

CB WEB & GIS

GeoRisk AI

Technical documentation, municipal user manual and planning applications | English edition

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Developed by CB Web & GIS | <https://cbwebgis.se>

Study area: Linköping, Sweden

Live demo: <https://concordebazi.github.io/CB-WebGIS-Demos/georisk-ai/>

Public API: <https://georisk-ai-api.onrender.com>

IMPORTANT: GeoRisk AI is a demonstration and preliminary terrain-screening tool. Its Stångån scenarios are illustrative, not verified flood forecasts or official flood-hazard maps. Results must not be used as the sole basis for municipal, engineering, emergency or regulatory decisions.

This manual explains the application from data acquisition and software architecture to everyday use by planners and municipal employees. Technical calculations, limitations, deployment, examples and future opportunities are described in accessible language.

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01 Purpose and executive overview

GeoRisk AI is a browser-based geographic information system (GIS) developed by CB Web & GIS. It demonstrates how elevation data, terrain calculations, map visualisation and automated explanatory recommendations can help users explore geographic conditions in a limited Linköping study area.

The application offers interactive mapping, terrain elevation, local slope, indicative depressions and low points, hypothetical Stångån water-level scenarios, simplified screening indicators and a downloadable GIS report.

The central idea

A municipal employee should be able to ask a geographic question, select a location and understand the answer without opening a specialist desktop GIS package. GIS specialists retain responsibility for interpreting the underlying methods and checking whether the data is fit for the intended purpose.

Current scope

- A functioning public demonstration, not a certified municipal system.
- A geographically limited Linköping study area, not municipality-wide or Sweden-wide coverage.
- Selected demonstration locations and layers, not a complete property/cadastral search service.
- Automated rule-based interpretation; not a validated machine-learning risk model.

02 Who benefits and what problems are addressed

Audience	Potential use
Municipal planners	Initial site screening, terrain-related questions and communication.
Building permit officers	Understanding local elevation and slope before requesting specialist evidence.
Stormwater/environment teams	Exploring indicative low-lying terrain and possible investigation needs.
GIS engineers	Reviewing raster calculations, spatial methods and map overlays.
IT departments	Evaluating a browser-to-Python API integration pattern.
Infrastructure and preparedness staff	Discussing terrain constraints and illustrative scenarios, without treating them as forecasts.

The main challenge is that geographic information is valuable but often fragmented across datasets, specialist software and technical reports. GeoRisk AI demonstrates a shared web interface for viewing, calculating and explaining selected terrain indicators.

Potential organisational benefits include quicker preliminary orientation, more consistent presentation of GIS indicators and clearer discussion between technical specialists and non-specialists. These benefits have not been independently measured in a municipal deployment.

03 System architecture: from click to result

GeoRisk AI separates the browser interface from its spatial-analysis service. The frontend runs on GitHub Pages; the Python FastAPI backend runs on Render. The browser requests calculations and receives structured JSON results.

End-to-end workflow

- 1. The user opens the web map and selects an available demonstration location.
- 2. JavaScript sends the geographic coordinates and selected water-level scenario to the HTTPS API.
- 3. FastAPI receives the request and checks the input.
- 4. Rasterio transforms coordinates into the elevation raster coordinate system and samples the DEM.
- 5. Python calculates local slope and samples available depression information.
- 6. SciPy evaluates the illustrative river-connected terrain mask for the selected scenario.
- 7. FastAPI returns the measurements and scenario result as JSON.
- 8. JavaScript updates the map, screening panels and explanatory recommendations.
- 9. The user can generate a GIS report containing the available observations and limitations.

Browser / Leaflet / JavaScript → HTTPS → FastAPI → Rasterio + NumPy + SciPy → JSON → GIS dashboard / report

The raster analysis is performed server-side, avoiding the need to download and process the full terrain model in the browser.

04 Tools, technologies and their responsibilities

Tool	Role
HTML5	Application structure: header, side panels, map and report controls.
CSS3	Visual design, responsive layout and accessible hierarchy.
JavaScript	Interaction, layer toggles, API requests, result rendering and report logic.
Leaflet	Interactive web map, markers, popups and geographic overlays.

Tool	Role
GeoJSON	Exchange/display of point, line and polygon geographic features.
PNG map overlays	Pre-rendered terrain elevation, slope and scenario visualisations.
Python	Server-side geospatial processing.
FastAPI	HTTP endpoints that expose analysis functionality.
Uvicorn	ASGI server running the FastAPI application.
Rasterio	Read georeferenced raster data and sample raster cells.
NumPy	Numerical arrays, masks and terrain calculations.
SciPy	Raster connectivity operation for the illustrative river scenario.
Git / GitHub	Source version control and repository hosting.
GitHub Pages	Public static frontend hosting.
Render	Cloud hosting of the FastAPI backend.
VS Code	Local development and testing environment.

The satellite background visible in the demonstration is attributed to Esri. Elevation information is attributed to Lantmäteriet. Background imagery and analytical data are distinct layers with different purposes and licensing obligations.

05 Geographic data, source and preparation

Primary data

The primary terrain input is a processed subset of Lantmäteriet's Markhöjdmodell Nedladdning product for Linköping. Elevation is expressed relative to RH 2000, the Swedish national height reference. CB Web & GIS prepared a study-area elevation raster and derived map overlays and analytical layers.

Main backend files

File	Purpose
linkoping_study_area.tif	Processed elevation model for the selected study area.
terrain_depressions.tif	Derived terrain-depression information, sampled when available.
stangan_river_mask.tif	Raster cells representing Stångån for connectivity analysis.
api.py	API endpoints and point-based spatial calculations.
requirements.txt	Python packages needed to run the backend.
index.html / style.css / app.js	Frontend structure, styling and interaction.
images/	Prepared visual raster overlays for the browser.

Geographic references

The browser supplies latitude and longitude in geographic coordinates. The backend transforms those coordinates to the elevation raster's own coordinate reference system using raster metadata. The height reference RH 2000 must not be confused with the horizontal coordinate reference system.

Attribution

The application and report credit "Markhöjdmodell Nedladdning, © Lantmäteriet", and identify the applicable CC BY 4.0 attribution. Any operational reuse should verify the exact source dataset, licence terms and attribution requirements.

Derived terrain products depend on the original DEM, processing parameters and study-area boundary. They are not a substitute for documented quality-assured municipal geodata.

06 Terrain elevation and slope calculations

Elevation (Markhöjd)

A digital elevation model (DEM) stores ground height in raster cells. For a selected location, the backend transforms its coordinates, identifies the corresponding raster cell and returns its elevation if valid. Example: `elevation_m = 45.02` means approximately 45.02 metres in RH 2000 at the sampled raster cell.

Slope (Marklutning)

The backend reads a small local raster neighbourhood (3 × 3 cells) and estimates the slope of the ground surface in degrees. Example: `slope_degrees = 2.86` indicates a gentle local gradient. A point measurement is not a site-wide topographic survey.

Practical interpretation

- Relatively flat ground may justify a closer look at local runoff, low points and drainage capacity.
- Steeper ground may require additional investigation of accessibility, erosion, earthworks or infrastructure design.
- Raster resolution, interpolation and elevation uncertainty affect the reliability of both measurements.

An elevation or slope value alone cannot establish land suitability, drainage adequacy or construction safety.

07 Depressions, low points and map layers

Terrain depressions (Terrängsänkor)

The application includes a derived depression raster. Where a usable value exists, the API returns `depression_depth_m`; where it does not, the value may be null. A depression indicates terrain lower than surrounding ground according to the preparation method. It does not prove that water will accumulate during a specific rainfall event.

Local low points (Lokala lågpunkter)

Selected low-point features help demonstrate areas worth exploring. They are indicative geographic features, not a comprehensive catalogue of municipal flood hotspots.

Visible map layers

- Analysområden (demo): demonstration analysis locations or areas.
- Terrängsänkningar: indicative depressions.
- Lokala lågpunkter: selected local low points.
- Översvämningsscenarier: illustrative Stångån scenario overlays.
- Screeningzoner (demo): simplified screening categories.
- Terrain Elevation / Terrain Slope: pre-rendered visual terrain overlays.

Layers can be toggled to compare the same location against different terrain characteristics. Map overlays provide visual context; numerical point results come from the backend where available.

08 Stångån scenario method and its limits

Scenario levels

The demonstration offers water-level increments from +0.0 m to +3.0 m in steps of 0.5 m. The backend uses a provisional reference elevation of 36.60 m RH 2000. This is an illustrative calculation baseline, not a verified observed Stångån water level.

Calculation example

At +1.0 m, the threshold elevation is $36.60 + 1.00 = 37.60$ m RH 2000. Valid DEM cells at or below this threshold are considered eligible. The algorithm starts from cells marked as river and propagates through eligible cells using four-neighbour connectivity (up, down, left and right).

The selected location is classified as inside or outside this calculated connected terrain area. The API explicitly returns `validated_flood_prediction = false`.

What is NOT simulated

- Measured river discharge, flood probability or return periods.
- Flow velocity, flood timing or water depth from a validated hydraulic model.
- Stormwater pipes, pumps, culverts or underground drainage connections.
- Complete hydraulic barriers, structures and calibrated boundary conditions.
- Rainfall-runoff processes, infiltration or detailed urban hydrology.

“Outside the scenario” does not mean flood-safe. “Inside the scenario” does not establish a legally or scientifically validated flood extent. Use authoritative flood hazard mapping and qualified hydraulic analysis for real decisions.

09 Screening indicators and automated recommendations

The dashboard combines selected geographic indicators into a simplified demonstration screening. The colours describe how many demonstration indicators are triggered, not official risk classes.

Colour	Interpretation
Green	No demonstration indicator triggered.
Yellow	One demonstration indicator triggered.
Red	Two or three demonstration indicators triggered.

Colour	Interpretation
Grey	Required data is missing or unavailable.

Recommendations translate GIS values into readable observations. For example, a low slope may trigger a suggestion to investigate local runoff and nearby low points. These messages are rule-based explanations rather than validated AI/ML hazard predictions.

Green does not certify safety. Red does not prohibit construction. Grey is missing information, not evidence of low risk. An appropriately qualified person must review results and the source data.

10 User guide: a municipal employee's workflow

Step-by-step instructions

- 1. Open <https://concordebazi.github.io/CB-WebGIS-Demos/georisk-ai/> in a browser.
- 2. Locate the left panel "Fastighetsanalys" and the selector "Välj analysområde".
- 3. Choose an available demonstration location; the selection is not a complete cadastral property search.
- 4. Click "Starta GIS-analys" and wait for the API response.
- 5. Read "Markhöjd", "Marklutning" and any available "Terrängsänkning" values in the right panel.
- 6. Open "Kartlager" and toggle relevant layers to understand the geographic surroundings.
- 7. Use "Scenarioanalys" to select a hypothetical Stångån water-level increase.
- 8. Read the screening indicators and GIS recommendations, remembering their demonstration status.
- 9. Click "Generera riskrapport" to create the report.
- 10. Record unresolved questions and request verified datasets or specialist review before taking any official action.

If results are slow or missing

The free Render service may sleep when idle and require a cold start. If the API is temporarily unavailable, wait and retry. Missing depression values or grey screening categories indicate unavailable data; they should not be silently replaced with zero.

Reading the map

Use the satellite background to recognise buildings and urban form; use Street Map for road and place context. Layer opacity and colours are visual aids and do not represent official thresholds unless explicitly stated.

11 Municipal use cases and decisions supported

Situation	What GeoRisk AI can contribute / next step
Early development inquiry	Show local elevation and slope; decide whether a detailed survey or terrain assessment is needed.
Stormwater screening	Display depressions and low points; request verified drainage and cloudburst studies.
Planning near Stångån	Compare illustrative connected-area scenarios; consult official flood maps and hydraulic experts.
Internal GIS communication	Create a shared map and report to explain preliminary terrain observations.
IT modernisation workshop	Demonstrate a hosted geospatial API integrated with a browser-based map.
Infrastructure concept planning	Explore broad terrain constraints; commission engineering design data before detailed planning.

The strongest immediate use is education, orientation and early-stage screening. It can help formulate better questions, but cannot independently answer statutory planning, engineering or emergency-management questions.

12 GIS report: contents and interpretation

The “Generera riskrapport” control creates a demonstration GIS analysis report. The report presents available point measurements, selected scenario information, observations, data attribution and a limitations statement. Its exact populated fields depend on the selected location and available analysis values.

How to use the report responsibly

- Keep the location, scenario level and date/context of the analysis together.
- Distinguish observed/calculated DEM indicators from the illustrative river scenario.
- Preserve Lantmäteriet attribution and other required source credits.
- Treat recommendations as prompts for investigation, not definitive conclusions.
- Include the explicit statement that the report is not an official or verified flood-risk assessment.

For operational municipal use, reports would need approved templates, dataset versions, quality metadata, reproducible processing, audit information and review/sign-off procedures.

13 API reference for developers

Health endpoint

```
GET https://georisk-ai-api.onrender.com/
```

Returns an application name, running status and data-source identifier. This confirms the web service is responding; it does not validate the scientific model.

Elevation and scenario endpoint

```
GET https://georisk-ai-api.onrender.com/elevation?lat=58.4100&lon=15.6280&water_level=1.0
```

Parameter / field	Meaning
lat, lon	Input geographic latitude and longitude.
water_level	Illustrative increment in metres; supported values 0.0, 0.5, ..., 3.0.
elevation_m	DEM-derived elevation, in metres RH 2000.
slope_degrees	Local slope in degrees.
depression_depth_m	Available depression depth; null if unavailable.
stangan_scenario	Object containing scenario increment, elevation and membership.
within_scenario	Boolean membership in the calculated connected-area mask.
validated_flood_prediction	False for this demonstration method.
vertical_reference / source	Height reference and source attribution.

Example response

```
{"latitude":58.41,"longitude":15.628,"elevation_m":45.02,"slope_degrees":2.86,"depression_depth_m":null,"stangan_scenario":{"water_level_increase_m":1.0,"scenario_elevation_m":37.6,"within_scenario":false,"method":"DEM-based terrain connectivity","validated_flood_prediction":false},"vertical_reference":"RH 2000","source":"Lantmäteriet"}
```

The frontend and backend use HTTPS across different origins. CORS is configured to permit the public GitHub Pages origin and local development origins.

14 Development, repository and deployment

Repository

The project is stored under the CB-WebGIS-Demos GitHub repository, with the web application in `georisk-ai/` and the Python service in `georisk-ai/backend/`. A root-level `render.yaml` contains deployment configuration.

Local development

- Edit HTML, CSS and JavaScript in Visual Studio Code.
- Run the frontend with a local static web server (for example VS Code Live Server).
- Install Python dependencies from `backend/requirements.txt`.
- Run the backend locally with Uvicorn and test the health and `/elevation` endpoints.
- Inspect the browser developer console and API responses when diagnosing issues.

Public deployment

- Commit and push approved frontend/backend changes to GitHub.
- GitHub Pages serves the static frontend.
- Render builds the Python service using `pip install -r requirements.txt`.
- Render starts the API with `uvicorn api:app --host 0.0.0.0 --port $PORT`.
- Test the public API before testing the complete public application.

The live Render service is on a free plan and may spin down when inactive. It is not appropriate for a critical municipal service without an operational hosting and service-level review.

15 Quality assurance, security and limitations

Scientific and data limitations

- Coverage is restricted to the prepared Linköping study area.
- DEM quality and raster resolution affect derived values.
- The local slope estimate does not replace surveyed site gradients.
- Depression and low-point layers do not model complete urban drainage.
- The Stångån baseline and scenarios are illustrative and unvalidated.
- Screening colours are not official planning or hazard categories.

Operational controls needed before municipal adoption

- Verify licensing, data provenance, processing scripts and CRS/height metadata.
- Validate analytical outputs against independent, authoritative reference data.
- Document model assumptions, thresholds, uncertainty and version history.

- Introduce monitoring, test coverage, error handling and performance budgets.
- Assess information security, access permissions, privacy and accessibility.
- Define professional review, approval, audit trail and incident procedures.

Never use this demonstration as the sole basis for building permits, land suitability decisions, engineering design, emergency response, insurance or statutory environmental assessment.

16 Roadmap: possible future municipal platform

The following are development opportunities, not capabilities already implemented in version 1.0.

- Authorised cadastral and property search with parcel-specific reports.
- Integration of municipal planning maps, zoning, infrastructure and stormwater assets.
- Official flood/cloudburst datasets and validated hydrological/hydraulic models.
- Expanded study areas and configurable municipality-specific data packages.
- Role-based access, user authentication, audit logs and governance controls.
- Documented model validation, uncertainty visualisation and reproducible reports.
- A carefully controlled AI explanation assistant with source citations and human review.
- Production hosting, automated tests, observability and support processes.

A practical pilot would start with one municipality, a clearly defined use case, an authoritative dataset inventory, acceptance criteria and a joint GIS/IT/planning review.

17 Glossary, sources and project information

Term	Meaning
GIS	Geographic Information System.
DEM	Digital Elevation Model: raster representation of ground height.
Raster / vector	Grid-based geographic data / points, lines and polygons.
GeoJSON	Format for geographic features.
RH 2000	Swedish national vertical reference system.
CRS	Coordinate Reference System used to locate geographic positions.
API / JSON	Software interface / structured data-exchange format.

Term	Meaning
FastAPI / Uvicorn	Python API framework / application server.
Rasterio / NumPy / SciPy	Geospatial raster I/O / numerical arrays / scientific operations.
Screening	Preliminary examination indicating questions for further investigation.

Project links

- Developer: CB Web & GIS — <https://cbwebgis.se>
- Live demo: <https://concordebazi.github.io/CB-WebGIS-Demos/georisk-ai/>
- API: <https://georisk-ai-api.onrender.com>
- Repository: <https://github.com/concordebazi/CB-WebGIS-Demos>
- Lantmäteriet Markhöjdmodell Nedladdning:
<https://geotorget.lantmateriet.se/geodataprodukter/markhojdmodell-nedladdning-api>
- Leaflet: <https://leafletjs.com> | FastAPI: <https://fastapi.tiangolo.com>
- Rasterio: <https://rasterio.readthedocs.io> | Render: <https://render.com>

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