University of Glasgow | School of Geographical & Earth Sciences

Spatial Analysis of Potential Visitor Center Locations in Galloway Forest

Course: GEOG5019 Principles of GIS
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1. Introduction

1.1 Background

Galloway Forest is a key nature reserve in the UK, offering rich biodiversity and unique landscapes. To promote conservation and wildlife education, the UK Forestry Commission plans to build a visitor center. This center will provide the public with opportunities to connect with nature and raise awareness of biodiversity conservation through educational activities.

Figure 1 The Galloway Forest

1.2 Relevance

Selecting a visitor center location involves factors like accessibility, landscape, ecology, and construction needs. GIS helps analyze these factors, identify suitable sites, and minimize ecological impact, supporting both planning and sustainability.

1.3 Objectives and Tasks

This report identifies suitable locations in Galloway Forest for a visitor center, considering factors like urban distance, water proximity, elevation, and visibility. It will provide recommendations that balance ecological protection, education, and accessibility, with areas for further investigation.

1.4 Report Structure

This report is organized as follows:

- **Methodology**: Describes the spatial analysis steps, datasets, and methods used.
- **Results**: Presents the suitability map and key findings, highlighting potential sites.
- **Discussion**: Interprets the results, discusses challenges, and suggests improvements.
- **Conclusion**: Summarizes findings, provides site selection recommendations, and reflects on the methods.
- **Appendices**: Includes supporting materials like maps and diagrams to aid understanding.

2. Methodology

2.1 Datasets

- **Ordnance Survey Terrain 50 DTM:** 50-meter elevation grid data for Galloway Forest.
- **Ordnance Survey Vector Map District (VMD):** Vector data of topographic features like roads, rivers, etc.
- **Land Cover Map 2015:** Land cover map showing forests, grasslands, and water bodies.
- **Loch Shapefile:** Vector data of the loch's center point for viewshed analysis.
- **OutlineNX Shapefile:** Defines the study area boundary for analysis.

2.2 Data Processing Workflow

1. **Data Loading and Preprocessing**: Load all geographic data (such as roads, rivers, lakes, and land cover), ensuring that their coordinate reference systems are consistent for further analysis.

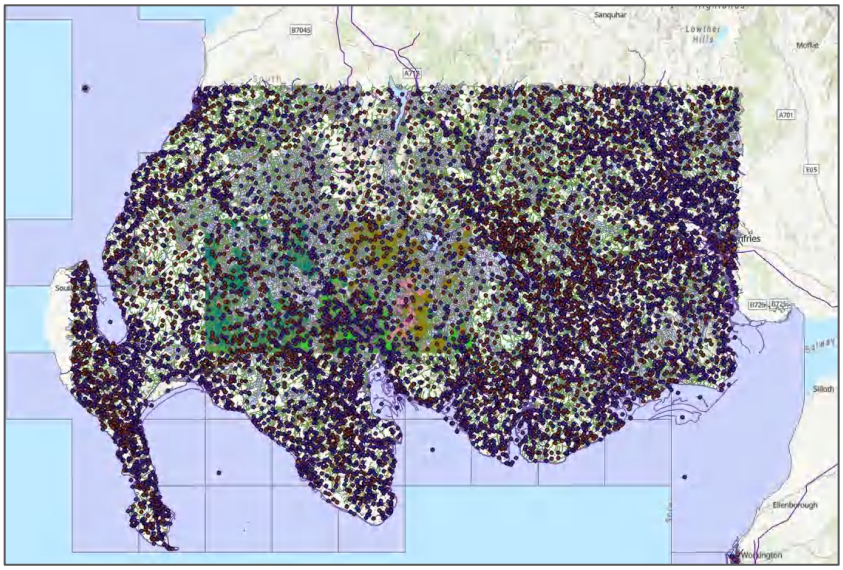

Figure 2 Data Loading and Preprocessing

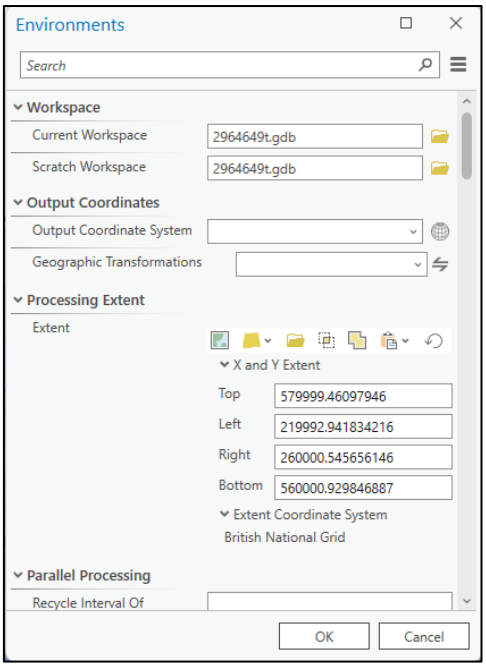

Figure 3 Environment Settings

2. **Data Clipping**: Use the **Clip** function in the **Geoprocessing** tool, and the **Batch Clip** tool to batch clip multiple data layers. All data layers were clipped to the study area boundary (OutlineNX) to ensure that the analysis is limited to the valid area.

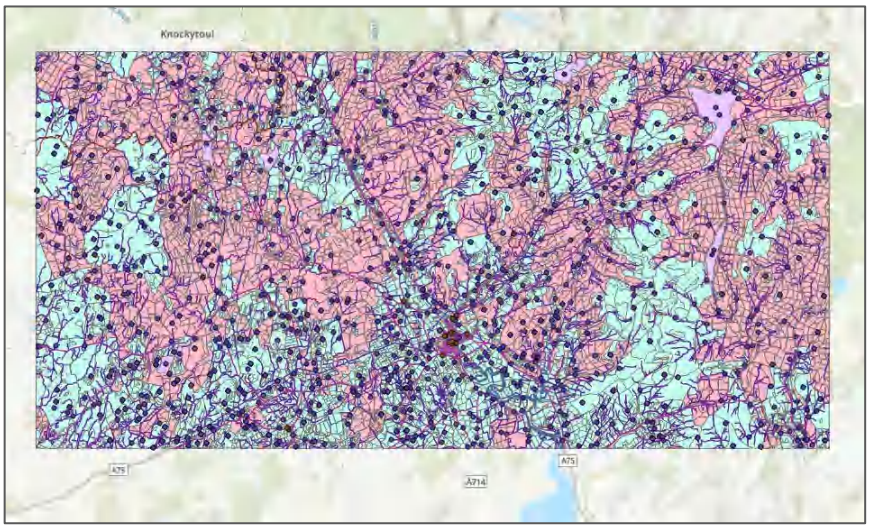

Figure 4 Data Clipping

3. **Buffer Analysis**: Generate buffer zones to identify areas that meet specific conditions:
    - **Within 500 m of water (river or loch)**: Identify areas within 500 meters of water bodies.
    - **Within 2000 m of a road**: Identify areas within 2000 meters of roads.

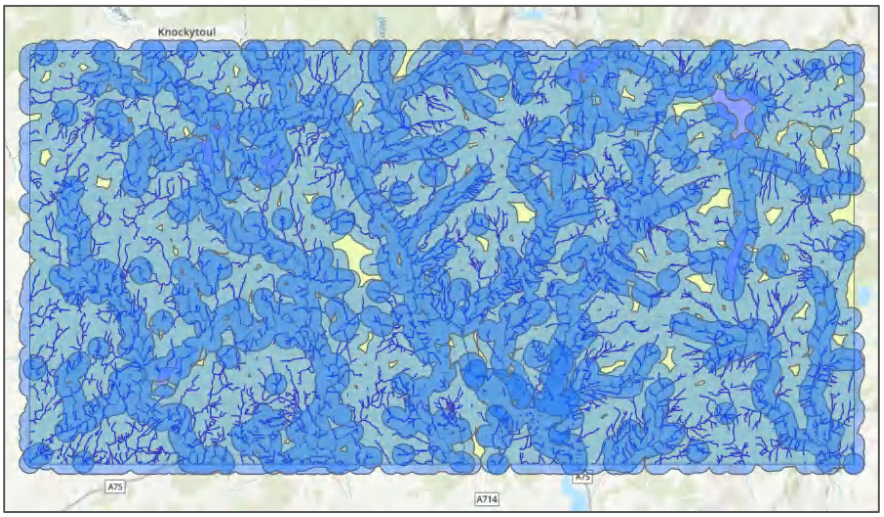

Figure 5 Within 500 m of water (river or loch)

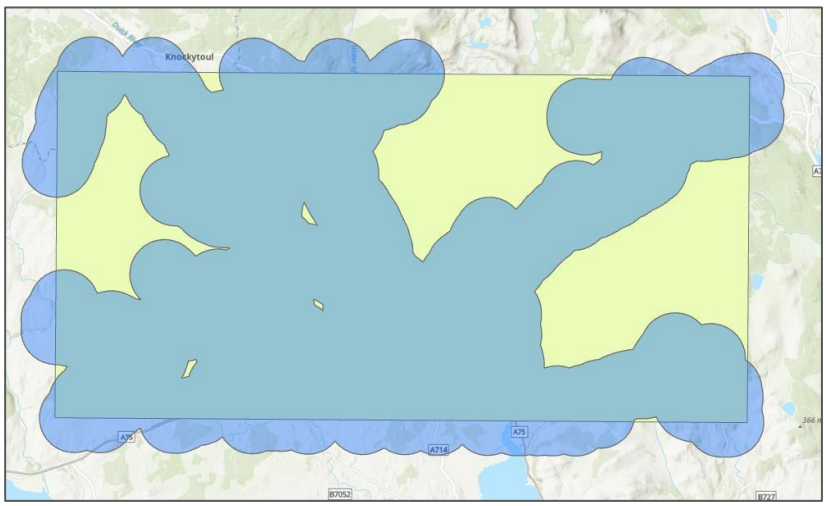

Figure 6 Within 2000 m of a road

4. **Reclassification**: Reclassify the Digital Terrain Model (DTM) elevation data. Areas with elevation greater than 300 meters were labeled as 1 (suitable), and those less than or equal to 300 meters were labeled as 0 (not suitable).

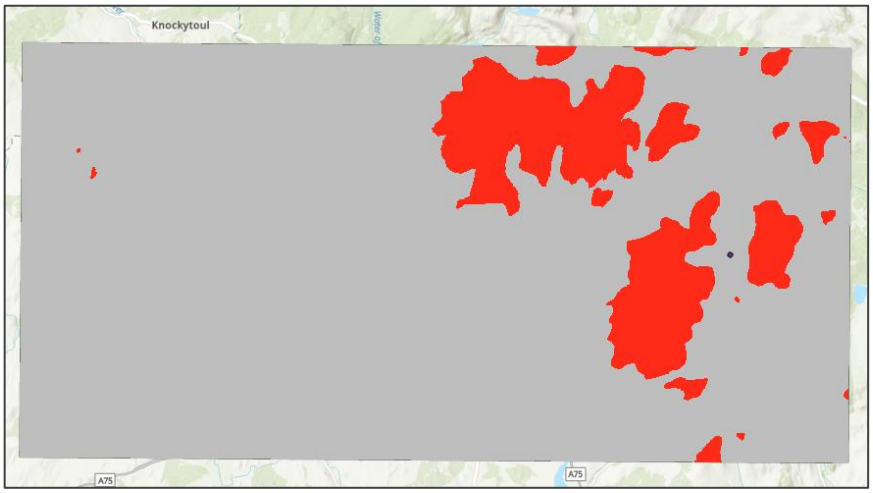

Figure 7 Reclassification

5. **Raster to Vector Conversion**: After filtering and reclassification, convert raster data (DTM and viewshed analysis outputs) into vector data for further analysis.

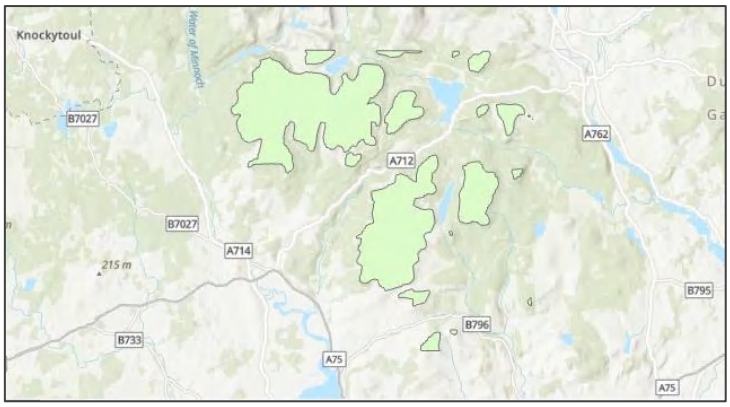

Figure 8 Raster to Vector Conversion

6. **Attribute Calculator**: Use the attribute calculator to filter regions based on specific conditions, including non-urban areas, forest regions (broadleaf or coniferous), areas with elevations above 300 meters, and those within viewshed range of the loch.

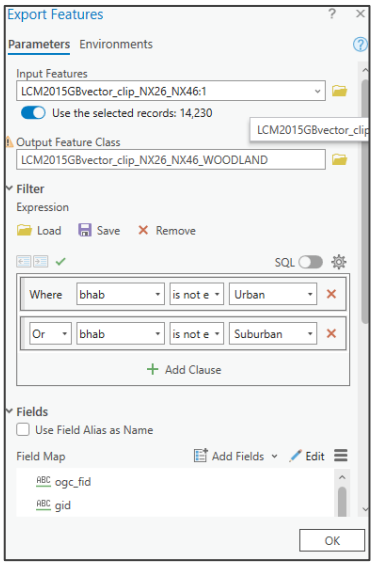

Figure 9 Use the attribute calculator to filter regions

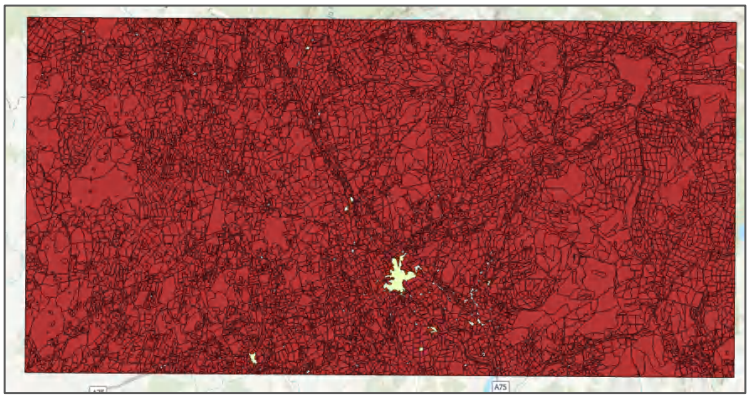

Figure 10 non-urban areas

7. **Viewshed Analysis**: Perform viewshed analysis to ensure that the selected areas provide a good visual range, meeting the requirement of being visible from the loch.

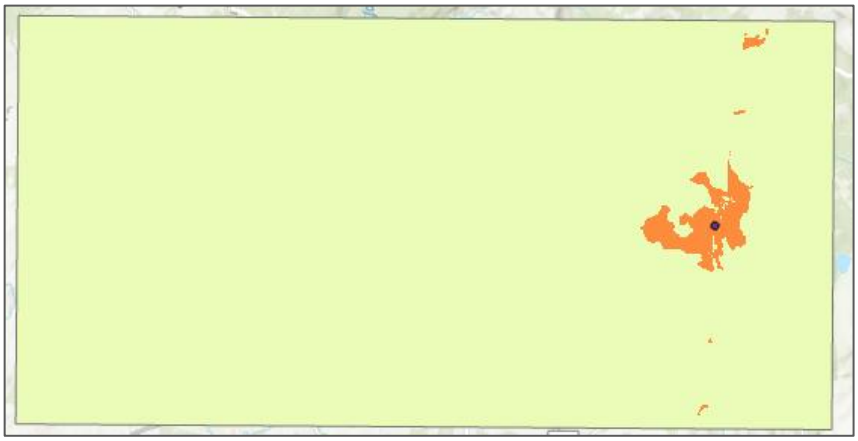

Figure 11 Viewshed Analysis

8. **Overlay Analysis**: Overlay all conditionally filtered layers to identify suitable areas that meet all spatial constraints, finalizing the selection of potential sites for further investigation.

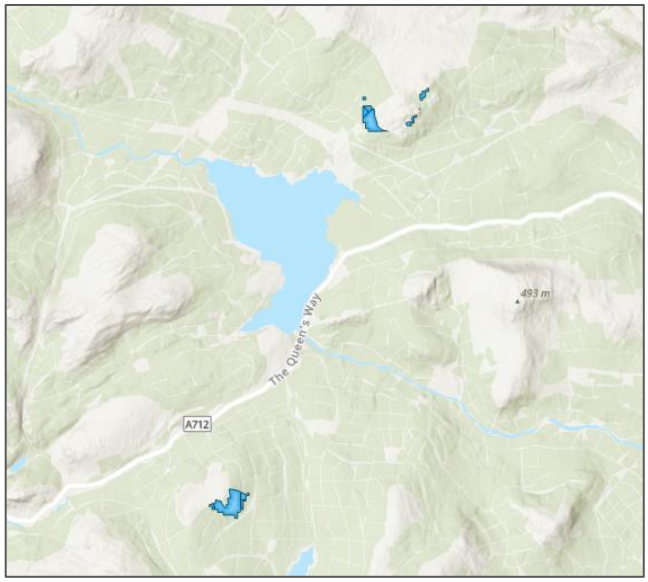

Figure 12 Overlay Analysis

9. **Polygon Merging**: After the overlay analysis, check adjacent polygons. Use remote sensing imagery or Google Street View to determine if adjacent polygons can be merged to increase site continuity and area.

10. **Filtering Polygons Greater than 2 Hectares**: Use the attribute calculator to filter polygons greater than 2 hectares to meet the minimum site area requirement.

2.3 Key Techniques and Methods

The key techniques and methods used in the analysis are described as follows:

- **Data Clipping**: The **Clip** function was used to ensure that all geographic features are constrained within the study area. This step is essential to limit the analysis to the relevant area of interest.
- **Buffer Analysis**: Buffer analysis is a common spatial method used to identify regions within a specific distance from a feature. In this analysis, buffers were created around water bodies and roads to select suitable areas.
- **Reclassification**: Reclassification involves changing the values of raster data to simplify analysis. In this case, areas with elevation above 300 meters were classified as suitable.
- **Raster to Vector Conversion**: Raster data was converted to vector format to facilitate further spatial analysis and overlay operations.
- **Attribute Calculator**: The attribute calculator was used to filter regions based on specific criteria, such as non-urban areas, forest types, and elevation conditions.
- **Viewshed Analysis**: Viewshed analysis identifies areas visible from a specific point (the loch) based on elevation data.
- **Overlay Analysis**: Overlay analysis combines multiple spatial layers to identify areas that meet all spatial criteria.
- **Polygon Merging**: Polygons were merged to increase the area and continuity of suitable sites, ensuring that selected regions were large enough for development.

2.4 Process Flow Diagram

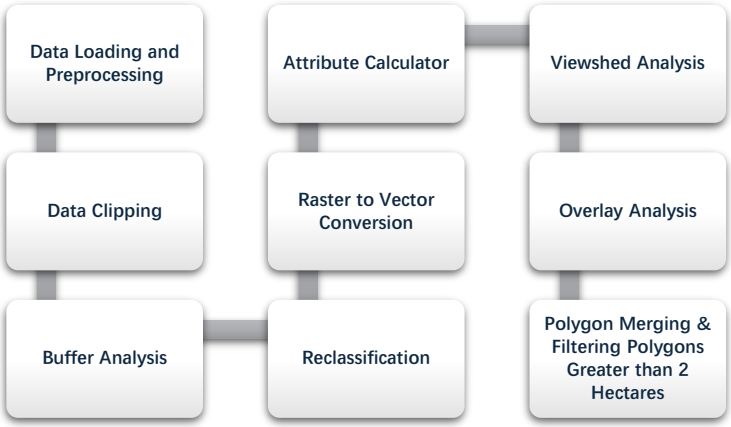

Figure 13 Process Flow Diagram

3. Results

3.1 Suitability Map

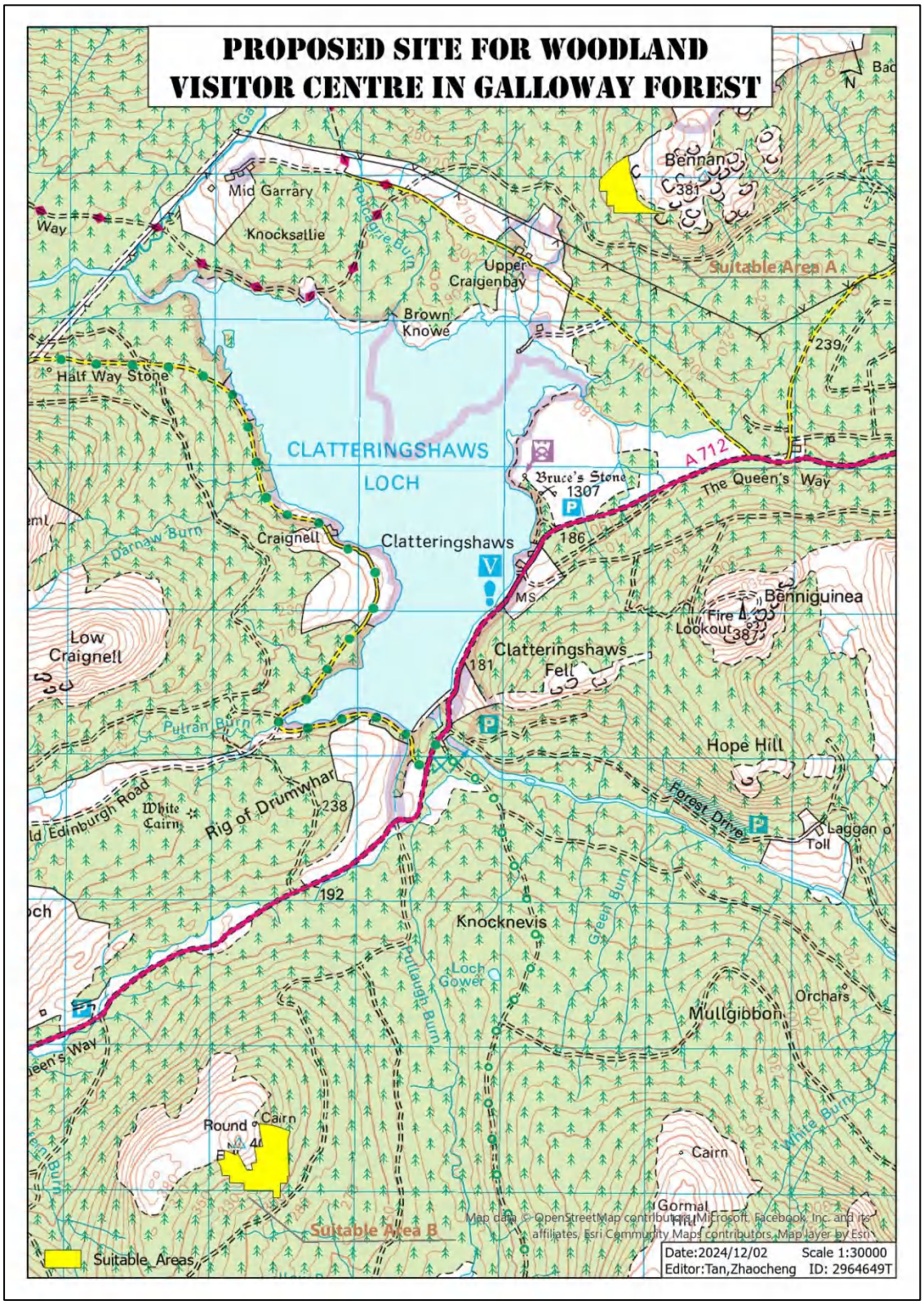

Figure 14 Suitability Map

The suitability map generated through the above analysis displays the regions within Galloway Forest that are suitable for constructing a visitor center. The map highlights areas that meet the conditions for elevation, proximity to water bodies, proximity to roads, and other key criteria. These areas are mostly located in higher elevation zones near rivers or lakes, and are far from urban or suburban developments.

3.2 Main Findings

- Suitable areas are mainly concentrated in the northeastern and southern parts of the forest, which not only meet basic environmental standards but also have good viewshed conditions.
- Some areas were excluded due to their proximity to urban areas or failure to meet the minimum area requirement of 2 hectares.

3.3 Key Observations

- Some areas, while meeting the water and road proximity requirements, were excluded due to the presence of historic sites (e.g., proximity to standing stones).
- The map of suitable areas shows a broad distribution, offering multiple potential locations for further examination by the developers.

4. Discussion

4.1 Interpretation of Results

- **Area Distribution:** Through buffer analysis, areas near water and roads were selected. These regions offer good ecological, transport, and landscape conditions, with most areas located in the northern and southern parts of the forest, providing clear views.
- **Ecological Protection and Accessibility:** The selected areas are far from urban or rural developments, minimizing ecological impact. They are also within 2000 meters of main roads, ensuring accessibility.
- **Suitability Criteria:** Most areas exceed 300 meters in elevation, meeting the viewshed requirement. All locations are larger than 2 hectares, providing sufficient space for construction.

4.2 Challenges Encountered

- **Data Precision:** Some inaccuracies were found in the land cover data, especially along forest edges, where remote sensing resolution was insufficient for fine details.
- Viewshed Analysis Limitations: The viewshed analysis is dependent on elevation data,

and terrain complexity or low-resolution data may have missed some obstacles, affecting accuracy.

- **Area Selection Complexity:** Some areas met the criteria but had irregular shapes or small sizes. Merging adjacent polygons was necessary but required careful consideration of transportation and ecological corridors.

4.3 Potential Improvements

- **Higher Resolution Data:** Using higher-resolution remote sensing or LiDAR data would improve classification accuracy, especially in complex forest or water boundaries.
- **Incorporating Multi-source Data:** Future analyses could include real-time data, such as traffic or ecological monitoring, to offer a more comprehensive site evaluation.
- **Dynamic Updates:** Regular updates to environmental data, like species habitat changes or climate impacts, could ensure the long-term suitability of selected sites.

5. Conclusion

5.1 Summary of Results

The suitability analysis identified two potential areas within Galloway Forest for constructing a visitor center.

5.2 Reflection on Maps and Process

- **Polygon Shape Issues:** Many suitable areas have irregular shapes, which may not be ideal for construction. Some areas are narrow or curved, requiring adjustments during the design phase.
- **Merging Adjacent Polygons:** Some adjacent polygons cross rural roads, which may not be visible in remote sensing data but can be seen on street maps. Merging these polygons could affect road traffic, so careful consideration is needed.

5.3 Recommendations

- **Field Survey:** On-site inspection is recommended to verify infrastructure details, such as rural roads or potential obstacles, that are not visible in remote sensing data.
- **Polygon Merging and Shape Optimization:** Developers should optimize polygon shapes to ensure the selected areas are suitable for construction and meet design requirements.
- **Further Data Collection:** Additional data layers, such as detailed land use, ecological

sensitivity, and community infrastructure, should be incorporated for a more comprehensive site evaluation.