EFFICIENCY IN INTERPOLATION WITH MATLAB AND RELATED PROGRAMS FOR ADVANCED TOPOGRAPHIC ANALYSES

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Abstract: *Exploring the vast field of topography, careful monitoring of contour levels and the application of point interpolation methods are two essential practices with significant implications in the field of terrain survey and geospatial data analysis. These activities become the foundations providing the possibility to give the topographic basis in the realization and evaluation of different engineering constructions or in a given surveyed area.*

In this context, contour monitoring and point interpolation are not just technical activities, but become key tools for urban planning, spatial planning and geological study. These practices bring significant benefits in understanding and assessing terrain, supporting decision-making processes in a variety of fields, from infrastructure projects to geographic and topographic surveys. Thus, in a surveying context, these techniques become not only essential, but also the driving force behind accuracy and efficiency in the exploration and understanding of complex land.

Keywords: *geospatial exploration; isohypses; three-dimensional terrain visualization; interpolation methods; interactive visualization; cohesive workflow; geospatial data analysis*

1. Introduction

Contour levels, reflecting equivalent lines of the same elevation, provide a detailed visual representation of the ground relief. This information is of crucial importance in identifying and mapping topographic features such as valleys, ridges and depressions. In this sense, the careful tracking of contours becomes a basic tool for a detailed understanding of land configuration.

In parallel, the use of interpolation methods, such as that applied to points, is a key aspect in the process of completing and extending data in unexplored areas. This is particularly useful in surveying for estimating values in locations where direct measurements have not been made. This provides a comprehensive and continuous picture of topographic variables, contributing to more detailed and accurate terrain maps.

2. Materials and Methods

Google Earth, as a geospatial visualization and exploration application, offers a number of significant benefits, establishing itself as an essential tool in the study of topography and the analysis of geographic data.

One of the key aspects of this application is its ability to provide users with a detailed and interactive visualisation of land in the form of satellite imagery and three-dimensional models. In this sense, by making use of this software, geographic coordinates can be generated from a given area, providing the possibility of a detailed study of topography and relief, accurately identifying geographic features such as mountain peaks, valleys or ridges.

Google Earth thus becomes not only a route planning tool, but also a partner in exploring and understanding natural land in detail. Its extensive functionality, such as image history, also allows changes over time to be monitored, making it particularly useful in environmental studies and the analysis of geographical developments.

In order to achieve geographical coordinates, the study area was identified, namely the mountain area Tunel - Vf. Negoiu, Făgăraş Mountains, Romania.

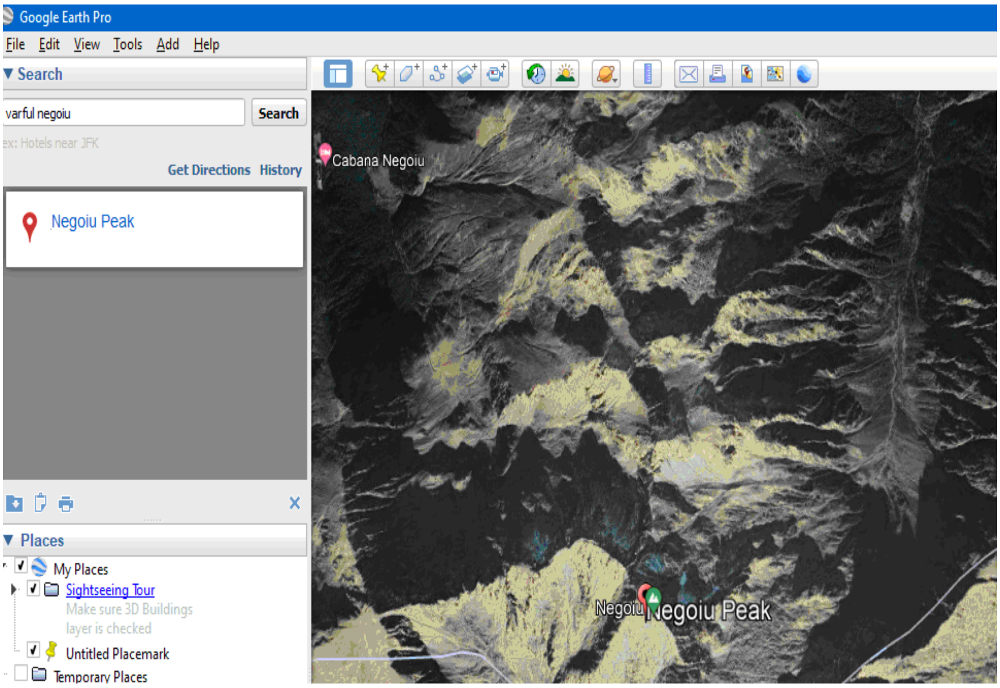

Fig. 1 – Identification of the study area

Following area identification, location markers were applied to the area of the area from which the geographic coordinates were to be extracted. This geographical information was saved in a *kmz file

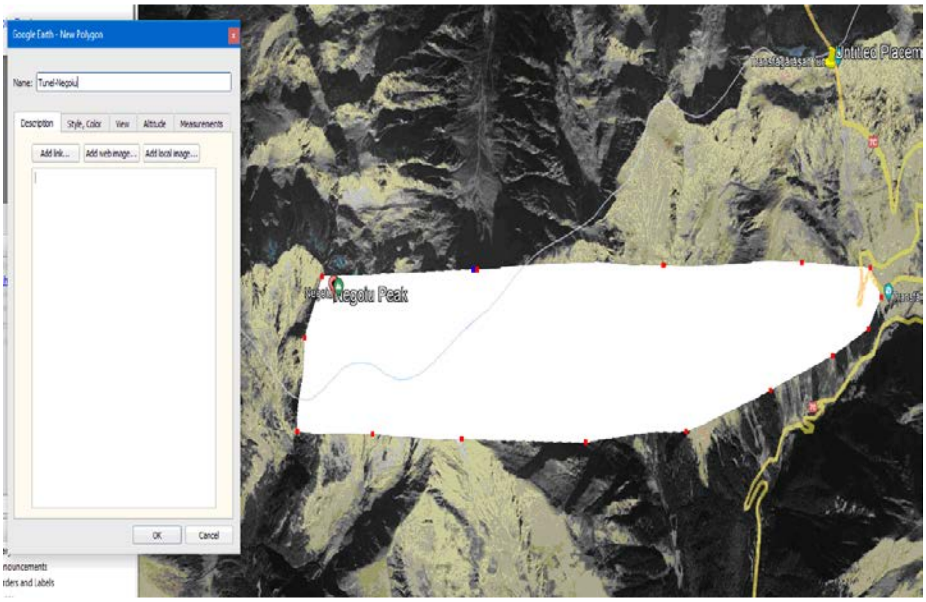

Fig. 2 – Delimitation with location markers

Global Mapper is a Geographic Information System (GIS) software developed by Blue Marble Geographics, designed for efficient manipulation of spatial data on the Microsoft Windows platform. With functionality covering vector, raster and elevation data management, Global Mapper provides essential tools for GIS visualization, conversion and analysis.

The sequence of steps and how to work is as follows:

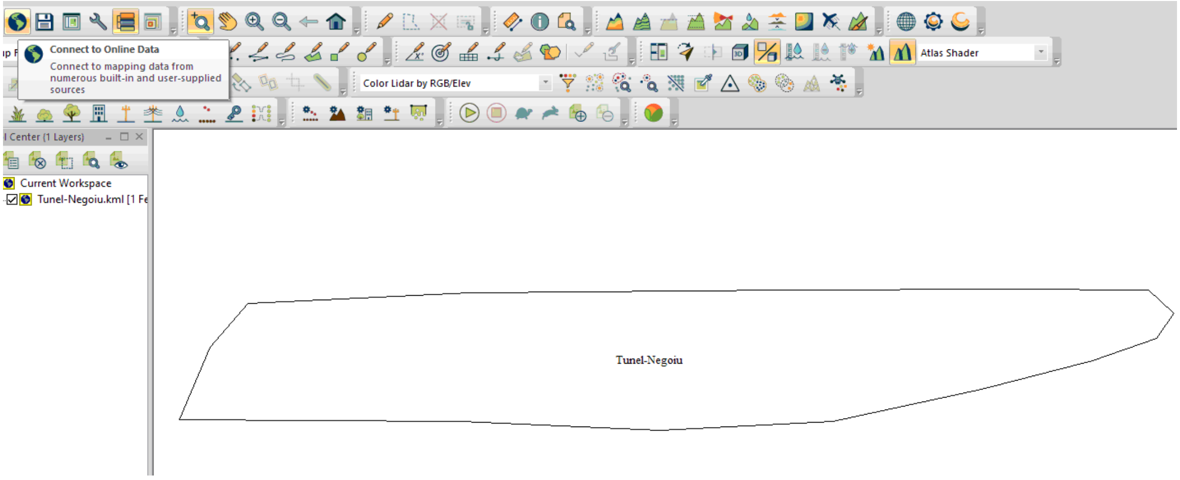

Fig. 3 – Connecting online with spatial information

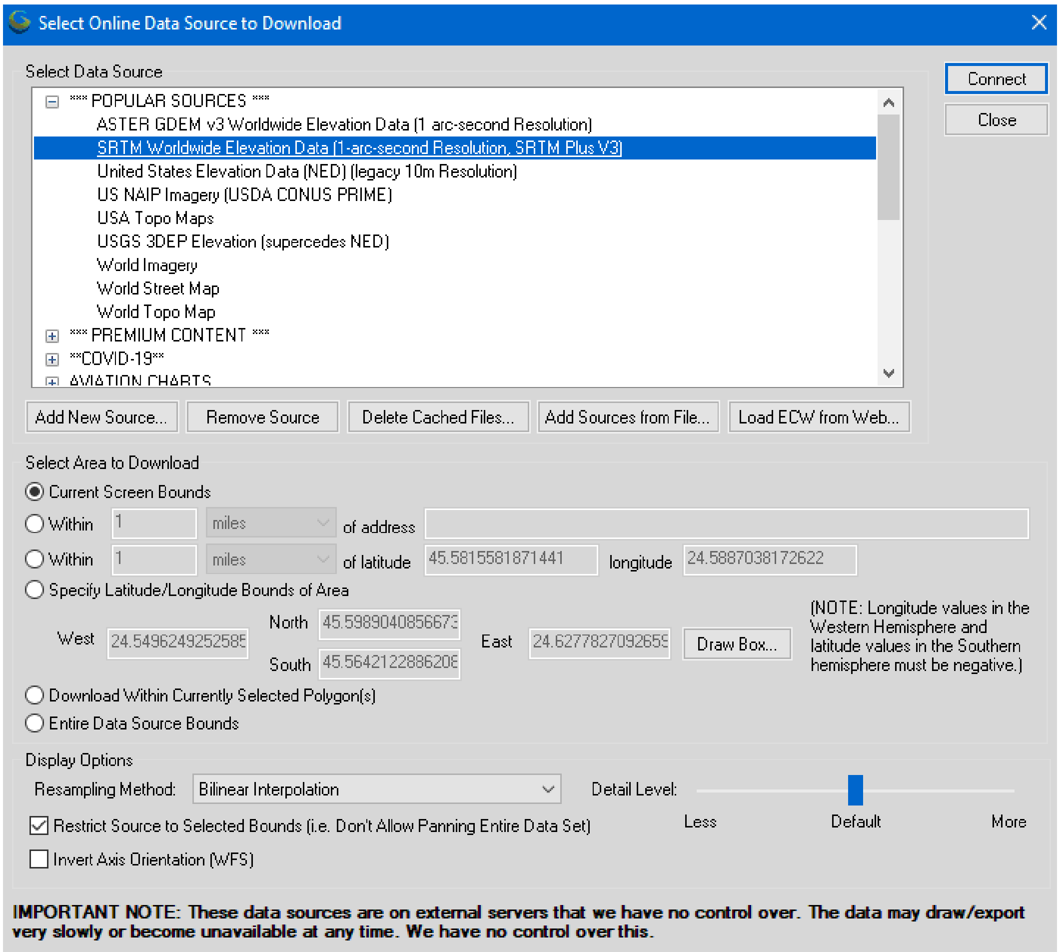

Fig. 4 - Defining the source of coordinate extraction

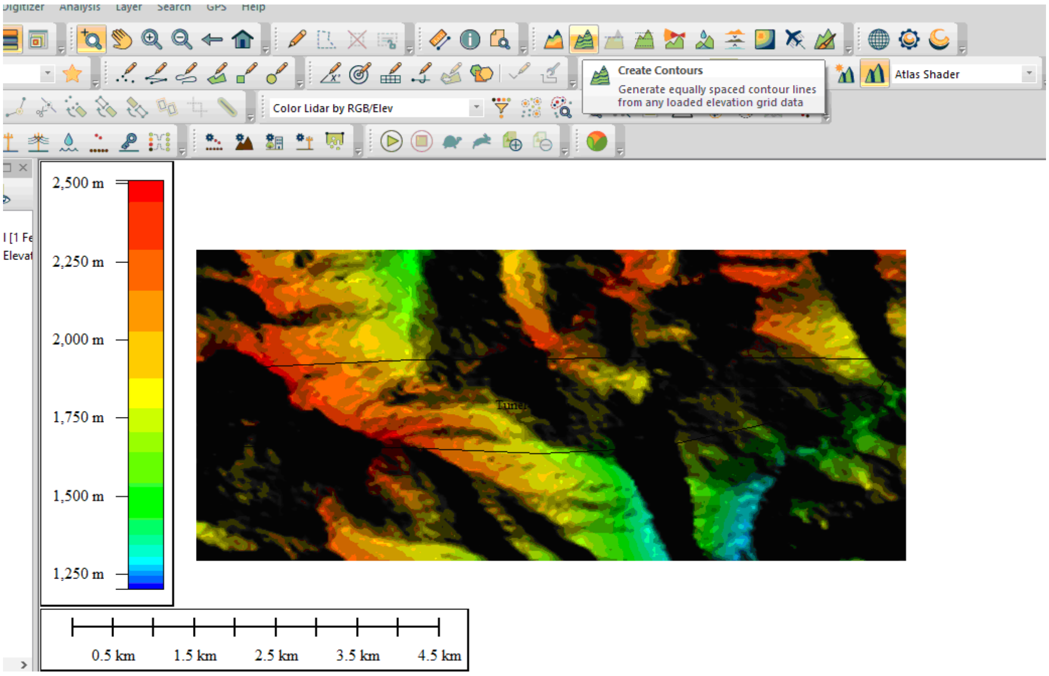

Fig. 5 - Generating contour levels

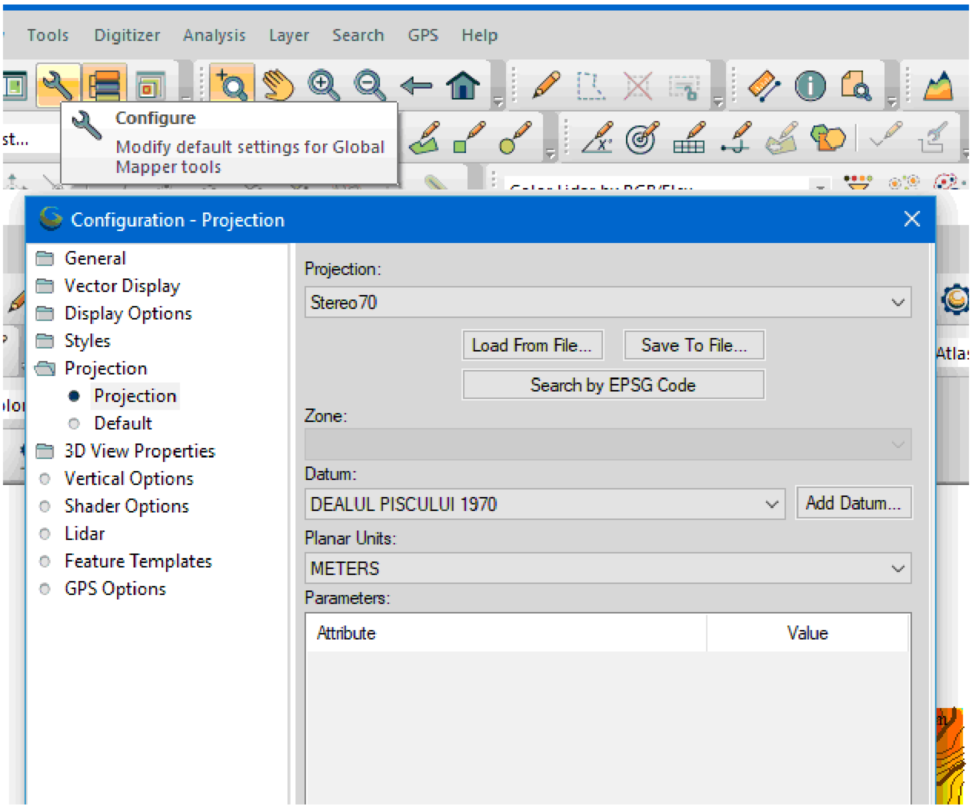

Fig. 6 - Level curve settings

Finally, the data were exported in vector/lidar format, which will then be processed with the help of Excel in order to obtain the X,Y,Z coordinates inventory.

inventarcoord.txt - Notepad

File Edit Format View Help

1	465528.033	454105.77	2461.632
2	465305.466	453739.681	2286.958
3	465122.478	453130.391	1955.383
4	465893.217	453121.532	2128.019
5	466769.936	453106.328	2353.068
6	467932.693	453027.57	1749.311
7	468935.523	453094.62	1767.194
8	469809.617	453363.539	1667.048
9	470458.137	453597.528	1622.739
10	470833.852	453780.015	1604.193
11	470935.101	453991.533	1663.345
12	470785.007	454186.311	1751.058
13	469982.77	454197.821	2105.062
14	468695.735	454200.658	1947.202
15	468683.698	454200.583	1950.053
16	466861.384	454188.655	1845.336
17	466825.45	454188.962	1844.161
18	465528.033	454105.77	2461.632
19	471087.459	455529.799	1250
20	471069.864	451751.289	1250
21	471065.867	451716.957	1250
22	471054.233	451690.294	1250
23	471027.323	451678.969	1250
24	470992.775	451675.314	1250
25	465045.972	451705.909	1250
26	465011.464	451709.92	1250
27	464984.672	451721.521	1250
28	464973.313	451748.302	1250

Fig. 7 - Inventory of coordinates

3. Results and Discussion

MATLAB, an acronym for Matrix Laboratory, is a development environment dedicated to numerical computation and statistical analysis, many type of calculations[1] including the associated programming language, created by MathWorks[2]. It provides extensive functionality for manipulating matrices, visualizing functions, implementing algorithms and creating interfaces, and can interact effectively with other applications.

In order to graph points, the griddata function[3] was used, making use of the following syntax in the command window:

[1] S.C. Chapra, “Aplied numerical methods with Matlab, for engineers and scientists”, Second edition, McGraw-Hill Science/Engineering/Math, 2006;

[2] https://www.mathworks.com/company.html

[3] interpolates the surface at the query points specified by (xq, yq) and returns the interpolated values, vq. The surface always passes through the data points defined by x and y.

```
%
minX=min(x)
maxX=max(x)
minY=min(y)
maxY=max(y)
 figure
 [xi,yi] = meshgrid(minX:20:maxX, minY:20:maxY);
%zi = griddata(X,Y,Z,xi,yi);
zi = griddata(x,y,z,xi,yi);
surf(xi,yi,zi);
```

Fig. 8 - Calling griddata function

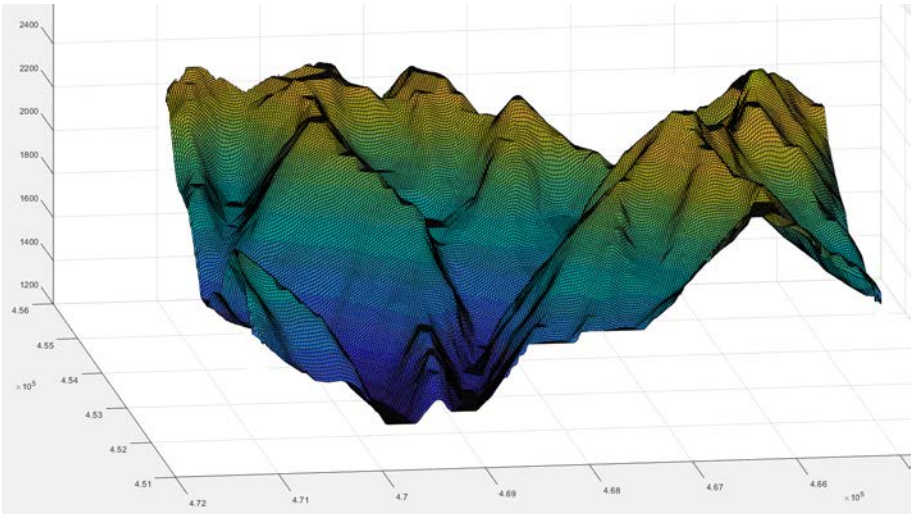

Fig. 9 - Graphic representation of area of interest

The Contour Method was used to determine contour lines by entering the following syntax into the program:

```
figure
[c,h] = contour(xi,yi,zi,10);
clabel(c,h);
xlabel('Longitudine')
ylabel('Latitudine')
```

Fig. 10 - Contour plotting script (Contour)

The use of interpolation methods, such as Griddata, together with contour plots, facilitates data estimation in locations where direct measurements cannot be made. This provides a continuous and consistent picture of the variability of the variables of interest.

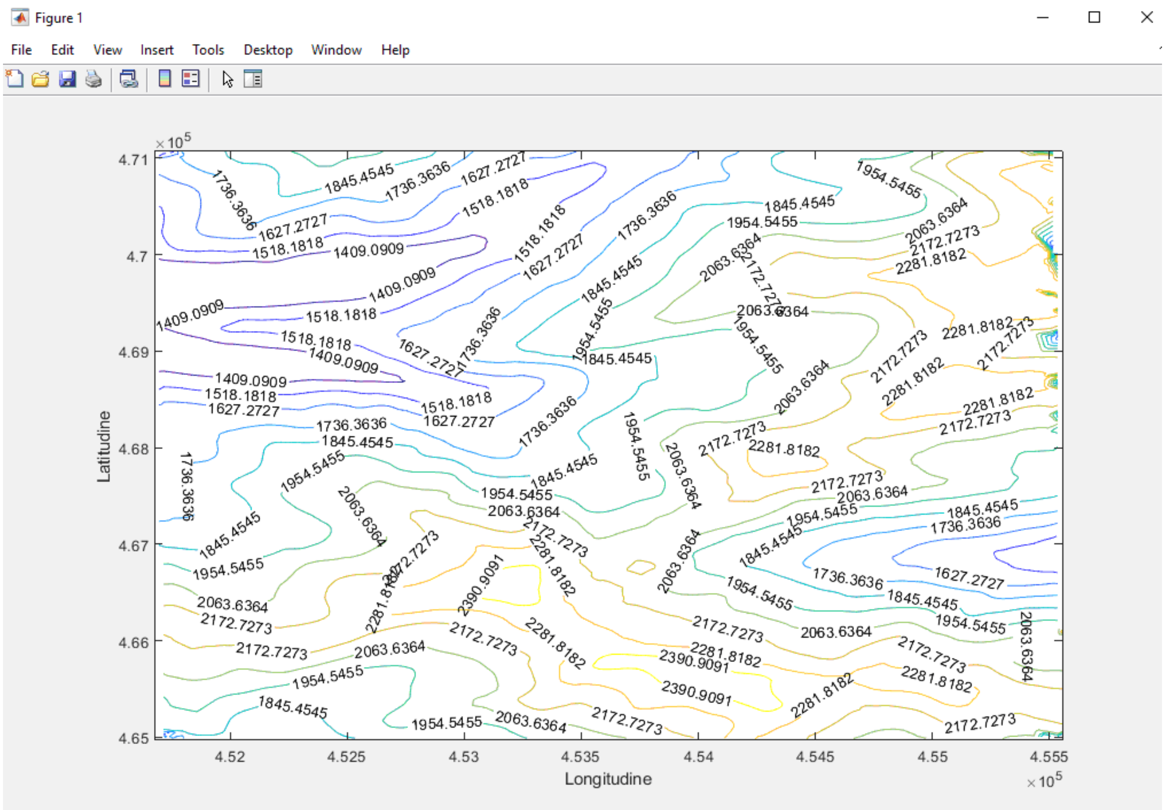

Fig. 11 - Graphical representation of isohypse

This identification of spatial patterns is crucial for understanding complex phenomena and making informed decisions.

In addition, three-dimensional ground visualisation using contour lines provides an effective way to interpret and communicate topography in an accessible way. By integrating interpolation methods, MATLAB functions and efficient data processing, contours become an essential tool for highlighting and understanding spatial variability in geospatial data.

4. Conclusions

In conclusion, the integration of multivariate function interpolation methods, especially using MATLAB Contour and Griddata functions, combined with the efficient export of data from Google Earth and their processing through advanced programs such as Global Mapper and Excel, is a key step towards optimizing geospatial data analysis and manipulation. This cohesive and efficient workflow approach not only facilitates a detailed and consistent visualisation of the data, but also contributes significantly to consistency in the interpretation of results.

By standardising data and optimising export and processing processes, consistency in data analysis is ensured, eliminating potential discrepancies and ambiguities. Proper visualisation of spatial data, supported by MATLAB functions, enhances clarity in communicating results to different audiences, thus strengthening understanding of the phenomena studied.

In addition, workflow efficiencies save time and resources, allowing researchers and professionals to focus more fully on complex analyses and interpretations. This not only optimises internal processes, but also ensures the quality of the final results, which are fundamental to decision-making and the development of future strategies.

Finally, the harmonious integration of these techniques and tools in the handling of geospatial data is not only a technical necessity, but also an essential pillar in obtaining reliable and meaningful results in fields such as geography, environment or urban planning.

5. Acknowledgements

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6. References

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