

PROXIMITY TO MEDICAL SERVICES: SPATIAL ANALYSIS OF FATAL ACCIDENTS, JAMAICA



Proximity to Medical Services: Spatial Analysis of Fatal Accidents, Jamaica

Transportation Study

Track: Transportation Safety

Authors:

Kenute Hare
Ministry of Transport and Works
Road Safety Unit
138H Maxfield Avenue
Kingston 10
Jamaica, West Indies
Phone: 1-876-
Email: khare@mtw.gov.jm

Shernette Sampson
Ministry of Transport and Works
Technical Services Unit
138H Maxfield Avenue
Kingston 10
Jamaica, West Indies
Phone: 1-876-754-1900-1
Email: ssampson@mtw.gov.jm

Kareen Graham
Ministry of Transport and Works
Technical Services Unit
138H Maxfield Avenue
Kingston 10
Jamaica, West Indies
Phone: 1-876-754-1900-1
Email: kgraham@mtw.gov.jm

Abstract

Although traffic accidents can be prevented, we live the reality of their frequent devastating occurrences. In 2006, the fatality rate in Jamaica was approximately 13.88 per 100,000 persons, which placed Jamaica in the Medium Level on the International Accident Radar. Research and Analysis of the accidents and factors that may influence the extent and severity of related injury is an important component in the identification of appropriate solutions. This study will assess, with the use of Geographic Information System, the spatial patterns of accidents in relation to the proximity of medical services from 2001- 2006, which may yield results that can be used to design targeted road safety measures, that may affect the survival rate of accident victims.

Key Words: *GIS, Fatal Accidents, Medical Services*

1.0 Introduction

A *road-traffic crash/accident* is an event involving a road vehicle that results in harm. Road-traffic accidents are one of the world's largest public health and injury prevention problems. The problem is all the more acute because the victims are overwhelmingly healthy prior to their accidents. According to the World Health Organization (WHO) more than a million people are killed on the world's roads each year ([Wikipedia](#), 2008). WHO has identified through studies in disability-adjusted life years that road accidents will be the third leading cause of death by 2020. (Cal et al, 2005, p.3184).

The problem of road safety transcends the transport sector. It is a health, social and economic problem as well. The health sector has to stretch its bed capacity in order to administer to traffic accident victims while still overseeing other important illnesses. Families are displaced and their futures shattered because of the sudden demise of their breadwinners, which is a social welfare problem (Cal et.al, 2005, p.3183). It is estimated that the Ministry of Health has expended over \$251 million Jamaican dollars in direct cost for treating motor vehicle accidents in 2006 alone.

In light of the overall issues pertaining to road traffic fatalities, the National Road Safety Policy and the National Transport Policy provides guidelines or measures in addressing these problems¹. Emphasis will be placed on the use of Geographic Information System to assess fatal accident locations in relation to medical services².

2.0 The Country

Jamaica is located in the Caribbean, South East of Florida. Kingston is the Capital City of Jamaica and is located to the South of the island. The country is approximately 234 kilometers in length and 80 kilometers in width and has a population of over 2.7 million people. The country has a mountainous terrain, with its highest peak of 7,402 feet (Wikipedia 2008)

2.1 Location Map



Source: www.worldatlas.com

1. "The National Road Safety Policy will be the basis on which the vision of a safe traffic environment, in accordance with internationally-accepted standards, is to be transformed into reality. There are five road safety performance indicators namely Education, Enforcement, Engineering, Emergency Response and Evaluation are classified as the five E's. For more information on the Policy, please visit the website <http://www.nationalroadsafetycouncil.org.jm/pressreleases/worldhealthday.htm>

² See Hospitals.

3.0 Methodology

3.1. Statistical

DESCRIPTIVE STATISTICAL VISUALISATION

Descriptive statistics were used to calculate fatal accidents in the software program, Micro-Computer Accident Analysis Package (MAAP). The analysis is represented in graphs and tables. Statistical Information was obtained from the Jamaica Constabulary Force (JCF), Police Traffic Headquarters.

3.2. Geographical Information System (GIS)

GIS ANALYSIS

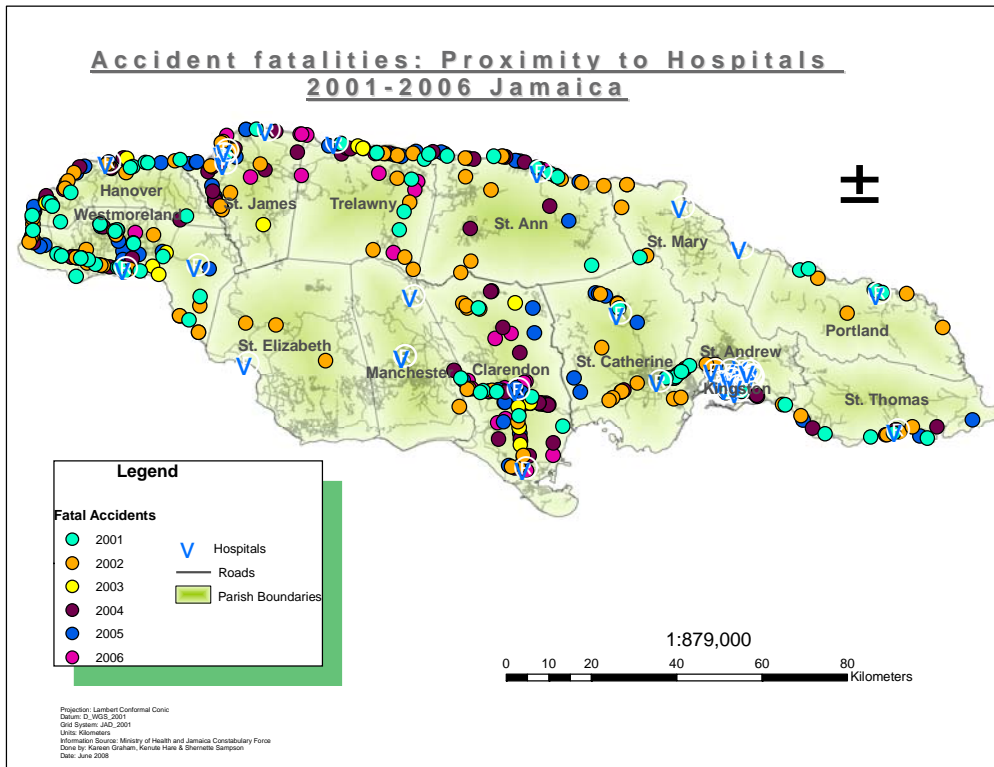
Traffic accident locations for the period 2001-2006 were collected with the use of Global Positioning System (GPS) in datum JAD_2001. GPS data was then transferred to Arc Map 9.2 and analyzed using Spatial Analyst Extension, and Geo- processing tools.

Topographic base map (1:50,000) of the island, Road and, Hospital data and GPS points on accidents were correlated to create the maps. Hospital information was supplied by the Ministry of Health.

3.3 Challenges

There were a number of challenges encountered while preparing this paper. These include but are not limited to the following:

- Data availability and collection of GPS points for the entire island; and
- Problems in data transfer



Map 1: Accident Fatalities: Proximity to Hospitals 2001-2006

4.1 Study Areas

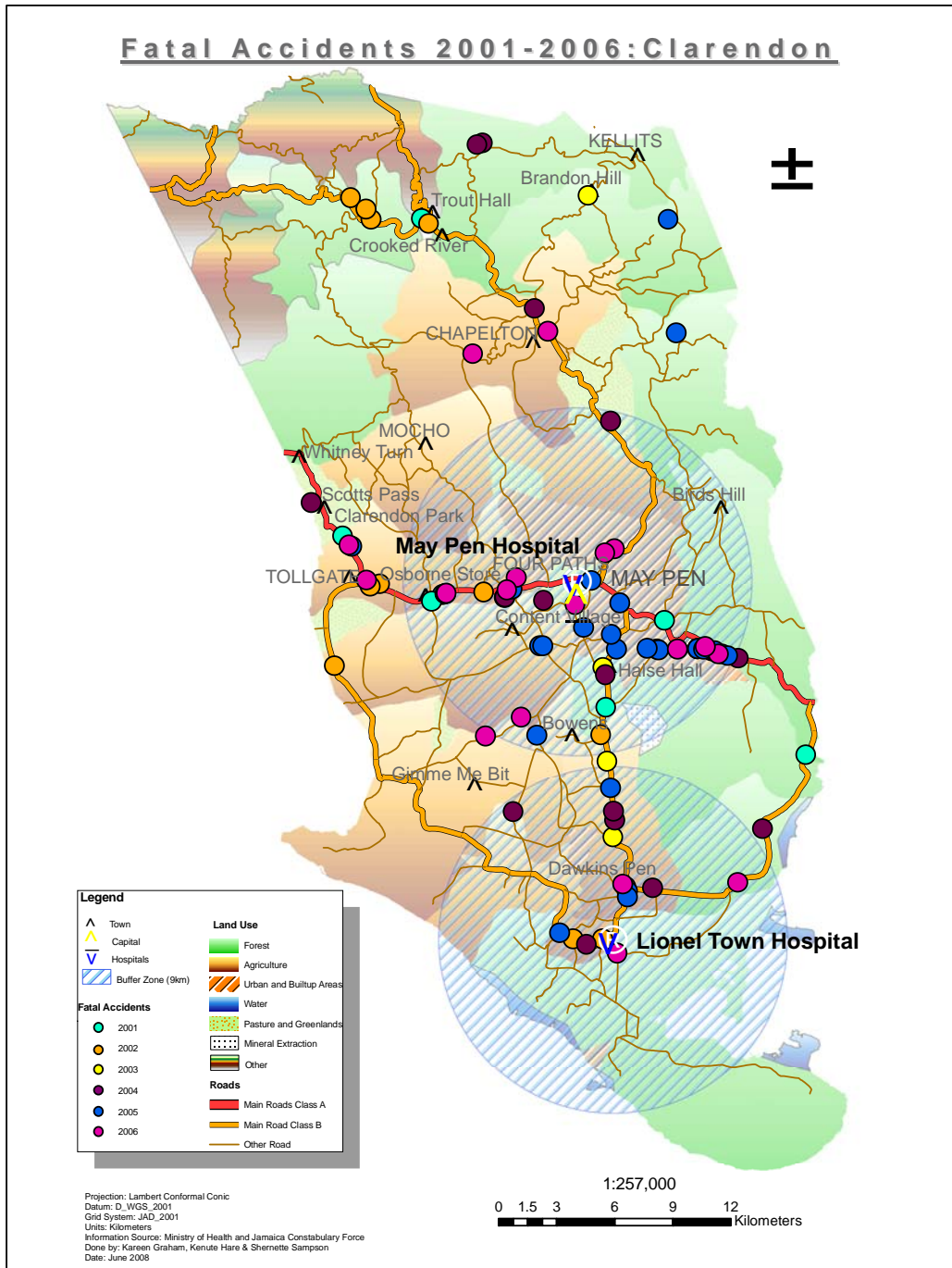
The Parishes of Clarendon and Westmoreland were selected case studies based on the prevalence of accidents occurring in these areas. The identified areas are located to the South and West of the island, respectively. It is noted that both areas experienced similar number of fatal accidents throughout the time period.

Clarendon has two (2) major hospitals which include: Lionel Town Hospital (Public- Type C)³ and May Pen Hospital (Public –Type C). A radius of 9 km was selected as the parameter to determine distance calculation of accidents within close proximity to medical services in Clarendon. This parameter was arbitrarily chosen in order to give a comprehensive picture of the situation.

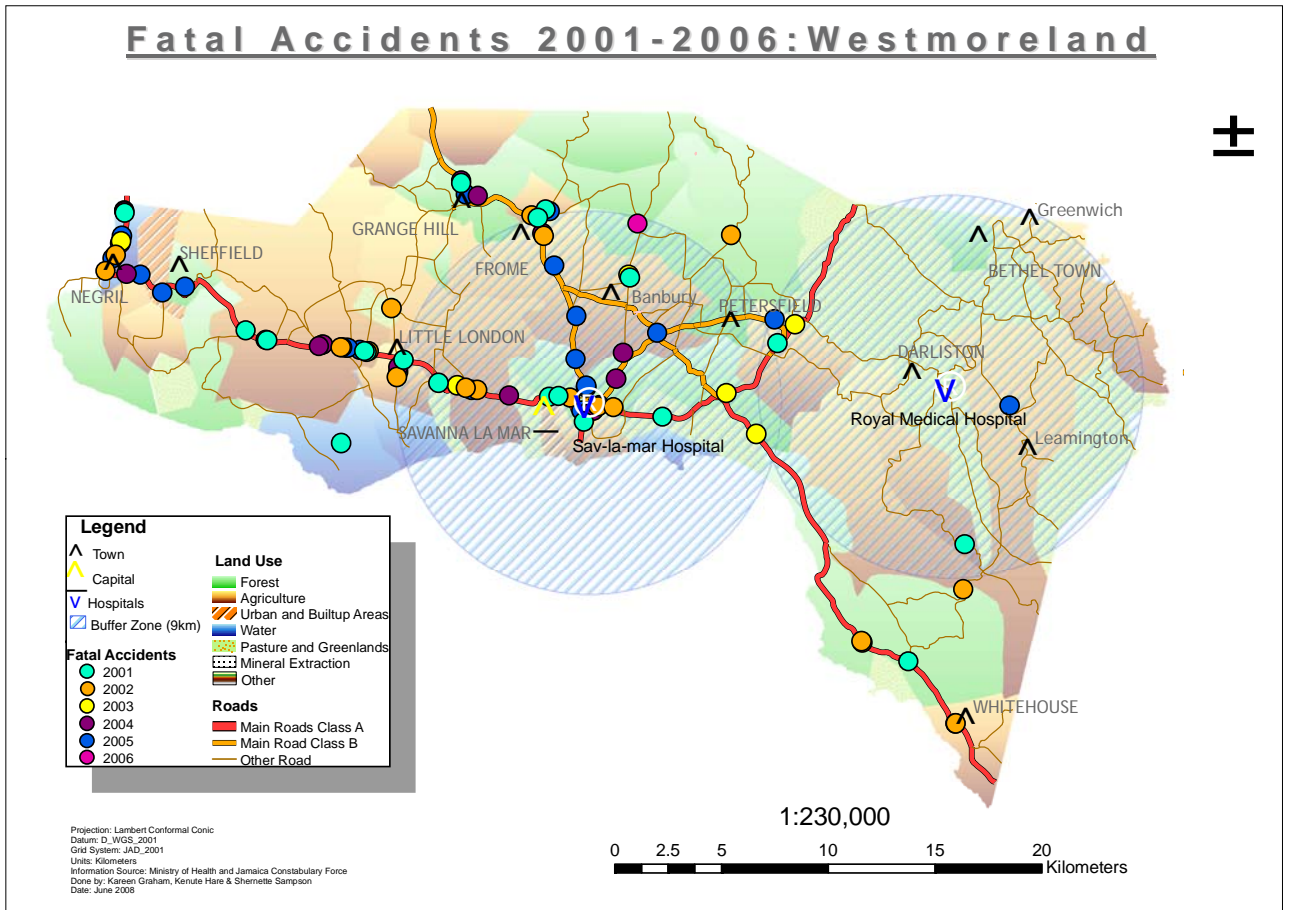
The second Parish, Westmoreland also has two hospitals namely the Savanna-la-Mar Hospital (Public- Type B) and the Royal Medical Hospital (Private). A similar parameter was defined for this parish.

³ See glossary

Map 2: Clarendon Fatal Accidents 2001-2006



Map 3: Westmoreland Fatal Accidents 2001-2006



4.2 Statistics on Study Areas

MAY PEN HOSPITAL AREA

Table 1. Traffic Accidents by Day of Week and Accident Type.

Day Of Week	Accident type						Total
	Bicycle accident	Head-on accident	Overtaking accident	Pedestrian accident	Single accident	Other accident	
Monday	0	2	0	2	2	1	7
Tuesday	1	1	0	3	1	0	6
Wednesday	0	0	0	3	2	0	5
Thursday	0	2	0	2	0	2	6
Friday	1	1	0	6	1	0	9
Saturday	0	1	1	4	1	0	7
Sunday	0	1	0	4	0	0	5
Total	2	8	1	24	7	3	45

20 % of the accidents that occurred in this area occurred on Fridays, while 16% occurred on Mondays. 53% of the accidents were pedestrian accident compared with 18% that were head-on accidents, single vehicle accident accounted for 16% of the accidents that occurred in this geographic area. The Sir Alexander Bustamante Highway accounted for

Table 2. Traffic Accidents by Road Name.

Road Name	Fatal accident
HAYES MAIN ROAD	1
CHATTEAU ROAD	1
COMFORT MAIN ROAD	1
CONTENT MAIN ROAD	2
COOKS GATE MAIN ROAD	1
DENBIGH KRAAL MAIN ROAD	1
FOUR PATHS MAIN ROAD	2
GRAVEL GROUND MAIN ROAD	1
HALSE HALL MAIN ROAD	3
ALUMINIUM WAY	1
HOWARD AVENUE	1
NEW ROAD	1
OSBOURNE STORE MAIN ROAD	4
RECTORY ROAD	2
SANDY BAY MAIN ROAD	5

SIR ALEXANDER BUSTAMANTE HIGHWAY	16
SWANSEA MAIN ROAD	1
TRENTON ROAD	1
Total	45

36% of the accidents that occurred in this area, while 11% occurred along the Sandy Bay Main Road. Speeding accounted for 31% of the reasons why these accidents occurred while 33% were due to pedestrian using the roadways improperly.

Improper overtaking contributed to 9% of these accidents, while the failure of motorists to keep to the nearside of the road, contributed also to 9% of the accidents in the geographical area. 57% of the accidents along the Sir Alexander Bustamante Highway were due to the fact that pedestrians were using the roadways improperly while 27% were due to the fact that motorist were engaged in improper speeding maneuvers. 11% of the accidents that occurred

Table 3. Traffic Accidents by Hit and Run Accidents.

Hit and run	Fatal accident
No	40
Yes	5
Total	45

in this geographic area were hit and run accidents. 60% of the hit and run accidents occurred along the Sir Alexander Bustamante Highway.

87% of these accidents occurred when the road surface was dry and asphalted, while 13% were wet and asphalted. 91% of these accidents occurred during fine weather, while 7% occurred when it was raining. 60% of the traffic accident that occurred in this geographic area took place during daylight while 27% occurred along straight roads while 16% occurred at corners.

Table 4. Traffic Accidents by Road Character and Light Conditions.

Light conditions	Road character			Total
	Straight road	Curve left 1st vehicle	Curve right 1st vehicle	
Daylight	24	3	0	27
Darkness	8	3	1	12
Dusk	3	0	0	3
Dawn	2	0	0	2
Night/Lit	1	0	0	1
Total	38	6	1	45

16% of accidents in Clarendon took place in the Lionel Town area. 67% of these accidents occurred in daylight, while 22% occurred in darkness. 83% of these accidents occurred along straight section of the roadway, while 17% occurred at corner.

Table 5. Traffic Accidents by Weather Condition and Road Surface.

Weather	Road surface		
	Wet + Asphalt	Dry + Asphalt	Total
Fine	3	38	41
Cloudy	0	1	1
Rain/Hail	3	0	3
Total	6	39	45

89% of these accidents took place during fine weather, while 11% were during cloudy weather. 89% of these accidents occurred when the road surface was dry and asphalted.

LIONEL TOWN HOSPITAL AREA

22% of these accidents occurred during the 8-10pm, while the 4-6pm time frames accounted for 17% of the fatal accidents.

39% of the crashed that occurred in this geographic area were bicycle accidents, while 17% were single vehicle accidents. 33% of the accidents occurred on Fridays while 22% were Sundays.

Table 6. Traffic Accidents by Day of Week and Accident Type.

Day of week	Accident type						Total
	Bicycle accident	Crossing accident	Head-on accident	Pedestrian accident	Rear end accident	Single accident	
Monday	2	0	0	0	0	0	2
Tuesday	0	0	0	0	0	1	1
Wednesday	0	1	0	1	0	0	2
Friday	4	0	0	2	0	0	6
Saturday	1	0	1	0	1	0	3
Sunday	0	0	2	0	0	2	4
Total	7	1	3	3	1	3	18

44% of the traffic accidents that occurred within the Lionel Town Hospital area were due to excessive speeding, while 11% of these accidents occurred due to the fact that motorists were engaged in improper overtaking manoeuvres. The improper usage of the roadway by pedestrians was a serious contribution factor that led to the fatal accidents that took place along this road section. 28% of these accidents were hit and run accidents and 60% of these

Table 7. Hit and Run Traffic Accidents by Accident Type.

Accident type	Hit and run
Bicycle accident	3
Crossing accident	1
Head-on accident	1
Total	5

hit and run accidents occurred along the Hayes main road. 60% of these hit and run

Table 8. Hit and Run Traffic Accidents by Street Name.

Street name	Hit and run
DACOSTA MAIN ROAD	1
HAYES MAIN ROAD	3
SALT RIVER MAIN ROAD	1
Total	5

accidents were bicycle accidents.

83% of the traffic accidents that occurred in this area occurred on the straight roads, while

SAVANNA-LA-MAR HOSPITAL AREA

19% of the traffic accidents that took place in this geographic area were due to the inappropriate usage of the roadway by pedestrians, while excessive speeding accounted for 16% of the traffic accidents that occurred in this area. 14% of these accidents were due to the fact that motorists lost control of their motor vehicles. Improper swerving manoeuvres, improper crossing manoeuvres, potholes, disobedience by motorists to traffic signs and

failure of motorists to keep their proper lane were the other contributing factors that lead to the occurrence of traffic accidents.

97% of the traffic accidents that occurred during fine weather, while 95% occurred when the road surface was dry and asphalted. 81% of these accidents took place along the straight section of the roadways, while 16% occurred at corners. 41% of these accidents took place during daylight, while 24% occurred in areas illuminated by streetlights. 40% of the accidents that occurred along the straight roads took place during daylight, while 27% occurred during darkness. Westmoreland is the parish that has been noted for its prevalence of bicycles. 27% of these accidents were bicycle accidents, while 24% were pedestrians' accidents. 19% of the accidents were single vehicle accidents, while 14% were head-on accidents which were concentrated on the Llandilo to Bay Road area.

Table 9. Traffic Accidents by Day of Week and Accident Type.

Day Of Week	Accident type							Total
	Bicycle accident	Head-on accident	Overtaking accident	Pedestrian accident	Rear end accident	Single accident	Other accident	
Monday	1	1	0	2	0	2	0	6
Tuesday	3	0	1	1	0	1	0	6
Wednesday	0	1	0	1	0	1	0	3
Thursday	1	0	0	0	0	0	0	1
Friday	3	1	0	2	0	1	2	9
Saturday	1	1	0	1	1	1	2	7
Sunday	1	1	0	2	0	1	0	5
Total	10	5	1	9	1	7	4	37

24% of the accidents occurred Fridays, while 19% occurred on Saturdays. 32% of these accidents took place on the weekends.

5.0 Results

During the period 2001-2006, there were a total of 1219 fatal accidents, with 1360 fatalities.⁴ 80% of the persons killed were males while 20% were females. A classification of the categories of road users and their gender is illustrated below.

Table 10: Fatalities by Category of Road User and Gender, 2001-2006

Category	Gender		
	Male	Female	Total
Driver	290	28	318
Pedestrian	295	107	402
Passenger	225	129	354
Conductor	2	1	3
Pedalcyclist	127	2	129
Motorcyclist	127	0	127
Pillion	19	8	27
Total	1085	275	1360

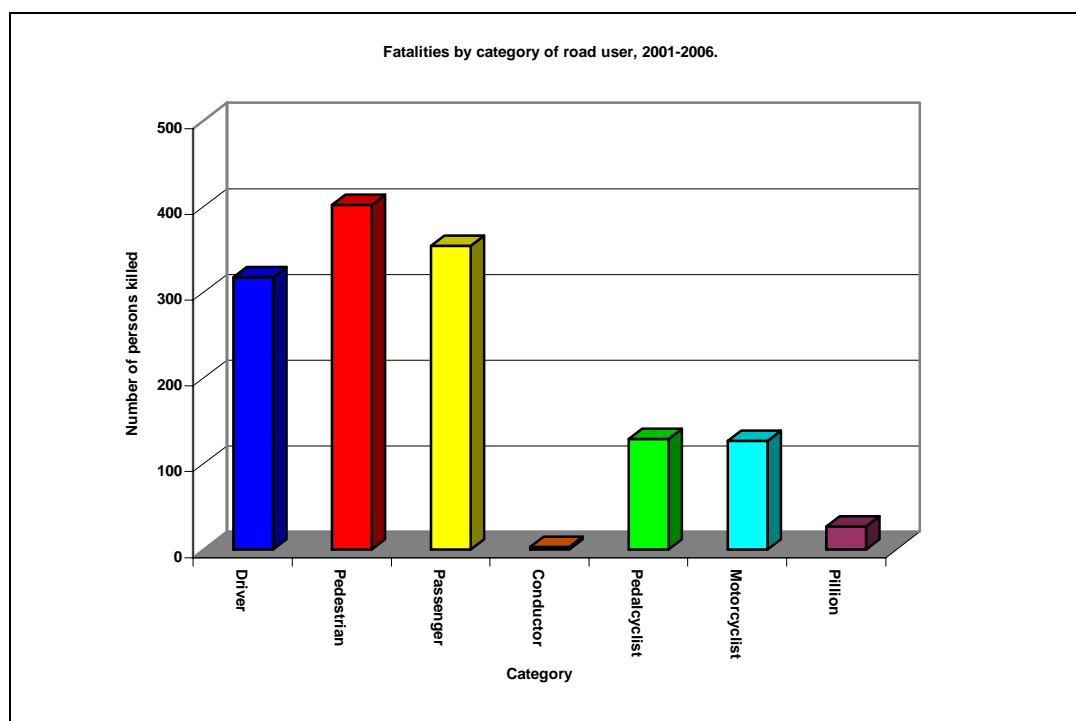


Figure 1: Fatalities by Category of Road User and Gender, 2001-2006

⁴ Fatal accidents refer to the number of accidents while fatalities refer to the total number of persons killed in each fatal accident.

Further analysis of the data revealed that pedestrians accounted for 30% of the road users killed. Twenty six (26%) of the road users fatalities were passengers in motor vehicles, while 23% were drivers.

Table 11: Fatal Accidents by Weather Condition and Road Surface, 2001-2006

Weather	Road surface					Total
	Wet + Asphalt	Dry + Asphalt	Oily + Asphalt	Wet + Unpaved	Dry +Unpaved	
Fine	33	1046	4	2	20	1105
Cloudy	23	18	0	0	0	41
Rain/Hail	63	0	0	2	0	65
Fog/Mist	2	8	0	0	0	10
Total	121	1072	4	4	20	1221

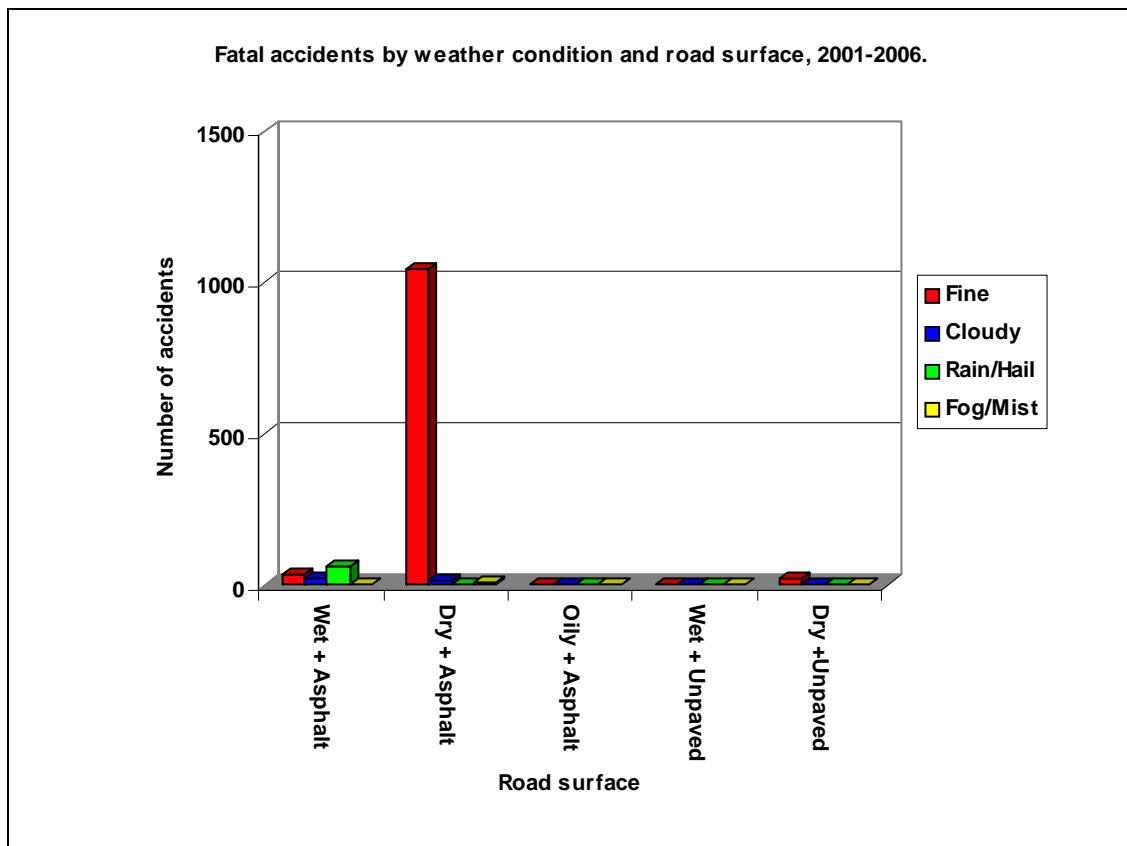


Figure 2: Fatal Accidents by Weather Condition and Road Surface, 2001-2006

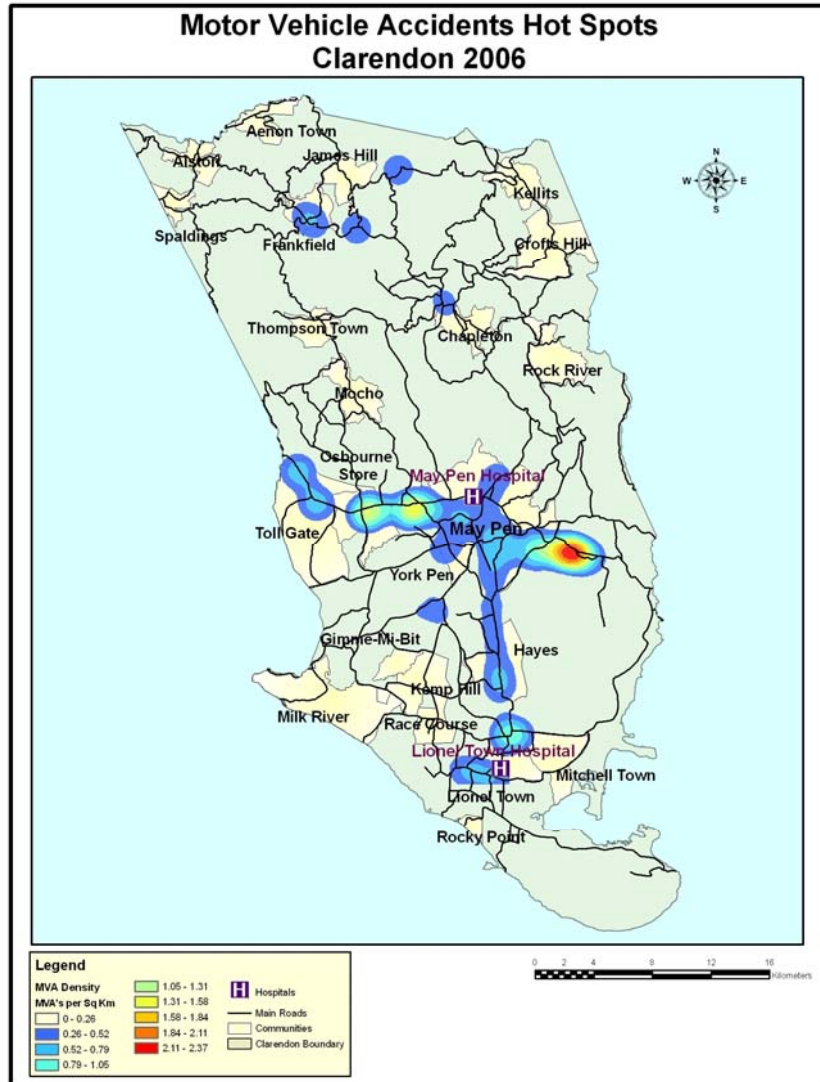
A total of 88% of fatal accidents occurred when the road surface was dry and asphalted while 10% occurred when the road surface was wet and asphalted.

Table 12: Main Causes of Fatal Accidents of the Study Areas

Main Causes of Fatal Accidents	Fatal accident
proceeding at excessive speed with no regard to conditions	28
failing to keep to the near side or to the proper traffic lane	7
overtaking improperly on off side	8
Reverse negligently	3
swerving	3
failing to stop to afford free passage of pedestrian	1
turning around on the road negligently	1
failing to comply with traffic signs or signals	2
pulling out from nearside without due care	1
inattention or diverted attention	2
misjudging clearance and/or distance speed	1
turning to the right without due care	1
crossing without due care at road junction	4
losing control	5
tailgating	2
moving off without taking proper precautions	1
apparent error of judgement /negligence	2
pedestrian error of judgement	24
other animal in the carriageway, inclusive bolting horses	1
pothole	2
other road surface condition	1
Total	100

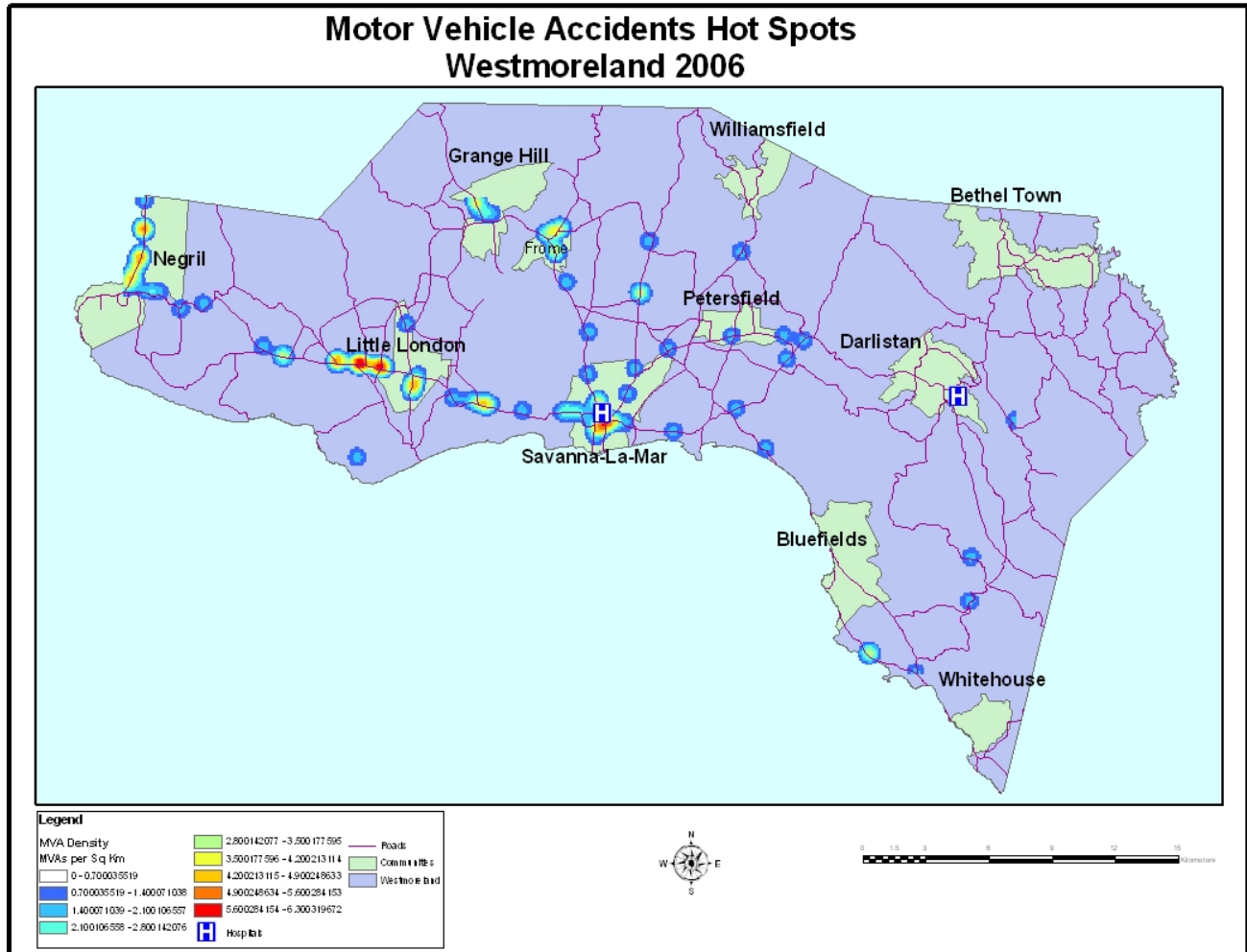
From the table above it is obvious that excessive speed and pedestrian error of judgment are the major factors related to fatal accidents. Other factors include motorists engaging in improper overtaking maneuvers and that proved perilous. The failure of motorists to keep to the proper traffic lane or the near side was among the many factors that contributed to fatal accidents within 9 km of the designated Hospitals.

Map 4: Clarendon: Motor Vehicle Accidents (MVA) Hot Spots 2006



Reference is made to **Map 4** – Main Roads such as, Sandy Bay, Osbourne Store and Sir Alexander Bustamante Highway have the highest density of traffic accidents in Clarendon.

Map 5: Westmoreland Motor Vehicle Accidents (MVA) Hot Spots 2006



Reference is made to **Map 4** – Main Roads such as, Norman Manley Boulevard, Bay Road-New Hope Main Road and Savanna-la-Mar Town Centre have the highest density of traffic accidents in Westmoreland.

6.0 Major Study Findings

The major findings are as follows:

- Most accidents occurred along the main roads;
- Pedestrians accounted for the highest number of persons killed;
- Urban and built-up areas were the major locations for the traffic accidents;
- Most of the fatalities occurred on dry and asphalted road during good weather;

- Fatal Accidents are mainly occurring within a 9km radius of the major Hospitals (39% and 58% of the accidents in Westmoreland and Clarendon respectively); and
- Excessive speeding and pedestrian error of judgment were the predominant factors contributing to fatal accidents.

Clarendon

- The data has revealed that 58% of the fatal accidents occurred within a 9km radius of the Hospitals.
- It is estimated that 40% of the persons died at the scene of the accident while it is inconclusive where the other 60% died.
- Both Hospitals are Type C which implies that they may not be equipped to deal with severe injuries as a result of traffic accidents.

Westmoreland

- In Westmoreland, 39% of the fatal accidents took place within 9km of the Savanna-la-Mar Public Hospital of which 30% died on the spot.
- Savanna-la-Mar Hospital is the only existing public Hospital in Westmoreland, which may suggest that the demand on the emergency services may be overwhelming.

6.1. Findings and Recommendation

Education

Based on data displayed in **Table 1**, most of the fatalities were pedestrians. Significantly, this brings to light numerous concerns. Pedestrians' error of judgment coupled with excessive speeding by motorists is a likely recipe for disaster.

Recommendations:

- Sustainable National Pedestrian Safety Campaign;
- Pedestrian Facility Needs Assessment Studies; and
- Improved Driver Training Techniques.

Engineering

Map 2, 3 and 4, illustrates that accidents are occurring along the main roads. This may be a result of a number of factors which includes inadequate road signage, overgrown vegetation and/or poor geo-metric engineering of roads.

Recommendations:

- Engineering Assessments; and
- Road Safety Audits.

Emergency Response

Most accidents occur within a radius of 9 km of the Hospitals. This is very daunting and may imply a few things. **Firstly**, a significant number of persons died at the scene of an accident. **Secondly**, the Emergency Response Teams may be unable to handle complex emergencies. **Finally**, Hospitals may not be equipped to deal with major emergencies.

Recommendations:

- Emergency Response to Traffic Accidents Studies; and
- Audits and upgrading of Hospitals.

7.0 Immediate measures that should be implemented

- Use of cats eye on all major road ways;
- Traffic Safety Plan for Fog Areas;
- Sustainable Public Education Programs;
- Good Samaritan Programs;
- Training of Community Persons in First Aid;
- Dedicated Emergency Vehicle Lanes.

7.0 References

1. CAL C. Primitivo, DE LEON Richmond Mark and SIGUA G Ricardo (2005). *Estimation of Socio-Economic Cost of Road Accidents in Metro Manila*. Retrieved June 24, 2008, from http://www.easts.info/on-line/journal_06/3183.pdf
2. Front Page Image, Retrieved June 10, 2008 www.googleimagesearch.com

3. Jamaica Constabulary Force Statistics.
4. National Road Safety Policy, March 2004,
<http://www.nationalroadsafetycouncil.org.jm/pressreleases/worldhealthday.htm>
5. Williams, Hank et al. (2004). *Mortality and Morbidity from Motor Vehicle Accidents in Jamaica*, Ministry of Health, Kingston.
6. Retrieved June 13, 2008, from http://en.wikipedia.org/wiki/Road_safety
7. National Transport Policy, October 2007. Retrieved June 13, 2008, from www.mhtww.gov.jm

8.0 Acknowledgements

We would like to thank Elsa-May Binns, Hector Burrowes, Barbara Cadogan, Julie Ann Campbell, Paul Clemetson, Martin Copping, Dr. Janine Dawkins, Kenny Edmond, Dr. Alwin Hales, , Kimonia Henry, Supt. Fred Hibbert, Cpl. Beverley Hill-Wright, Garfield Knight, Greg Palmer, Douglas Pennant, Ricardo Saunders, Denise Whyte-Bryan, Altius Williams, and Hank Williams.

Glossary

Bicycle accident	Accident involving bicycle and/or moped, except pedestrian.
Crossing accident	At junction, motor vehicles on different roads, turning or not turning.
Fatal accident	An accident which results in death.
Fatality	One resulting in the death of an injured person within 30 days of the accident and as a direct result of the accident.
Head-on accident	Motor vehicles on the same road in the opposite directions, no turning.
Hospital	An institution for health care providing treatment by specialised staff and equipment, and often but not always providing for longer-term patient stays.

Killed	killed in a traffic accident means, (for the purpose of uniform international statistics) that the person has died within 30 days after the accident has happened as a direct result of injuries received in the accident.
Motor vehicle	Any power-driven vehicle which is normally used for carrying persons or goods by road or one that is drawn on the road; vehicles used for the carriage of persons or goods.
Pedestrian accident	Accident involving pedestrian and/or handcart.
Road traffic accident	Is an event, which has occurred in traffic on a road, involving at least one vehicle in motion and has caused injury and/or property damage.
Road	The entire surface of any way or street open to public traffic.
Road user	Anyone traveling or staying on a road or in a vehicle on a road.
Other accident	Collision with train, animal or animal-drawn vehicle, other vehicle like tractor, parked vehicle, when reversing, turning around, entering or moving off the road or when due data are missing.
Overtaking accident	Motor vehicles on the same road when overtaking and traveling in the same direction.
Rear end accident	Motor vehicles on the same road in the same direction, no turning or overtaking.
Single vehicle accident	Accident with only one moving vehicle, with the exception of pedestrian and bicycle and accidents with parked vehicles.
Turning accident	At junction, motor vehicles on the same road, in opposite direction, when turning, intended or carried out.
Type C Hospital	Basic district hospital. In-patient and out-patient services are provided in general medicine, surgery, child and maternity care. Basic x-ray and laboratory services are usually available.

Type B Hospital	These hospitals are situated in the larger urban centers. They provide in-patient and out-patient services in the four basic specialties; general surgery, internal medicine, obstetrics and gynecology and pediatrics.
Type A Hospital	These Hospitals are multi-disciplinary. They are the final referral points for secondary and tertiary services. The Kingston Public Hospital and the Cornwall Regional Hospital are examples of such institutions.
Vehicle	Any conveyance or structure which is designed to be propelled or drawn on land and is not rail borne.