Moving Towards Transportation Sustainability on University Campus

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Abstract

University traffic systems aim to sustain safe and reliable access to campus. A university essentially functions as a small city which has to deal with issues on parking, pedestrian, vehicle and multimodal movements. The uniqueness of the University traffic revolves around the characteristics of variable movements from students, faculty and visitors passing through with shifting schedules. Sustainable measures are implemented by encouraging walking, bicycling, carpooling, and the use of public transportation. Despite these measures, single occupant vehicle remains to be the most popular mode of travel. Vehicles contribute to GHG emissions and puts pedestrian/bicyclist safety at risk.

This paper presents the results of traffic flow and speed studies on campus and an estimate of the GHG emissions of campus vehicles. Seven locations were selected to capture the majority of vehicles on campus and depict a fair representation of the traffic patterns.

Results of the study show most vehicles flow between 8:00AM to 12:00 PM and between 3:00 PM to 8:00 PM on a university campus such as CSULB. These vehicles emit around 6.7 million grams of CO_2 on a weekday. A reduction in vehicle volumes by expanding public transportation service and aggressively promoting other sustainable transportation options would lead to a reduction on GHG emissions. Majority of on-campus vehicles violate the speed limit based on the 85^{th} percentile speed data. This has an implication on pedestrian and bicyclist safety and needs to be addressed.

Introduction

University traffic systems aim to sustain safe and reliable access to campus. A university essentially functions as a small city which has to deal with issues on parking, pedestrian, vehicle and multimodal movements. The uniqueness of the University traffic revolves around the characteristics of variable movements from students, faculty and visitors passing through with shifting schedules. The majority of congestion points are seen at parking lots and intersections with a high volume of student crossings or where the university campus roads connect to city streets.

Varying class schedules, which is typical of university campuses, results in traffic peaking at various hours of the day. Most of the vehicle traffic is experienced between 8:00 AM to 10:00 AM and between 6:00 PM to 8:00 PM during which many vehicles either enter or exit the campus. Aside from this, pedestrian safety is also one of the major issues. Crosswalks with stop signs are provided at every major building and parking structure, and a traffic signal is provided in one location with heavy pedestrian movements. In partnership with the Long Beach Transit, free public transportation and a recently operational off-campus tripper are provided to an area where there is a high population of students. This has helped to reduce the on-campus traffic and demand for parking spaces. However, campus traffic volumes remain high. An increase in enrollments has a direct impact on the increase in vehicular traffic ultimately leading to an increase in emission of greenhouse gases. Carbon dioxide is the major component that affects the environment.

The main purpose of this paper is to present the results of traffic flow and speed studies on campus and an estimate of the GHG emissions of campus vehicles. As the number of motor vehicles increase, there is a subsequent increase in the emission of greenhouse gases on campus. These emission rates are at its highest level during peak hours resulting in an adverse effect on campus environment. The result could lead to an escalation in climate temperature.

Literature Review

The uniqueness of the University traffic model revolves around the characteristics of variable movements from students, faculty and visitors passing through with shifting schedules. Olio et al. (2014) performed a survey on university pedestrians based on their travel patterns and choices. Their study showed that income affects bus fee concerns. Middle class people were more concerned with bus fare prices than any other income level. It was also discovered that people believe the cost to park was worse than bus fare or using the bicycle systems. Furthermore it was found that the choice to ride a bicycle was most influenced by the travel time of buses. They suggested that the community commit to adding safe bicycle routes in more areas to decrease the amount of bus riders while decreasing the travel time of the most sustainable option, cycling.

Balsas (2013) looked into the mobility plan of eight pre-selected universities in the United States who claim to be bicycle and pedestrian friendly. He found that the vehicle trends reflect those found in society and concluded that planning an area receptive to vehicle traffic can be extremely expensive and can severely affect air quality. Cities where the largest employer is the local university causes a large transportation demand that can lean more toward vehicles or pedestrian and bicycle friendly plans if the effort is made.

Methodology

Seven locations around California State University, Long Beach (CSULB) campus were identified for traffic flow and speed observations as shown on Figure 1. In Fall 2015, twenty-four hour data were recorded at each location using a radar recorder mounted at strategic positions. The data were downloaded from the radar recorder and processed using a special software. Two types of analysis were performed in this study. Level of Service (LOS) analysis was done using Synchro software by Trafficware. Green House Gas (GHG) emissions calculations were based on 2010 Environmental Protection Agency (EPA) standards for 2012-2016 vehicles.

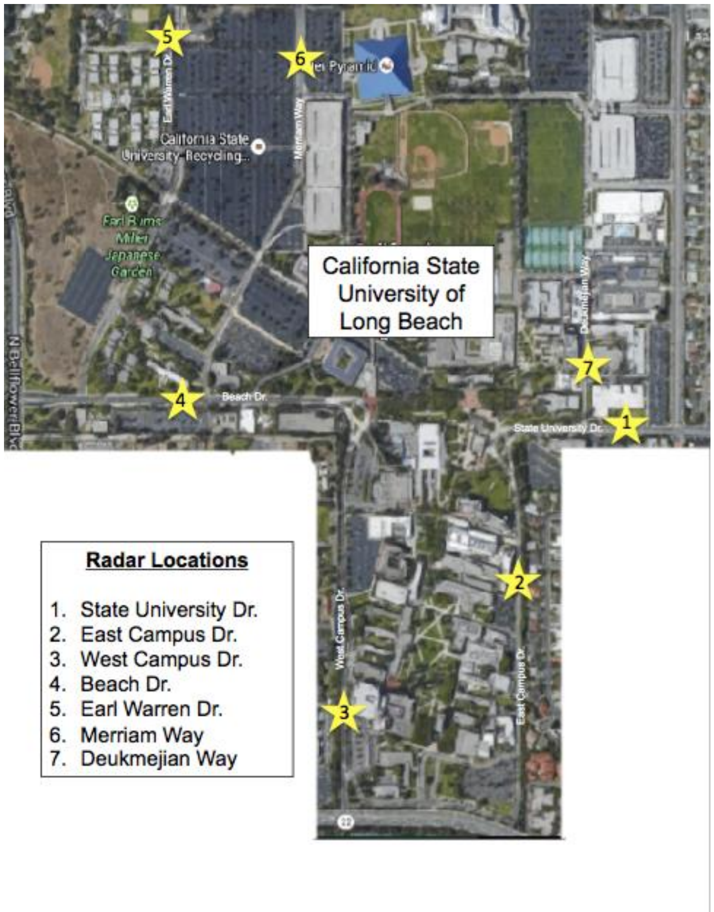

Figure 1. Location of Data Collection

Traffic Volume

Table 1 shows a summary of traffic volumes during the morning and afternoon peak periods. Traffic builds up from 8:00 AM to 12:00 PM and from 3:00 PM to 8:00 PM. Two streets, Beach Drive and Merriam Way showed the highest volumes.

Table 1: AM and PM Peak Hour Volumes

ID	**Location**	**AM Peak Period**	**AM Peak Hour Volume**	**PM Peak Period**	**PM Peak Hour Volume**
1	State University Drive	8:00 - 10:00	881	6:00 - 8:00	837
2	East Campus Drive	8:00 - 10:00	792	5:00 - 7:00	959
3	West Campus Drive	10:00 - 12:00PM	295	3:00 - 5:00	524
4	Beach Drive	8:00 - 10:00	1354	6:00 - 8:00	1404
5	Earl Warren Drive	10:00 - 12:00PM	295	4:00 - 6:00	479
6	Merriam Way	10:00 - 12:00PM	1057	6:00 - 8:00	1168
7	Deukmejian Way	9:00 - 11:00	402	4:00 - 6:00	509

Synchro analysis was done using the volume data collected at each point. Left turn and right turn vehicle volumes were determined by equalizing the volumes on adjacent sections. This analysis was done only for peak hour volume data between 5:30pm and 6:30pm. Table 2 shows the Level of Service (LOS) and Intersection Capacity Utilization (ICU). Merriam Way and Beach Drive intersection is the critical intersection. While the current level of service is C and ICU factor is 88.5%, future increase in traffic may be challenging.

Table 2. LOS and ICU at Various Locations

Intersection	**LOS**	**ICU**
Beach Drive and Earl Warren Drive	B	70.6%
Beach Drive and Merriam Way	C	88.5%
Beach Drive and West Campus Drive	B	58.3%
State University Drive and Deukmejian Way	A	40.3%

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Speed

The university campus almost constantly has pedestrians walking around and their safety should be a priority. Speeding vehicles are not acceptable and need to be mitigated. A collection of vehicle volumes and speeds at seven different locations on campus were taken in order to focus on the high-risk areas that compromise safety. Results of the speed observation are summarized in Table 3.

Table 3. Vehicle Speeds at Various Locations

ID	**Location**	**Number of lanes (both directions)**	**Segment Length (mi)**	**Speed Limit (mph)**	**85^{th} Percentile Speed (mph)**	**50^{th} Percentile Speed (mph)**
1	State University Drive	2	0.2	15	24	18
2	East Campus Drive	2	0.4	25	28	24
3	West Campus Drive	2	0.4	25	22	19
4	Beach Drive	4	0.4	15	28	24
5	Earl Warren Drive	2	0.5	25	23	18
6	Merriam Way	5 (2 NB, 3 SB)	0.5	15	26	22
7	Deukmejian Way	2	0.3	15	17	13

Speed limits on campus are either 15 mph or 25 mph. It is noted that most of the 85^{th} percentile speeds found are above the speed limit, except for two locations West Campus Drive and Earl Warren Drive. State University Drive, Beach Drive and Merriam Way have 85th percentile speeds well above the speed limit. Typically speeds tend to decrease with an increase in volume. However, these two streets have the highest recorded traffic volumes.

Beach Drive runs parallel to the campus dormitories creating many pedestrian activities. There are three cross walks on this length and all are used by students or faculty walking to and from their personal vehicles or to their dorm room. Merriam Way by the CSULB Pyramid provides direct access to the largest parking structure on campus. State University Drive while it facilitates the fourth highest campus volume also deals with a great deal of speeding vehicles due to the lack of pedestrian activity. From observation, most pedestrians stay on the sidewalk and are protected by parked vehicles, creating the illusion of pedestrian safety which could influence drivers to drive at higher speeds. Speed calming measures should be implemented in order to maintain a safe and sustainable transportation on campus.

Greenhouse Gas Emissions

Carbon dioxide is a major Green House Gas (GHG) emitted from vehicles. These emissions are directly proportional to the volume of vehicles travelling at that time. Volume data collected by radar recorder was used for calculation of emissions. The calculation was based on EPA (2010) standard 411 grams of Carbon Dioxide (CO_2) emissions per mile on 2012-2016 vehicles with an average fuel consumption of 21.6 miles per gallon. Figure 2 shows total emissions on campus. The figure shows high emission levels exceeding 35 million grams occur between 10:00 AM to 12:00 PM and between 3:00 PM to 8:00 PM.

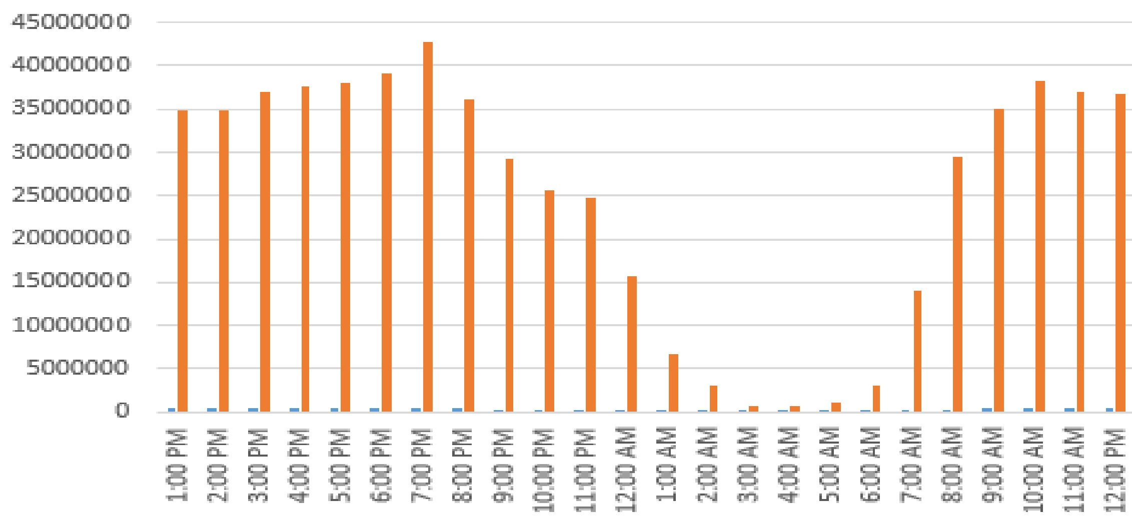

Figure 2: Total Emissions vs. Time

Based on our data, it is estimated that around 602 million grams of CO_2 is emitted per semester in CSULB campus. Daily emissions during week days are around 6.7 million grams. This number increases every semester with an increase in number of enrollments. A number of measures such as public transportation and carpooling which are already in place should be promoted more aggressively. According to the University study, around 67 percent of the campus population drove alone. The remaining 33 percent use sustainable modes of transportation such as public transit, carpooling, walking, bicycling, and others. GHG emissions may be reduced by further reducing the percentage of population who drove alone. Some strategic steps should be taken such as follows:

- Parking permits should be priced based on how far away from the school a student lives. For Example if students live within 4 miles of campus they should pay a higher fee than those that live a greater distance. Any distance past 4 miles pays a flat rate.
- Increase in the number of carpool parking spaces to encourage students to travel together.
- Strict laws should be enforced for those using carpool parking spaces.
- Increase the number of off campus trippers to locations where the Cal state student concentration are high.
- Educate students on the statistics of CO_2 emissions.

Conclusion

This paper presents the results of traffic flow and speed studies on campus. It helps to understand the present traffic conditions and provide recommendations for future growth in student population.

This research also deals with calculation of GHG emissions. Emissions were calculated using volume data collected. Results of the study show most vehicles flow between 8:00AM to 12:00 PM and between 3:00 PM to 8:00 PM. These vehicles emit around 6.7 million grams of CO_2 on a weekday. While these streets operate at levels of service A to C, a reduction in vehicle volumes by expanding public transportation service and aggressively promoting other sustainable transportation options would lead to a reduction on GHG emissions.

Majority of on-campus vehicles violate the speed limit based on the 85^{th} percentile speed data. This has an implication on pedestrian and bicyclist safety and needs to be addressed.

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