

RESEARCH ARTICLE	A study on the effects of hail on agriculture and preventive measures in touristic areas of Azerbaijan	
Nariman A.Pashayev	Prof. Dr.	
	Azerbaijan National Academy of Sciences, Institute of Geography	
	Azerbaijan, Baku	
	Email: pasayevneriman@mail.ru	
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Abstract		
Although hailing is typical in mountainous areas of the world, it is impossible to avoid the social and environmental problems caused by hailstorm to human life and farming activities. According to the International Meteorological Organization, the cost of damage caused by hail to agriculture in the world is amounted to 6 billion US dollar each year. As a part of the mountainous countries of the world, Azerbaijan with its own physical and geographical conditions and geographical location is one of the South Caucasus territories affected much more by the hailstorm. As the result of the hailstorm, around 9 to 10 million US dollar is damaged to our economy. The hailstorm mainly causes damage to the agriculture sector. However, sometimes flora and fauna, cars, social infrastructure, the roof of residential areas and other buildings, livestock, electricity and communication lines, state and local communication network have been severely damaged by the hailstorm. Intensive hailstorm often is accompanied by the powerful lightning and the tornado over 20-30 meters per second. Although the hailstorm comparing with other natural disasters surround local areas, sometimes these events are accompanied by major property and environmental damages with its intensity and scale.		
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1. Introduction

Even though hailstorm is the natural process for its essence, creation, duplication and distribution, its results describe the socio-economic character for its damage to the human life and the agriculture. Therefore, investigation of the hailstorm as a complex problem from the economic-geographical point of view matter the scientific urgency. Studying of hailstorm considered as distinctive for the mountainous, foothill areas from the economic, and the geographical point shows that the hailing process in different regions along with its similar aspects have the significant regional differences. Investigation of the regional characteristics of the hailstorm depending on the location of agriculture and specification of hailstorm repeated and befallen areas play great importance in the forecasting of processes and the territorial organization of production. A.M.Sixlinski (1949), A.A.Madatzade (1957), F.A.Mutallibov (1964), E.C.Eyyubov, X.S.Rahimov (2000) and S.H.Safarov (2012) have important roles in studying the physical-geographical and the synoptic meteorological conditions of the hailstorm and N.A.Babaxanov and N.A.Pashayev (2004) in studying of the hailstorm from the economic-geographical point of view.

2. Discussion

Hail consists of spherical and shapeless ice crystals and usually arises from ball-rain clouds. Hail clouds arise in the cold atmosphere lines and mainly in the warm period, however, it is rarely related with a mass inside the process. Hail cannot form in the warm lines. Hail crystals can be in conical, pear-shaped, ellipsoid-shaped and formless. Depending on the forming condition, the density of hail changes between 0,6 and 0,9 g/cm². Being in possession of mountain terrain, having the vertical power of clouds, intense convection, cold lines and high-speed movement of air masses coming after them, the low temperature in the upper part of clouds play great importance while the formation of the hail. The speed of hail can reach 15-20 and sometimes 20-30 m/sec. Clouds should have high mellowness for the formation of the hail crystals. The diameter of hail can be 5 to 50 mm and more and it has more damage to the agriculture sector. Usually, hail is observed in the hottest period of the year when there is the high temperature. Strong hailstorm is accompanied by a tornado with the speed of 40 m/s. This kind of wind increases the damage caused by hail. Hail sometimes is accompanied by sustainable lightning and high intensive heavy rain, the area with the width up to 10 km and the length to a dozen, and sometimes hundreds of kilometers can be covered [13; 15; 17].

The diversity of the surface structure of the Azerbaijan has caused to unequal distribution of territory. Northeast and the south slope differ from each other in intensity and repetition of hail fall in the Greater Caucasus Mountains. The proximity of the northeast slope to the sea impacts on hail fall and there is the relatively unfavorable conditions for the formation of clouds. Convective currents arising hail are relatively intensive in the southern slope.

The average long-term data analysis on the frontal mountain of the Greater Caucasus southern slope indicates that hail fall is observed one time per year while the lower parts of the mountain this hail fall reach two times per year. The repetition of hail falls at the areas located 1000 m above the sea level increase 0,4 day per 100 m in height between 1000 and 2000 m. The territories up to 2300-2700 meters above sea level in the high mountainous areas have more hail repetition with 7-8 days. Most of the hail fall on the northeastern slope of the Greater Caucasus is observed at the height of 2200-2400 meters and its repetition is 3-4 days per year.

Lesser Caucasus is observed more hail fall than Greater Caucasus comparatively and hail fall on the northern and southern slope differs from each other. According to long-term data, hail fall is observed 1 time at the foothills of the northern slope of the Lesser Caucasus and 3 times at middle mountain areas. Most repeated event of hail is at the height of 2300-2700 m zone. Most repeated hail on the northern slope of the Lesser Caucasus reaches to 9-11 days per year and 7-8 days on the southern slope at the heights of 2400-2900 m.

The most repeated hail fall in Nakhchivan AR is observed at the height of 2800-3200 meters and it is equal to 5 to 6 days.

Hail falling days are about 2 days per year at the height of 1000-1200 m because of the lack of suitable conditions for the formation of hail clouds around the Talysh Mountains. Hail fall is observed less at the height more than 1200 m above the sea level. Hail falling event take place once every 2-3 years on the coastal areas [5; 13].

60% of hail occurs in April-May on the Kura-Araz lowland and coastal areas in May-June, the hail fall decreases in the mountainous areas (60-70%). Second maximum hail fall is observed in the autumn months of September-October at the lower and mountainous areas. Generally, hail fall is observed much more in May and June months in the most of our republic territories. Only in the Nakhchivan Autonomous Republic, intensive hail repetition occurs in April and May months. The reason of hail fall in region, which observed in April and May months is connected with Nakhchivan mountain ranges, valleys and their bare slopes [12; 15].

According to individual components changes of the climate in recent years, investigation of distribution characteristics on hail falling territories in this new circumstances and identification of changing tendency of its recurring arouse great interest. Data regarding to impact of hail on agriculture in Azerbaijan could be found consistently in document and data from 1960 to 1995 drawn up by State Insurance Department, annual materials published in the scientific research institute of Hydrometeorology of National Hydrometeorology Department of the Ministry of Ecology and Natural Resources from 2000 to this day and in Hydrometeorology Commission from 1966, in the reports of the Ministry of Emergency Situations Commission from 2006 to this day. By using personal observation materials and above mentioned sources, we have tried to study the damages caused by the hail to Azerbaijan agriculture sector. According to the analysis of the actual materials last 20 years, damages caused by hail to agriculture areas are not less than damages caused by other natural disasters.

Analysis materials between 1990-2015 years obtained by Ecology and Natural Resources Ministry National Hydrometeorological Department show that repetition of hail damage in different regions and districts of Azerbaijan are completely different (table 1).

Statistics analysis the impact indicators of hail on different regions of republic reveals the major problems in both local and regional scale. Ganja-Gazakh economic region is particularly remarkable in this area and more than 40% of damage caused by hail to the agriculture is related to this region. Ganja-Gazakh economic region with its 14% of the area and 13% of the population covers the north and northeastern parts of the Lesser Caucasus. The scientific analyzes show that, until the 1990s the repetition of hail in the economic region is 7-10 days and this figure with a decrease of 2 times in 2000-2015 become 3-5 days. The damage figures of hail are descending Gadabay, Tovuz, Agstafa, Dashkasan, Gazakh and Shamkir consecutively [18].

Repetition of hail damage in Azerbaijan (2003-2015)

№	The areas observed damages caused by hail	Repetition of hail process for years													Total
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
1	Gadabay	8	6	6		1	4	3		8	5	1	7	5	54
2	Dashkasan	6	4	3		1	4	1		8	3	1	7	5	43
3	Qazakh	4	5	1	1			2		1	3		1	4	22
4	Agstafa	4	4	1		1		2		3	3	1	1	4	24
5	Tovuz	4	3	5	3		2	1		3	3		6	3	33
6	Shamkir	3	2	4	1					4	2		7	4	27
7	Goy-gol	1		1						2	6	1	7	3	21
8	Samukh			1			1			1	2		2	2	9
9	Balakan	1		1	2				1	1	5		1	2	14
10	Zaqatala	1			2	1	1		1	1	5		3	2	17

11	Qakh	1		2				1	5		3	2	14
12	Oghuz	1		2					3		2	1	9
13	Shaki		1	1					3		1	2	8
14	Qabala			2			1		1	2	3	2	11
15	Shamaxy					1		3	5	2	1	1	13
16	Aghsu					2			2	1		1	8
17	İsmayilli		1	2	1	1	1	2	6	2	2	3	21
20	Tartar			1			1		2		2		6
22	Yardımlı								4				4
23	Lankaran							6					6
24	Nakhchivan IR			5			4	4	3	4			23
											4	2	
25	Goychay					1			2				3
27	Aghdash								4				4
30	Qobustan								4	1	1		5

Source: It has been compiled on the data of Hydrometeorological Department of Ecology and Natural Resources Ministry.

Only in 2000 year, 1.2-million man damage was caused to Ganja-Gazakh economic region and this amount is divided into 42% in Gadabay, 38% in Tovuz, 20% in Goy-Gol regions. 2,000 hectares of meadows, gardens, and 12440 pieces of the roof of 83 private houses fell into disrepair in Gadabay.

Hail crystals up to 1, 5 cm in Goy Gol region, up to 1,8 cm in Gadabay and 7-10 mm in Tovuz damaged seriously agriculture on May 27. Hail crystal in diameter 28 mm on May 6 and 38 mm on June 17 have been recorded in Gadabay and 3 thousand hectares of potatoes and other crops suffered from serious damage [1; 2; 6].

Strong hailstorm was occurred 4 times in Gadabay, 2 times in Gazakh and Goy-Gol and 1 time in other regions which known as generally Ganja-Gazakh economic and geographical region in May and August of 2001. The crops and roof of private houses of some residential settlements in Dashkasan region, Qaralar, Boyuk Qışlaq, Qardash, Cheshmali of Tovuz region, Goyelli, Hajilar, Mormor, Duz Rasullu, Qaravalilar of Gadabay region and Farahli and Boganis Ayrim of Qazakh region were suffered from hailstrom. A total of 1.8 million damage was caused to the economic region in 2001. The amount and cost of hailstorm damage in defferent years is estimated as follows: 12 times and 2.5 mln in 2002, 3 times and 36,8 thousand in 2003, 16 times and 2,2 mln in 2004, 26 times and 2,4 mln in 2005, 3 times and 22,4 thousand in 2007, 11 times and 786 thousand in 2008, 7 times and 690 thousand in 2009, 14 times and 2,6 mln in 2011, 27 times and 3,2 mln in 2012, 4 times and 148 thousand in 2013, 38 times and 3,7 mln in 2014 and 30 times and 2,8 mln in 2015. Overall 23 million manats was damaged to agriculture of Ganja-Gazakh economic and geographical region as a result of hailstorm in 200-2015.

Statistics analysis of hailstrom show the serious damage after Ganja-Gazakh in Sheki-Zagatala, Nakhchivan IR, the Upper-Garabakh and Kalbajar-Lachyn economic and geographic regions consecutively. For example, in 2000, hailstorm in diameter of 10 mm in Nehram village of Nakhchivan on April 21, 10-15 mm in Qullar and Hamida village of Balakan region on September 5, 10-20 mm in some mountains villages of Qakh regions was falled and

caused several damage. In 2002, hailstorm damaged on average 10-12 mln manat to construction and agriculture of country surrounding 15 regions of republic in wide range [1; 2; 4; 6].

Hail fall covering middle and partially high mountain areas of Greater and Lesser Caucasus coincided with the May-July in 2003 did not damage so much to agriculture. Hailstorm was more intensive in the Ganja-Gazakh economic region mainly in May-August months of 2004. Thus, hailstorm was fallen to Shusha and Khankandi at about 17:00 o'clock of June 21. Maximum size of hail crystal in shapeless pieces of ice was reached to 10 cm sometimes. Hailstorm was observed in the area of Qakh region at about 21:00 of June 10. The most powerful hailing process was happened on June 21 in our republic. Hail crystal fell to Lahyj village of Ismayilli region was sometimes reached to 10 cm in the form of shapeless piece of ice.

Analysis of materials about hailstorm indicate that, in comparing with other regions as opposed to previous years, the hailstorm damaged seriously to the plantation which coincided with the months of May-June of 2005 in Shaki-Zaqatala economic region. During this period, the hailstorm also fell and considerably damaged to the agriculture of the Mountainous-Shirvan and Guba-Khachmaz economic regions. 1480 ha territory in Shaki-Zaqatala economic region, 270 ha in Mountainous-Shirvan and 634 ha in Quba-Khachmaz region have fallen into disrepair because of damage done by hail. Compared to previous years, the hailing events have been observed very weak in the part of western regions, in the foothills zones of the southern slope of the Greater Caucasus and Shamakhy-Ismayilli and Nakhchivan AR in 2006.

The hailstorm in the country was very weak in 2007 compared with previous years. The hail was fallen and damaged to agriculture in Khynalyg on April 2, Khaldan on June 1 and Alibey on June 1. Hailstorm was observed in not only Ganja-Qazakh economic region, but also Zagatala, Gabala, Goychay, Tartar and Ismayilli and 1570 ha of plating lands have been determined to fall into disrepair in 2008 [1; 6; 7].

The most hail falling areas have been observed in Aghstafa, Gazakh, Tovuz, Shamakhy-Ismayilli and Nakhchivan Autonomous Republic in May of 2009. A hailstorm damaged seriously to planting as well as fruit growing. Hailstorm was observed in low and middle mountains areas of Greater, Lesser Caucasus in 2010, north, and northeast slope of Lesser Caucasus in 2011, as well as territories of Ismayilli and Quba-Kahchmaz economic regions. Torrential rains were accompanied by hail across the country in May, June, July and September months of 2012.

Hail crystal was recorded with the diameter of 20 mm in Qadabay, 17 mm in Zurnabad point of Ganja, 10-15mm in Shamakhi, 10 mm in Lankaran, 8 mm in Khaltan, 6 mm in Maraza and Ilisu, 5 mm in Dashtatuk point, and 0.5-1.0 mm in Tartar, Pirqulu and Ismayilli. In addition, hailstorm with different size was observed in Gazakh, Aghstafa, Tovuz regions, in Kalvazda, Saribash, Oghuz and Gabala.

According to information from Shamakhy RMS, intensive hailstorm was observed mainly in Shamakhy, Ismayilli, Maraza and Qabal on June 23, 2013. Hailstorm was observed in Khynalyg village of Quba region at 15:00-15:07 clock, in Kuzun village of Qusar with diameter of 6 mm at 15:30-15:38 o'clock, in Yuxan Aghjakend village of Goranboy region with diameter of 8 mm at 14:20-14:24 o'clock, in Oghuz station and Dahnasusay point of Quba region with diameter of 5 mm at 16:30-16:45 o'clock and in Pirsat-Poladly points of Shamaxi region at 22:00-22:45 o'clock on May 14 of 2013.

The hail has fallen with a diameter of 10 mm in Hacigarvand and Aghjakand villages of Tartar region and in Gadabay on May 1 and 7 at 2:20 pm. According to the Agstafa Radiometeorologic Station, there was evidence of hailstorm in some territories of Greater Caucasus.

According to Aghstafa Radiometeorologic Station, hail with the local character has fallen to some areas (Poylu village so.on) of Agstafa region around 19:00 o'clock on August 9. According to Goygol Radiometeorologic Station in 2014, hailstorm was observed with the diameter of 6 mm in Lankaran at 14:15 and diameter of 14mm in Gadabay at 13:35 on April 22. According to Ganja Radiometeorologic Station on April 26, the hail have been fallen to outside of the station at 00:30 o'clock. According to Agstafa Radiometeorologic Station, the hailstorm was observed in the area of Tartar and Barda region at 19:50. The evidence of hail with a diameter of 10 mm was observed in Shamkir region around 20:00 o'clock. The hail was observed in Goychay with diameter of 9 mm at 22:50-22:55 o'clock, in Shamaxy 13mm at 18:00-18:15, in Novil point of Lankaran with diameter of 11mm at 17:33, in Sumagly village of Ismayilli with diameter of 20-25 mm in the evening and in Talysh vilage with diameter of 5.0 mm on May 4 According to Tovuz

Radiometeorologic Station, the hailstorm was observed in Ashaghy Ayibi meteorological station with diameter of 16 mm at 16:30-16:32 o'clock on May 25.

According to the Gobustan Radio Meteorological Station, the 8 mm hailstorm was observed at 17:34-17:46 o'clock and also in Ismayilly region with diameter of 15 mm at 15:43-15:48 o'clock on May 28.

According to Lankaran Regional Hydrometeorological Institution, the hailstorm have been fallen in Khanbulag Agrometeorological station with diameter of 17 mm at 15:35-15:55 o'clock, in Lankaran Meteorological Station with diameter of 10 mm at 15:35-15:38 clock and in Novel Meteorological station with diameter of 17 mm at 15:20-15:55 o'clock. Earlier this year, the first full-torrential process have happened in the territories of Agdam and Aghdere regions of Garabagh zone on May 28 and as a result of the timely manner by the Automated control system of Goygol station the appropriate warning has been given.

There was heavy rains in Ganja and hailstorm in Goygol, Dashkesen and Gedebe regions on April 22. Heavy rains, intensive hail falling, flood and flow events were occurred in Gabala, Ismayilly, Shamaxy and Goychay regions consistently on May 4. The hailstorm accompanied by the strong winds and the cloudburst have caused considerable damage to settlements and economic areas.

Intensive heavy rains and hail have been observed in some territories of Tovuz, Shamkir, and Gadabay on May 21. Heavy rains have caused flooding of residential and planting areas in some parts of Tovuz region. On the same day, the amount of rainfall was about 100 mm in Qovlar centre of the Tovuz Radiometeorologically Station.

Heavy rains and intensive hail were observed in the territories of Ismayilli, Qabala, and Qobustan regions on May 28. Ismayilly region has recorded a hail falling more intensively. Intensive and big hailstones accompanied by strong winds have caused serious damage to agriculture and social facilities, electricity and communication networks.

Beginning from the evening of June 10, the heavy rains accompanied by hailstorm was recorded in the areas of Tovuz, Gadabay, Dashkasan, Goygol, Ganja, Ganja, Goranboy, Naftalan, Goranboy regions. The hail that fell to Tovuz, Goygol, Gadabay and Dashkasan regions became more intensive and have made crisis. Hail fallen to some areas of Dashkasan, Gadabay and Goygol regions have overtaken more than 4 cm in diameter. As a result of natural disasters, agriculture, including livestock, personal farms, vehicles, bridges, and electricity and communication line have been damaged seriously. 25 people have received injuries of various degrees because of a hailstorm in Dashkasan region. Intensive and big hailing has been observed in mountain and foothill areas of Tovuz region on June 11 and this event caused significant losses. Starting at 23:00 on June 2, there was the local characteristic heavy shower in southern slopes of Greater Caucasus. The strengthening of rainfall process, sometimes intensive lightning, hailing, and strong wind were observed on the night of the third day and hail was recorded in some residential points of Aghstafa and Qazakh regions in the morning of next day. Starting from the evening of July 7, intensive heavy shower was observed in most part of Lesser Caucasus. It was hailing in some areas of Gadabay, Dashkasan, Shamkir, Goygol regions. More intensive and large scale hailing was recorded in Dashkasan region. Starting from the second half of day on July 8, bad weather condition of some western part of republic and sometimes intensive heavy rains was observed which accompanied by hailing. The intensity of hailing and heavy rains have been great in some areas of Gadabay, Dashkasan, Kalbajar and Goygol regions. Intensive rains were accompanied by strong hurricane winds. Starting at the second part of the day on August 21, local characteristic heavy shower and sometimes small sized hailing were recorded in some territories of Tovuz, Gadabay, Dashkasan, Shamkir, Goygol and Kalbajar regions. Rains were accompanied by the lightning [2; 7].

Intensive downfall accompanied by hail was bucketed in the territory of Tovuz, Barda, Guba, Khachmaz, Zagatala, Shaki, Shamkir, Samukh, Ganja regions on 4-5 September. Precipitation in most areas has been accompanied by intense lightning storm and strong wind. A thunderstorm caused many problems in Balakan and Zagatala regions. As a result of the flood, about 50 tenement residential buildings, public facilities, and hundreds of individual houses and subsidiary building roof have fallen into disrepair in regions. Many tall trees were collapsed and electricity poles were overturned in the city. Because of natural disasters, mountain villages, mainly Mahamalar, Katekh, Gerekli, Qazbina villages was affected and public services were paralyzed due to the electricity, communications, and the gas lines were out of order.

Intensive downfall and hailing were observed in Terter and Agdere region on the night of September 13 and in Zaqatala, Qakh, Oghuz and Gabala regions on the night of September 14. Rains sometimes were accompanied by strong winds and lighting. Heavy downfall accompanied by the intensive lighting and the hailing was observed in western parts of republic beginning from the second half of 16 September. Rains were sometimes accompanied by strong winds [6; 7; 12].

If we pay attention above analysis, the magnitude of damage caused by hail depends on size, intensity, speed of winds, scope, structure of sowing areas and so. on. Intensive hail with a diameter up to 10 mm causes considerable damage to agriculture plants and orchards. The hail 1-20 and 2-40 mm in diameter destroys agriculture fields. The roofs and windows of houses break and poultry and small animals could perish. Therefore, the special attention should be given to protect agriculture and construction from hail in the research areas. It is obvious that the high-performance radar and forecast methods were used until 1987 year in cotton-growing and grape growing regions of the republic to determine security and degree of clouds occupancy by Soviet scientists in the 60s. By utilising this purpose, it is possible to protect approximately 200 thousand hectares of sown area by hail and the effectiveness is 75-80% on average. The crop in 6-8 mln hectares has been protected from hail by using these methods in Shamakhi-Ismayilli and Guba-Khachmaz economic and geographical regions in 1981-1987. Since 1987, the methods of dispersing loaded clouds by using rocket and artillery were completely forgotten. Plants and vineyards in Shamakhi and Ismayilli and orchards and vineyard in Quba-Khachmaz regions are exposed to constant hailing. The measures to prevent hailing in Sheki-Zaqatal region is almost zero [8; 19; 11]. The results of our study indicate that the hailing process lasts rarely from 1-30 minutes to 1 hour in our republic. The hailing process continues 10-15 minutes in the Azerbaijan Republic. Our research showed that the hail mainly occurs during the period from 14:00 up to 22:00 in Ganja-Gazakh economic region. The hail was observed in the period from April to October in this region and it coincides mainly with the period of vegetation. It is a distinctive increase of repetition of hailing from spring to summer in most areas and it reaches the maximum level in May-June months. June-July are the months when maximum hailing activity dates in mountainous areas.

Overall, the primitive methods were used recklessly against hailing process in recent years. Therefore, active and consecutive precaution should be prepared against active and large-scale hailing areas at a state level. The Cabinet of Ministers should take measures in time to prevent this process. The hail problems have to be considered when budgeting for research areas.

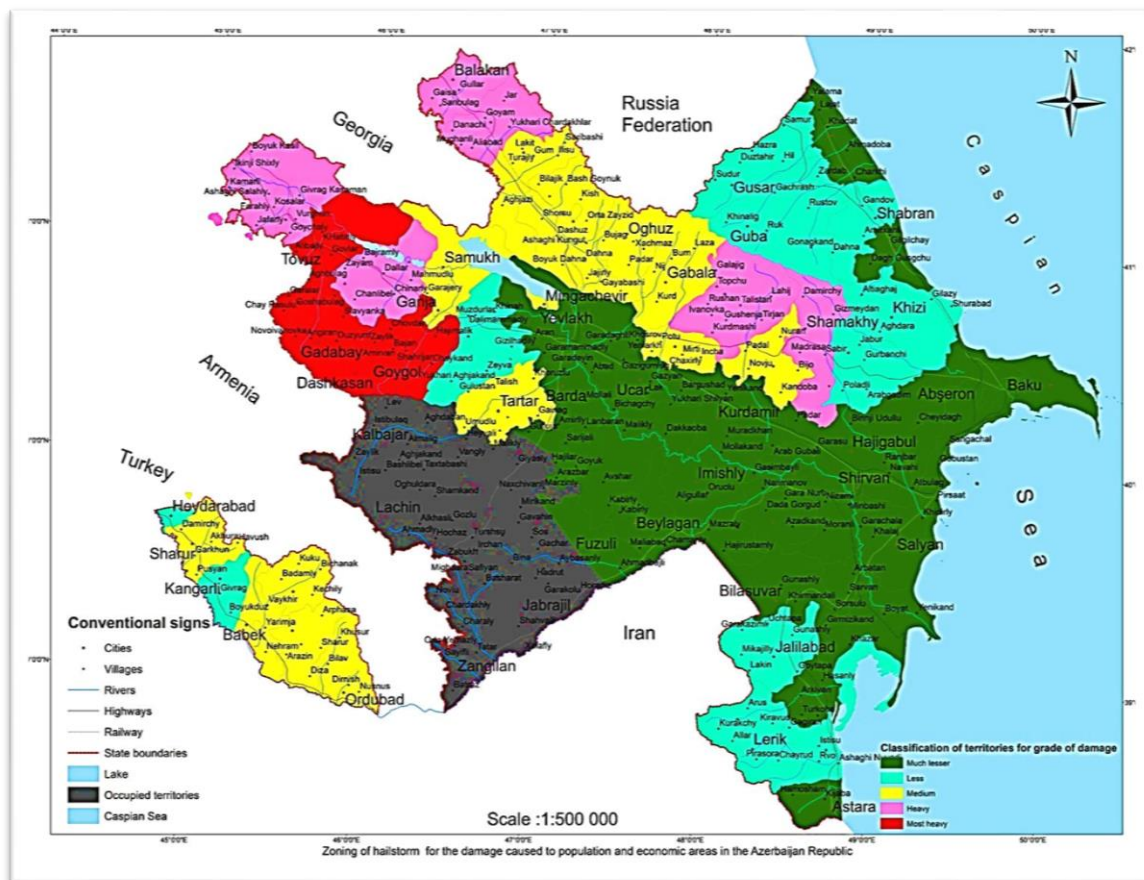
The creation of complex struggle networks against hailing cover the main areas of research in Azerbaijan. Foreign scientists give special attention to study the physics of hailing process and to find active measures against it. So far, theoretical and experimental studies gathered in the areas of cloud physics allowed to develop a variety of methods to influence meteorological processes. The new technical facilities namely rocket and artillery against hailing is used not only in developed countries and in the territory of CIS, but also in Bulgaria, Hungary, Argentina and other countries [3; 4; 10; 16]. Formerly, this method was used mainly for the wine growing areas in 7 regions (until 1987) of Azerbaijan. Currently, this method must be utilised to increase and develop the local agriculture crops and to ensure food security. The protection of agricultural areas from hail is completely forgotten because of 23 years lasting war in our country. If the productivity has been 13 thousand rubles by using above-mentioned methods in 1974-1984, in contrast, damage caused by hail has grown tremendously since 1987 until the present day. The automated system of impact for the hailing process was established on the basis of radiolocator, modern computing technology, "Neba" and "Crystal" missiles complexes in scientific production centers against hail in most countries. Creation of concept for artificial rains early in hailing areas and missile technology is appropriate for the prevention of hail in the future.

Exploration of this system and newly exhausted forecasting methods will allow for an additional 10 thousand hectares of crops saved from hail and 7-8 times increase in productivity. There is a need for expansion of the network against hail, application of newly exhausted methods and a large amount of investment in our country [4; 11].

Taking into account the impact of hail on living and economic activities of people in the territory of Azerbaijan, the economic and geographical zoning of regions relies on the scientists who conducted a research in terms of synoptic and climatology. In this regard, the research written by A.A. Madatzade which called as "Zoning of region for speed and repetition of hailing in Azerbaijan" (1957) have more detailed information. Author separated our country into 6 regions in according to the degree of exposure by hail and he also made a detailed analysis of the hailing change toward the height above the sea level [12].

We also have tried to clarify the repetition of hail in different regions of the country, as well as the size of damage to agriculture system based on zoning. When we were carrying out zoning process in the field, the damage caused by hail to productivity and residential settlements have been taken as a key indicator. Thus, the following zoning process were made due to damage caused by hail to agriculture and settlements:

1. Gadabay, Dashkasan, Tovuz and Goygol regions are the territories that were seriously damaged by a hailstorm. 79 hail processes have been recorded during the studies and only 14 or 17,7% agricultural areas and settlements were damaged mostly. The average annual repetition of hail recorded by scientists is 5-6 days at altitudes of 1000-1500 and 1-2 days in the plain. In comparison with other regions, there is a great amount of damage in the area because of the specialisation in viticulture and potato. The population of the region is 178.1 thousand persons in 278 residential settlements and there are 54.6 thousand hectares of sowing area, which mainly is exposed to the hailstorm in May-July. Our research shows that the hail decreases the productivity of agricultural crops by 20-25 % and damage the region's economy more than 6.0 million manat.



2. Aghstafa, Gazakh, Shamakhy, Zagatala, Balakan, Ismayilli and Shamkir are the territories subjected to more damage by hail. The population of the region is 120 thousand persons in 143 residential settlements and there are 38,4 thousand hectares of sowing area which mainly is exposed to a hail storm in spring and summer. About 20-30% of agricultural areas in region are damaged by hail. The average annual repetition of hailing days is 4-5 days at altitudes of 2500-3000 m above the sea level. This figure is 1-2 days at 1000-1500 and 1 day in plain areas. The average annual repetition of the hailing day is 4-5 days in Alibey residential settlement of Zagatala region. Hailing process reduces the agricultural crops productivity about 15-20% and this average decrease is equal to 2,0-6,0 mln manat damage to the region's economy.

3. Hail process which caused damage to all sectors in Mingachevir, Ganja and Shaki cities and in Qakh, Oghuz, Gabala, Nakhchivan AR(except the Kangarli) regions continued three to four days annually. Each year, as a result of

damage done by hail, the productivity of agricultural plants decrease about 10-15% and about 1,0-2.0 mln manat damage to the economy of the region.

4. Gobustan, Lankaran, Khyzy, Yardimli, Lerik, Guba, Gusar, Kangarli, Sadarak, Shabran regions are included to the areas damaged less by hail. The repetition of hailing process in regions is 1-2 times and the damage caused by hail to productivity of agricultural farms is 5,0-10%. Each year an average of 0,5-1,0 mln manat harmed annually to the region's economy. Goychay, Samukh, Aghsu, Tartar regions with the population of 108 thousand persons in 106 residential settlements at altitudes of 1000-1500 m and more is included in damaged areas hail process damaged up to 5-10% to overall productivity of agricultural crops.

5. Lowland (except Mingachevir, Goychay regions) areas, Absheron economic region (except Khyzy region), Khachmaz and Siyazan include in the less damaged zones. Hail damage up to 1,0-5,0% of the productivity in the agricultural crops. The average annual repetition of the hailing in mountain areas is 1-2 days and 0,1-0,3 day in the plains.

If we look at the analysis, we could see the damage caused by hail depends on size, intensity, the wind speed, the scope, the structure of sowing areas and other reasons. The intensive hail with a diameter of 10 mm considerable damage to agricultural crops and orchards. The hail crystals in diameter of 1-20 and 20-40 mm completely destroyed cropland. The roofs and windows of houses break and poultry and small animals could perish. So, the special attention should be given to protect agriculture and constructions from hail in the research areas.

The following results were obtained in regarding the personal observations, hydrology and meteorological research, the material analysis of statistics and extensive scientific literature on the study of economic and social geography problems created by hailing process in the territory of the Azerbaijan Republic:

- The significant decrease was observed in an average annual number of hailing days in the period of 2000-2015 in comparison with the 1990s in most regions of the country. Even though there is a decrease in the repetition of hail, the damage caused to agriculture has significantly increased due to the poorly organized insurance payment and lack of measure.
- Heavy damage caused by hail was defined in the lower and middle mountain parts of Mountainous Shirvan region, in the mountainous areas of Ganja-Gazakh, Kalbajar-Lachyn, Upper Garabagh that belongs to Lesser Caucasus and Nakhchivan AR regions and in the plain and foothills areas of Shaki-Zagatala and Guba-Khachmaz regions of the Greater Caucasus.
- The effectiveness of the anti-hail measures to protect product loss was counted about 9 million by an average (until 1990). The costs of organizing and carrying out the self-protection measures have been justified by an average of 7-8 times.
- Applied active impact technology and concept against hail in different regions of the world, as well as analysis of materials and statements against hail that was carried out in Azerbaijan territory facilitate the prevention of this problem in the future. Restoration of work against hail will help the economic development of regions where are based on reducing the damage caused by hail.
- Unlike other natural disasters, a universal method against hail is to create neutralized artificial rains by the inclusion of crystal reagents into clouds. It is also advisable to apply two methods- rocket and artillery out of 4 methods (rockets, artillery, aviation and land-generator methods) which effect hailing clouds in the territories of Azerbaijan Republic.

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