Spatial Analysis of Road Traffic Accidents in Kandy Police Division in Sri Lanka

By

S.A.C. Prasad Subasinghe

M. Sc. Degree in GIS & Remote Sensing
28 MAY 2016
University of Sri Jayewardenepura, Sri Lanka.

Thesis Submitted to the Faculty of Graduate Studies University of Sri Jayewardenepura For the Partial Fulfillment of Master's of Science Degree in GIS and Remote Sensing on 20th March 2016

DECLARATION OF THE CANDIDATE

I do hereby declare that work described in this thesis was carried out by me under the supervision of Professor R.M.K.Ratnayake and Senior Lecturer Dr. Shirantha Heenkenda and report on this thesis has not been submitted in whole or in part to any University or any other institution for another Degree/Diploma.

Date 20/05/2016

....

S.A.C. Prasad Subasinghe

24 C, Dharmashoka Mawatha

Kandy

i

ACKNOWLADGEMENTS

Table of Content

Chapter Six - Conclusions and Recommendations

List of Tables

List of Figures

Spatial Analysis of Road Traffic Accidents in Kandy Police Division in Sri Lanka

S.A.C. Prasad Subasinghe

ABSTRACT

Road safety is a major issue of the modern world and Poor traffic management directly leads to an increase in traffic accidents. Knowing the hotspots in the road network may help to determination of accidents effectively. Geographic Information Systems (GIS) with spatial information collection capabilities with the visualization, and ability of the integration with Databases; GIS based applications can play a significant role to determine the Road Traffic Accidents instead of having clock charts and conventional hard mapping which doesn't illustrate the actual detailed situation. Moreover there is a hypothesis in general public that some factors are positively involving for traffic accidents such as Slope, weather, road surface, light condition etc., consequently there was a dire need to carry out a systematic analysis to find out if these parameters are actually involving for this phenomena. Selected the Kandy police area as the study area. Collected required data from government institutes and online. Research is clearly focused on two major aspects. Since the accident point data have their spatial location, author identified the importance of analyzing the 'Hotspots' of the accidents over the sample area. And subsequently the data includes accidents details in attributes author recognized the significance of finding the relationship of these factors to the phenomena as in-depth analysis. And also to find temporal relationship if may exist among the accidents.

Keywords: GIS, spatial analysis, Hotspots, IDW, KDE.

CHAPTER ONE
INTRODUCTION

1.1. INTRODUCTION

Road safety is a major issue of the modern world as the more roads are developed and millions of vehicles adding to the road network day by day. Poor traffic management directly leads to an increase in traffic accidents and the loss of thousands of lives each year. The traffic accidents are predictable and most accidents can be avoided by understand the issues and constrains and improving prevention.

The main important aspect in accident studies is locating the Hot Spots (Black spots-the most critical points) in a road network, And then in depth analysis would be carried out to find out whether the involving spatial parameters have an impact on these accidents, such as Slope, weather, road surface, light condition, whether the traffic control present, working day or a holiday, etc. has an impact or a relationship in Road Traffic Accidents, to examine whether the Driver's behavior such as Drink and drive has an impact of grievous Traffic accidents and Fatal Traffic accidents, and to find out whether the day of the week has an impact of Traffic accidents and Fatal Traffic accidents. Another aspect is the in-depth analysis is to find whether there are identifiable patterns for temporal fluctuations such as month of the year, day of the week. By doing these analysis will also be helpful to find out if these said parameters are involved to increase traffic accident in an area concerned.

These kind of analysis can be carried out in the conventional way by using manual clock charts and hard maps but as by experience decision makers have an understanding of how difficult to get an idea for a large scale of areas and accuracy of the out puts could not be appropriate.

But in the other hand Geographic Information Systems (GIS) has been using for analyzing accident data all around the world recently. with spatial information collection capabilities with the visualization, and ability of the integration with Databases; GIS based applications can play a significant role to determine the Road Traffic Accidents instead of having clock charts and conventional hard mapping which doesn't illustrate the

actual detailed situation of an area and GIS technology enables Spatial data recording, analyzing, modeling and visualization as well.

This study is mainly concerned on collecting pre-collected data of Traffic accidents in road network in Kandy Police area and conduct a thorough analysis regarding the grievous and fatal accidents happened during past few years by using the ArcGIS tool which is one of the most popular tool in in the field of GIS.

1.2. RESEARCH PROBLEM

Although the technology is developed over decades about road safety procedures and road condition is highly developed even in the rural areas, Drivers' and pedestrians' awareness regarding the matter is in high level due to continuous awareness programs done by the Police, other institutions and the Media etc., Law is enforced recently than the history and police is giving massive effort to enforce the Traffic law to motivate drivers to drive safely; but still it seem like unable to reduce the increasing Traffic Accidents in sufficient manner.

It appears Fatal and grievous accidents have been increased for past few years than in the history. Roads are highly developed even in rural area as mentioned before but there is a uncertainty of those developed roads are at least on required minimum standards. Poor engineering standards may cause continuous accidents in a road network. By determining accidents hotspots can be focus on the road if there are any engineering faults in the road network.

When focusing about traffic issue there are three main topics are concerned by experts. Those are Education, Engineering and the Law enforcement. Enforcing Law and educating public including drivers has been done by the police recently by their best for past few years and so on.

Moreover there is a hypothesis in general public as well as experts regarding the accidents that involving spatial parameters such as Slope, weather, road surface, light condition, whether the traffic control present, working day or a holiday, etc.; Driver's behavior such as Drink and drive; temporal fluctuations such as month of the year, day of the week have an impact on this phenomena.

Consequently there is a dire need to carry out a systematic analysis to find out if these parameters are actually involving for this phenomena.

1.3. SIGNIFICANCE OF THE STUDY

Road traffic accidents are a social and public health challenge, as they almost always result in injuries or fatalities. The World Health Organization estimates over 1 million people are killed each year in road collisions. This is equal to 2.1% of the annual global mortality and an estimated social cost of $518 billion. (Jing, 2012)

Road injuries occurred in about 54 million people in 2013. This resulted in 1.4 million deaths in 2013, up from 1.1 million deaths in 1990. About 68,000 of these occurred in children less than five years old. Almost all high-income countries have decreasing death rates, while the majority of low-income countries have increasing death rates due to traffic collisions. Middle-income countries have the highest rate with 20 deaths per 100,000 inhabitants, 80% of all road fatalities by only 52% of all vehicles. While the death rate in Africa is the highest (24.1 per 100,000 inhabitants), the lowest rate is to be found in Europe (Anon., 2013).

In Sri Lanka during the three decades of terrible war against terrorism; country has lost thousands of lives by protecting the country. But when analyze the accidents records in past few years it is revealed that more people are dying on roads for nothing, when comparing death count occurred by both phenomenon per a day as average than the war.

Even the Law enforcement agencies are trying their optimum capacity to minimize the deaths by traffic accidents by their vast experience but the lack of new technological analysis tools and the knowledge of these technologies seems the barrier to realize the phenomena.

To significantly reduce traffic fatalities and serious injuries on public roads, we need to review the characteristics of traffic accidents and identify the hidden patterns behind the accidents records, referring mainly to the actual knowledge contained in the collision data rather than the raw data records themselves. For example, road safety managers or

residents may be interested in the accident patterns near their communities and not the data records.

Previous traffic safety studies show that, in most cases, the occurrences of traffic accidents are seldom random in space and time, but form clusters that indicate accident concentration areas in geographic space. A concentration area is defined as an area or location where there is a higher likelihood for an accident to occur based on historical data and spatial dependency. Thus, if we can identify the locations with the high risk on the roads, road safety managers can analyze the reasons behind the fact; and, the public can be aware of the danger, so that they can drive more carefully on the dangerous road or avoid it altogether (Jing, 2012).

There are many researches have been carried out to identify the Accidents Hotspots and to minimize traffic deaths all over the world and can be found various methods used by the researchers.

Yonggang Wang, used the *Collision patterns* method. They have clearly showed that the occurrence of a traffic crash is the result of multiple contributory factors. By their research, they have shown that driver's behavior, geometrics and environmental conditions all contribute to the traffic crashes and collisions. Using the policy reported crash data over significant period, and checked how the factors (e.g. time, location, number of lane, with or without divided median, mean speed, diversion of speed, etc.) have influenced the crashes to provide necessary insight into understanding and coupling with the safety performance of the roadway network effectively. The findings indicate that driver's behavior is an important factor in the occurrence of crashes than do vehicle, environmental or geometric factors. (Yonggang, et al., 2013)

There are a wide range of approaches taken by researchers which are often limited to complex statistical modelling to identify accident hotspots. Only recently has GIS made a noticeable impact in road accident hotspot research and it brings with it a wide range of sophisticated spatial-statistical techniques to increase the accuracy and information of road accident hotspots. Road accident hotspots are often determined by a range of methods, however there is no universal method, which is why continuous comparison of

methods is vital if road accident hotspots are to be determined in the most successful way (Chainey & Ratcliffe, 2005).

As mentioned before there is a hypothesis in general public as well as experts regarding the accidents that involving spatial parameters, temporal fluctuations have an impact on this phenomena.

The significance of this study is Author questions if involving environmental and geographic factors have an impact on accidents in Kandy police area than the drivers' and pedestrians' attitudes and behaviors as *Younggang* and *Chunbo* reviled by their research

However as mentioned by *Chainey* and *Ratcliffe* that since there are no any universal method to identify the phenomena using a same model will not work for Kandy itself as all these involving factors may vary from area to area with the Geography, Climate, and Condition of the Road network, knowledge and the Attitudes of the general Public and availability of the data Etc.

And also as they mentioned usage of GIS for these kind of analysis, definitely enables the illustration of more significant outputs which are closer to the reality.

1.4. OBJECTIVES

Main Objective

To identify spatial pattern of road traffic fatal and grievous accidents, in Kandy Police area.

Specific Objectives

- To examine whether the slope of the roads has an effect on road traffic accidents.

- To examine the other spatial parameters has an impact or a relationship in road traffic accidents.

- To examine the impact of Driver's behavior for the grievous traffic accidents and fatal traffic accidents.

- To find out whether there are identifiable temporal patterns for traffic accidents and fatal traffic accidents.

CHAPTER TWO

THEORETICAL PERSPECTIVE OF GIS BASED SPATIAL ANALYSIS OF THE ROAD TRAFFIC ACCIDENTS

2.1 Introduction

A traffic collision, also known as a motor vehicle collision (MVC), traffic accident, motor vehicle accident, car accident, automobile accident, road traffic collision, road traffic accident, wreck, car crash, or car smash occurs when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree or utility pole. Traffic collisions may result in injury, death and property damage (Anon., 2013).

The main perspective of analyzing the spatial distribution of accidents is to find out the accident hotspots aka Black spots of an area based on determination of the possible accidents might occur in the future. Once identified the accident hotspots Law enforcements agencies and other respective agencies will be able to understand the failures of the system and mitigate the imminent catastrophes.

Identifying accident hotspots and appending value added data to understand the processes happening in these hotspots are important for the appropriate allocation of resources for safety improvements. By identifying road accident, a more robust understanding can be gained, with regards to indicators of casual effects (Anderson, 2009). In order to conduct a reliable analysis of the Road Traffic Accidents develop control strategies, it is required to investigate firstly how the accidents are geographically distributed, secondly regions where accident is observed more dense, and thirdly their geo-statistical aspects (Ozkan, et al., 2013). An improved understanding of the spatial patterns of Road Traffic Accidents can make accident reduction efforts more effective (Xie & Yan , 2008).

Geographic Information Systems (GIS) are an innovative and powerful tool that helps analysts and decision makers organize, visualize, analyze, present, and understand complex layers of data. The key to spatial analysis is that most data contain a geographic component that can be tied to a specific location, such as a state, county, zip code, Census