

RESEARCH ARTICLE

# Tranquility Assessment of the Loch Lomond and Trossachs National Park, Scotland

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**Abstract:** The Loch Lomond and Trossachs National Park is of great value to locals and visitor alike, and its continued protection and effective management need to be ensured. Measuring wilderness and the tranquility connected to it has been a struggle, especially due to their subjectivity. In this study a multi-criteria analysis was undertaken, using viewshed analysis of the loch and man-made structures as well as proximity to forests and roads/rail. View of the lochs was assigned highest weight alongside proximity to forests as these increase tranquility. The resulting tranquility map shows highest values along Loch Lomond, the biggest loch in the park, while highlighting the difficulty to define remoteness.

**Keywords:** tranquility, mapping, GIS, Loch Lomond, Trossachs

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## 1 Introduction

The rugged wilderness shaped by lochs, glens and mountains of the Scottish Highlands is so iconic that many associate the Scottish identity with it. Its protection is important not just for economic gains through tourism but also to protect an unique ecosystem and one of the few untouched wilderness areas left in Europe. Numerous national and European guidelines, plans and policies are trying to aid the protection of such areas ([6], [7], [8], [4], [2]). To better manage and protect these areas, analysis of the extent and quality of wilderness with the use of a Geographic Information System (GIS) is required.

This report will focus on the Loch Lomond and Trossachs National Park (LLTNP) which is situated in Scotland's central belt (see Figure 1), providing amenity green space for at least 50% of Scotland's population ([1]). At only 1865 km<sup>2</sup>, it has 22 lochs, 20 mountains

as well as rivers, forests and lowlands (see Figure 2). Due to the proximity to cities and existing infrastructure across the park, the LLTNP lacks remoteness and naturalness which are usually key features of wilderness ([1], [3]). The Scottish National Heritage (SNH) definition of wilderness includes the lack of man made structures, remoteness, ruggedness and inaccessibility ([7]). For this report the tranquility across the LLTNP will be analysed through multi-criteria overlay analysis of the visual and noise aspects of tranquility.

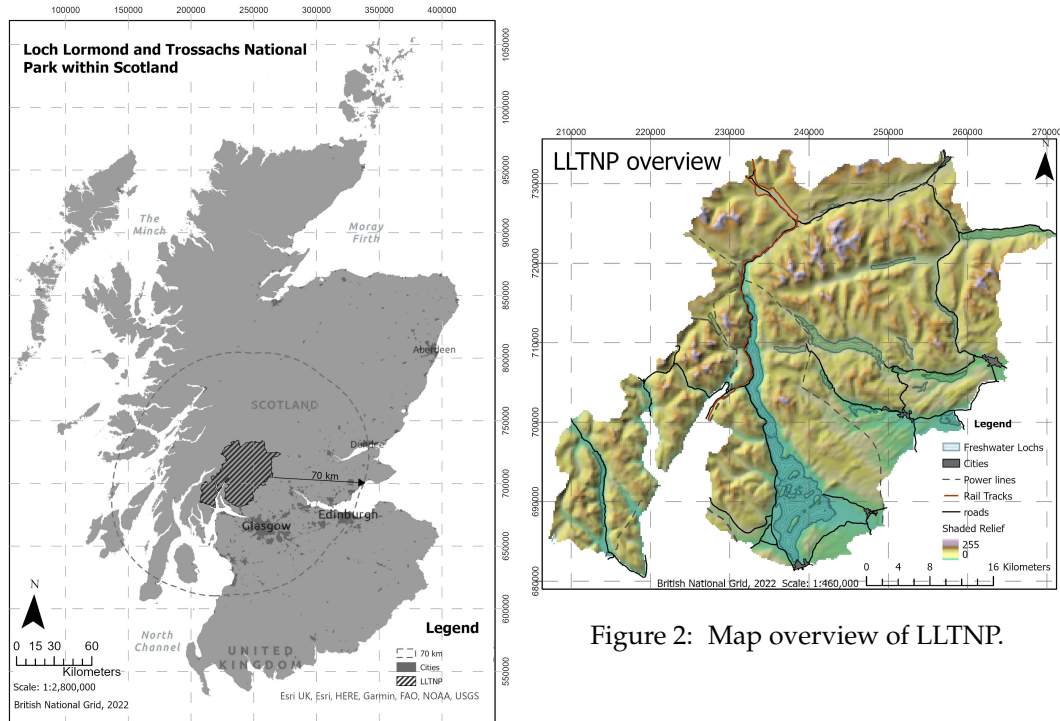


Figure 1: LLTNP within Scotland.

## 2 Methods

For the analysis of tranquility a simple overlay analysis would be possible. Due to the many visual and aural aspects considered, however, a multi-criteria analysis will get more detailed results, especially when assigning weights to the different parameters. For the visibility aspects, a viewshed analysis will be undertaken. For proximity, Euclidean distances will be calculated before normalising all layers. Finally, each individual analysis will be assigned weights before bringing them together to create a tranquility map. The conceptual map can be seen in Figure 3.

There have been numerous studies on tranquility, each focusing on different characteristics of what people consider important. View and noise will be the basis of this analysis. Based on the literature ([10], [11], [5], [9]), visibility of the lochs will be assigned the highest weight (0.5), followed by proximity to woodlands (0.26), proximity to roads/rail (0.13) and

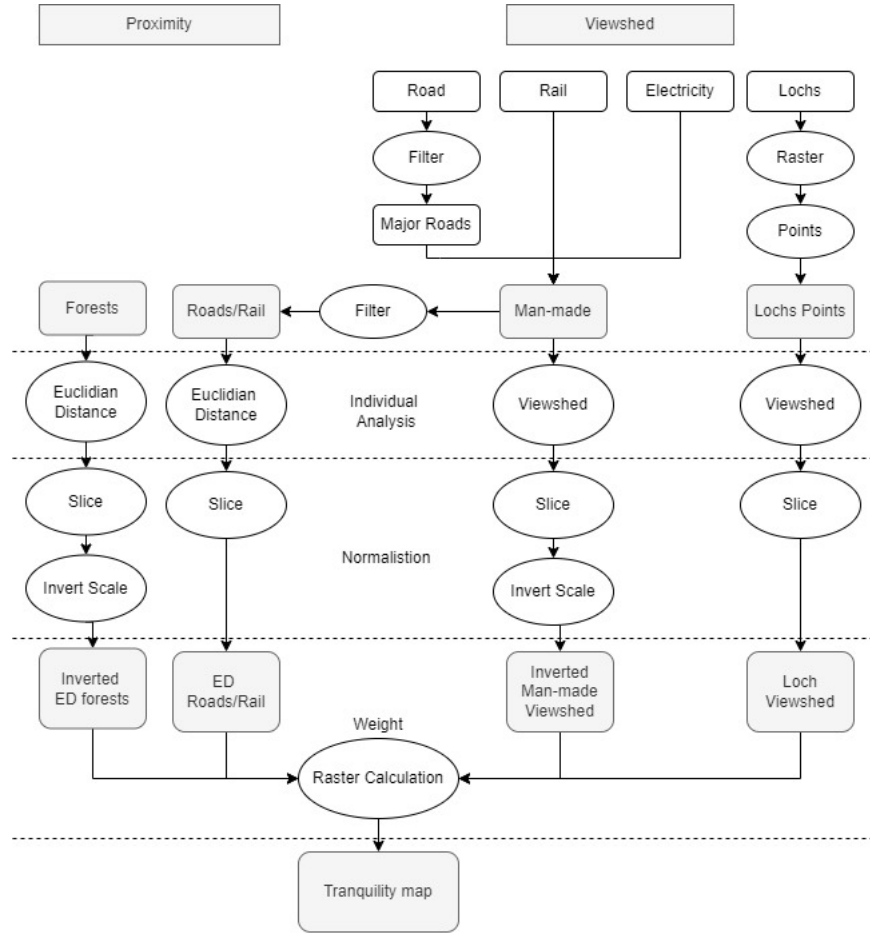


Figure 3: Conceptual model of the multi criteria analysis

view of man-made objects (0.11) will have least weight since both are very subjective and brought into question by Wartmann et al. ([9]). Tables 1a and 1b depict the confusion matrix that lead to the exact weights used for this analysis.

## 2.1 Viewshed

To perform a viewshed analysis of the lochs dataset provided by the Scottish Environmental Protection Agency (SEPA), the polygons had to first be turned into raster data and then converted into points to analyse the view from multiple points of the loch surface rather than the centroid or circumference. For the man-made viewshed analysis the major roads were selected and merged with the rail and power line data, all provided by Ordnance Survey (OS) Vectormap District OpenData.

Using the provided Ordnance Survey Terrain 50, 200 meter Digital Elevation Model (DEM) viewshed models for the lochs and man-made structures were created. Both were

	Loch	Man-made	Forest	Rail/Road	Total
<b>Loch View</b>	1	8	5	9	23
<b>Man-made view</b>	1/8	1	1/5	1	3.3
<b>Forest ED</b>	1/5	5	1	8	14.5
<b>Roads/Rail ED</b>	1/9	1	1/8	1	3.7
<b>Total</b>	3.2	15	7.3	9	

(a) Pair wise comparison matrix.

	Loch	Man-made	Forest	Rail/Road	Total	Standardised
<b>Loch View</b>	0.31	0.53	0.68	0.47	1.99	<b>0.5</b>
<b>Man-made view</b>	0.25	0.07	0.07	0.05	0.44	<b>0.11</b>
<b>Forest ED</b>	0.16	0.33	0.14	0.42	1.05	<b>0.26</b>
<b>Roads/Rail ED</b>	0.28	0.07	0.11	0.05	0.51	<b>0.13</b>

(b) Standardised matrix.

Table 1: Pair wise confusion matrix and standardisation to find weights.

then sliced into 100 equal Output Zones, after which the man-made structures view scale had to be inverted using the Raster Calculator as its view is to be avoided. Both of these viewsheds can be seen in Figure 4a and 4b.

## 2.2 Proximity

For proximity analysis electricity lines were excluded from the man-made structures. Proximity from rail/road can be used for both absence/presence of noise as well as remoteness. Forests are included in this section because they block out sound and view, and tranquility is experienced inside or close to them, therefore they are analysed in a similar way.

To analyse proximity to forests (OS Vectormap District OpenData) and rail/roads Euclidean Distances were calculated and sliced into 100 equal Output Zones for both data sets. Furthermore the forest Distances had to be inverted using Raster Calculation, the results are depicted in Figures 4c and 4d.

## 3 Results

Figure 5 depicts the tranquility map of the Loch Lomond and Trossachs National Park. Most areas of high tranquility are around the biggest loch, this is most likely due to the points created for the viewshed analysis. Loch Lomond having disproportionately high number of points offsets the values, leading to low values of visibility around the smallest lochs. This has clearly influenced the outcome of this study, due to the high weight assigned to the loch viewshed.

Despite putting little weight on remoteness, some of the areas with higher tranquility are still remote, this might be due to doubling the numbers from the viewshed and proximity of man-made objects as well as the presence of forests in those areas. Even though two of the aspects were “not being close to roads” and “not seeing roads”, most areas along the road next to the biggest loch have high tranquility, this could be because there are forests surrounding the roads.



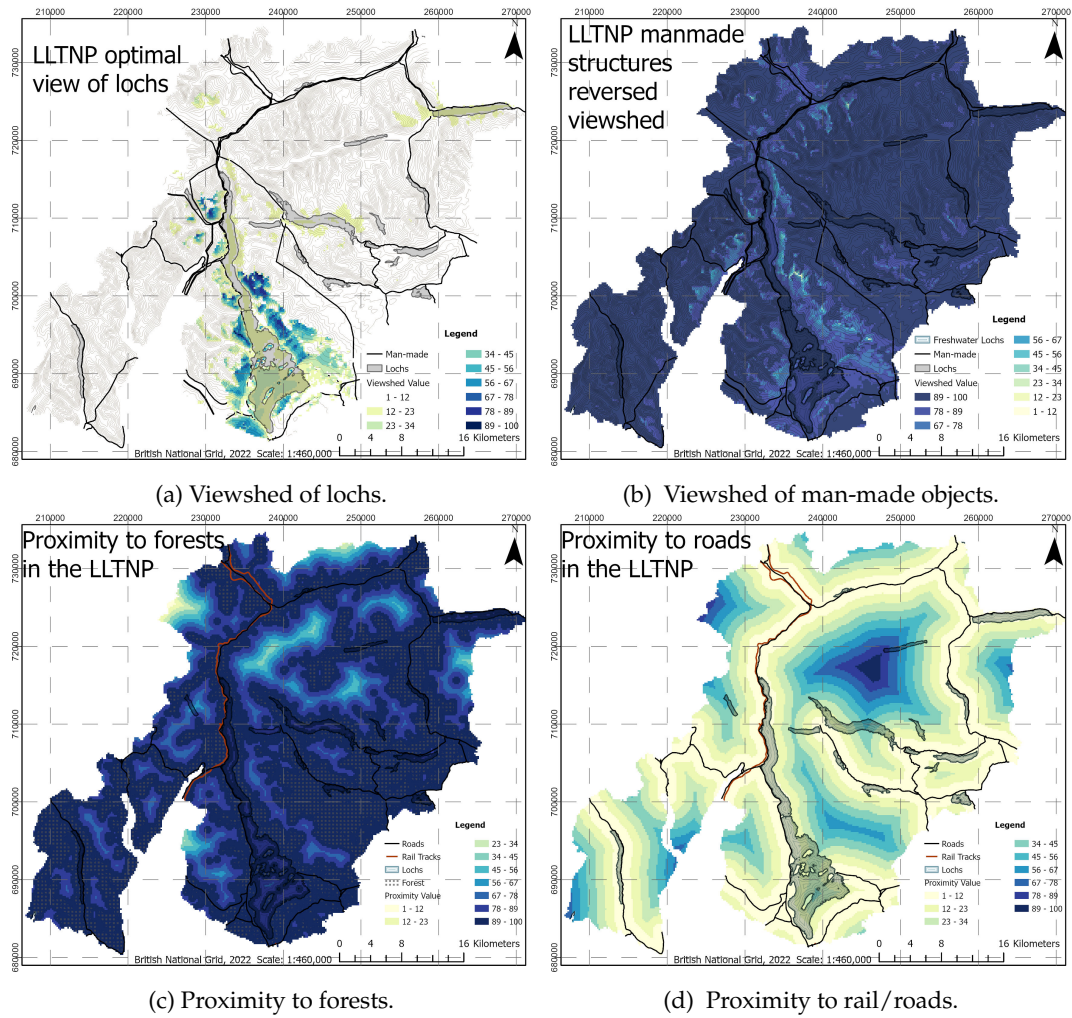


Figure 4: Analysis of the four aspects under consideration.

Surprisingly mountain peaks do not show high levels of tranquility, at such a distance the sight of man-made structures should be minimal, this leads back to the problem of high weights for the loch viewshed and proximity to forests.

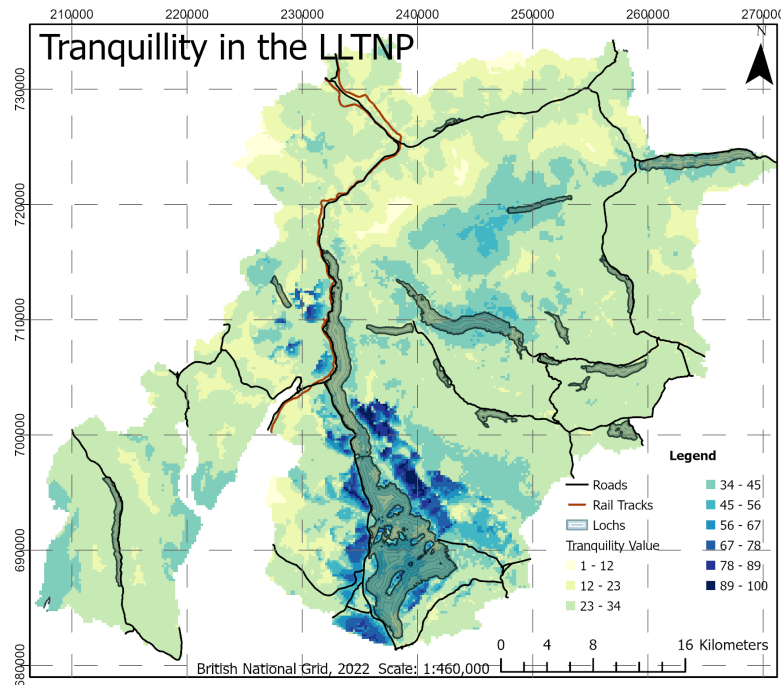


Figure 5: Tranquility map of LLTNP

## 4 Discussion

With the chosen parameters and weights the analysis produced a clear map of areas with highest tranquility that should be the focus for protection. Management efforts can focus on keeping them tranquil by making sure any negative effects like litter and noise are minimised.

Areas with low tranquility values can be focused on to increase their value, by increasing accessibility or forest cover. The islands in Loch Lomond suggest potential but an introduction of boats for access would most likely lower the tranquility for other visitors.

### 4.1 Limitations of the analysis

Despite utilising the necessary data for visual and aural analysis, this study lacks data on man made structures that could have a significant impact on the tranquility, examples are wind turbines just outside the parks boarder and the buildings and cities across the park and along the boarder of the park. The impact of both are subjective and therefore difficult to weight in an analysis, some might enjoy the turbines, or enjoy the tranquility of the view at a cafe while others might find they lower tranquility.



The data available on the environment is lacking information too. The lochs dataset only includes some of the fresh water lochs, there is no information on salt water lochs or rivers which would increase the area perceived as tranquil due to proximity to water. The forest data is lacking information as well, looking at aerial images there is evidence of logging and some forest areas appear planted which decreases the naturalness of the wild areas.

In their analysis of tranquility at the LLTNP, Wartmann et al. found that tranquility is very subjective, with a minority of people seeking inaccessibility for tranquility, while the majority found camping sites and parking lots that are easy accessible more tranquil ([9]). More than half of their study sites do not reflect the tranquility level of the map produced here. To improve the analysis one would need to include popular sites or split the study between people looking for remoteness and tourists passing through the area.

Finally, a major issue concerns the weights used in the multi-criteria analysis. The weights used were based on literature and the author's subjectivity, far from the reality of users' actual needs. To better reflect the criteria for tranquility, a survey of users of the park should be conducted, ranking the factors they consider important and adjusting the weights accordingly.

## 5 Conclusion

The multi-criteria analysis of loch views, proximity and visibility of man-made structures and the proximity to woodland produced a simple map of tranquility across the Loch Lomond and Trossachs National Park. Despite its simplicity and the low number of datasets used, it shows a clear focus of tranquility around Loch Lomond. But the results brought into question the weights used and the lack of datasets that would improve these results: a user survey should be used to (a) help consider further factors affecting tranquility and (b) assist in assigning more accurate weights.

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