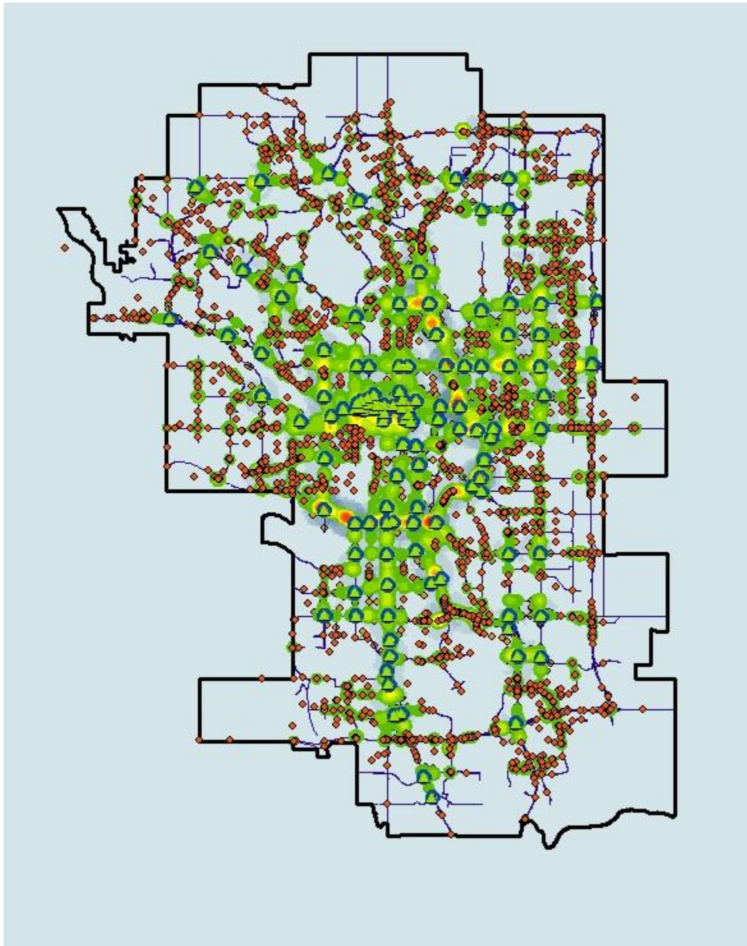

Project Report

PROJECT CALGARY ACCIDENT REDUCTION

Group-7B | BGIS Group B | 12/01/2019

Submitted by	
Jyothish Prabhakaran Jayasree Subhash Nicholas Viraj Patel Joel Love Kelsey Hahmo	GEO GEOGRAPHY · CARTOGRAPHY · ANALYSIS · TECHNOLOGY

Acknowledgement

We GeoCAT team express our gratitude to all Instructors of BGIS for the constant motivation, encouragement and advices in work. It gives us immense pleasure to express gratitude to all those who have been there all the while, during our project period extending their help in every possible way in accomplishing the course.

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Executive Summary

This report is submitted as a part of the Final Project Submission for BGIS first semester. The project Calgary accident reduction was approved by the project owners and the team was primarily using the data from the open data portal of the city of Calgary. The final the output was generated using the help of Spatial Analyst tool in ArcMap.

The project is divided into 9 stages from Data Acquisition to Final Output.

In the first stage we downloaded open data from Open Data Calgary and mapped it ArcMap. In the second stage we were able to successfully geocode the camera location with address locator. After that we cleaned the data using the R programming and with MSSQL we managed the database. Before exporting the data to MSSQL we created the ERD diagram and we follow the ERD for generating the database. After connecting the MSSQL data to ArcMap we used the spatial analyst tool for finding the Kernel density of the traffic incidents. Once the hot spots are identified with Trimble Juno SC we captured 4 Location for new camera location to reduce the accident in Calgary. Once the GPS data is captured the team decided to digitize three more points for the proposal as it was identified as potential accident-prone area.

Once digitizing was finished team moved into another analysis to find the relation with Season and number of incidents. The team found out that winter is having more incidents when compared with other seasons.

From several research the team concluded the project with a positive impact to the Calgary city road safety. Installing traffic camera in accident prone areas has significantly reduced the traffic collisions and the team is hoping to reduce traffic incidents in Calgary with the help of the proposed camera.

Introduction

As the third largest municipality in Canada with an estimated population of more than 1.2 million people with approximately 900 km of road spans, which is one of the most expansive in North America and considered as one of the safest cities in Alberta in terms of road safety. Yet Calgary has a significant number of traffic collisions. Traffic Collisions have been recognized as one of the adverse elements which effect the economy in developing and developed countries. Traffic safety plays a vital role in modern road transportation systems and accidents have a negative impact to the economy as it leads to severe damage to the property, injuries and even loss of a precious live.

Road safety is a major concern for all the major cities and there are several factors which contribute to it. The city of Calgary has several programs in place to create awareness and reduce traffic collisions in Calgary. Project CAR (Calgary Accident Reduction) will have a small contribution in reducing the traffic collisions in the City of Calgary in Alberta, Canada.

Project Background

The team "GeoCAT" are students of Southern Alberta Institute of Technology (SAIT), who are studying Bachelor's in applied technology Geographic Information Systems (BGIS) and as part of the curriculum the team had chosen Project CAR for the first semester Final Project Submission for Fall 2019.

What is "GeoCAT"

The team consists of 5 members from different field of study and experience. GeoCAT was chosen as the name for the team as it relates with the field of study.

Geo – Geography
C- Cartography
A- Analysis
T-Technology

Logo designed by Subhash Nicholas

Figure 1

Team Members

Resource ID	Name	Role	Status
000826444	Subhash Nicholas	Project Manager	Full Time
000821802	Jyothish Prabhakaran Jayasree	GIS Analyst	Full Time
000825566	Viraj H Patel	GIS Technician	Full Time
000	Joel Love	GIS Team Lead	Part Time
	Kelsey Hahmo	GIS QA	Part Time

Project CAR - Calgary Accident Reduction

The purpose of this project (Project Calgary Accident Reduction) was to identify the accident-prone areas in the City of Calgary and as a remedial measure, Project CAR will propose to install traffic camera in the hot spots where there is no installed traffic camera. As we all know there are several factors which contribute to traffic collisions, such as road conditions, weather, speed limit and even wildlife crossings. Since Calgary is exposed to severe weather conditions Team GeoCAT will be submitting a data analysis report on the number of Traffic incidents in each season.

Project Scope

The primary scope of this project was to identify the hot spots of Traffic Incidents in the study area and propose a traffic camera in the identified hot spot if there is no traffic camera installed. The secondary scope for this project was to analyze the Traffic incident data and identify whether severe weather in Calgary plays any role in traffic incidents.

Project Study Area

GeoCAT had chosen the City of Calgary as the study area and it was approved by the stake holders and mentors. Calgary is the largest city in Alberta, Canada with area of 825.56 sqkm and population density of approximately 1,501.1/km².

Project Tools

There are a wide variety of tools which had been used in this project and listed below are the tools with their respective purpose in Project CAR.

Name	Software/Hardware/Device	Purpose
ArcMap 10.6	Software	Spatial Analysis/Digitizing/GIS
ArcPad	Software	Data Capture
Trimble Juno SC	Device	GPS Data Capture
Microsoft SQL	Software	Database Management System
R studio	Software	Data Quality & Cleaning
Adobe Photoshop CC	Software	Graphic Designing
Microsoft Project	Software	Project Management
Microsoft Word	Software	Documentation
Microsoft Excel	Software	Data Analysis
Windows 10	Software	Operating System

Project Data

As part of Project CAR, the team was having two data sets from the Open Calgary Data Source 1. Traffic Incidents 2. Traffic Cameras, the data captured using GPS device and by digitizing.

Name	Source	Details
Traffic Incidents	Open Data, Calgary	https://data.calgary.ca/Transportation-Transit/Traffic-Incidents/35ra-9556
Traffic Camera	Open Data, Calgary	https://data.calgary.ca/Transportation-Transit/Traffic-Cameras/k7p9-kppz
City Boundary	Open Data, Calgary	https://data.calgary.ca/Base-Maps/City-Boundary/7t9h-2z9s
Major Road Network	Open Data, Calgary	https://data.calgary.ca/Transportation-Transit/Major-Road-Network/mybc-x96b
Proposed Camera Location	ArcPad, ArcMap, GPS Device	Captured Data

Project Management

Project CAR has been successfully managed and completed by the team. Project CAR comes under waterfall methodology as it was focused on the final output and the project was broken down into packages where each package depends on the deliverable from the previous package. The project was broken down into linear sequential stages.

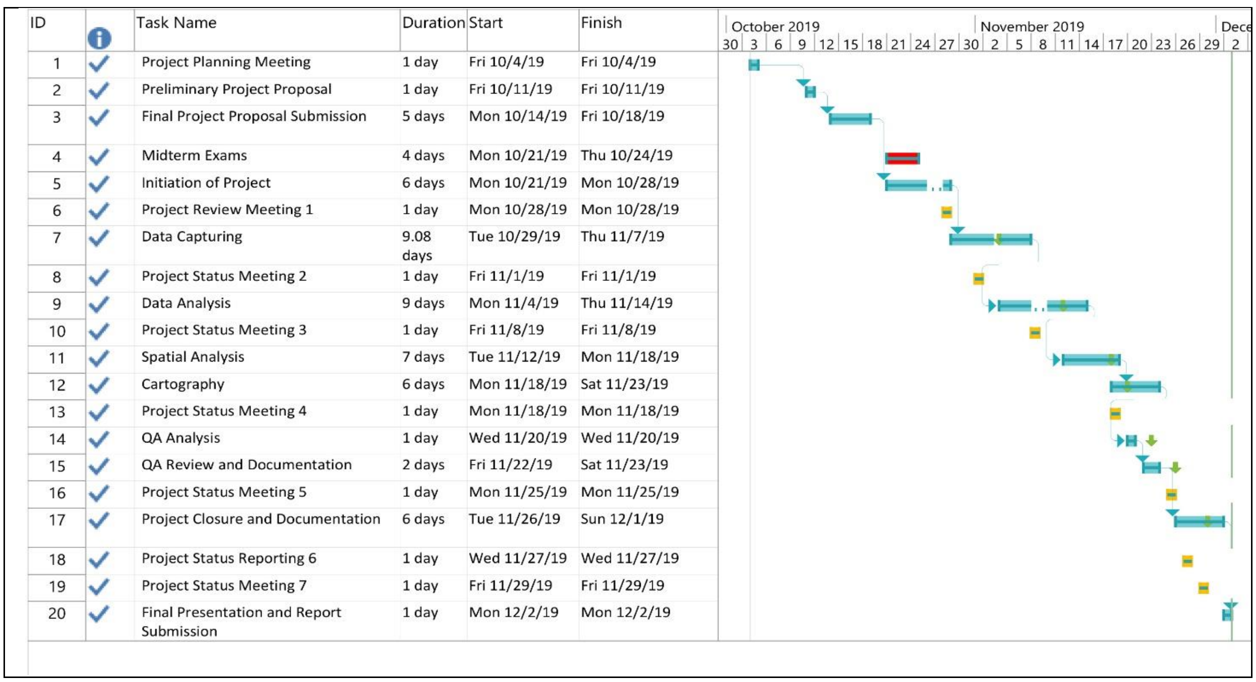
The project had milestones to achieve and the team was able to achieve 95% of the milestones on time by sticking on to the project plan. A detailed Gantt Chart which was a deliverable is attached in the Gantt Chart session of this document. The project was managed using Microsoft Project as the Project management tool. As mentioned earlier the project was divided into multiple packages, a detailed Work Breakdown Structure (WBS) has been attached in the WBS session of the document. After creating the Project Timeline and setting the baseline the team decided to work on assigning the available resources. There were few issues with assigning resources as two of the team members were part time students, details of this risk are mentioned in the Risk Management session of the document. The details of resources and their allocated hours for each task can be seen in the MS Project Document file submitted with the document. The project was having predefined QA analysis check list to make sure the quality is up to the standards. The team was also maintaining a risk log and risk management document, which has been attached in the Risk Management session of the document. The project has been closed with a lessons-learned document.

Listed below are the deliverables for this project and the resource assigned for the task.

Serial No	Deliverable	Assigned Resource
001	Final Project Report	Subhash
002	Final Presentation	Viraj & Jyothish
003	Output Map in PDF format	Jyothish
004	Gantt Chart	Subhash
005	Work Breakdown Structure	Subhash
006	Risk Management / Risk Log	Subhash
007	Project Status Reports	Subhash
007	Resource Allocation Document	Subhash
008	QA Check List	Jyothish, Kelsey & Viraj
009	Excel Data Analysis Output Document	Jyothish & Joel
010	Lessons Learned Log/ Document	Viraj & Subhash

Gantt Chart

Listed below is the Gantt Chart which was followed by the team.



ID		Task Name	Duration	Start	Finish
1	✓	Project Planning Meeting	1 day	Fri 10/4/19	Fri 10/4/19
2	✓	Preliminary Project Proposal	1 day	Fri 10/11/19	Fri 10/11/19
3	✓	Final Project Proposal Submission	5 days	Mon 10/14/19	Fri 10/18/19
4	✓	Midterm Exams	4 days	Mon 10/21/19	Thu 10/24/19
5	✓	Initiation of Project	6 days	Mon 10/21/19	Mon 10/28/19
6	✓	Project Review Meeting 1	1 day	Mon 10/28/19	Mon 10/28/19
7	✓	Data Capturing	9.08 days	Tue 10/29/19	Thu 11/7/19
8	✓	Project Status Meeting 2	1 day	Fri 11/1/19	Fri 11/1/19
9	✓	Data Analysis	9 days	Mon 11/4/19	Thu 11/14/19
10	✓	Project Status Meeting 3	1 day	Fri 11/8/19	Fri 11/8/19
11	✓	Spatial Analysis	7 days	Tue 11/12/19	Mon 11/18/19
12	✓	Cartography	6 days	Mon 11/18/19	Sat 11/23/19
13	✓	Project Status Meeting 4	1 day	Mon 11/18/19	Mon 11/18/19
14	✓	QA Analysis	1 day	Wed 11/20/19	Wed 11/20/19
15	✓	QA Review and Documentation	2 days	Fri 11/22/19	Sat 11/23/19
16	✓	Project Status Meeting 5	1 day	Mon 11/25/19	Mon 11/25/19
17	✓	Project Closure and Documentation	6 days	Tue 11/26/19	Sun 12/1/19
18	✓	Project Status Reporting 6	1 day	Wed 11/27/19	Wed 11/27/19
19	✓	Project Status Meeting 7	1 day	Fri 11/29/19	Fri 11/29/19
20	✓	Final Presentation and Report Submission	1 day	Mon 12/2/19	Mon 12/2/19

WBS – Work Break-down Structure

The project was divided into 20 packages / tasks each package is dependable on the previous one and thus it was managed using waterfall methodology. The project initiated on October 4th, 2019 with a Project Planning and signed off with a Presentation on December 6th, 2019.

Listed below are the list of tasks, duration of each task and the resource assigned for each task with its respective deliverable.

Serial No	Task Name	Duration	Start Date	Finish Date	Resource Assigned	Deliverable
1	Project Planning	1 day	10/04/2019	10/04/2019	GeoCAT - Team	
2	Preliminary Project Proposal	1 day	10/11/2019	10/11/2019	Subhash	Project Proposal
3	Project Initiation	6 days	10/21/2019	10/28/2019	GeoCAT - Team	Gantt Chart, WBS, Resource allocation document, Risk Analysis document
4	Data Capture	6 days	10/29/2019	11/03/2019	Viraj, Jyothish, Subhash	GPS data capture work flow document, Digitizing work flow document
5	Data Analysis	6 days	11/04/2019	11/09/2019	Joel, Jyothish	Excel Data analysis document
6	Spatial Analysis	5 days	11/12/2019	11/16/2019	Jyothish, Subhash, Viraj	Kernal density analysis map.
7	Cartography	2 days	11/18/2019	11/19/2019	Subhash, Viraj	Final Map output
8	QA Analysis	2 days	11/20/2019	11/21/2019	Subhash, Jyothish, Dakota	Check list document
9	Documentation	2 days	11/22/2109	11/23/2019	Jyothish	Status reports, Lessons learned log
10	Project Closure and Documentation	7 days	11/26/2019	12/02/2019	GeoCAT	Final Project Report, PowerPoint presentation document.

Resources

GeoCAT is a team of 5 members and listed below are the resources with the hours allocated for each resource.

Resource Name	Initials	Hours Allocated
GeoCAT(all available resources)	TGCAT	200 hrs
Subhash Nicholas	SN	76 hrs
Jyothish Prabhakaran Jayasree	JPJ	74 hrs
Viraj H Patel	VHP	72 hrs
Joel Love	JLO	45 hrs
Kelsey Hahmo	KH	12 hrs

Project Communication

Project communication is one of the most important part in every project and GeoCAT had agreed to follow all the communication guidelines which were pre-defined by the team. The team was also having Project Status Meetings conducted every week on Mondays and Fridays to discuss the progress in the project, risks, monitoring quality control, task analysis and team management.

All team members were able to attend the Status Meetings actively. The progress was communicated throughout the project and all the risks were successfully mitigated. Project Status Meetings were the back bone of this project as all the team members were able to actively participate and was properly communicated.

Communication Guidelines

Scenario	Preferred communication method	Description
Communication within the team	Online, Meetings, Phone, Text, Email	As agreed, the team will the communicating through different mediums of communication and everyone was responsible for responding to their team mates.
Communication with mentors and project owners	Email	The team had agreed to, make project manager as the primary contact for communicating with project owners & mentors
Communication with instructors	Meetings with appointments/ in class, Email	The team has agreed to contact the instructors when there is an unresolved issue within the team and when the team cannot resolve a problem with the project or needs instructor's attention.

Meeting schedules/ Project status reporting

Listed below are the meetings and the outcomes of each meetings.

Name	Date	Description	Outcome
Project Planning Meeting	10/04/2019	The team GeoCAT was introduced for doing the Final Project.	The team decided to do Project CAR and started to work on the Project Proposal.
Project Review Meeting	10/28/2019	Project Initiation	The team has developed status report, ms project document for managing the team, assigned resources for tasks, risk management document.
Project Status Meeting 2	11/1/2019	Discussing the project status and the risks.	The data was downloaded from open data source and started working on data analysis and decided to capture data after kernel density analysis

Project Status Meeting 3	11/8/2019	Discussing the project status and assign resources for spatial analysis.	After completing the kernel density analysis, the team decided to capture the data and do another analysis using excel with the traffic incidents data.
Project Status Meeting 4	11/18/2019	Discussing the status and the risks. Discuss about the milestones and tasks to follow in QA Analysis.	There were few errors with the geocoding and the team has resolved the issue with the help of our mentor Jay Reid
Project Status Meeting 5	11/25/2019	Project Status reporting and analyzing risks	The project data was successfully captured and all the milestones till date was achieved.
Project Status Reporting 6	11/27/2019	Discussing about the final outputs, presentation.	The team has decided to work as a team of three to work on submitting the final output to the project owners with a presentation on 12/06/2019.
Project Status Meeting 7	11/29/2019	The team has decided to work on the final submission.	Project Report draft.

Project Risk Analysis

The team has developed a risk log and risk management document. The team has encountered 4 risks which did affect the schedule but there was no damage in achieving the milestones. Listed below are the risks which are encountered by GeoCAT.

1. Weather Conditions
2. Geo-Coding Error
3. Scope Change
4. Data Capture plan change.

All the above-mentioned risks were encountered by the team while in project and they were identified in the project initiation phase of the project.

Updated Risk Log

Listed below are the updated risk log with all the identified and encountered risks.

Risk ID	Risk	Resource Assigned	Mitigation Plan
R001	Scope creep can happen at any point of time in a project.	Team GeoCAT	Discuss as a team and come up with a mitigation plan which will not severely impact the project
R002	Possibility of taking more time than allocated time to complete a task or completion of project	Team GeoCAT	The team has agreed to seek help from mentors to mitigate the risk.
R003	The project team may fail to identify all the activities required to create the deliverables and improper communication within the project team.	Subhash	As the PM for the team the resource assigned must follow all the guidelines as mentioned in D2L and successfully generate all the necessary document and deliverables.
R004	Failure to meet the project goal due to improper utilization of available resources.	Subhash	Team member will be allocated for proper utilization of the resource.
R005	External risks that are outside the control of the project team such as poor weather condition, illness of resource.	Team GeoCAT	The team has faced this risk and we mitigated it buy digitizing 3 locations.
R006	GPS Malfunction	Viraj	The assigned resource must work with the GPS and report as issues with the device and seek help from the mentors.
R007	QA/QC Failure	Jyothish/ Subhash	Team has generated a check list and guidelines to follow from the QA meeting. The assigned resource must follow the check list.
R008	Software Malfunction	Jyothish	The assigned resource has to report the issue to PM and seek help from mentors.
R009	Inaccurate Data	Subhash Jyothish	The team has agreed to discuss this issue and come up with a better source for accurate data and seek supervision from mentors.
R010	Data Corruption	Team GeoCAT	Data will be stored in Cloud, HDD and other storage devices. Github is a solution for this risk.

QA Analysis

The team was having a well-organized Quality Control in place and the team has always followed it. Apart from the QA Check List the team was also maintaining a defect tracking record as well as the part of QA analysis. Two resources were assigned for Quality Assurance and they have successfully managed all the quality control tasks. Listed below are the Check list used by the team and the defect log.

Check List

	Final Project- Check List	Group-7B

CHECKLIST FOR GIS MAP EVALUATION

PROJECT:	Calgary Accident Reduction	Report No	1	DATE:	12/1/2019

Sl. No.	ACTIVITY TO BE CHECKED	YES	NO	NA	REMARKS
1	**Cartography**				
1.1	Pupose of the maps has been visible in the final output?	YES			Map looks good and the details are visible.
1.2	Does the legend is properly organised?	YES			Legend was properly designed.
1.3	Is the symbology for qualitative and quantitative data effectively applied?	YES			
1.4	Do the colors and symbols support the substantive and affective objectives?	YES			
1.5	Are the symbols and labels legible? Are the symbols intuitive and easy to decipher or do they have good explanation?	YES			
1.6	Is there appropriate use of graphics, images, text blocks, and other supporting information?	YES			
1.7	Is the map projection suited to the map's purpose (equal area, conformal, etc)?	YES			Yes , It's a good projection for this project.
2	**Geodatabase and Layers**				
2.1	Are the captured and digitized points acceptable ?	YES			
2.2	Is the projection matches with the study area?	YES			
2.3	Is the Kernel Density Raster layer visible and understandable ?	YES			
2.4	Geodatabase, Layer and Attribute has followed proper naming convention?	YES			
2.5	Is all the unnecessary data and layers have been removed?	YES			there is no visible unnecessary layer / data
2.6	Is the attribute table has Null values ?		NO		Its good to use have R programming skills to clean data.
3	**Map Elements and Layout**				
3.1	Do all the map elements support the objectives of the project?	YES			
3.2	Does the output map aligned properly?	YES			
3.3	Are the map elements placed logically on the page and are the map elements aligned to each page?	YES			
3.4	Does the map have appropriate borders?		NO		Border should have been better.
4	**Map Orientation and Scale**				
4.1	Is the map orientation looks good ?	YES			
4.2	Does the map require a north arrow?	YES			Yes the north arrow is properly placed
4.3	Is the scale bar appropriately designed?	YES			
4.4	Are the scale units logical?	YES			
5	**Legend**				
5.1	Are all necessary elements included in the legend?	YES			
5.2	Do the symbols in the legend appear exactly as they do on the map (size, color, etc)?	YES			
5.3	Are the elements, and descriptions appropriately alligned?	YES			
5.4	Are the titles and/or subtitles suitably descriptive and relevant (area mapped, subject, date, etc)?	YES			
5.5	Are the titles and/or subtitles suitably positioned and sized?	YES			
6	**MXD**				
6.1	"Store relative pathways to data sources"?	YES			
6.2	Is the layers are properly named ?	YES			
6.3	Is the definition query was properly used ?	YES			
6.4	Does the unneccessary fields have been removed from the table?	YES			

Remarks : Worked on the map border and made sure that the map is properly designed.

Checked by:		Approved by:	
Name	Jyothish Prabhakaran Jayasree	Name	**Dipal Mehta**
Date	12/2/2019	Date	**12/3/2019**

References:-

(Esri, 2017)

Esri. (2017). Download. *Retrieved from Mapping* : https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwiBy9Kqi-HlAhXoJDQIHXAcA7MQFjABegQIAxAC&url=http%3A%2F%2Fdownloads.esri.com%2FMappingCenter2007%2FarcGISResources%2Fmore%2FMapEvaluationGuidelines.pdf&usg=AOvVaw299jC

Defect Log

Defected log was logged throughout the project and listed below were the defects identified by the team.

Defect_ID	Defect_Name	Description	Plan	Resolved Y/N
D001	Projection error	The data received from Calgary open data was a custom designed projection and the team was agreed to use another projection from the shape file.	The team has used the Calgary_3TM_WGS_1984_W114 projection for this project, because the team found that it will be a perfect fit for Calgary as this projection was for the City of Calgary. The resource allocated for this issue successfully resolved this issue by exporting the shape file with Calgary_3TM_WGS_1984_W114 projection and the issue was resolved.	Yes
D002	Feature outside study area	The data received from Calgary Open Data was having a feature outside of the study area.	The team decided to clip the layer with the study area to eliminate any point features outside study area. And the team successfully completed this task.	Yes
D003	Null Values	The data received from Calgary Open data was having null values.	One of the resources was having skills in R programming and Using R we checked the presence of Null Values in the data and the data was having zero null values after checking the data for null values.	Yes

Lessons Learned

As a part of the project closure we created a lesson learned log. From the lessons learned from the project the team has concluded the project management and in the next session we will discuss about the GIS implication on this project.

Listed below is the Lessons learned log.

ID	Name	Description
LL001	GPS Device	The team was able to gain thorough knowledge to handle the basic functionality of GPS device and how to handle data using Arc Map and Arc Pad.
LL002	Digitizing	With the knowledge we gained from GEOS 409 the team was successfully able to mitigate the risk mentioned above.
LL003	Data Management	With the knowledge gained from GEOS 410 the team was able to successfully manage the data
LL004	Data Analysis	With the knowledge gained from Data Analysis and Output the team was able to analyze the data using excel and add it as a new scope for the project.
LL005	Kernel Density	The team was able to use the tool KERNEL DENSITY in ArcMap to get clear understanding of the hotspots which was required for the successful completion of the project.
LL006	Geo Coding	With the help of our mentor the team has successfully placed all the camera location in Arc Map using the address locator tool.
LL007	Project and Team Management	The team has gained a clear understanding of the importance of project management, Scope and team management.

Geographic Information Systems

Project – Project CAR
Projection – Calgary_3TM_WGS_1984_W114
Analysis – Kernel Density Analysis
Analysis 2 – Season-wise data Analysis
Geodatabase – ProjectCAR.gdb
MXD – Kernel_Analysis.mxd, Kernel_Analysis_Accidents.mxd, Proposed_Camera.mxd, Traffic_Incidents_W.mxd

Feature Classes

Name	Feature
Boundary	Polygon
Local_Road	Line
Major_Road	Line

Standalone Raster

Kernel

Feature Datasets

Calgary
Traffic

Name	Feature
Installed_Traffic_Cam	Point
Proposed_Cam	Point
Traffic_Incidents	Point

Geocoding

Address Locator

Summary of GIS Analysis

The team had agreed to get data from Open Data Calgary which is an open source data from the city of Calgary and the team had used the Calgary_3TM_WGS_1984_W114 as the projection for this project. There were two feature classes named Calgary with all the features of the Calgary city like Local Roads, Major Roads and the Boundary of the City, Traffic is the next feature dataset with features we are analyzing and the final output features. Installed Traffic Cameras are visible in this feature, Proposed Camera is the feature with digitized and GPS captured data, Traffic incident has all the incidents in point feature using this data the team did the Kernel Analysis to find out the hot spots for accidents in Calgary. Kernel raster layer was the output standalone raster file by doing the Kernel Density analysis in the project.

Listed Below are the summary of tasks which we completed as a part of the Project.

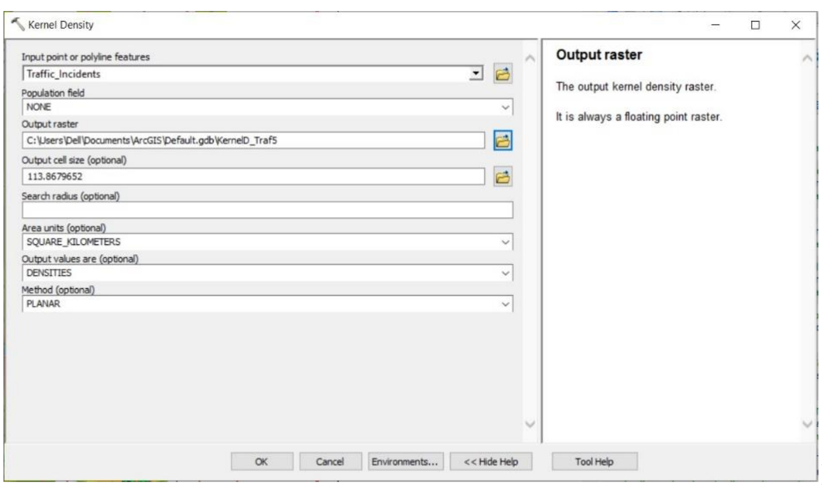
Data Capture	Data Analysis	Data Manipulation	Data Modelling
Digitizing	Excel Data Analysis	Metadata	MS-SQL - RDBMS
Geocoding	Kernel Density Analysis	Data Dictionary	Excel
GPS data capture	Output is generated	Geodatabase	R programming
		Naming Convention	
		Coordinate System Assessment	

Why Kernel Density Analysis?

“The Kernel Density tool calculates the density of features in a neighborhood around those features. It can be calculated for both point and line features.

Possible uses include analyzing density of houses or crimes for community planning or exploring how roads or utility lines influence a wildlife habitat. The population field could be used to weight some features more heavily than others, or to allow one point to represent several observations. For example, one address might represent a condominium with six units, or some crimes might be weighted more heavily than others in determining overall crime levels. For line features, a divided highway may have more impact than a narrow dirt road.” (ESRI, 2018)

Team has done research on the analysis and came to understand that Kernel Density tool in ArcMap will create raster files which will create hot spots over the traffic incidents and the team will be able to identify accident prone areas in the city of Calgary. The tool can be found in Spatial Analyst tool in ArcMap. Figure given below is captured during the process.



Kernel Density Window

Research details on Kernel Density

Listed below are the research and findings on Kernel Density Analysis for finding accident prone areas.

Source	Name	Url
Science Direct (Website)	Development and application of traffic accident density estimation models using kernel density estimation (Development and application of traffic accident density estimation models using kernel density estimation, 2016)	https://www.sciencedirect.com/science/article/pii/S2095756415305808
Research Gate (Website)	Application of GIS to Traffic Accident Analysis: Case Study of Naypyitaw-Mandalay Expressway (Application of GIS to Traffic Accident Analysis: Case Study of Naypyitaw-Mandalay Expressway, 2016)	https://www.researchgate.net/publication/327404974_Application_of_GIS_to_Traffic_Accident_Analysis_Case_Study_of_Naypyitaw-Mandalay_Expressway_Myanmar

The team understood from the research we made through internet which came us to a conclusion that we will use kernel density analysis for finding accident prone area in the City of Calgary.

Stages and Achievements of the project

Stage 1

Data Acquisition

- We used data from Calgary open data base for our project. (https://data.calgary.ca/)
- We export traffic incident data from Calgary open database to csv file(https://data.calgary.ca/Transportation-Transit/Heat-map-Based-on-all-Traffic-Incidents/yj8z-ptzu)
- For making our project to simple we only consider the traffic incident between January 2017 to October 2019.
- We also used traffic camera location from Calgary open database for proposing new camera locations after analysis(https://www.calgary.ca/Transportation/Roads/Pages/Traffic/Advisories-closures-and-detours/Calgary-Traffic-Cameras.aspx).

After analysis we use GPS device for collecting GPS coordinate for proposing new camera locations.

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Stage 2

Geocoding

- We geocode traffic camera (122 camera) data from Calgary open data based.
- For that purpose, we use Calgary Roads (CALGIS_TRANSNET_CENTERLINE.shp) from module 8 Geocoding exercise.
- We create address locator using the Calgary Roads shape file.
  Steps

Creating Address Locator

1. Open **Arctoolbox** and expand Geocoding options and double click on the Create Address Tool.
2. Select **US Address – Dual Ranges** from the Select Address Locator Style.
3. Select the Calgary Roads (CALGIS_TRANSNET_CENTERLINE.shp) for the Reference Data
4. Set the **Role** to **Primary Table**
5. Change the Field Map like
   - Feature ID **FID**
   - From Left **LEFT_FROM_**
   - To LEFT **LEFT_TO_AD**
   - From Right **RIGHT_FROM**
   - To Right **RIGHT_TO_A**
   - Street Name **NAME**
   - Suffix Type **STREET_TYP**
   - Left City or Place **MUNICIPALI**
   - Right City or Place **MUNICIPALI**
6. Save the **Output Address Locator** as **Address_Locator**.
7. Leave others as default options.
8. Click OK.

Geocoding Address

1. We added the csv file of traffic camera which is exported from MSSQL using SQL SQL Server Management Studio to the ArcMap.
2. Activate Geocoding toolbar and open the Address Location Manager.
3. Click the **Manage Address Locators** option under the Select Address Locator section.
4. Click on Add and then select **Address_Locator** we created.
5. Click **Ok**
6. The matching fields with the geocode values were selected
7. We got **23** matching field, **84** 80% match field and **15** non-matching field.

8. We select the matching address using using Address table.
9. We done automated and interactive matching.
10. In some location our geocoded camera locations were entirely different from the actual location.
11. For that location we created edit session and moved our point to exact camera locations.

Stage 3

R Programming

The team has decided to use R for finding null values and below given is the code used for finding null values from csv file.

- #Getting the Working Directory#
  > getwd()
  [1] "C:/Users/826444/Documents"

- 2. #Setting Up the Working Directory#
  > setwd("H:/Project_data/Project CAR Data")
  > getwd()#Getting the Working Directory#
  [1] "H:/Project_data/Project CAR Data"

- #Reading the .csv file #
  > Camera <-read.csv ("H:/Project_data/Project CAR Data/Traffic_Camera_Locations.csv")

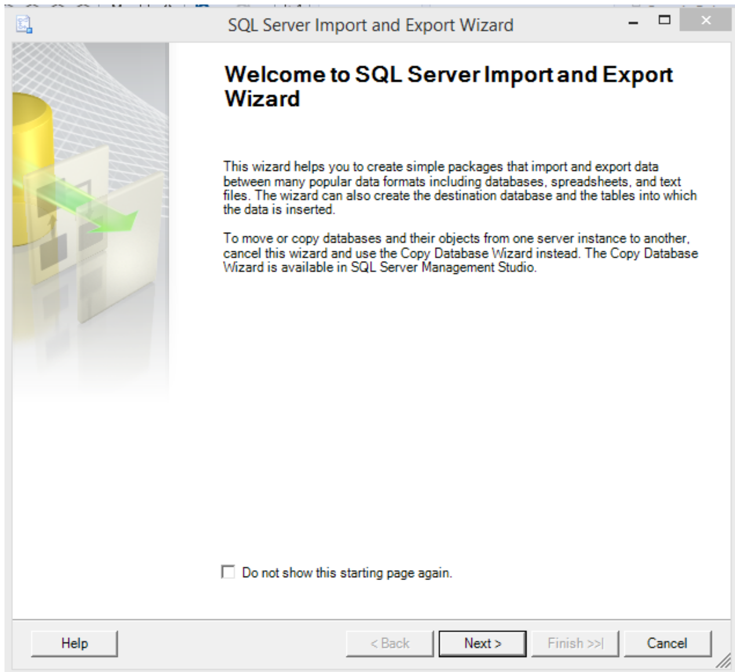
- #Printing the data#
  > Camera

- #Checking the number of null values / missing values in the Data frame#
  > colSums(is.na(Camera))
  0

Stage 4

Data Modelling

We use Microsoft SQL Server for creating tables in our project. We create a database named dbProjectCAR and imported csv file we got from Calgary open database. There were two csv file one for traffic incidents and other for traffic camera. Used 'Microsoft SQL server import and export wizard' for importing csv data to the MSSQL table. We created tblAccidents and tblCamera using the wizard.



There are many fields which is not necessary for our analysis, so we use SQL Alter query for dropping that fields. For making the field names in proper format we use SQL 'sp_RENAME' and for adding proper data type we used SQL 'Alter' query.

We created another table named tblSeasons for classifying seasons based on months and added ses_id as the primary key. For making relationship between tblSeasons and tblAccidents a new field named named 'season_id' is added in tblAccidents and make it as Foreign key. Using update query, the season id was inserted into the tblAccidents.

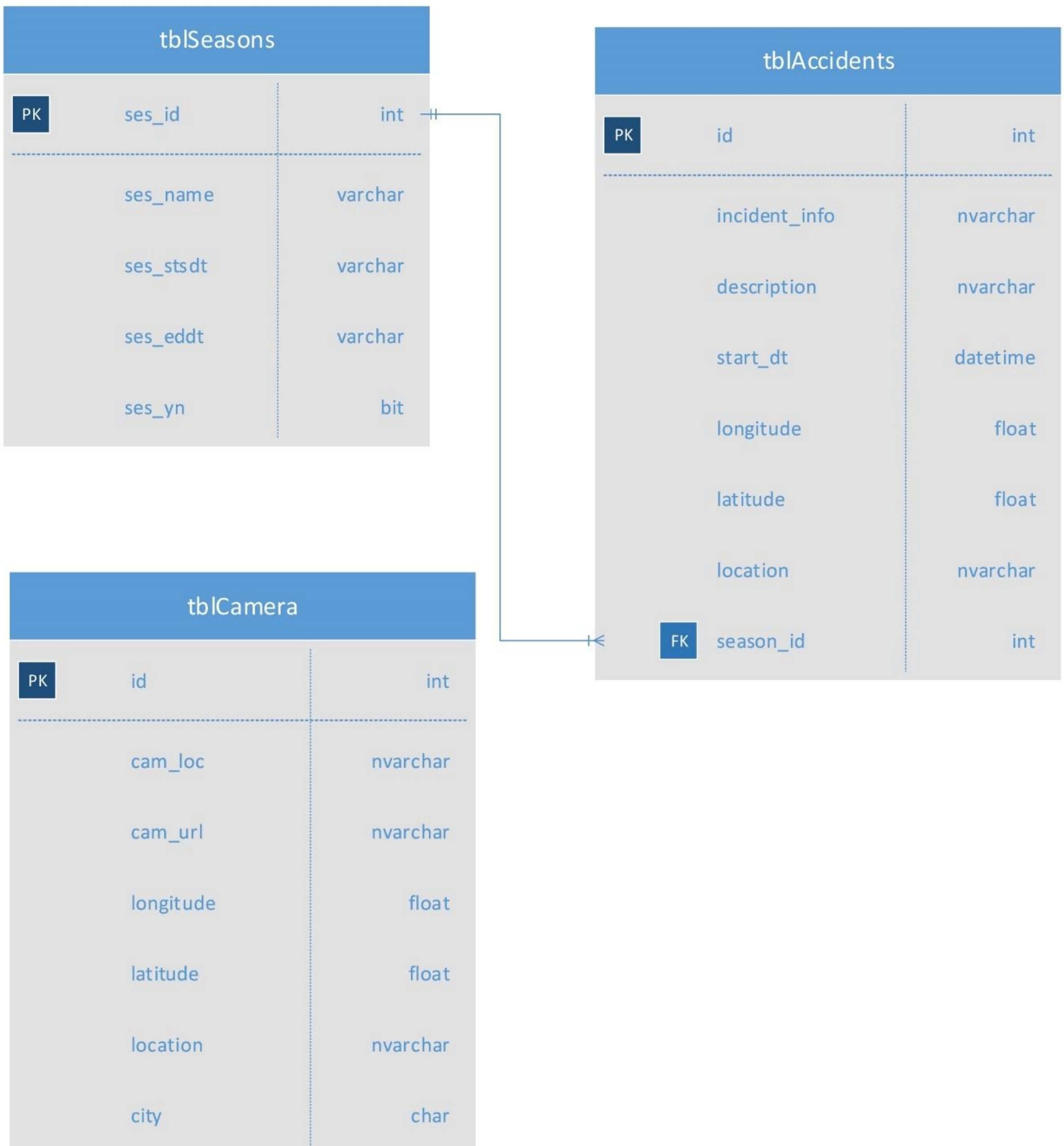
Connecting to ArcMap

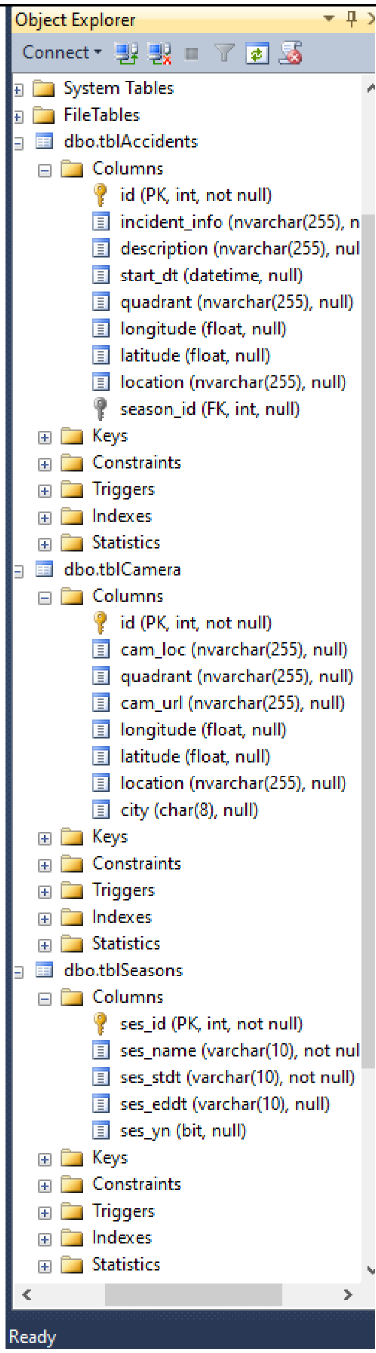
The ArcMap was connected our MSSQL database using 'Database connections tool' in ArcCatalog. In 'Database connections tool' tool we were able to connect with the database server name.

Stage 5

Entity Relationship Diagram (ERD) & MSSQL

The team has used Visio for designing ERD and the Visio project file is attached with the Project submission folder.



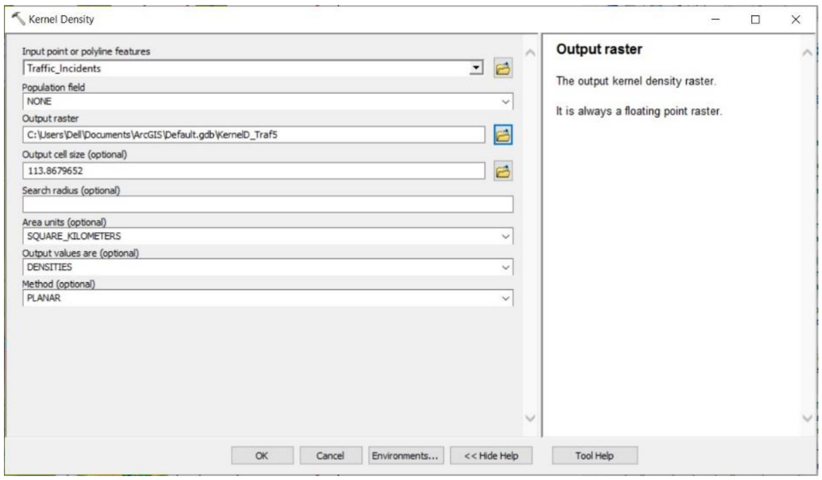


Based on the ERD the team has developed the database in MSSQL.

Stage 6

Kernel density Analysis

The kernel density tool in spatial analyst tool session of ArcMap helped the team to find the accident-prone areas in the City of Calgary. The team has made proper research on kernel density and agreed to do kernel density analysis in ArcMap.



"Kernel Density calculates the density of point features around each output raster cell.

Conceptually, a smoothly curved surface is fitted over each point. The surface value is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the Search radius distance from the point. Only a circular neighborhood is possible. The volume under the surface equals the Population field value for the point, or 1 if NONE is specified. The density at each output raster cell is calculated by adding the values of all the kernel surfaces where they overlay the raster cell center. The kernel function is based on the quartic kernel function described in Silverman (1986, p. 76, equation 4.5).

If a population field setting other than NONE is used, each item's value determines the number of times to count the point. For example, a value of 3 would cause the point to be counted as three points. The values can be integer or floating point.

By default, a unit is selected based on the linear unit of the projection definition of the input point feature data or as otherwise specified in the Output Coordinate System environment setting. If an area unit is selected, the calculated density for the cell is multiplied by the appropriate factor before it is written to the output raster.

For example, if the input units are meters, the output area units will default to square kilometers. Comparing a unit scale factor of meters to kilometers will result in the values being different by a multiplier of 1,000,000 (1,000 meters x 1,000 meters)." (ESRI, 2018)

Stage 7

GPS Data Capture

1. We Scheduled our collection for points of proposed camera after analyzing Kernel density.
2. Date of collection of GPS Points: **27 November 2019, 11 am**
3. Domains created in the ProjectCAR.gdb for Features – **Location type.**
4. Trimble device set up for the reference map and point data collection using Arcpad data manager.
   - Reference map included – **Boundary, Kernel Density, Installed_Traffic_Cam.**
   - For edit – **Proposed_Cam.**
5. Points were collected by the exact location which was found by geocoding.
6. Collected Data exported from Trimble to get the updated feature class in Arc Map.
7. By collecting points through the Trimble device, we pointed the new proposal camera by visiting same location in person.
8. Point collection on the exact location by GPS device reduces the Data inaccuracy.

right side found on many pages.

Select start of calculation:
Date: 27 November 2019
Time: 11 : 00 : 00 Now

Select duration: 3 Hours
Select interval: 30 Minutes
go!

Global Navigation Satellite System GNSS (GPS/GLONASS)

This tool can be used for assessing the constellation geometry of navigational satellites (U.S. GPS, Russian GLONASS and European Galileo). This is useful for planning good time windows for e.g., remote sensing flight campaigns, or terrestrial surveys. The orbital parameters for the currently operational GNSS satellites are updated daily. Remark: scheduled off-duty times of satellites are not accounted for.

Satellite Systems
Satellites available for navigation are marked by "X" or "|". The 4 satellites marked by "X" make up for the optimum constellation used for PDOP and TDOP calculation.
☑ Show list of GNSS satellites at the selected moment of time, rather than the quality chart. ☐ Hide satellite numbers
☑ US GPS ☐ Russian GLONASS ☐ European Galileo Minimum elevation of satellites: 25° ☐ Only at daylight
go!

```
Input Elevation Mask:   25°
Satellites in view:     6 (SV8 SV10 SV14 SV20 SV24 SV32 )
Optimum Constellation:  SV8 SV10 SV20 SV24
Solution Accuracy:      GDOP=4.21  PDOP=3.79  HDOP=2.35  VDOP=2.97  TDOP=1.84
```

Wednesday, 27 November 2019

Object (Link)	Event
Observer Site	Calgary, Canada WGS84: Lon: -113d51m21.60s Lat: +51d07m58.80s Alt: 1047m Geoid Alt: 1064m All times in MST or MDT (during summer)
PRN 32/GPS BIIF-(41328 2016-007-A)	Mag=13.8m Bootis az: 197.3° SSW h: 71.6° dist: 20523.5km ra: 14:24.2 de: +33:21 angular velocity: 0.61'/s
PRN 10/GPS BIIF-(41019 2015-062-A)	Mag=13.5m Herculis az: 84.7° E h: 65.8° dist: 20624.7km ra: 17:17.6 de: +47:13 angular velocity: 0.60'/s
PRN 14/GPS BIIR-(26605 2000-071-A)	Mag=14.2m Virginis az: 213.0° SSW h: 43.0° dist: 21992.5km ra: 13:15.0 de: +8:22 angular velocity: 0.57'/s
PRN 20/GPS BIIR-(26360 2000-025-A)	Mag=14.1m Herculis az: 100.5° E h: 35.0° dist: 22253.7km ra: 18:47.7 de: +20:39 angular velocity: 0.56'/s
PRN 08/GPS BIIF-(40730 2015-033-A)	Mag=13.3m Leonis az: 261.5° W h: 27.5° dist: 23135.3km ra: 10:26.3 de: +16:06 angular velocity: 0.57'/s
PRN 24/GPS BIIF-(38833 2012-053-A)	Mag=13.2m Cygni az: 54.0° NE h: 27.3° dist: 22848.0km ra: 21:27.3 de: +43:13 angular velocity: 0.59'/s

6 Items/Events: Export to Outlook/iCal Print

(Calsky, 2019)

Stage 8

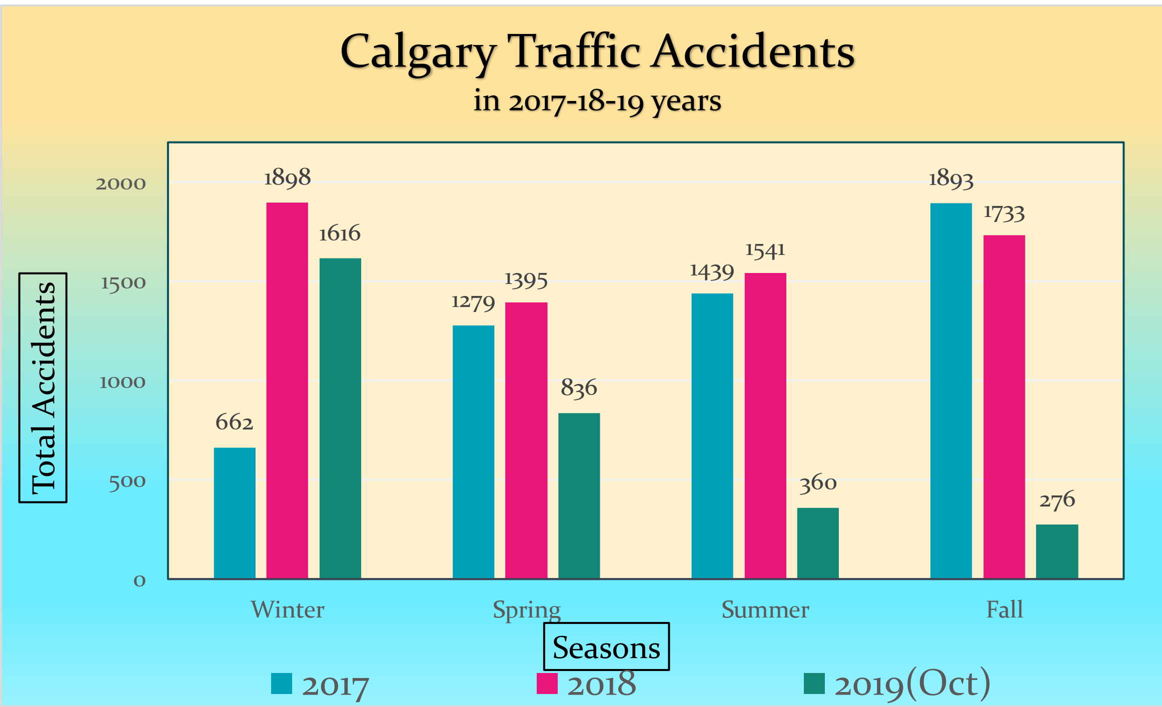
Digitizing

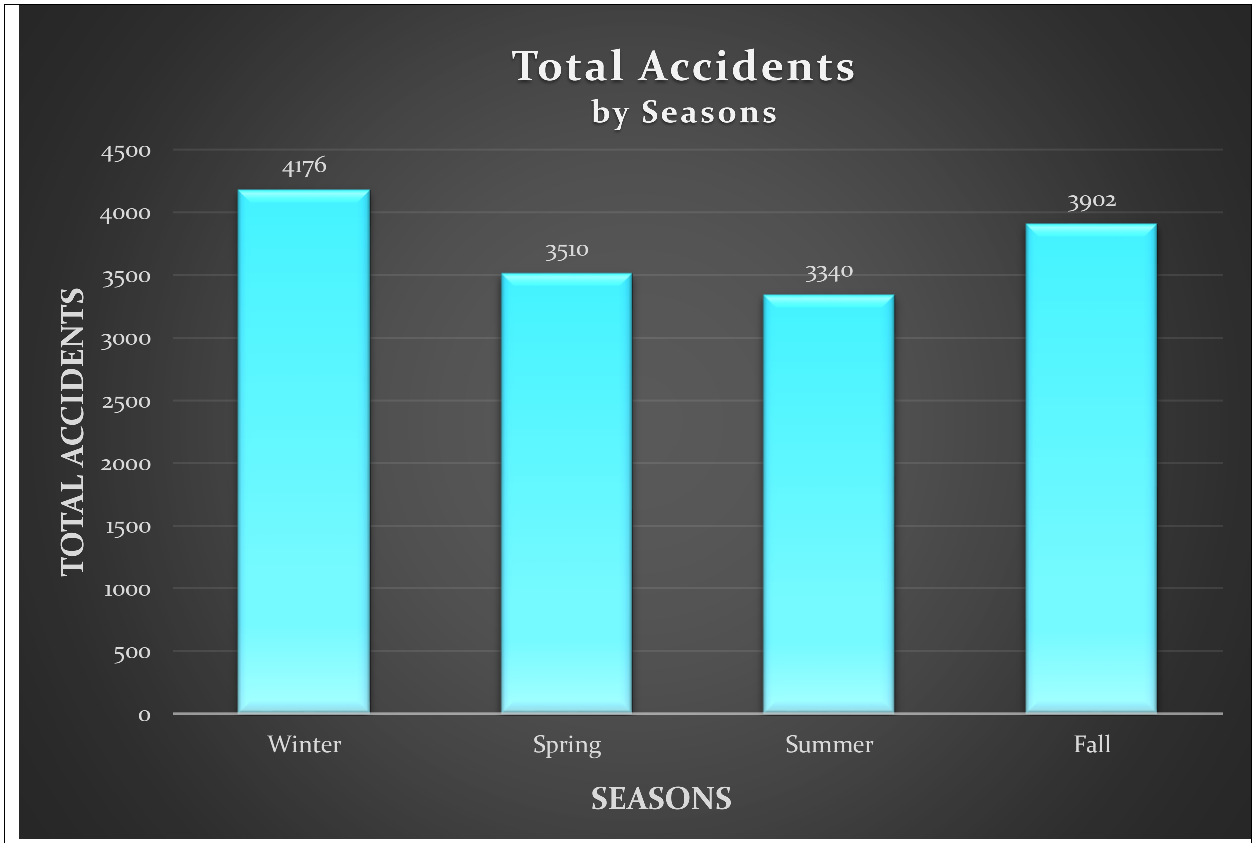
- Due to sudden change in weather condition and schedule time for GPS collection, we've digitized some of the points by digitizing.
- Arc Map used to digitize the point locations
- After importing collected data from Trimble, the other remaining points (approximately 3) were digitized as point feature class and domains were applied manually.
- Our project goal requirement is proposing the new camera locations to reduce the traffic collision.
- By digitizing the remaining points, we tried to reach to the goal of our project.

Stage 9

Data Analysis

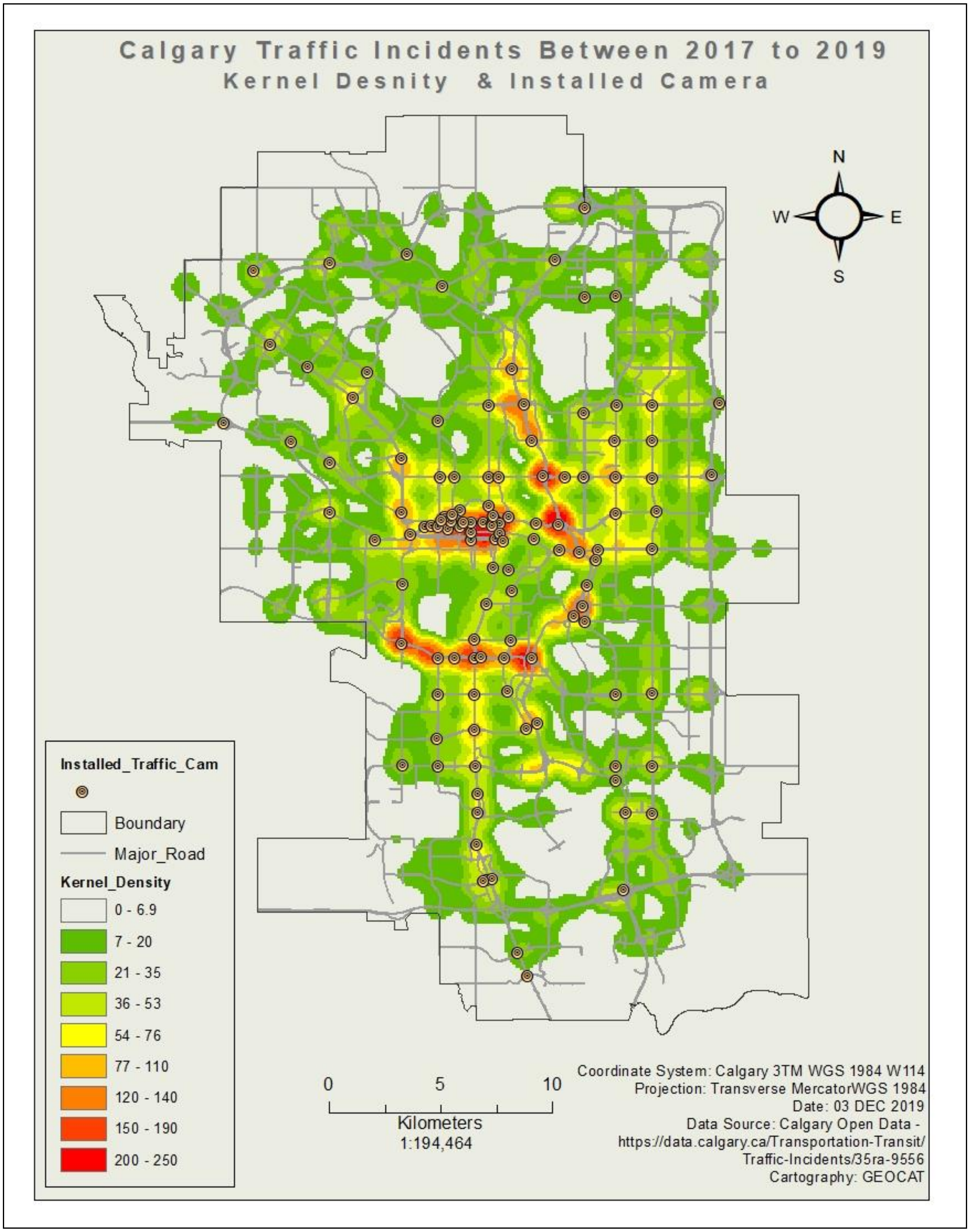
In this stage the team decided to do excel data analysis. The team created two charts which are listed below, and the finding is that in the winter season there are comparatively more accidents are happening and the team assume that severe weather is also contributing to traffic incidents in Calgary.



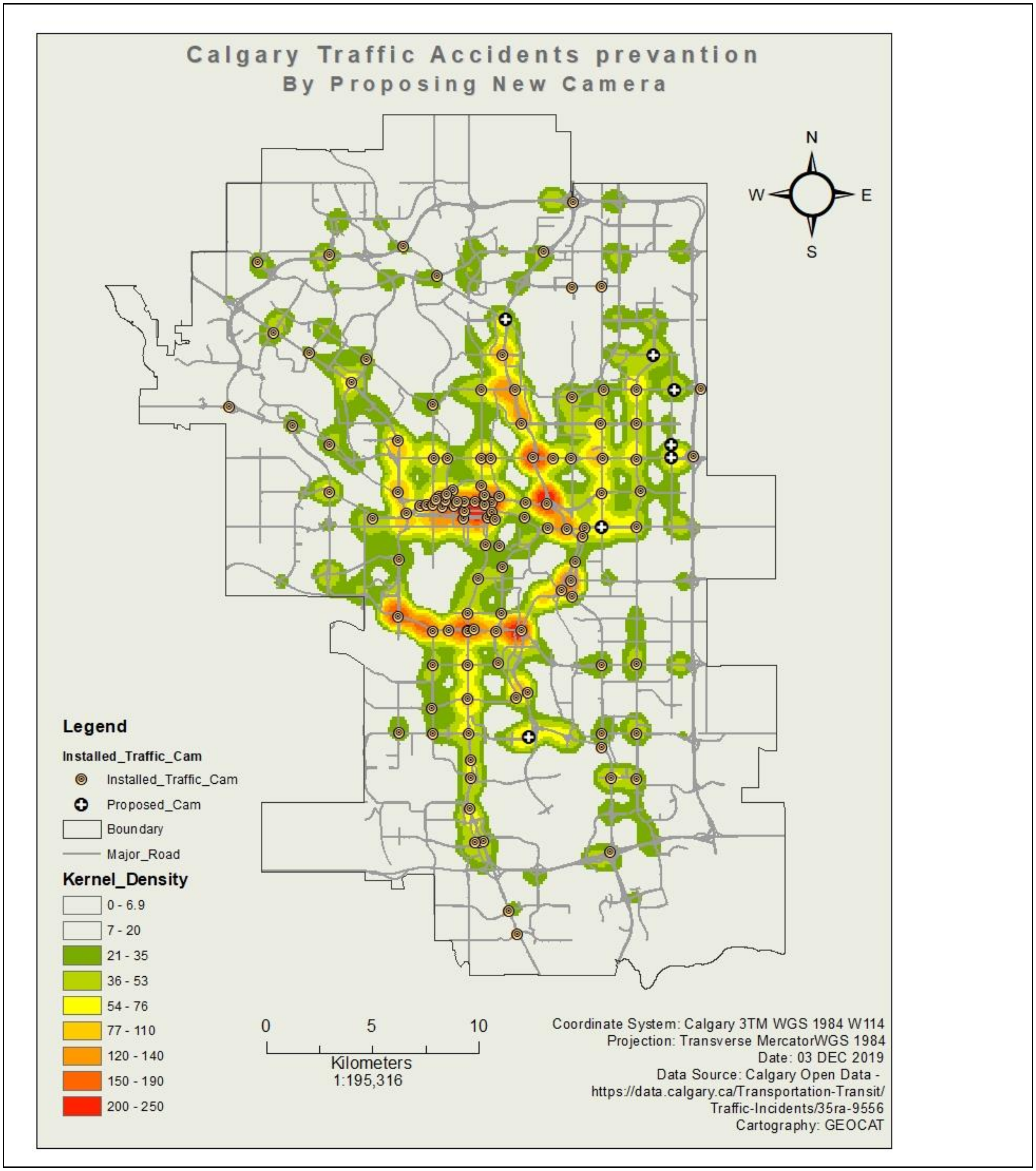

Total Accidents
by Seasons
TOTAL ACCIDENTS
4500
4000
3500
3000
2500
2000
1500
1000
500
0
4176
3510
3340
3902
Winter
Spring
Summer
Fall
SEASONS

Final Output and Findings

With the help of the Spatial Analyst tool Kernel density in ArcMap the team was able to find the accident-prone areas in the city of Calgary with the Traffic incidents.



In the next step the team was able to map the proposed camera locations with the help of GPS device and the final output for the project was the proposed traffic camera locations in the city of Calgary.



Locations of the Proposed Cameras

Capture Method	Location	X Coordinate	Y Coordinate
Using GPS device	68th Street ,16 Avenue North East Calgary	4570.7346	5659003.483
Using GPS device	68th Street, California Blvd North East Calgary	4554.2473	5659604.453
Using GPS device	McKnight Blvd, Nort East Calgary	4682.6981	5662199.010
Using GPS device	36 Street, 17 Avenue South East Calgary	1295.5115	5655758.177
Digitized	Falcon Ridge Blvd, 64 Ave North East Calgary	3710.7719	5663834.759
Digitized	Deerfoot Trail, Beddington North East Calgary	-3232.1078	5665522.032
Digitized	Bow bottom Trail South East, Deerfoot trail Calgary	-2143.0073	5645855.334

References

Application of GIS to Traffic Accident Analysis: Case Study of Naypyitaw-Mandalay Expressway. (2016). Retrieved from Researchgate: https://www.researchgate.net/publication/327404974_Application_of_GIS_to_Traffic_Accident_Analysis_Case_Study_of_Naypyitaw-Mandalay_Expressway_Myanmar

Calsky. (2019). Retrieved from https://www.calsky.com/cs.cgi/Satellites/12?

Development and application of traffic accident density estimation models using kernel density estimation. (2016, June). Retrieved from Science Direct: https://www.sciencedirect.com/science/article/pii/S2095756415305808

ESRI. (2018). *How Kernel Density works*. Retrieved from ESRI: https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/how-kernel-density-works.htm