Interreg Baltic Sea Region

Co-funded by the European Union

SMART GREEN MOBILITY
CITYAM

Consolidated geospatial tool for landing site planning and prioritisation

Based on the FGI Web Collaborative GIS (CGIS) platform

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January 2025

Table of Contents

Contents

1. Introduction 2
2. Planning process 3
2.1 Phases of the planning process 4
2.2 Roles and responsibilities in the planning process 5
3. Piloting feedback 6
3.1 Key Feedback on CGIS Tool 6
3.2 Functionalities of the tool 10
3.3 Suggestions for Improvement 12
4. Accessing and using the CGIS tool 13
References 13
Annex 1. User manual 14

1. Introduction

The CITYAM project (funded by Interreg Baltic Sea Region) focuses on advancing the sustainable and efficient integration of drones into urban environments. A key principle of drone landing site planning within the project is the fostering collaboration among diverse stakeholders to ensure functionality, safety, and social acceptance. By leveraging geospatial data and advanced analytics, the planning process aims to balance technical feasibility with community needs, enabling cities to adapt to the growing demands of urban air mobility.

The Collaborative Drone Landing Site Planning and Selection Tool was conceptualized in 2023, detailed by Mladenović et al. (2024), and implemented in 2024 by the Finnish Geospatial Research Institute (FGI) based on their earlier work on Collaborative GIS (CGIS, Kettunen et al. 2020). It is designed to support the efficient integration of urban air mobility into city landscapes by facilitating the strategic planning and establishment of drone landing sites. As the use of drones in urban areas continues to grow, the tool enables stakeholders, such as city planners, drone operators, civil aviation authorities (CAA), and residents, to collaboratively identify and assess suitable locations for drone landings (Figure 1).

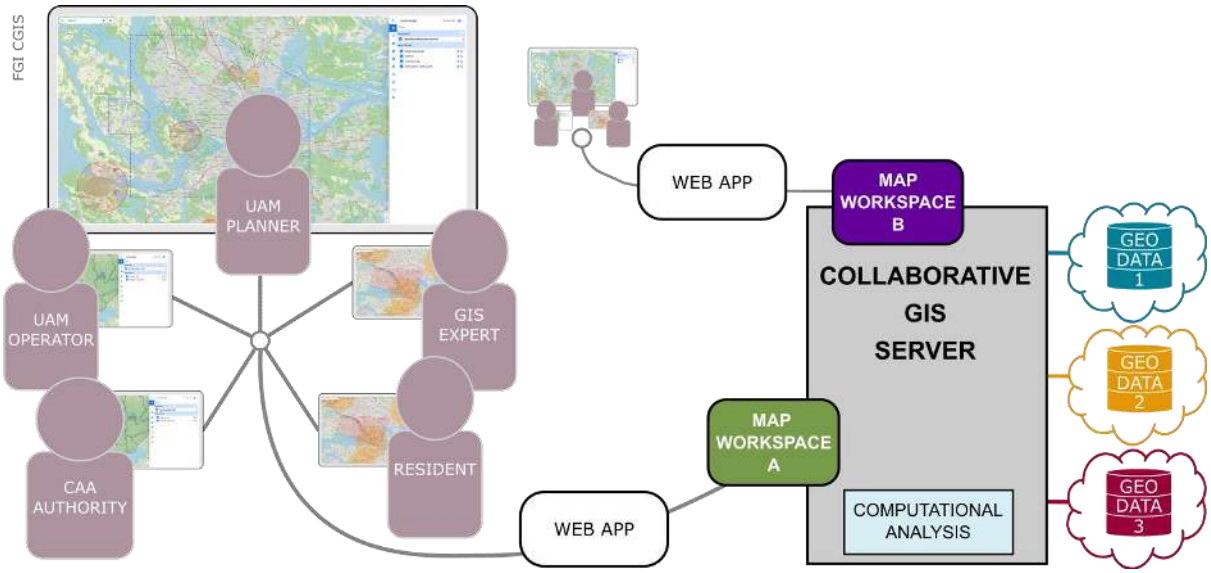


Figure 1: Concept of the Web Collaborative GIS

Through comprehensive geospatial data analysis, the tool enhances situational awareness and considers factors such as urban functions, activities, social values, and human factors. Its weighted multi-criteria analysis approach guides local level decision-making, optimizing landing sites for safety, efficiency, and alignment with community needs. This collaborative process promotes effective communication among stakeholders, fostering well-informed and sustainable urban drone operations.

An example of the analysis and generated “Traffic Light Map” is presented in Figure 2. The map is based on a weighted multi-criteria analysis, with the applied criteria and their weighting displayed on the right. Green bars represent 'pull' factors that favor suitability, while red bars indicate 'push' factors that constrain or limit site selection.

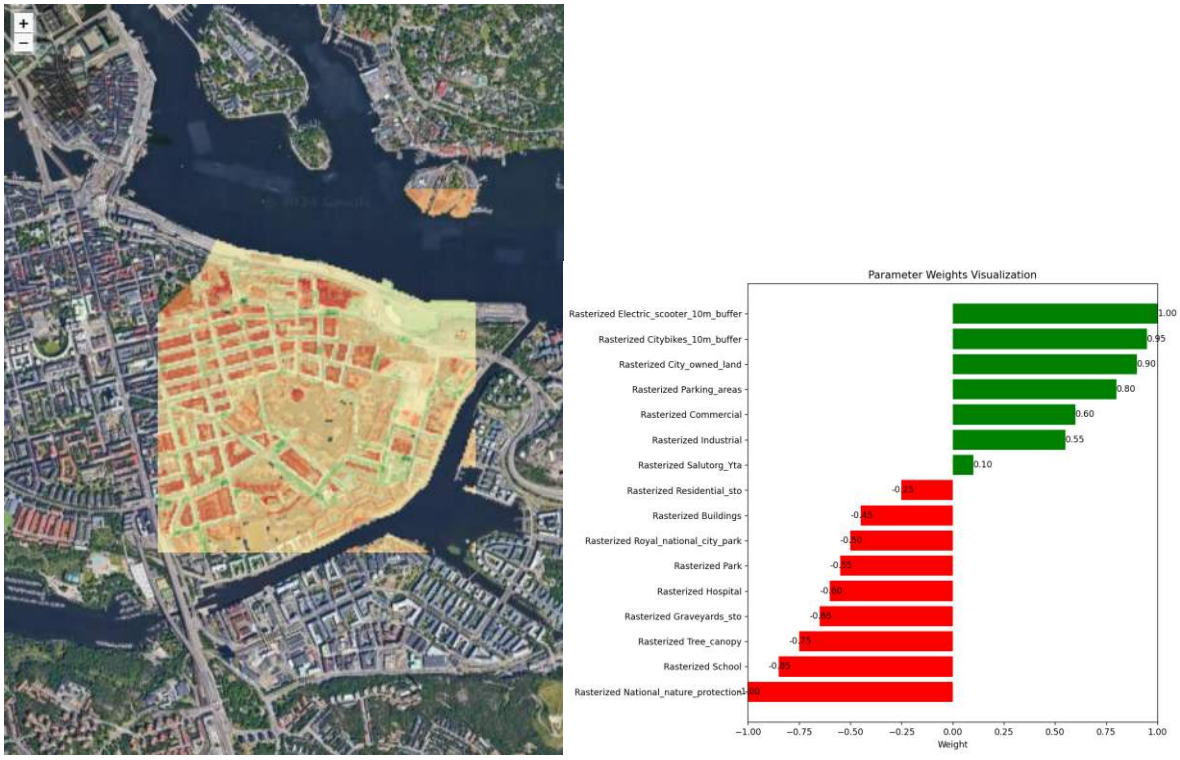


Figure 2: A Traffic Light Map for Drone Landing Sites in Stockholm, created using the cGIS platform, highlights potential landing sites within the area of interest.

The technical implementation prioritized end-user requirements, which were gathered through user stories in workshops with the three CITYAM lead cities: Helsinki, Stockholm, and Hamburg. Piloted by these cities in October 2024, the tool was subsequently refined based on their feedback. The final version is shared with the CITYAM replicator cities of Tartu, Riga and Gdansk and additional users.

This document outlines the intended use of the tool. Section 2 details the principles guiding the proposed landing site planning and selection process in urban environments, forming the foundation for piloting and testing the tool. Section 3 summarizes the initial evaluation of the tool conducted during its piloting phase in the CITYAM lead cities. Section 3 provides a comprehensive technical user guide.

2. Planning process

Dividing the planning process into phases is essential for the successful execution of Urban Air Mobility (UAM) projects in local or regional authorities. The sequence of phases in the proposed planning process can be adjusted to accommodate local practices, and iterations of the same phases can enhance the overall outcome. For instance, revisiting location choices or incorporating public participation might require reordering phases or repeating specific ones to address emerging needs.

The planning process was initially defined in the CITYAM Deliverable 1.4 (Mladenović et al., 2024) and is generally recommended to follow five phases. However, the precise number and sequence of phases should be determined by the UAM planner in collaboration with key stakeholders, including municipal authorities, regulatory bodies, and civil aviation authorities (CAAs), ensuring shared responsibility and alignment with local requirements.

The planning process and its stakeholders is visualized in Figure 3 and discussed in the following subsections.

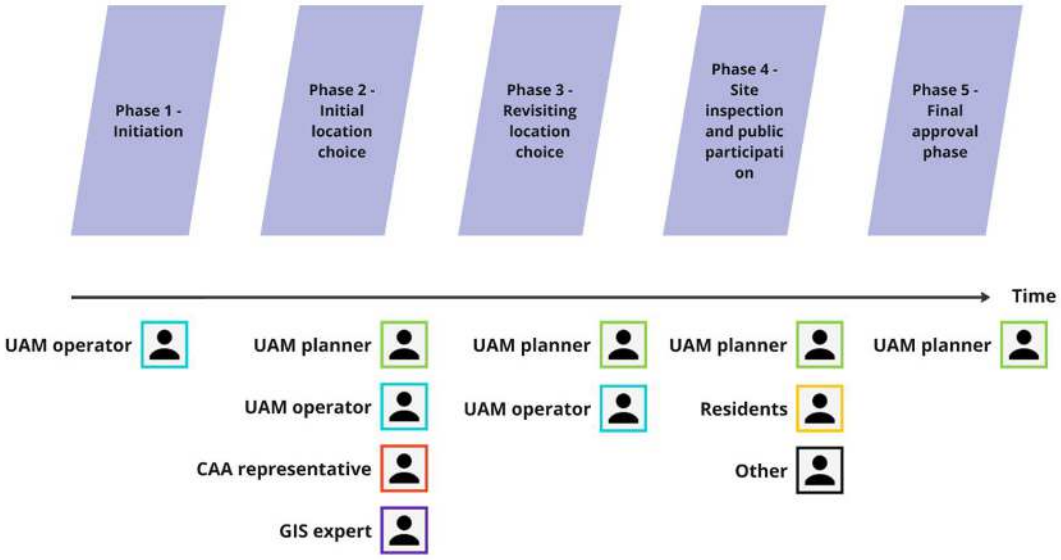


Figure 3: The concept of phases and stakeholders of the planning process.

2.1 Phases of the planning process

Phase 1 - Initiation (suggested as mandatory): In this phase, the strategic objectives of the project are defined, the project team is established and a preliminary estimation of the resources to be used for the whole project and the challenges expected are estimated by the UAM operator. The UAM operator requests locations from both CAA representative and UAM planner. The initial plan includes a visual representation of the requested sites along with the operational characteristics of planned UAM service. Further details are discussed in Mladenović et al. (2024).

Phase 2 - Initial location choice (suggested as mandatory): In the second phase, the UAM Planner organizes a meeting aimed to preliminary analyze the requested sites or locations with respect to basic criteria such as airspace regulations, suitable infrastructure and other factors according to the city-development strategy. During the meeting, various stakeholders from municipalities, the communities, and the agencies participate in the decision-making. Further details are discussed in Mladenović et al. (2024).

Phase 3 - Revisiting location choice (suggested as optional): As new data, information or circumstances evolve, this phase allows a dynamic revision of preliminary location choices. This phase provides an opportunity to adapt to changing conditions, which may involve updated information on aspects such as urban development plans, environmental considerations, and technological changes to make sure the selected locations fit optimally within the long-term vision and a municipal strategy. Further details are discussed in Mladenović et al. (2024).

Phase 4 - Site inspection and public participation (suggested as optional): In this phase, the site inspection team conducts an assessment of the selected locations from previous phases. The factors such as infrastructure readiness, environmental impacts, and safety considerations are analyzed for shortlisted locations. Public participation can also be integrated with these activities as an important means of collaboratively understanding challenges and solutions.

Phase 5 - Final approval (suggested as mandatory): In this phase, the project team consolidates findings from the different analysis stages into a comprehensive proposal for regulatory bodies and various key municipal and CAA stakeholders. During this phase, the process navigates through the regulatory processes at play, the resolution of outstanding concerns, and further permissions required. Passing through this phase marks a green light for the implementation of the proposed UAM service in selected locations.

2.2 Roles and responsibilities in the planning process

The following provides an overview of the anticipated roles and responsibilities of stakeholders involved in Urban Air Mobility (UAM) planning and operations. The exact number of stakeholders may vary depending on the municipality. Each stakeholder plays a vital role in the successful planning, implementation, and operation of UAM, contributing to the overall safety, effectiveness, and societal acceptance of this emerging mode of transportation. The need for additional stakeholders should be assessed regularly, guided by the responsibility principles outlined by Mladenović et al. (2024). Importantly, the UAM planner is positioned as a deliberative authority, aligning with the modern concept of democracy as described by Mäntysalo et al. (2023).

UAM Planner (Municipal or Regional): Responsibilities: Develop and implement strategic plans for integrating UAM into the municipal or regional transportation infrastructure. UAM planner organizes the meeting where stakeholders discuss the suitability of requested sites with help of DST. UAM planner assess and choose suitable locations for UAM infrastructure, considering urban development, zoning regulations, and community impact. Collaborate with various stakeholders to ensure alignment with broader urban planning goals. Could be a cross-departmental position, in contrast to existing similar roles in transport or planning departments

UAM Operator (City-Owned or Commercial): Responsibilities: Manage the day-to-day operations of the UAM service, including scheduling, maintenance, and safety protocols. Collaborate with the UAM Planner to select optimal locations for vertiports or takeoff/landing zones. Ensure compliance with aviation regulations, safety standards, and community expectations. Implement marketing strategies to promote UAM services to residents and visitors.

GIS Expert in a Municipal Organization; Responsibilities: Utilise Geographic Information System (GIS) tools to analyse spatial data and support UAM planning. Provide mapping, assist in using DST and spatial analysis to identify suitable locations for UAM infrastructure. Collaborate with planners and operators to integrate GIS data into decision-making processes, ensuring efficient and safe UAM operations.

Civil Aviation Authority (CAA) Representative: Responsibilities: Enforce aviation regulations and standards related to UAM operations. Work with UAM planners and operators to ensure compliance with safety, airspace management, and licensing requirements. Provide regulatory guidance to facilitate the integration of UAM into existing aviation frameworks.

Residents: Responsibilities: Actively participate in public engagement sessions to express concerns, preferences, and feedback related to UAM implementation. Stay informed about the project's progress and potential impacts on the community. Engage in discussions to ensure that UAM planning considers residents' perspectives and addresses their needs.

Other Stakeholders Land Owner/Property Owner: Provide input on land use and property development related to UAM infrastructure. Collaborate with planners to negotiate land use agreements.

Police/Emergency Services: Collaborate on emergency response planning and procedures related to UAM incidents.

Air Navigation Service Provider: Coordinate airspace management and navigation services to ensure the safe integration of UAM within existing air traffic.

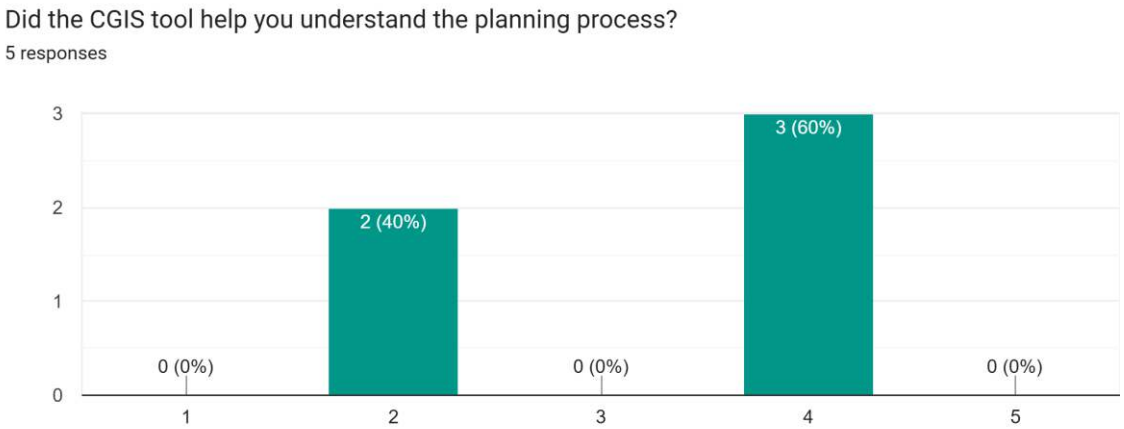
Environmental Organisation: Advocate for environmentally responsible UAM practices and assess potential environmental impacts.

3. Piloting feedback

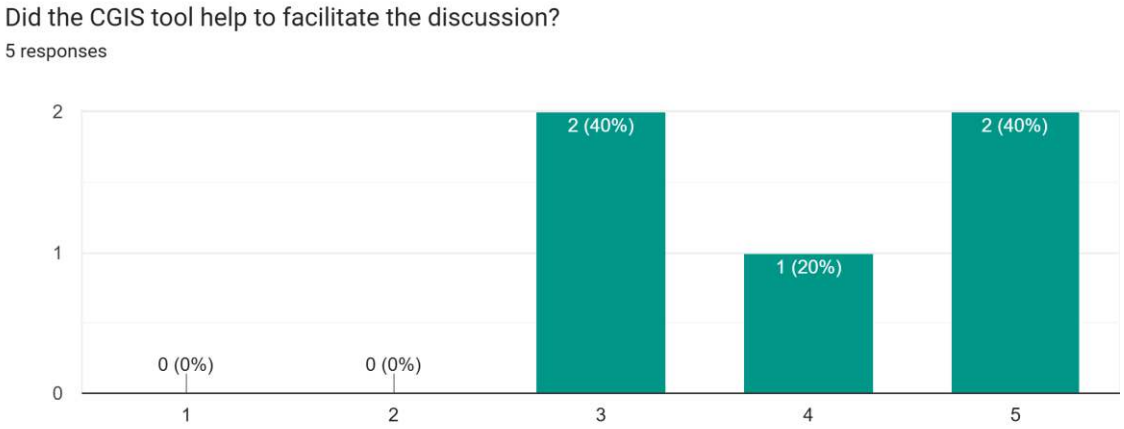
The planners in the CITYAM lead cities of Helsinki, Hamburg and Stockholm conducted three workshops to test the CGIS tool. After the workshops, participants filled a survey questionnaire. The survey evaluated the effectiveness of the tool in aiding understanding, participation, and informed decision-making in planning processes. This section includes an overview of the responses and highlights the key areas for improvement based on participant feedback. The presented feedback must be considered preliminary and not as a comprehensive or scientific evaluation of the tool due to the low number of respondents.

3.1 Key Feedback on CGIS Tool

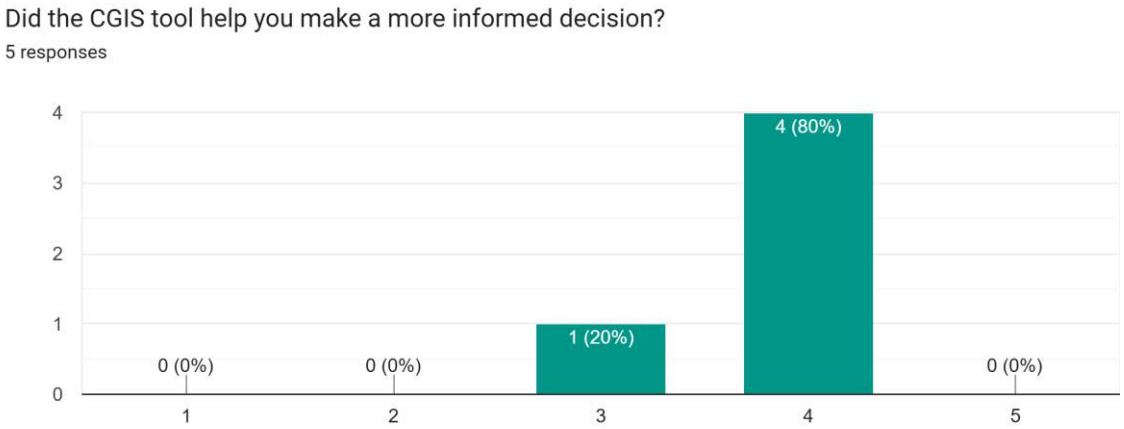
Understanding the Planning Process: Out of 5 respondents, 40% rated the tool “2”, and 60% rated it a “4” on a scale of 1 to 5, reflecting its effectiveness in helping users understand the planning process.



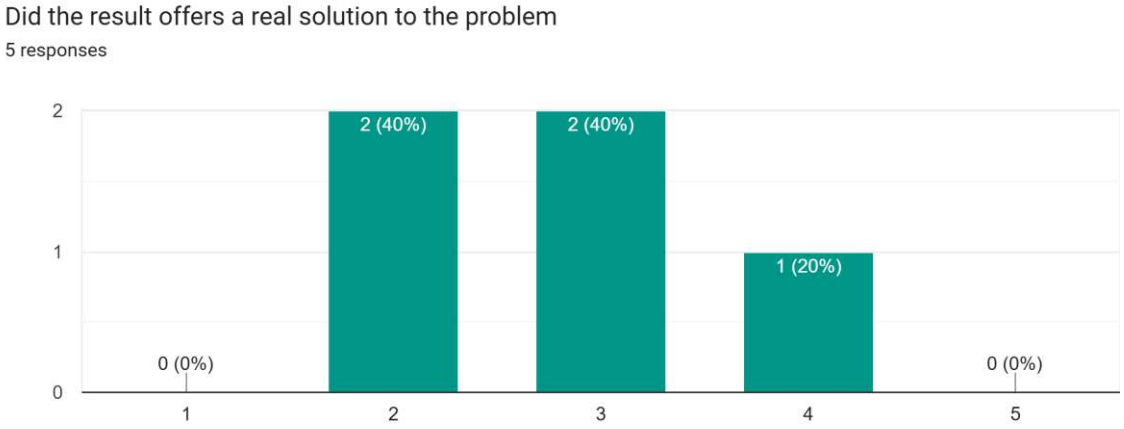
Facilitating the discussion: It can be seen that 40% rated the tool “3”, 20% rated it “4”, and 40% rated it “5” on a scale of 1 to 5, indicating its role in facilitating the discussion.



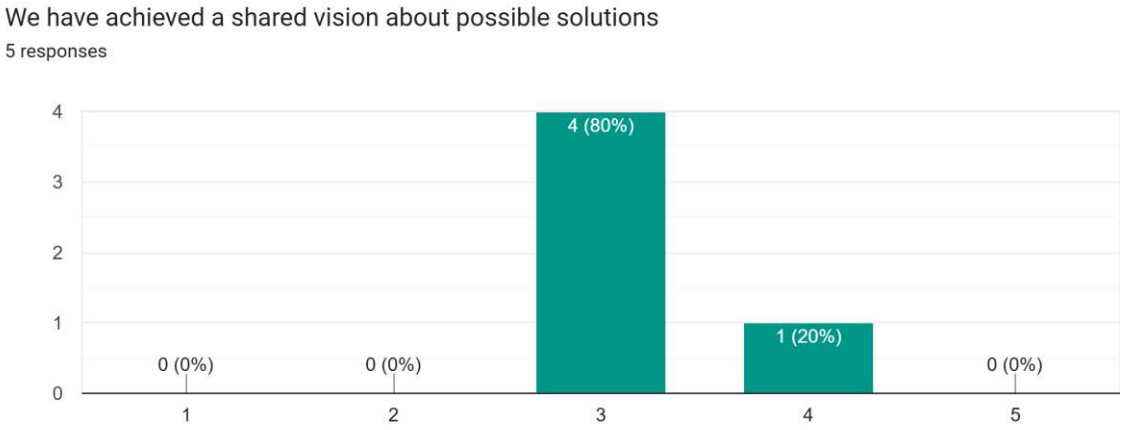
Making Informed Decisions: Of 5 respondents, 20% rated the tool “3”, and 80% rated it “4” on a scale of 1 to 5, indicating its role in helping make a more informed decision.



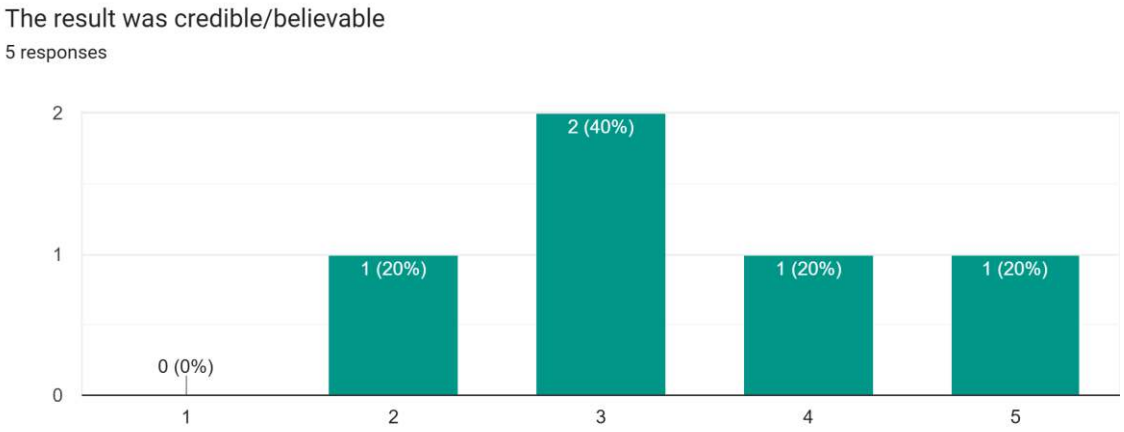
Solution to real problem: The 40% of respondents rated the result “2”, 40% rated it “3”, and 20% rated it “4” on a scale of 1 to 5, indicating its effectiveness in offering a real solution to the problem.



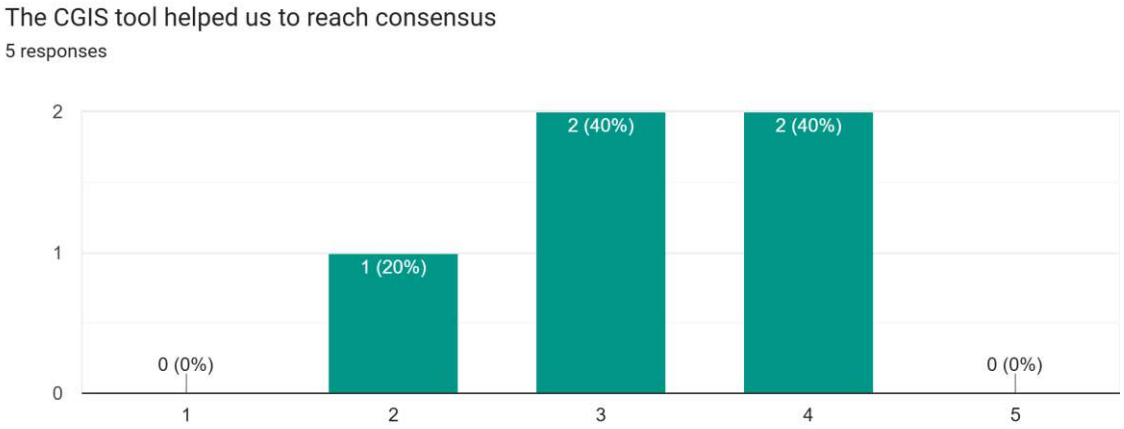
Achievement of shared vision: 80% of respondents rated the level of shared vision as "3," indicating a moderate consensus, while 20% rated it as "4," suggesting a slightly higher agreement. No respondents rated it as "1," "2," or "5," reflecting a general perception of moderate alignment.



Credibility of the result: 40% of respondents rated the result as “3,” indicating moderate credibility, while 20% rated it “2,” “4,” and “5” each. No respondents rated it as “1,” suggesting a range of opinions leaning towards the mid to high scale of credibility.

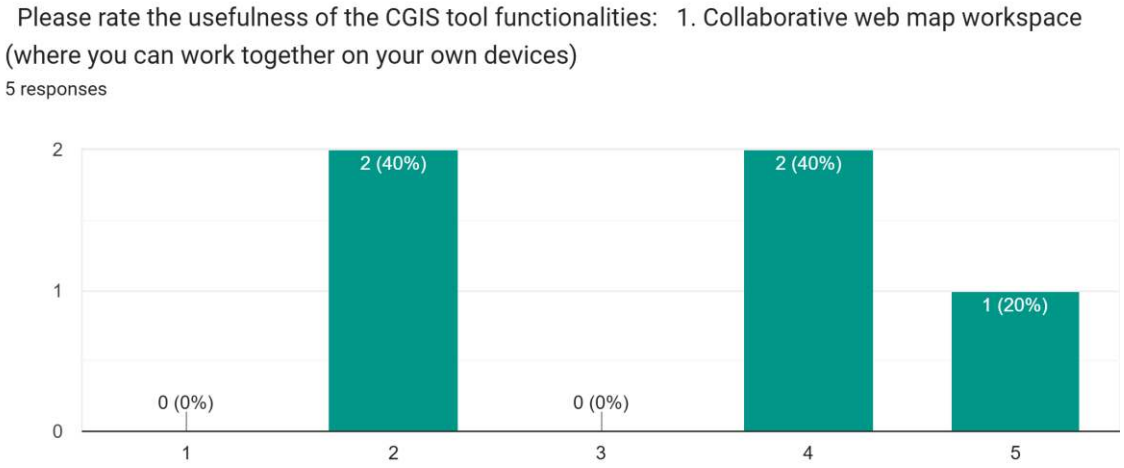


Consensus through the CGIS tool: 40% of respondents rated the tool as “3” and another 40% rated it as “4” on a scale of 1 to 5, indicating moderate to high effectiveness in helping reach consensus. Additionally, 20% rated it as “2,” and no respondents gave ratings of “1” or “5.”

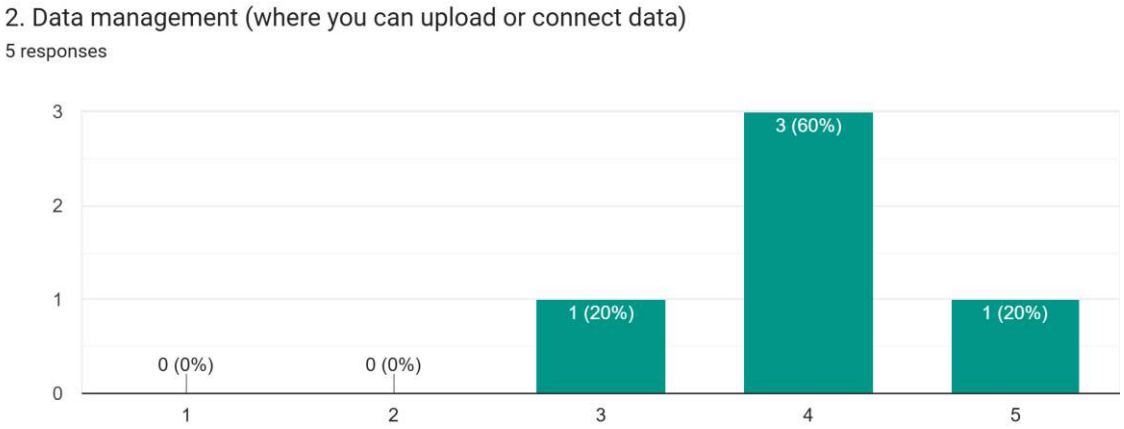


3.2 Functionalities of the tool

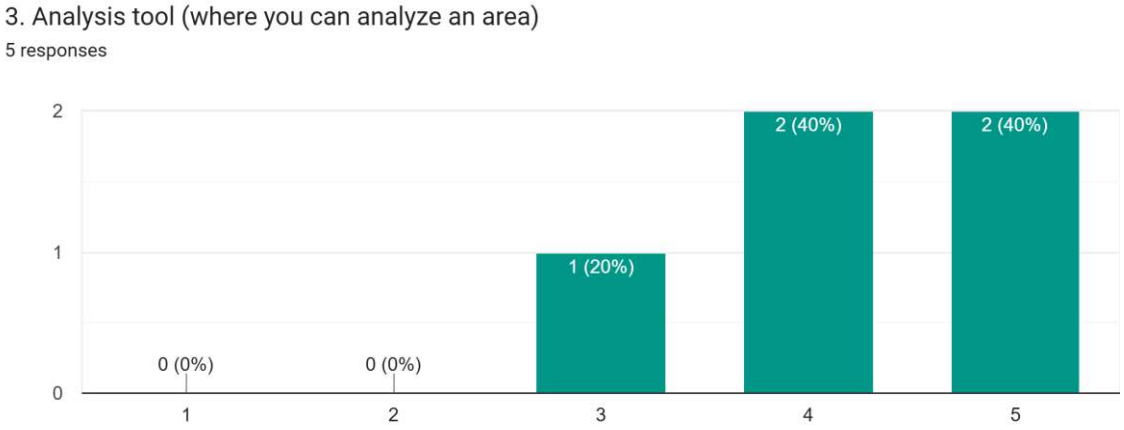
Collaborative web map workspace: 40% of respondents rated the usefulness as “2” and another 40% rated it as “4,” indicating a split perception between lower and higher usefulness. Additionally, 20% rated it as “5,” suggesting high usefulness. No respondents rated it as “1” or “3,” reflecting varied levels of satisfaction with the tool's functionality.



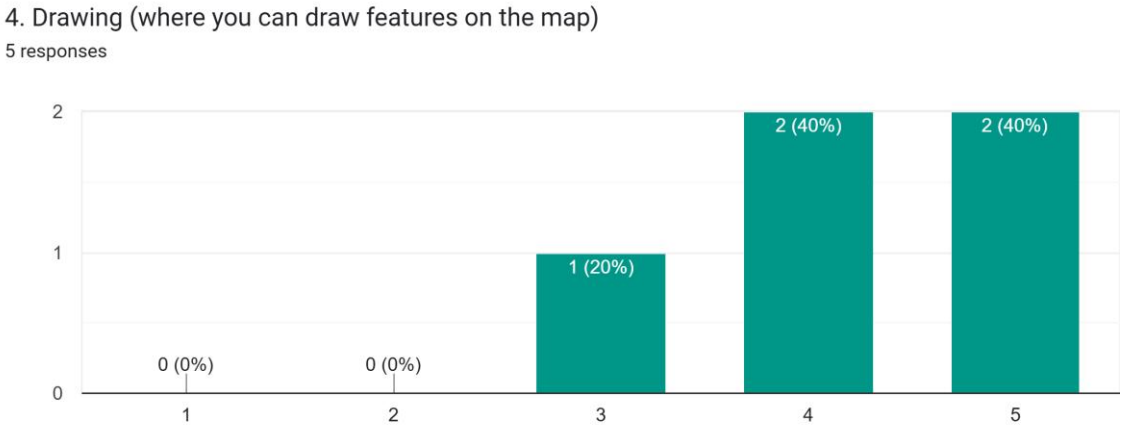
Data management functionality: 60% of respondents rated the usefulness of data management as "4," indicating a high level of satisfaction. Additionally, 20% rated it as "3," suggesting moderate usefulness, and another 20% rated it as "5," reflecting very high satisfaction. No respondents rated it as "1" or "2," indicating a general perception of the functionality as useful to very useful.



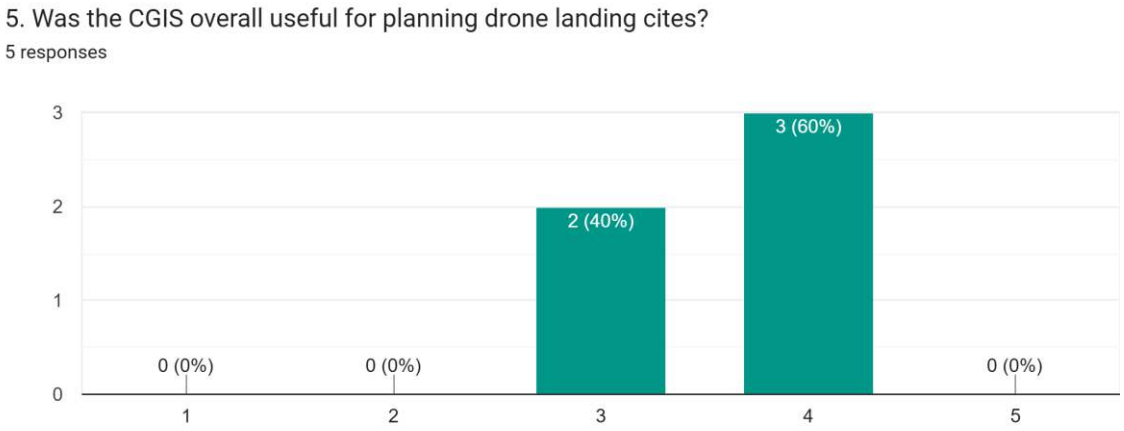
Analysis tool functionality: 40% of respondents rated the analysis tool as "4," and another 40% rated it as "5," indicating high to very high satisfaction. Additionally, 20% rated it as "3," suggesting moderate usefulness. No respondents rated it as "1" or "2," reflecting a generally positive perception of the tool's ability to analyze areas.



Drawing functionality: 40% of respondents rated the drawing feature as "4," and another 40% rated it as "5," indicating high to very high satisfaction. Additionally, 20% rated it as "3," suggesting moderate usefulness. No respondents rated it as "1" or "2," that reflects an overall positive perception of the ability to draw features on the map.



Overall usefulness of the CGIS for planning drone landing sites: 60% of respondents rated it as "4," indicating high usefulness, while 40% rated it as "3," suggesting moderate usefulness. No respondents rated it as "1," "2," or "5," which reflects a consensus of moderate to high satisfaction with the tool's overall functionality for this purpose.



3.3 Suggestions for Improvement

Participants suggested the following areas for improvement in the CGIS tool:

Streamlining Workflow for Layer Management: The process of switching from the data manager to the layer manager when adding new layers could be streamlined. Users should have the option to add multiple layers to the map and manually switch to the layer manager when ready.

Addressing Development Gaps: The tool appears to be in an early development phase, with missing key data layers and limited template support. A demonstration video could enhance usability and onboarding.

Enhancing Technical Reliability: The tool's functionality needs to be refined, as technical issues were encountered during use, such as errors in analysis runs and difficulties with data uploading. These challenges highlight the need for improved system reliability.

Integrating Help and Guidance: Basic integrated help or guidelines should be included in the application to explain how weighting affects the analysis. For example, the relative impact of changing a layer's weight from 0.4 to 0.6 should be clarified to aid decision-making.

4. Accessing and using the CGIS tool

The FGI Web Collaborative GIS (CGIS) for CITYAM is a web map platform for collaborative spatial planning. It is a Spatial Decision Support System (SDSS) in which participants can work together on a shared map workspace each on their own devices (see Figure 1). The key features of the CGIS are:

- map user interface
- workspace manager
- data manager
- layer manager
- map drawing tools
- analysis tool for weighted multi-layer analysis

For example, the CGIS platform can be used by multiple people working together to discuss, plan, and decide the locations of drone-in-a-box sites, where drones are recharged and stored.

The CGIS tool is available for pilot use at https://vm2425.kaj.pouta.csc.fi/.

Features, functionalities and usage of the CGIS are further described in the dedicated user manual in Annex 1. This manual includes information on the various tool views, User authentication and login, how to work with the Workspaces, information on Data Management, information on the features as well as Drawing Tools and Feature Management. It goes on to describe the Launch and Landing Site Analysis Tool and concludes with an explanation on Print and Export Options.

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Annex 1. User manual

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SMART GREEN MOBILITY
CITYAM

FGI Web Collaborative GIS (CGIS) for CITYAM

CGIS User Manual

20.12.2024

Table of Contents

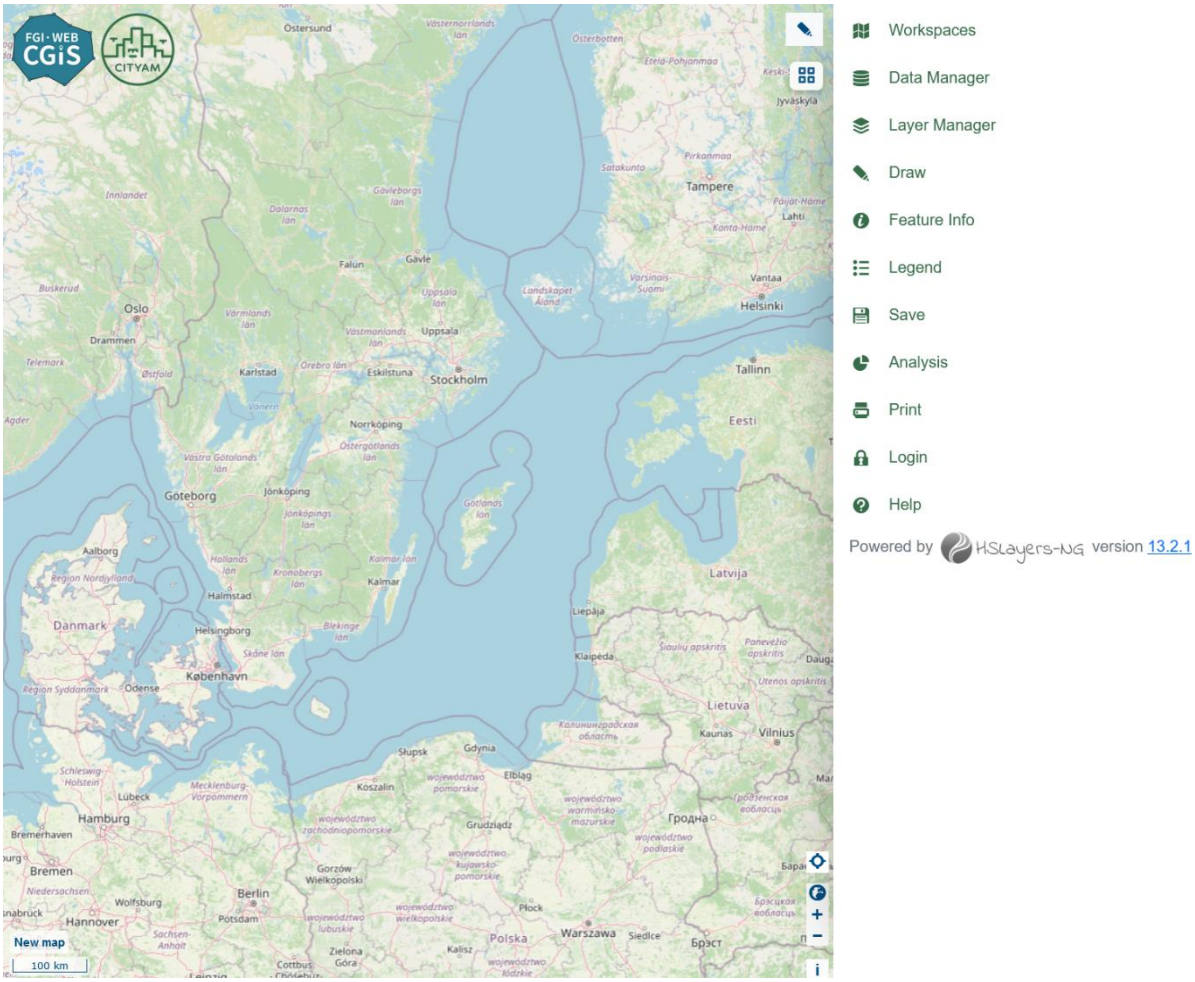
1. Introduction 2
2. Overview 2
2.1. Map View 3
2.2. Panel Selector 3
3. User Authentication and Login 3
4. Working with Workspaces 4
4.1. Managing Workspace Permissions and Sharing 4
5. Data Management 4
5.1. Adding Data via URL or File 4
5.2. Searching, Filtering, and Managing Data 5
5.3. Layer Manager 5
6. Drawing Tools and Feature Management 5
6.1. Creating and Editing User-Generated Layers 5
6.2. Performing Operations on Drawn Features 5
7. Feature Information 6
8. Legend 7
9. Saving the Workspace 8
10. Launch and Landing Site (LLS) Analysis Tool 9
10.1. Configuring and Running the Analysis 9
10.2. Results and Metadata 11
10.3. Troubleshooting 12
11. Print and Export Options 12

1. Introduction

This manual introduces a platform called FGI Web Collaborative GIS (CGIS) for CITYAM, a tool designed to help users visualize, analyse, and collaborate with geospatial data for planning urban drone landing sites by groupwork. The CGIS interface provides, for example, interactive map, data management panels, drawing and editing functions and an analysis module. Users can import geospatial data from external providers, manage their own geospatial datasets, control access and permissions, and perform spatial analyses — such as identifying optimal launch and landing sites for drones in urban areas.

2. Overview

The CGIS interface is composed of two main sections: the **Map View** on the left and a **Panel Selector** on the right.



Landing page: map view (left), panel selector (right).

2.1. Map View

Navigation of the map view:

- **Mouse/Touchpad:** Drag the map to pan; scroll or use pinch gestures to zoom in and out.
- **Zoom Controls:** Zoom-in and zoom-out buttons are located at the bottom-right corner.
- **Base Layer Selector:** At the top-right of the map, switch between available basemaps.
- **Locate Me:** A button at the bottom-right corner centres the map on your current location (with permission).
- **Draw Shortcut:** A “Draw” button at the top-right opens drawing tools, mirroring the “Draw” panel functionality.

2.2. Panel Selector

The right-hand panel provides access to various functionalities. Selecting a panel reveals its tools and options:

- **Workspaces:** Login, open, delete, share, set permissions and filter workspaces.
- **Data Manager:** Add or remove layers, set permissions, and import data from URLs or files.
- **Layer Manager:** Toggle layer visibility, edit styling, reorder layers, rename them, and zoom to their extent.
- **Draw:** Create and edit vector features (points, lines, polygons), and perform operations such as difference, union, intersection, and splitting.
- **Feature Info:** Inspect attributes of layer features by pointing specific locations on the map.
- **Legend:** View the legend for all visible layers.
- **Save:** Save the current view as a workspace for collaboration.
- **Analysis:** Configure and run weighted overlay analysis on selected layers, then add the resulting layers back to the map.
- **Print:** Print or export the current map view with optional styling and scale settings.
- **Login:** Login and logout to and from the system.
- **Help:** Access the user manual and other help resources.

3. User Authentication and Login

You can authenticate to the system via the Login panel that guides you to Layman Portal. When prompted for application permissions, authorise reading and writing rights. After logging in, you can manage your own data, workspaces, and layers with associated access controls.

4. Working with Workspaces

In Workspaces you can login to the system and open, delete, share, and set permissions for workspaces. Workspaces act like saved map files or projects.

Through the Workspaces panel, you can:

- **Open a Workspace:** Select a workspace to load its layers, extent, and settings.
- **Import a Workspace:** Import a workspace from a JSON file or by entering a workspace URL.
- **Filter Workspaces:** Use keywords, INSPIRE themes, map extent filters, and sorting options (by title, date, bounding box). You can also show only workspaces that have been created by the user logged in.
- **Reload the list of workspaces:** Refresh the list of available workspaces.
- **Save:** Save the workspace.

4.1. Managing Workspace Permissions and Sharing

In the Workspaces panel:

- **Set Permissions:** Define read and write access rights of workspaces to be public or private. The rights can also be set for everyone or for specific users.
- **Delete Workspaces:** Remove unwanted workspaces.
- **Metadata View:** View workspace metadata, thumbnails, and links to full records.

(Note: Social network sharing is not available.)

5. Data Management

The **Data Manager** panel allows you to discover, filter, and add layers to the map. Layers can come from external URLs (WMS, WMTS, WFS) or from local files (KML, GPX, GeoJSON, Shapefile, Raster). You can also set permissions for users and remove layers.

5.1. Adding Data via URL or File

- **URL Imports:** Add layers from a WMS/WMTS/WFS or other supported OGC-compliant sources.
- **File Imports:** Drag-and-drop or select files from your device (KML, GPX, GeoJSON, Shapefile, Raster image, and Raster time series).

5.2. Searching, Filtering, and Managing Data

- **Search and Filter:** Limit results to your data, current map extent, or specific keywords.
- **Record Count:** Set how many records appear per page.
- **Add to Map:** Once a dataset is found, click “Add to map” to load it as a layer.
- **Metadata and Permissions:** Check metadata, set public/private permissions, and remove data if needed.

5.3. Layer Manager

In **Layer Manager** you can toggle the visibility of layers added to the map as well as edit their opacity or styling. The styling options available depend on the format/file type of the layer. You can also rename layers and zoom to their extent. You can also reorder layers.

- **Visibility and Styling:** Toggle layer visibility, adjust opacity, and edit styling (where supported, e.g., WFS layers).
- **Reorder Layers:** Drag and drop layers to change their drawing order.
- **Rename and Zoom:** Rename layers or zoom to their extents.
- **Download and Copy:** Download layer content as GeoJSON or create a copy of a layer.
- **Remove Layers:** Remove selected layers from the map or entirely from the Data Manager.
- **Resetting the Map:** Remove all added layers and reset the background map. Refresh the browser to restore default basemaps.

6. Drawing Tools and Feature Management

6.1. Creating and Editing User-Generated Layers

In the **Draw** panel, you can create new layers for points, lines, polygons, and circles, or load previously saved layers from the server. When creating a new layer:

- **Title and Access Rights:** Name the layer and define read and write permissions for all or specific users.
- **Advanced Options:** Set folder (default “User generated”) and attributes.

6.2. Performing Operations on Drawn Features

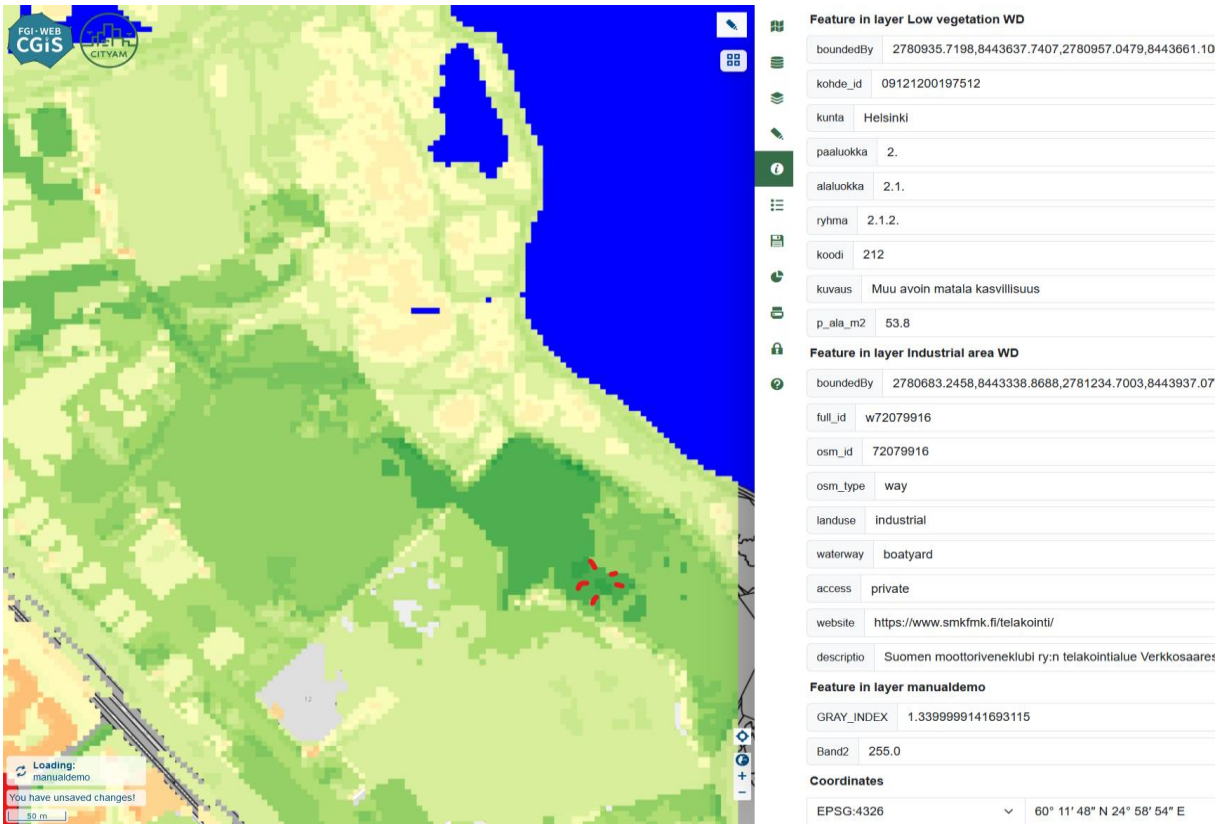
You can also perform operations on and between drawn layer features (difference, union, intersection, split).

- **Drawing:** Hold SHIFT for free-hand drawing; press BACKSPACE to remove the last point. When drawing you can also copy and move features.

- **Attributes and Measurements:** The user can add attributes, and the layer will record centre point coordinates, line lengths (km), and polygon/circle areas (km²).
- **Feature Selection:** Use a bounding box to select multiple features.
- **Feature Operations:** Perform difference, union, intersection, and split on selected features.
- **Export Drawn Features:** Download drawn features as WKT or GeoJSON.

7. Feature Information

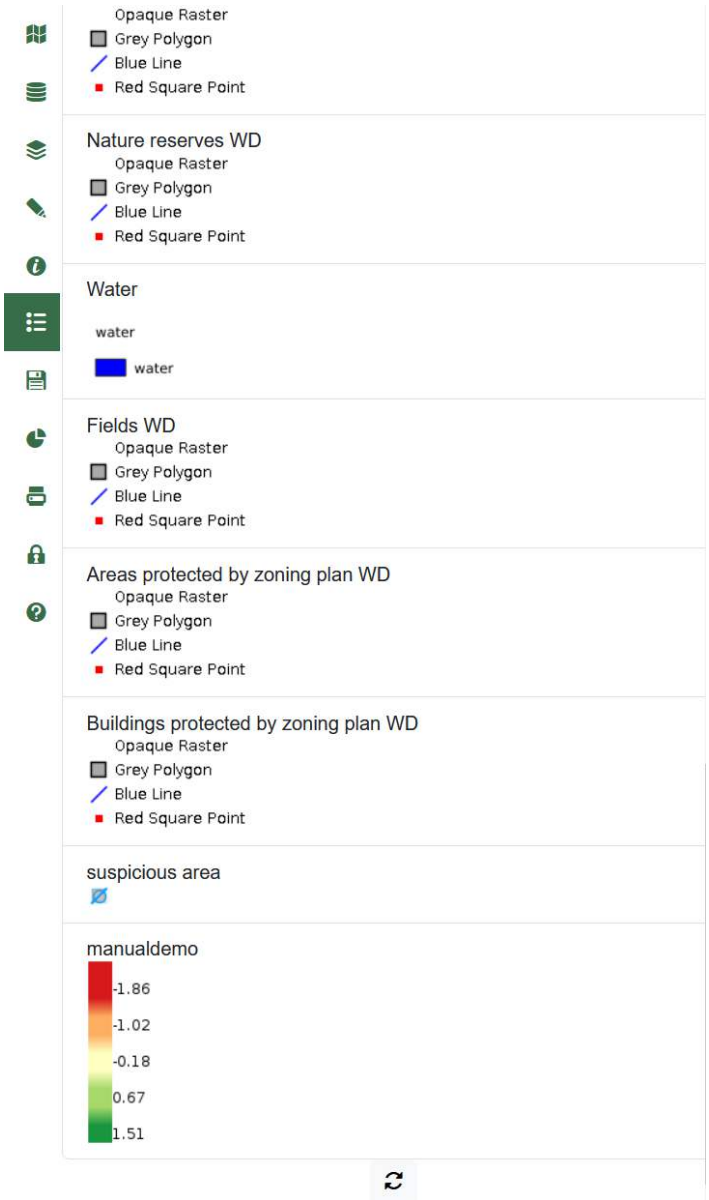
Use the **Feature Info** panel to inspect properties of any selectable feature on the map. For layers with write access, you can copy, move, download, or delete features directly.



Clicking a point on the map brings information about the layers and the attributes at the specific location.

8. Legend

The **Legend** panel displays the symbols and styles for all visible layers. Click **Reset** if changes you have made are not yet visible.

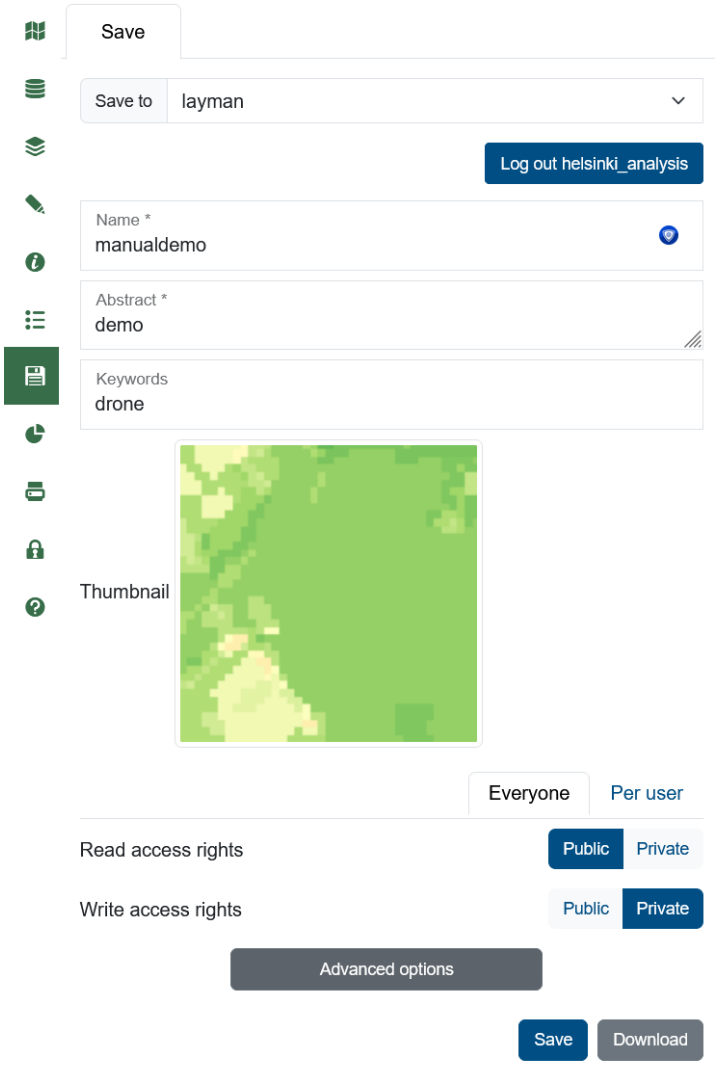


Legend Overview.

9. Saving the Workspace

The **Save** panel allows you to store your current map, layers, and configurations as a new workspace. Saving enables collaboration across users as saved workspaces will be available in Workspaces.

- **Name and Abstract:** Provide a title and description.
- **Keywords & Thumbnail:** Add keywords and review the automatic thumbnail.
- **Access Rights:** Set public or user-specific read and write permissions.
- **Extent and Layers (under "Advanced options"):** Adjust the workspace extent and choose which layers to include.
- **Save Workspace:** Default option to easily save the newly created workspace or update changes.
- **Download Workspace:** Export your workspace as a JSON file for backup or sharing.



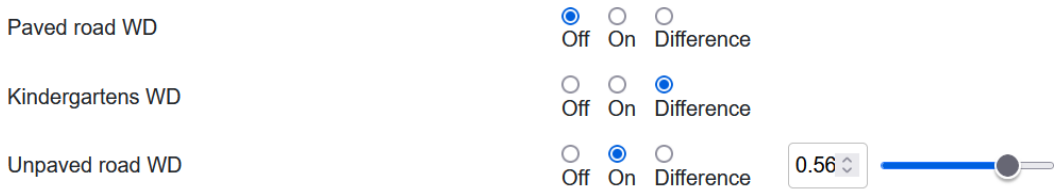
Save panel overview.

10. Launch and Landing Site (LLS) Analysis Tool

10.1. Configuring and Running the Analysis

The **Analysis** panel enables you to run weighted overlay analysis using selected vector layers. Layers in the **Layer Manager** appear here and can be categorized as:

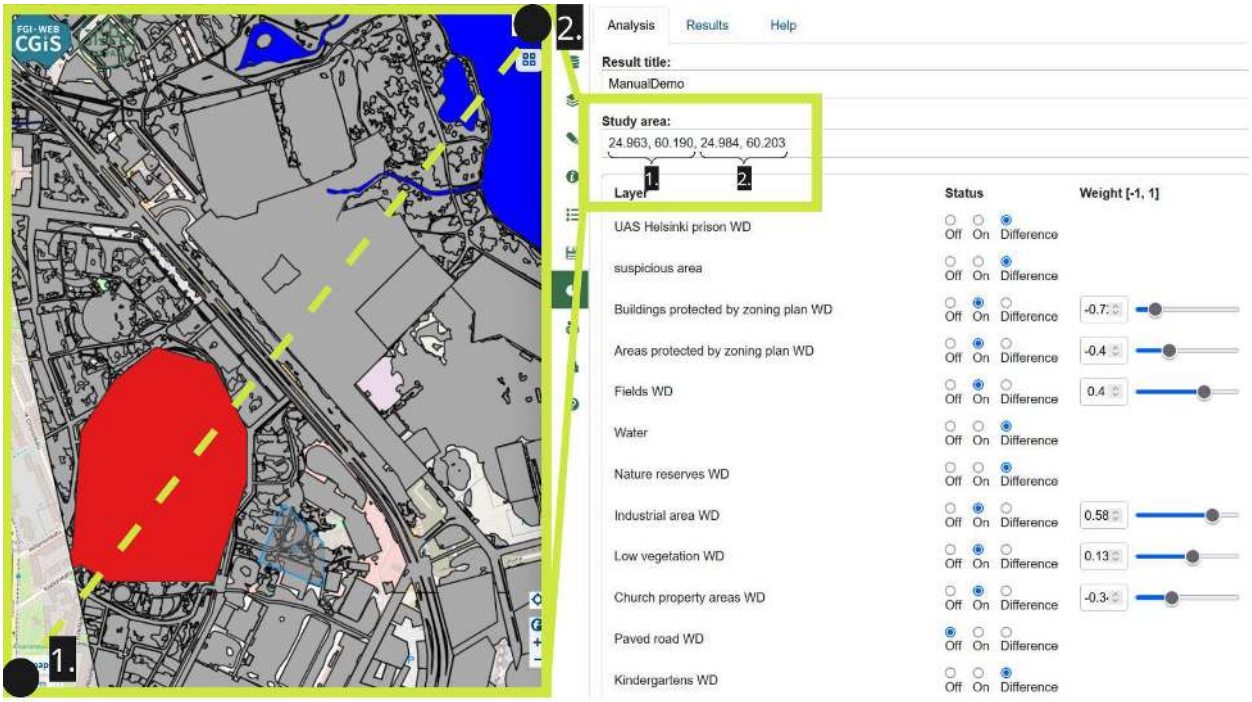
- **Off:** The layer will not be used in the analysis.
- **On:** Include layer to the analysis. Choose a weight between -1 and 1, where -1 is a very unsuitable (e.g., cemetery, daycare) and 1 very suitable (e.g., parking lot, bare ground)
- **Difference:** Use layer as a mask to exclude areas from the analysis (e.g., waterbodies). This can also be used to define areas where certain activities are prohibited (e.g., no-fly zones).



Configuring Analysis Parameters

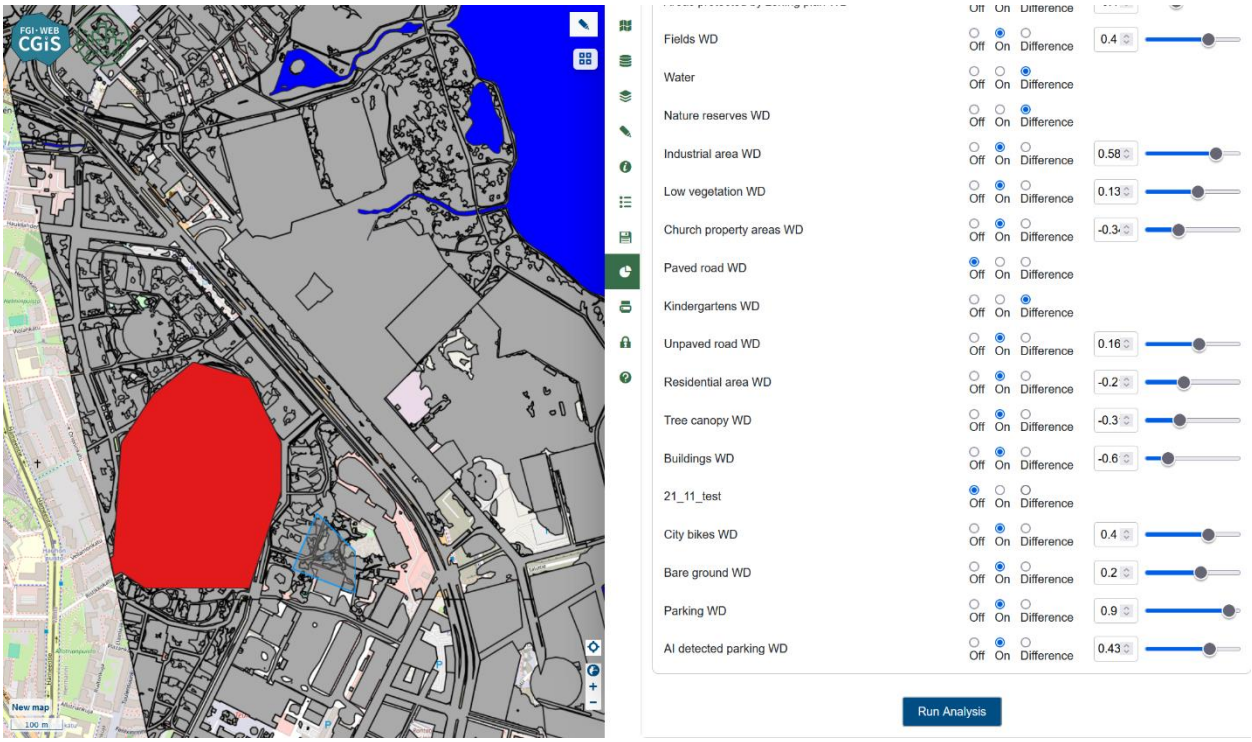
After assigning classifications and weights:

1. **Set the Result Title:** Provide a unique name for the analysis result.
2. **Study Area:** The analysis runs on the current map view extent. Adjust the map before running to focus on a small enough area. Currently the limit is at zoom level 14 and a good proxy is to take a look at the scale bar in the bottom left corner and make sure it displays less than 500 meters, preferably less than 200 meters. If the zoom is too high, a notification will appear and then you can zoom closer without losing the analysis settings.



Relation between map extent and study area parameters.

3. **Run Analysis:** Confirm and run. Once complete, a notification appears.

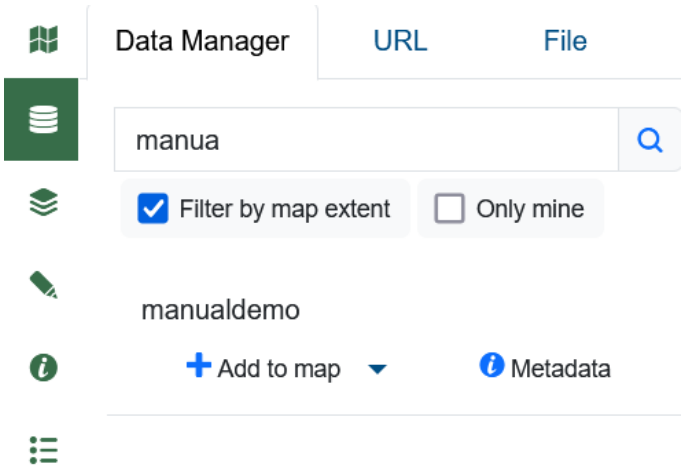


Run Analysis button is shown at the bottom of the analysis tab layers.

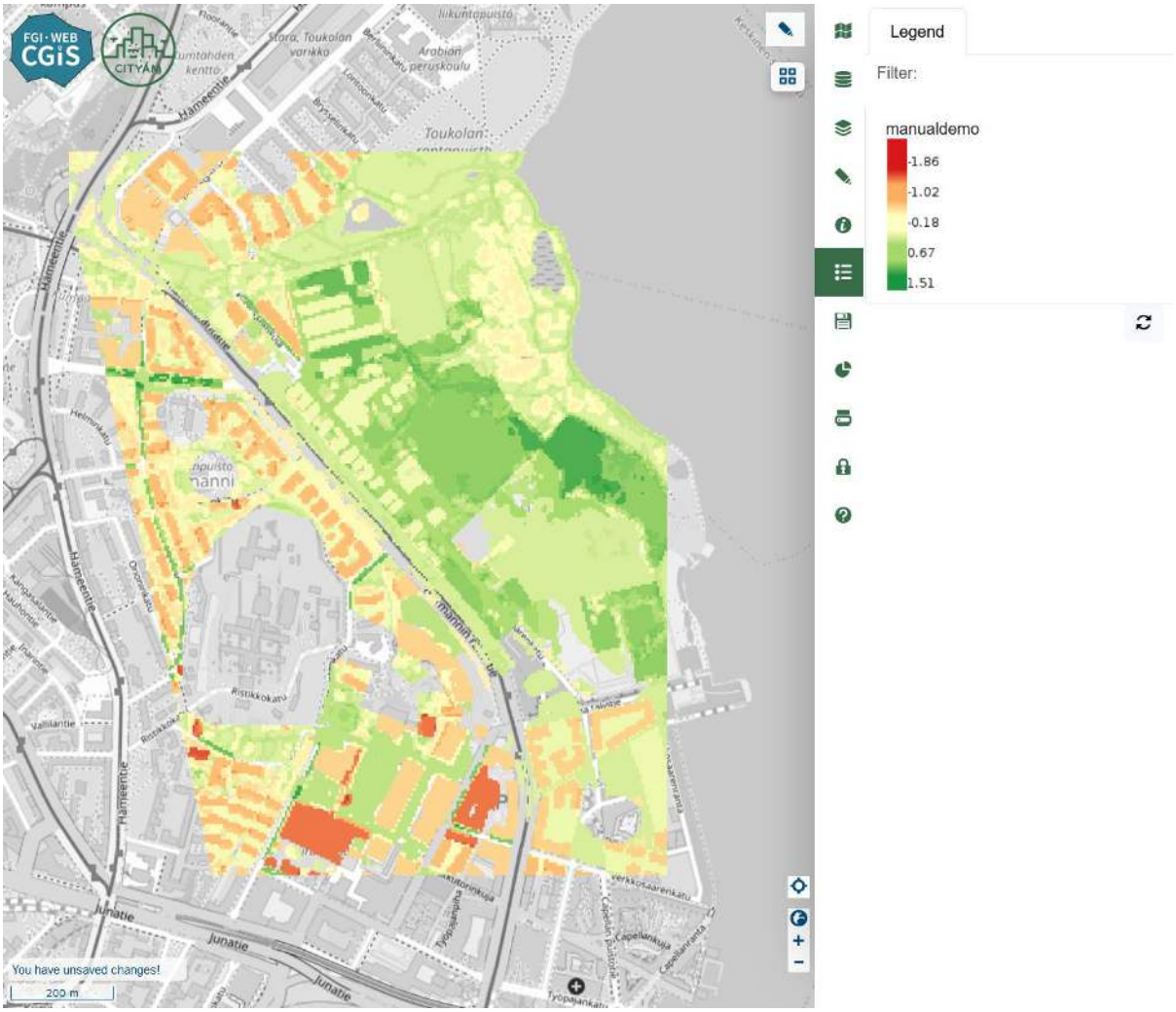
10.2. Results and Metadata

After completion, the resulting analysis layer is added to the Data Manager. If the analysis output is not instantly visible you can search it by the name that you used in result title. Click “Add to map” to view it.

Results panels displays metadata for each analysis ran. The metadata includes the parameters set to each layer in the analysis.



Pressing “Add to map” will result in visualizing the analysis output and adding it to layer manager.



Analysis result.

10.3. Troubleshooting

- Make sure you are logged in with the correct user. Only analysis users are able to run the analysis.
- The analysis accepts only vector layers (WMS) from the Layman.
- The analysis user must have write permission for all input layers.
- Remember to give the analysis result unique name. The system is not able to overwrite files with same names.
- Test running the analysis at smaller scale. The server is not able to handle large analysis areas.
- Check layer manager for analysis result. The result layer is not loaded to the scene automatically.
- In some cases, the analysis throws an error even if the analysis was successful. Check layer manager just in case for the layer.

11. Print and Export Options

Use the **Print** panel to produce a hard copy or digital version of your current map view:

- **Title and Legend:** Add a custom title and legend. You can edit the style of the legend.
- **Imprint and Scale:** Include author, abstract, and choose a scale bar or line. Scale units can be adjusted (metric, degrees, US inch, nautical mile).
- **Format:** Print to PDF, preview in a new tab, or download as PNG.
- **Reset:** Restore default print settings.