Documentation of the GIS project

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Module: T3120 – Geographic information systems and remote sensing

Date: 2024/02/04

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1. Structure of the GIS project and the data folder

It is possible to write a common documentation for the “Collect data for the study area” part. Please mark the common text in each documentation.

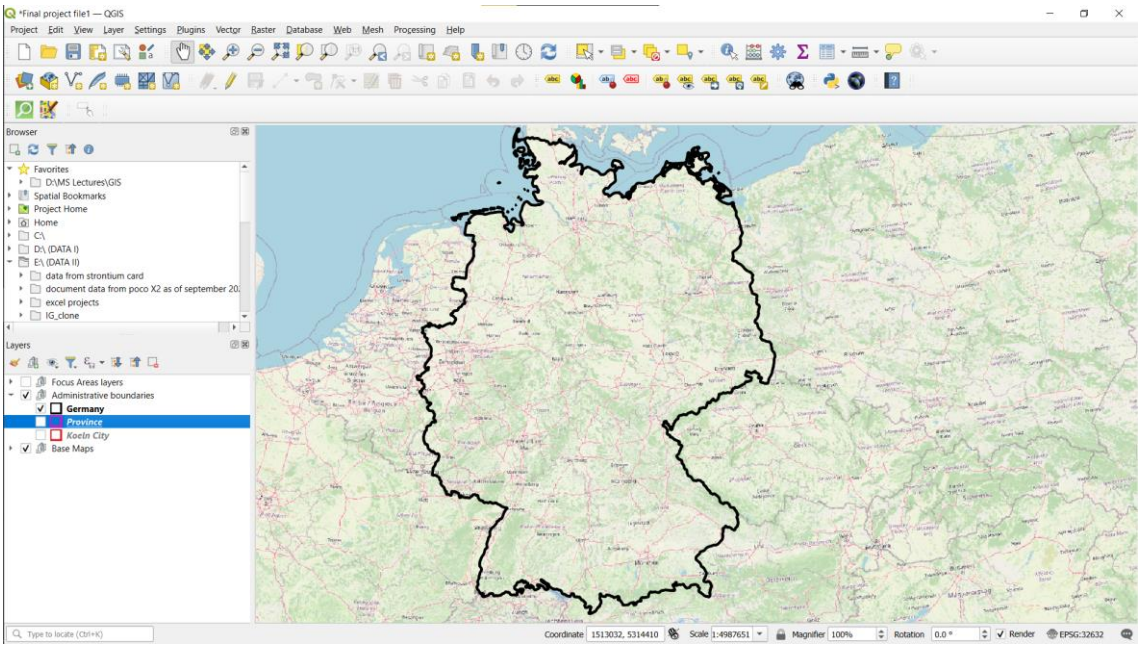
Basic Data:

1. Open Street Map: The layers for the National, Provincial and city boundaries were downloaded from the QOSM Plugin. Though, the metadata for these layers was not to be found; the layer ‘Cologne Districts-Schiedsamtsbezirk’ was downloaded from the https://www.offenedaten-koeln.de/ website and had most of the metadata filled in.

Broader Regional Information:

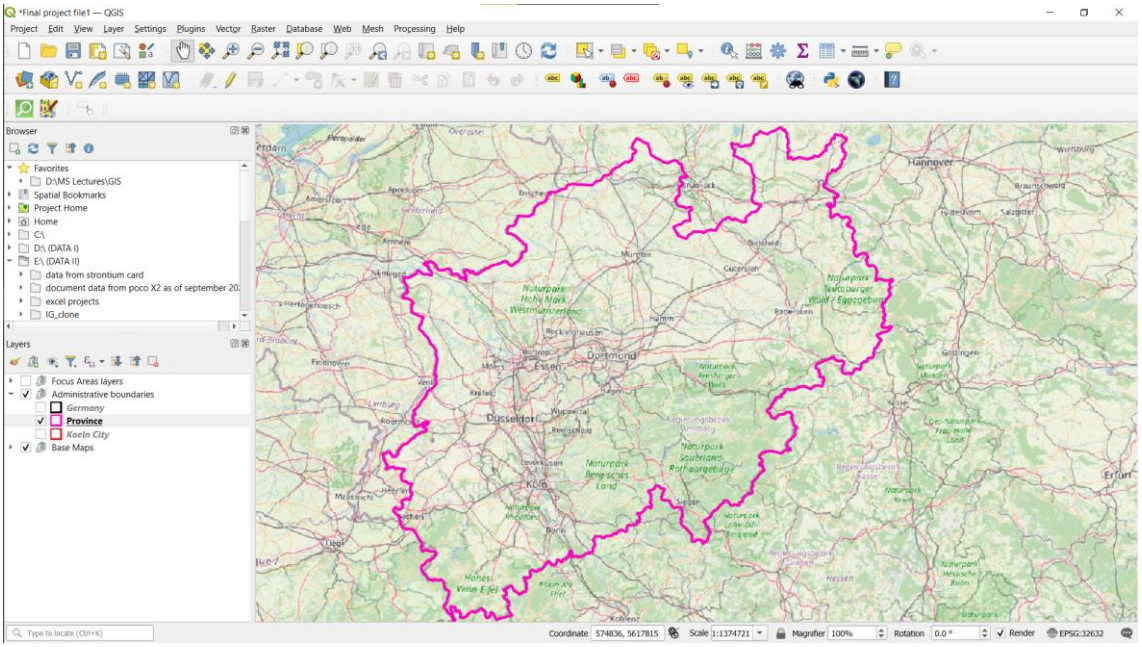
a. National Boundary: Germany

Figure 1: National Boundary



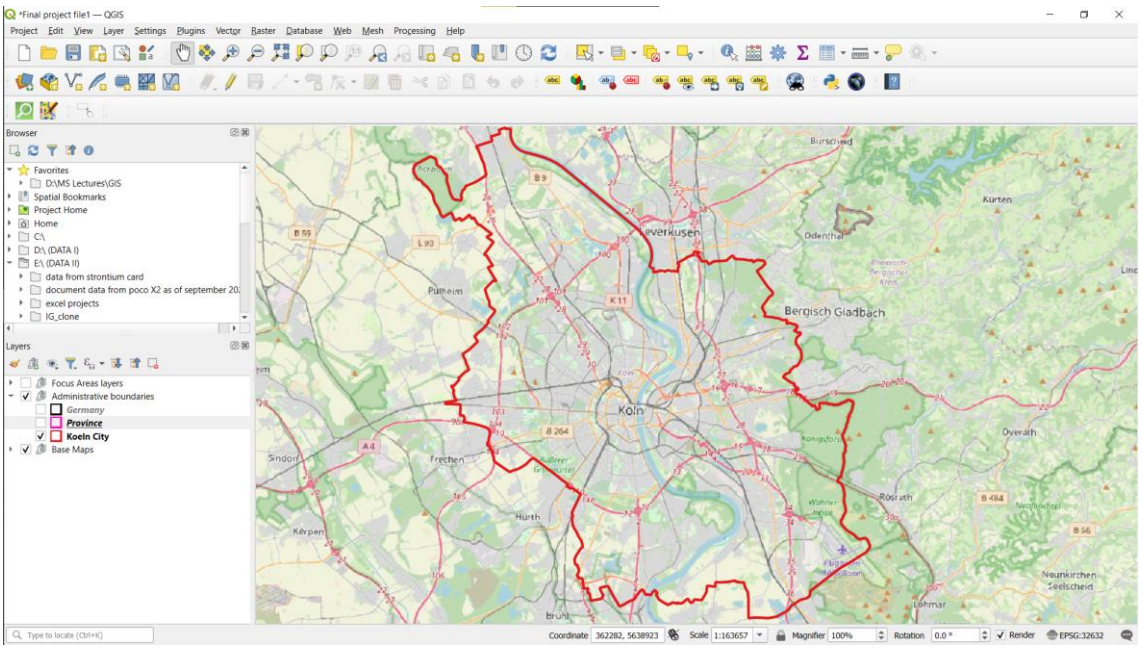
b. North Rhine Westphalia:

Figure 2: North Rhine Westphalia



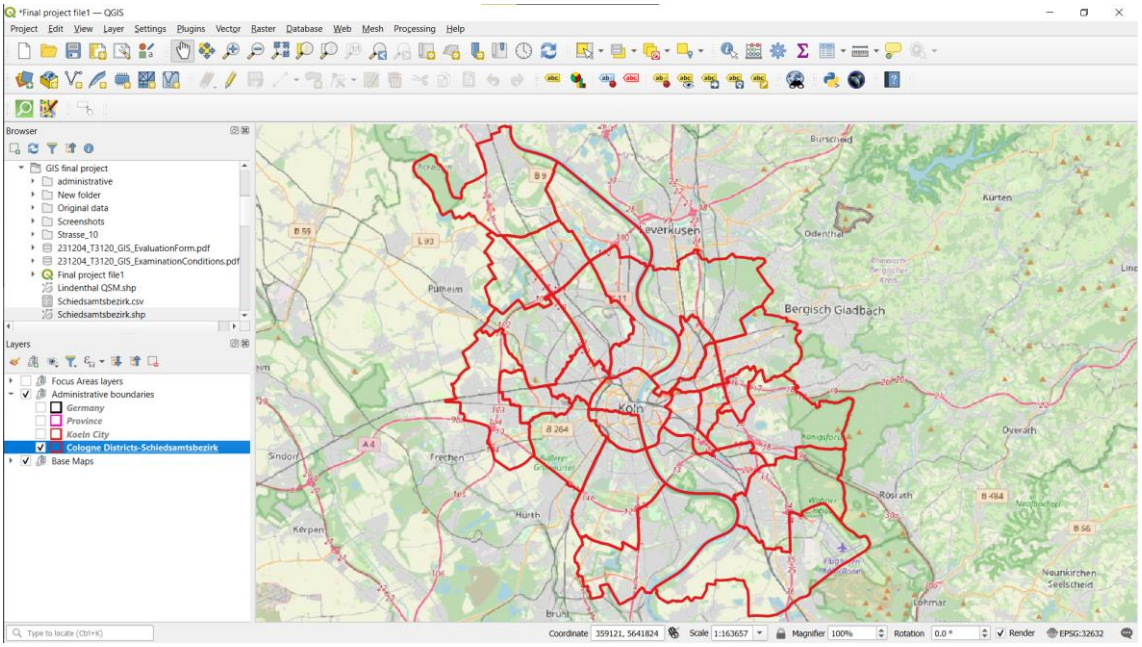
c. Cologne City

Figure 3: Cologne City



d. Cologne District Division into quarters

Figure 4: Cologne District Division into quarters



- What datasets are part of the GIS project?

For this GIS project we have taken both Raster and Vector datasets. Following datasets are part of our project:

Table 1: Datasets part of the project

Name of Dataset	Dataset/ Layer type	CRS of dataset	Source/links
Open Street Map	Raster	EPSG:3857 - WGS 84 / Pseudo-Mercator	https://www.openstreetmap.org/#map=7/50.209/5.977
Germany	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	QOSM Plugin
Province	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	QOSM Plugin
Koeln City	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	QOSM Plugin
Cologne Districts	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	https://www.stadt-koeln.de/politik-und-verwaltung/statistik/statistikatlas-koeln
Streets (Strasse)	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	https://www.offenedaten-koeln.de/dataset/strassen-k%C3%B6ln/resource/e3ef5673-db76-4053-bb82-46a87126c6c7
Hospitals	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	https://www.offenedaten-koeln.de/dataset/krankenh%C3%A4user-k%C3%B6ln
Unfallstatistik 2021	Vector	EPSG:32632 - WGS 84 / UTM zone 32N	https://offenedaten-koeln.de/dataset/unfallatlas-k%C3%B6ln

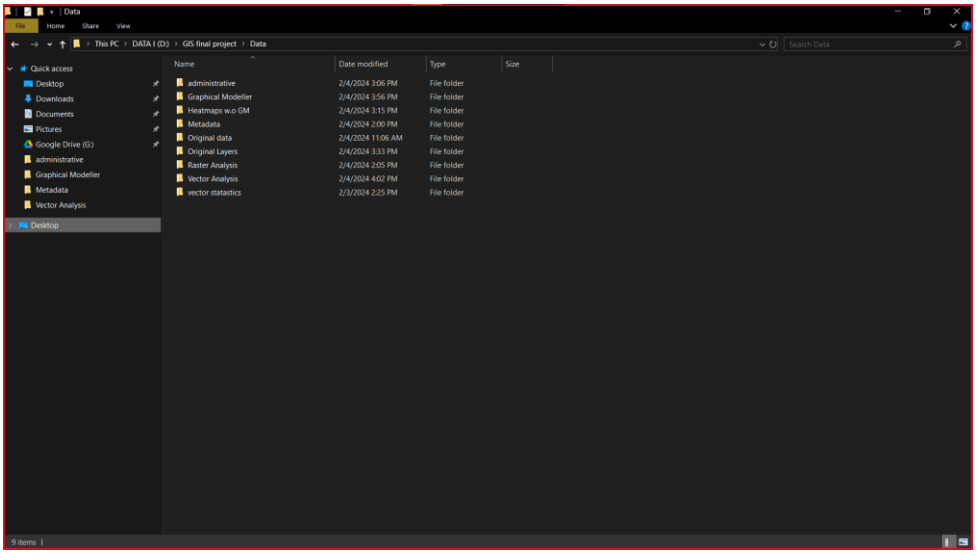
The above table show the total datasets used for our group project. The layers which are marked in RED are the ones which are used/generated for/from my individual work for spatial analysis task.

* For the layer Unfallstatistik 2021, I have converted the .CSV format data file to point vector layer after processing the data. Furthermore, I used the location columns in the data file to mark them as points layer.

- How are the datasets organized …
  - …in the folder or database structure?
  - …in the GIS project itself?

Datasets can be found in the folder at location as can be seen in the following image

Figure 5: Folder arrangement



- What datasets are the result of spatial analysis and how are they organized?

The following data sets are results of spatial analysis.

Table 2:Dataset resulted from spatial analysis

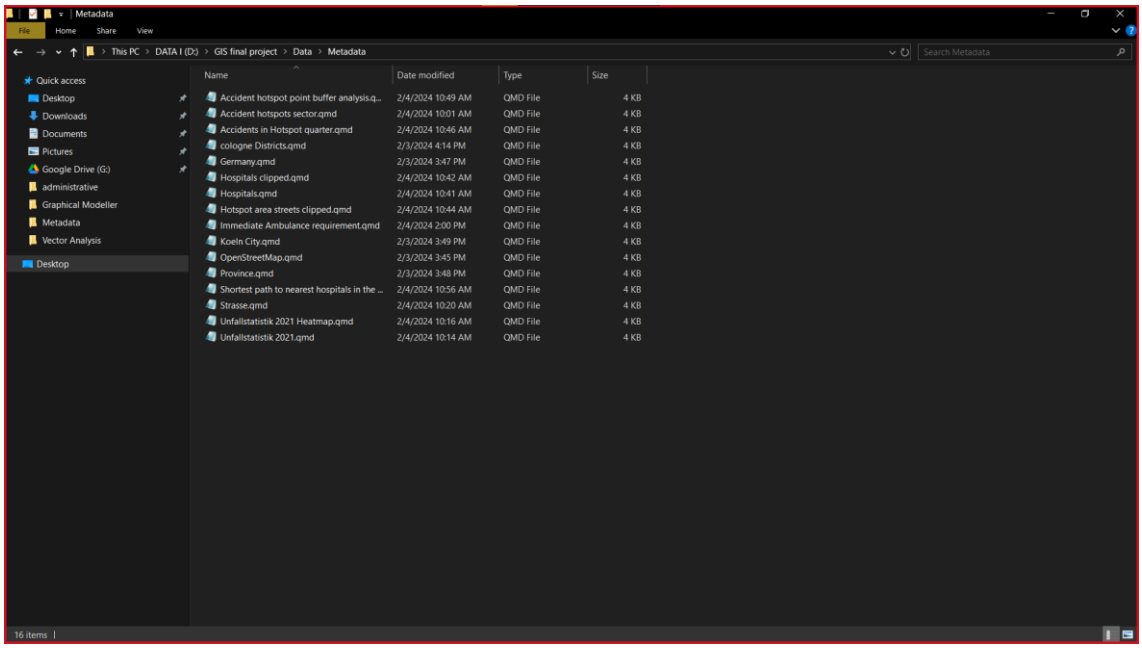
Name of Resulted Dataset/layer	Purpose	Type
Accident hotspot sector	To further analyze the hotspot area	Vector
Accidents in Hotspot quarter	To select the accident points in the selected quarter	Vector
Accident hotspot point buffer	To know the hospitals inside the 500 meters of the selected accident point	Vector
Hospitals clipped	To know the hospitals inside the selected quarter	Vector
Shortest path to nearest hospitals in the buffer range	To identify the shortest path to the hospitals in the buffer range	Vector
SECTOR:Hillshade, Aspect, Slope , Relief	Result of Raster Terrain Analysis for DEM layer of selected quarter	Raster

2. Metadata

What kind of metadata is available for each dataset? Where have the metadata information been saved?

For most of the layers the metadata is seldom available in the layer itself, however almost all answers with regards to “who generated the data”, “where is the layer area?”, “What does the data contain?”, “how was the data generated?”, “when was the data Generated?” can be found in the sources or their respective .qmd files which are mentioned in this document and stored in the project folder respectively.
The metadata folder contains the metadata of the layers used in the project.

Figure 6:Metadata folder



2.1. Original data

Can you answer all relevant metadata requirements for each dataset? Which information is missing? What does that mean for the data quality and accuracy?

The metadata requirements were followed by addressing the questions below. For the missing metadata, we have filled in the information in the excel sheet. Excel sheet can be accessed from this link:

https://thkoelnde.sharepoint.com/:x:/s/GISFinalExamProject/EWvKIAoJAohCjtSRtAIMH_oBeS7gLbkDd1hiz9ZmJDIdcQ?e=MKFkYr&nav=MTVfezAwMDAwMDAwLTAwMDEtMDAwMC0wMDAwLTAwMDAwMDAwMDAwMH0

The missing content of metadata signifies the quality of data accessed. The missing content for all layers was not much hence the data / layers accessed were reliable and accurate to a significant extent. However, certain datasets were downloaded through plugins and didn't contain the required metadata information. Hence such datasets are not that reliable for practical projects.

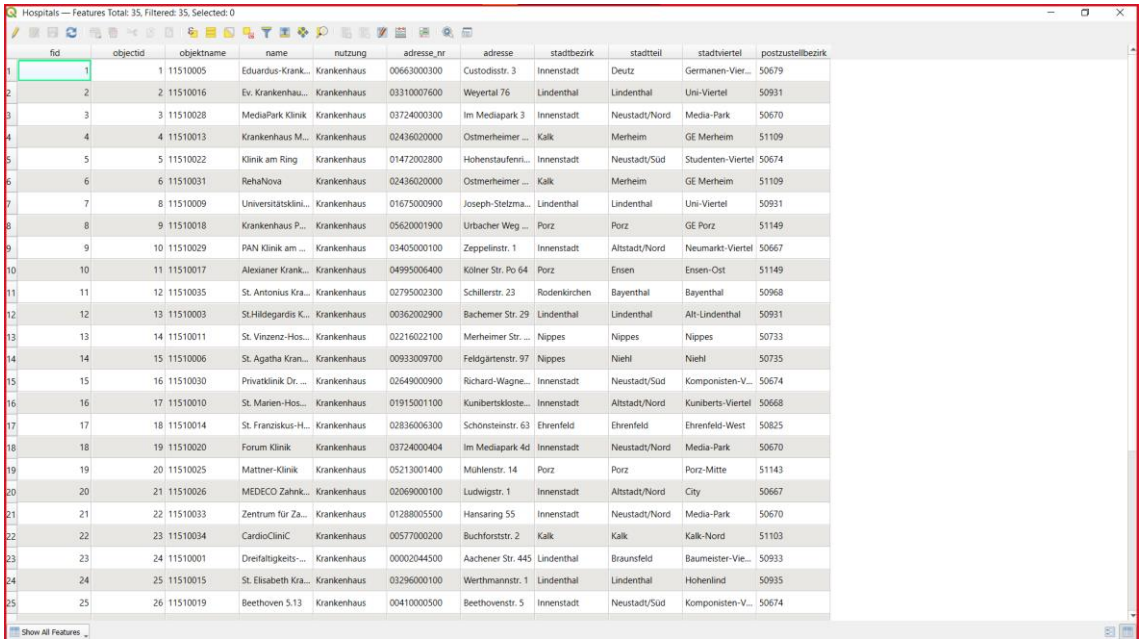
2.2. Modified and generated data

What are the modified or generated data? How have they been modified? What does the result show? Which methods and algorithms have been used for the modification?

The layers mentioned in the vector and raster analysis group of the project contain the data that is modified or generated from the original datasets. They have been modified so as to utilize them effectively in the further spatial analysis of the project. The result of these contain the fields similar to their parent datasets but only in a restricted form as

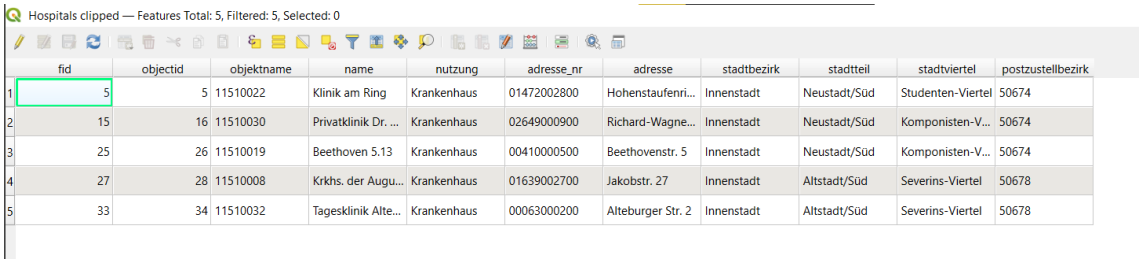
per the necessity of the further analysis. For instance, the ‘Hospitals clipped’ is a clipped layer of the original ‘Hospitals’ layers and thus their attribute tables are comparable.

Figure 7:Original Hospitals attribute table



	fid	objectid	objektname	name	nutzung	adresse_nr	adresse	stadtbezirk	stadtteil	stadtviertel	postzustellbezirk
1	1	1	11510005	Eduardus-Krank...	Krankenhaus	00663000300	Custodisstr. 3	Innenstadt	Deutz	Germanen-Vier...	50679
2	2	2	11510016	Ev. Krankenhau...	Krankenhaus	03310007600	Weyertal 76	Lindenthal	Lindenthal	Uni-Viertel	50931
3	3	3	11510028	MediaPark Klinik	Krankenhaus	03724000300	Im Mediapark 3	Innenstadt	Neustadt/Nord	Media-Park	50670
4	4	4	11510013	Krankenhaus M...	Krankenhaus	02436020000	Ostmerheimer ...	Kalk	Merheim	GE Merheim	51109
5	5	5	11510022	Klinik am Ring	Krankenhaus	01472002800	Hohenstaufenri...	Innenstadt	Neustadt/Süd	Studenten-Viertel	50674
6	6	6	11510031	RehaNova	Krankenhaus	02436020000	Ostmerheimer ...	Kalk	Merheim	GE Merheim	51109
7	7	8	11510009	Universitätsklini...	Krankenhaus	01675000900	Joseph-Stelzma...	Lindenthal	Lindenthal	Uni-Viertel	50931
8	8	9	11510018	Krankenhaus P...	Krankenhaus	05620001900	Urbacher Weg ...	Porz	Porz	GE Porz	51149
9	9	10	11510029	PAN Klinik am ...	Krankenhaus	03405000100	Zeppelinstr. 1	Innenstadt	Altstadt/Nord	Neumarkt-Viertel	50667
10	10	11	11510017	Alexianer Krank...	Krankenhaus	04995006400	Kölner Str. Po 64	Porz	Ensen	Ensen-Ost	51149
11	11	12	11510035	St. Antonius Kra...	Krankenhaus	02795002300	Schillerstr. 23	Rodenkirchen	Bayenthal	Bayenthal	50968
12	12	13	11510003	St.Hildegardis K...	Krankenhaus	00362002900	Bachemer Str. 29	Lindenthal	Lindenthal	Alt-Lindenthal	50931
13	13	14	11510011	St. Vinzenz-Hos...	Krankenhaus	02216022100	Merheimer Str. ...	Nippes	Nippes	Nippes	50733
14	14	15	11510006	St. Agatha Kran...	Krankenhaus	00933009700	Feldgärtenstr. 97	Nippes	Niehl	Niehl	50735
15	15	16	11510030	Privatklinik Dr. ...	Krankenhaus	02649000900	Richard-Wagne...	Innenstadt	Neustadt/Süd	Komponisten-V...	50674
16	16	17	11510010	St. Marien-Hos...	Krankenhaus	01915001100	Kunibertskloste...	Innenstadt	Altstadt/Nord	Kuniberts-Viertel	50668
17	17	18	11510014	St. Franziskus-H...	Krankenhaus	02836006300	Schönsteinstr. 63	Ehrenfeld	Ehrenfeld	Ehrenfeld-West	50825
18	18	19	11510020	Forum Klinik	Krankenhaus	03724000404	Im Mediapark 4d	Innenstadt	Neustadt/Nord	Media-Park	50670
19	19	20	11510025	Mattner-Klinik	Krankenhaus	05213001400	Mühlenstr. 14	Porz	Porz	Porz-Mitte	51143
20	20	21	11510026	MEDECO Zahnk...	Krankenhaus	02069000100	Ludwigstr. 1	Innenstadt	Altstadt/Nord	City	50667
21	21	22	11510033	Zentrum für Za...	Krankenhaus	01288005500	Hansaring 55	Innenstadt	Neustadt/Nord	Media-Park	50670
22	22	23	11510034	CardioCliniC	Krankenhaus	00577000200	Buchforststr. 2	Kalk	Kalk	Kalk-Nord	51103
23	23	24	11510001	Dreifaltigkeits-...	Krankenhaus	00002044500	Aachener Str. 445	Lindenthal	Braunsfeld	Baumeister-Vie...	50933
24	24	25	11510015	St. Elisabeth Kra...	Krankenhaus	03296000100	Werthmannstr. 1	Lindenthal	Lindenthal	Hohenlind	50935
25	25	26	11510019	Beethoven 5.13	Krankenhaus	00410000500	Beethovenstr. 5	Innenstadt	Neustadt/Süd	Komponisten-V...	50674

Figure 8: Hospitals clipped layer attribute table



	fid	objectid	objektname	name	nutzung	adresse_nr	adresse	stadtbezirk	stadtteil	stadtviertel	postzustellbezirk
1	5	5	11510022	Klinik am Ring	Krankenhaus	01472002800	Hohenstaufenri...	Innenstadt	Neustadt/Süd	Studenten-Viertel	50674
2	15	16	11510030	Privatklinik Dr. ...	Krankenhaus	02649000900	Richard-Wagne...	Innenstadt	Neustadt/Süd	Komponisten-V...	50674
3	25	26	11510019	Beethoven 5.13	Krankenhaus	00410000500	Beethovenstr. 5	Innenstadt	Neustadt/Süd	Komponisten-V...	50674
4	27	28	11510008	Krkhs. der Augu...	Krankenhaus	01639002700	Jakobstr. 27	Innenstadt	Altstadt/Süd	Severins-Viertel	50678
5	33	34	11510032	Tagesklinik Alte...	Krankenhaus	00063000200	Alteburger Str. 2	Innenstadt	Altstadt/Süd	Severins-Viertel	50678

So the metadata of all such originated layers are mostly similar to the original layers.

3. Spatial analysis

- List the steps for each of the spatial analysis tasks and briefly describe why you have chosen the steps (what do the steps generate).

For this particular project, I intend to carry out the following analysis:

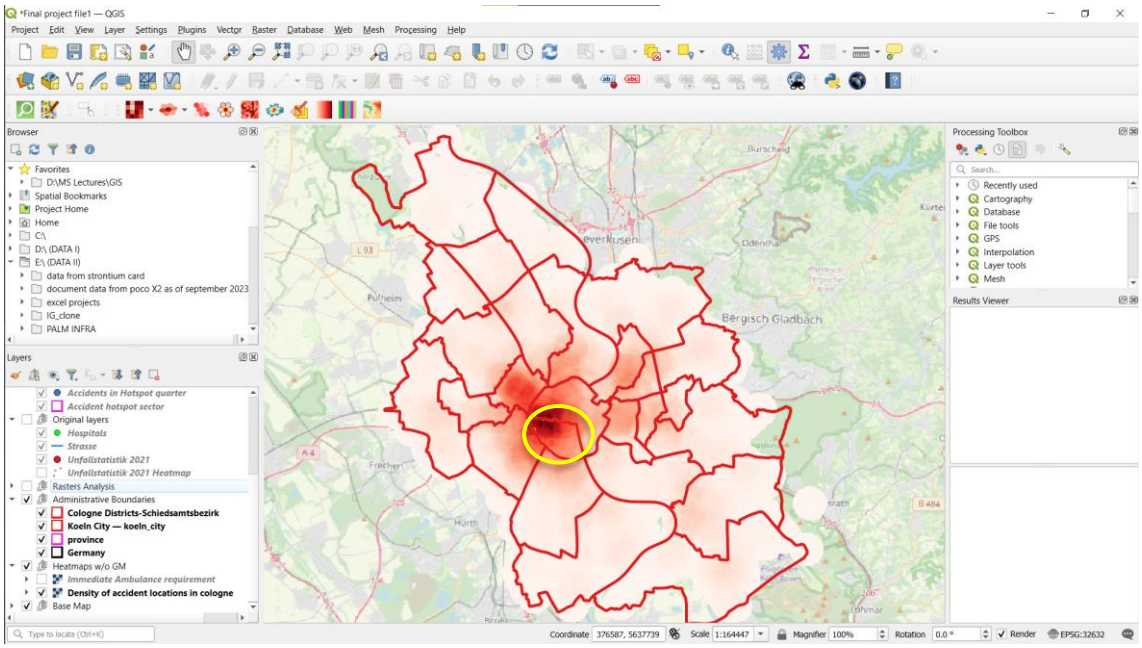
1. Create a heatmap to illustrate the locations with the most accidents in the city of Cologne.
2. After identification of the sector/quarter with high density of accidents, create a map which illustrates accident points with their ambulance urgency.
3. Carry out a shortest path analysis for an accident to the nearest hospital in its vicinity.

Spatial Analysis:

1. **Creation of Heatmap to display the accident distribution in the city:**

   This layer was created using the ‘Heatmap (Kernel Density Estimation)’ tool in the QGIS, which gave a resultant raster layer as can be seen below.

Figure 9:Heatmap displaying the accident distribution in the city



The yellow encircled area is the quarter with the most accident density, so this layer is selected for further analysis.

2. Creation of a map which illustrates accident points with their ambulance urgency in the identified quarter:

The map shows the accident points in the quarter and also the urgency with which the ambulance is required at the site. The darker the blue circles, the faster the ambulance is required. These blue circles are created utilizing the ‘Ambulance’ field of the accident points data. This ‘Ambulance’ field was created using the field calculator on the ‘UKATEGORIE’ field which contains numbers 1,2,3 which represent death, severe accident, minor accident respectively. The code use was as follows:

When

‘UKATEGORIE’ is 2 then 1

End

Further in the created Ambulance field the value ‘1’ is filled for the corresponding value ‘2’ in the ‘UKATEGORIE’ field. Now these ‘1’ values in the ambulance field correspond to the dark blue circle on the map, which are in a dire need of an Ambulance as the location represent a severe accident using the weight values of this ‘Ambulance’ field. Whereas, the rest where there is a confirmed death or minor accident are portraying a lower urgency and thus a white colour for such accident points.

Figure 10:Accident points with their ambulance urgency

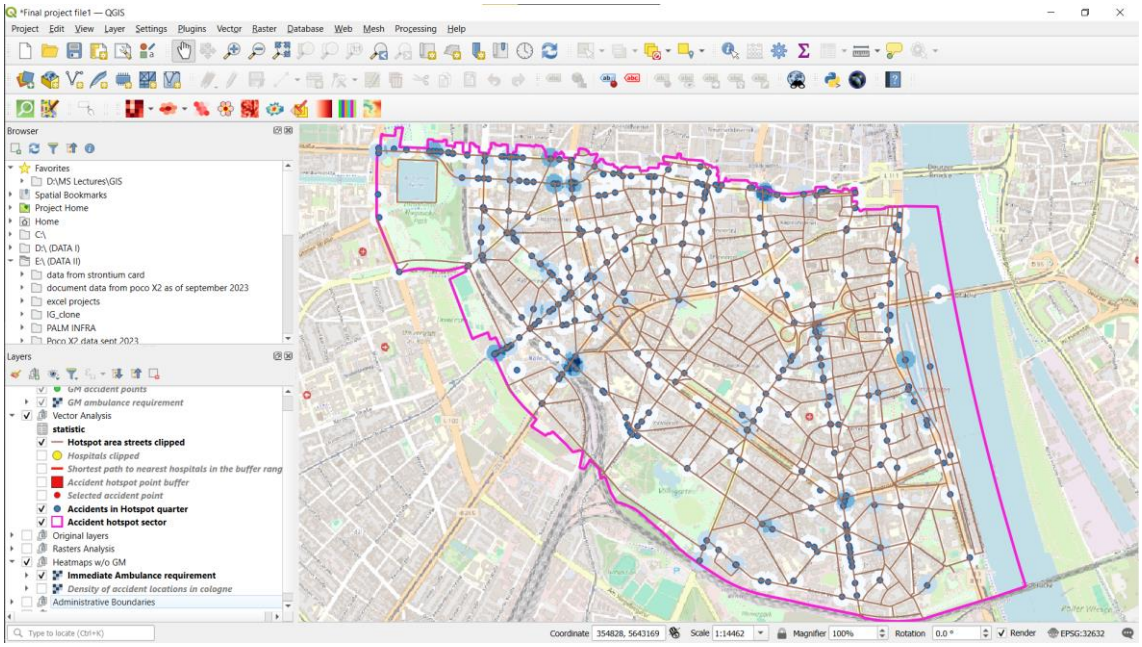


Figure 11:Attribute table showing AMBULANCE field

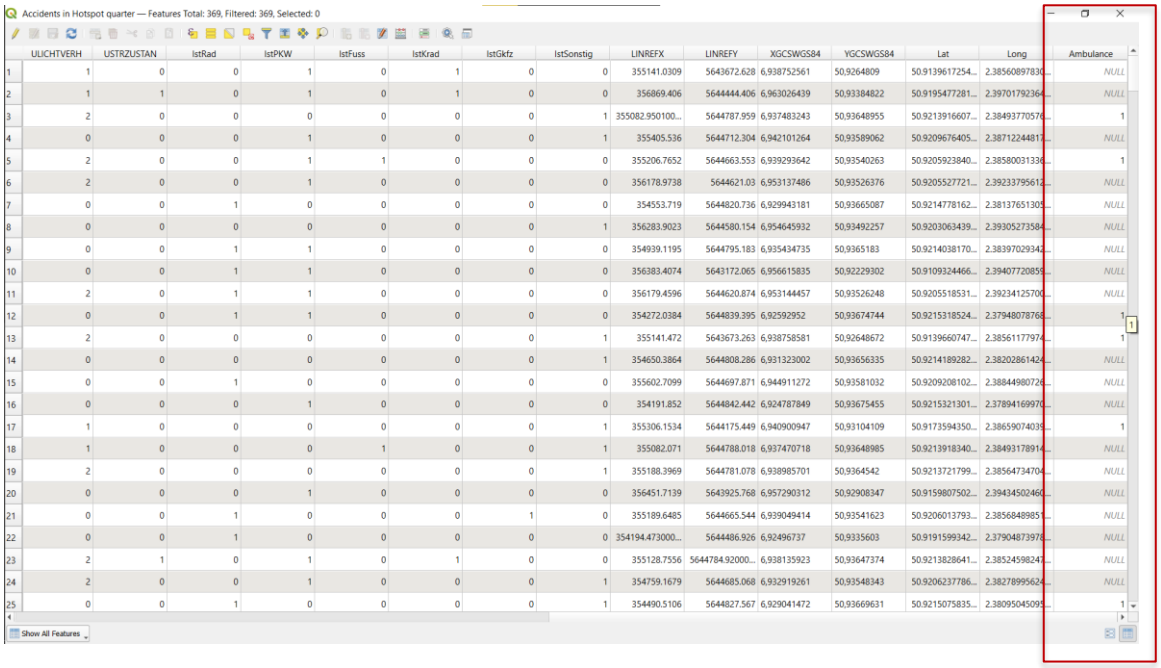
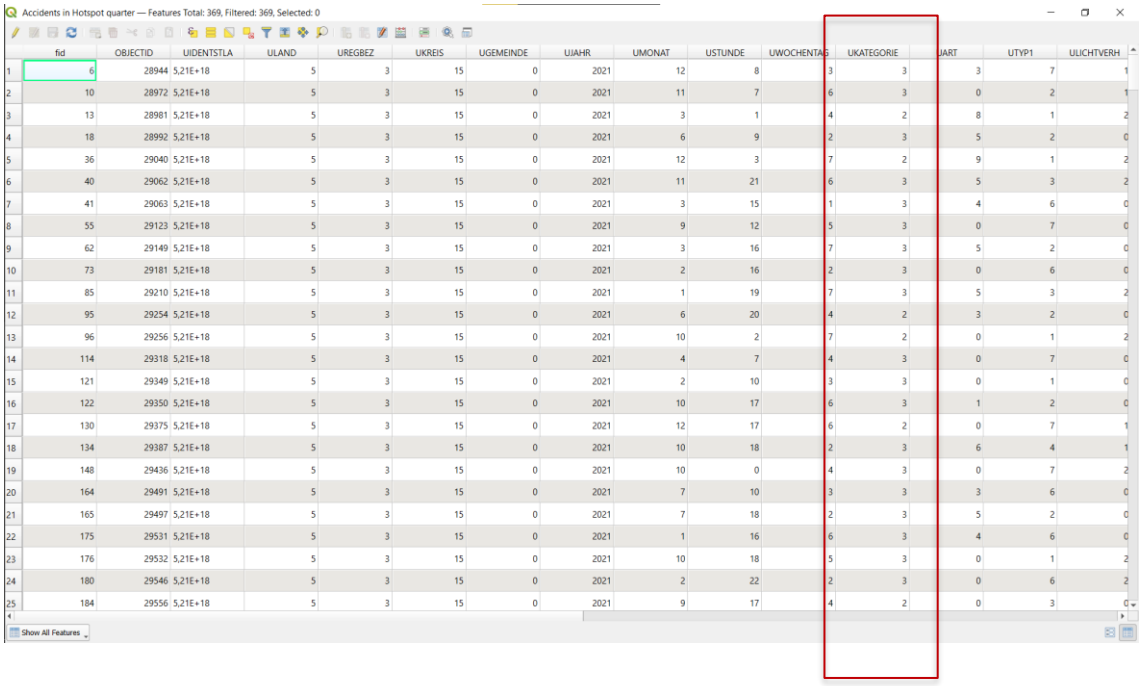
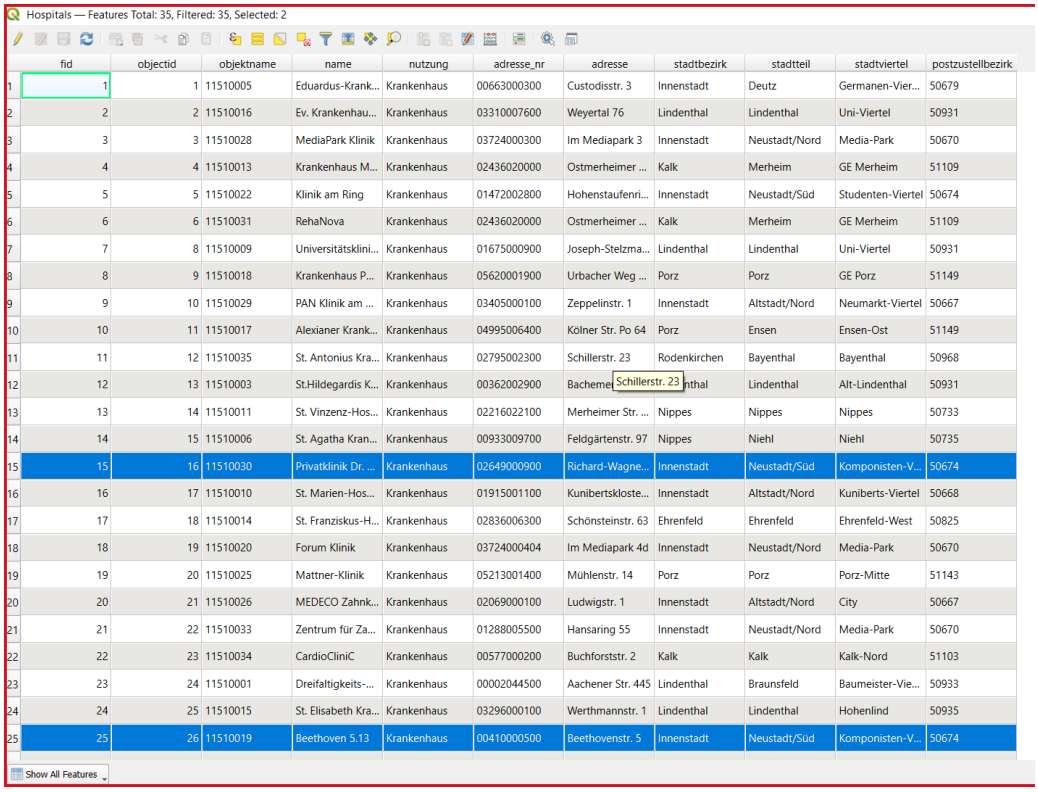


Figure 12: Attribute table showing UKATEGORIE field



3. Creation of a shortest path for an accident to the nearest hospital in its buffer of 500m.

Figure 13:Selected hospitals based on 500m buffer from the accident location

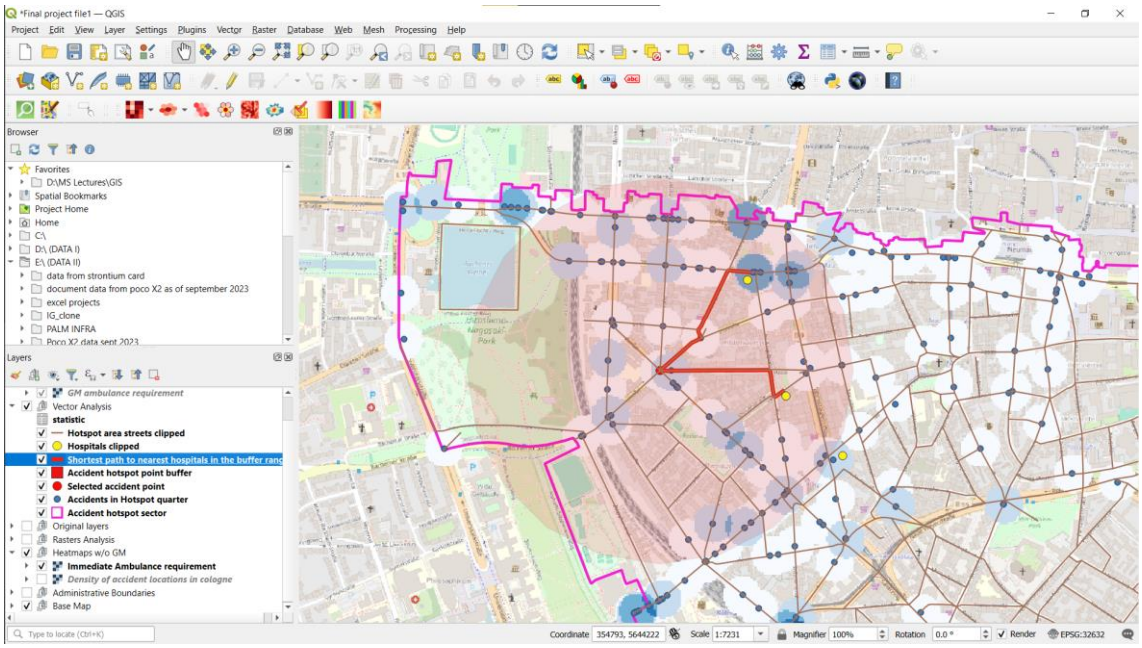


Hospitals — Features Total: 35, Filtered: 35, Selected: 2

	fid	objectid	objektname	name	nutzung	adresse_nr	adresse	stadtbezirk	stadtteil	stadtviertel	postzustellbezirk
1	1	1	11510005	Eduardus-Krank...	Krankenhaus	00663000300	Custodisstr. 3	Innenstadt	Deutz	Germanen-Vier...	50679
2	2	2	11510016	Ev. Krankenhau...	Krankenhaus	03310007600	Weyertal 76	Lindenthal	Lindenthal	Uni-Viertel	50931
3	3	3	11510028	MediaPark Klinik	Krankenhaus	03724000300	Im Mediapark 3	Innenstadt	Neustadt/Nord	Media-Park	50670
4	4	4	11510013	Krankenhaus M...	Krankenhaus	02436020000	Ostmerheimer ...	Kalk	Merheim	GE Merheim	51109
5	5	5	11510022	Klinik am Ring	Krankenhaus	01472002800	Hohenstaufenri...	Innenstadt	Neustadt/Süd	Studenten-Viertel	50674
6	6	6	11510031	RehaNova	Krankenhaus	02436020000	Ostmerheimer ...	Kalk	Merheim	GE Merheim	51109
7	7	8	11510009	Universitätsklini...	Krankenhaus	01675000900	Joseph-Stelzma...	Lindenthal	Lindenthal	Uni-Viertel	50931
8	8	9	11510018	Krankenhaus P...	Krankenhaus	05620001900	Urbacher Weg ...	Porz	Porz	GE Porz	51149
9	9	10	11510029	PAN Klinik am ...	Krankenhaus	03405000100	Zeppelinstr. 1	Innenstadt	Altstadt/Nord	Neumarkt-Viertel	50667
10	10	11	11510017	Alexianer Krank...	Krankenhaus	04995006400	Kölner Str. Po 64	Porz	Ensen	Ensen-Ost	51149
11	11	12	11510035	St. Antonius Kra...	Krankenhaus	02795002300	Schillerstr. 23	Rodenkirchen	Bayenthal	Bayenthal	50968
12	12	13	11510003	St.Hildegardis K...	Krankenhaus	00362002900	Bachemer	Schillerstr. 23	nthal	Alt-Lindenthal	50931
13	13	14	11510011	St. Vinzenz-Hos...	Krankenhaus	02216022100	Merheimer Str. ...	Nippes	Nippes	Nippes	50733
14	14	15	11510006	St. Agatha Kran...	Krankenhaus	00933009700	Feldgärtenstr. 97	Nippes	Niehl	Niehl	50735
15	15	16	11510030	Privatklinik Dr. ...	Krankenhaus	02649000900	Richard-Wagne...	Innenstadt	Neustadt/Süd	Komponisten-V...	50674
16	16	17	11510010	St. Marien-Hos...	Krankenhaus	01915001100	Kunibertskloste...	Innenstadt	Altstadt/Nord	Kuniberts-Viertel	50668
17	17	18	11510014	St. Franziskus-H...	Krankenhaus	02836006300	Schönsteinstr. 63	Ehrenfeld	Ehrenfeld	Ehrenfeld-West	50825
18	18	19	11510020	Forum Klinik	Krankenhaus	03724000404	Im Mediapark 4d	Innenstadt	Neustadt/Nord	Media-Park	50670
19	19	20	11510025	Mattner-Klinik	Krankenhaus	05213001400	Mühlenstr. 14	Porz	Porz	Porz-Mitte	51143
20	20	21	11510026	MEDECO Zahnk...	Krankenhaus	02069000100	Ludwigstr. 1	Innenstadt	Altstadt/Nord	City	50667
21	21	22	11510033	Zentrum für Za...	Krankenhaus	01288005500	Hansaring 55	Innenstadt	Neustadt/Nord	Media-Park	50670
22	22	23	11510034	CardioCliniC	Krankenhaus	00577000200	Buchforststr. 2	Kalk	Kalk	Kalk-Nord	51103
23	23	24	11510001	Dreifaltigkeits-...	Krankenhaus	00002044500	Aachener Str. 445	Lindenthal	Braunsfeld	Baumeister-Vie...	50933
24	24	25	11510015	St. Elisabeth Kra...	Krankenhaus	03296000100	Werthmannstr. 1	Lindenthal	Lindenthal	Hohenlind	50935
25	25	26	11510019	Beethoven 5.13	Krankenhaus	00410000500	Beethovenstr. 5	Innenstadt	Neustadt/Süd	Komponisten-V...	50674

Show All Features

Figure 14:Shortest paths to the nearest hospitals in the buffer range of the selected accident hotspot location.



From the attribute table we can see in the cost field that the Beethoven 5.13 Krankenhaus has the most short path of the two hospitals in the buffer range.

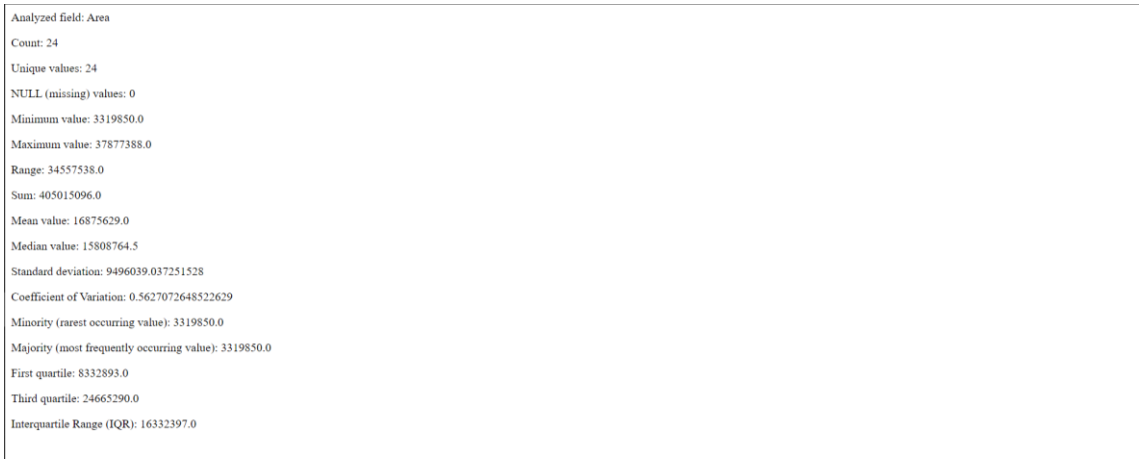
Figure 15: Attributle table showing why Beethoven 5.13 Krankenhaus is most prefered

fid	objectid	objektname	name	nutzung	adresse_nr	adresse	stadtteil	start	end	cost	stadtbezir	stadtviert	postzustel
1 15	16	11510030	Privatklinik Dr. Stet...	Krankenhaus	02649000900	Richard-Wagne...	Neustadt/Süd	354858.868917,...	355084.156099,...	385.44243096...	Innenstadt	Komponisten-V...	50674
2 25	26	11510019	Beethoven 5.13	Krankenhaus	00410000500	Beethovenstr. 5	Neustadt/Süd	354858.868917,...	355183.978199,...	382.234251773...	Innenstadt	Komponisten-V...	50674

Vector Statistics:

Basic vector statistics was performed on the ‘Cologne Districts-Schiedsamtsbezirk’ layer to get the following information

Figure 16: Vector Statistics



Analyzed field: Area

Count: 24

Unique values: 24

NULL (missing) values: 0

Minimum value: 3319850.0

Maximum value: 37877388.0

Range: 34557538.0

Sum: 405015096.0

Mean value: 16875629.0

Median value: 15808764.5

Standard deviation: 9496039.037251528

Coefficient of Variation: 0.5627072648522629

Minority (rarest occurring value): 3319850.0

Majority (most frequently occurring value): 3319850.0

First quartile: 8332893.0

Third quartile: 24665290.0

Interquartile Range (IQR): 16332397.0

Terrain Analysis:

The terrain of the selected quarter/sector was done using the various raster analysis tools as follows:

Figure 17: DEM layer of quarter in focus

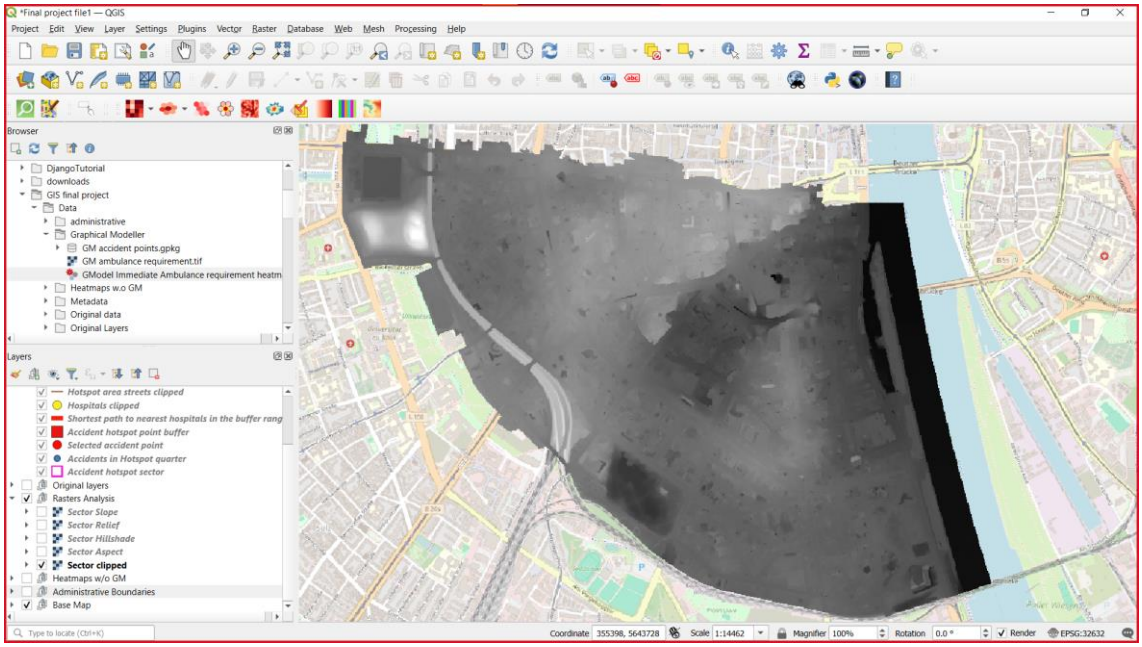


Figure 18:Quarter Aspect

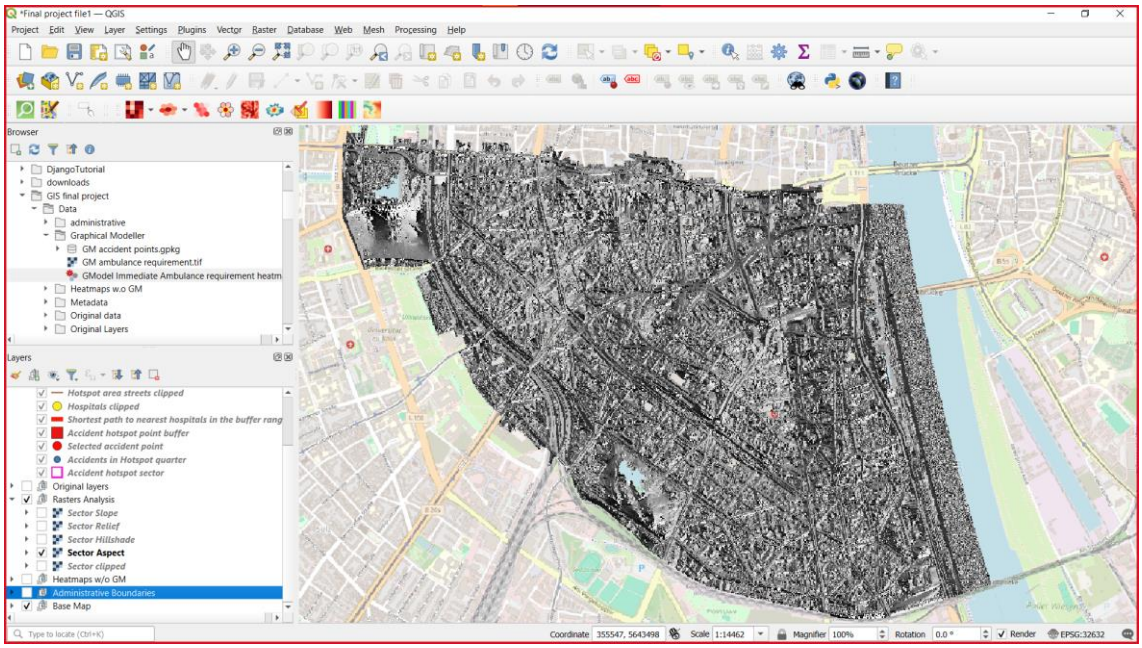


Figure 19:Quarter Hillshade

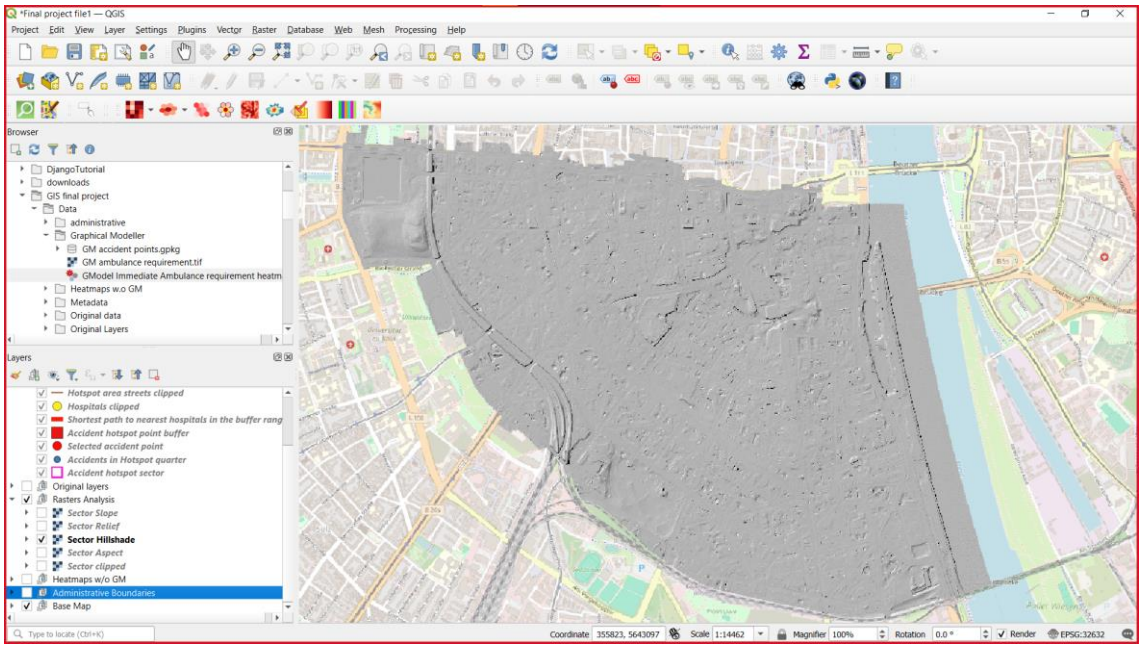


Figure 20:Quarter Relief

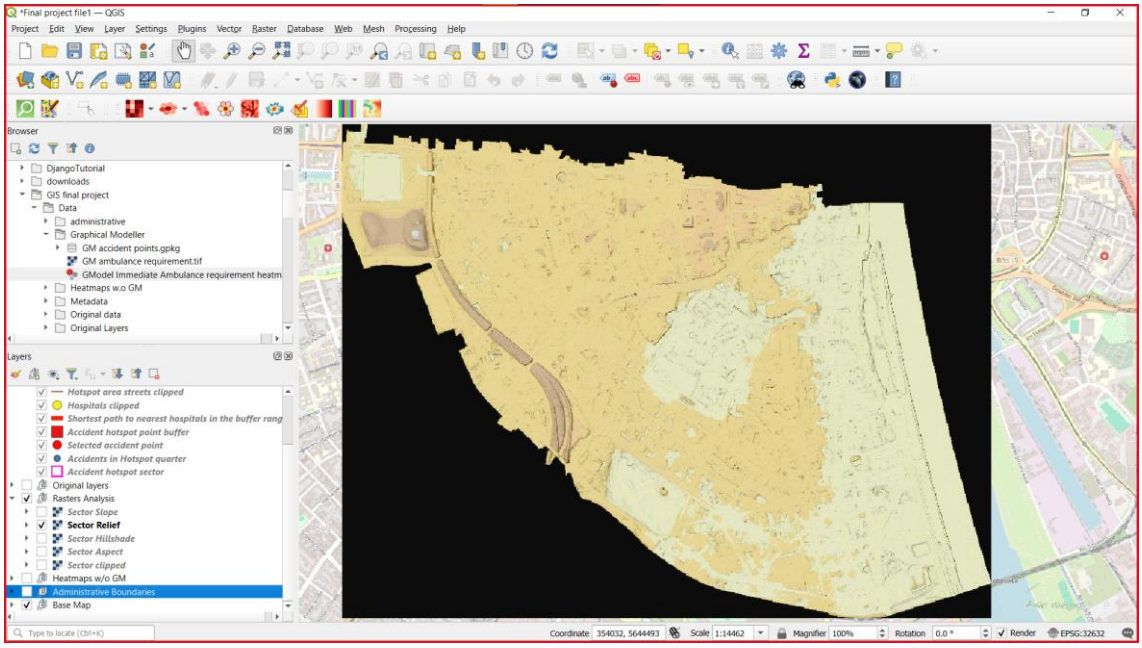
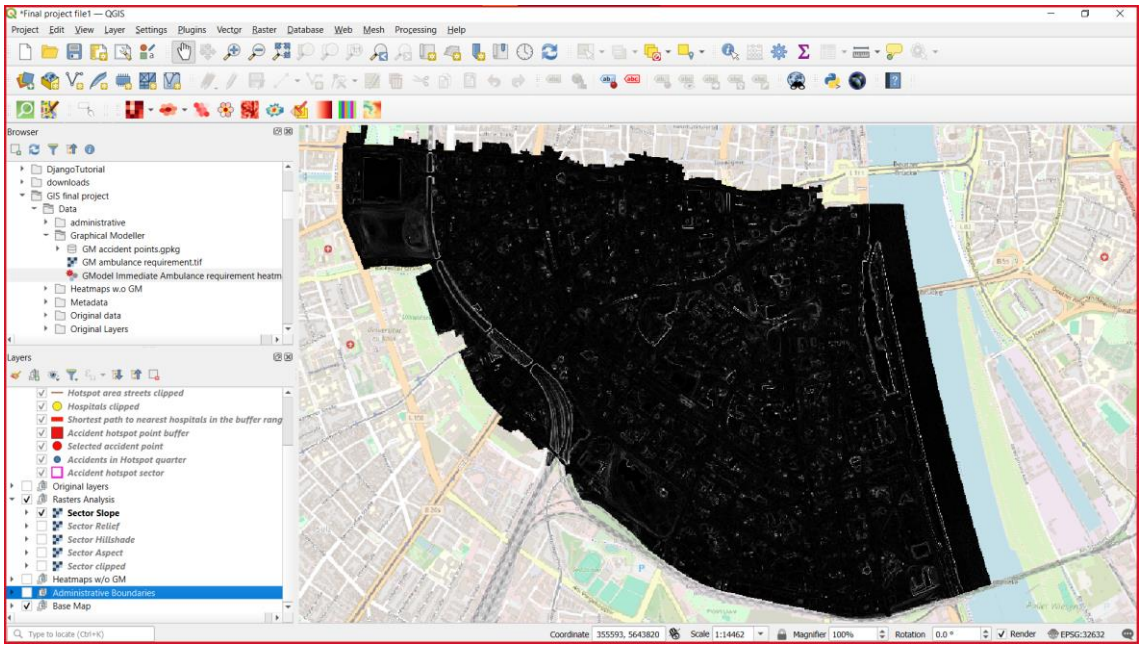


Figure 21:Quarter slope

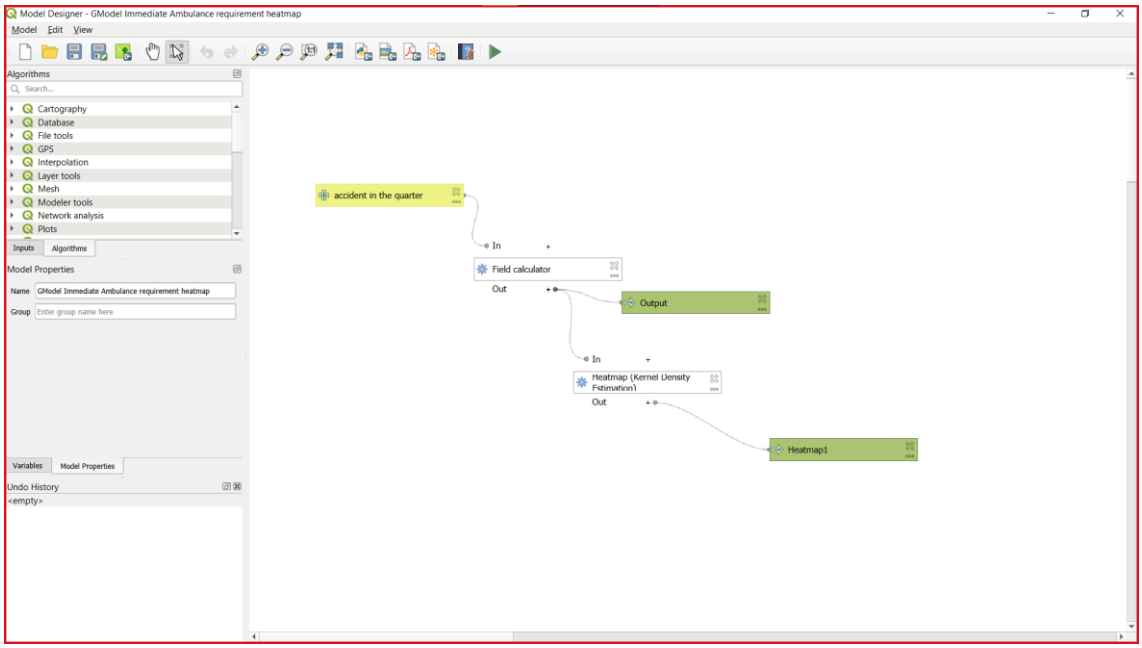


Graphical Modeller

Document the steps in a process diagram that can be used in the Graphical modeler for process automation.

For the raster analysis I have recreated the analysis of accident points with their ambulance urgency in the identified quarter and automated it using the Graphical modeler.

Figure 22:Graphical Modeller for Ambulance requirement heatmap

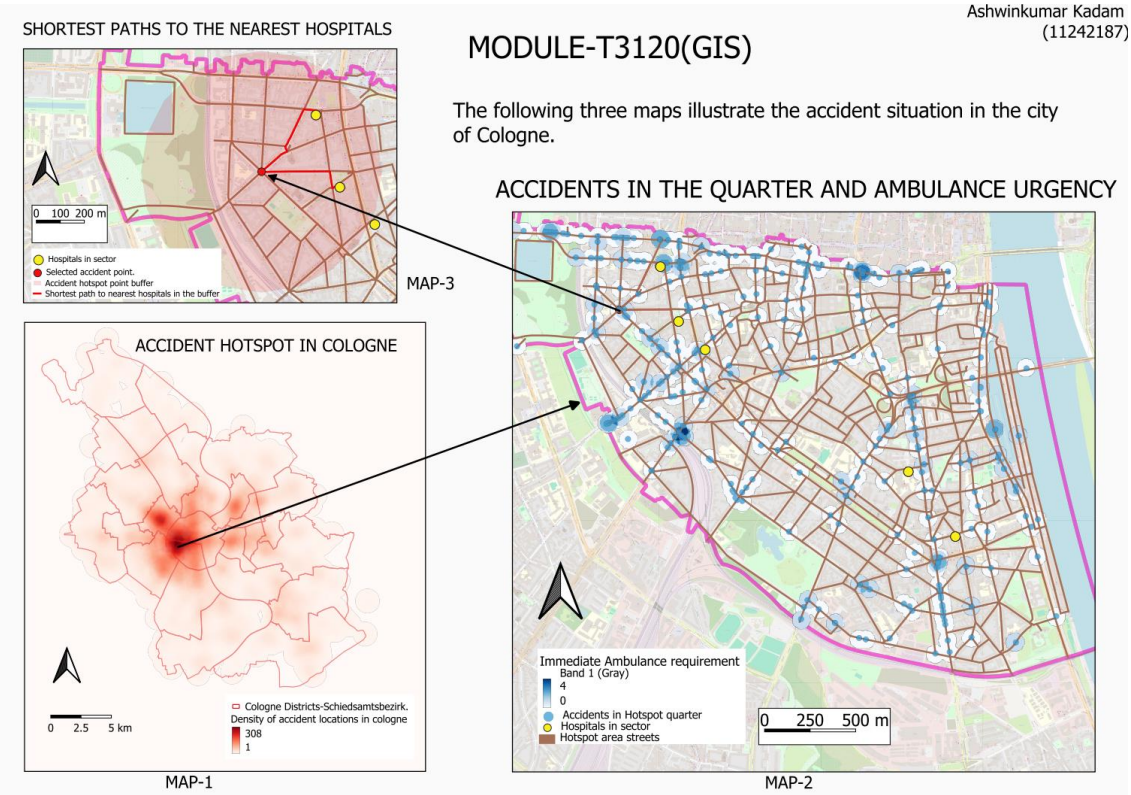


4. Map generation

- Describe the content of your map in one sentence.

‘Accident locations, their ambulance urgencies and the shortest way to a hospital’

Figure 23: All 3 focus area maps



- What does the map show? What should the user see?

The three maps show the following;

1. General accident hotspots in the cologne city.
2. How high was the necessity of an ambulance to reach at the accident location in a particular accident hotspot quarter of the city.
3. The nearest hospitals in a buffer of 500m and the shortest way to reach them from the accident location.

- What datasets are part of the map and what information are the datasets transporting to the user?

1. For the **ACCIDENT HOTSPOT IN COLOGNE** map the ‘Density of accident locations in cologne’ and ‘Cologne Districts-Schiedsamtsbezirk’ dataset are part of the map.

2. For the **ACCIDENTS IN THE QUARTER AND AMBULANCE URGENCY** map, Accidents in Hotspot quarter, Hospitals in sector, Hotspot area streets and Immediate Ambulance requirement layer dataset are a part of it.
3. For the **SHORTEST PATHS TO THE NEAREST HOSPITALS** map, Hospitals in sector, Selected accident point, Accident hotspot point buffer and shortest path to nearest hospitals in the buffer datasets are part of it.

- Which scale did you use and why?

1. The **ACCIDENT HOTSPOT IN COLOGNE** map has a scale in Kilometres as the entire city of Cologne is panned in this map and as a Kilometre scale optimally suffices the readability in the map, that particular scale is used.
2. For the rest of the two maps (**ACCIDENTS IN THE QUARTER AND AMBULANCE URGENCY, SHORTEST PATHS TO THE NEAREST HOSPITALS**), the areas in focus are much smaller and a meter scale rightfully justifies all the distances in those maps, hence it is used.

- Explain the order of the layers in the map and the chosen symbology and labelling. Why did you choose colors, labels and layers?

The symbology of the layers in the map was selected such that the entire readability of the map is enhanced in most of the aspect. For instance, the red colour in the ACCIDENT HOTSPOT IN COLOGNE map makes it easy to quickly identify the area in focus. The labels and layers too were selected such that all the aspects of the map are clear to the viewer so as to interpret the ultimate result.