研 究 速 報

Season effect on traffic: A case study in Switzerland

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1. Introduction

One of the most important differences between seasons is weather characteristics. While it is cold and snowy in the winter, the heat from the sun in the summer may cause high air temperature. Does this difference affect drivers' behaviors on Swiss motorways and what can we do to increase the traffic safety, knowing the effects of weather on drivers' behavior?

Season effects on highway traffic have been well documented in several countries especially in the countries where the difference between weather in the summer and in the winter is large. Fu L. et al.[4] mentioned very large effects of winter weather on highway traffic safety in Ontario, Canada. In the winter, snow storms are very frequent, and this makes roads more slippery and visibility poorer. This explains the large number of accidents in the winter in comparison to other seasons. Thanesuen S. et al.[5] while investigating the speed limit in Hokkaido, Japan detected that with the same speed limit in summer and winter, the number of accidents was greater in the winter. This was caused by the slippery road conditions and by the fact that people could not stop in time. The proposed solution was to apply different speed limits in the winter (which is snowy and icy) and in the summer (which is generally dry). In these researches, snowy and icy conditions make winter differ from other periods of the year. The season effects on traffic in areas with heavy snowfalls are thus quite clear.

However, there are areas with little or no snow in the winter, while the temperature is quite low. Will there be any season effect on traffic in this case? Chung E. et al.[2], while studying the effects of rain on capacity and speed, and the effects of daylight on capacity, in Tokyo Metropolitan Expressway (MEX), reported that capacity in the winter decreased by 12.8% over summer lighting conditions. This was explained by the effects of natural lighting conditions at around 06:00AM, the time of morning peak, where the visibility is better in the summer than in the winter.

The aim of this paper is to study the season effects on speed in Switzerland using real traffic and meteorological data. Field data, studied sites, as well as analyses will be described in the next section. Although on the studied sites there is no or little snow, in the first quarter of the year it is cold and icy, while in the third quarter, the temperature is high. Some results from this study are compared in sections 2.2 and 2.3 to the results reported in [2].

2. Observation

2.1. Field data and study sites

In Switzerland, the network of Automatic Traffic Counts (ATCs) has been installed since 1961 and is operated by FEDRO (the Swiss Federal Roads Office), which is the federal authority responsible for national road infrastructure in the country. At the end of 2006, there were 259 permanent automatic traffic counting stations located in almost every motorways and main roads of the country. However, individual vehicle data from only 73 stations are downloadable online. Besides, the spacing between ATCs is large, for example there is no ATCs that have a distance less than 5km.

Two sources of meteorological data are available: one from the Boschung system and the other from the Federal Office of Meteorology and Climatology (MeteoSuisse). While meteorological data from MeteoSuisse have more general purposes, Boschung road weather stations are installed beside the road sections, specifically for monitoring the weather conditions on the Swiss road network. Therefore, we have chosen to use weather data from Boschung stations in this study. Boschung stations provide raw data collected every 6 minutes. Two important data fields namely, type of precipitation and intensity of precipitation - in the data have been preprocessed, and only symbolic values for these fields are provided. For the type of precipitation, for example, three values are assigned: "R", "S" and "-" for rain, snow, no-precipitation (or fine weather) conditions, respectively. For any weather condition, the precipitation level is graded by "–", "F", "F1", "F2", "F3", which represents precipitation levels ranging from nil to high intensity.

There are a total of 13 ATCs and 33 Boschung stations in the Vaud canton. Three ATCs, which have the closest weather stations are sites 226, 116 and 149 and are chosen for this study. The distances from the ATCs to their nearest weather stations are

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about 30m, 2000m and 1100m respectively. The linkage of traffic and weather data, the number of lanes and the locations of ATCs are resumed in Table 1.

Table 1: Combination of traffic sites and weather stations

Site	Location	Weather station	Lanes
226	A1/A9	41.21.1.3	8
116	A9	41.21.1.32	4
149	A1	41.21.1.4	4

2.2. Weather effect

Traffic and weather data for the whole year of 2005 were collected. During the first and third quarters of 2005, typical weather conditions (cold in the 1st quarter and warm in the 3rd quarter) are observed. The clear distinction between the weather in the first and in the third quarters is the reason why these two 2005 quarters were used.

In general for the whole year 2005, the average speeds under three weather conditions - namely, fine weather, rain and snow - are different. The average speed under fine weather condition is higher than under rain or snow conditions. When it snows the reduction of speed is larger than when it rains. In reality, snow makes people more careful while controlling their vehicles and the reduction of speed in this condition is thus greater. This effect of different weather conditions on traffic speed has been acknowledged in previous studies[1] [3].

Results from our study about weather effect on traffic speed are also shown in Figure 1 and Table 2. Table 2 presents the reduction of median free flow speed of 500-600veh/h under three weather conditions. In [2], types of rainfall are classified based on the intensity of precipitation in mm/h and the reduction of speed under light rainfall conditions (0-1mm/h) is about 4.5%. The results in this paper are based on different situations: three pre-defined types of precipitation and the intensity of each type. It is recognizable that the obtained results in our study are similar to the results reported in [2]: the average speed under rain condition is slightly lower than the average speed under fine weather condition.

Table 2: Median free flow speed at 500-600 veh/h under 3 weather conditions.

	Median free flow speed (km/h)	Percentage reduction in speed compared with fine weather (%)
Fine weather	87.9	
Rain	87.1	0.91
Snow	86.3	1.82

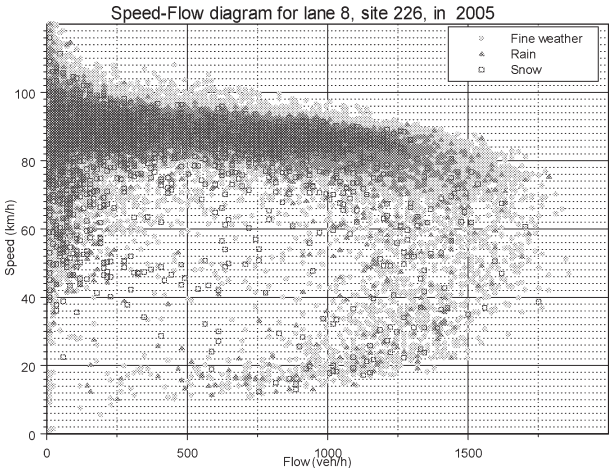

Figure 1: Speed-Flow curve for 3 weather conditions

Because of the effects of different weather conditions on free flow speed as shown in Table 2, investigating the season effect on traffic is carried out for fine weather only.

2.3. Lighting effects

Drivers may have different driving behaviors during periods with and without day light. In [2], for instance, a capacity reduction of 12.8% has been acknowledged while considering the morning peak hour in the summer (when the visibility is high) and in the winter (when the visibility is low). To better focus on season effects, the comparisons between the same lighting conditions of different seasons were considered and hence eliminated the lighting effect as well.

The sunrise and sunset during the 1st and the 3rd quarter of the year are different. Based on this, the following time ranges were used for 2 lighting conditions:

Table 3: Time ranges for lighting conditions.

	1st quarter	3rd quarter
Duration	01.01-31.03/2005	01.07-30.09/2005
Day light	9:00AM – 4:00PM	6:00AM – 7:00PM
Without day light	6:30PM – 6:30AM	9:30PM – 4:00AM

As the time of sunrise and sunset over the quarter changes, there are several hours where it is not clear whether it is a period with or without day light. The hours shown in Table 3 exclude these “fuzzy” periods.

Data from the right lane and overtaking lane of sites 226, 116, 149 are used. This gives a total of 6 lanes for the analysis.

2.4. Analysis

Analyses of speed difference between daylight and non daylight in the first and third quarters, under fine weather and rain conditions were performed. Figure 2 shows the speed for lane 8 of site 226 under fine conditions. The average speed during non

daylight in the third quarter is higher than the first quarter by 1.5 km/h. A smaller difference of about 1 km/h is observed for the daylight condition. This is not unexpected as the non daylight case for the first quarter includes PM peak (5:30PM – 6:30PM). However, speeds are still higher for the third quarter than for the first quarter under the same flow rate for both daylight and non daylight conditions.

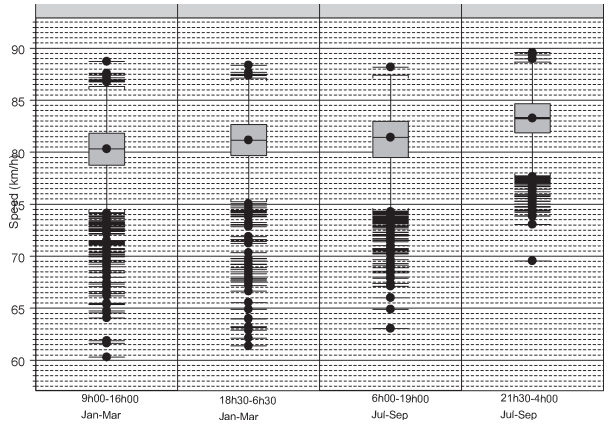

Figure 2: Box-plot of speed for lane 8 of site 226 during daylight and non daylight under fine weather condition.

Similar results are also obtained for other sites under fine weather conditions. The results are resumed in Table 4. It is interesting to notice that, for the considered sites, the average speeds in the third quarter for both daylight and non daylight periods are greater than in the first quarter. Also, during the non daylight, the difference between the two quarters tends to be larger than during daylight.

Table 4: Results for fine weather conditions, sites 149 and 116

	Speed difference between 3rd and 1st quarter (km/h)	
	Daylight	Non daylight
Lane1,149	107.4 − 106.7=0.7	112.9 − 109.3=3.6
Lane2,149	119.7 − 119.0=0.7	125.2 − 121.4=3.8
Lane4, 116	99.9 − 99.2=0.7	100.4 − 99.4=1.0
Lane3,116	110.7 − 109.5=1.2	109.4 − 108.6=0.8

Under rain conditions, similar trends are also observed, i.e. average speeds in the third quarter are greater than in the first quarter and the difference during non daylight is greater than during daylight.

Statistical tests were performed on the mean speed for the different quarters. The results confirm that the higher mean speed in the third quarter than in the first quarter is statically significant at 95% confidence interval.

Note that in Table 4, 5 out of the 6 lanes tested show that average speed during non daylight is greater than during day light for the same quarter. The lane where this phenomenon is not observed is lane 3, site 116.

3. Conclusion

This study looks at traffic data collected from automatic traffic counters on Swiss national highways A1 and A9 in combination with weather data provided by Boschung system in Vaud canton, to determine the season effect on speed. After segregating the effects of day light and different weather conditions on speed, statistical analysis were performed. The results show that average speed in the first quarter is less than in the third quarter under the same lighting conditions and weather conditions. This suggests that season effect should be considered when studying traffic safety issues in the highway network in Switzerland. On the other hand, speed difference due to daylight effect for the same quarter showed higher speed for non daylight than for daylight. However, this is only observed in 5 out of the 6 cases. Further investigation is needed to explain the exceptional case. Finally, we will also investigate traffic composition effects, as its segregation may be of importance.

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