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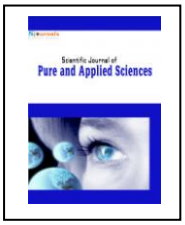

Original article

Spatial analysis of hail and its suppression methods (case study: East-Azerbaijan province, Iran)

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ABSTRACT

Atmospheric hazards are considered as the main environmental hazards, which threaten plants, animals and human communities. Hailing is one of these hazards which cause a lot of damages to different activities, especially agriculture, transportation, economy and so on in the world. East Azerbaijan is one of the main areas of these activities in Iran. In this paper to study the time and place of occurring of hail in East Azerbaijan province, the data are collected from 10 synoptic stations in a span of 10 year-time (2001-2010). For presenting the diagrams Excel software and for zoning GIS software were used. The results of this study show that the most proportion of hailing is related to Marand St. with 10 times falling, and the least one is related to Jolfa St. with only one time falling of hail. This issue is clearly observable in zoning map of the province. Time survey for hailing showed that the most rate of hail falling is occurring in April which is 23 times and the least one is related to September which is only one time. In the circular diagram for seasonal falling it is considered that the most rate of hailing is in the spring which is 49 times and the least one is in the summer which is 8 times. In the rest of this study the principles and fundamentals of decreasing hail is discussed and methods of decreasing damages and hail suppression is studied.

1. Introduction

Environmental hazards are inevitable parts of daily life that human beings are encountered whit them, in some methods every day. Most of environmental hazards have the atmospheric origin which is the most outstanding case of hazards in the world. When atmospheric elements become more individually, they form one danger (Mohamaddi 2009, p. 33). Atmospheric hazards are resulted from different reasons and are taking place in great scales. One of this hazards is hailing, which is the result of intensive vertical droplets of rain that is happing in thunderstorms. Hailing consists of circular dark cores and if it is broken shows concentric shapes and they are made up in frequently steps under the freezing temperature.

Hailing causes a lot of damages in agriculture, transportation, economy and etc. yearly in all over the world. Damages caused by hailing are sometimes greater than the storms and hurricane ones. Most of these damages are related to agriculture activities especially in the beginning of spring in which some hailing causes a lot of irreparable damages and decrease the amount of crop-growth. (Ashjaei, 1997, p. 115). The most important problem in air transportation, except from thunder bolt, is hailing. Hailing for 10 to 20 minutes causes serious damages for the air plane (Asyaie, 2007, p.203).

Apart from all these cases big hailing beams causes to kill or injury small and big animals and even human beings. Therefore the ability to know, predict and applying the methods to suppress and prevent of falling this in order to reduce the damages is of great importance. Predicting the serious and severe storms and hailing which are as a result of unstable atmospheric conditions is very complicated. Due to the geographical and special statues in each place, there are some areas which are more inconsistency than other places. Furthermore the time life for these Activities is short. These Activities are not just made up with one factor but are based on the combination of different factors which are used to evolve them. Therefore determining the type and the time when the Activities occurs is very difficult. Predicting of hail is usually followed by predicting strong storm, which is happen after the strong storm. By determining the factors that make this Activities the time of hailing can be identified. Increasing the amount of information about atmosphere and accurate prediction time of hailing is necessary (Ashjaei, 2001, p.116). Hail is happening in several parts of Iran because of special climatic conditions. According to Seyf (1997) which studies the distribution of hail in the country, the west and north-west parts of Iran including Azerbaijan are the main areas for hail falling.

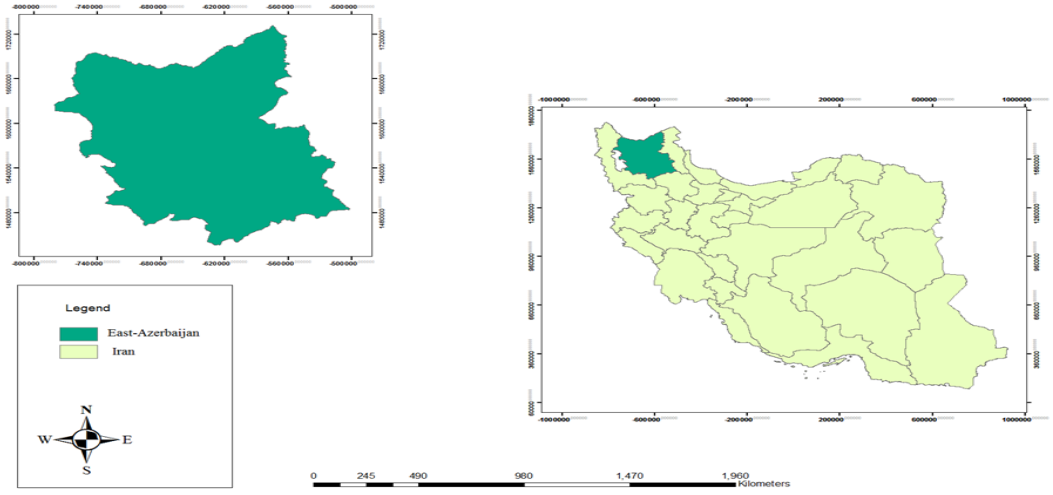

Fig..1. Geographical Position of East-Azerbaijan.

East-Azerbaijan province is located in the North-West part of the Iran (Fig.1). The existence of seven mountainous regions, valleys and plains among them make unique topographical differences in this province. Placing on the method of different air masses which blown up in different seasons, causes air fallings and moderate weather in this province. High elevation condition is an important factor for making cold weather in most parts of this area. Cold weather condition of this area is resulting of streams of air currents that causing 142 hailing occurrence in a year. East-Azerbaijan imposes to different hails and receive a lot of damages every year in

the gardening and agriculture areas. For example, according to agriculture organization in 2007-2008, 76136 billion Rails, in 2008-2009, 739190 billion Rails, and in2009-2010, 855820 billion Rails is the cost of hail damages. This is just small part of environmental damages which happened every year in the province.

2. Methodology

In climatological researches, weather statistics are the main resources of study. In this research the data of 10 synoptic stations of East-Azerbaijan in 10-year span (2001-2010) were used. In these stations, the synoptic codes are recorded after every three hours observation and are announced. In these codes all of the climatological factors and existing Activities with their sorts, intensity and amount of them are recorded. Meanwhile codes of seventh group (7www1w2) shows the conditions of present and past air that consists of 100 codes. These codes are related to the information of sort, intensity and amount of atmosphericActivities, during observation and 3-previous hours. For data related to hailing in present air group codes (99, 27, 89, 88, 87, 90, 93, 96) are used, which different kinds of hailing with different severity is considered (table 1).

Table 1
table of present-air codes (7www1w2).

Transmittal code	Description
27	In the past hour there was hailing which in the time of observation was stopped.
87	Hailing with or without rain and snow and the combination
88	Light hailing and moderate one with or without rain and snow
89	Hailing with or without rain and snow and combination and without storm
90	Moderate and severe hailing with or without rain and snow or combination and without storm
93	Rain or snow or combination of two in the time of observation and thunder storm in the past hour
96	Light and moderate thunderstorm with hailing in the time of observation
99	Severe thunderstorm with hailing in the time of observation

For determining the general view from distribution of hail and the differences of several regions in East-Azerbaijan, time and place of occurring hailing is studied. For presenting diagrams excel software and for zoning GISsoftware are used and then the methods of suppressing of hail were applied.

Results

By using existing data the frequency of hailing in East-Azerbaijan, is studied. Table (2) shows the frequency of hailing in synoptic stations of the area.

Table 2
frequency of hailing in synoptic station in East-Azerbaijan (2001-2010).

ST.	Ahar	Bonab	Jolfa	Maraghe	Kalibar	Marand	Mianeh	Sahand	Sarab	Tabriz
Frequency	5	3	1	9	7	20	15	11	8	14

As it is shown in table (2) the most amount of hailing is related to Marand St. with 20 times. Mianeh St. with 14 and Tabriz St. with 15 times hailing has the most frequency of hailing occurrence in the province. The least occurrence of hailing is in Jolfa and Bonab St. with 1 and 4 times respectively. (Fig.2) is the cylindrical diagram of hail frequency of in synoptic St. of the East-Azerbaijan.

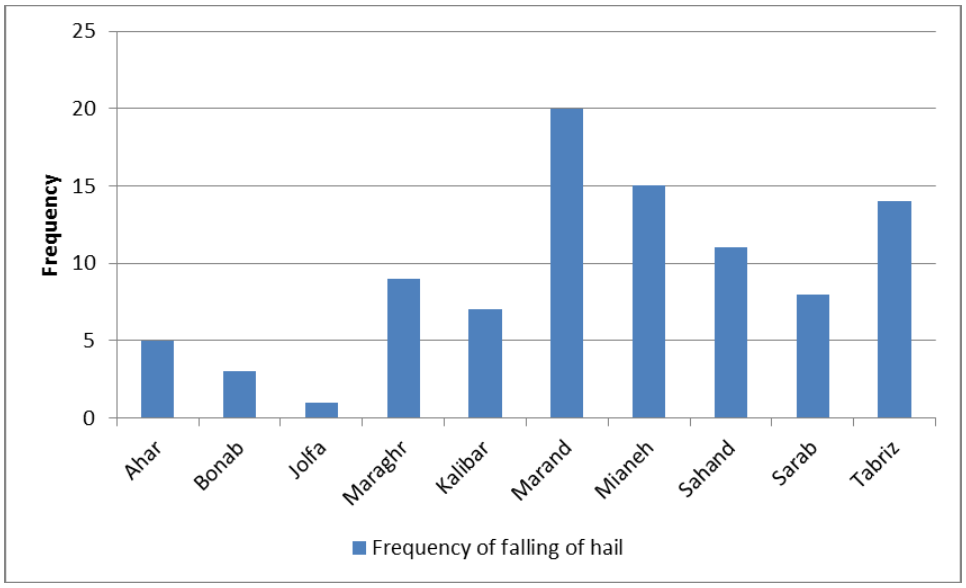

Fig.2. Frequency of hailing in synoptic stations of the East-Azerbaijan (2001-2010).

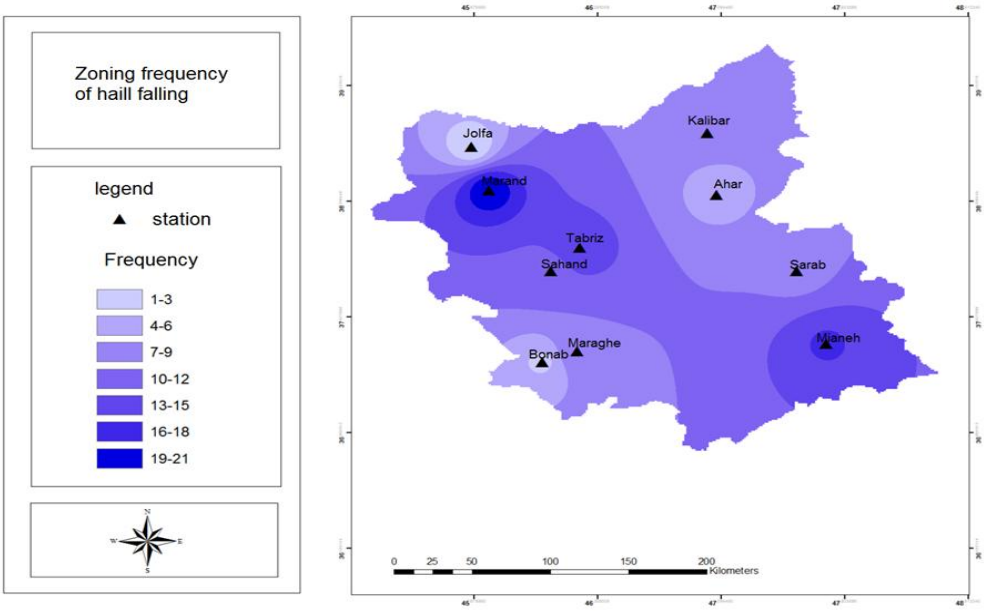

Fig.3. Zoning map frequency of hailing in synoptic stations of East-Azarbaijan (2001-2010),

According to Fig.3 which is zoning of hailing in theEast-Azarbaijan, two center of maximum falling is observed, first in south-east with the center of Mianeh St. and another in north-west with the center of Marand St. Generally the most frequency of hailing was observed in along of central area of province in direction of north-west to south-east.

In order to survey of the time of hailing in East-Azerbaijan, monthly and seasonal distribution of hailing is considered. Table (3) shows the frequency of monthly falling and table (4) shows the seasonal hailing in the province. As it is observed the most amount of monthly falling is occurs in April with 23 times and the least one is related to September with only one case. In circular diagram seasonal falling is observed. Spring with 49 times has the most hail falling and winter, autumn and summer seasons have 21, 15, and 8 falling respectively.

Table 3
Frequency of monthly hail falling in synoptic stations in Esat-Azerbijan (2001-2010).

Month of the year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Frequency	6	9	13	23	14	4	4	3	1	5	8	3

Table 4
Frequency of seasonal falling of hail in synoptic stations of East-Azerbaijan (2001-2010).

Seasons of the year	Spring	Summer	Autumn	Winter
Frequency	49	8	15	21

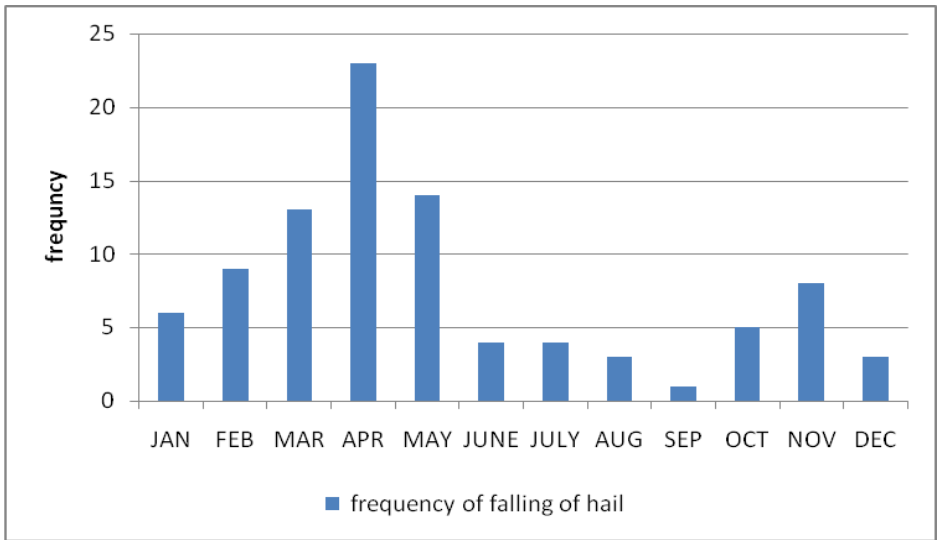

Fig.4. monthlyFrequency of hail falling in synoptic stations ofEast-Azerbaijan (2001-2010).

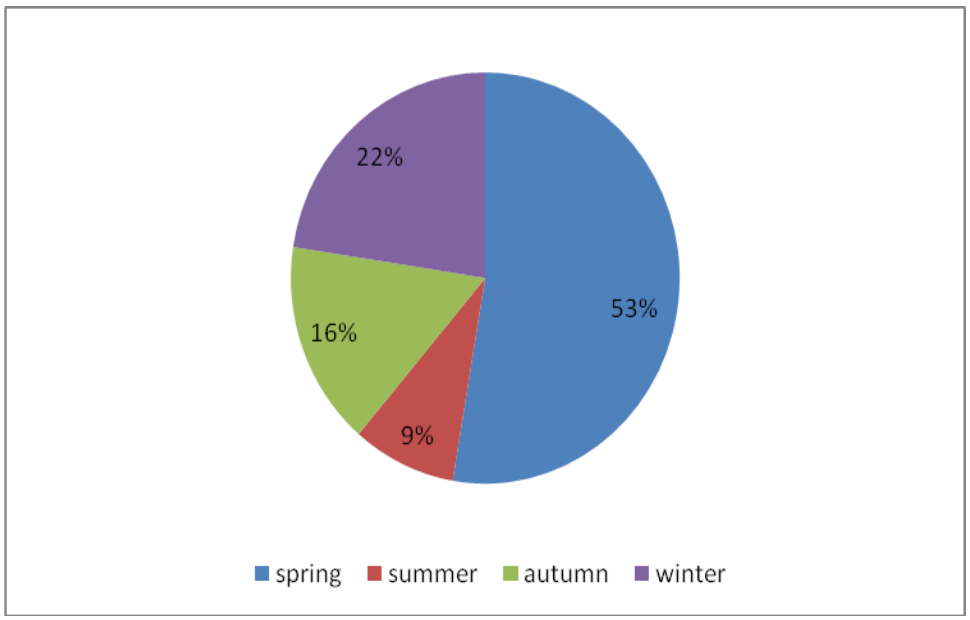

Fig.5. seasonalFrequency of hail falling in synoptic stations ofEast-Azerbaijan (2001-2010).

3. Hail suppression methods

Now a day, it is 50 years that this fact has been known that the human beings can affect the atmosphere to determine the amount and kinds of fallings. Establishing the science of physics, clouds and weather enables the man to overcome the destructive hazards of weather. This technology as an effective method is used to modify the amount of hail and fog, suppression the amount of falling and even affects the thunder and lightning (National center of studying and expedition of cloud seeding 1389, p.2). Hailing is one of the most important solid falling that more than 30 countries use the technology of hail- suppression. Because of the high speech in which the hail falls and the amount of its destruction, most studies have been done on the reducing the speed of falling the hail. In order to prevent or hail- suppression, a large amount of ice-making cores, such as silver repossession should be inserted to the clouds that have the ability to produce hail in a specific period of the time.

Increasing the number of ice-cores resulting from high dense of ice particles the competition for using water, increase the cold water inside the cloud. As a result it produces bigger pieces of hail and smaller ones but in large numbers. If hail pieces are small enough, while passing through the atmosphere have enough time to be melted but it only can happen in a temperature of above zero degree of centigrade.

In most projects cumulonimbus storms are seeded by using the airplanes or by using the rockets from the ground to the sky and also by using the ball containing ice-making cores and these are all successful in the reducing amount of damages. The most important factor which plays an essential role in removing the hailing is the time of getting seeding materials in to the cumulonimbus clouds and also the specific spots of cumulonimbus. The time life for all the clouds is less than 45 minutes and the time for forming hail in these clouds even is less than this time. So the scientists to achieve their goal of the cloud seeding prefer the transfer of the large amounts of ice making cores into the clouds during very short time by reacting of rockets and shells. They send these materials by using airplanes and rockets. Table (5), shows the characteristics of materials and equipment's used in hail suppression (Asyaie, 2007, p.4).

Table 5
Characteristics of materials and equipment's used in hail suppression.

Material type	Equipment's and common methods	Rate of seeding materials	Kind of weather modification
Combination of core making material like iodine silver	Rocket, launching bullet balls, air operation (mechanical seeding)	A large amount of artificial ice-making core(several iodine silver per KM), cement power 40-50-4 Kg for each cloud, %3 Kg for each Km of dry ice	Prevention or suppress of hail or splitting up the cloud

The most practically method that has ever been used to prevent hailing is launching the seeding materials by rockets in to the clouds. Hail suppression projects in Iran are also done signed to organize and apply the protective system from agricultural product to be damaged by hailing, with the application of Russian automatic rocket technology which has of great effect. In recent years most action and activities are done in Russia in order to hail suppression. Because of good experience and successful function in this country for hail suppression the best rockets for launching rockets are produced in this country.

In hail suppression technology one automatic radar control system is used to launch the rocket which is known as ANTIGRAD. This system has the following elements:

- ✓ Weather radar whit double wave length.
- ✓ Analyzing radar products software.
- ✓ Remote control for rocket containing computer, software communication system to launch the rocket.
- ✓ The above system presents the following products:
- ✓ Three-dimensional picture and recognizing the clouds in a distance of 350 Km (with 3 minutes distance).
- ✓ Identifying and determining hail-producing clouds and the clouds likely to fall hail in a distance of 150 Km.
- ✓ Locating the appropriate places to cloud seeding inside the hail-producing clouds in a distance of 80 Km.

- ✓ Locating the optimal rocket sites and controlling the launching of it. (Asyaie and Khanzanedary, 2007, p.191).

4. Conclusion

As hailing causes a lot of damages to the agricultural products and gardens of East-Azerbaijan every year, Agriculture organization decided to install the anti-hailing devices and equipment's in the province. These device work by using butane and propane gas and have 12 Km range. These devices prevent hailing by launching sound waves into the hail-producing clouds and changes the hail into the rain, which every one covering 150 Km of the covering lands. The purpose to use this technology according to the climate of the province is to protect the gardens from damages. Besides the real insurance of gardens is considered by agriculture organization and covering the whole gardens under the insurance of gardens and cattle with legal and educational ways.

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