

Relating highway traffic congestion events and crimes – a case study in San Francisco

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Summary

Urban traffic congestion has many appearances and influences the daily routine of thousands of commuters. Due to the various publicly available geodata resources, it is possible to perform extended spatial analyses, which aim to explain various daily processes and events in urban environments. In this work, we study the link between traffic congestion and reported criminal activity in the city of San Francisco. Our dataset allows us to investigate the relationship among traffic situations and specific types of unlawful behaviour on both spatial and temporal level. As one first step towards finding correlations, we inspect typical traffic situations that appear at inferred traffic-related and non-traffic-related crime hotspots. The outcomes of these analysis steps are more or less specific indicators, which are connectable with particular components of the built transportation infrastructure such as overpasses, interchanges and on-ramps. After interpreting the first results, we argue that our findings could be beneficial in understanding the recent traffic development in San Francisco together with its complex impact on the society.

KEYWORDS: Spatial analysis, Traffic congestion, Crime mapping, hotspot analysis, mobility

1. Introduction

Society and economy largely relies on the highway system for commuting to and from work, transporting goods and services, and connecting residents with services, businesses, and entertainment (McGroarty, 2010). Very often it is the case that the number of vehicles trying to use the highway system exceeds the available capacity of the highways. In other words, people are experiencing traffic congestion events which make it difficult for commuters to reach their destinations on time. Additionally, traffic congestion imposes substantial costs on the economy due to the lost time, pollution, and increased gasoline expenditure, especially in metropolitan areas (Schrang et al., 2012). Besides these side effects, traffic congestion may invoke another negative impact – criminal behaviour among those stuck in a traffic. In their research, Beland and Brent (2017) measure the psychological costs of traffic jams in Los Angeles County. More specifically, they study the link between crime and emotional cues associated with unexpected traffic. Combining traffic and police data, they found that unexpected high traffic leads to an increase in domestic violence.

In this work we take another approach by investigating whether the presence of criminal activity is related with traffic congestion events. We additionally seek to discover which crime types are most likely to occur in highway zones. We assume that merging crime and traffic data can be beneficial in understanding the connection between specific dynamic information (such as crime or traffic data) and

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existing infrastructure in urban areas. Keler and Mazimpaka (2016) follow a similar focus by assigning selected infrastructure elements, such as streetlights or highway to perceptual aspects of vehicle drivers, and indicating perceived safety or danger.

2. Inspection of traffic congestion information and crime records from San Francisco

According to Inrix, a Seattle company that provides traffic information worldwide, San Francisco is the fourth most congested metropolitan area in the world, and third worst in the United States. The crime data we use is available at San Francisco Open Data Portal[‡]. The dataset is freely available and contains crime records from the city of San Francisco. Among dataset variables, our special interest is on the type of criminal activity. There are 39 different types of criminal activity recorded in the San Francisco dataset. Other useful information for our analysis include the dates when crimes were reported and the spatial location (latitudes and longitudes) at which they were reported.

Furthermore, we use Open Street Map road network extracts, overlapped with typical traffic congestion events coming from the Google Maps traffic layer[§] and delay hotspots coming from TomTom^{**}. This way we enrich the crime dataset with additional information for further analysis. The typical TomTom delay hotspots in San Francisco from the year 2015 are shown in Figure 1. These delays represent the average daily traffic (ADT), inferred from the annual average daily traffic (AADT) for the year 2015. In this map view, Interstate highway 80 (3) and Interstate highway 280 (4) are considerable as two main highways in our study area around which we want to investigate the most persistent types of reported criminal activity.

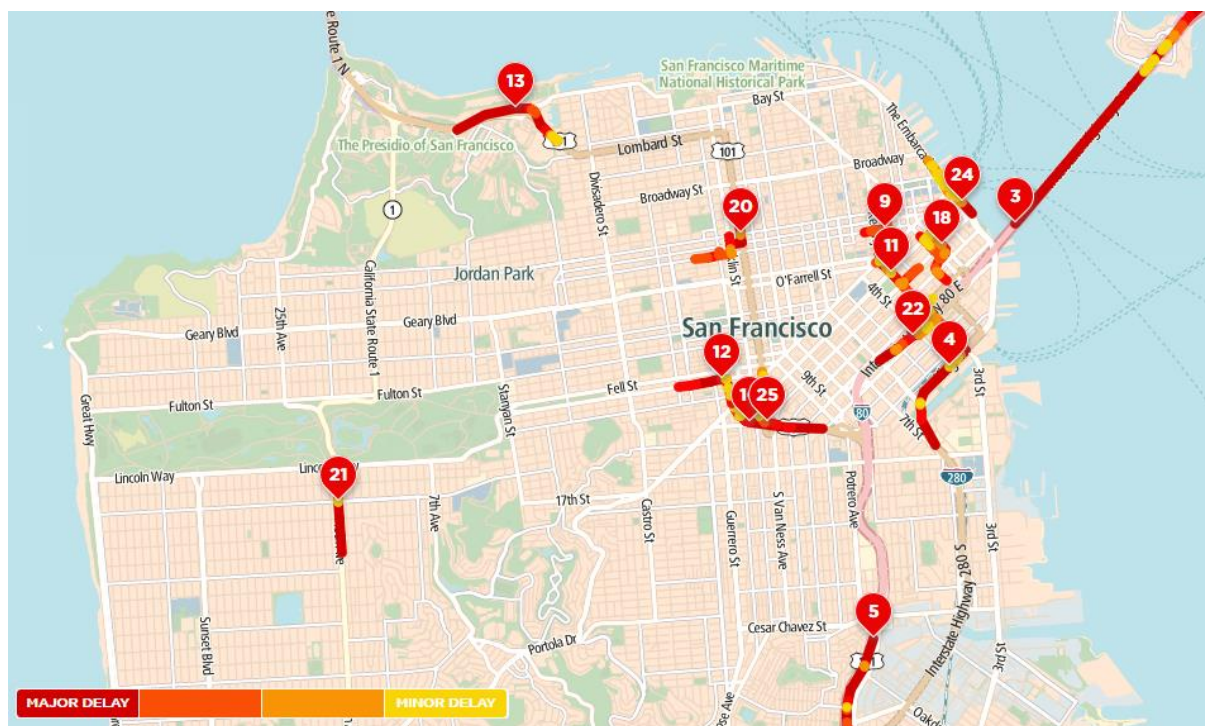


Figure 1 TomTom delay hotspots in San Francisco from the year 2015:

https://www.tomtom.com/en_gb/traffic-news/san-francisco-traffic/delay-hotspots

Spatiotemporal distribution of criminal behaviour refers to understanding and visually communicating where and when crimes have occurred. Knowing where crimes occur can help rise police awareness on

[‡] <https://datasf.org/opendata/>

[§] <https://developers.google.com/maps/documentation/javascript/examples/layer-traffic>

^{**} https://www.tomtom.com/en_gb/traffic-news/san-francisco-traffic/delay-hotspots

how to more efficiently relocate their sources. Knowing when may help prevent future crimes to happen. In our analysis we provide hourly, daily and monthly occurrences of crimes in San Francisco as a temporal indication of criminal behaviour. Spatially, different types of crimes have been reported at almost every district of the city. However, we consider only narrow buffer (300m) around two main highways crossing San Francisco. Figure 2 shows where statistically significant clusters of crimes are emerging and receding throughout the city. Red areas indicate high numbers of crime clustering over time (year 2015), while low crime counts are indicated with blue areas. Dark red areas represent persistent hot spots, which do not have discernible increase or decrease in the intensity of the crime clustering over time. On the contrary, light red hexagons represent intensifying hot spots where intensity of crime counts clustering has increased over time, and this increase is statistically significant. On the other side, dark blue areas represent cold spots where crimes are statistically less prevalent. Light blue bins stand for intensified clusters of low crime counts, which means that cold spots are getting colder. Of particular importance for our analyses are the areas with persistent and intensifying crimes (dark and light red).

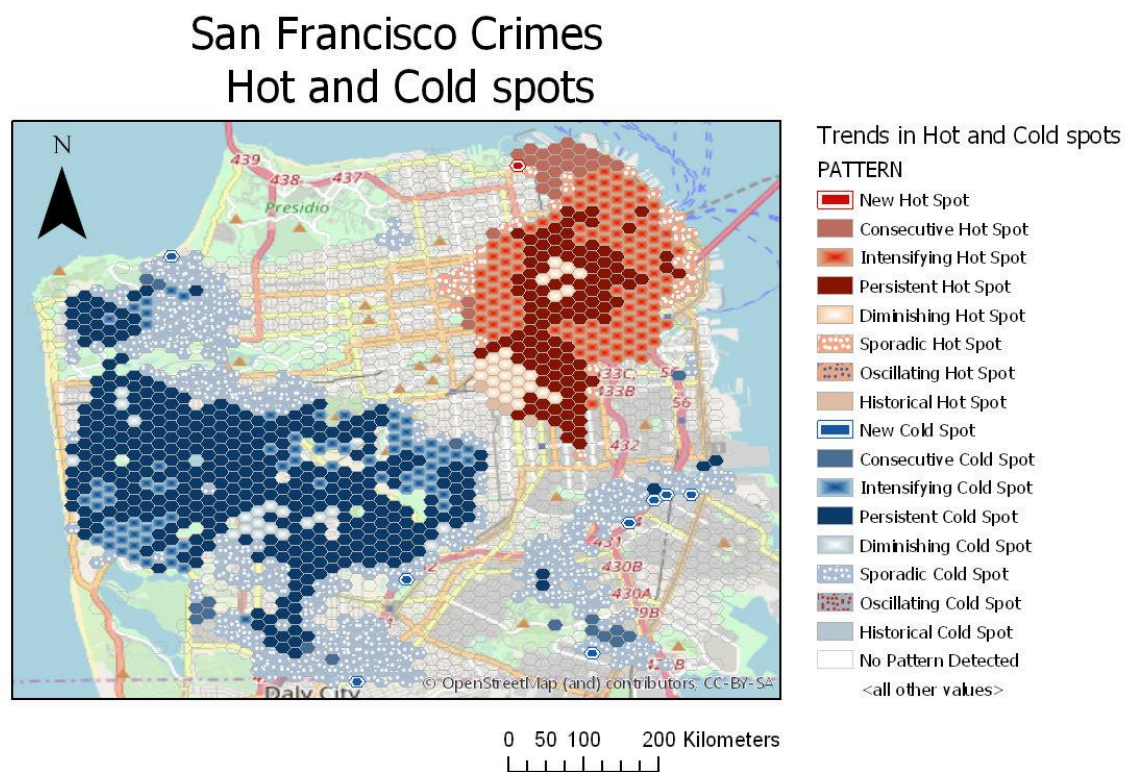


Figure 2 Trends in spatiotemporal distribution of crimes in the city of San Francisco, from Kalinic (2017)

3. Methodology

We use our enriched dataset (merged crime and traffic data) to determine community hot spots. By using this term, we refer to both criminal activity and traffic congestion occurrences. We aim to investigate the connection between criminal activity reported near or on highways and traffic congestion at the same locations. For our analysis, we propose a three-step method of investigation. First, we analyse and visualize temporal distributions of both crimes and traffic congestions on an hourly, weekly and monthly level. That gives us the possibility to investigate the link between these two events on temporal level.

Second, we overlay the crime data with records of traffic congested highway segments and create a buffer of criminal activity around highways of interest. With this procedure, we are able to infer the

extents of criminal activity in specific zones of the city.

Third, we group newly selected crimes, according to their category, to show crime types, which are most related with highway congestion events.

4. First results and Outlook

Carried analysis takes into account the hourly, daily and monthly time interval for both event types. The findings show that the highest criminal activity in the year 2015, considering the average daily traffic (ADT) information, is around 12pm and 6pm, which corresponds to the detected temporal peaks of traffic congestions. The first results of our spatial analysis show that there is a spatial overlap of areas with congested traffic and crime hot spots. We are mainly interested in highway zones (Interstate highway 80 (3) and Interstate highway 280 (4)) and the Downtown district where we observe both positive and negative spatial correlation between crime-traffic events. Further findings show that northern areas of the city suffer from traffic congestion while criminal activity does not show any significant patterns. Moreover, while central western parts of the city show strong traffic hot spots, the same areas show persistent criminal cold spots.

The very first output confirms our assumptions that there is a spatiotemporal overlap between traffic congestion and criminal records in the city of San Francisco. In addition, our analysis reveals that thefts and assaults are the most common crime categories within crime-traffic overlapping zones.

For future work, we plan on furthering the analysis and pattern detection on the type of criminal activity over longer periods of time. That way, we would be able to argue, with more confidence, upon which measures are useful for understanding the time dependency of this specific connection. Additionally, measuring the car-friendliness of selected investigation areas might benefit further understanding.

5. Biography

Maja Kalinic is a research assistant at the University of Augsburg, Professorship Applied Geoinformatics. She holds bachelor degree in geodetic engineering and master degree in cartography. As a PhD candidate her interests go towards fuzzy logic analysis and their possible application in GIS domain.

Andreas Keler, PhD, is a postdoctoral researcher at the Technical University of Munich (TUM), Chair of Traffic Engineering and Control. Besides Location-Based Services (LBSs), his recent research focus is analysing the interaction between bicyclists and car drivers in urban environments.

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