

Climatic Phenomena and Traffic Safety Management in Mountain Roads of Iran

(Case study: Sanandaj – Hamedan road)

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Abstract

Accidents are one of the bad aspects of each kind of transportation system, especially the road transportation. There are always four elements interfering in this disaster: human, vehicle, road and environment. Among the environmental elements the climate and related phenomena are the most effective ones. Although these phenomena are inevitable and even in some cases are out of human's control and empowerment, we can reduce the effect of some of them to minimum level by helping road designing methods and on time attending of the road maintenance agents in the place.

In this paper, first the critical threshold of Sanandaj-Hamedan road is determined as a case study and then the accidents of this road are analyzed in the cold months of the year, in order to check the effect of climatological parameters on safety of road transportations.

The obtained results of the data analysis are as follows:

- 1- March is the most dangerous month in Sanandaj - Hamedan road in which gales flow (with the speed of more than 10 m/s).
- 2- January is the most dangerous month for the visibility of less than 1000 m, frost and snowfall.
- 3- Among the atmospheric instabilities, most accidents have occurred under cloudy weather.
- 4- The most accidents occurred in March whose rate is 22.4 percent.
- 5- The most accidental part sheet in Sanandaj- Hamedan road is the first segment (1-5 km from Sanandaj).

Key words: CLIMATE/ ACCIDENT/ TRANSPORTATION SAFETY/ CRITICAL THRESHOLD/ SANANDAJ - HAMEDAN ROAD

1. Introduction

Transportation in a country plays the role of vessels in a body which human's health is depended to their health and verity of them and their blood. As describes it is a change of time and place of people's position and goods by using the technical tools (vehicle and road).

One of the undesirable sides of each transportation system which can be mentioned is accident. A majority accident occurs when the vehicle can not adapt itself with the environment. We should always consider four elements of human, vehicle, road and environment together in analysis of this heart – rending phenomenon. Although different experts like geologists, geomorphologists, civil engineers, economists, industrial designers and etc, have studied the case according to their kind of skill and view, because of complexities and connection of the four elements, we can not blame anyone or any certain factor in the happening accidents. According to the present growing trend of the roads section, vehicles, and their expected growth in the future, it is more necessary to do research studies in this area.

The safety of roads and transportation is one of the issues which form the basis of traffic engineering and transportation planning. Now a day in the developed countries along with the development of the other sections of the traffic engineering the issue of safety is considered too, and by doing necessary studies and attempts it is tried to reduce the accidents and the subsequent accidents to the minimum level. But unfortunately in Iran and other third world countries the

number and the rates of the accidents have an upward trend because of the oversight to the safety guide lines and the factors which affects them. So accidents and their consequences economically and emotionally impose a lot of problems to the society.

Among the factors affecting the safety of transportation and accidents we can mention climatic phenomena some of which effect directly and some others indirectly the safety of transportation. Although this phenomenon is inevitable and in some cases out of human control, but we can reduce the subsequent effects of some of them by using methods in road design and on time attending of the road maintenance agents in the place.

The case study road is 153.717 km length and located in the west of Iran, among the Zagross Mountains toward west to east which connects Kurdistan province to Hamedan province (figure 1).



Figure 1 – Sanandaj – Hamedan road in the west of Iran

2. Data and Method of Research

In this paper in order to check the effects of climatic parameters on safety of transportation, first critical threshold of Sanandaj – Hamedan road was considered as a case study and then the accidents in the cold months of the year in this road were analyzed. In order to clarify the critical threshold in this road, meteorological data was necessary which was prepared from the Iran Meteorological Organization (IMO). The data included hourly data and daily data of temperature, humidity, precipitation, wind, horizontal view and snowy days of synoptic station of Sanandaj, Ghorveh and Hamedan. Period of 10 years (1994 – 2003) is also selected according $y = [(4.030t) \log R]^2 + 6$ to enough data test, Mackus technique, on the Resolution level of 90% and quantity degree of freedom ($y = 6$). The rate of the accidents in cold months of the year was collected from the beginning of October to the end of April from the police assistant of Kurdistan province.

4. Data Analysis

4.1. Analyzing the critical thresholds

4.1.1. Storm

April is the most dangerous month because of storms more than 20 Knot. So that Ghorveh station with 9 storms is one of the critical areas is in this road. The drown wind rose also show the direction of storm as southern for Sanandaj, southwestern for Ghorveh and western for Hamedan. March and May are two other dangerous months for storms, especially March can break the order in trafficking the vehicles because of the direction of storms (figure 2, 3 and 4).

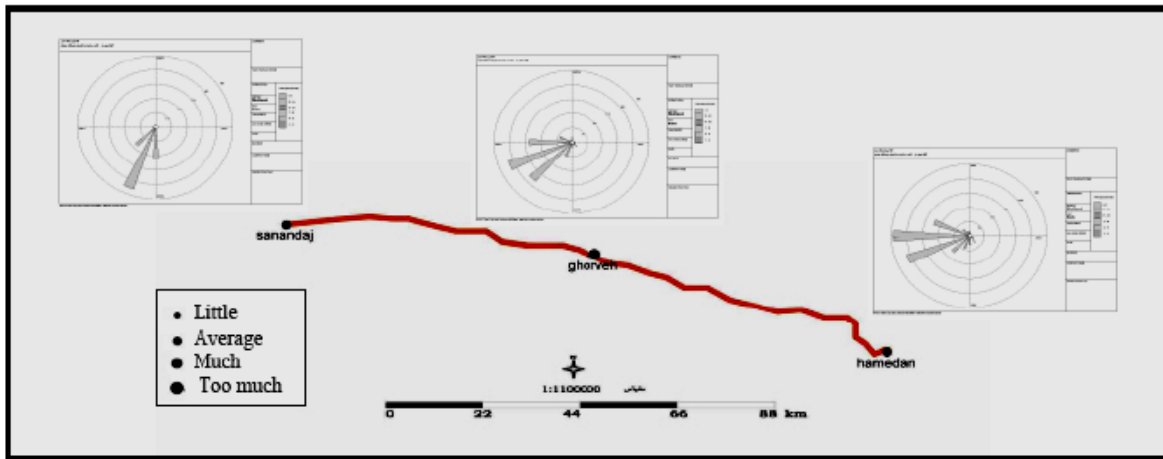


Figure 2. Map of place distribution of points frequency of with speed more than 20 Knot (April)

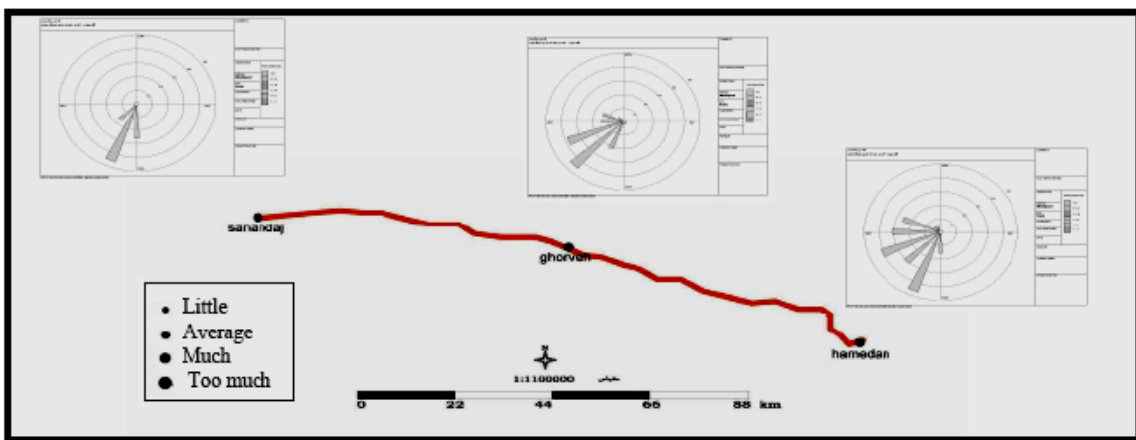


Figure 3. Map of place distribution of points frequency of with speed more than 20 Knot (March)

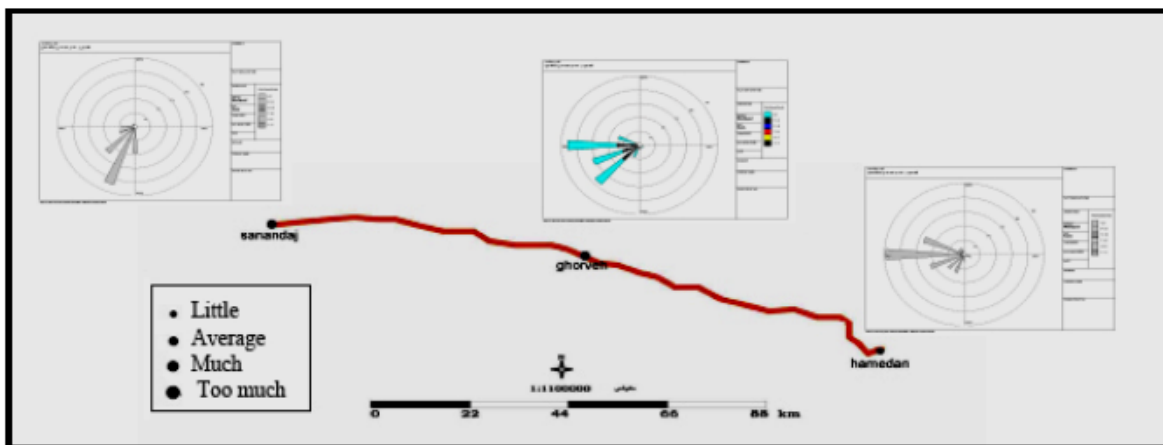


Figure 4. Map of place distribution of points frequency of with speed more than 20 Knot (May)

4.1.2. Visibility less than 1000 m (fog)

January is the most dangerous month for Sanandaj – Hamedan road because of fog. So that the Ghorveh station has a critical situation in this month. From the point of view the hourly distribution of the fog clarified that about 75% of the critical fogs belong to Ghorveh and Hamedan stations between 9 PM to 6 AM. The kind of fog at this time is radiation fog and this is because of the angle of sun radiation in this season and also coldness in this month is compared with the other season.

December and February in raw are the second and third dangerous months for visibility less than 1000 m. All the fog in December is created between 12 o'clock at night and 9 AM. Also among them radiation fog is more than the other kinds (figure 5, 6 and 7).

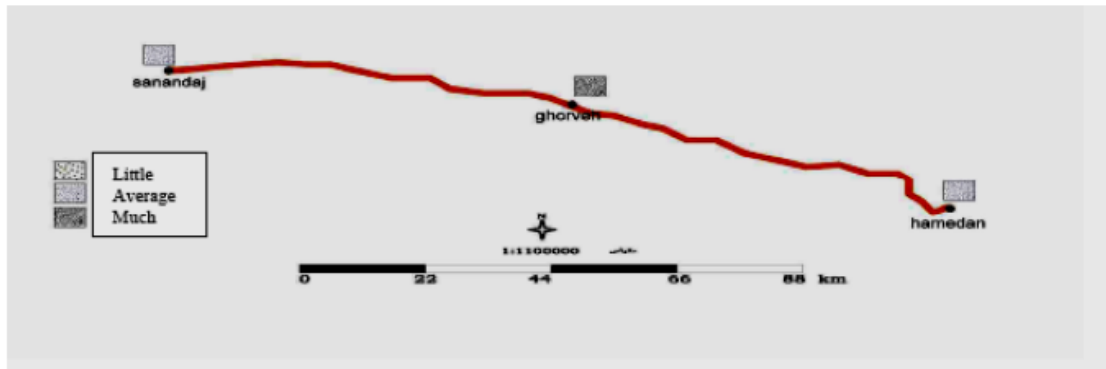


Figure 5 – Map of place distribution of points frequency of with visibility less than 1000 m (January)

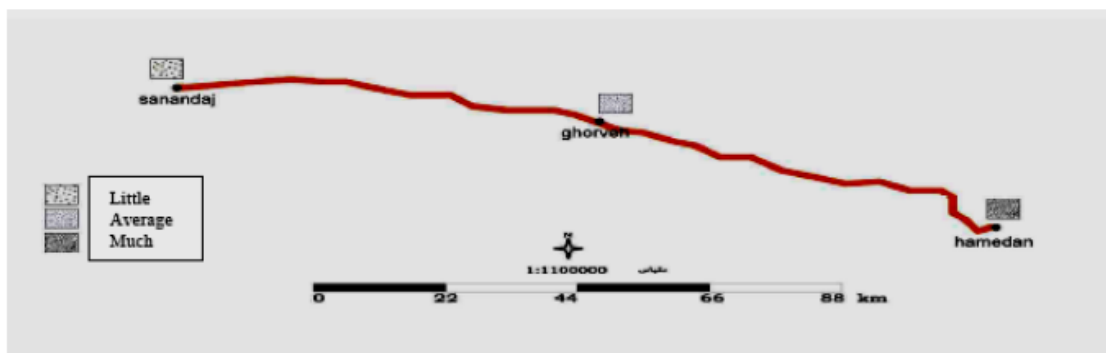


Figure 6 – Map of place distribution of points frequency of with visibility less than 1000 m (December)

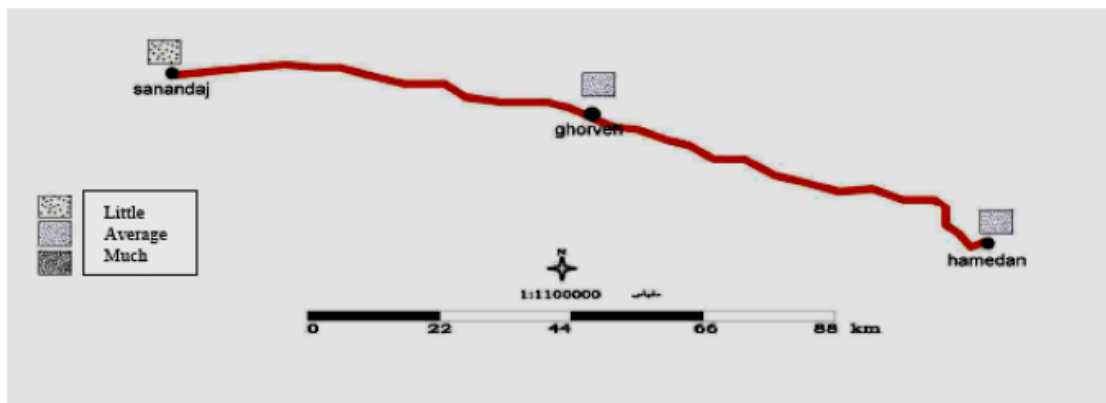


Figure 7 – Map of place distribution of points frequency of with visibility less than 1000 m (February)

4.1.3. Frost and rainfall

According to the calculation done in Sanandaj – Hamedan road frost mostly occurs in September. The first frost in Ghorveh station occurs on the 30th September and the reason for this early frost is the high elevation of the region but as we advance toward east or west from Ghorveh because of lower elevations, the first frost will be delayed. The time of the first and the last frost in the three stations are shown in the table No – 3, and also their place of distribution is shown according to the road elevation in the pictures No – 8 and 9.

Table 3 – time of first and the last frost in the Sanandaj-Hamedan road on probability level 75%

Climatic parameter	Time of first frost	Time of last frost
Station		
sanandaj	22 October	18 February
Ghorveh	29 September	5 March
Hamedan	7 October	27 February

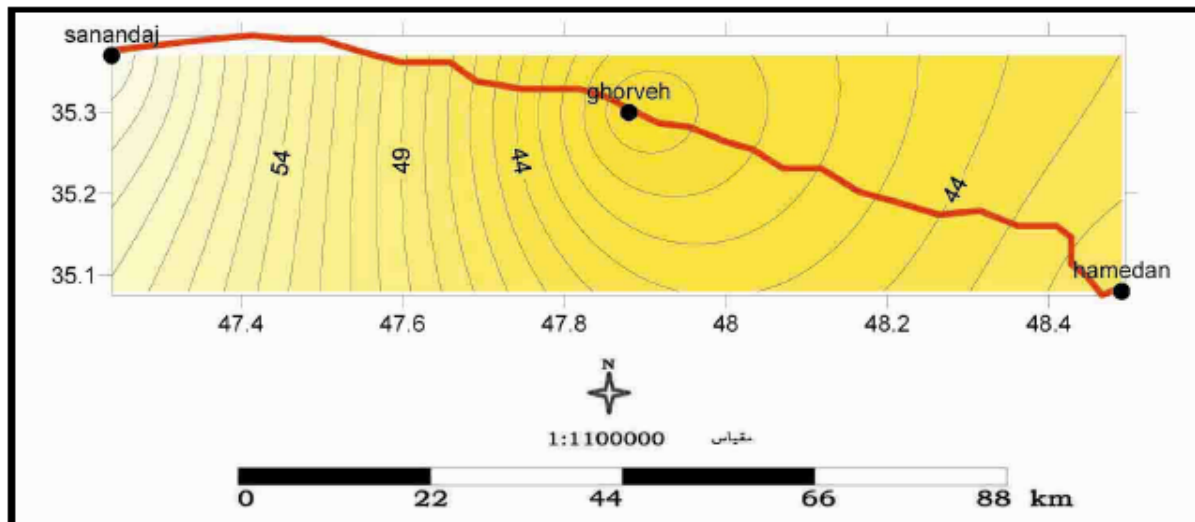


Figure 8- map of place distribution of first frost on Sanandaj-Hamedan road

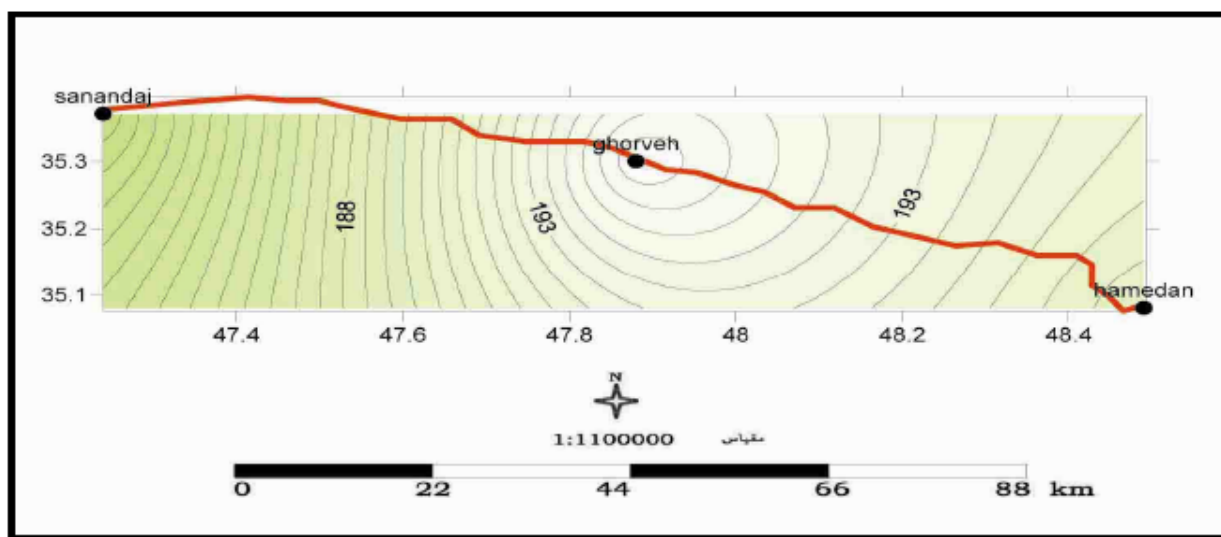


Figure 9- map of place distribution of last frost on Sanandaj-Hamedan road

As the last frost finishes at the beginning of March according to the table NO 3, it is important to know that the kind of frost which may be dangerous for transportation system, occurs at the temperatures less than 2°C and humidity more than 80%, so mostly this case occurs in January.

The first snowfall in this road occurs in the Ghorveh elevation around the first days of November, but in other stations (Sanandaj and Hamedan) snowfall delays because of their elevation, so the snowfall delays until the end of the November in Sanandaj station. And the last snowfall occurs in the middle of February. Table No 4 shows the time of the first and the last snowfall in Sanandaj – Hamedan road and also place distribution of the first and the last snowfall. Also some maps provided to show the place distribution of the first and the last snowfall are shown in the pictures No 10 and 11.

Table 4 – time of first and the last snowfall in the Sanandaj-Hamedan road on probability level 75%

Climatic parameter station	Time of first snowfall	Time of last snowfall
sanandaj	24 November	30 January
Ghorveh	6 November	12 February
Hamedan	14 November	7 February

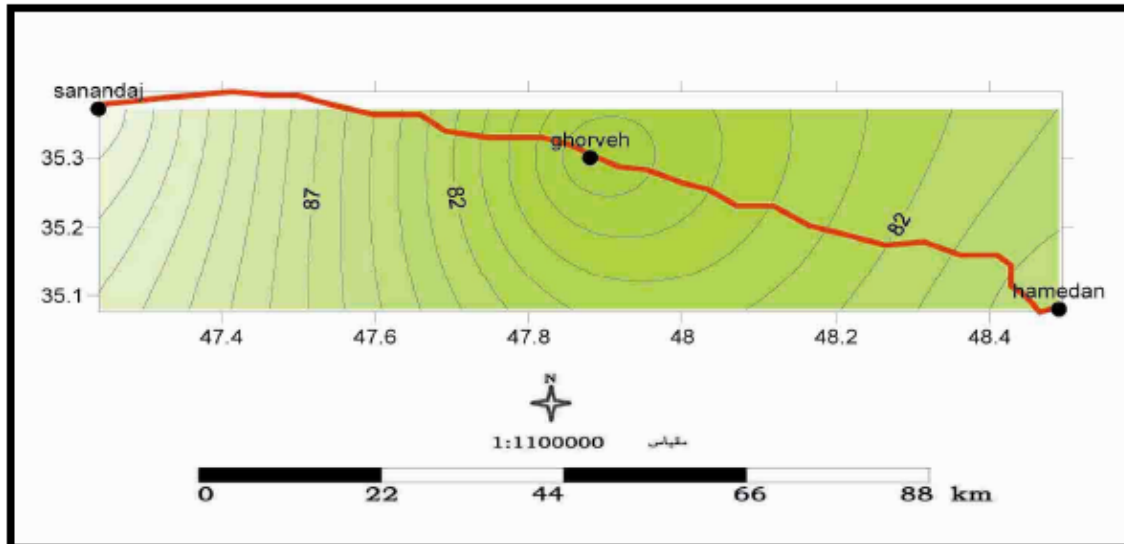


Figure 10- map of place distribution of first snowfall on Sanandaj-Hamedan road

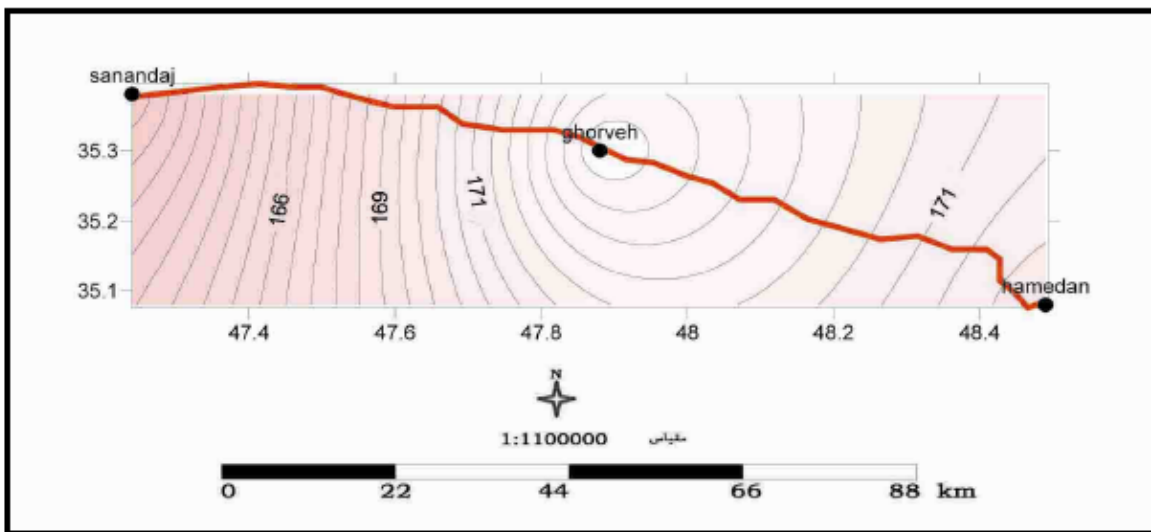


Figure 11- map of place distribution of last snowfall on Sanandaj-Hamedan road

4.2. Analysis of the accidents and their relation with the weather condition

According to the analysis most accidents in the cold months of the year in Sanandaj-Hamedan road occurred when the sky is clear and the traffic rate is high. When the weather is unstable in the road the rate of the accidents decrease because of the lighter traffic. Among the unstable atmospheric phenomena most accidents occur in the high humidity condition. This condition affects the drivers emotionally and makes them feel tired. In this situation the drivers hurry up in order to not be trapped in the rainfall or snowfall, and this is an other reason for accidents. Snowfall and frost are the second phenomena which can affect the rate of the accidents in this road (figure 12).

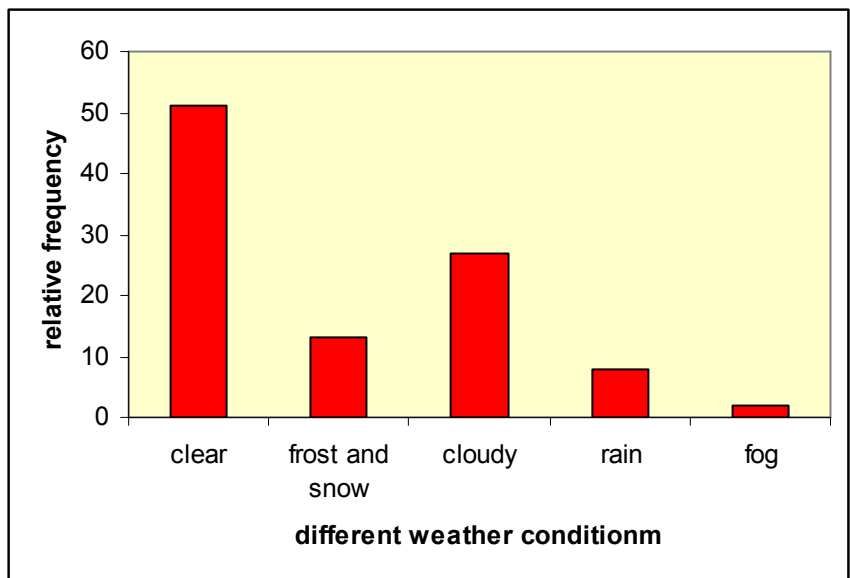


Figure 12 – diagram of relative frequency of accidents rate in different weather condition in Sanandaj-Hamedan road

Among the accidents which occur during the cold months of the year, most accidents belong to March, which is 22.4%, and the reason is the high rate of the traffic because of the New Year vacations (New Year in Iran begins on the 20th March). November is the second month of the year in which most accidents occur (figure 13).

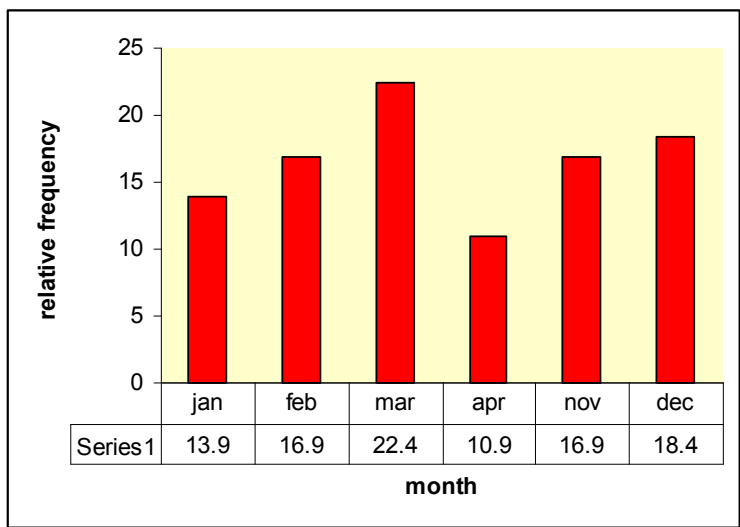


Figure 13 – diagram of accidents rate of Sanandaj-Hamedan road in during the cold months of the year

Most accidents have occurred during the daylight, between 1 PM to 9 PM, because of the rate of the traffic, and the least rate is between 12 PM and 6 AM (figure 14).

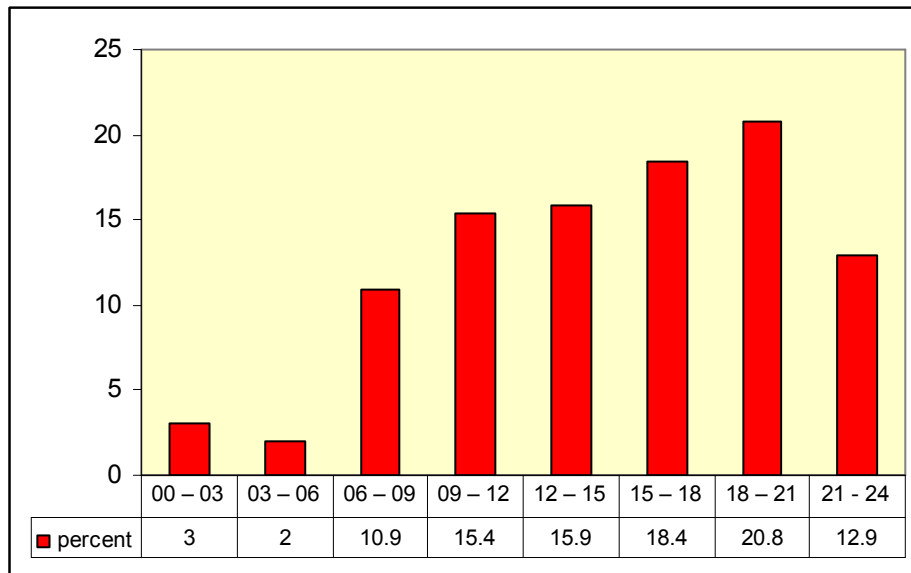


Figure 14 – diagram relative percent of accidents in hours of different in one day in Sanandaj-Hamedan road

In order to check the accidents in different distances, we have divided Sanandaj – Hamedan road and considered each 5 kilometers as a sheet which is shown as a diagram (figure 15). According to this diagram, in the first sheet, 23 accidents, in the 3rd sheet 16 accidents, and in the 2nd sheet, 13 accidents have occurred. The first sheet has had the most rates of accidents and the 3rd and 2nd sheet have had the second and third rate of accidents in raw.

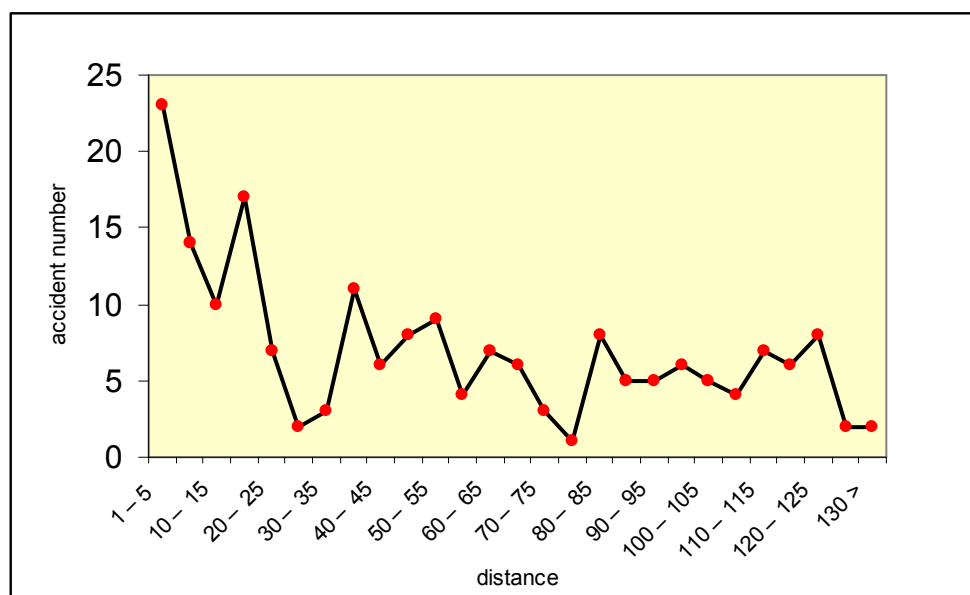


Figure 15 – number of accidents in different distance in Sanandaj-Hamedan road

Most accidents have occurred on Fridays (this day is weekend in Iran), which include 20% of all the accidents in this road especially in the distance between Sanandaj – Hamedan police station and Salavat Abad village where had the highest rate of accidents during holidays (figure 16).

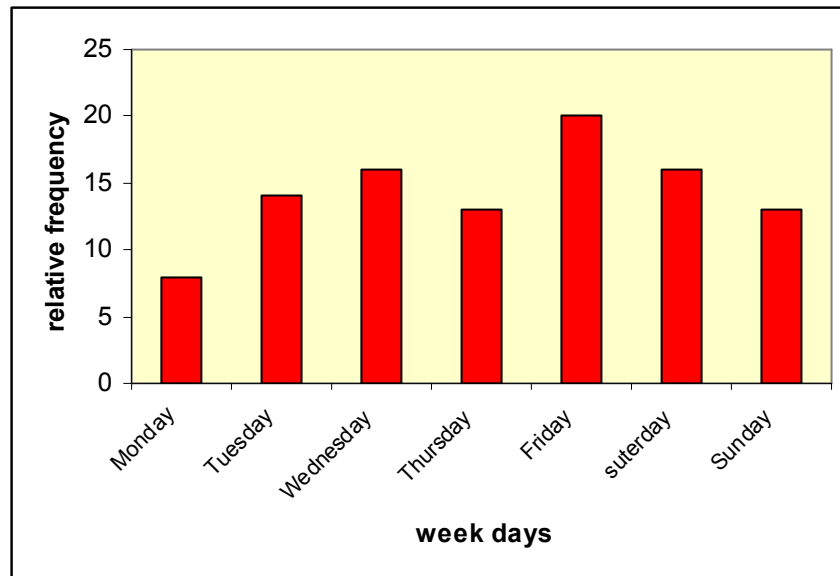


Figure 16- diagram of relative frequency of accidents rate in weekdays in Sanandaj-Hamedan road

5. Determining the dangerous segments according to the climate in Sanandaj – Hamedan

Most accidents in snowfall and frost have occurred in December and January, and the 4th segment (15 – 20 km) from Sanandaj has been the most dangerous sheet.

Most accidents in rainfall have occurred in November and March and the 4th segment (15 – 20 km) from Sanandaj is known as the most dangerous sheet in the mentioned months.

Most accidents in fog have occurred in January and February at Salavat abad Pass and 17th segment (80 – 85 km) from Sanandaj is the most dangerous part.

Most dangerous part in storm has been the 5th segment from Sanandaj and Hame Kasi region Between Ghorveh and Hamedam. The 5th segment is a corridor for the south-west wind to the north-east which causes some accidents.

6. Suggestions

Atmospheric condition of the mountainous regions has a main role in the rate of the accidents, damage and death. In order to reduce the mentioned condition to the least level following suggestions and strategies are given:

- Educating police to use GPS in order to register the data like altitude, longitude and latitude about the place in which the accidents occur. The registered data will be used by traffic engineers and road meteorologist.
- Installation of two roads meteorological sites one in the Salavat abad Pass between Sanandaj and Ghorveh and the others between Ghorveh and Hamedan. These two sites will register and send the data about the road surface and climatic parameters related to transportation to meteorological organizations in Sanandaj and Hamedan city.
- Controlling the speed of the vehicle at 3 PM to 9 PM in January and February (because of the frost and fog in these months).
- Controlling public transportation vehicle like bus and cars carefully. They should carry on safety tools (like chin) and check their vehicles before leaving in January, February and March.

- A constant relationship among meteorological organization with Sanandaj-Hamedan police station, Red Crescent, transportation organization and medical centre during December, January and February and March.
- Broadcasting in time the information about the road condition especially in unstable atmospheres by radio and television (each two hours) by meteorological organization.

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