A Bicycle Accident Study
Using GIS Mapping and Analysis

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Summary

Surveys show that traffic safety is a major concern among commuter bicyclists in the United States. The lack of safe and adequate facilities discourages many from using the bicycle as a transportation mode. Too little is being done to improve safety conditions for bicyclists and to promote cycling as an economically and environmentally beneficial mode of transportation.
This study is a pilot effort to investigate locations in New Jersey with high bicycle accident occurrences using Geographic Information System (GIS) technology. The goal is to raise public awareness of the bicycle safety issue, especially among local governments, transportation advocates, and the general public, by providing an easy tool to organize and communicate accident data better and to focus attention on the need for safer bicycle facilities in New Jersey.
The study highlights the benefits of using GIS technology for data analysis related to bicycle accidents. It further shows that accidents involving bicyclists can be directly associated with road design and conditions, and demonstrates that GIS can be used as a decision support for bicycle network planning. It provides a strong tool and support for communities and municipalities to make improvements for bicycle commuting and to press for fairer allocation of funds among transportation modes. Jersey City, a densely populated urban area with the second highest rate of accidents involving bicyclists, was used as a case study example to show how the GIS analysis can be applied.
As part of New Jersey's commitment to create bicycle and pedestrian friendly communities, our Institute is about to receive State funding to use GIS technology to identify critical locations and accident “hot-spots”. The long-term goal is to present the analysis to many interested communities and municipalities in New Jersey to raise much more awareness of bicycle and also pedestrian safety issues and to demonstrate progress. Easily generated reports and maps can be used to track the state's goal of reducing bicyclists (and also pedestrian) injuries and fatalities.

1. Introduction

In 1995, walking and cycling together accounted for approximately 6% of all urban trips in the U.S. Approximately 1% of all trips were made by bicycle. In contrast, of all traffic fatalities in the U.S., 16% involved pedestrians and bicycles. This means that total fatal accidents involving pedestrians and bicyclists, represent a disproportionate share of all fatal accidents nationally. The New Jersey experience mirrors national patterns.
Many people are discouraged from riding bicycles, even in New Jersey's more urban and densely populated areas, because of safety concerns related to motor vehicles. The sheer

volume of cars and trucks, and the speed and assertiveness with which they are driven, creates a constant climate of danger for bicycle riders. An important step toward reducing this danger and to increase ridership is to inform people and decision-makers why existing conditions are dangerous and to educate them of the benefits of improving conditions for bicycling.

In recognition of the nation's increasing efforts to enhance bicycling and walking, New Jersey officials have increased efforts to promoting pedestrian and bicycle safety and mobility. There is a growing national and local awareness that pedestrian and bicycle mobility and safety are important concerns, and that existing transportation facilities and policies favor auto travel to the detriment of pedestrians and cyclists. In 1998, the Governor of New Jersey introduced her "New Jersey First: A Transportation Vision for the 21st Century" initiative, which set a goal to reduce auto fatalities by twenty-five percent and pedestrian fatalities by fifty percent by the year 2010. Although this is a great vision, it does not include a goal for reducing bicycle accidents, which leave many people injured and even killed each year in New Jersey.

This accident study focuses attention on bicyclists' needs and issues. It includes photographic presentations to help visualize the problems related to design and road conditions that often contribute to bicycle accidents. The study uses photo simulation to illustrate different improvement choices. It is anticipated that the study process described in this paper can help communities and their transportation professionals develop recommendations for improving bicycle mobility and safety.

The presentation gives an introduction of how to apply the technology, data gathering and possible methods of evaluating the data. It also highlights problems associated with applying the technology, such as the lack of data, and emphasizes the importance of comprehensive data collection.

2. Existing Bicycling Conditions in New Jersey

During 1993 and 1996 an average of 19 bicyclists were killed, and an average of 3,130 bicyclists were injured, each year in New Jersey. Given the very low percentage of total trips made by bicycling, the numbers of accidents are alarmingly high. One problem, not unique to New Jersey, is that for decades bicycling has been seen as recreational. Consequently, most transportation investment related to bicycle transport has been in scenic bikeway projects rather than towards enhancing potential bike commute routes. Since the passage of the Federal Transportation Equity Act (TEA-21) in 1998, which provides a considerable portion of the funding for transportation projects in New Jersey, pedestrian and bicycle facilities eligible for funding *must* now be transportation-related and not just linked or solely for recreational purposes. In addition, provision of safety and educational activities for pedestrians and bicyclists are eligible under the Enhancement Program. A bicycle accident analysis, such as the one described in this paper, can help ensure that newly available funding is allocated fairly and effectively. It can also provide an effective tool for municipalities to press for an appropriately sized “piece of the pie”.

Before going into the details of the accident analysis, it should be noted that locations with high accident occurrences do not necessarily mean that those locations are least safe. It rather indicates that, at those locations, many people already bicycle and, therefore,

conditions may need to be improved. Many areas where no accidents occur in New Jersey most likely reflect the fact that few people bicycle there. These locations should not be ignored in a comprehensive bicycle planning and modeling approach; however, this study is not designed to be that detailed.

In states where bicycling has a greater share of total trips, efforts to identify accident locations should include an analysis of population density and income levels because both factors relate to bicycle use rates. This can provide a simple model to identify bicycling demand and to aggregate accidents by looking at occurrence as percentage of total trips.

3. Data Collection and Methodology

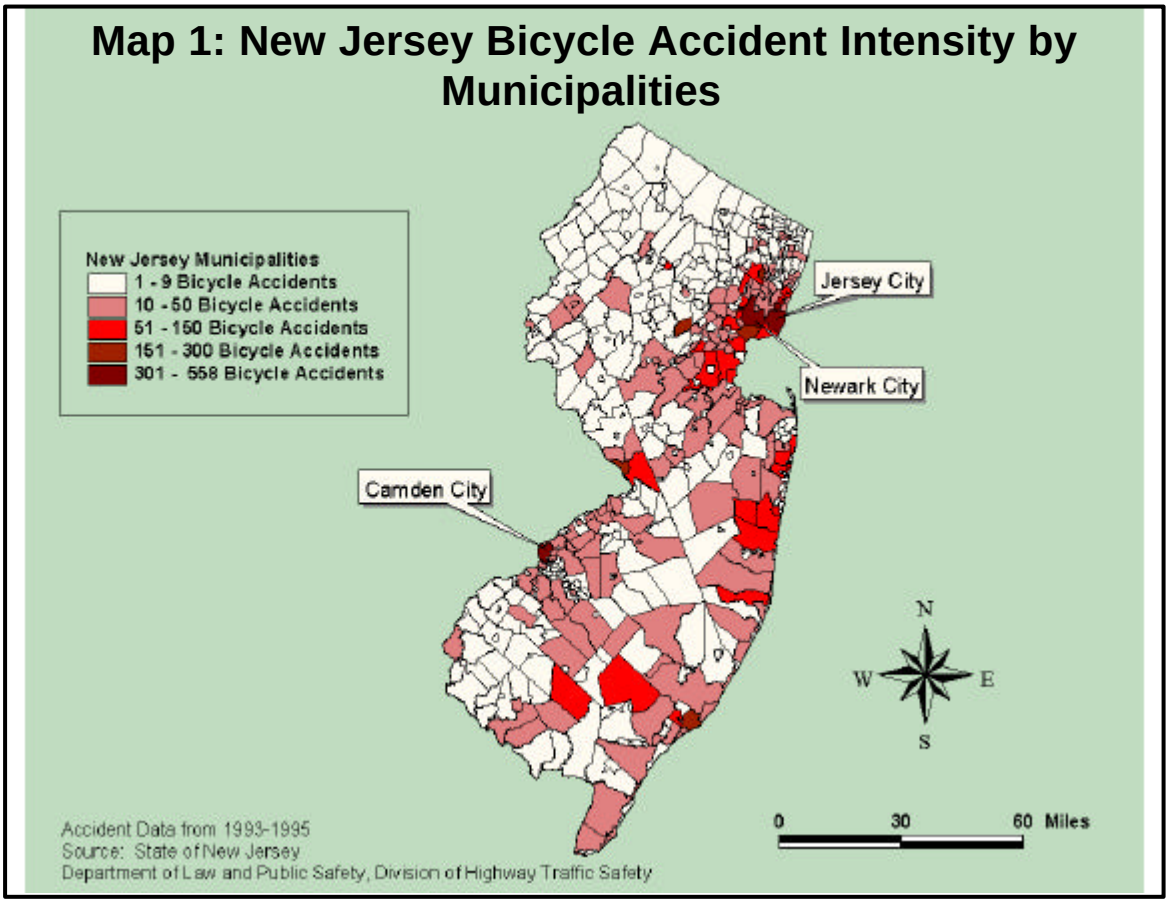
One additional goal of this study is to increase awareness regarding the importance of data collection. Whereas the NJ Department of Transportation in the past has at least included pedestrian accidents in its vehicular accident location database, historically bicycle accidents were not included. Accurate and up-to-date data is crucial for decision making and setting investment priorities. This is especially true when data is available for the other competing modes. The only New Jersey statewide electronic accident data available concerning bicycles is the total number of accidents within each municipality. This data did not indicate the exact accident locations as was available for vehicular and pedestrian accidents.

Using the most recent database available (1993-1995), from the New Jersey Department of Transportation, we used GIS to identify the municipalities with the highest accidents involving bicyclists. From this overview of the state, we prepared a more detailed case study analysis for Jersey City, which had the second highest accident rate in New Jersey. Jersey City was selected for this case study because city officials have shown a great interest in improving conditions for bicycling, including the city's recent funding of a citywide bicycle plan. For the Jersey City case study, we compiled our own database, searching through several thousand police accident reports for the year 1999. Some 148 accidents involving bicycles were identified. The information was geocoded in ArcView/ GIS, using the intersect command. The crash locations were moved to the nearest intersections as reported in the accident records.

The GIS accident analysis described above can provide every municipality and the general public with the tool to generate their own accident reports and maps. With an updated statewide database expected to be available in the near future, it will be possible to generate reports and maps of intersections for example, which have the most bicyclists of a certain age group hit, injured or killed by a vehicle; or we can report and map bicyclists hit, injured or killed during a special time of the day. Weather conditions and roadway classifications can be determined, and it will even be possible to identify the turning movement that most often resulted in a bicyclist accident. This type of data is already available for vehicular and pedestrian accidents. That this has not been included for bicycling just underlines how little attention is given to that mode of transportation. Eventually the goal of this effort is to produce an easy to use interface for anybody who wants to find out more about their neighborhood bicycling traffic safety situation.

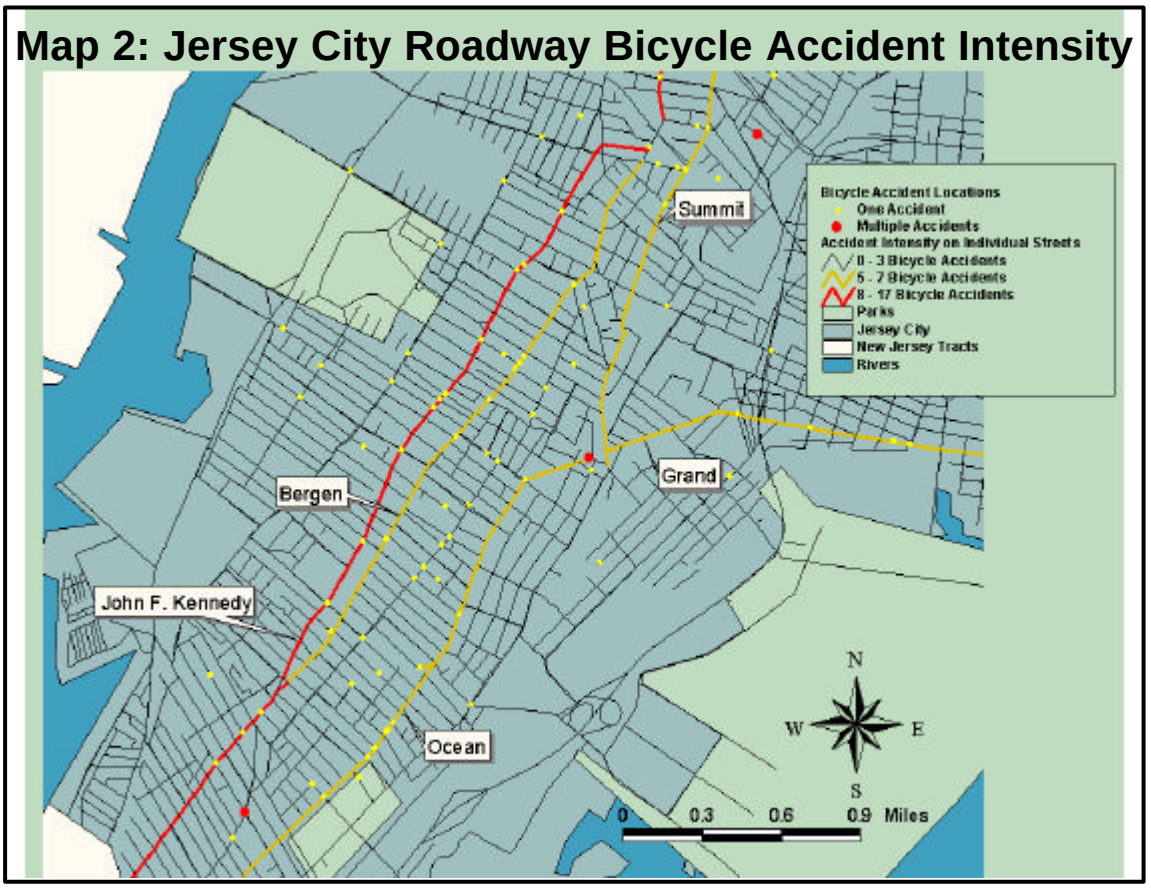
4. Applying GIS for Detailed Site Analysis

Map 1 was prepared to show the intensity of bicycle accidents within each municipality in New Jersey. As mentioned earlier, the most recent data available was for 1993-1995. This map, as the others, can be interpreted in two ways, either that the municipalities with high accident occurrences are very unsafe for bicycling or that there is a higher bicycle demand in those municipalities. The second interpretation is likely true in New Jersey, since in most municipalities with very low accident rates, few people bicycle. As shown, the municipalities with the highest accident occurrences were Newark, Jersey City and Camden. Each of these had over 300 accidents involving bicyclists during that period of time.



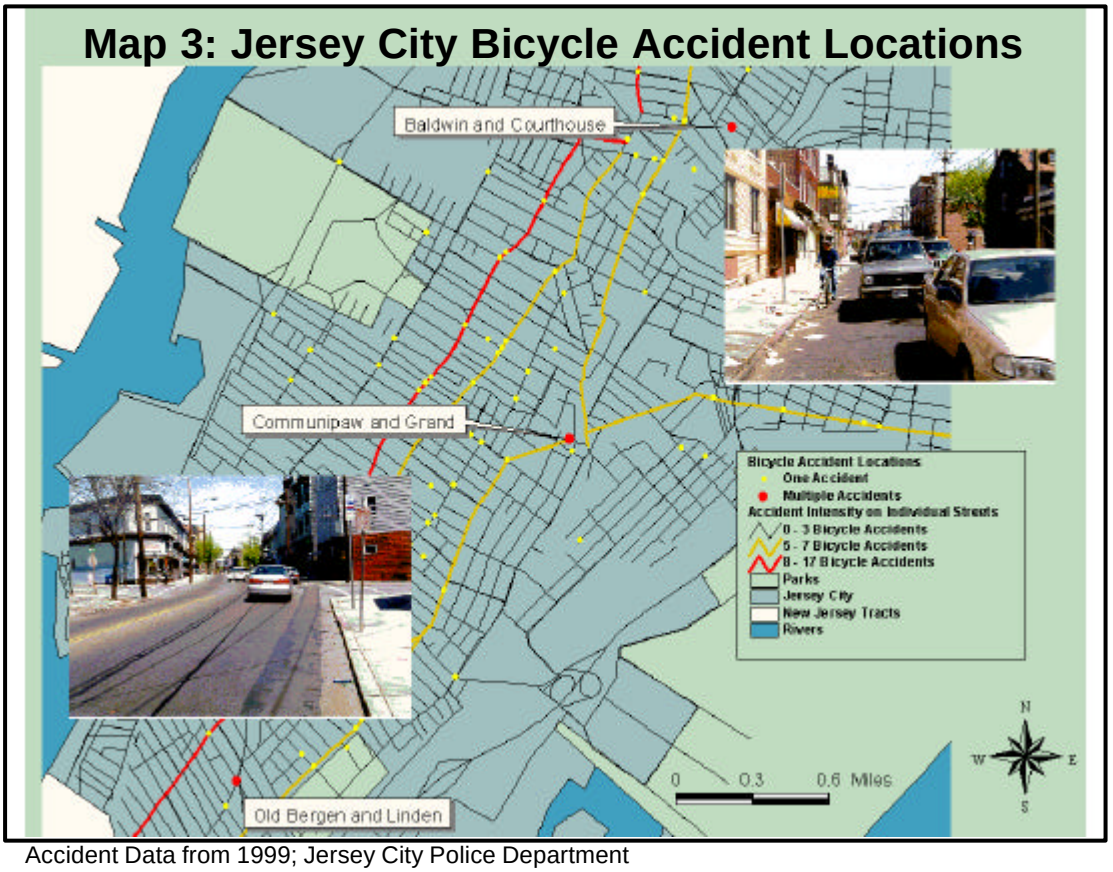
Maps 2 and 3 provide an overview of Jersey City's road network and exact bicycle accident locations. The graduated colors of the roads indicate accident intensity on each road during 1999. This map shows that John F. Kennedy Boulevard (red line) was by far the road with the most accidents involving bicyclists during that one-year period. Several accidents also occurred near intersections on Bergen, Grand, Ocean, Summit, and Communipaw (orange line). (Several accidents also occurred on intersections with Martin Luther King Boulevard, however, most police reports mentioned the cross streets

as accident locations and therefore the Boulevard is not highlighted as a high accident route but can be easily determined through this analysis). The individual accident locations are shown as points on the map, the larger red points indicate that multiple accidents occurred at those specific intersections. These include Old Bergen and Linden, Grand and Communipaw, and Baldwin and Courthouse.



Accident Data from 1999; Jersey City Police Department

GIS enables us to incorporate photographs of problem intersections into the maps. The Photos in *Map 3* show the critical intersections of Old Bergen with Linden and Baldwin with Courthouse where multiple accidents occurred. The photos can show that the condition of pavement, lack of maintenance and absence of road space create hazards for bicyclists.



Accident Data from 1999; Jersey City Police Department

Photos 1-3 show several intersections on John F. Kennedy Boulevard. These photos illustrate that the roadway does not provide a safe and convenient environment for cyclists.

Pictures 1, 2 and 3:
John F. Kennedy Boulevard at Different Intersections

5. Applying the Analysis to Develop Recommendations

Once critical roadways and intersections are identified, additional field observations can be undertaken. With the combination of maps, photographs and subsequent observations, bicycle advocates can press for better bicycling conditions. For example the analysis of John F. Kennedy Boulevard shows: Travel lanes are wide which encourages speeding; field observations proved that the average speed was much higher than the posted 25 mph speed limit along the route. Unmarked parking, driveways and badly placed bus stops near intersections create hazards to bicyclists; field observations showed that at several bus stops buses squeezed in between parked cars, leaving the back of the bus out in the

roadway. This forces bicyclists to merge into auto traffic to avoid waiting behind the bus. In addition many parts of the boulevard lacked basic maintenance concerning street cleaning.
While these are just some of the obvious obstacles that may contribute to high accident rates along John F. Kennedy Boulevard, this case study demonstrates how each municipality can use the analysis to identify their own hazards and develop specific recommendations.

6. Conclusion

The GIS bicycle accident analysis presented above can support and entrance decision-making processes, concerning bicycling. The analysis in addition to pointing out unsafe locations also provides a great indicator of demand for bicycling within municipalities and especially for specific routes.
For example, Jersey City's proposed bicycle plan recommends a dedicated bike lane on John F. Kennedy Boulevard. Since this road has high vehicular volumes and travel speeds, it may seem antithetical to encourage bicycling on this route. This analysis, however, clearly shows that there is high demand on John F. Kennedy and the Boulevard already serves as a major bicycle route. Given it connects many residential neighborhoods with commercial and retail shopping districts and other major destinations, cyclists should have as much of a right as motor vehicles to travel conveniently and safe on this route.
We hope the benefits of implementing or using a GIS based accident analysis are made clear with this presentation. If data is available, it will be very helpful for implementation of projects and to focus on specific locations. Making the analysis available through an easy to use interface will be an ultimate goal to provide the general public with the safety conditions for bicycling in their communities.

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