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NOVA
INFORMATION
MANAGEMENT

Bachelor's degree Information Management
Geospatial Intelligence

Safety in Lisbon

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1. Abstract

Lisbon is a beautiful place to visit and to live in, but like any other major city, it too has its fair share of crime, accidents, and general unsafety. For the purpose of this study, we imagine that the local government within Lisbon has tasked us with figuring out which areas are the most unsafe for citizens in Lisbon Metropolitan Area. To do this, we analysed the criminality, as well as other factors, in Lisbon using the ArcGIS Pro tool. We applied spatial analysis techniques and took into account the factors that contribute to unsafety, and it allowed us to understand which zones of Lisbon are more dangerous than others.

The result that we found was, that the municipalities: Vila Franca de Xira, Odivelas, Loures, Alfragide, Campolide, Lisboa, Lumiar, Setúbal and Oeiras, are the safest municipalities within the Lisbon Metropolitan Area. These areas are the ones which should receive the least funding from a given budget. Instead, money should be divided among the municipalities that require more attention in order to be safer for habitants.

2. Keywords

Funding; Crime; Lisbon; Security; Safety.

3. Introduction

In the course “Geospatial Intelligence”, under the responsibility of the teachers Pedro Cabral, João David and Susana Martins, our group decided to do a project about “Safety in Lisbon Metropolitan Area”, taking into account information based on, among others, crime and accidents. Using the methods we learned during the course, within the field of GIS (Geographic Information Systems), we found that we could do exactly that. “*GIS as an area of activity has been driven by the success of its applications in solving real world problems*” (1). GIS is a very useful tool for this project, because it allows us to present all the information about the respective area, its characteristics, and if it is safer or more dangerous. Using the ArcGIS software, we can take our datasets and present them in such a way, that the data becomes easy to visually approach, meaning better decisions can be made much faster. “*GIS as part of the process of exploring change geographically and temporally”* (2).

The main goal of this project is to help inform the local government of Lisbon, where they should transmit funds for police officers, try to improve safety efforts, and in general where funding should be put towards fighting crimes, by highlighting which zones are more dangerous than others. The main result we reached was a map, from which we could deduct conclusions on which municipalities were the safest and most unsafe, within the Lisbon Metropolitan Area.

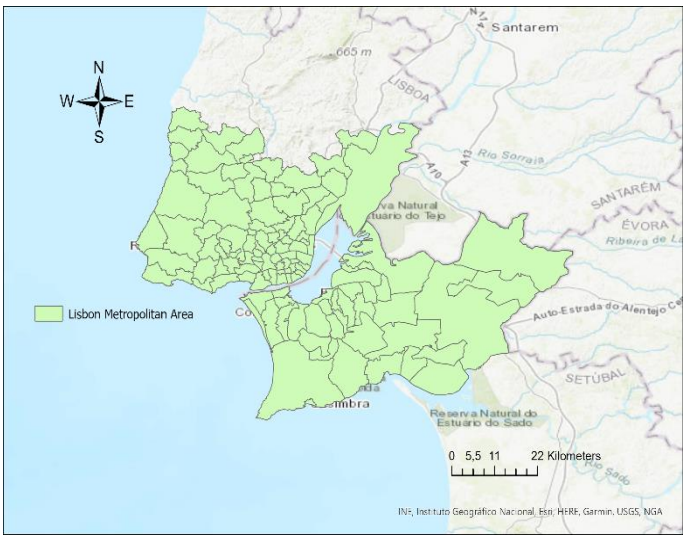
4. Study Area

The report will be focused on the Lisbon Metropolitan area, which has an area of 3000km². The city is located in the occidental part of Europe, on the coast of the Atlantic Ocean, which means that it's a vital point for Europe, because a lot of goods that come from abroad, enters Europe through Portugal here.

The city has 18 counties: Alcochete, Almada, Amadora, Azambuja, Barreiro, Cascais, Lisboa, Loures, Mafra, Moita, Montijo, Oeiras, Palmela, Sesimbra, Setúbal, Seixal, Sintra, Vila Franca de Xira, Odivelas, and it's located by two peninsulas: Lisbon Peninsula and Setúbal Peninsula. The counties with the closest population density are Amadora with 7361,7 thousand hab/km, Lisboa with /2474,6 hab/km, and Odivelas with 5474,6 hab/km, the counties with lower population density are Montijo with 146,9 hab/km, Alcochete with 136,9 hab/km and Palmela with 135,1 hab/km. Lisbon is the most touristed county in the Metropolitan area. According to an INE census from 2021, 544851 habitants currently reside in the city. In 2019, (before Covid-19 had an impact on the numbers), Lisbon was the fourth city most looked at for visits, and housed tourists for a combined total of 11.7 million overnight stays. While these numbers are certainly very high, reducing crime and improving general safety in the city, could help push the tourism numbers for the city even higher. Lisbon has a lot to offer, and it would be a shame if the city were to ever gain a reputation of being unsafe.

Using GIS we could help this process by moving away from old paper maps, and allow information to be displayed on a visual spatial dataset instead, which is easier to interpret: "*GIS modelling involves entirely new spatial reasoning concepts and procedures that are not reflected in our paper map legacy"* [(3).](#) We decided to focus on Lisbon specifically, because it's an area of Portugal that has a lot of data available for analysis. We also felt that analysing this particular area of Portugal, was interesting due to the nature of the university's location. As students at the university, we all live in the city, and found it interesting to learn more about the city we live in.

Map of the Lisbon Metropolitan Area



Map 1: Lisbon Metropolitan Area

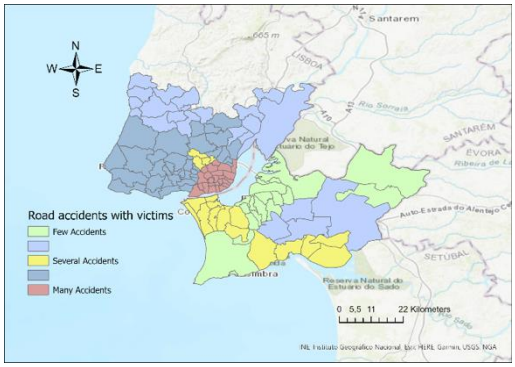
5. Methods

Before beginning our analysis, in order to reach a final result and to answer our research question, we decided on which criteria to use. The criteria's *Accidents* (Accidents in each municipality in Lisbon Metropolitan Area), *Crimes* (how many crimes we had each municipality in Lisbon Metropolitan Area), *Employees* (higher job security, less people out of work) and *Residents* (how many people live in each municipality of Lisbon Metropolitan Area). These criteria's help us define which areas are more in need of help than others.

After deciding the criteria´s for which we will base our findings on in our project, we started exploring all documents needed for the project (shapefiles, excel documents). Following ensuring all relevant data was found, we imported it into the program ArcGIS Pro. After importing them, we organized our data using intersections in respective tables and deleting data attributes, attributes that we don't use, in our project. After collecting our data and organizing the criteria´s of our project (the accidents, employees influence, the crimes and their residents), we wanted to obtain the Lisbon area data for each respective criteria, and their final result with all criteria together, so we intersected all layers with CAOP 2020 in order to have a respective geography to work from. A more in-depth view into the action taken behind each criterion, can be found below. For our work, we used the software ArcGIS Pro (v. 2.8).

5.1 Road Accidents

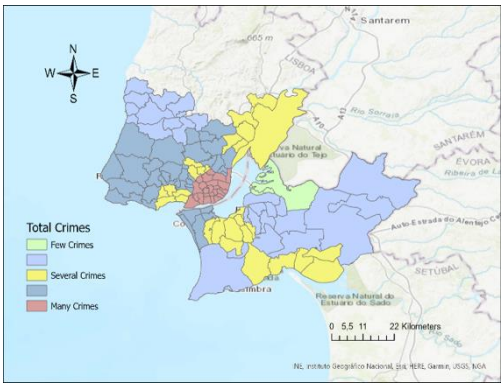
For road accidents, we began by firstly obtaining the relevant data. We consider road accidents to be an important aspect to take into account when it comes to safety in the Lisbon metropolitan area, as they highlight an idea of general safety. Next, after transforming the excel data, we introduce the excel tables into ArcGIS Pro, and using the tool "Add Join" we interconnect with the CAOP data, in order to obtain the accidents for each municipality of Lisbon. Finally, we change the symbology for "Gradient Colours" and change their label names. Using this, it is possible to conclude which areas have more road accidents.



Map 2: Road Accidents

5.2 Crimes

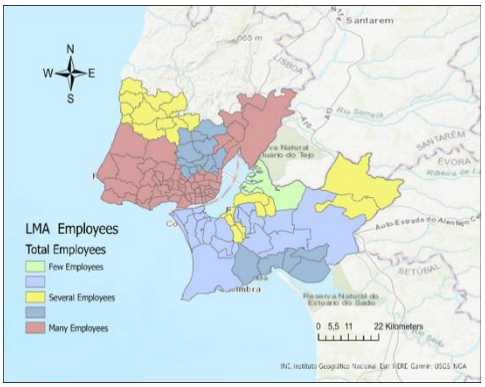
Crime is a fundamental aspect of one's safety, in that the more crime a municipality has, the less safe it is. This is of course one of the main factors for evaluating safety within Lisbon. After gathering relevant data, we then extracted the crime data for the Lisbon metropolitan area, and after transforming the tables in excel we inserted them in ArcGIS Pro. After inserting the tables in ArcGIS, we use the tool "Add Join" intersected with the municipalities of Lisbon, then we change the symbology for "Gradient Colours" and their label names. Thus, we were able to conclude which municipalities have the highest crime in Lisbon.



Map 3: Crimes

5.3 Employees

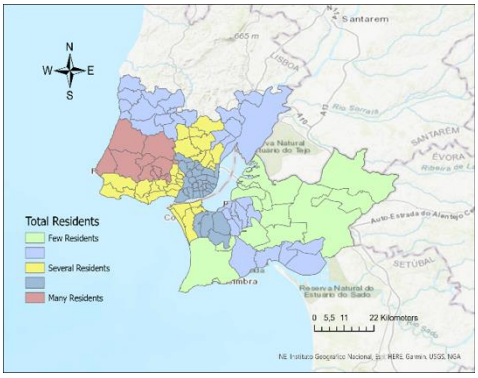
We consider employability to be a determining factor in a person's safety, in those areas where there is less employability, there is also less purchasing power, which can sometimes lead to an increase in criminal activity. We take data on employment in the municipalities of Lisbon and after transforming the excel tables we add the data to ArcGIS Pro. After adding the data, we use the "Add Join" tool with the parishes of Lisbon. Finally, we change the symbology for "Gradient Colours" and their label names. This way, it was possible to conclude which municipalities in the Lisbon area have the highest or lowest employment.



Map 4: Employment

5.4 Residents

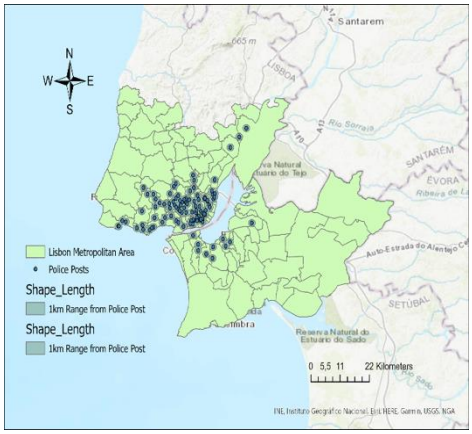
Another factor that we took into account was the resident population, because normally areas with higher values of residents, also have a higher crime rate. This data is also valuable in order to understand where more police is required, due to a larger area of responsibility. We took the data about the resident population in each parish, transformed the tables and added them to ArcGIS Pro, used the "Add Join" tool and changed the symbology for "Gradient Colours" and their label names. This allowed us to be able to conclude which areas have more or less resident living within them.



Map 5: Residents

5.5 Police Station

By setting up the data for locations of police stations, it allowed us to understand where the police stations are located, in which areas are the most densely, in the Lisbon Metropolitan Area. We began by extracting the police station shapefile and selecting the CAOP 2020 (with a query that only selected the municipalities from Lisbon Metropolitan Area). We also did a "Buffer" in police stations to have a perception of, if all parishes have at least one station currently.



Map 6: Police stations

5.6 Combining the criteria's

After defining our criteria's, we then individually transformed all our criteria in Raster's using the tool "Feature to Raster". This is done such that we can understand the importance of each criterion, by separating their range by a scale. We used the tool "Reclassified" to have a color pattern, which creates a specific scale in our ranges. We decided to use a scale of 1 to 5, as to not have too many colors in our results, for an easier understanding of findings.

LMA_Residents		
19787-64507	1	Very Unsafe
64507-14199	2	Unsafe
14199-161900	3	Fairly Safe
161900-167899	4	Safe
167899-391402	5	Very Safe

LMA_Employees		
5230-6000	1	Very Unsafe
6000-9000	2	Unsafe
9000-13000	3	Fairly Safe
13000-18000	4	Safe
18000-31982	5	Very Safe

LMA_Accidents		
66-270	5	Very Safe
270-470	4	Safe
470-640	3	Fairly Safe
640-700	2	Unsafe
700-2768	1	Very Unsafe

LMA_Crimes		
727-3470	5	Very Safe
3470-4250	4	Safe
4250-5800	3	Fairly Safe
5800-11600	2	Unsafe
11600-35115	1	Very Unsafe

Table 1: Classification of the four criteria

After using the reclassification in each criterion, we use the analysis tool "Weight Sum", which in ArcGIS Pro serves as a way to understand the importance, by giving each Raster a value. For that, we needed to the know weights of each variable, so we created the Pairwise Comparison Matrix and then found the Normalized Pairwise Matrix, as to be able to discover each criterion weight.

	Crimes	Employees	Residents	Accidents
Crimes	1	5	5	3
Employees	0.2	1	1	5
Residents	0,2	1	1	3
Accidents	0,333333	0,2	0,3333333	1
Total	1,533333	7,2	7,3333333	12

Table 2: Pairwise comparison matrix

	Crimes	Employees	Residents	Accidents	Weights
Crimes	0,65	0,69	0,68	0,25	0,569609
Employees	0,13	0,14	0,14	0,42	0,205588
Residents	0,13	0,14	0,14	0,25	0,163922
Accidents	0,22	0,03	0,05	0,08	0,060881

Table 3: Normalized pairwise comparison matrix

Crimes	5	4	3	2	1	2	3	4	5	Employees
Crimes	5	4	3	2	1	2	3	4	5	Residents
Crimes	5	4	3	2	1	2	3	4	5	Accidents
Employees	5	4	3	2	1	2	3	4	5	Residents
Employees	5	4	3	2	1	2	3	4	5	Accidents
Residents	5	4	3	2	1	2	3	4	5	Accidents

Survey 1: by Diogo Jorge, Luis Silvano, Nikolaj Skov Wacher, and Vaso Reis

To reach our final result, of which location are the safest and which are the most unsafe, we used the tool "Raster Calculator" with one condition. The purpose of using the condition, was to better be able to see the location of the safest zones in Lisbon Metropolitan Area.

The result was a map scaling between 1 to 5, wherein the values closest to 5, are the safer areas. On the map, the red areas are the most unsafe, and the dark greens are the safest.

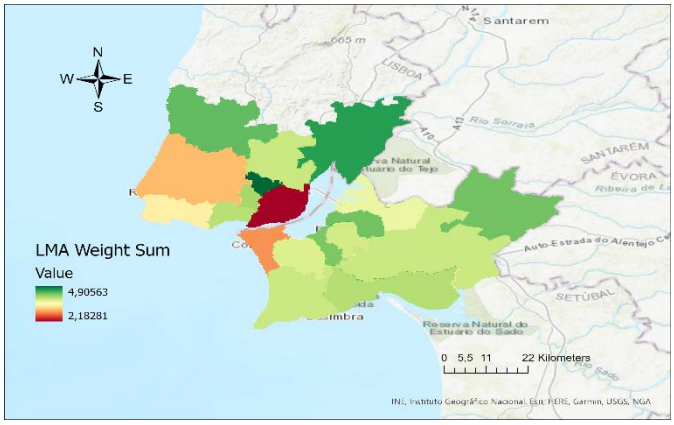
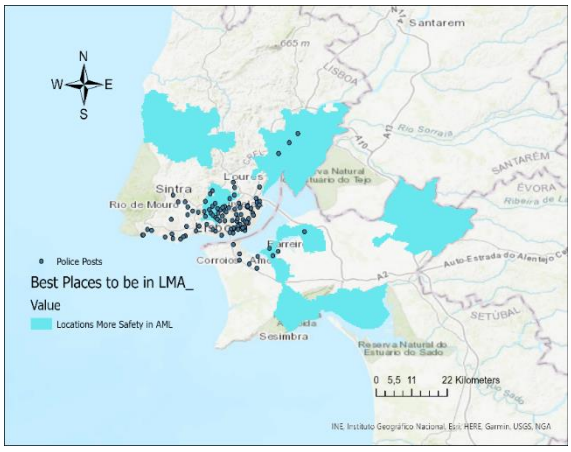


Table 7: Weight sum

6. Results & Discussion

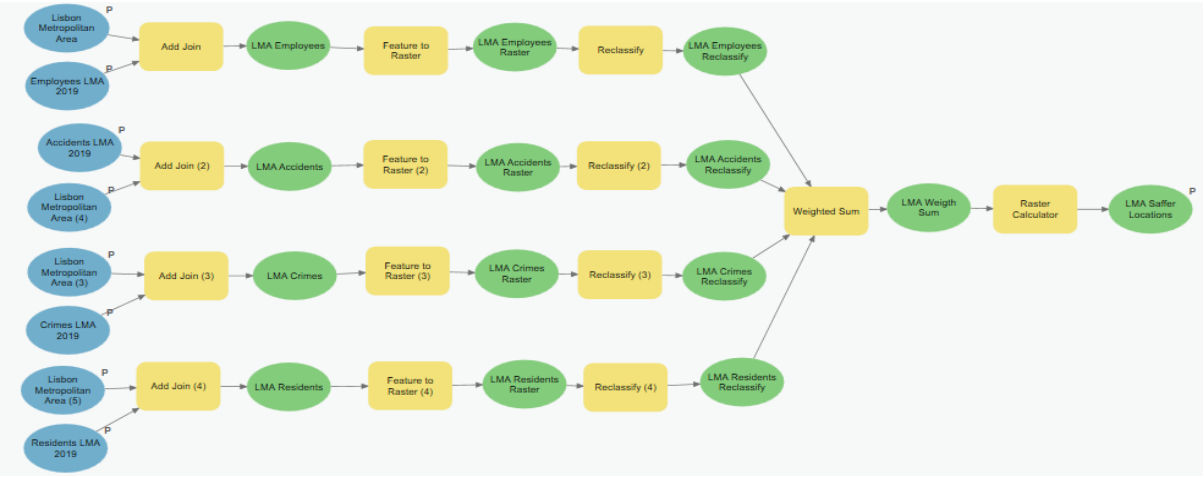
Continuing our analysis, we obtained the safest areas from Lisbon Metropolitan Area represented on this map herewith the colour blue. From this map it is possible to conclude, the municipalities: Vila Franca de Xira, Odivelas, Loures, Alfragide, Campolide, Lisboa, Lumiar, Setúbal and Oeiras, are the safest municipalities within the Lisbon Metropolitan Area.



Map 8: Final result

After obtaining this result from our analysis, we can conclude all criteria were satisfied. The resulting map we reached, however, comes only from these 4 criteria. If we were to improve the final result, other criteria could likely have allowed more insights. We might also have seen different results from using different data sources. If more research was to be done on his subject, we believe including criteria such as: wealth distribution, current police efforts etc., would help to reach a more precise result. Another important note in regard to police stations in our methodology, is that that some are lacking on the map, because our shapefile did not let us put all values in. We tried to use the "Add Join" tool with one table with the respective coordinates and also tried to "make XY Event Layer", but we were unsuccessful.

In order to document our work, we created a graph to display how work took place within ArcGIS, and which steps were taken to reach our final result. The graph is presented below, with first steps starting from the left and following steps going towards the right.



7. Conclusion

The main goal of this study was to find the safest location in the Lisbon Metropolitan Area. This goal was reached using different combination of tools within ArcGIS Pro, by combining it with relevant data we found from different sources "*Geographic information systems (GIS) are capable of managing large amounts of spatially related information, providing the ability to integrate multiple layers of information and to derive additional information*" (4).

From our result we were able to conclude that the municipalities: Vila Franca de Xira, Odivelas, Loures, Alfragide, Campolide, Lisboa, Lumiar, Setúbal and Oeiras, are the safest municipalities within the Lisbon Metropolitan Area. These areas are the ones which should not receive the least funding from a budget. Instead, money should be divided among the municipalities that require more attention in order to be safer for habitants.

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