

# Impact of Different Inclement Weather Conditions on Two-Wheeler user across Socio-Economic Groups

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**Abstract:** Two-wheeler commuting in inclement weather conditions is difficult and it increases with severity of adverse weather conditions. It's been observed that people rate these climatic conditions differently. This study focuses on the perceived severity of ten weather conditions by different socioeconomic groups.

**Keywords-** Two-wheeler, Commuting, Inclement weather conditions, Socioeconomic groups.

## I. Introduction

While commuting in inclement weather, commuters try to avoid adverse conditions. A survey done on Brussels commuters [1] seem to indicate that 59 percent of automobile users change their mode, departure time and / or route choice in response to weather conditions. Another study done at Chicago [2] in 1991, indicates that more than 80 percent of automobile commuters change their one or more normal travel decision. Inclement weather seems to affect daily commuting in a city. Different socioeconomic groups seem to respond differently to these adverse situations. Same previous study done in Chicago [2], also suggest that middle income households are more likely to change their mode, than lower income groups.

These studies are conducted in western countries and mainly focus on car users. India has large percentage of two-wheeler users in medium size cities. After pedestrians, two-wheeler commuters are most affected in inclement weather. It's been observed from the survey that, two wheeler users belong to every socioeconomic group in India and their responses in different inclement weather conditions differ among these groups. A study is required to identify the perceived severity of different inclement weather conditions by two-wheeler user of different socioeconomic groups in Indian medium size cities. For this study, Kuppuswamy's Socioeconomic scale is used. It is calculated by summing the scores of three variables, namely; income, occupation and education [3]. It further divides the score in five socioeconomic categories, namely; Upper, Upper Middle, Lower middle, Upper Lower and Lower class.

It's noteworthy that, for this study only work trips were considered. As they are time bound and fairly regular in nature. For the study, weather was divided into normal and nine inclement weather conditions. Scientific description of it is given in table.1.

TABLE.1

CATEGORIZATION OF INCLEMENT WEATHER CONDITIONS FOR SURVEY DESIGN

Sl. No	Weather description in Study	Scientific description
Summer		
1.	Hot day	Whenever, the maximum temperature remains 40°C or more and minimum temperature is 5° C or more above normal, it may be defined as Hot Day, provided it is not satisfying the heat wave criteria given below. [4]
2.	Hot-humid	Relative humidity of 60% or greater.
3.	Heat Wave	Heat wave need not be considered till maximum temperature of a station reaches at least 40° C for Plains and at least 30° C for Hilly regions. a) When normal maximum temperature of a station is less than or equal to 40° C. Heat Wave Departure from normal is 5° C to 6° C Severe Heat Wave Departure from normal is 7° C or more b) When normal maximum temperature of a station is more than 40° C, Heat Wave Departure from normal is 4° C to 5° C, Severe Heat Wave Departure from normal is 6° C or more c) When actual maximum temperature remains 45°C or more irrespective of normal maximum temperature, heat wave should be declared. [4]
Monsoon		
4.	Light Rain	Will include light rain, moderate rain i.e. when rainfall is between (2.5 to 35.5 mm per day) [4]
5.	Heavy rain	heavy rain. i.e. rainfall between 35.6-124.4mm [4]
6.	Very heavy rain	will includes very heavy, extremely heavy and exceptionally heavy rain with precipitation ≥124.5mm or thunderstorm [4]
Winter		

7.	Cold	In the plains of north India, foggy conditions prevail during winter for several days or weeks. The minimum temperature on these days remains above normal, while maximum temperatures remain much below normal. This creates cold conditions for prolonged period. When maximum temperature is less than or equal to 16°C in Plains [4]
8.	Cold wave	Wind chill factor (WCTn) is taken into account while declaring the cold wave situation. Departure of WCTn from normal minimum temperature is from -5°C to -6 C where normal minimum temperature > 10°C and from -4°C to -5°C elsewhere, Cold Wave is declared. For declaring cold wave etc. WCTn only is used and when it is < 10°C only, cold wave is considered. [4]
9.	Cold precipitation with	When cold is accompanied by any type of precipitation which further reduces the temperature.
10	Normal Weather Conditions (Prevailing climate of the region)	

Table 2 Weighted Average Score of Ten Weather Conditions according to Kuppuswamy's SES Class, Raipur

Weather Condition	Upper	Upper Middle	Lower Middle	Upper Lower	Lower
Normal	1	1	1	1	1
Hot Day	5	4.53	4.59	4.97	2
Hot Humid	6.43	6.37	6.49	6.86	8
Heat Wave	7.91	7.95	8.09	8.57	4.5
Light Rain	5.56	5.89	5.78	5.84	7.5
Heavy Rain	8.32	7.95	8.09	7.69	9
Very Heavy Rain	9.67	9.58	9.64	9.24	10
Cold	2.08	2.27	2.30	2.25	4.75
Cold Wave	3.67	3.78	3.61	3.71	5.75
Cold With Precipitation	5.32	5.68	5.32	4.85	7.5

## II. Case Study Areas

Two Indian medium size cities, namely; Raipur and Jamshedpur were selected for the study. Four hundred and eighty responses each, from both the cities were collected in summer, monsoon and winter to prevent internal bias. Only 430 responses in Raipur and 444 in Jamshedpur were found valid for analysis. All the respondents were then categorized according to Kuppuswamy's socioeconomic status scale (SES).

## III. Results and Table

To assess the perceived severity of the inclement weather condition, Respondents were asked to rank normal and nine inclement weather conditions from 1 to 10, 1 being not at all important to 10 being very important. To calculate the weight of each weather condition, the rank number was assumed as a perceived weight of each rank, then the frequency of occurrence of that rank was multiplied with its weight and all the responses were added and then divided by the total number of respondent in that category to calculate the score. The scores were then compared, to rank weather conditions. Table 2 and table 3 indicate the weighted average score of ten weather conditions according to Kuppuswamy's SES class.

Table 3 Weighted Score of Ten Weather Conditions according to Kuppuswamy's SES Class, Jamshedpur

Weather Condition	Upper	Upper Middle	Lower Middle	Upper Lower	Lower
Normal	1	1	1.01	1.02	1
Hot Day	4.2	4.38	4.15	4.43	2.5
Hot Humid	6.06	6.32	6.38	6.56	3.7
Heat Wave	7.66	7.8	7.95	8.07	6.1
Light Rain	5.6	5.63	5.10	5.09	1.3
Heavy Rain	8.33	8.07	7.84	7.91	6.3
Very Heavy Rain	9.26	9.67	9.65	9.66	9.8
Cold	8.13	2.53	2.7	2.47	3.6
Cold Wave	3.93	3.77	4	3.91	6
Cold With Precipitation	5.8	5.66	5.98	5.76	7.6

Upper class appeared to have similar perceived severity of the weather condition in both the cities. Very heavy rain appeared as the most severe inclement weather condition while commuting,

followed by heavy rain in both the cities. In Raipur, heat wave seemed to be third and hot humid as fourth in severity scale, followed by light rain. In Jamshedpur cold appeared as the third and heat wave as fourth important inclement weather condition, followed by hot humid. After this, cold with precipitation appeared to be equally important in both the cities. Hot day, cold wave, cold, didn't appeared as concerning weather while commuting in Raipur, Similarly, light rain, hot day and cold wave weather conditions didn't seemed important in Jamshedpur.

Upper middle class seemed to show similar preferences like upper class. Very heavy rain appeared to be the toughest inclement weather condition, followed by heavy rain in both cities. Heat wave appeared to be equally important in Raipur as heavy rain, but in Jamshedpur, it ranked third. In Raipur, cold with precipitation appeared next in line whereas in Jamshedpur it was light rain. Hot day, cold wave and cold didn't seem to be pressing inclement conditions in both the cities.

In lower middle class, heavy rain and heat wave appeared as important inclement condition after very heavy rain, while commuting, whereas in Jamshedpur, heat wave seemed to be most important after very heavy rain. Surprisingly in both the cities, hot humid day appeared as third severe inclement condition, followed by light rain in Raipur and cold with precipitation in Jamshedpur. Hot day, cold wave and cold day, didn't appear to be a bothering condition in both the cities.

Similar ranking pattern were observed in Jamshedpur in lower middle and upper lower class. After very heavy rain, heavy rain in Raipur and heat wave in Jamshedpur appeared as most considerable inclement condition. Light rain seemed to be fourth in line in Raipur, whereas, it was hot humid followed by cold with precipitation in Jamshedpur. Hot day, cold with precipitation, cold wave didn't appeared to be important enough in Raipur, same could be said for light rain, cold wave and cold in Jamshedpur.

In lower class, again very heavy rain appeared to be most significant in both the cities, followed by heavy rain in Raipur and cold wave in Jamshedpur. Hot humid condition seemed to be third most important concern in Raipur, same can be said for heavy rain in Jamshedpur. Light rain and cold with precipitation appeared to be equally important for Raipur commuters whereas, heat wave seemed to be fourth severe climatic condition in Jamshedpur. Cold wave in both the city seemed to have same impact on the commuters. Cold, heat wave and hot day didn't appear to be important enough to have a considerable impact in both the cities.

#### IV. Conclusion

After summarizing above finding it was observed that, very heavy rain appeared to be the most severe inclement condition in both the cities, followed by heavy rain in Raipur. In Jamshedpur,

heat wave seemed to be second problematic condition in lower middle, upper lower and lower class. Normal day appeared to be of least concern and had travel pattern BAU( business as usual) in both the cities, followed by hot and cold day.

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