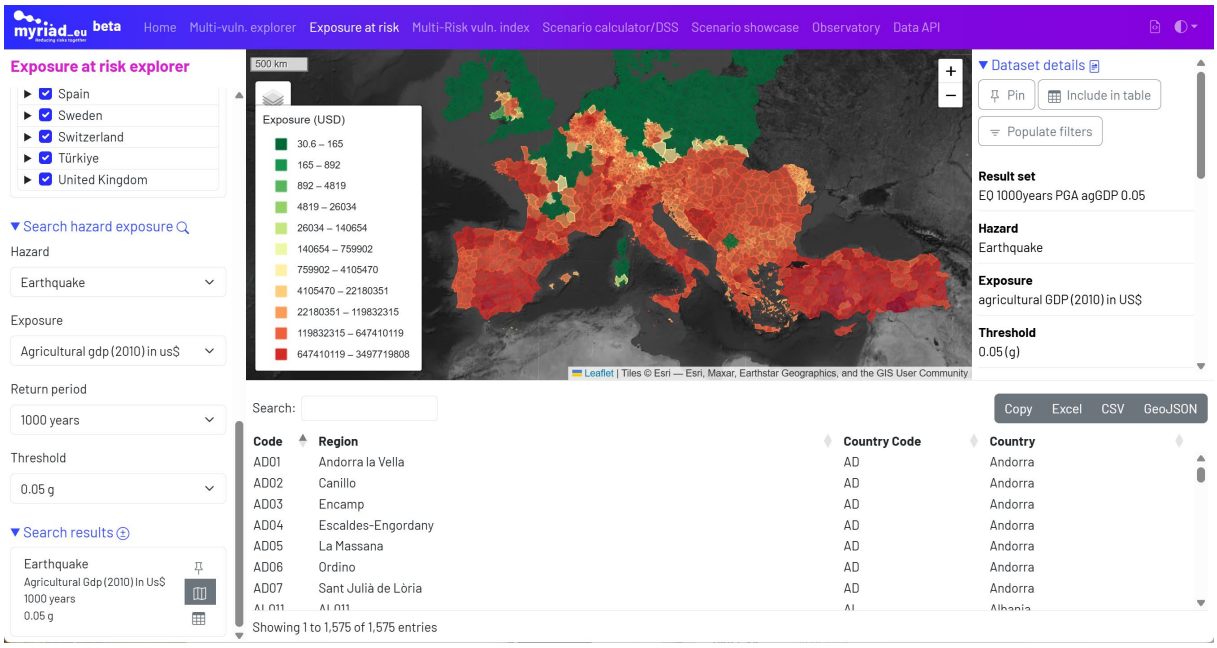


Figure 7: MYRIAD-EU Exposure at Risk output screen

2.3.3 Scenario Calculator

The Scenario Calculator is one of the core modules in the MYRIAD-EU Software Multi-Risk Toolkit. It provides users with the ability to estimate potential losses by integrating hazard intensity maps, spatial exposure datasets, and associated vulnerability functions. This simulation tool is essential for decision-makers and risk analysts aiming to quantify economic and physical damages under hypothetical or observed hazard scenarios.

The Scenario Calculator operates by applying vulnerability curves to intersected exposure and hazard data. Each exposure asset or pixel is assigned a damage ratio based on the intensity of the hazard at its location and the relevant vulnerability curve. These ratios are then multiplied by asset values to compute losses. The module is capable of processing multiple hazard layers and exposure types in a single run, facilitating rapid scenario comparison.

Users can generate visual outputs in the form of choropleth maps, bar charts, and data tables summarising key metrics such as total losses, affected assets, and average damage ratios. These outputs can be downloaded for external analysis or used to compare the effectiveness of various mitigation strategies.

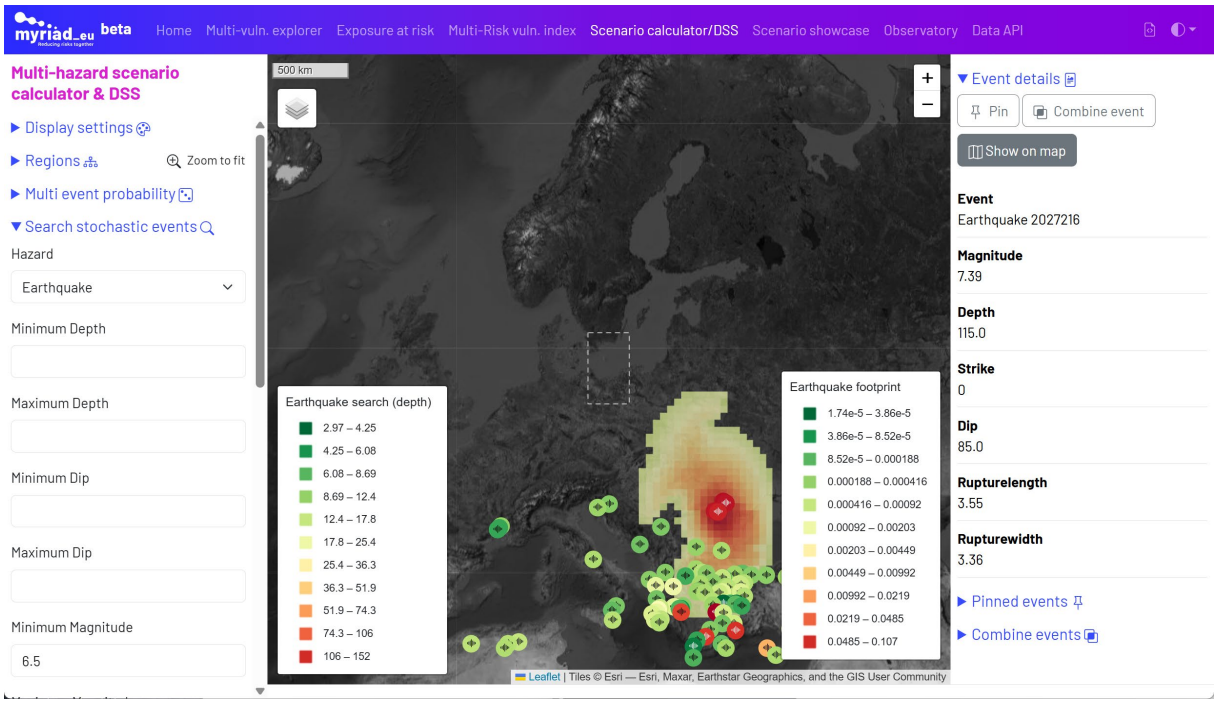


Figure 8: MYRIAD-EU Risk Scenario Calculator screen

Steps:

1. **Open the Scenario Calculator**: Navigate to the Scenario Calculator module from the Multi-Risk Toolkit. Wait for the interface to initialise, which will include input selectors and a central map panel.
2. **Select or Upload Hazard Layers**: Choose a hazard intensity raster (e.g. flood depth, wind speed) from previously uploaded data, or upload a new GeoTIFF file. Ensure that the spatial resolution and CRS are compatible with your exposure data.
3. **Select Exposure Datasets**: Choose the corresponding exposure layer (e.g. building footprints with asset values). The layer must contain spatial geometry and a numeric field representing replacement or economic value.
4. **Assign Vulnerability Curves**: For each asset type present in the exposure dataset, assign a vulnerability curve. This determines how the hazard intensity will translate to a damage ratio.
5. **Configure Scenario Parameters**: Specify additional scenario details, such as scenario name, loss type (e.g. structural vs. content loss), and desired aggregation level (e.g. by administrative unit or grid).
6. **Run the Simulation**: Click the “Simulate” or “Run Scenario” button. The system will process the input layers, apply the vulnerability functions, and generate loss outputs. This may take several minutes depending on data size.
7. **Review the Results**: View summary statistics such as total economic loss, number of affected assets, and average loss ratio. These will appear in tabular format and can be sorted or filtered by asset type or region.

8. **Visualise Loss Outputs**: Use the interactive map to display spatial patterns of loss. You can switch between absolute losses, damage ratios, or scenario comparisons. Zoom and pan to explore high-impact areas.

9. **Export Scenario Outputs**: Download loss maps (PNG/SVG), tables (CSV), and scenario configuration files (JSON) for further reporting or to rerun later.

10. **Compare Multiple Scenarios**: Use the comparison tools to load and contrast multiple simulated scenarios side by side. This is particularly useful for evaluating the sensitivity of results to changes in hazard intensity or mitigation assumptions.

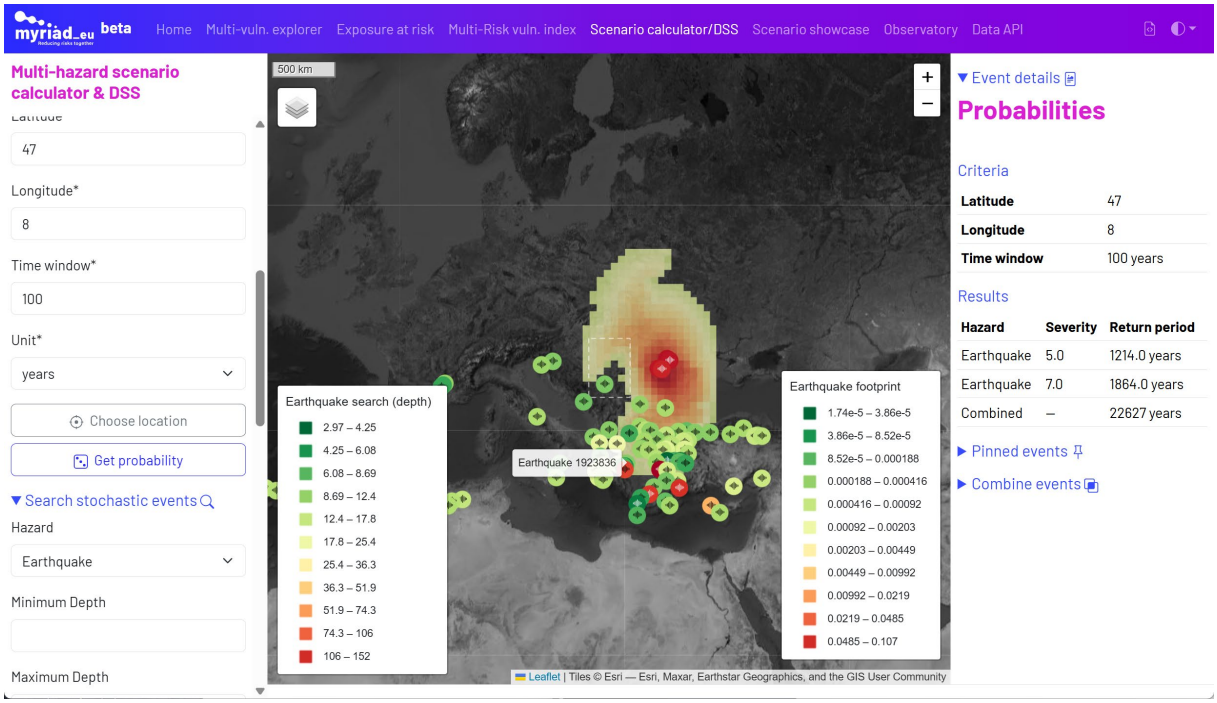


Figure 9: MYRIAD-EU Hazard Scenario – concurrent probability of hazards for time period overlaps

2.3.4 Scenario Showcase and DSS

The DSS (Decision Support System) tool is currently being developed in order to allow users to see results of multi-hazard risk results produced as part of the MYRIAD-EU project.

In the scenario showcase, users can choose the results of certain event combinations for extraction and visualisation. The DSS provides a useful interface for choosing what is possible in terms of analysis from different EU projects. MYRIAD-EU was only able to produce a limited number of risk results for Europe given that it was not designed to be exhaustive in terms of types of hazard, exposure and methods. However, there are a myriad of other projects have produced risk results, and thus these are used in order to provide a useful view as to what can be used from other projects i.e. taking a MYRIAD-EU dataset, plugging it into the CLIMAAX engine, and then returning to MYRIAD-EU to look at the multi-risk editor. The MYRIAD-EU Datasets are those found here:- https://drive.google.com/drive/u/1/folders/1IBNhD9oVeVrEqI-a5SdPpSXq5ExcX2XA which include scenario risk results for Danube, exposure-at-risk results etc.

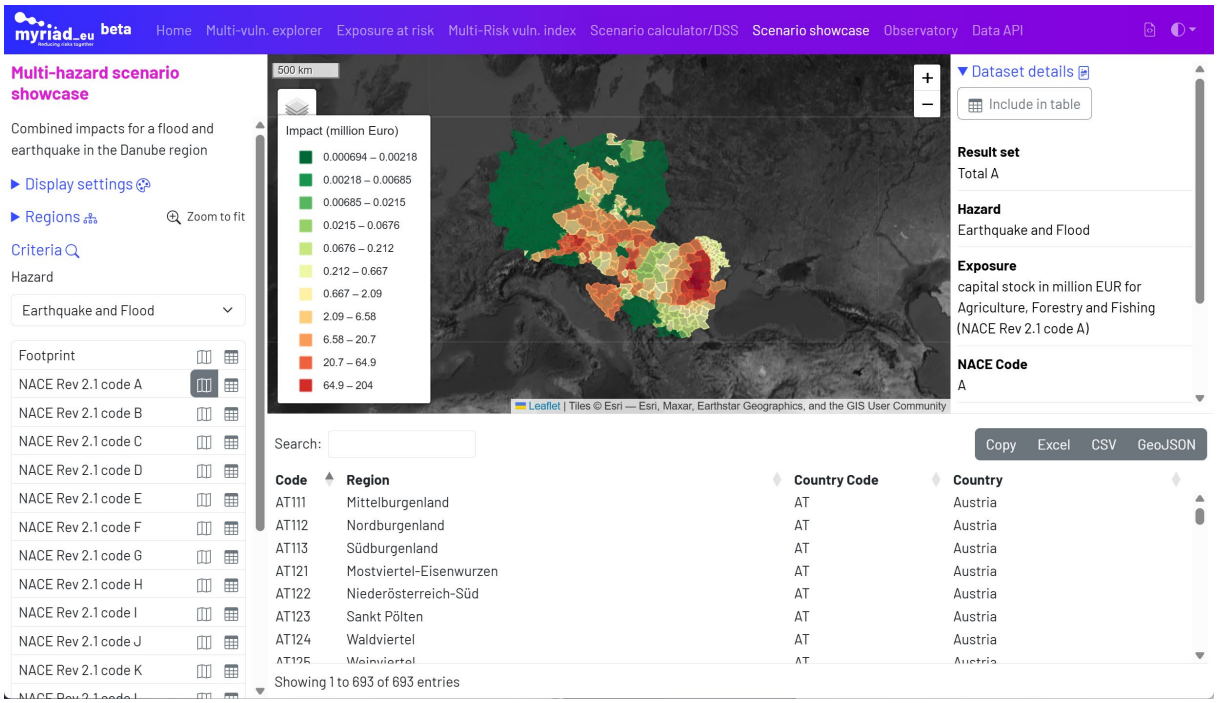


Figure 10: MYRIAD-EU Scenario Showcase – Earthquake and Flood overlapping scenario with risk results

2.3.5 Vulnerability Index Editor

The Vulnerability Index Editor is a QGIS plugin included in the MYRIAD-EU ecosystem, designed for constructing spatially explicit indices of vulnerability across administrative units or grid cells. This tool is ideal for researchers and analysts who need to evaluate relative vulnerability based on multiple socio-economic, environmental, or infrastructural indicators. Rather than being accessed through the web Multi-Risk Toolkit, the tool functions within the QGIS environment, providing tight integration with geospatial data and powerful map-based interactivity.

Originally developed by the World Bank, the City Disaster Vulnerability Index (MRVI) plugin is a QGIS plugin which allows a user to generate and adjust custom vulnerability indexes in connection with geospatial data. It has been customised in the MYRIAD-EU project to become the Multi-Risk Vulnerability Index plugin (MRVI).

The index editor allows users to define custom indicators, assign relative weights, select normalisation methods, and aggregate results into a single composite index. Output layers can then be visualised in QGIS or exported for integration with the Scenario Calculator or Exposure at Risk modules in the Multi-Risk Toolkit.

Some of the other tools in this suite have been developed to allow you to share data with this plugin. For example, you can export GeoJSON files from the Exposure at Risk tool, which includes NUTS3 regions and corresponding vulnerability data for each region. These files can then be imported into QGIS and the data used within the plugin.

Steps:

Install and Enable the Plugin: Open QGIS and install the Vulnerability Index Editor plugin either from the Plugin Manager (if available) or manually by copying the plugin folder into your QGIS plugins directory. Restart QGIS and activate the plugin.

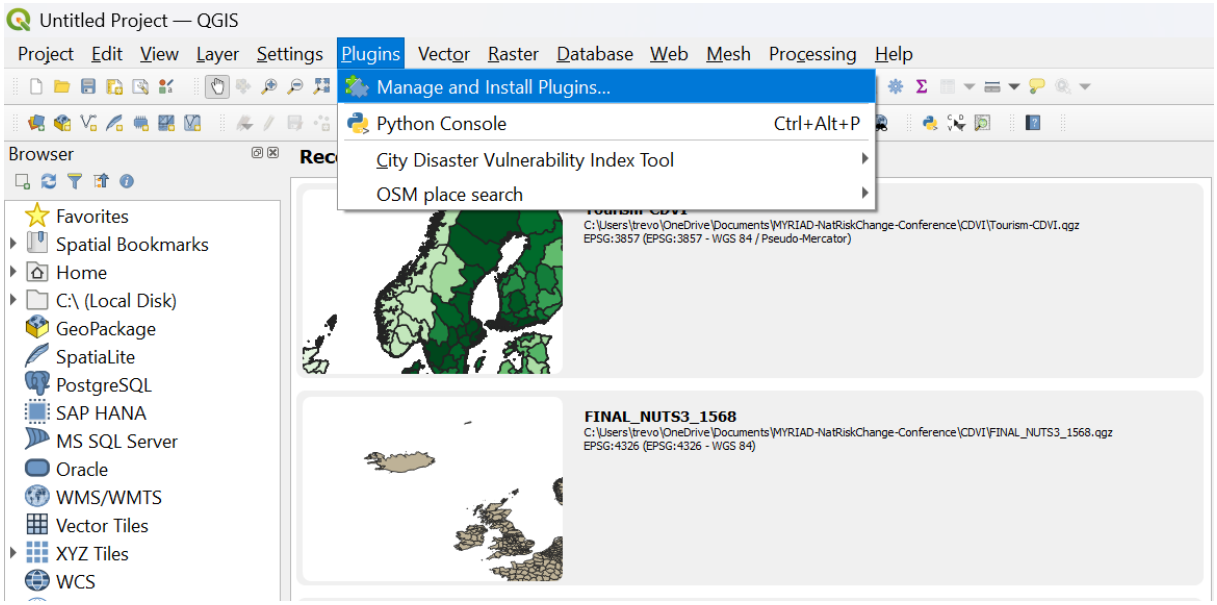


Figure 11: Starting screen in QGIS

To install the MRVI plug-in, navigate to Plugins > Manage and Install Plugins

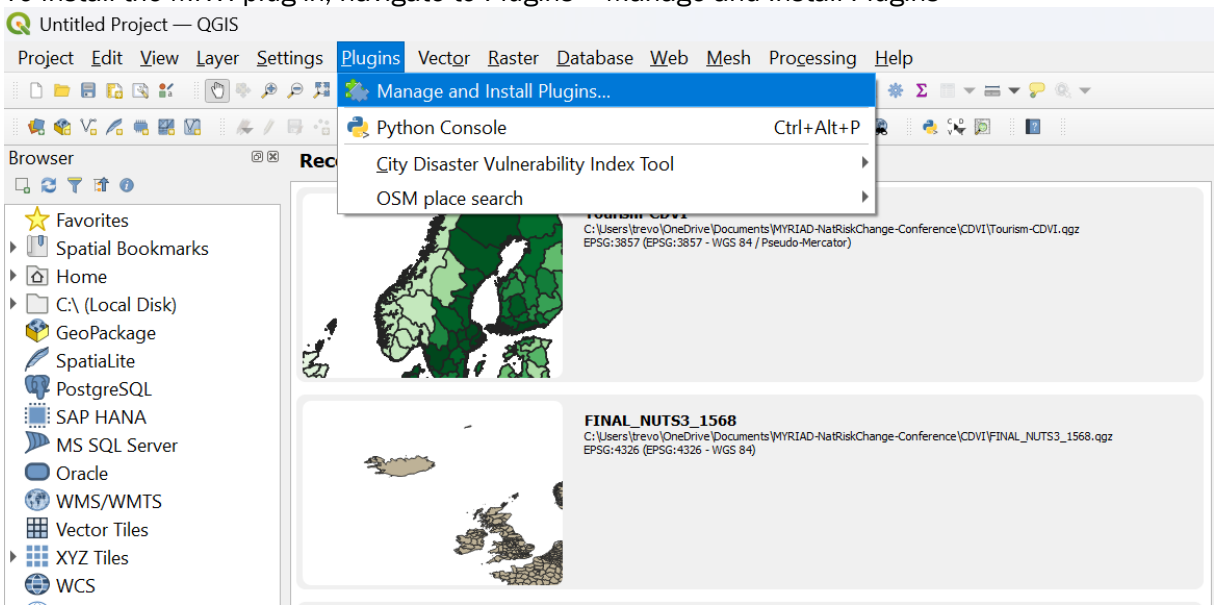


Figure 12: Navigating to MRVI Plugin in QGIS

Select “Install from ZIP”. Navigate to the zip file you downloaded from the platform and click “Install plugin”. Congratulations, the plugin is now ready to use.

Open the MRVI plugin by navigating to Plugins > City Vulnerability Index Tool

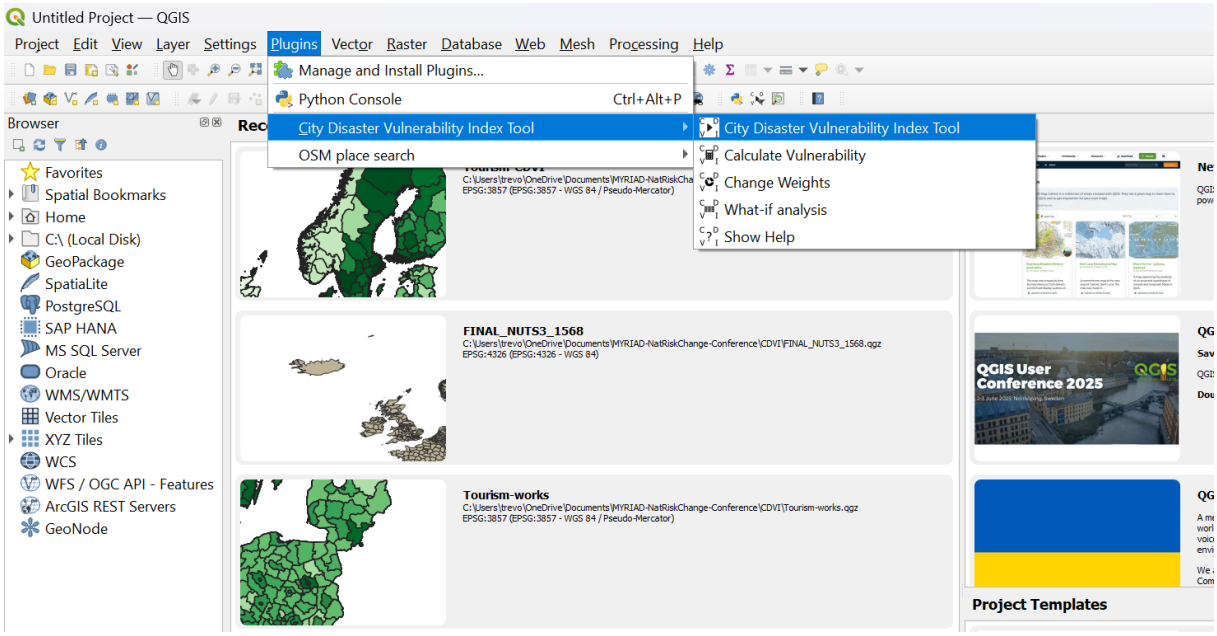


Figure 13: MRVI Plugin options in QGIS

Select the region, e.g., Europe, and enter the sector. Click “Additional indicators” to select individual indicators.

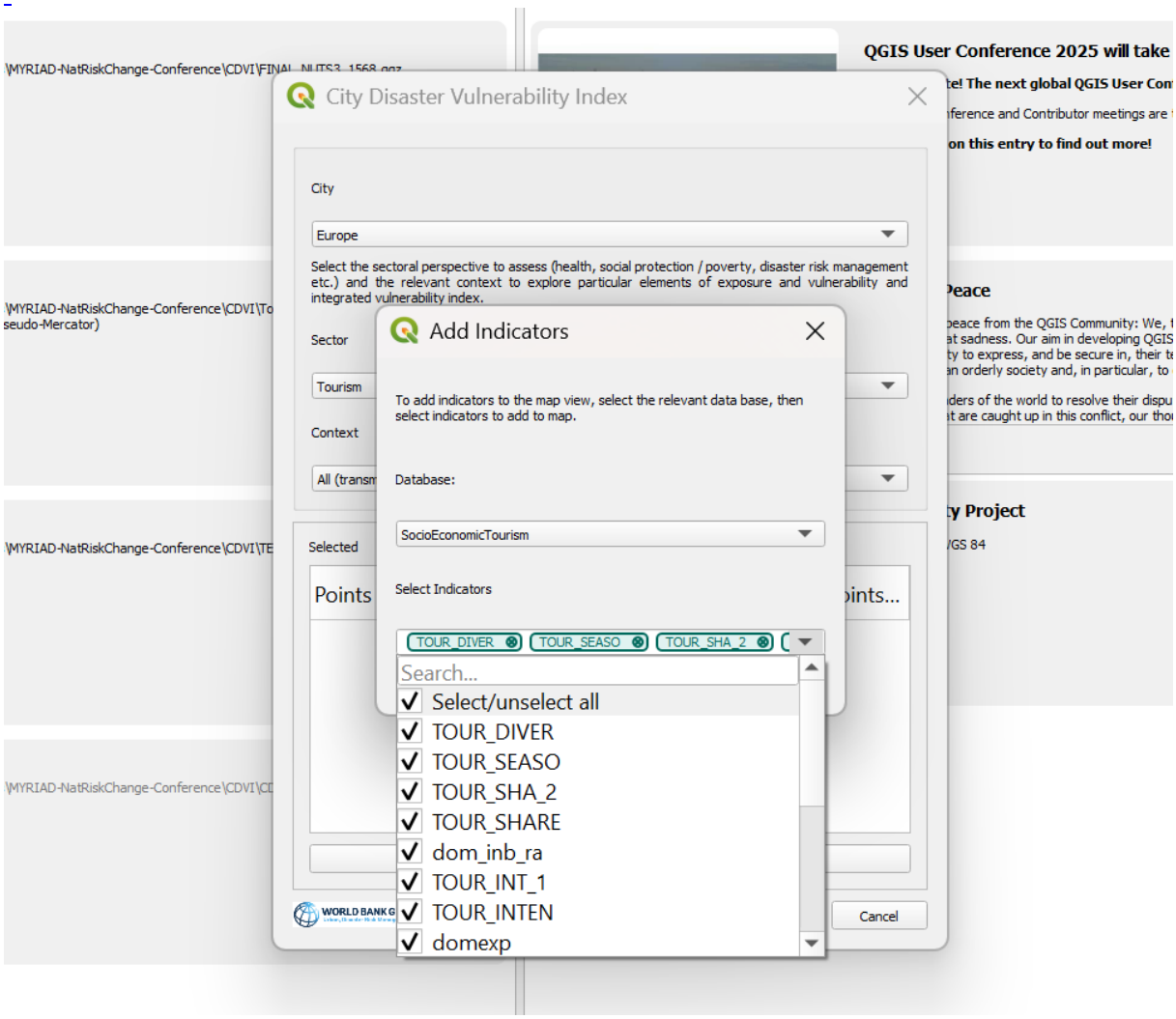


Figure 14: Choosing the Tourism indicators within QGIS in the plugin

To change weights, navigate to “Change weights”.

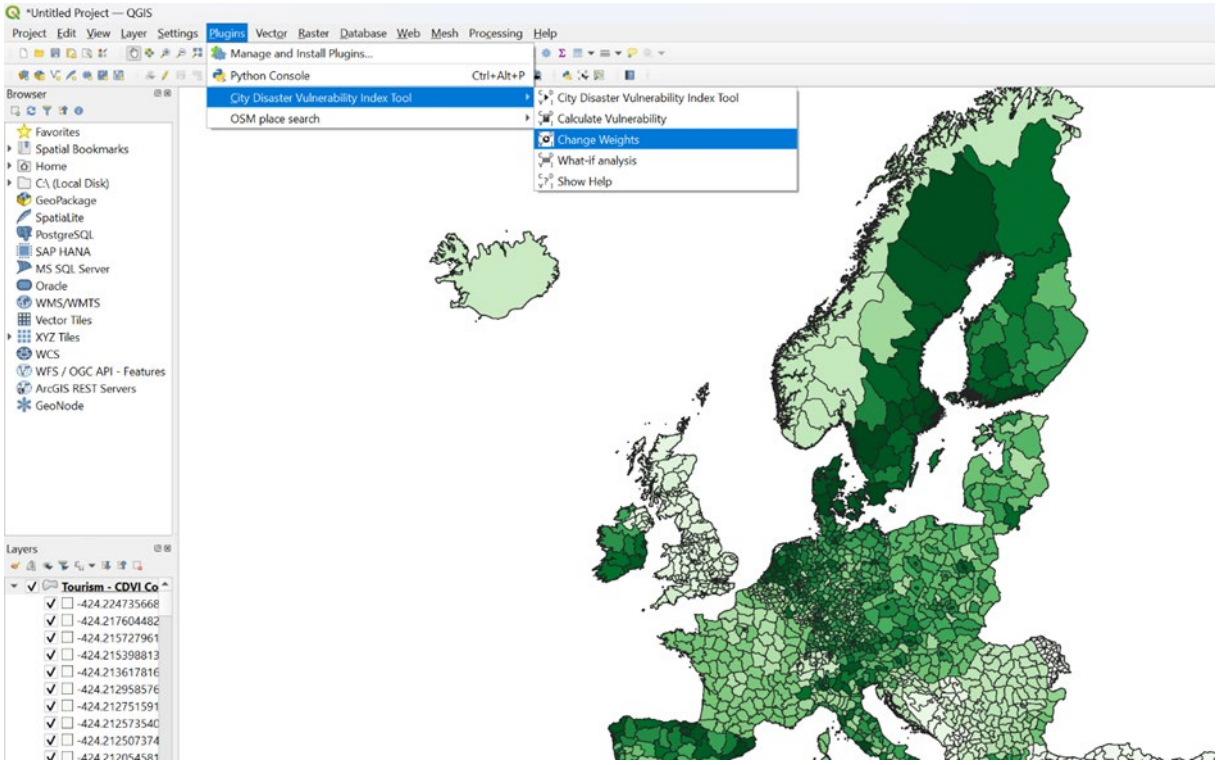


Figure 15: Changing weights within the plugin

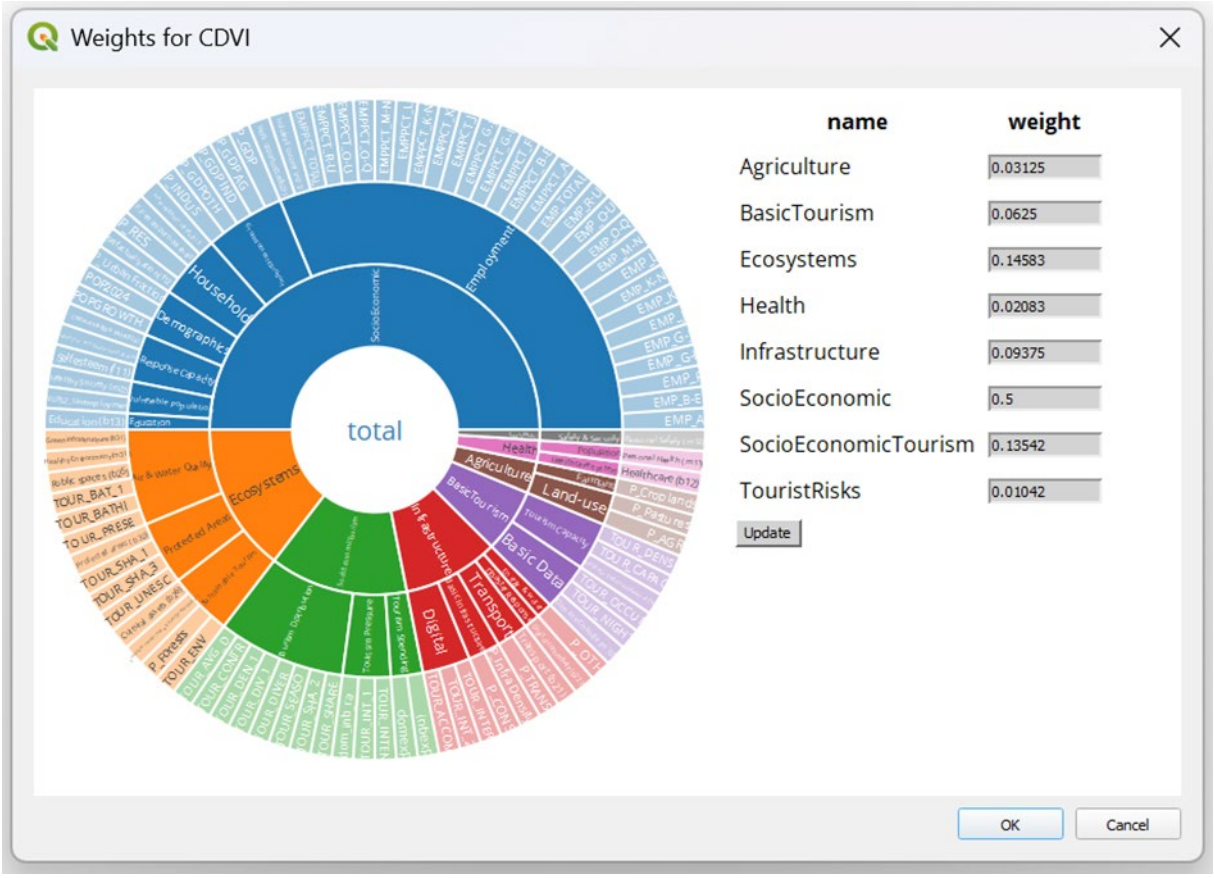


Figure 16: Changing weights in the interface to choose different weightings of indicators

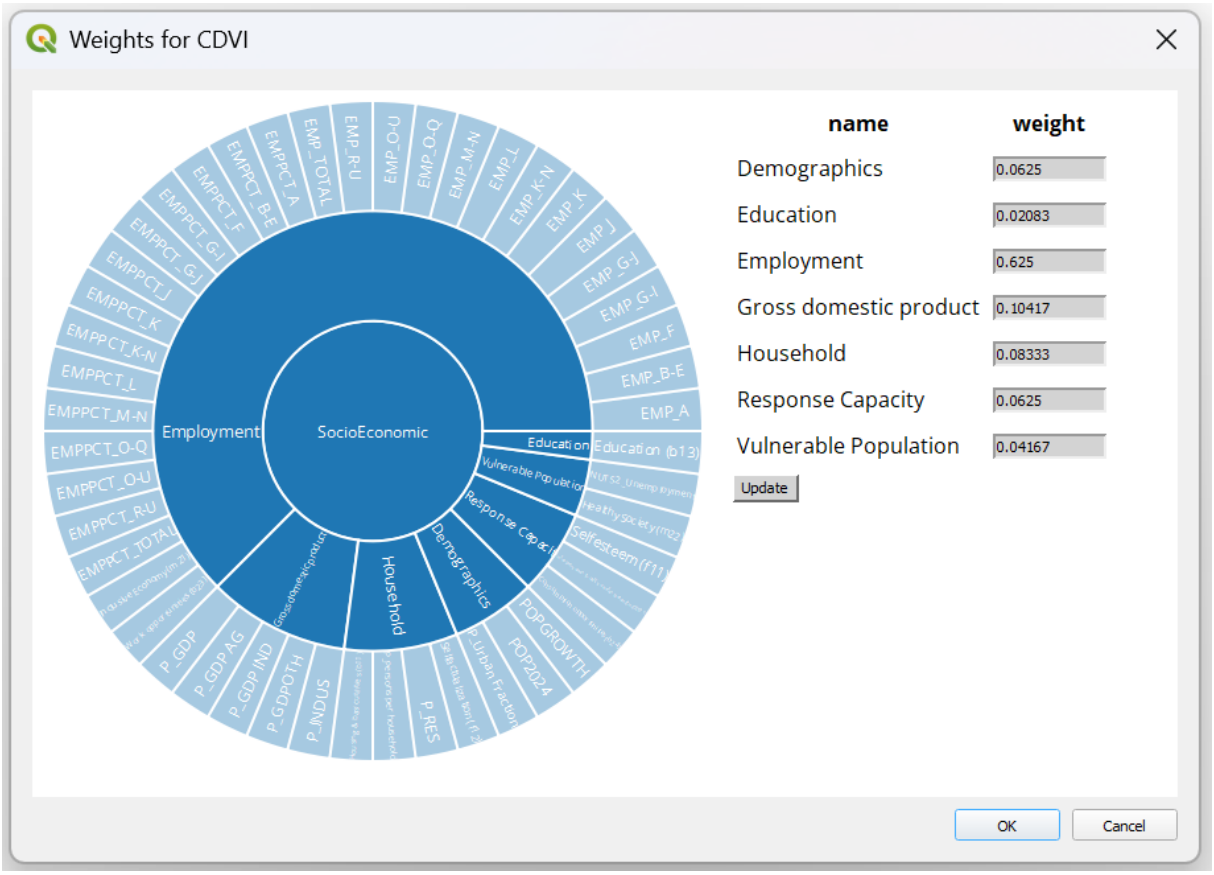


Figure 17: Changing weights within a sub-section in the plugin.

Navigate to “Calculate vulnerability” to calculate the values per pillar on the map view.

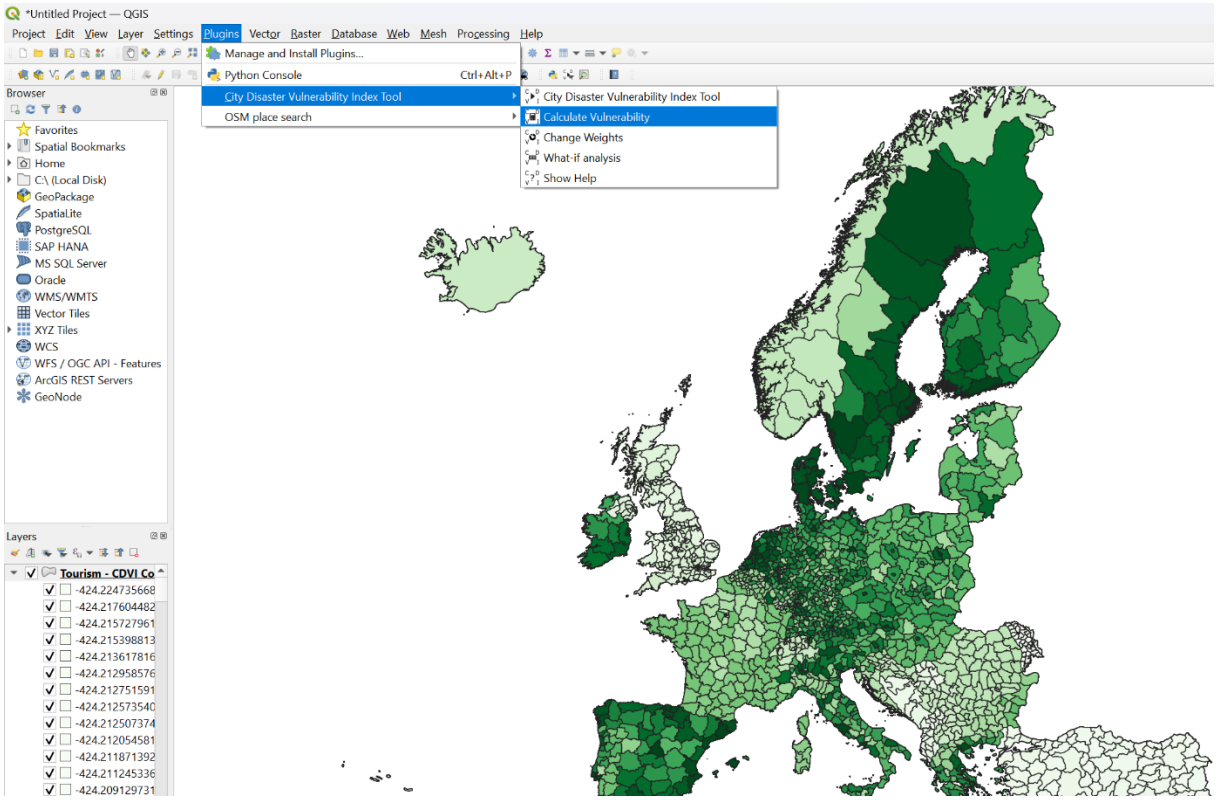
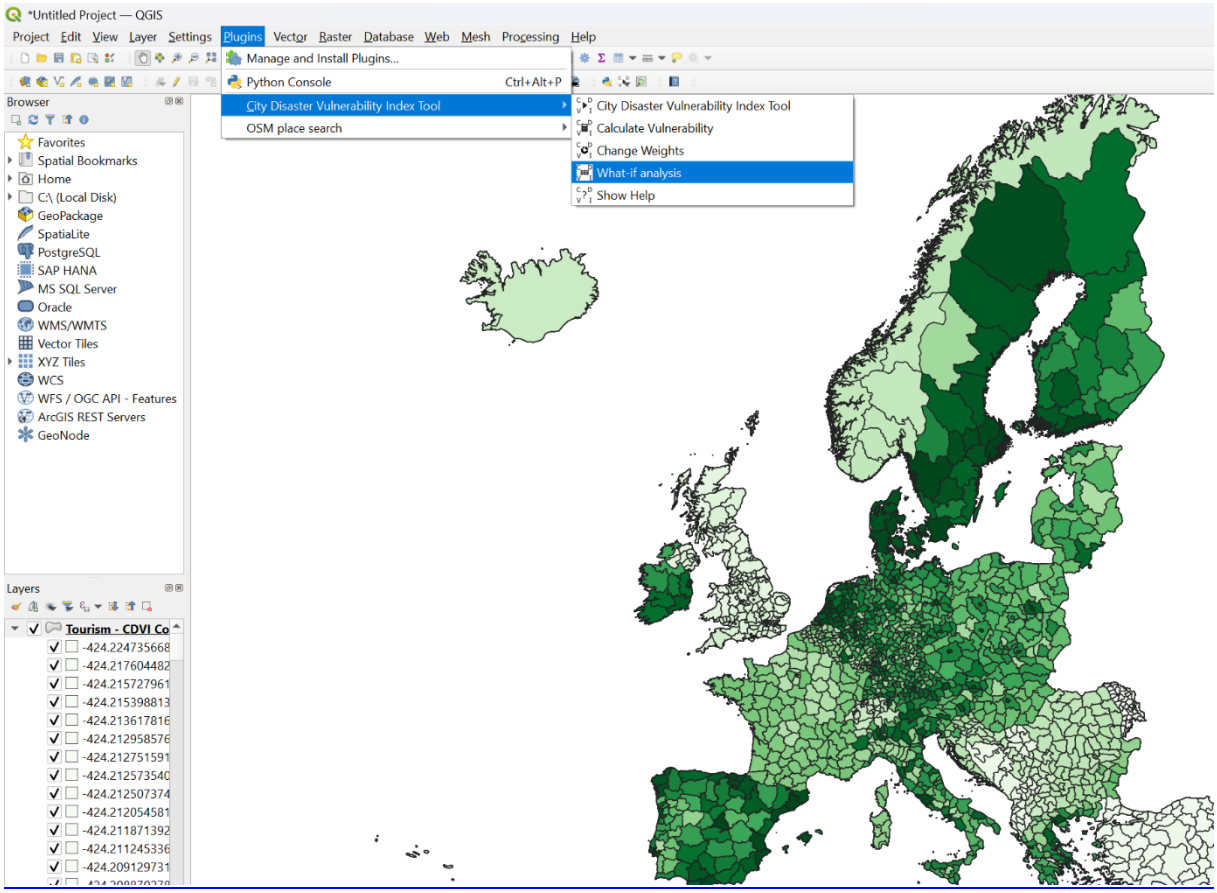


Figure 18: Output of the index in the plugin.

The “What if” analysis allows you to create multipliers for particular indicators and locations to test the impact of changes to conditions in the vulnerability index.



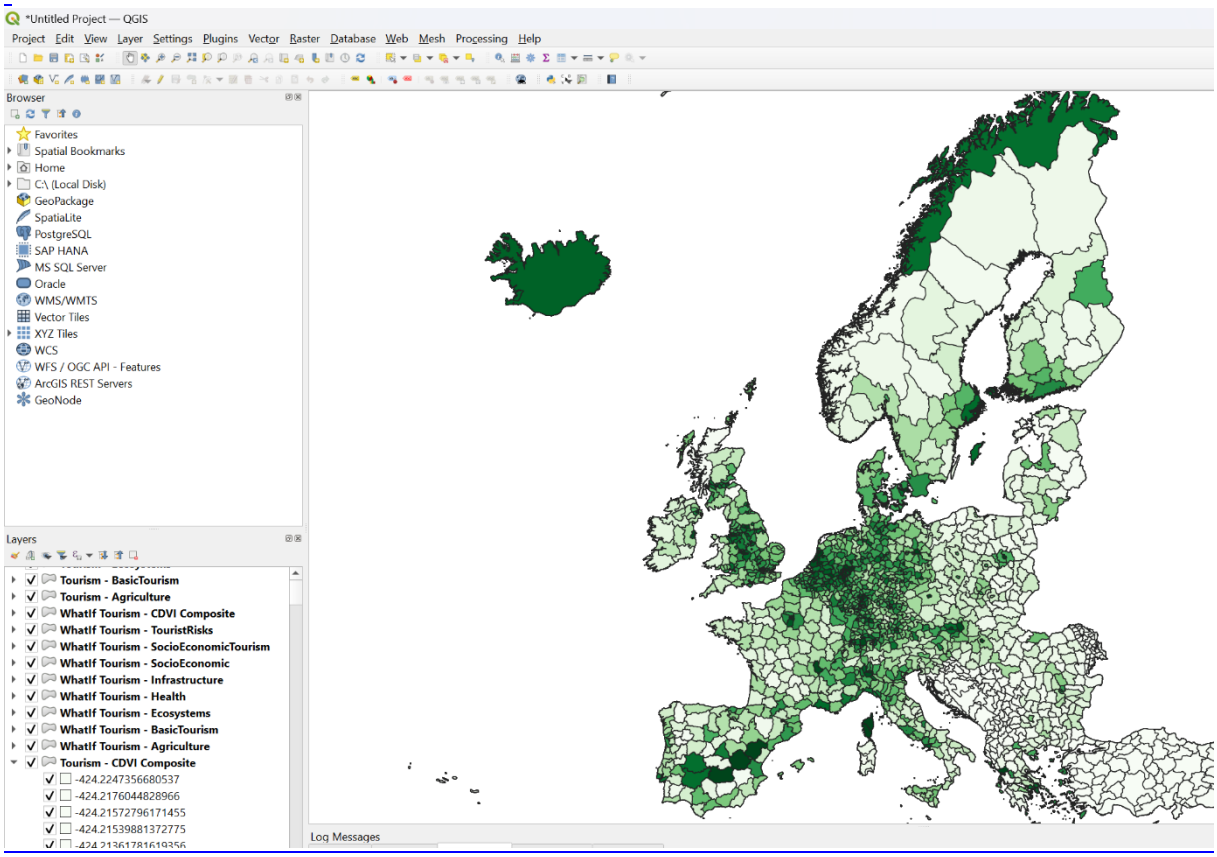


Figure 19: The results of a What-If Analysis – upper (how to click), lower (result)

Other options:

Load the Input Layer: Load a vector dataset (e.g. administrative boundaries, census zones) that will serve as the spatial basis for the vulnerability index. Ensure that the layer includes attribute fields for the indicators you wish to use.

Launch the Index Editor: Access the plugin via the QGIS menu. The interface will prompt you to select the input layer and define a name for the new vulnerability index.

Select and Configure Indicators: Choose attribute fields to be used as indicators. For each indicator, specify the directionality (positive or negative contribution to vulnerability), the normalisation method (e.g. min-max, z-score), and the weight (e.g. 0.25 for equal weighting across four indicators).

Review and Validate Input Settings: Use the summary panel to review the list of indicators, weights, and transformations. Ensure that the total weight sums to 1 (or 100%) and that all fields exist and are correctly formatted.

Run the Index Calculation: Click the "Calculate Index" button to apply the selected transformations and aggregation method. The resulting index will be written as a new attribute field in the input layer.

Visualise the Index Output: Style the output layer using QGIS symbology. Apply graduated colour ramps, quantile breaks, or threshold categories to highlight differences in vulnerability across the region.

Export for Further Use: Save the updated layer as a new shapefile or GeoPackage for use in the Scenario Calculator or other modules in the MYRIAD-EU system. Optionally export the indicator configuration as a JSON or CSV file for documentation or replication.

Iterate and Refine: Repeat the process with adjusted weights or alternative indicators to perform sensitivity testing or to reflect stakeholder priorities.

2.3.6 EU Tourism Resilience Observatory and Canary Islands Observatory

The EU Tourism Resilience Observatory and Canary Islands Observatory is currently under development incorporating knowledge from the interface to the pilots in WP3. These are tools that are part of the software suite, however like the QGIS Plugin is a standalone integration into the software through a link. The EU Tourism Resilience Observatory is being finalised in M48-M51 of the project, with the interface to be visualised within the MYRIAD Multirisk tool. The Canary Islands Observatory will have a separate interface.

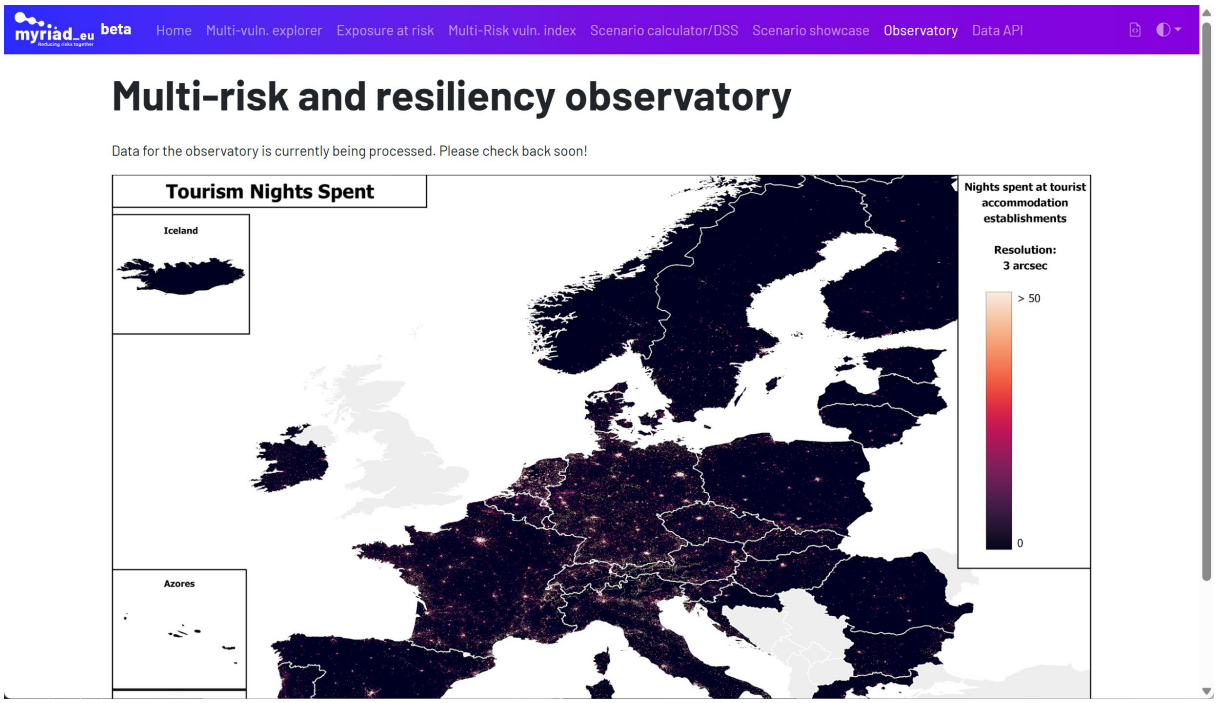


Figure 20: Start Screen currently for the EU Resilience Observatory

The semi-quantitative index methods described above have been applied to the tourism sector, which directly and indirectly supports one in 10 jobs globally. The vulnerability of the tourism sector to various shocks and stresses has been assessed using publicly available tourism indicators to establish a tourism vulnerability index. The analysed data provide a comprehensive stocktake for the resilience of the tourism sector through indicators that track key connections between disaster risk from a multi-hazard perspective, climate change, and tourism's vulnerability to disruptions in interconnected sectors such as infrastructure, ecosystems, socio-economic and health. Over 90 metrics were identified and 40 analysed at the sub-national NUTS 2 and NUTS 3 levels, providing a comprehensive framework to assess the tourism sector's progress in climate and disaster resilience at the sub-national level. Criteria for metric selection prioritised meaningfulness, policy relevance, scientific acceptance, reliability, upgradability, and geographical representativeness for EU-wide comparisons.

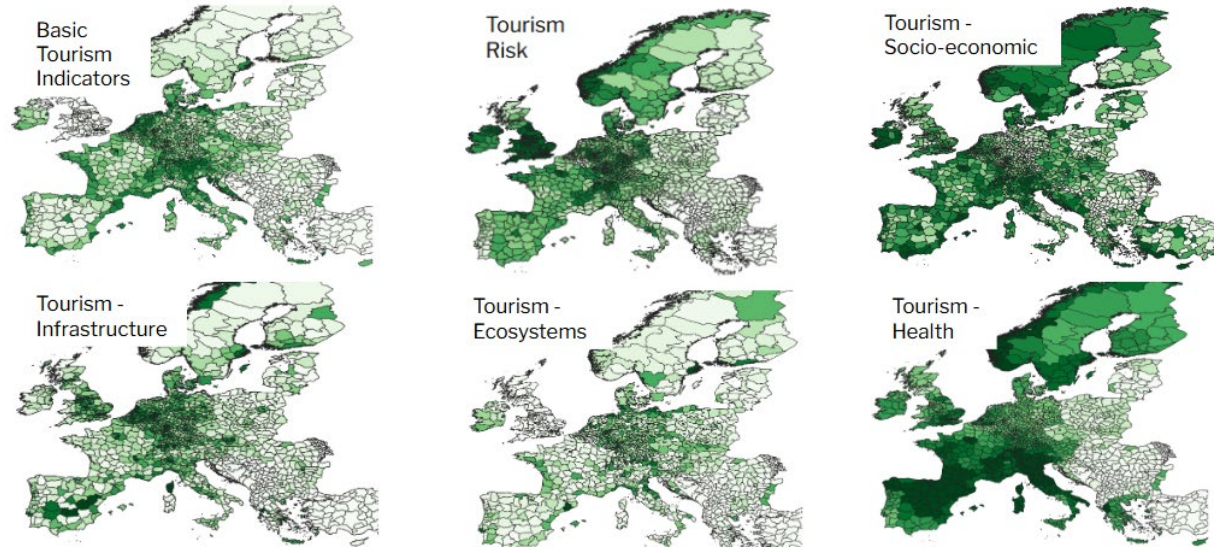


Figure 21: Indicators for the Tourism Multi-hazard vulnerability index using a base weighting across indicators.

The purpose of the tourism disaster vulnerability index is to provide a holistic measure of vulnerability specific to tourism destinations, identify concentrations of vulnerabilities and support targeted and prioritized cross-sector interventions. We therefore generate insights for tourism stakeholders at local, regional, and national levels about risk concentrations and factors driving vulnerability. The methodology assesses the risk of multiple hazards and impacts to a particular sector, allowing sector stakeholders to prioritise resilience improvement strategies.

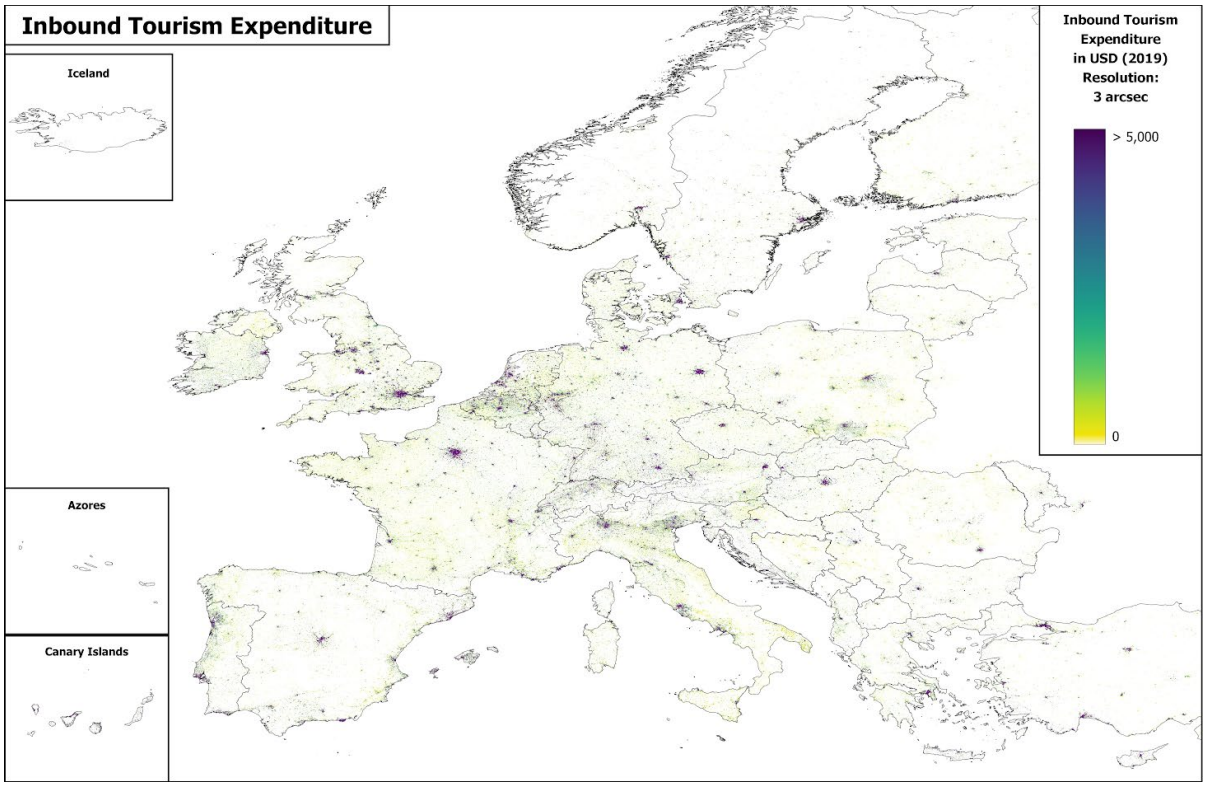


Figure 22: Distributed 3-arc-sec Inbound Tourism Expenditure for Europe for combination with exposure-at-risk calculations on a NUT3 level.

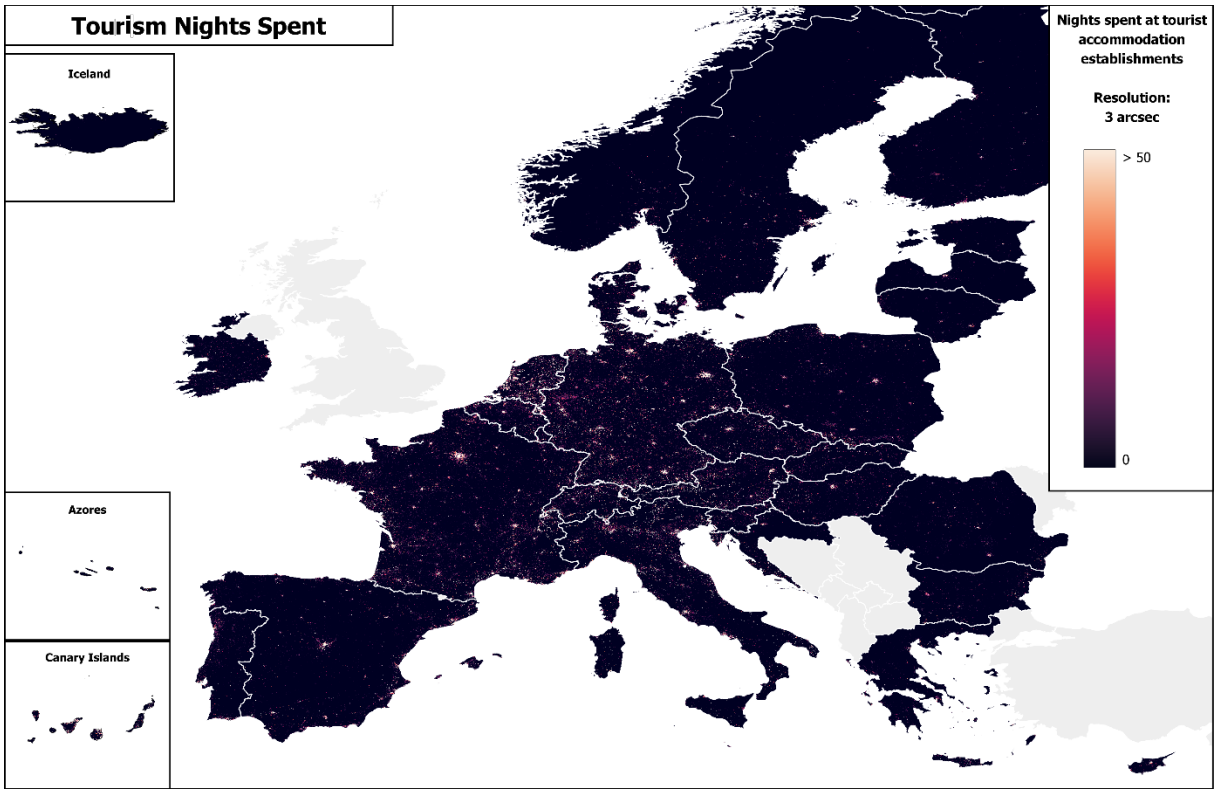


Figure 23: Distributed 3-arc-sec Tourism Nights spent for Europe for combination with exposure-at-risk calculations on a NUT3 level.

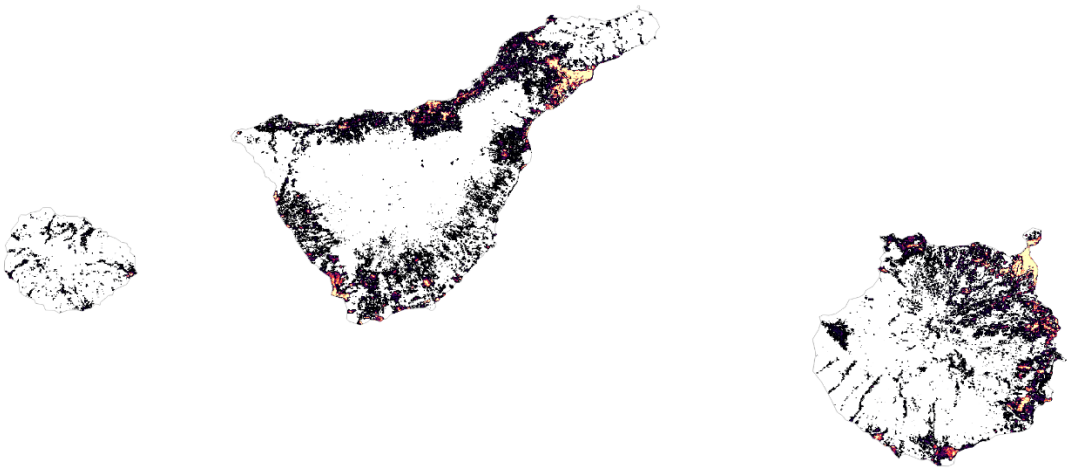


Figure 24: A detailed view of Tourism nights spent for the main islands in the Canary Islands in Spain. Further disaggregation methods can be used.

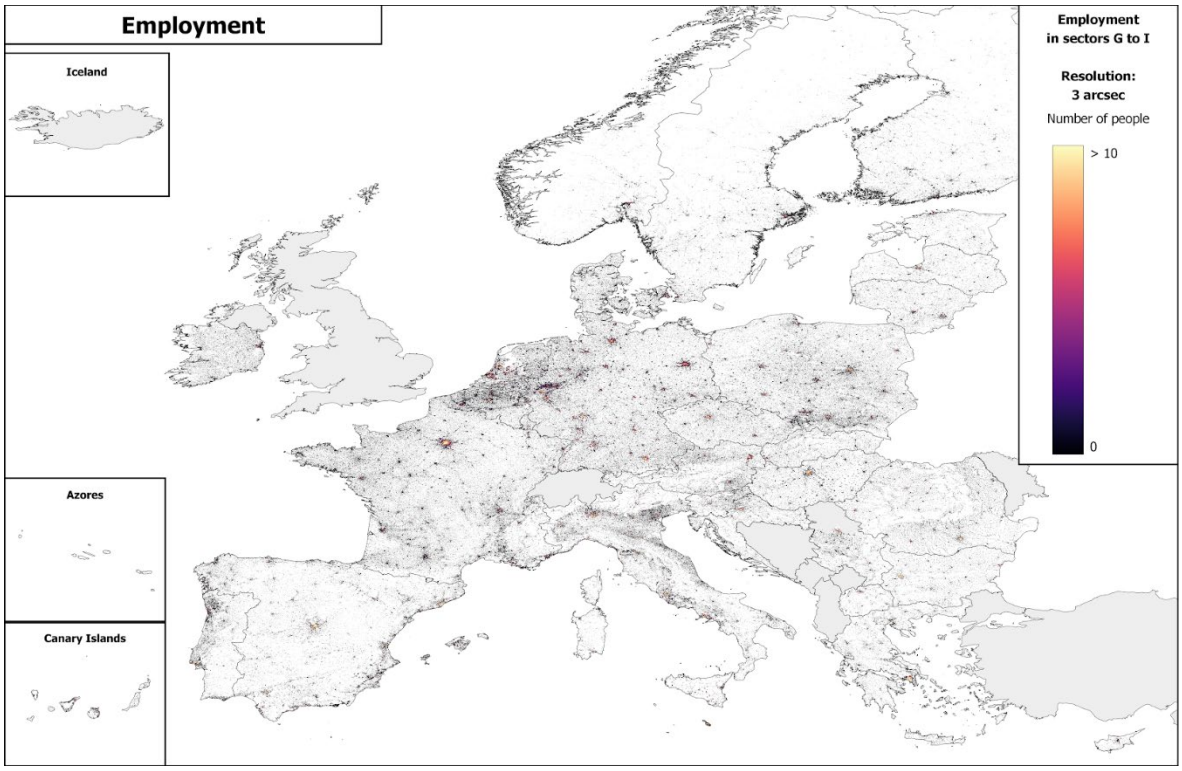


Figure 25: Employment (number of people per pixel) in each 3 arc sec pixel for sectors G (Wholesale and retail trade), H (transportation and storage) and I (accommodation and food service facilities) distributed from NUTS3 data.

The following provides a brief description of the quantitative, semi-quantitative and qualitative approaches used as part of the tool.

Quantitative Modelling (Risk Outputs): Quantitative risk modelling in WP5 has been employed to assess direct and systemic vulnerabilities and risks for the tourism sector's infrastructure. This will include estimations of potential impacts such as the number of affected hotels and attractions, the extent of damage to transport and power infrastructure, and potential loss of connectivity. Interdependencies within the tourism sector of La Palma, as well as with the energy and agricultural sectors, will be considered to quantify the augmented economic losses from such inter-sectoral interactions.

Semi-quantitative Modelling (Destination Vulnerability Composite Index): Complementing the quantitative analysis, a semi-quantitative approach as part of WP5-WP4 will be utiliszed to appraise dynamic vulnerabilities at the destination scale. This approach will factor in sensitivities within the tourism sector and other determinants such as population, economic stability, environmental factors, and infrastructure robustness. The selection of indicators will be informed through close collaboration in WP4 through the development of VulneraTour, a database of vulnerability drivers for tourism destinations, which categorises vulnerability drivers from scientific literature to assess resilience against natural hazards, providing crucial insights for disaster risk management and enhancing destination-specific strategies. Vulnerability indicators, particularly pertinent to the tourism sector's susceptibility in La Palma to volcanic activities and drought, and their linkages to agriculture and energy, will be selected. These indicators will be weighted and aggregated through a participatory approach with local experts and stakeholders used the AHP approach described in Sections 2.4.2 and 2.6.2 to provide an "Impact Factor," which will in turn be combined with the direct risk outputs to provide an "integrated risk" score for the various administrative divisions within La Palma.

Qualitative Approach (Destination Resilience Scorecard): In a parallel, qualitative approach, a Destination Resilience Scorecard has been devised for tourism stakeholders and decision makers, focusing on governance aspects pertinent to managing risks and resilience within the destination. The Scorecard has been anchored in the priorities of the Sendai Framework for Disaster Risk Reduction to provide a policy lens aligned with internationally agreed-upon risk reduction criteria relevant to tourism stakeholders. Accordingly, the Scorecard has been contextualised through the tourism lens and addresses conditions in La Palma, particularly incorporating the forensic disaster analysis and its impacts on the tourism-agriculture nexus conducted by ULL for the volcanic eruptions in La Palma. The Scorecard encompasses five dimensions from risk comprehension to the implementation of long-term resilience strategies.

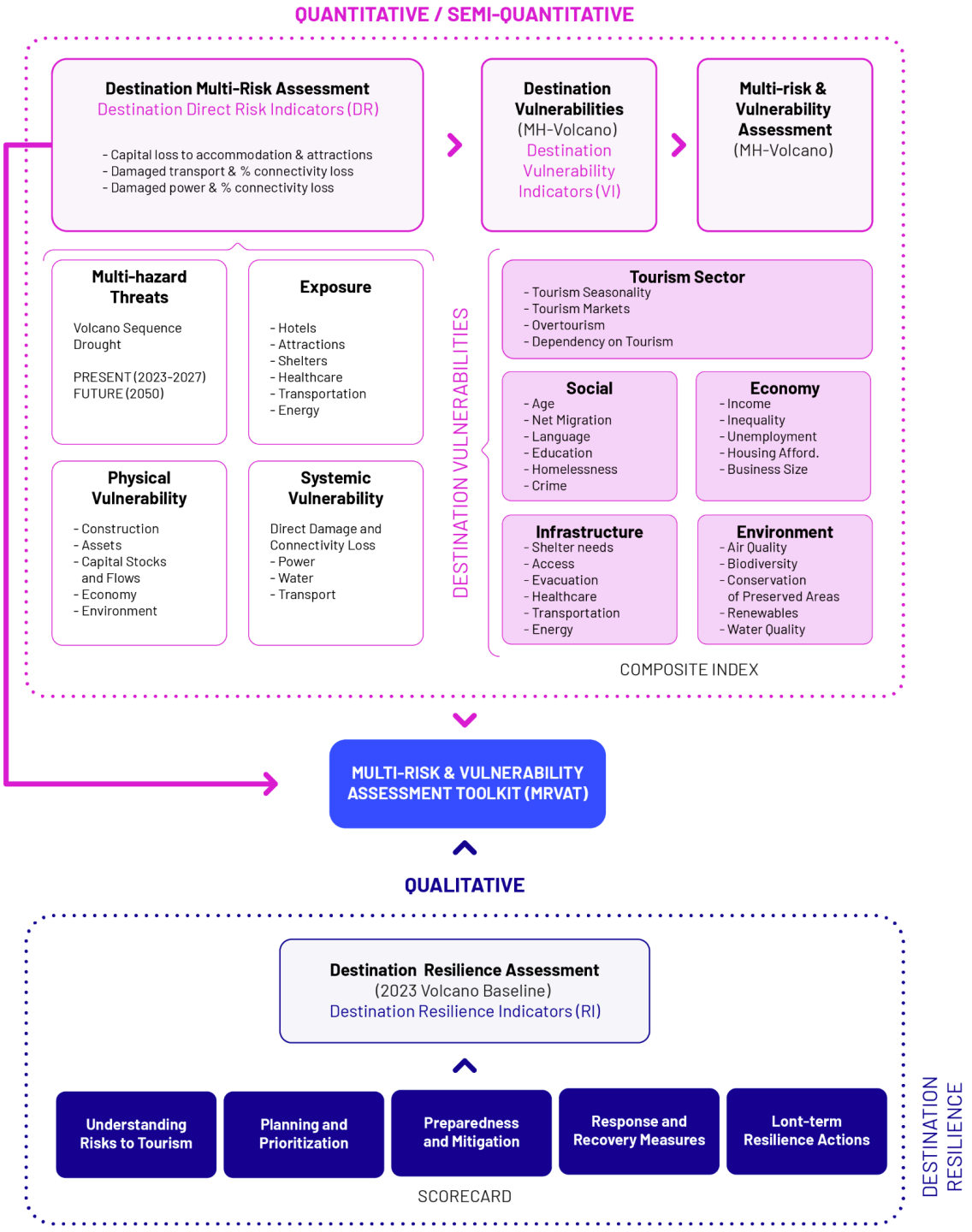


Figure 26: Integration of quantitative, semi-quantitative and qualitative approaches for the Canary Islands Pilot.

2.4 Data Management and other Concepts

2.4.1 Background

Effective data management is a crucial component of working within the MYRIAD-EU Software Multi-Risk Toolkit. This chapter outlines the procedures and good practices for handling geospatial

datasets, preparing data for analysis, and managing outputs generated by the Multi-Risk Toolkit modules. Users can interact with both spatial and non-spatial data types, including vector and raster formats, through a series of upload panels, configuration menus, and export interfaces.

The Multi-Risk Toolkit supports a wide variety of file formats and provides internal validation mechanisms to ensure that uploaded datasets meet minimum requirements for compatibility. Whether managing hazard layers, exposure inventories, or vulnerability functions, the integrity and structure of input data have a direct impact on the quality of analysis and simulation outputs.

Supported File Types

- **Vector Data**: Shapefile (.shp), GeoJSON (.geojson), GPKG (.gpkg), CSV (.csv with spatial fields)
- **Raster Data**: GeoTIFF (.tif), ASCII Grid (.asc)
- **Curves/Functions**: JSON (.json), CSV (.csv)
- **Metadata/Config**: YAML (.yml), JSON (.json)

Uploading Data

1. **Navigate to the Upload Panel**: Within any analytical module (e.g. Exposure at Risk, Scenario Calculator), locate the data upload section at the top of the interface.
2. **Select a Dataset**: Use the "Browse" or drag-and-drop interface to select your file. Ensure the file is in a supported format and that the relevant coordinate reference system (CRS) is compatible with existing layers.
3. **Assign Layer Roles**: Specify whether the uploaded dataset should be treated as exposure, hazard, or ancillary data. In some modules, you may also define asset value fields, unique identifiers, or matching keys.
4. **Validate and Preview**: Once uploaded, a preview panel will show the first few rows or a map rendering of the dataset. Any schema mismatches, missing fields, or geometry errors will be flagged for review.
5. **Edit Metadata**: Optionally add a title, description, source, and date of collection for each dataset to enhance traceability.

Managing Multiple Layers

- Layers uploaded in one module are shared across others via the internal storage system.
- Use the "Manage Datasets" panel in the sidebar to view all uploaded datasets. You can rename, duplicate, or delete layers from this menu.
- Datasets can be grouped by theme or scenario for ease of retrieval during comparison analyses.

Exporting Results

1. **Output Formats**: Analytical outputs (e.g. exposure summaries, damage maps, or curve comparisons) can be exported in multiple formats: CSV for tables, PNG/SVG for visual outputs, GeoJSON or Shapefile for spatial layers.

2. **Scenario Snapshots**: Save a complete scenario—including input layers, curve selections, and output metrics—as a snapshot to enable reproducibility or share with collaborators.
3. **Integration with External Tools**: Exported layers can be directly used in GIS software (QGIS, ArcGIS), statistical packages (R, Python), or re-uploaded into MYRIAD-EU for new analyses.

Good Practices

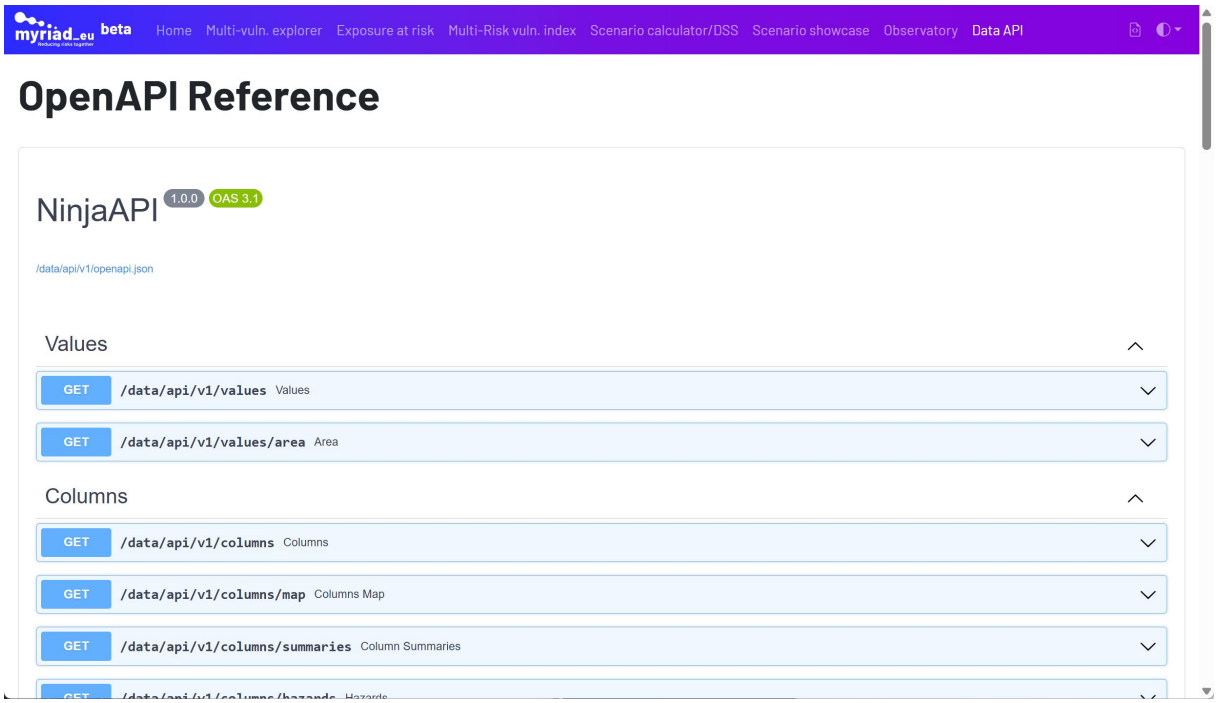
- Always ensure datasets use a consistent CRS (e.g. EPSG:4326 or EPSG:3857) to avoid alignment issues.
- Keep attribute fields clearly named and standardised, particularly for asset value, IDs, or category fields.
- Where possible, reduce large datasets to focus on relevant regions or time periods to improve performance.
- Use scenario-specific naming conventions when uploading datasets to keep versions and variants organised.

In summary, the MYRIAD-EU Multi-Risk Toolkit provides a robust framework for managing all types of risk-related data. By adhering to consistent practices and leveraging the built-in data tools, users can ensure high-quality, reproducible results throughout the risk analysis process.

2.4.2 Advanced Tools

The MYRIAD-EU Software Multi-Risk Toolkit includes a range of advanced tools aimed at experienced users who need to extend functionality, perform batch operations, or customise risk analysis pipelines. These tools are typically accessed outside the main graphical user interface, either via command-line utilities or integration with programming environments such as Python or R. This chapter introduces the core advanced capabilities of the system, including API usage, automation scripts, custom scenario building, and integration with other MYRIAD-EU components.

Advanced users may leverage these tools for automating repetitive analyses, integrating large-scale simulations, or embedding the Multi-Risk Toolkit into broader multi-risk modelling frameworks. These functions are ideal for institutional users, research consortia, or technical teams maintaining operational risk platforms.



API Access and Custom Integrations

The MYRIAD-EU Multi-Risk Toolkit offers an internal REST API that facilitates programmatic interaction with the core modules. This includes endpoints for:

- Uploading and retrieving datasets
- Triggering exposure or damage analyses
- Fetching vulnerability curves and model parameters
- Downloading result outputs in machine-readable formats

API access allows users to build automated pipelines, integrate the MYRIAD-EU software with third-party risk engines, or incorporate Multi-Risk Toolkit functionality into external Multi-Risk Toolkits.

To get started, users should authenticate using API keys (where applicable), reference the Swagger documentation bundled with the source code, and issue requests to the appropriate local or deployed server endpoints.

Command-line Batch Processing

For bulk analysis tasks or when working with large geospatial archives, the system provides command-line scripts that replicate Multi-Risk Toolkit functionality without launching the web interface. These scripts, located in the scripts/ or tools/ directories, include:

- run_batch_exposure.py: Batch analysis of exposure under multiple hazard layers
- simulate_scenario.py: End-to-end scenario execution including loss calculation
- convert_curve_library.py: Transformation of vulnerability curves between formats

Each script supports configuration via YAML or JSON input files and can be scheduled to run on remote servers or in high-performance environments.

Vulnerability Curve Customisation

Beyond using the Multi-Risk Toolkit's Curve Explorer module, users can define and load their own vulnerability functions manually. Curves must be saved in compatible formats (e.g. JSON, CSV with intensity-damage mappings). These custom curves can then be referenced by name when configuring Scenario Calculator runs via scripts or API.

Advanced users may also write scripts to generate synthetic curves based on empirical data, literature reviews, or damage probability distributions. This allows for rapid testing of different vulnerability assumptions across sectors and hazard types.

Linking with QGIS and Spatial Tools

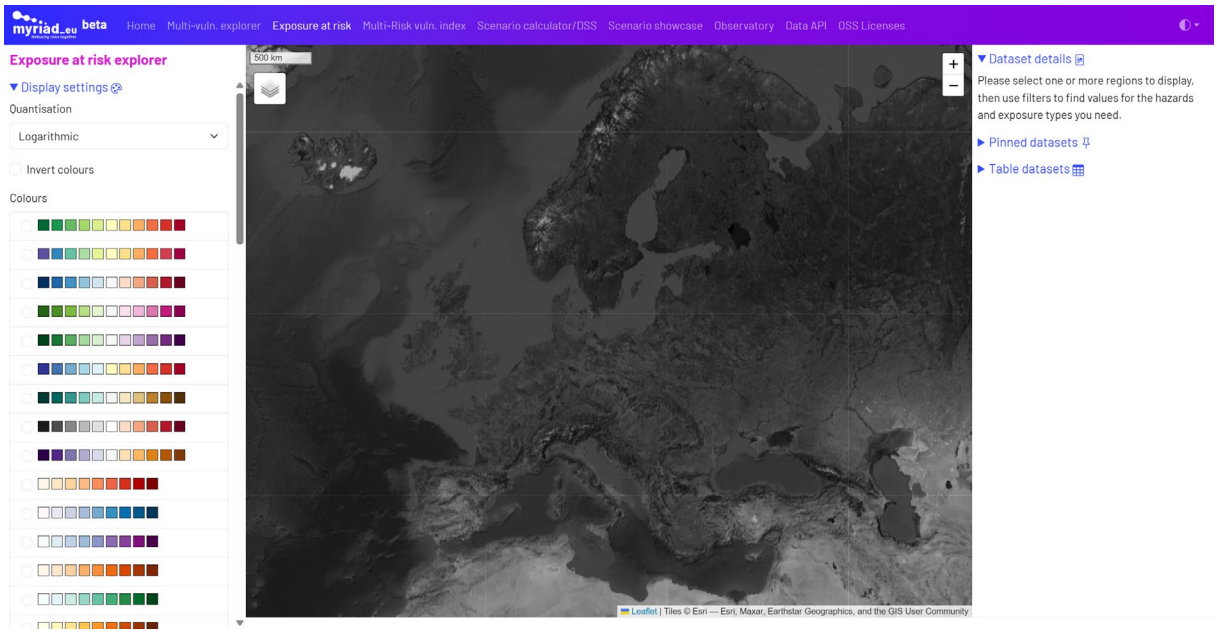
Advanced GIS users often work alongside QGIS or other desktop GIS systems. MYRIAD-EU supports direct file exchange via common formats (GeoPackage, Shapefile, GeoJSON) and includes plugins such as the Vulnerability Index Editor for advanced spatial composition. Output files from Multi-Risk Toolkit modules can be imported into QGIS for additional analysis or cartographic display, while QGIS-prepared datasets can be uploaded into MYRIAD-EU for scenario testing.

The advanced tools in MYRIAD-EU extend the platform's functionality beyond point-and-click usage. They empower technical users to deploy the Multi-Risk Toolkit in production workflows, scale analysis to national datasets, and ensure seamless integration with broader research and decision-support systems.

2.5 Visualisation and Outputs

The MYRIAD-EU Software Multi-Risk Toolkit provides a comprehensive suite of visualisation tools and export capabilities that support the analysis, communication, and dissemination of results. Outputs from the various modules—such as exposure summaries, vulnerability assessments, and scenario-based loss estimates—can be visualised in tabular, graphical, and spatial formats directly within the interface, with options to download results in standard data formats for integration into reports or further analysis.

Visualisations play a key role in enabling users to interpret complex datasets, identify spatial patterns of risk, and evaluate differences between scenarios or intervention strategies. Each module provides tailored visualisation components that respond to the context of the analysis, while maintaining a consistent user experience across the platform.



Map Visualisation

Interactive maps are central to the Multi-Risk Toolkit experience, particularly in modules such as Exposure at Risk and Scenario Calculator. These maps allow users to visualise hazard extents, affected assets, damage estimates, and vulnerability scores spatially across selected regions.

Users can:

- Overlay multiple geospatial layers (e.g. flood depths, building footprints, vulnerability zones)
- Adjust symbology based on categorical or continuous data
- Apply filters by attribute values to highlight specific subsets (e.g. buildings over a certain value)
- Access interactive pop-ups that provide information on each feature when clicked
- Switch base maps (e.g. satellite, street, terrain) for contextual clarity

Charts and Graphs

In addition to spatial outputs, the Multi-Risk Toolkit includes a variety of charts to represent data trends, comparisons, and summary statistics. These include:

- Bar charts comparing total damages across scenarios or regions
- Pie charts showing asset type composition within exposed areas
- Line graphs illustrating vulnerability curves or temporal evolution of risk
- Histograms showing distribution of exposure values or damages
- Charts update dynamically based on the user's selections and can be downloaded as SVG or PNG files for reporting purposes.

Tables and Data Summaries

Every module includes detailed tabular outputs that provide precise numerical summaries of the results. Users can:

- Sort tables by any column (e.g. descending damage, ascending exposure value)
- Filter rows based on multiple criteria
- Export tables as CSV for use in Excel, R, Python, or other analysis tools
- Typical tables include summaries by administrative unit, or by hazard intensity class.

Scenario Snapshots and Output Management

Users can create and save scenario snapshots that preserve all input parameters, selected datasets, and output results. This enables reproducibility, sharing with collaborators, or comparison over time.

- Snapshots can be exported as JSON or YAML files
- Result layers can be downloaded in GeoPackage, Shapefile, or GeoJSON format
- Graphical summaries can be downloaded in image formats (PNG, SVG)
- Export logs can be maintained for record-keeping or institutional workflows

In summary, the visualisation and output features of the MYRIAD-EU Multi-Risk Toolkit are designed to support informed decision-making and transparent risk communication. Whether presenting findings to stakeholders, preparing a scientific report, or exploring the data internally, the suite of visual tools allows users to transform raw data into meaningful insight.

3 Future Edits to the Software

From the key challenges and opportunities come many chances for future research in the field. Although a huge step is made within every EU project towards improving quantitative modelling processes of risk metrics in Europe for natural hazards, as has also been done in MYRIAD-EU, there still exists a huge amount of need for hazard, exposure, vulnerability and risk efforts across all hazards especially with a focus on sectors. Thus, the MYRIAD-EU Multi-Risk Toolkit has been designed to be extensible. In addition, Risklayer has decided to host the website until at least 2035 to continue developing the software and user tools to ensure longevity.

There exist very few studies focussing on infrastructure, or ecosystems or indeed sectoral buildings and processes; with much of the focus on residential, commercial and industrial buildings with little splits, thus further work in the infrastructure space is needed.

The following specific future research topics are proposed:

- Improved stakeholder engagement in the quantitative and semi-quantitative index approach for specific sectors with increased focus on improving the Multi-Risk editor and the number of dependent scenarios between hazards.
- Simplified approaches for the integration of dynamic vulnerability pertaining to risk changes over a development plan period which can then be included in the analysis.
- Further improvement of exposure sets for specific sectors across Europe after consultation with what is important for stakeholders in those sectors which can then be included in the analysis.

4 Conclusion

The MYRIAD-EU Multi-Risk Toolkit represents an advancement in the field of systemic and multi-hazard risk assessment ensuring that quantitative, semi-quantitative and qualitative outputs are integrated into decisions given the complexity of multi-hazard and multi-risk environments. Designed to support a wide range of users—from researchers and technical experts to policy analysts and planners—it provides a comprehensive, modular, and interactive environment for exploring complex risk scenarios.

Through the combination of intuitive design and powerful analytical capabilities, the software facilitates the visualisation and analysis of vulnerability functions via the Curve Explorer, supporting comparisons and scenario-specific risk inputs; Exposure at risk assessments under threshold-based hazard conditions with the Exposure at Risk module, enabling users to understand who and what is at risk from different hazard intensities; Scenario-based multi-risk evaluations and displays through the Scenario Calculator, where users can quantify direct and indirect impacts and integrate mitigation assumptions; Interactive sectoral semi-quantitative and qualitative outputs through the Multi-Risk Editor and Resilience Observatory.

In terms of the UI/UX experience, the www.myriad-multirisk.eu site has integrated data and layer management, including the import, export, and curation of spatial datasets and vulnerability curves; as well as customisable user settings, deployment configurations, and plugin extensions such as the Vulnerability Index Editor for geospatial vulnerability mapping within QGIS.

This guide has walked the user through every major module of the dashboard, offering practical steps for installation, configuration, and execution of analyses. Each chapter has been supplemented with examples, expected inputs, and visualisation support, ensuring the tool is approachable while remaining scientifically robust.

The MYRIAD-EU Software – Multi-Risk Toolkit is not only a standalone assessment platform but also a collaborative, evolving framework. It encourages integration with local data, promotes transparency in assumptions, and supports the policy-making and operational planning processes with credible and reproducible outputs. As systemic risk becomes increasingly complex in the face of climate change, urbanisation, and social vulnerability, tools like this will be essential. The MYRIAD-EU Multi-Risk Toolkit thus stands as both a product and a process—offering a transparent, open, and flexible means to assess and communicate risk across sectors, scales, and scenarios.

Appendix A – Additional Risk Concepts

Duration of 60 days

Return Period (years)	1	2	5	10	20	50	100	200	250	500	1000	2000	2500	5000	10000	Hazard 1
1	0.280027	0.218396	0.178912	0.165313	0.158429	0.154271	0.152881	0.152185	0.152045	0.151767	0.151627	0.151558	0.151544	0.151516	0.151502	
2	0.218396	0.151488	0.108625	0.093861	0.086388	0.081874	0.080365	0.079609	0.079458	0.079155	0.079004	0.078929	0.078913	0.078883	0.078868	
5	0.178912	0.108625	0.063596	0.048087	0.040236	0.035494	0.033909	0.033115	0.032956	0.032638	0.032479	0.0324	0.032384	0.032352	0.032336	
10	0.165313	0.093861	0.048087	0.03232	0.02434	0.01952	0.017908	0.017101	0.016939	0.016616	0.016454	0.016374	0.016358	0.016325	0.016309	
20	0.158429	0.086388	0.040236	0.02434	0.016293	0.011433	0.009808	0.008994	0.008831	0.008506	0.008343	0.008261	0.008245	0.008212	0.008196	
50	0.154271	0.081874	0.035494	0.01952	0.011433	0.006549	0.004916	0.004098	0.003935	0.003607	0.003444	0.003362	0.003346	0.003313	0.003296	
100	0.152881	0.080365	0.033909	0.017908	0.009808	0.004916	0.00328	0.002461	0.002297	0.001969	0.001805	0.001723	0.001707	0.001674	0.001658	
200	0.152185	0.079609	0.033115	0.017101	0.008994	0.004098	0.002461	0.001641	0.001477	0.001149	0.000985	0.000903	0.000887	0.000854	0.000837	
250	0.152045	0.079458	0.032956	0.016939	0.008831	0.003935	0.002297	0.001477	0.001313	0.000985	0.000821	0.000739	0.000723	0.00069	0.000673	
500	0.151767	0.079155	0.032638	0.016616	0.008506	0.003607	0.001969	0.001149	0.000985	0.000657	0.000493	0.000411	0.000394	0.000361	0.000345	
1000	0.151627	0.079004	0.032479	0.016454	0.008343	0.003444	0.001805	0.000985	0.000821	0.000493	0.000328	0.000246	0.00023	0.000197	0.000181	
2000	0.151558	0.078929	0.0324	0.016374	0.008261	0.003362	0.001723	0.000903	0.000739	0.000411	0.000246	0.000164	0.000148	0.000115	9.86E-05	
2500	0.151544	0.078913	0.032384	0.016358	0.008245	0.003346	0.001707	0.000887	0.000723	0.000394	0.00023	0.000148	0.000131	9.86E-05	8.21E-05	
5000	0.151516	0.078883	0.032352	0.016325	0.008212	0.003313	0.001674	0.000854	0.00069	0.000361	0.000197	0.000115	9.86E-05	6.57E-05	4.93E-05	
10000	0.151502	0.078868	0.032336	0.016309	0.008196	0.003296	0.001658	0.000837	0.000673	0.000345	0.000181	9.86E-05	8.21E-05	4.93E-05	3.29E-05	
Hazard 2																

Duration of 6 years

Return Period (years)	1	2	5	10	20	50	100	200	250	500	1000	2000	2500	5000	10000	Hazard 1
1	0.999994	0.999876	0.99925	0.998633	0.998156	0.997792	0.997656	0.997585	0.99757	0.997541	0.997526	0.997518	0.997517	0.997514	0.997513	
2	0.999876	0.997511	0.984961	0.972609	0.963033	0.955748	0.953014	0.951584	0.951293	0.950705	0.950409	0.95026	0.95023	0.95017	0.95014	
5	0.99925	0.984961	0.909133	0.834497	0.776641	0.732623	0.716101	0.707461	0.705702	0.702152	0.70036	0.699461	0.69928	0.69892	0.698739	
10	0.998633	0.972609	0.834497	0.698558	0.59318	0.513008	0.482915	0.467178	0.463974	0.457508	0.454245	0.452606	0.452278	0.451621	0.451292	
20	0.998156	0.963033	0.776641	0.59318	0.450963	0.342764	0.302152	0.280914	0.276589	0.267862	0.263459	0.261248	0.260805	0.259918	0.259474	
50	0.997792	0.955748	0.732623	0.513008	0.342764	0.213243	0.164627	0.139204	0.134027	0.12358	0.118309	0.115662	0.115131	0.11407	0.113538	
100	0.997656	0.953014	0.716101	0.482915	0.302152	0.164627	0.113007	0.086013	0.080516	0.069423	0.063827	0.061016	0.060453	0.059326	0.058761	
200	0.997585	0.951584	0.707461	0.467178	0.280914	0.139204	0.086013	0.058197	0.052533	0.041103	0.035336	0.03244	0.031859	0.030698	0.030116	
250	0.99757	0.951293	0.705702	0.463974	0.276589	0.134027	0.080516	0.052533	0.046835	0.035336	0.029535	0.026621	0.026037	0.024868	0.024283	
500	0.997541	0.950705	0.702152	0.457508	0.267862	0.12358	0.069423	0.041103	0.035336	0.023698	0.017827	0.014878	0.014287	0.013104	0.012512	
1000	0.997526	0.950409	0.70036	0.454245	0.263459	0.118309	0.063827	0.035336	0.029535	0.017827	0.01192	0.008954	0.008359	0.007169	0.006574	
2000	0.997518	0.95026	0.699461	0.452606	0.261248	0.115662	0.061016	0.03244	0.026621	0.014878	0.008954	0.005978	0.005382	0.004188	0.003591	
2500	0.997517	0.95023	0.69928	0.452278	0.260805	0.115131	0.060453	0.031859	0.026037	0.014287	0.008359	0.005382	0.004785	0.003591	0.002993	
5000	0.997514	0.95017	0.69892	0.451621	0.259918	0.11407	0.059326	0.030698	0.024868	0.013104	0.007169	0.004188	0.003591	0.002395	0.001797	
10000	0.997513	0.95014	0.698739	0.451292	0.259474	0.113538	0.058761	0.030116	0.024283	0.012512	0.006574	0.003591	0.002993	0.001797	0.001198	
Hazard 2																

Figure 27: Examples of overlapping hazard joint probabilities for independent events for a certain duration which are available for production within the tool depending on the hazards.

Appendix B - Exposure data sets and Sectors

Table 1: Statistical Classification of Economic Activities in the European Community Rev. 2 (2008): Level 1 Codes

Code	Economic Area
A	Agriculture, Forestry and Fishing
B	Mining and Quarrying
C	Manufacturing
D	Electricity, Gas, Steam and Air Conditioning Supply
E	Water Supply; Sewerage, Waste Management and Remediation Activities
F	Construction
G	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
H	Transportation and Storage
I	Accommodation and Food Service Activities
J	Information and Communication
K	Financial and Insurance Activities
L	Real Estate Activities
M	Professional, Scientific and Technical Activities
N	Administrative and Support Service Activities
O	Public Administration and Defence; Compulsory Social Security
P	Education
Q	Human Health and Social Work Activities
R	Arts, Entertainment and Recreation
S	Other Service Activities
T	Activities of Households as Employers; Undifferentiated Goods and Services Producing Activities of Households for Own Use
U	Activities of Extraterritorial Organisations and Bodies

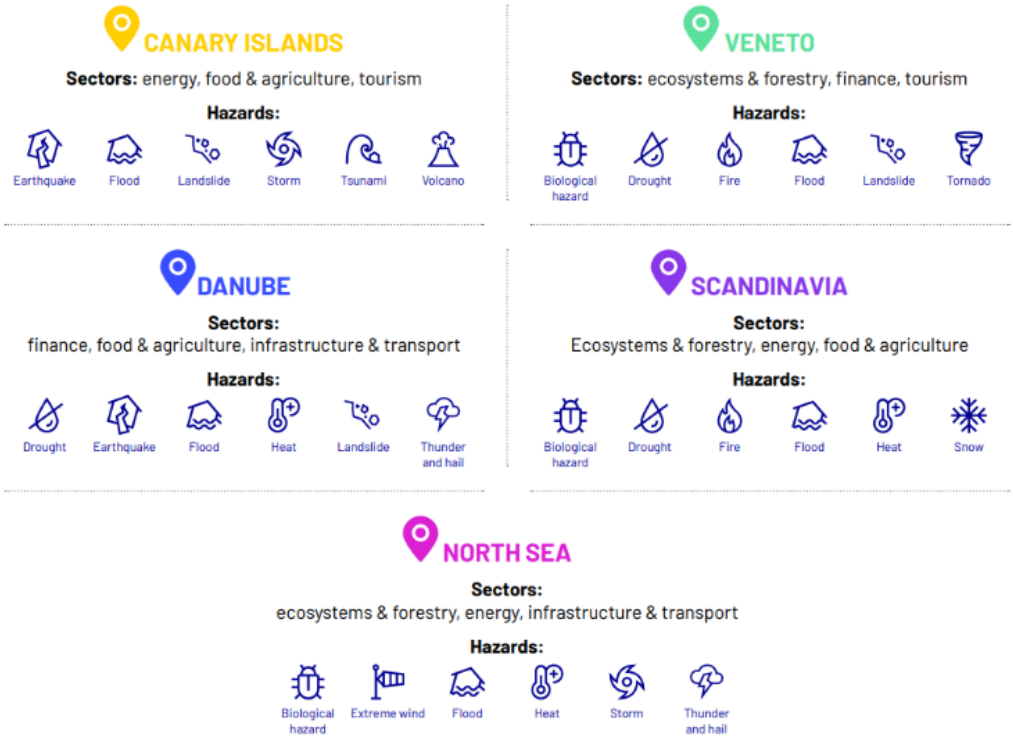


Figure 28: The different focus regions of MYRIAD-EU with the principal hazards and affected sectors.