Conference Paper

Elaboration of Geotechnical Thematic Maps in Urban Areas

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Abstract

In urban areas it is difficult to access natural terrain due to strong human intervention. Therefore, any exposure of the natural terrain is considered an important source of geological and geotechnical data collection. The Geographic Information Systems (GIS) has been responsible to provide great development in geotechnical cartography, particularly in urban environment, using geographic databases and new analysis tools. Our goal is to create a geographical database that will allow and/or improve the elaboration of geotechnical thematic maps, using cartographic data of open platforms combined with free and open source GIS software. In the presented study our focus was related with the identification of the granite alteration degree...Through the geographical database, along with the geological map of the study area, the areas related to the degree of granite alteration were identified and delimited. The data were collected through "Street View" which results from the integration of a specific module in the GIS software (QGIS). The obtained data were validated by direct observation and were photographically recorded. This approach proved to be an effective method, with no significant differences when compared with direct observations. The methods' limitations are the quality of some "Street View" images, and the existent subjectivity related to the observer in the identification of the degree of alteration of the rocky massif. Its advantage is to reduce the data collection's time and the possibility of comparing the same place at different time points.

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1. Introduction

The cartography's execution in urban areas is confronted with the permanent reorganization, either by new buildings construction either by the reorganization of the existing one's. The diffusion of Geographic Information Systems (GIS) provided a big step towards the development of geotechnical cartography by the use of geographic database and new analysis tools [1]. Additionally, the increasing necessity of a more completed and diversified information, which favours open code free software "Free Open Source Software" [2], and the web platforms, which provides somehow cartographic information. Google stands out with its platforms variety: Bing Maps, igeo (web site of "Direção Geral do Território" (DGT)) and OpenStreetMap.

This work's aim is to make a viable geographic information data, which allows the geotechnical theme maps elaboration, mainly maps identifying the degree of granites' alteration, using cartographic data from open platforms combined with free SIG software and open code.

2. Informatics Applications

Geotechnical cartography has multiple applications, either on engineering or on territorial and regional planning. In the local and urban planning, these applications on integrated maps elaboration, with various geologic-geotechnical aspects, at small and medium scale. In engineers we make previous studies or viability maps to select the constructions or layout location. There are also maps with geotechnical profiles and cross sections on big scales.

In recent years, a set of informatics applications have appeared in the geotechnical cartography area [4], especially:

- In the automatic data approach;

- In the elaboration of elements or individual factors maps, or a combination between them;

- In the database preparation;

- On the continuous update of maps with informative data;

- On 3D models preparation and on fieldwork simulations.

2.1. Free open source

In the last decades open code free softwares have emerged, known by "Free Open Source Software". The "Open Source Software", or open code, intends to stimulate the error detection, creation, modification and new resource investigation, with the purpose of developing and upgrading the program. The open code projects involve people with different programming skills and necessities, which lead to create a complete product. This development methodology allows the access to the products source, which means to its' goods and knowledge.

On the Free Software case there's an ethical and social question, being the programs free character important. There are free applications, but its' code is not open, like the case of the Spatial Commander (GDV GeoSoftware-Germany), Forestry Gis (Winsconsin

department of natural resources-USA), Google Earth (Google- USA), ArcExplorer (ESRI-USA), TNTlite (microimages, inc- USA) and TatukGIS Viewer (TatukGIS-Poland) [2].

The most known Desktops GIS Open Source are: GRASS GIS, Quantum GIS (QGIS), uDig, OpenJump e gvSIG. Some of which are focused on specific field application, like the development in C++ and Java, which present a high flexibility degree, due to the uniformed interfaces and the ability of being able to be launched on the inside of architectures service-oriented.

On one hand, the increasing necessity of a more complete and diverse information seems to positively favour the open code softwares. On the other hand, the need of becoming competitive towards commercial softwares led to the appearance of free Softwares: Free Open Source Software.

3. Geographic Information Systems

3.1. QGIS

QGIS is a free open source Geographic Information System. The first version emerged in 2002, with the initial objective of providing a GIS model to visualize data of a diverse nature, but with spatial character, according to its creator Gary Sherman. Currently it is still only used to visualize raster and vector data in various formats. New features have been added through add-ons, currently QGIS offers several features common to other GIS programs.

It is an official project of the Open Source Geospatial Foundation (OSGeo), licensed under the GNU general Public License (GPL). Currently runs on various operating systems, Linux, Unix, Windows, Mac OSX and Android. It is developed using the QT Toolkit (http://qt.nokia.com) and C++, which allows it to have an easy-to-use graphical user interface.

It consists of a nuclear part, which contains a set of pre-installed internal modules, and a second part consisting of external modules. The external modules are present in the official repository PyQGIS and can be easily installed using the Python plugin installer [5].

3.2. EPSG identifiers

The indication of the reference systems in Geographic Information Systems, namely in QGIS, can be carried out through the use of EPSG identifiers, defined by the European

Petroleum Search Group (EPSG) and the National Geographic Institute of France (IGNF), largely referenced by those used in the Geospatial Data Abstraction Library (GDAL). The EPSG identifiers or codes are present in the QGIS database and can be used to specify the reference system.

In the DGT digital site (http://www.dgterritorio.pt/dados_abertos/codigos_epsg/), there is a list of EPSG codes used in Portugal and their correspondence with national systems.

In relation to the global systems used by Google, Bing, OpenStreetMap and other platforms of this type, the most used are the following:

- EPSG: 4326 (Datum WGS84/ Geographical Coordinates).

- EPSG: 3857 (Datum WGS84/ Pseudo-Mercator).

4. Results and Discussion

4.1. Geographic Base

The geographic base consists of the geological map produced by the "Laboratório Nacional de Energia e Geologia" (LNEG), and non-traditional cartographic sources.

The geological map used is the sheet "203-Guarda", to scale 1:25 000 which derives from map 1:50 000 of 1963. The map is referenced to the Lisbon datum of the IGeoE, projection Hayford-Gauss, in ShapeFile format. This format has the advantage of being interpreted by most geographic information systems, containing two major components; the graphic component, which contains the geometric definition of the place, and the descriptive component, which characterizes through various attributes the graphic component.

In the study example, the graphic component consists of polygons in which each polygon is characterized by a code (UC_cod), and the respective attributes inherent in this code. The table is editable and can be complemented with field observations, which lead to the refinement of the respective geometric shapes.

Regarding the non-traditional Geographic Base, it was given preference to open platforms, using Google maps, Bing maps and OpenStreetMap. As software, QGIS was used for the reasons indicated in the previous point.

Graphic/Cartographic data were used in raster and vector models. The vector data originated from the OpenStreetMap platform and the geological map. Raster data originated on the Bing Maps platform.

4.2. Procedures

In the raster data, through the module OpenLayers plugin, we selected the aerial image of Bing Maps, because it showed, at the time, to be the best quality image.

The information provided by the OpenStreetMap platform of the urban region under study, City of Guarda, was imported for the vector data. The file obtained comes in "osm" format [6], this file contains several themes or layers, which can be filtered thus obtaining the desired themes.

The themes are divided geometrically into points, lines and polygons. Each theme has a table of attributes, from which you can refine the results. The streets and routes of communication, in general, are obtained from the line's theme. From the polygon theme we obtain administrative areas, land use, etc.

This way, the polygon theme has extracted the limit of the residential area of Guarda, giving rise to the GuardaAreaResidencial theme, keeping the line's theme unchanged. The selected themes should be stored in a shapefile format for better manipulation and coherence.

Thus, with this geographic information, one can develop a thematic map, for example, a map that identifies the degree of alteration of granite. For this case, we can use the "StreetView" platform, in two ways: directly from the Google platform (Figure 1) or integrated into QGIS (Figure 2).
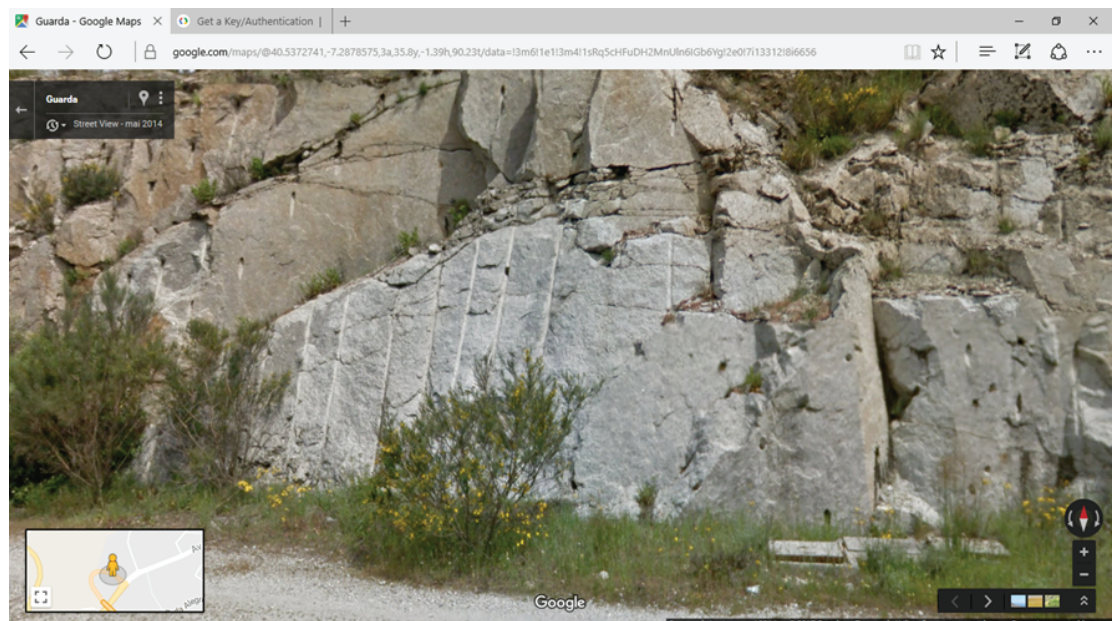

Figure 1: Google Street View, Granite (degree of alteration of the rocky massif, w1 e w2).

For integration into QGIS, it is necessary to install one of the plugins available to access the data from the platform "Google Street View".
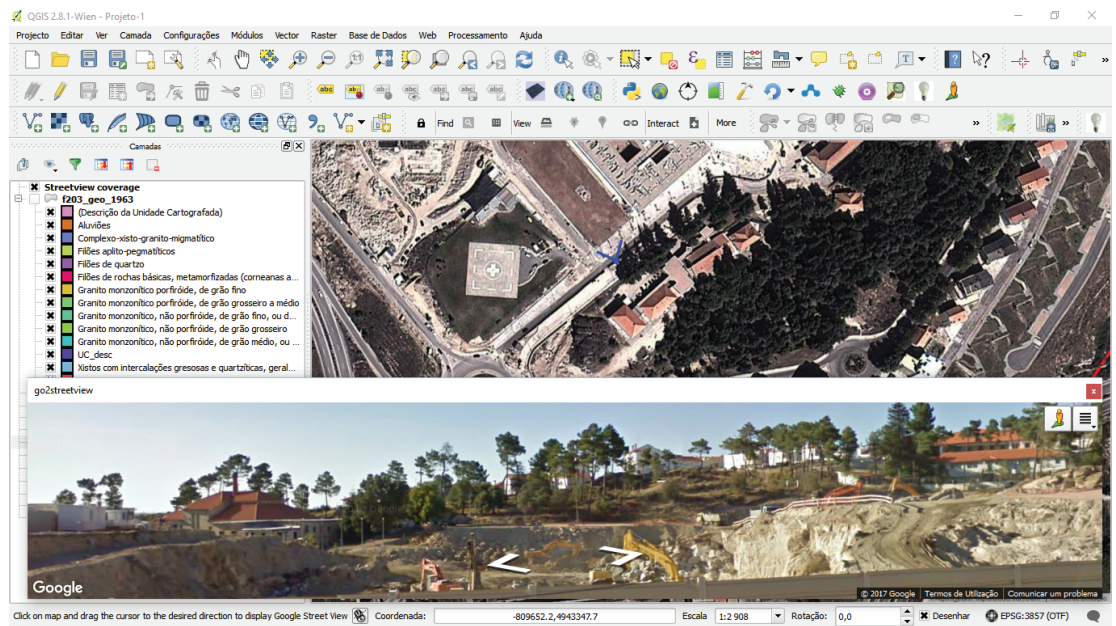

Figure 2: QGIS with Plugin "go2streetview".

As can be seen, through figures 1 and 2, the platform "Street View" allows access to images with great proximity and resolution in urban areas. It can be identified, in most cases, the degree of alteration of the rocky massif.

Figure 2 shows a peculiarity, the fact that the capture of images by Google occurred at the excavation time, allowing the visualization of the type of rock underground. The current state is reflected in figures 3 and 4, through the current photo field.

QGIS allows the creation and optimization of forms: Figure 3 shows the form that was created to facilitate the data filling in the respective fields of the attribute table, allowing when creating a graphic element to insert the data, characterizing this element at the same time.

Therefore, in relation to the theme that will characterize the degree of alteration of granite (GrauAlteraGranito), the fields created (Figure 4), were: ID (identifies the graphic by a number); Degree of alteration of the granite (combo box with the list of possible degrees of change), date of entry (indication of the date of the creation of the element, or other) and current photo (current photo of the area under study).

The use of forms facilitates the insertion of the data that characterizes the element to be represented and simultaneously decreases the error in the data writing in the respective fields.
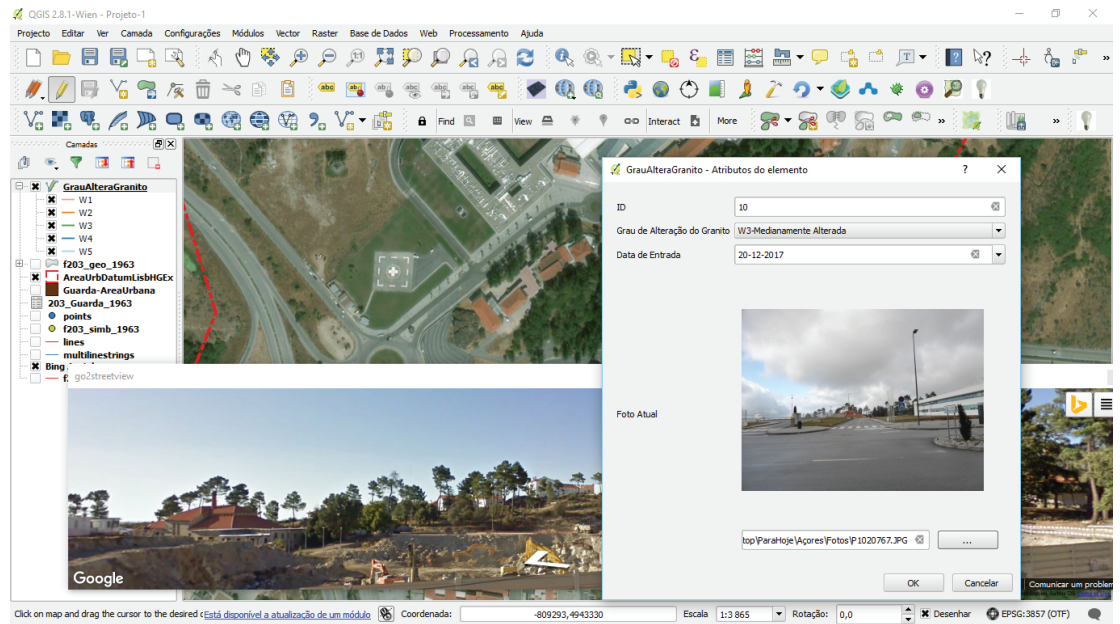
Figure 3: QGIS graphic element creation and its form.

We obtained 513 polygons (n = 513): 1.0% of polygons (5) were classified as W1, 10.1% of polygons (52) were classified as W2, 13.3% of polygons (68) were classified as W3, 8.6% of polygons (44) were classified as W4 and 67.1% of Polygons (344) were classified as W5, (Figure 5).

In order to validate the obtained results, field observations were made with photographic documentation of all points, where it was found that 89.9% of the points were adequately classified, changing only the classification in 10.1% of the points (17), (Figure 6).

As we can observe, there were no significant differences between the two methods. The greatest alterations were observed in W3 and W4 degree.

5. Conclusions

The highlight of this work is the possibility to create a viable geographic information base for the geotechnical cartography' elaboration, using cartographic sources of open platforms, so as free software and the creation of thematic maps.

Applying this type of platforms decreases de data collection time and, sometimes, careful observation of the images, obtained during the excavations, can reveal important details for geological cartography in the field of study.

This model had the geological map's input of the area study and free cartography existing on web platforms (Google, Bing, Igeo, OpenStreetMap,...). It had as output, some
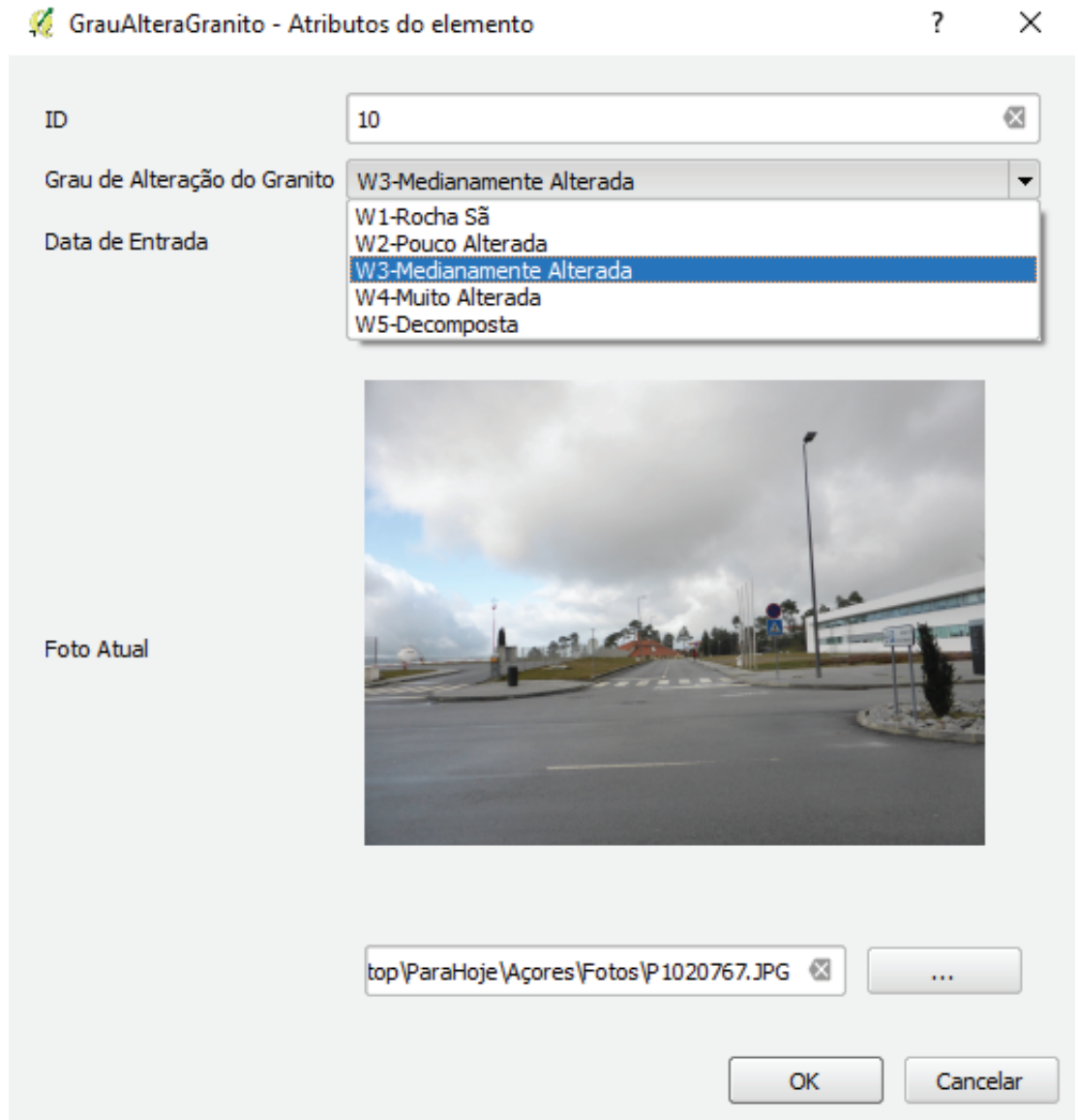
Figure 4: QGIS, form, combo box.

graphical outputs were obtained, demonstrating the possibility of overlapping various themes, filtered from Web files.

In this study, from this model, a theme was created that allowed the identification and delimitation of areas related to the degree of alteration of granite. For this case, the data was first collected with the platform "Street View" and then validated in the field. The limitations of this methodology are the quality of some images, and the subjectivity of the observer, in the identification of the degree of alteration of the rocky massif. On the other hand, it has as its advantages the reduction of data collection time and the possibility of comparing the same location at different temporal times, because there are photographic covers made by Google company at time intervals of some years.
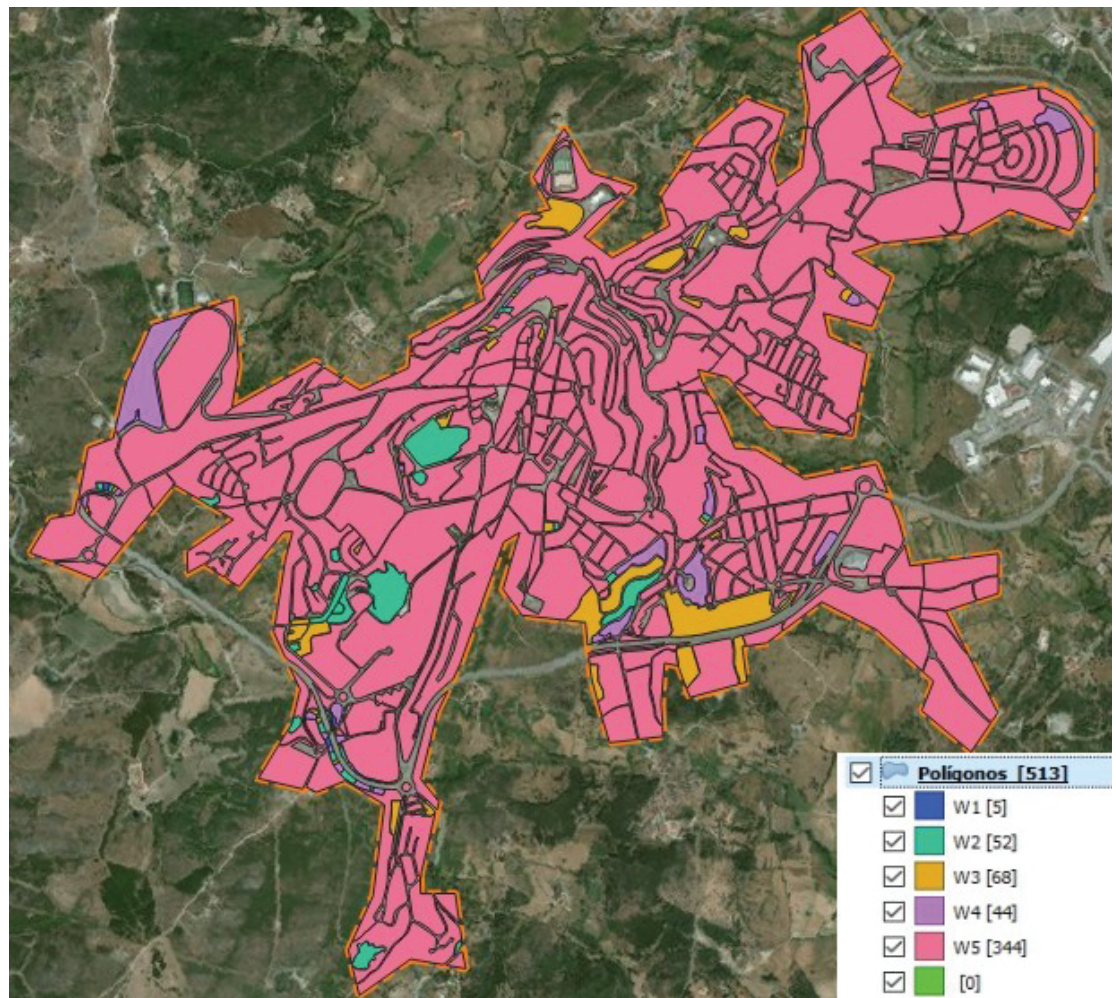
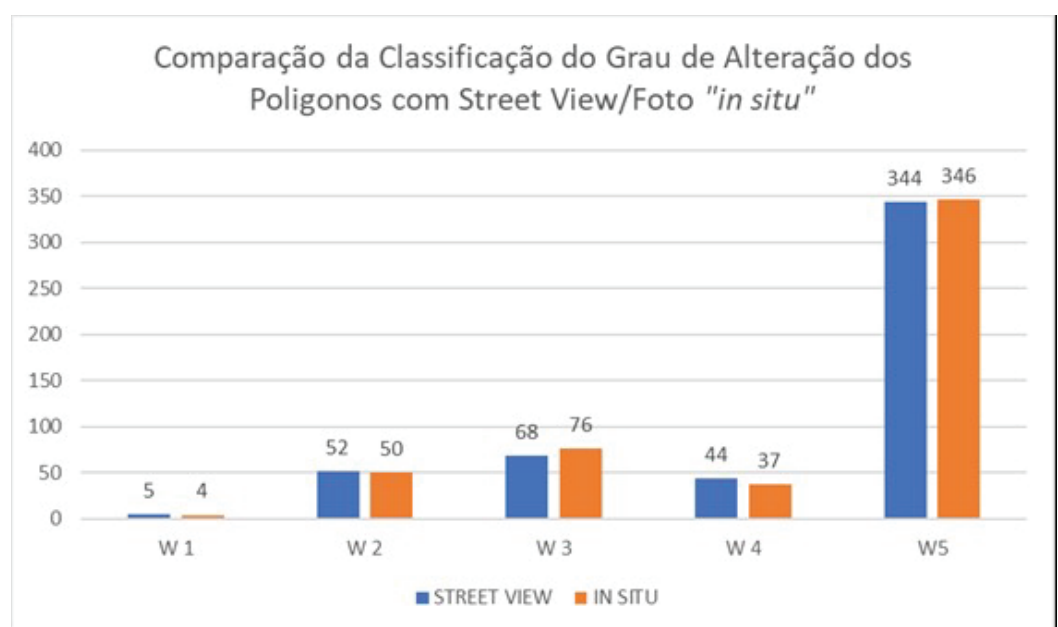**Figure** 5: QGIS, areas with delimitation of the degree of alteration of the rocky massif.

Figure 6: Comparison of the degree of alteration of the rocky massif, polygons of the urban area, Guarda.

Acknowledgements

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