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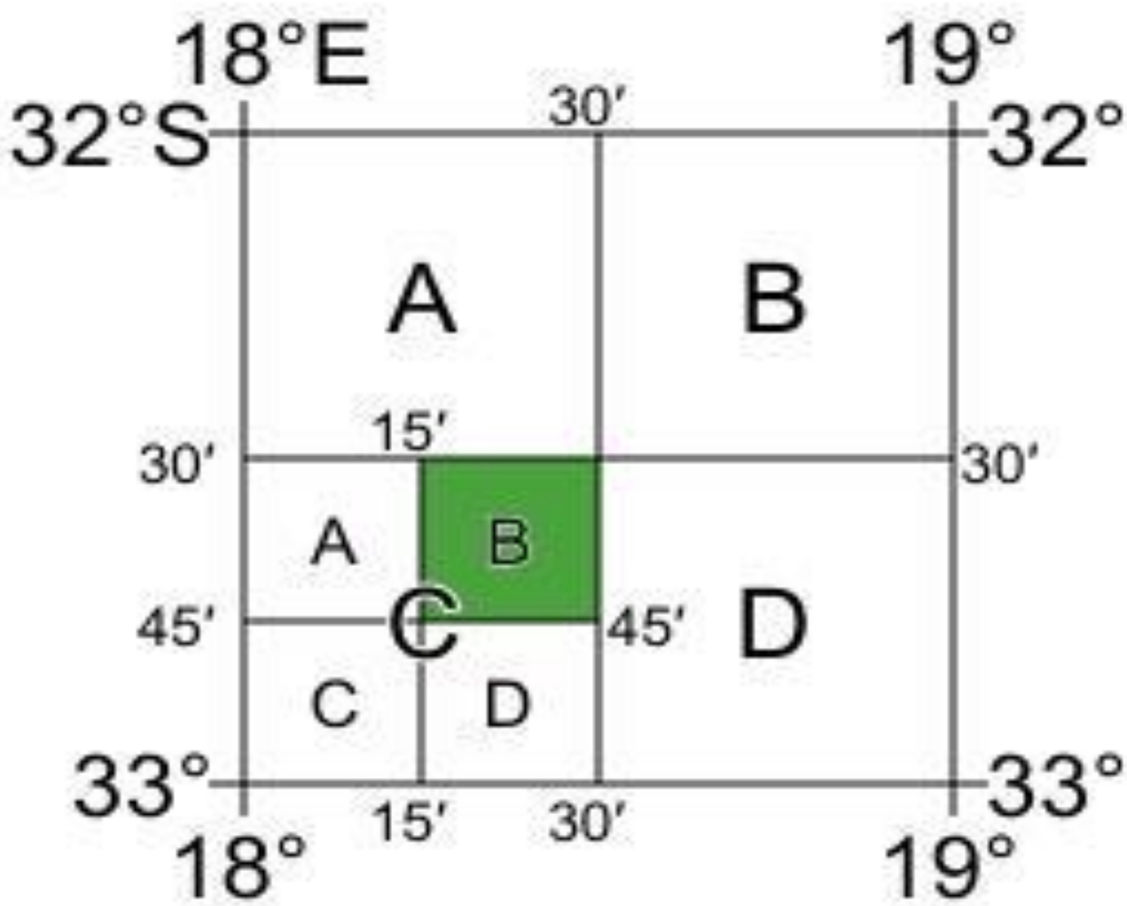
Assessment Name: SDI Project 2023
Topic: Western Cape SAPS crime management and monitoring system: Crime Statistics



Declaration

I Njabulo Mthiyane declares that:

1. I know that that plagarism is wrong.

2. The work that I submitted is my own work and I did not copy the work of other student,

3. I have not shown my work to another student to view and copy it for their own submission.

Date : 26 May 2023

Signature

Acknowledgements

The author would like to also acknowledge MapTiler for supplying the raster tile layer which was used as the basemap of the a geoportal. The leaflet documentation website played a role in explaining how to add features to a geoportal. I would also like to give a big thank you to GitHub of which it host all my project files.

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1. Introduction

The proposed system that will be discussed in this report is a Spatial Data Infrastructure (SDI) system for Western Cape SAPS to monitor and manage crime in the province. Before proceeding to the actual implementation of the proposed system, the reader is made aware that the components of the system that will be discussed in this report is the database, and the second one is the geoportal. Entity-relationship diagrams, dataflow diagrams, database dictionary, and the definition of data terms are found in the database component. Statistical analyses, and web a digital maps can be accessed from the geoportal component. The relational database is also contained in the database website.

The database contain non-spatial information, whereas the spatial information is represented in a geoportal. The non-spatial values data is attached to the spatial features in the geoportal so that the geoportal will make sense to the map reader. The proposed system will use crime statistics to aid in the monitoring and management of crime. The reader is warned that values of crime statistics used in this report are invalid. Arbitrary numbers were used to represent crime statistics data. The purpose of the values used in the prototype of a design is to demonstrate how the system operate. The author did not feel the need of using correct statistical values since this is not a real research project.

2. Database

The database can be reached out to by clicking this web link https://mthnja014.github.io/WC-SAPS-SDI/ the login portal like the one in Figure 1 appears.

Figure 1: *Western Cape Login portal*

Press database login button and a login page like the one on the screen in Figure 2 will be shown. Type “database” in both username and password input fields and then press “sign in”. Before successfully signing in, the login success message or the login error alert message will show up. Kindly press ok in the alert message. If looking at the database model.

Figure 2: *Login page.*

Now you have successfully logged into the database and you should have a website page with like the one in Figure 3 on the top left. The entities of this database are given attributes just as the ones in a database dictionary.

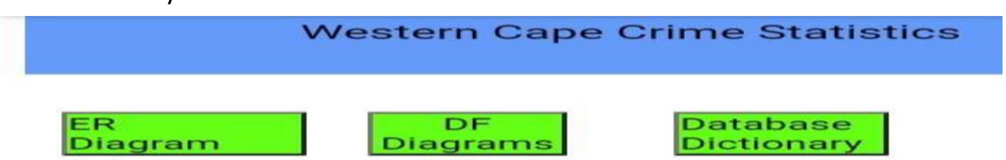

Figure 3: *Database buttons*

Pressing the “ER Diagram” button on the left direct the reader to the entity relationship diagram, the middle button “DF Diagrams” has a decomposition diagram, context diagram, and dataflow diagrams. The button “Database Dictionary” on the right has the database dictionary and data dictionary. Database dictionary define each entity present in this database. Data dictionary defines data terms.

2.1 Database tables

(APG2015F and APG4007F) briefly describe Databases. A relational database is made of data tables. In a relational database each table is a set of rows and columns. In a relational database table, the attributes are represented by columns. Each column contain attributes with a similar characteristics. The table is given a primary key. Sometimes the attributes in a column can have similar record, but this cannot happen in a primary key column. Shall it happen that the primary keys are similar, another column is added into a table so that a table has a composite primary key.

Composite primary key is common if the relationship between two entities in tables that has a many-to-many relationship. Tables relationships are briefly discussed below. Relational database table rows record the tuples. Tuple is a set of attributes recorded in the table row. The tuples can never be similar since there is a primary key column(s) which has unique values.

2.1.1 Relationships between tables entities

The relationship between table entities is well represented by a entity relationship diagram. The relationship between entities can be considered to be a one-to-one, zero-to-one, one-to-many, zero-to-many, and many-to-many . The footcrews used in entity relationship diagram are shown in Figure 4 below.

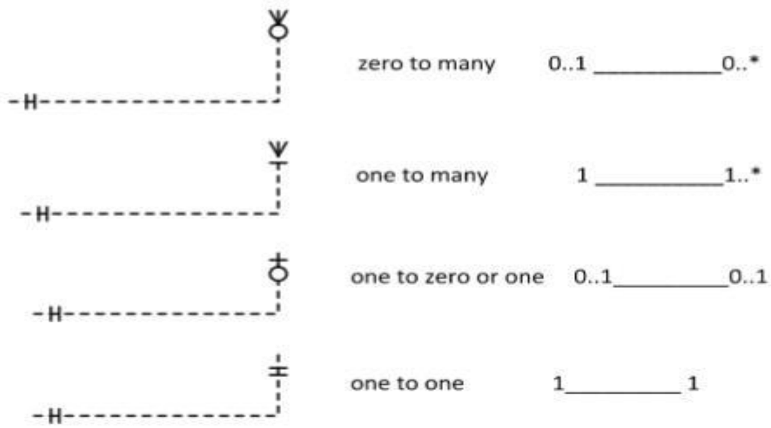

Figure 4: Entity Relationship footcrew and their corresponding UML notation (Lake & Crowther 2013: 84).

In a one-to-one relationship, one entity in table 1 must only be linked to one entity in table 2. Zero-to-one means that the entity in table can be linked with one or no entity in table 2. If a table has a "many" relationship, the secondary (foreign) keys are used to define the "many" relationship. The secondary keys are formed by taking the column of table 2 and add it to table 1. The table keys are referred to as constraints.

The zero-to-many relationship means that the entity can be linked with no or many entities in table 2. The one-to-many means that the entity in table 1 must be linked with at least one entity in table 2. The business rules are used to determine the relationship between tables entities. The many-to-many relationship means that at least one entity in table 1 can be linked to at least one entity in table 2. The many-to-many relationships are complicated and their complexity is resolved by creating a new table with composite primary key using primary keys of both tables.

2.1.2 Publishing crime statistics.

Having briefly described the button found in the database website, there is also an additional button used to compute crime statistics and that button is labeled "Compute Statistic". Before any calculation is carried out please make sure that there are no duplicate primary keys and duplicate composite primary keys because you will receive a primary key error message. The foreign keys should also correspond to the values in reference table or else you will get a foreign key error message. But you will see that the test database has values in it. You can change these values to check database integrity.

Now that the input values are consistent with relational database rules, press the "compute statistic" button. You will see a message saying "Please Select police station ", kindly click the select options above the "compute statistic" button and select "Bredasdorp" then click the button. Now you will see another message saying "Please Select Crime Category ", please kindly select the "Attempted Murder" option in another select options above the "compute statistic" button.

This Statistics publisher query depends on three tables and they are ccase table, ccase_suspect table, and the police station table. Because Bredasdorp is used to test this calculation, kindly make sure that the ps_id in the ccase table is set to "003" and the crime category is set to "Attempted Murder". This will only work to UpTo four rows in the ccase table and first four rows of the ccase_suspect table. This means all the data in the first four rows in the ccase_suspect table have a traceable relationship (ccase_id) with the first four rows of the ccase table.

The crime statistics will be calculated in this manner demonstrated above and loaded into the website as crime Statistics tables, see 2.2 for crime statistics.

2.2 statistical Analysis

Statistics are attached to the geoportal web page. First click this link https://mthnja014.github.io/WC-SAPS-SDI/ . Now press Geoportal Login button, and a screen like in Figure 2 will appear. Type "geoportal" in both username and password input fields, after successfully logging in a screen like in Figure 11 appears. Press the "statistical analysis" button which will direct you to the statistical analysis pages (see Figure 5). These buttons in Figure 5 are all used to derive crime statistics.

2.2.1 Statistics Tables

Recall from section 2.1.2 on how crime statistics are published for this system. Now it will be demonstrated on how these tables can be searched and play a role in statistical analysis. Clicking "Statistics Tables" in Figure 5 will return a screen as in Figure 6. In Figure 6 there is a JavaScript button, two select options, and the output space. The first select option gives output tables for the Western Cape crime statistics. If one want to see a table with all Western Cape crime statistics, one can select "All Crime Statistics ", if they want to see a table with police stations that recorded Low Crime Statistics (Less than 3000 cases) they must select "Low", for medium crime statistics (between 3000 and 6000) select "Medium" option. The Intermediate, and High options contains table for crime statistics between 6000 and 9000, and a table with police stations that recorded greater than 9000 cases respectively. Of course after making selection you press the "view statistics" button.

Figure 5: Western Cape Crime Statistics Analysis Tools.

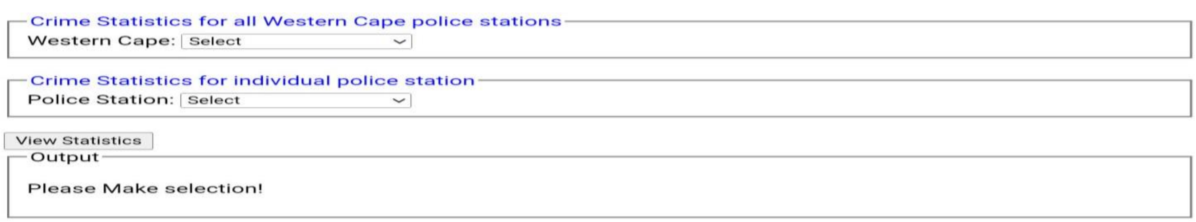

Figure 6: Crime Statistics Clearinghouse.

The second select options output crime statistics for an individual police station. If one want to see Rondebosch crime statistics, they can scroll down and select “Rondebosch” and click “view statistics “ button. Since the list of Western Cape police stations is long, the police stations are arranged in an alphabetical order. If both options are selected in both select options, an error message will be shown telling the user to unselect one option. If nothing is selected, an error message telling the user to make selection will be shown in the output space as in Figure 6.

2.2.2 Inverse Distance Weighting

Clicking the Inverse Distance Weighting button will direct you into a IDW calculator as shown in Figures 7a and b below.

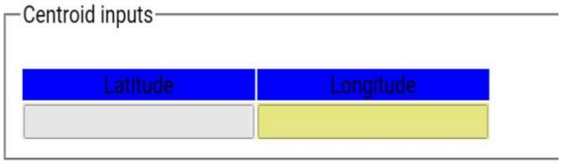

Figure 7a: Centroid coordinates input.

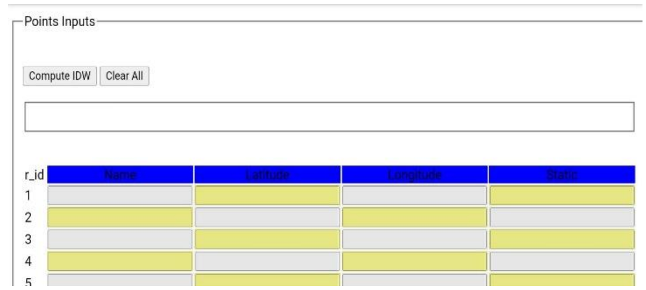

Figure 7b: Surrounding points input

The initial coordinates of the police station points were in the form of latitude longitude degrees. The above calculator assumes that the radius of the earth is 6371000 m. The geographic coordinates conversation was ran using (1) and (2) to convert geographic latitudes and longitudes into catersian YX coordinates.

$$Yk = \ Rcos(phi)cos(lamda) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$Xk = \ Rcos(phi)cos(lamda) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In script format (1) and (2) can be written as (3) and (4)

$$var\ Yk \ = \ R * Math.cos(phi) * Math.sin(lamda) \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$var\ Xk \ = \ R * Math.cos(phi) * Math.cos(lamda) \ \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where R is the radius of the earth, phi is the geographic latitude, and lamda is geographic longitude. The script of this calculator can rad the values of latitudes and longitudes inserted in the table cells and convert them into YX coordinates. The coordinates are inserted as decimal degrees. The script first converts the coordinates from decimal degrees into radians by multiplying the inserted values of latitudes and longitudes by (360/2π) which is equivalent to (180/π). Each field in Figure 7b is linked to the fields in Figure 7a to calculate distances using a simple distance equation in (5).

var d = Math.sqrt(Math.pow(Math.abs(Yk - Yc), 2) + Math.pow(Math.abs(Xk - Yc), 2)); ....(5)

Where Yk is the y value computed from (3) and Xk is the x value computed from (4).

Now suppose there are two points in a degree 3118 square. The center of this degree square has a latitude of -31.5 and a longitude of 18.5. Now say that the first point has a latitude (-31.056) and longitude (18.9812), and the second point has latitude (-31.560) and longitude (18.911), and their crime statistics values are 1000 and 2000 respectively. In Figure7a you would insert -31.5 in the latitude field, and 18.5 in the longitude field. In the first row insert the either point one value and in the second row insert values of the second point. The result will be the IDW for these two points in relation to the center of a degree square.

The conditions made for this calculator will give a syntax error if one skip the row, in other words you cannot insert row2 without inserting in row1 and row3 without inserting row2. Since the latitudes are defined to be +90 degrees in the north pole and -90 degrees in the south pole, the calculator can only take values in the range [-90, 90]. Since the longitudes run start at zero degrees and end at 360 degrees, the calculator can only take values in the range [0, 360] for longitudes inputs.

2.2.3 Degree Squares Inverse Distance

The IDW discussed in section 2.6.2.2 is longer, therefore an effort to reduce user inputs in for computations was introduced. The inputs here is limited to the number of police stations in a degree square. The coordinates of the police stations and centroid coordinates are keyed in JavaScript code. This option will allow the user to only insert crime statistics values in the input field and press one button to compute the IDW for crime statistics in a degree square.

Going back to Figure 5. It was briefly described in section 2.6.2.1 on how Figure 5 can be arrived to. Now click “Degree Square Inverse Distance Weighting “ button, a screen like in a figure 8 appears. These are actually a list of buttons. For demonstration purposes click the first button “3118”, a screen like in Figure 9 appears.

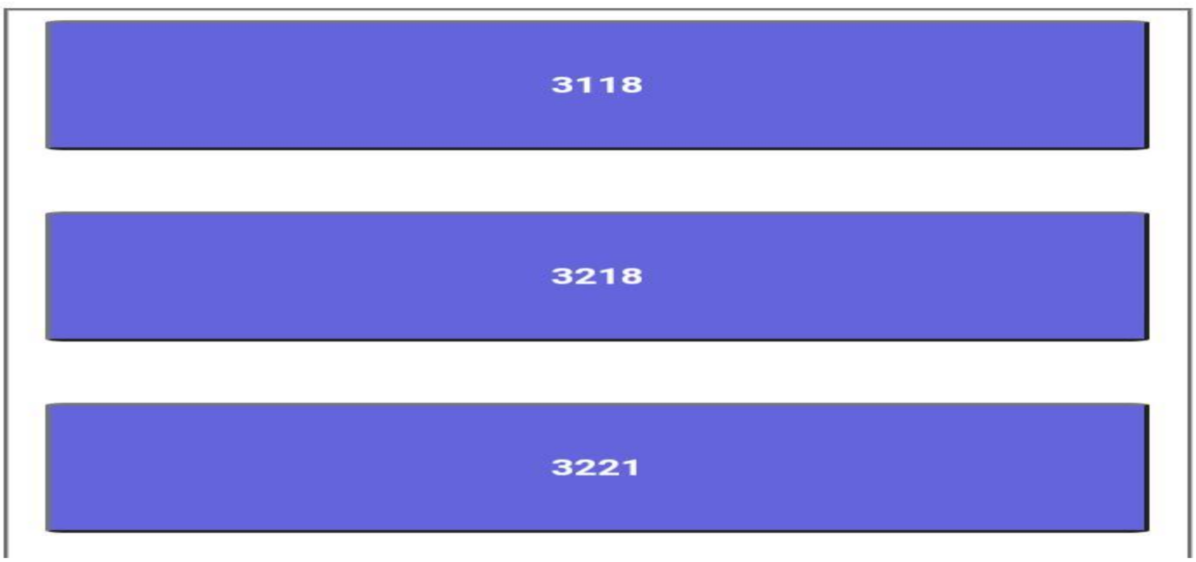

Figure 8: Degree Squares with police station(s) in them.

If the crime statistics for the police stations in degree square 3118 are known, they can be inserted into the fields of Figure 9. Click “Get Crime Statistics “ button and a crime statistics table for police stations in degree square 3118 , see Figure 10. Insert statistics values in the input fields and click “compute IDW” button. The output IDW result is then used to weight a degree square in geoportal. The output for 3118 is approximately 8269, thus a degree square has Intermediate crime statistics.

To monitor crime in a degree square a police station can have at least on of the following statistics pairs:

Low-Low; Low-Medium; Low-Intermediate; Low-High; Medium-Low; Medium-Medium, Medium-Intermediate; Intermediate -Low; Intermediate -Medium; Intermediate-Intermediate; Intermediate -High; High-Low; High-Medium; High-Intermediate; and High-High. The left description represent the police station statistic and the right handed side description is for a degree square. In degree square

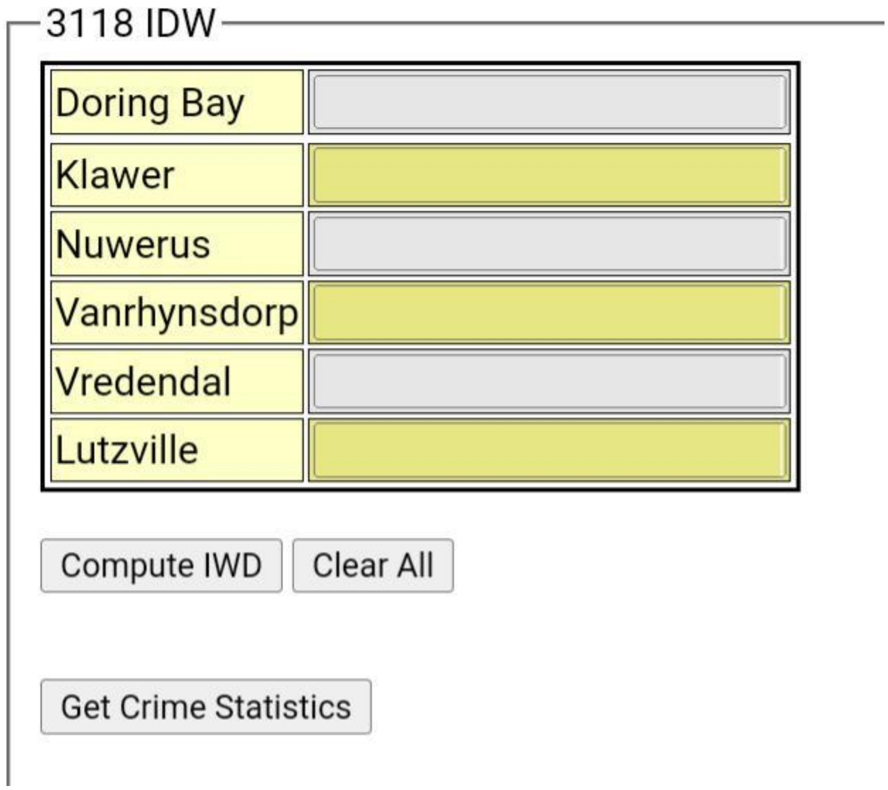

Figure 9: IDW calculator for 3118 police stations or crime statistics.

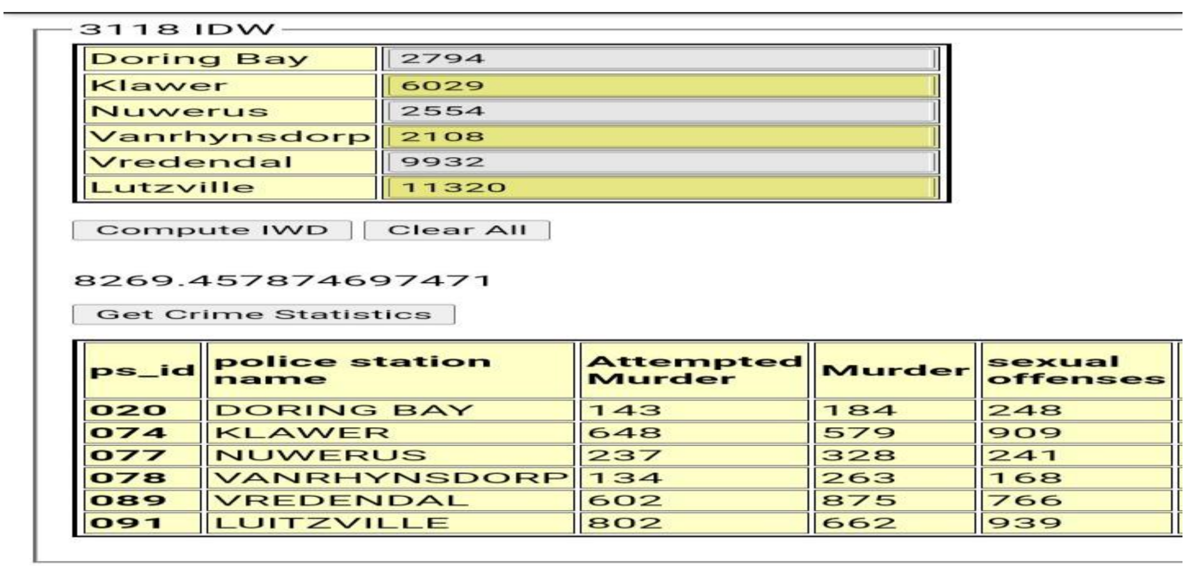

Figure10: IDW computation for degree square 3118 police stations.

3118 Doring-Bay can be considered to be Low-Intermediate, Klawer is Intermediate -Intermediate. For more clarification about the terms “Low”, “Medium”, “Intermediate”, “High”, please revisit section 2.2@.1 or jump to section 3.3.1.

3. Geoportal

Geoportal page can be just like what was done to access the database page. Click this website link https://mthnja014.github.io/justice-center-login-portal/ . After clicking the website link, press “Geoportal Login” (see Figure 1). Then the geoportal login page appears as in Figure 2. Type “geoportal” in both username and password input fields. Before successfully signing in, the login success message or the login error alert message will show up. Kindly press ok in the alert message. Now you have successfully logged into the geoportal and you should have a website page like the one in Figure 11.

Making a geoportal using leaflet relies on both raster tiles and vector layers. The raster tiles are more useful when they are used as a basemap. The vector layers can then be drawn and overlaid on top of the base raster tile. The leaflet understand the [latitude, longitude] for positioning geoportal vector layers. These layers are viewed in a map tile. Map tiles are provided by organizations like Maptiler. The attribution is added to a vector tile to acknowledge the organization that owns the raster tile used as a basemap.

3.1 geoJSON.

It is worth noting that leaflet works perfect with JavaScript. Geographic Information can also be stored in format similar to the JSON format by adding geometry and coordinates to a JSON format to form a GeoJSON format. In most cases, a GeoJSON can be saved as a JSON file. Global libraries can be used to link a GeoJSON file to a script containing a raster tile. A GeoJSON can also be hosted directly in a script containing a raster tile. The syntax for storing a point feature (say Rondebosch police station) in a GeoJSON format is as in (6):

$var\ Rondebosch\ = \{$
$“type”: “feature”,$
$“properties”: \{$
$“name”: “Rondebosch”\},$
$“geometry”: \{$
$“type”: “point”,$
$“coordinates”: [-33.96262, 18.46833]\}$
$\}; \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (6)$

Another police station feature can be created in a similar fashion. When you want to group two GeoJSON features together, the syntax can be extended by storing GeoJSON features in an array and adding type featureCollection. Suppose that another GeoJSON feature is created as in (7):

$var\ Mowbray\ = \{$
$“type”: “feature”,$
$“properties”: \{$
$“name”: “Mowbray”\},$
$“geometry”: \{$
$“type”: “point”,$
$“coordinates”: [-33.96262, 18.46833]\}$
$\}; \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (7)$

These two GeoJSON can grouped together into a GeoJSON feature group as in (8):

$var\ police\_stations\ = \{$
$“type”: “featureCollection”,$
$“features”: [Rondebosch, Mowbray]$

$$\}; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (8)$$

3.2 Leaflet Markers Libraries.

3.2.1 Creating Vector features using Markers Libraries.

Like geoJSON, markers can also create geometry on the leaflet raster tile. Leaflet supply various ways that can be used to create geometry. Suppose that the coordinate pairs variables are created as in (9) – (12):

$$const\ a\ =\ [lat(a), lng(a)]; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .(9)$$
$$const\ b\ =\ [lat(b), lng(b)]; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . \ldots\ldots\ldots\ldots\ldots\ldots .. (10)$$
$$const\ c\ =\ [lat(c), lng(c)]; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . \ldots\ldots\ldots\ldots\ldots\ldots .. (11)$$
$$const\ c = [lat(d), lng(d)]; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (12)$$

Creating a polygon defined by the coordinates from the variables created above would be as in (13):

$$var\ polygn\ =\ L.polygon([a, b, c, d]); \quad \ldots\ldots\ldots .. \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (13)$$

Polyline with these coordinates could look as in (14):

$$var\ polyln\ =\ L.polyline([a, b, c, d]); \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . \ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (14)$$

The points can be marked in various ways. There is a standard marker icon that comes with leaflet. In addition to the traditional leaflet marker, circles can also be used to draw points on the map. Drawing circles marker for point (a) could be done as in (26):

$$var\ crcle\ =\ L.circle([a]); \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (15)$$

There are options that are used to control features created using (13), (14), and (15). In this geoportal design each circle was binded to a popup. Binding a popup to a circle can be done by extending (5) to be as shown in (21).

$$var\ pup\ =\ crcle.bindPopup(""); \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (16)$$

The leaflet is a wide because the bindPopup library has its own options.

3.2.2 Setting styles to Markers and other vector features.

Leaflet also allows a person who is creating a geoportal to style features they created. The style can be given to a circle marker at the time of marker creation. But creating styles for one circle at a time could be a long process accompanied by hard coding. To avoid creating style for one feature at a team, the laeflet featureGroup library can be used using the syntax in (17):

$$var\ fg\ =\ featureGroup([feature1, feature2, \ldots, featuren]); \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

Suppose that there are two circle markers created using (26) and binded a popup in (27) as follows:

var Rondebosch = L.circle([-33.96262, 18.46833]).bindPopup(“id: 006 </br> name: RONDEBOSCH </br> lat: -33.96262 </br> lng: 18.46833”);

var Mowbray = L.circle([-33.96262, 18.46833]). bindPopup(“id: 035 </br> name: MOWBRAY </br> lat: -33.96262 </br> lng: 18.46833”);

These two features can be grouped together using (17)

```
var fg = featureGroup ([Rondebosch, Mowbray], 50).setStyle({
Stroke: true,
Color: “green”,
Opacity: 1,
Weight: 4,
Fill: true,
fillColor: “green”,
fillOpacity: 0.3
}).addTo(map);
```

50 is a radii of the circle, stroke is a boolean, color assigns color green to the grouped features, capacity ranges from 0 to 1 and is used to define the strength of the outline color of the circle. Weight is a integer and it refers to the weight or the circles, larger values of weight will result in bigger circles. Fill is a boolean such that if fill is true the circle will be filled with a color corresponding to a color given to fillColor. The fillOpacity is used to define the strength of color that will fill the circle. This fillOpacity is between 0 and 1.

Now that the circles are grouped, the layer of featureGroups can be created. The cartographer might be interested to group features with similar characteristics into a single layer. There are many layers that can be created using leaflet layerGroup library. The syntax used to create layer group is shown as (18).

$$var\ lg\ =\ layerGroup([feature1, featureGroup1, feature2, \ldots, featureGroupn]); \quad \ldots \ldots (18)$$

Suppose a layer called “green” for “fg” is to be created, (29) can simply create this layer as follows:

```
var green layerGroup([fg]).addTo(map);
```

The .addTo(map) adds the layer to the map. The layerGroup can also be created for ungrounded features, and for multiple featureGroups .

3.3 Implemented Geoportal

It was briefly described how to access geoportal earlier in this section. It can be seen that after logging into a webpage, there is a geoportal, legend, and JavaScript buttons. The buttons contain statistical analysis tools were discussed in section 2 above. The home button, directs the website user to the home website page, the “Search Degree Squares” button works with the input field next to it, later in this chapter degree squares reference system will be discussed as it is being used to locate police stations on the map. On the top right of the geoportal there is a layers icon and the search icon, the search icon works on the basis of geocoding. This search icon does not play much role in the operation of the geoportal, however it can be used to geocode other map features that were not created by the author.

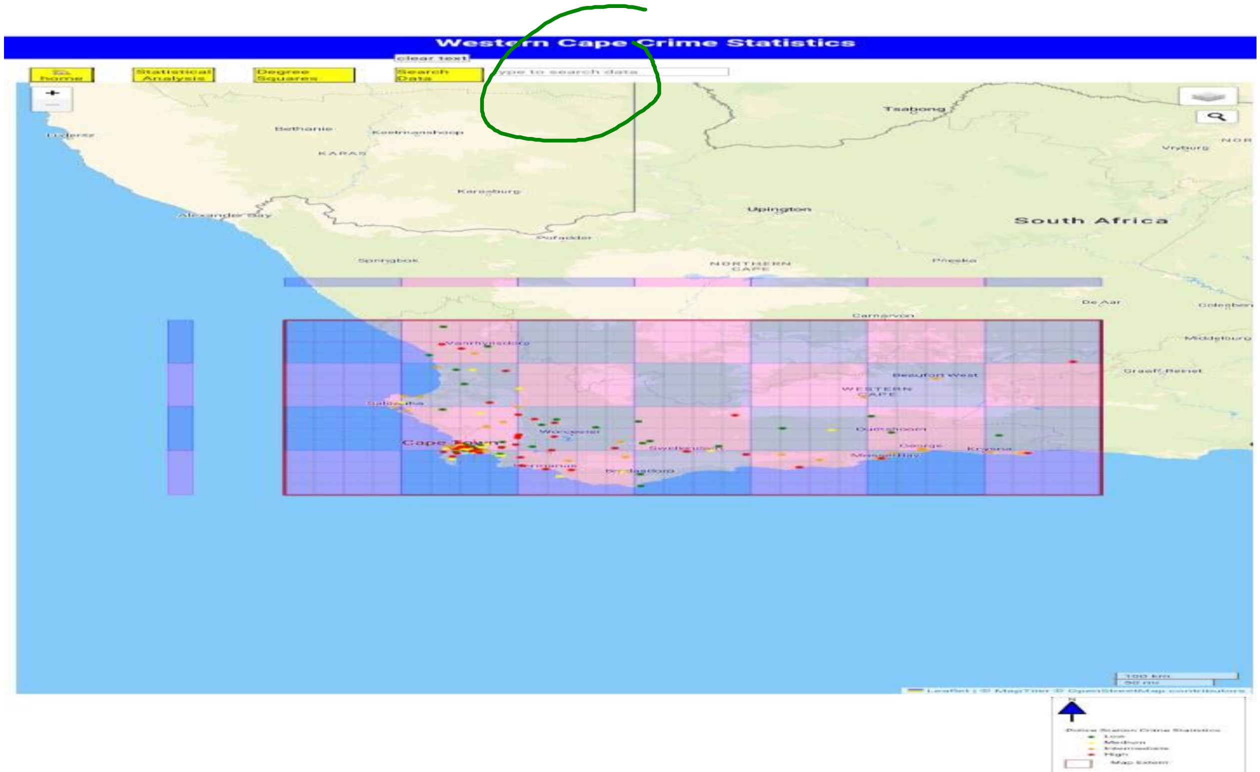

Figure 11: *Western Cape SAPS Crime Statistics Geoportal.*

3.4 Western Cape Crime Management System Through Geoportal.

3.4.1 Degree Squares Overview

In section 2 degree squares were briefly discussed. This section briefly described how degree squares can be used for georeferencing of map features. Chapman & Wiczorek (2022) briefly explains the use of degree squares for geo referencing. The authors points out that there are countries using degree squares when dealing with Public Land Survey System (PLSS). For instance, in a township subdivision, a township can be divided into sections. The sections of a township is given numbering system. See Figure 12 below which shows the numbering system used in degree squares. The top left corner of a degree square is the reference point of a grid. The coordinates of the left corner are used as the number of a degree square.

The number of a degree square in Figure 12 is “3218” bcause the topleft corner has a latitude 32°S and Longitude 18°E. The original size of a degree square is (1°×1°). It can be further divided into 16 quarter degree square. A (1°×1°) degree square is firstly divided into four equal half degree squares. The half degree squares are then label “A” on the top left, “B” on the top right, “C” on the bottom left, and “D” on the bottom right. The half degree squares can also be divided in a similar fashion. In Figure 12, the half degree square 3218C is divided in four quarter degree squares, and the quarter degree square shaded in green can be referenced as 3218CB.

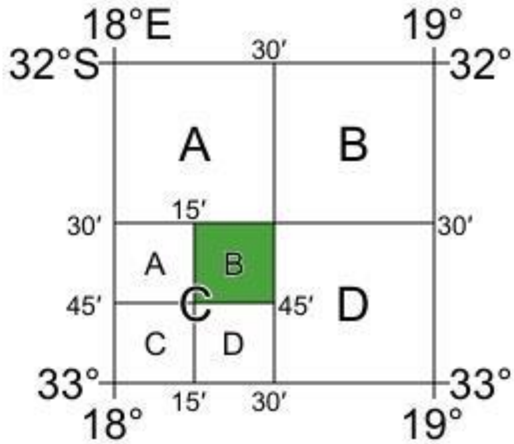

Figure 12: Degree Square, half degree squares, and quarter degree squares. Chapman & Wiczorek (2022)

3.4.2 Degree Squares in the proposed system

The proposed system will make use of degree square to manage and monitor crime. The existing system use irregular polygons as police stations bounds. The shapefile for Western Cape police bounds can be found from the Western Cape SAPS website. The shapefile can be opened by a program that has the ability to view shapefiles.

For the proposed system, each degree square will be considered as a police bound. The degree squares will be defined according to the number of police station(s) point(s) it has in them. Similar to the concept of human settlements, which describes describe places according to the number of buildings per specified area. A degree square with only one police station can be said to be an isolated police station. A degree square with police stations between two to five police stations will be called by its name, a degree square with six to ten police stations will also be given a name, degree square with eleven to twenty police stations will be given a name, and degree squares with more than twenty police stations will also be given its name.

3.4.3 Preparing Geoportal for Searching features.

It has been shown, how Western Cape SAPS crime statistics is stores in tables. Now it is going to be shown how these can be represented in a geoportal. Clicking the layer icon in the top right corner of the geoportal will show layers contained in this geoportal as shown in Figure 13a. Click the circle next to reference grid and click “grid layer”. Now the information shown on the map is reduced since the reference grid lines are hidden. To hide all police stations points, check the boxes; “All Cases”, “Low”, “Medium”, “Intermediate”, and “High”. Uncheck checked boxes and see the police stations points vanishes from the geoportal.

3.4.4 Searching map features

The searching of data in this geoportal will require the geoportal reader to have a basic understanding of referencing map features using degree squares. Suppose one want find Rondebosch police station point from the geoportal. If the map user scroll further down in the layers and click check Rondebosch box as shown in Figure 13b. Now Only Rondebosch police station appears on the map. If zooming in and clicking the Rondebosch police station point, a popup appears.

Finding Rondebosch police station in this system using degree squares can be done following simple steps:

Step 1: Type the police station identifier(006) in the input field circled by color green in Figure 11 and click the "Search degree square " button. The output will be a table with the row of a police station name and a degree square at which the police station belongs to. This small table will be located in a blank space below a geoportal (see Figure 14).

Step 2: Check the box for the police station you are searching for (for this example check Rondebosch as shown in Figure 13b). The search result found in step 1 confirms that Rondebosch is located in 3318CCD degree square. Therefore, also check 3318. Checking 3318, will highlight a degree square with the top left corner having -33° Latitude and 18° Longitude. After checking 3318, check 3318C box will divide the bottom left corner (3318C) into 4 squares. Rondebosch will located in the bottom right of the 3318C squares (3318CD). If Rondebosch was located in 3318CC, it would have been located on the bottom left of the 3318C squares. (See Figures 15 and first and second ticks of Figure 16).

Now suppose that the map user want to look at all the police stations located in the degree square 3318CD (see Figure 17 and the third tick of Figure 16). There are various police stations inside a degree square 3318CD. Therefore 3318CD degree square can be further divided into the fourth order degree square (see Figure 18). The 3318CD degree square is divided by blue cross hairs, those blue cross hairs are got by checking layer 3318CDD. The square can be divided until a square has only one police station in it. For this report, the police stations are referenced by the second order degree squares. The example of a second order degree squares are those degree squares with four digits and one letter. In a second order degree squares, Rondebosch is 3318CD therefore it can be found by checking 3318C.

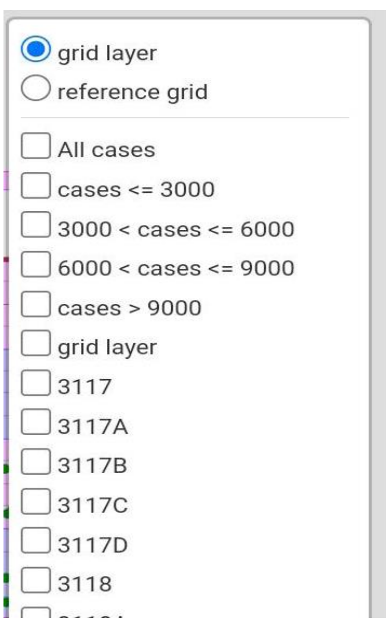

Figure 13a: Geoportal layers.

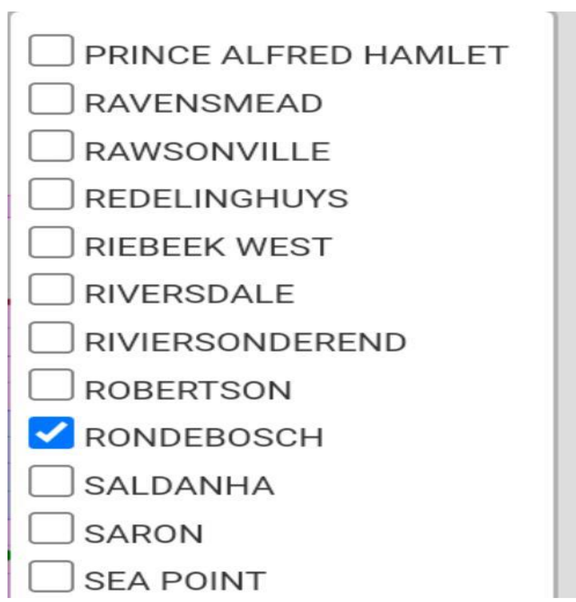

Figure 13b: Geoportal layers

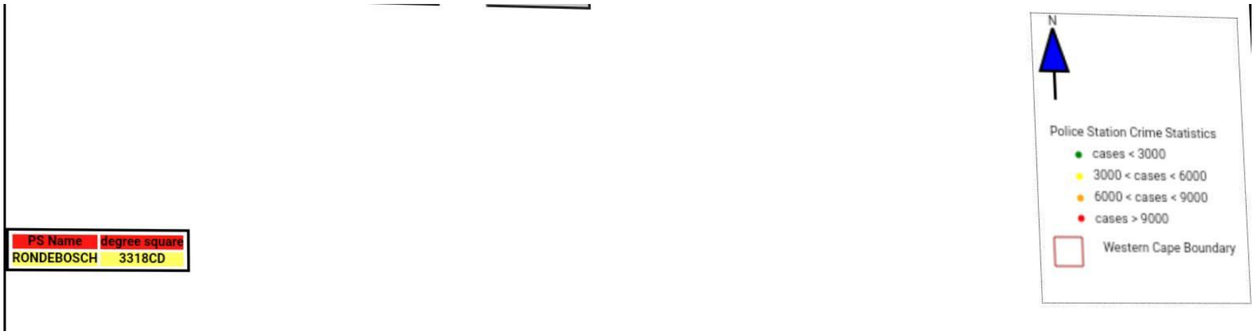

Figure 14: Result of a Rondebosch degree square search.

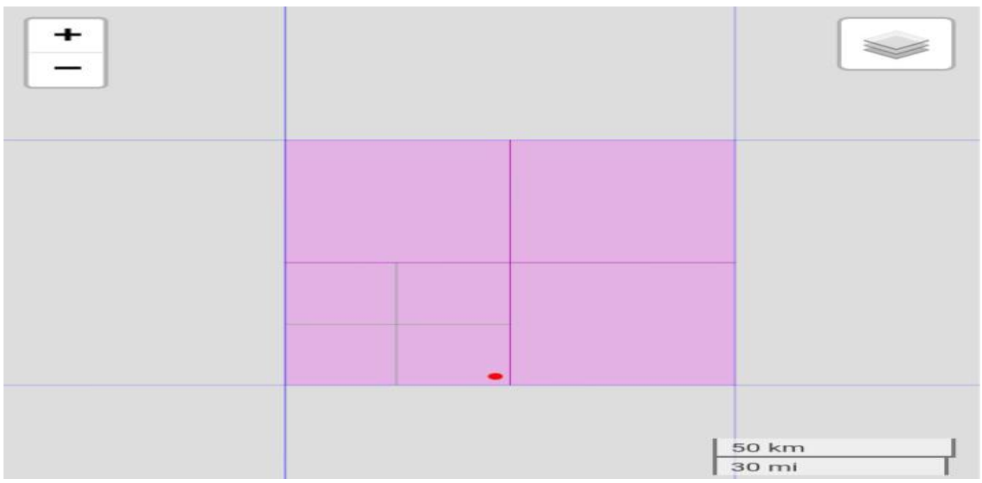

Figure 15: Degree square for Rondebosch (first order 3318 degree square)


3317C
3317D
3318
3318A
3318B
3318C
3318CD
3318CDD
3318D
3318DC
3318DCC
3319
3319A
3319B

Figure 16:

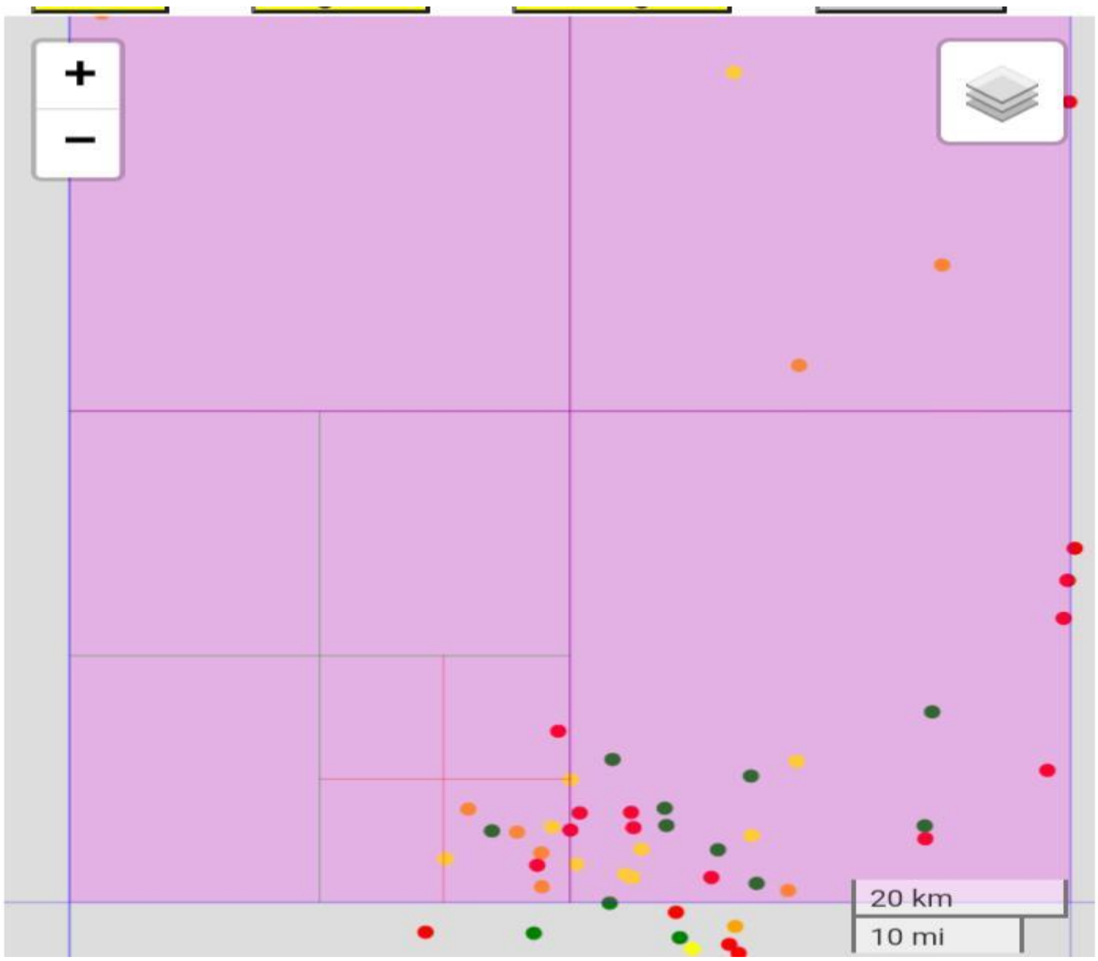

Figure 17: third order 3318 degree square divided by red cross hairs.

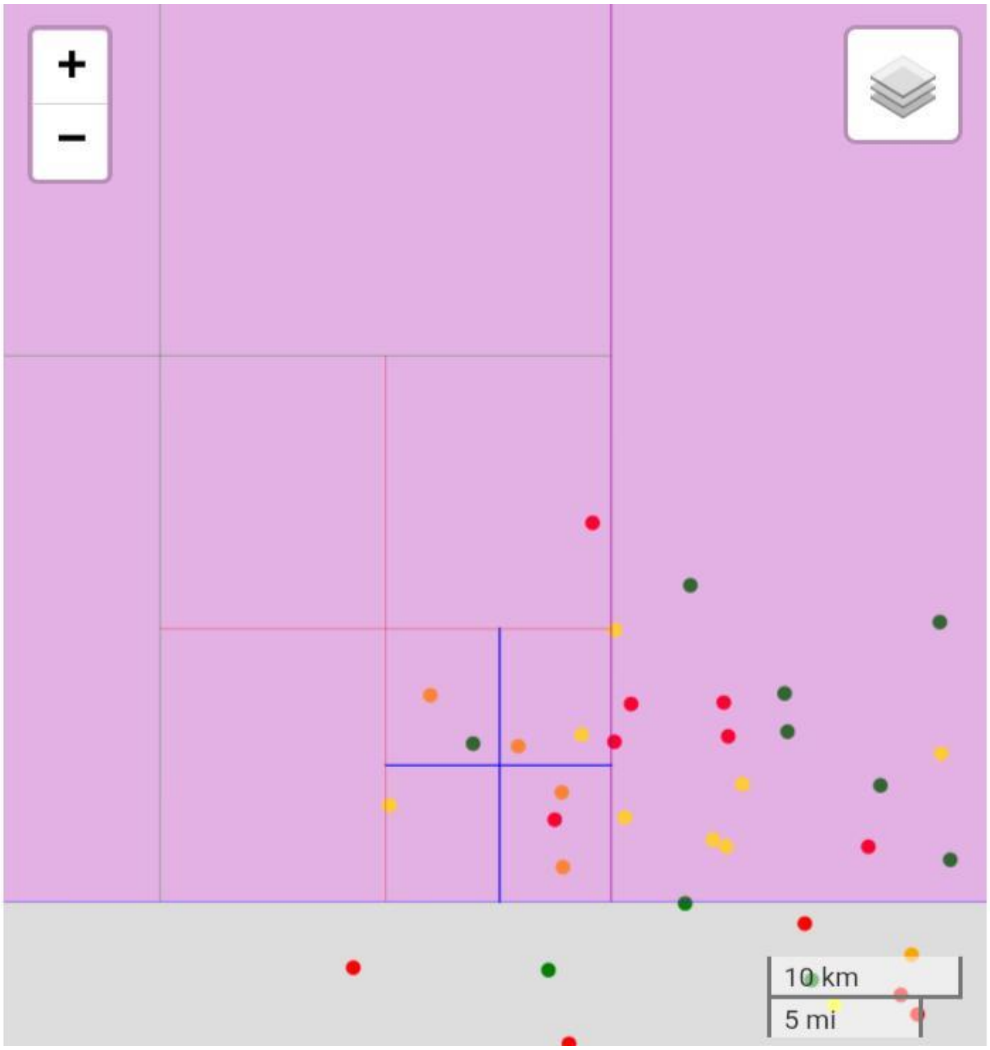

Figure 18: Forth order 3318 degree square divided by blue cross hairs.

4. Conclusion

The metadata is there in all webpages. It was written in the <meta> tag of each HTML file. The <meta> tag has the administrative metadata, descriptive metadata, and technical metadata for each webpage. The metadata content differ for each website page. Of course geoportal metadata content included things like map extent, zoom control, etc. These contents of metadata cannot be included in the webpages of E-R diagrams, dataflow diagrams, statistical analysis, statistics tables webpages.

5. References

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