Identification and Ranking of High Pedestrian Crash Zones Using GIS

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Abstract

Identification of high pedestrian crash zones to enhance pedestrian safety is important to develop and implement strategies to enhance safety. Unlike analysis of motor vehicle related crashes limited research has been done on identifying high pedestrian crash zones. Studies in recent years have focused on the application of Geographic Information Systems (GIS) in safety analysis as they have immense potential to evaluate crash characteristics. This paper documents the development of a systematic methodology to identify high pedestrian crash zones, prioritize these zones, and the development of a customized GIS based tool to assist in this process. The process identifies spatial concentration patterns and high pedestrian crash zones, uses the crash characteristics and population details of selected zones, and computes crash rates. The tool utilizes crash data recorded by law enforcement personnel, and street network characteristics.

Introduction

Between the years 1999 and 2003, over 24,000 pedestrians were killed in the United States because of motor vehicle related crashes (NHTSA, 2003). On average, a pedestrian is killed in a traffic crash every 109 minutes. These data shows the importance of analyzing pedestrian crashes

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to improve safety. Identification of pedestrian high crash zones is an important first step of any pedestrian safety improvement program. High crash zones identify the locations that have posed high risks for pedestrians. Several analytical techniques and tools are available to identify high crash zones. However, studies in recent years have focused on the application of GIS in safety analysis, which can influence the four E's of traffic safety: engineering, enforcement, education, and emergency response (PBIC, 2003). The objectives of this paper are to introduce a GIS based tool to identify pedestrian high crash zones and to prioritize them, and also to illustrate its application using data from the Las Vegas metropolitan area.

Data Requirements

Pedestrian crash data, street network data, and population data (in GIS formats) are the three basic sets of data required for the pedestrian safety analysis presented herein. The street network and population data in GIS format for the most of the urban areas in the U.S. can be obtained from the U.S. Census Bureau website. However, the most common sources of pedestrian crash data are the crash reports filed by the local law enforcement agencies, and the state department of transportation or traffic safety.

Pedestrian Crash Density

Figure 1 shows the spatial distribution of pedestrian crashes in the Las Vegas metropolitan area. It is very difficult to identify locations that have multiple crashes using this figure, since the presence of a dot does not necessarily equal one crash. Several crashes may have occurred at a point. A solution for this problem is crash density maps. Density maps help to identify locations that have higher crash concentrations. This application uses a kernel method to calculate density. Figure 2 shows the resultant density map for the Las Vegas Metropolitan area with the five-crash concentration levels (Very low, Low, Medium, High, and Very high).

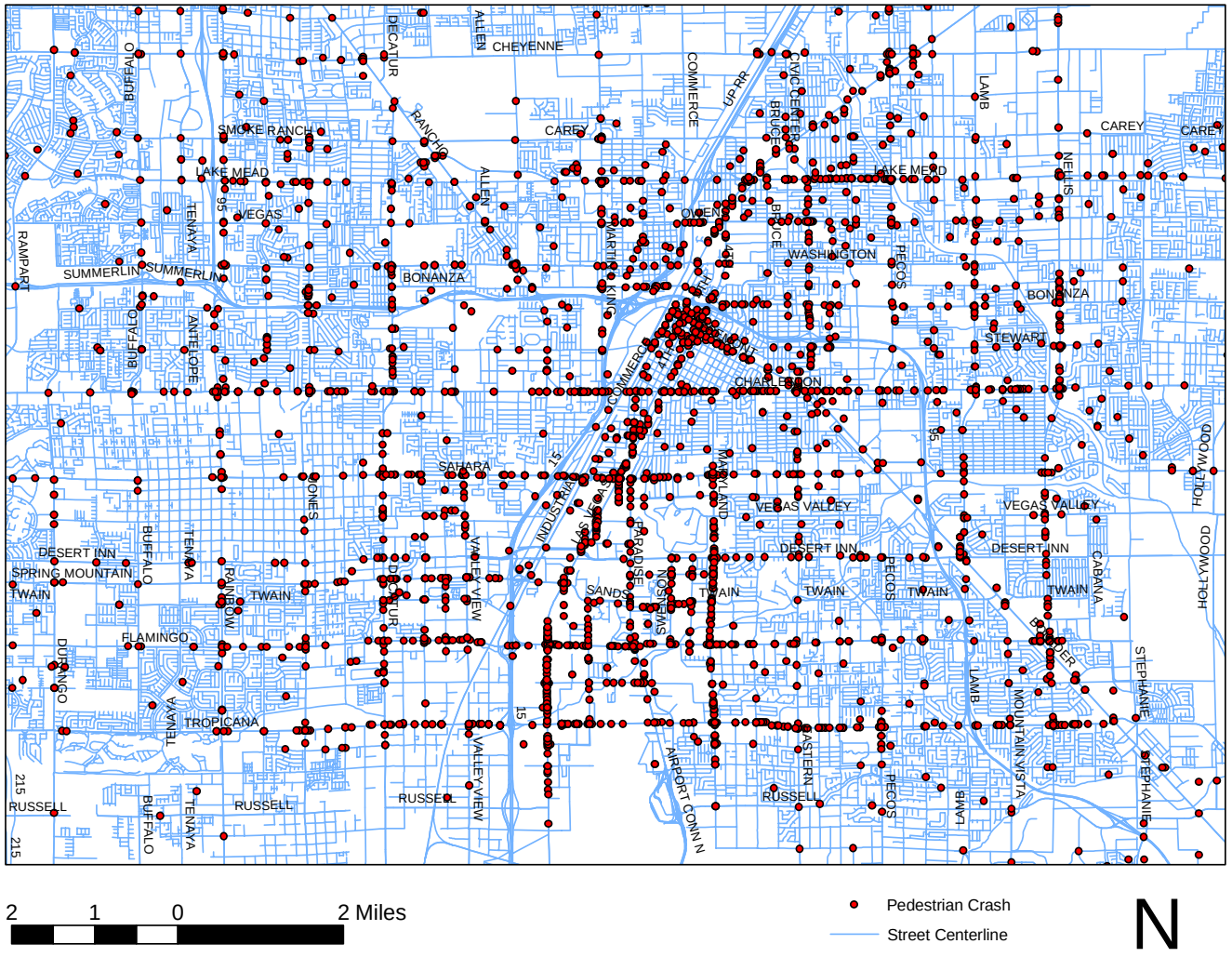

Figure 1-Pedestrian Crashes in the Las Vegas Metropolitan Area

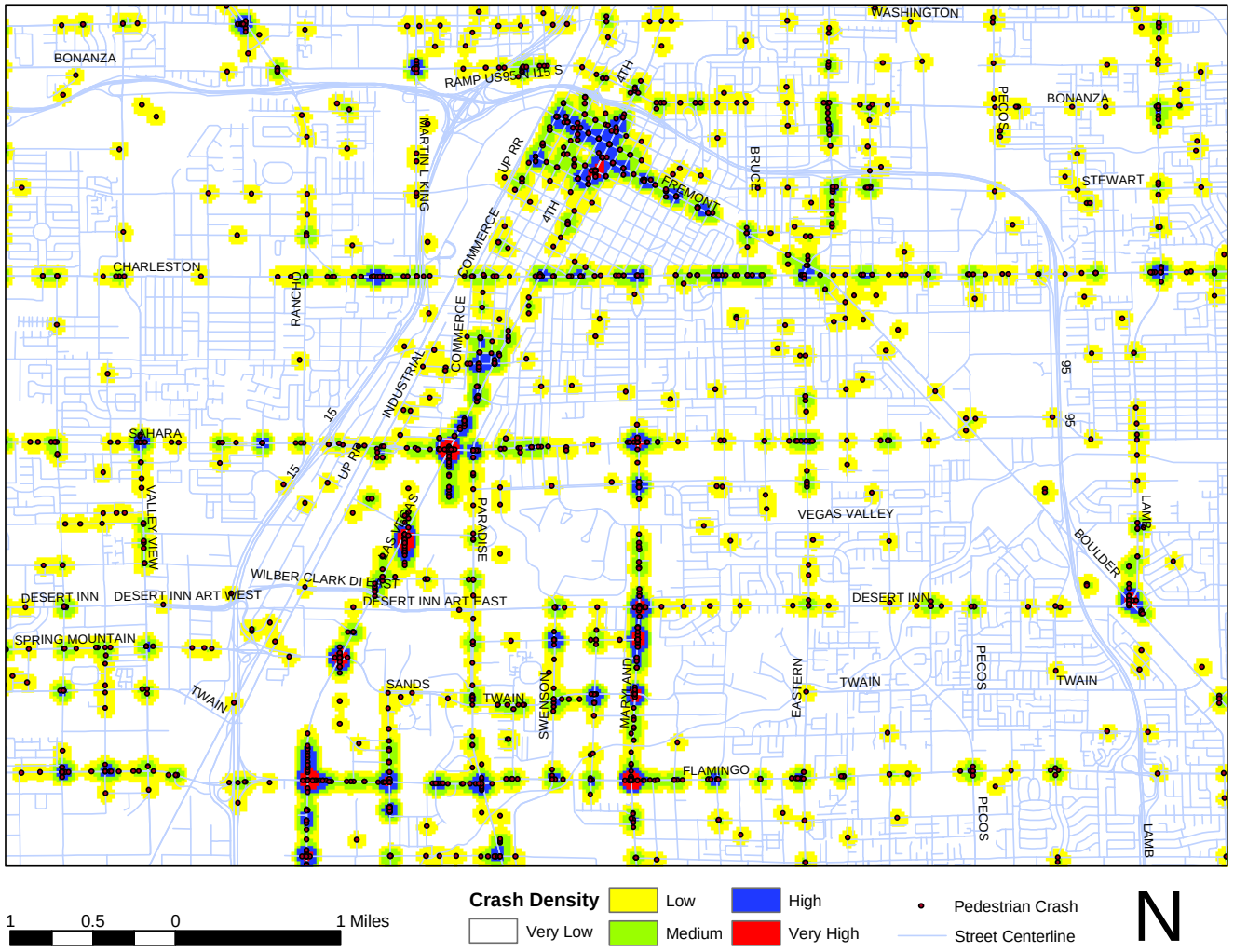

Figure 2-Pedestrian Crash Densities in the Las Vegas Metropolitan Area

Pedestrian High Crash Zones

The next step is to identify pedestrian high crash zones based on the density maps. Zones could be linear or circular in shape (NHTSA, 1998). Linear zones are appropriate if the crash density pattern is along a corridor. Circular zones are suitable if the crash density pattern is circular in nature. Capabilities afforded in the GIS environment are used to preview and create a linear or circular zone in a GIS format (Figure 3 and 4). Figure 5 shows the pedestrian high crash zones identified in the central part of the Las Vegas metropolitan area.

Prioritizing High Crash Zones

After identifying high crash zones, the next step is to prioritize or rank these high crash zones. High crash zones with higher ranks generally warrant greater attention in the safety enhancement programs. Three methods generally used to rank high pedestrian crash zones are Crash Density Method, Crash Rate Method, and Crash Score Method (Pulugurtha and Nambisan, 2002a,b; Krishnakumar, 2004; Pulugurtha, Nambisan and Uddaraju, 2005). Ranking of high crash zones based on the severity of the crashes and the area of high crash zone is called Crash Concentration Method. Ranking of high crash zones based on the severity of crashes and population in the vicinity of the high crash zones by giving different weights to different age group of people is called Crash Rate Method. The Crash Score Method is based on normalizing the values to the same scale so as to obtain a score for each method (Pulugurtha, Nambisan and Uddaraju, 2005). Such a normalizing procedure is used to address the challenge of combining disparate components. The individual scores for each component are normalized using a 0 to 100 scale and then summed to estimate the crash score for the zone.

The GIS-based tool developed extracts the necessary crash and population data of the high crash zones to compute the crash density and crash rates. After extracting the crash and population details, the tool computes crash concentrations and crash rates of the selected high crash zones, ranks the zones using the crash score method, and summarizes these data in a tabular format. Tables 1 and 2 illustrate the output obtained from the ranking process.

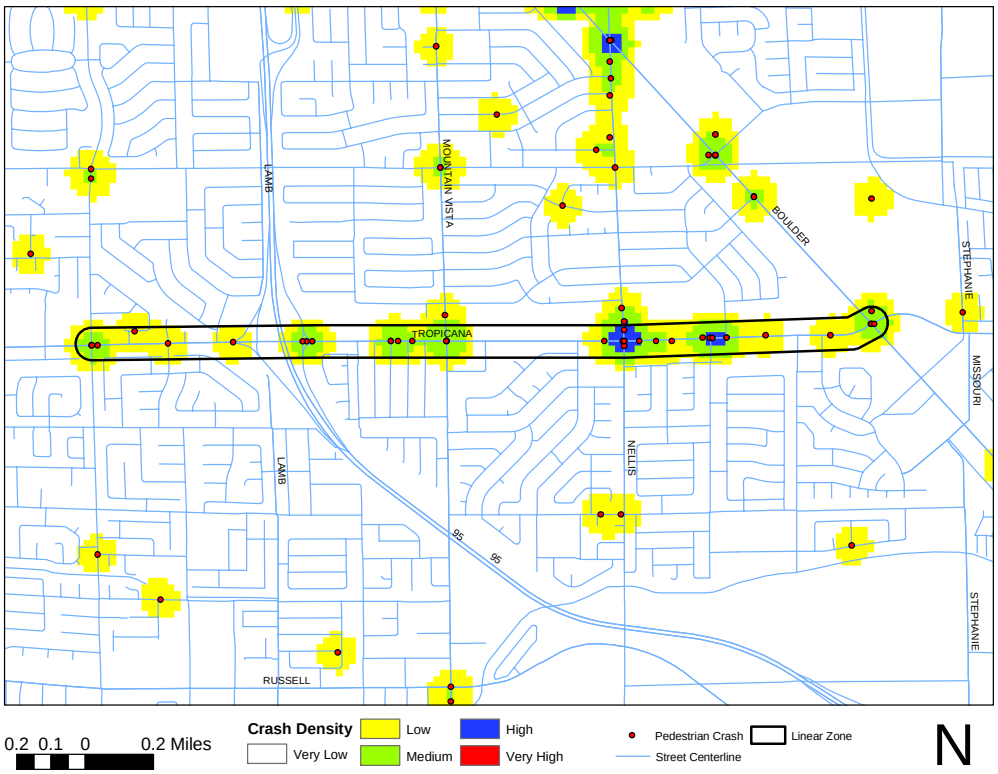

Figure 3-Identifying Linear High Crash Zones

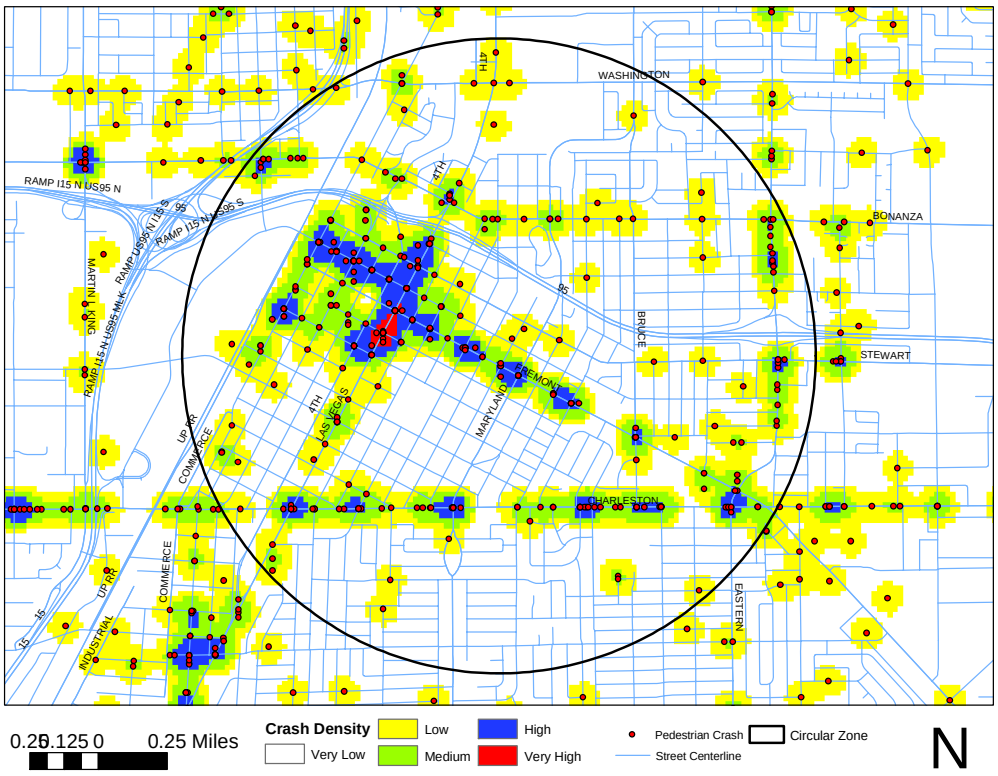

Figure 4-Identifying Circular High Crash Zones

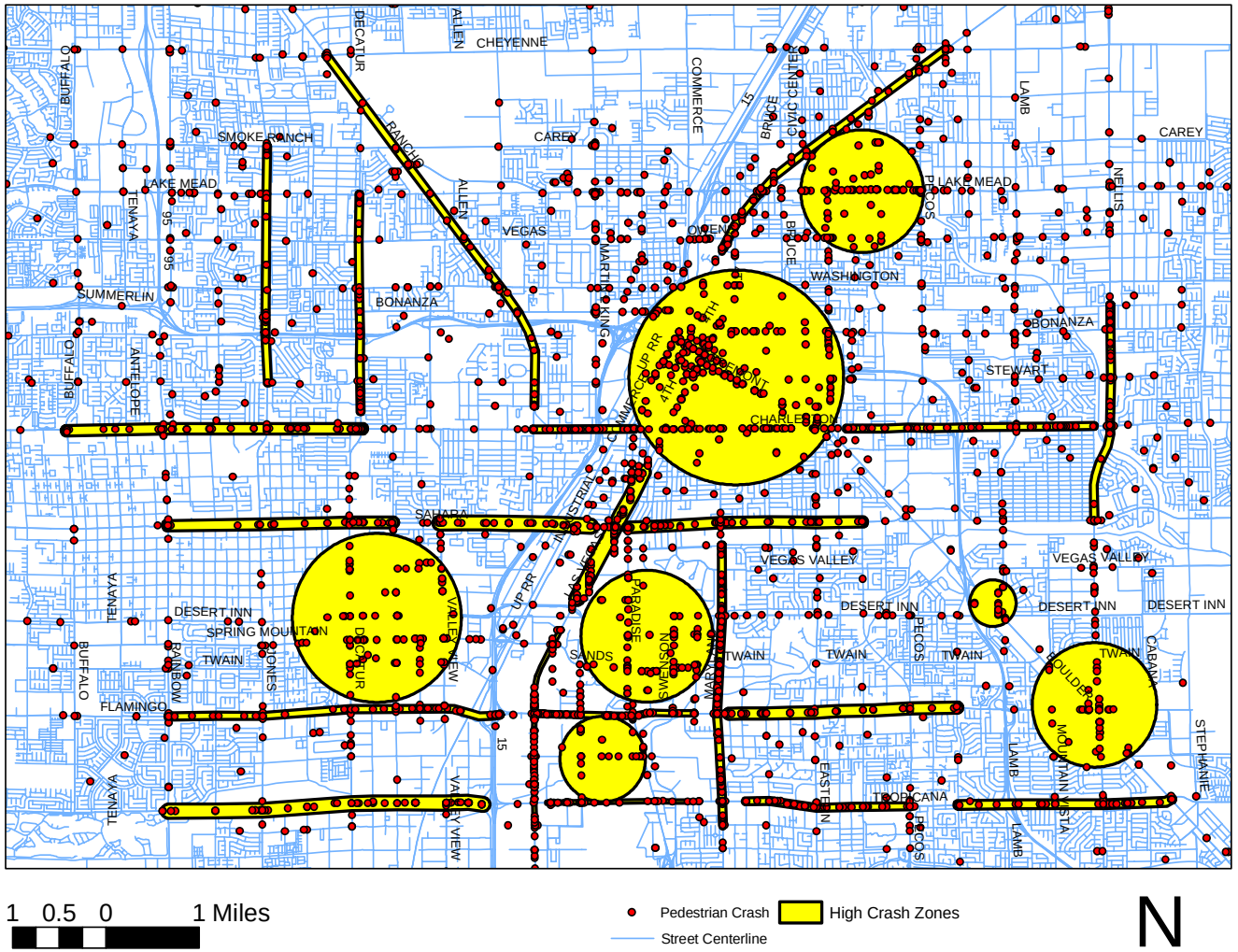

Figure 5 Pedestrian High Crash Zones in the Las Vegas Metropolitan Area

Table 1-Pedestrian Crash Data of High Crash Zones in the Las Vegas Metropolitan Area

#	Zone	Area (Sq. Miles)	# Crashes						Population
			Total	Fatal	Injury	Inury Type			
						A	B	C	
1	Tropicana Ave : Rainbow Blvd - Industrial Rd	0.53	57	1	56	9	19	28	27,771
2	Tropicana Av : Tropicana Cc Bdry - Wilbur St	0.06	47	9	38	4	15	19	11,032
3	Las Vegas Blvd : Fashion Show Dr - Reno Av	0.08	109	3	106	16	39	51	3,267
4	Flamingo St: Las Vegas Blvd - Cambridge St	0.10	63	4	59	6	23	30	23,072
5	Harmon Av / Paradise Rd	0.66	31	2	29	5	10	14	15,583
6	Maryland Pkwy : Karen Av - Reno Av	0.23	150	4	146	17	46	79	43,797
7	Tropicana Av : Sandhill Rd - Boulder Hwy	0.22	38	1	37	9	12	16	24,465
8	Flamingo Rd : Escondido St - Sandhill Rd	0.31	44	2	42	4	17	22	23,247
9	Tropicana Av : Tamarus St - Pecos Rd	0.14	50	1	49	3	25	20	22,501
10	Las Vegas Blvd : Wyoming Av - Convention Center Dr	0.25	106	3	103	16	33	54	10,819
11	Swenson St / Sierra Vista Dr	1.57	82	8	74	12	32	30	36,621
12	Sahara Av : Paradise Rd - Mcleod Dr	0.30	59	3	56	9	16	31	26,590
13	Nellis Blvd / Flamingo Rd	1.40	49	4	45	11	19	15	28,554
14	Boulder Hwy / Desert Inn Road	0.20	28	3	25	4	8	13	12,519
15	Carson Avenue / Las Vegas Blvd	4.16	344	13	331	34	98	197	67,271
16	Charleston Blvd : 27th St - Arlington St	0.21	53	2	51	4	23	24	32,435
17	Nellis Blvd : Sahara Av - Harris Av	0.18	57	1	56	10	11	35	27,281
18	Las Vegas Blvd : Cheyenne Av - Foremaster La	0.25	66	6	60	20	15	25	39,769
19	Lake Mead Blvd / Pecos Rd	1.36	98	3	95	31	24	40	46,079
20	Flamingo Rd : Rainbow Blvd - Ramp I 15 N Flam W	0.27	59	1	58	13	17	28	33,991
21	Sahara Av : Valley View - Industrial Rd	0.26	39	4	35	8	8	19	18,042
22	Sahara Av : Arville St - Rainbow Blvd	0.29	34	0	34	3	12	18	18,975
23	Decatur Boulevard / Pennwood Av	2.57	94	1	93	16	31	46	48,689
24	Charleston Blvd : Main St - Rancho Dr	0.09	31	1	30	4	10	16	5,812
25	Charlestion Blvd : Decatur Blvd - Buffalo Dr	0.37	50	1	49	8	15	26	28,661
26	Jones Blvd : Smoke Ranch Rd - Alta Dr	0.20	31	1	30	2	8	20	35,391
27	Decatur Blvd : Lake Mead Blvd - Dover Pl	0.18	38	2	36	3	13	20	21,330
28	Rancho Dr : Cheyenne Av - Palomino La	0.34	46	3	43	7	13	22	24332

Table 2-Rankings of High pedestrian crash Zones in the Las Vegas Metropolitan Area

Rank	Zone	Crash Density	Crash Rate	Crash Score
1	Las Vegas Blvd : Fashion Show Dr - Reno Av	1815	0.0895	200
2	Tropicana Av : Tropicana Cc Bdry - Wilbur St	1218	0.0154	84
3	Las Vegas Blvd : Wyoming Av - Convention Center Dr	580	0.0302	66
4	Maryland Pkwy : Karen Av - Reno Av	837	0.0104	58
5	Flamingo St: Las Vegas Blvd - Cambridge St	908	0.0072	58
6	Charleston Blvd : Main St - Rancho Dr	489	0.0148	44
7	Tropicana Av : Tamarus St - Pecos Rd	481	0.0072	35
8	Las Vegas Blvd : Cheyenne Av - Foremaster La	420	0.0070	31
9	Nellis Blvd : Sahara Av - Harris Av	409	0.0066	30
10	Charleston Blvd : 27th St - Arlington St	354	0.0056	26
11	Sahara Av : Paradise Rd - Mcleod Dr	277	0.0082	24
12	Flamingo Rd : Rainbow Blvd - Ramp I 15 N Flam W	300	0.0056	23
13	Carson Avenue / Las Vegas Blvd	108	0.0152	23
14	Decatur Blvd : Lake Mead Blvd - Dover Pl	286	0.0059	22
15	Boulder Hwy / Desert Inn Road	215	0.0082	21
16	Sahara Av : Valley View - Industrial Rd	225	0.0075	21
17	Tropicana Av : Sandhill Rd - Boulder Hwy	246	0.0057	20
18	Flamingo Rd : Escondido St - Sandhill Rd	200	0.0078	20
19	Charlestion Blvd : Decatur Blvd - Buffalo Dr	182	0.0062	17
20	Rancho Dr : Cheyenne Av - Palomino La	188	0.0061	17
21	Tropicana Ave : Rainbow Blvd - Industrial Rd	146	0.0065	15
22	Lake Mead Blvd / Pecos Rd	108	0.0084	15
23	Sahara Av : Arville St - Rainbow Blvd	147	0.0050	14
24	Jones Blvd : Smoke Ranch Rd - Alta Dr	199	0.0031	14
25	Swenson St / Sierra Vista Dr	80	0.0080	13
26	Nellis Blvd / Flamingo Rd	55	0.0072	11
27	Decatur Boulevard / Pennwood Av	50	0.0069	10
28	Harmon Av / Paradise Rd	68	0.0059	10

Conclusions

This paper presents development of a GIS tool to identify and rank pedestrian safety problem areas. The tool helps to calculate crash densities, identify pedestrian high crash zones, and rank the selected high crash zones based on crash density and crash rates. The use of the tool is illustrated using a case study with data from the Las Vegas metropolitan area.

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