

## **Influence of Inundations on Territorial Organization of Economy in Aran Region of Azerbaijan**

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### **Abstract**

*In recent years, inundations take place more compared to other natural processes as a result of global climatic changes in the world. Scientific study and prediction of inundation process is very important issue for researchers of this field. Within the last decades, population and industrial areas of many lowland areas have been experiencing inundation regularly. Damage caused by this natural disaster is at the center of attention of scientists. In the Republic of Azerbaijan, more than 3 million people dwelling in 570 settlements also face inundation. Most destructive inundations in Azerbaijan take place in Aran economic region which shares 20% of the country's population and 23% of the overall territory. Study of economic and socio-geographical aspects of inundation that creates huge problems for the country's economy is a topical issue to-day. In this paper, damage caused by inundations to living condition of population and economy in Aran region have been researched.*

**Key words:** territorial organization of economy, social infrastructure, environmental risk, preventing inundation, defensive measures.

### **Introduction**

Scientific analysis and researches, natural and anthropogenic factors have been identified that are responsible for arising inundations in Azerbaijan. These factors are the followings:

- Distribution of population, and location of industries below the height of river bed, line of flooding regime, and sea level;
- Snow-melting that happens earlier due to sharp rise of temperature of atmospheric after snowing as well as long-term rainfall and heavy rains in areas of river basin as a result of which the amount of precipitation exceeds the norm in some years by winter;
- Shaping of thick sedimentary layer in the river bed and delta areas of Kura, the largest river in the territory of Azerbaijan; decay and break of protective dams in many areas, and adverse results of inefficiently conducted damming works;
- The global climatic changes throughout the world and hesitations by level of Caspian Sea;
- Irregular protection of settlement system along the rivers with flood regime.

Industry of Azerbaijan Republic has been facing problem of negative influence and damage caused by inundations and floods for decades. It was defined that more than 8% of all 2790 registered industrial enterprises are located under the threat of flooding. These enterprises include not only those that are situated in the river basins of Kura, Araz and partially Samur but also objects located in areas with higher environmental risk entailed by possibility of raising water level of the Caspian Sea. Part of these objects already has been experienced invasion by raising water of the noted basin. Flooding directly affects some areas of fuel- and energy industry as well as areas of construction, light industry, and production of food. Some other industries face threat of flooding indirectly. In the last 10 years, the country's industry experienced damage at 2.0 million AZN because of floods and inundations. Amount of losses were higher in 2003, 2006 and 2010. Industrial enterprises located on (or near) the banks of Kura and Araz, including Shirvan city had seen less destructions and damage in comparison with other areas due to influential defensive measures conducted against natural disasters. In the meantime, most negative influences on industrial areas take place not on the banks.

In addition, during flooding, enterprises are unable to receive raw material and primary production from other areas because of low level of infrastructure and highways. Industries function inefficiently as thousands of people cannot work when natural disasters take place. 40% of the territory of Azerbaijan includes areas altitude of which is below the ocean level. Most areas are namely in Aran economic region. Some part of enterprises related to *oil and gas industry* functions under the threat of potential flood and inundation. Many oil- and gas-extracting enterprises as well as power stations situated in administrative regions of Salyan and Neftchala, and cities of Mingachevir and Shirvan. Conducting high- and medium tension lines of electricity, poles of electricity, transformers and other equipment are also being exposed to danger. Oil and gas-extracting enterprises of the economic region Aran, exploiting fields of Neftchala, Kurovdag, Mishovdag, Galmaz, Garabaghly, Kursangi and Muradkhanli particularly should be noted. Oil fields near Kur-river are located distantly each other, periodically facing inundation. Three fields out of the seven above-noted oil fields as well as twelve oil- and gas extracting enterprises operate under threat of flooding. Cooperation with foreign companies has been improved in the area, but problem of protection from flooding still remains unsolved. Fuel-extracting enterprises in Shirvan, Salyan and Neftchala had a loss of 12 thousand AZN in 2003, 36 thousand AZN in 2006, and 67 thousand AZN in 2010.

*Chemical industry* also periodically suffers from inundation. The natural disaster seriously harms primary sector of industry. As a result of inundation, complications related to transition of raw material in time damages economy. Inundation damages also exploitation of deposits of iodine and bromine water that are primary elements of chemical industry in some areas, including deposits named Khilli, Babazenen, Mishovdag, Bina-Hovsan, and Neftchala. Water resources in these deposits mingle with flooding water and lose its original quality. This process has taken place almost 5 times within the last 20 years in the territory of Aran economic region. In 2003 and 2010, floods happened in the lowland area seriously disrupt normal functioning of iodine plant in Neftchala area. Ministry of Economic Development takes measurements related to activity of this enterprise.

Baku iodine plant, functioning on the basis of deposits of Bina-Hovsan area, produces potash iodine, technical iodine, and crystalloid iodine. However, quality of water in the mentioned area also is changed as a result of mixing with subsoil-and flooding water. It is advisable to prevent abandonment of boron, potassium, strontium, lithium, and other elements as industrial wastes after exploitation process.

It should be noted that economic regions of Absheron and Aran are rich in salt and soda – the other elements useful in chemical industry. Process of inundation injures deposits of natural salt and soda as well as entails salinization after of which lands become unusable.

Damage of inundations is being experienced also *in construction industry*. Deposits of constructional significance particularly face great influence from this natural disaster. Stone- and sand quarries as well as deposits of gravel and other primary materials of construction located in basins of Kura and Araz as well as pre-Caspian areas have been undergoing inundations within the past 10 years. Covering mainly the areas situated below sea level, sources of raw material of construction industry expose to danger both directly and indirectly.

*Light- and food industries* are also regularly suffering from inundation in Azerbaijan. More than 100 areas of light (mainly textile) industry as well as over 4000 registered enterprises are functioning in the country. 4% of enterprises of light industry as well as about 12% of food producing ones operating in planes directly or indirectly suffer from inundation.

In some regions, particularly economic region of Aran, primary enterprises related to light (textile) industry are not being provided with corresponding primary products in time during inundation. In recent years, surroundings of these enterprises have been inundated for a few days. In 2003 and 2006, 4 cotton plants, and some other small ones have been stopping operating for 15-20 days.

Functioning of food industry is an area that is more perceptible to inundation. As a result of inundation, agricultural enterprises of primary production on basis of which food industry develops face barriers in delivering raw material, and part of them are exposed to direct influence of the natural disaster. In 2010, 60 percent of enterprises of food industry located in lowland areas of Aran region have seen serious damage. Sturgeon-farming enterprises in Neftchala, and Banka-based fish- and roe farm have had a loss at 100 thousand AZN because of inundation. In the same year, tens of tons of grain and flour products collected in mills became unfit for use because of inundation. Therefore, demand of population for flour was not meted at about 20 percent as a result of which Azerbaijan was obliged to import this product in 2011.

*Agriculture* faces more losses than any other area when floods take place. Territory area of overall land resources of the country is 8660 thousand hectare of which 2847,6 thousand hectare or 33% have become unsuitable due to natural disasters. Total square of areas suitable in agriculture is 6981,6 thousand hectare. 1419,5 thousand hectare or 20,3 percent of the overall area is regularly influenced by floods and inundations. Inundation-affected areas have grown in the country, particularly basins of Kura and Araz. The process also results in salinization of lands. Process of salinization leads to decreasing arable lands and impedes satisfying demands for food products. Salinized lands and marshes grow year by year. 373,4 thousand hectare of area in the economic region of Aran have become salinized. This makes 56,1 percent of the all irrigated lands.

As a result of researches carried out by planting, it was determined that area of inundation-affected lands by the region made 74,6 thousand hectare in 2003, 54 thousand hectare in 2006, and 110 thousand hectare in 2010. Reclamation of salinized, semi-salinized, mudded and erosion-affected lands as well as measurements on preventing inundation is needed for providing stable food security. Plant-growing (farming) is being exposed to inundation more compared to other agricultural areas. Production of grain plays a considerable role in agricultural output of the country. In 2010, 60% (or 1125,5 thousand hectares) of the total sown area fell to the share of this grain production. Wheat-producing covered 803,5 thousand hectares. Barley-sowing areas constituted 257,3 thousand hectares, whereas corresponding indicator by areas of spring crops made 64,5 thousand hectares.

Unstable climatic condition creates serious problems in meeting demands for cereals in Azerbaijan. Especially 2003, 2006 and 2010 were the years when repeating inundations impeded dynamic development of grain-producing in lowland areas near rivers of Kura and Araz. According to official statistics, in 2003, wheat-sown areas constituted 592,2 thousand hectares. Production in this area was at 1546,5 thousand tons whereas real indicator was only 1874,3 thousand ton. This discrepancy was related to inundation. According to the data of Ministry of Agriculture, autumn crops in 48 thousand hectare of area were spoiled damaging economy at 5,5 million AZN because of the natural disaster that happened the same year. In 2006, 11,2 thousand hectare of wheat-sown areas was inundated in economic region of Aran, including administrative regions of Saatli, Sabirabad, Neftchala, Hajigabul and others.

In 2010, inundations damaged cereal-producing areas much more. Thus, the natural disaster seriously harmed economy of Aran that shares 38% of grain-sown areas of the country as well as 40% of the overall production in this area. 18 thousand hectare of areas of autumnal grain became spoilt. Productivity fell from 30-32 centners to 18-20 centners per hectare. So, inundation damaged not just cereal-producing economy of Aran but also national economy.

Within agriculture, *production of technical plants* holds third place for sown areas behind production of grain and forage. Territory area of *cotton-planted areas* has been decreased by over 5 times as less since 1995. Within 1995-2010, production of cotton has been decreased by 6 times as less. As a plant that requires large irrigation and abundant solar energy for growing, cotton is developed mainly in Aran due its favorable natural condition. 80% of cotton-planted areas are in this region. The reasons of decrease in cotton-producing were related to privatization of lands, errors made in organization of production in agrarian sector, and also damage consecutively caused by inundations. In 2003, cotton-planted fields at 3581 hectares were destroyed in Aran as a result of this natural disaster. The loss was at about 1 million AZN. In 2010, 12,4 thousand hectares of cotton fields were inundated. Observations and analysis carried by us in the studied area show that the problem gains more accurate character as the cotton-producing area of Aran's economy may completely disappear because of unsatisfactory level of governmental assistance as well as repeating natural disasters. Conversations with population of the economic region also affirm existing threat of abolition of cotton-producing which is traditionally considered to be an area of specialization in Aran.

In recent years, special attention is being given to areas of technical plant production such as sunflower, sugar-beet and fodder maize in Aran region. 58.3% of areas of fields of *sugar beet* as well as 52% of production in this area fall to the share of this region. The inundations that took place in 2003 seriously damage production of sugar-beet. The natural disaster caused destruction in areas at 2,2 thousand hectares. In 2010, the corresponding indicator constituted 5,4 thousand hectares. Influence of inundation on production of sugar-beet especially should be at the center of attention as a new large sugar-producing enterprise of Imishli has been commissioned a few years ago.

The basin of Kura-Araz is considered to be an area specialized on *melon- and gourd growing*. 68% of melon- and gourd growing areas as well as 70% of the production is shared by Aran region. In 2003, inundations in the rivers of Kura and Araz caused fields to become inundated. Total area of these areas constituted 2,3 thousand hectares. The corresponding indicator by 2010 made 7,7 thousand hectares, and the production were as 10-12% as less. Inundations also negatively influence on *production of different vegetables*, including production of potato. Aran shares 33% of the country's vegetable-grown areas as well as 26% of the production. 11% of potato is being produced in Aran. According to the data given by the Ministry of Agriculture, in 2003, 6239 hectares of vegetable-sown areas was inundated. The related damage made 3,1 million AZN. In 2010, the harder inundation was responsible for destruction at 12,4 thousand hectares by vegetable-sown areas as well as 2,8 thousand hectares by potato-sown areas.

*Perennial plantation* is one of inundation-exposed areas. Being perspective agricultural area for the economic region, it includes cultivation of mainly dry subtropical plants and grapes. *Wine-growing* is known as the oldest agricultural area as well as area of specialization in Aran region. According to surveys and analyses carried in the territory of Aran, the wine-growing areas exposed to hard damage by inundation made 568 hectares in 2003, 396 hectares in 2006, and 873 hectares in 2010.

*Horticulture* holds significant place in perennial plant-growing. 27% of production of fruit and berry falls is shared by Aran region. This area faces negative impact by natural disasters, particularly inundation in recent years. Inundations of 2003 resulted in damage in the gardens, total area of which made 315 hectare. The damage was at 164,8 thousand AZN. In 2006, inundations caused gardens to become unusable at 825 hectares. In 2010, the corresponding indicator constituted 2346 thousand hectares. Productivity and production output were lower in 2006 and 2010 because the last two inundations occurred in period of flowering and fruiting of trees. Restoration of some gardens requires 5-10 years as well as great expenses in the region.

Pastures of winter, located in the lowland of Kura-Araz and Pre-Caspian areas, are regularly being exposed to inundation. *Cattle- and sheep breeding*, and *poultry farming* share 30,2% of income in agriculture of Azerbaijan. Inundations that took place in 2006 annihilated 28 thousand large and small cattle, causing also pastures at 1847 hectare to become unusable. In 2010, inundations damaged cattle- and sheep breeding in 40 administrative regions of the country. The territory of Aran region remained inundated within 20 days. On May 12, 2010, inundation taking place in three villages of Sabirabad destroyed 120 large cattle, and about 300 sheep and goats. More than 15 thousand hens and chickens were perished in Sabirabad and Saatli. It will take 3-5 years at the minimum recovering livestock farming in the region.

*Transportation system* of the Republic of Azerbaijan plays an important role in development of its regions, particularly distribution of population, in territorial organization of economic sectors, development of new territories, and exploitation of natural resources. Transport and infrastructure sectors also see damage caused by natural resources, particularly in the economic region of Aran with lowland relief.

*Railways* in Aran are being exposed to inundation. The lines of railway of Baku-Agstafa-Tbilisi and Baku-Shirvan-Astara have international significance. Inundations regularly taking place in recent years were responsible for disruptions in functioning of trains. For example, it took more than a week to restore breaking of line of railway of Hajigabul-Shirvan as a result of inundation in 2009. Results of the natural disaster that took place in 2010 were heavier when lines of railway completely stopped operating in Aran. Part of railway line of Baku-Horadiz named Shirvan-Osmanli was exposed to damage caused by inundation. As a result of the natural disaster, stations of Hajigabul, Saatli, Sarijalar, Salyan, Ujar, Kurdamir, Goychay as well as others situated at the junctions of Yevlakh and Shirvan stopped operating for 15-20 days. Water flow rapidly passing under the railway bridge called "15 eyes" caused damage in the wide area (approximately 1.5-2 meters high) by the direction of Sabirabad-Salyan. The only highway connecting the center of administrative region of Sabirabad and some rural settlements was closed. Relations between rural settlements of Minbashi, Garaghaj, Yakha-Dallay, Polad, Toghay, Azadkend, Chagirgan, Khankechen, Tazakend, and Muganganjali located on the bank of Kura were disrupted for a few days. Keeping relations with these villages was possible only via administrative region of Salyan. In the meantime, connection between Shirvan city and Sabirabad region also was disrupted. Movement of trains stopped functioning by the direction of Shirvan-Astara railway line for a long time because of inundation that took place on May 9, 2010, damaging 10 km long line.

Constructing a bridge on the 15<sup>th</sup> kilometer of railway line of Osmanli-Azadkend and water transmission pipe is necessary. Projects on the appropriate arrangements have been developed.

*Highway network* is also should be regarded as an object exposed to damage by inundation. Highways in Aran region are 4381 km long in total, including 1101 km long asphalt ways, 2557 km long gravel-covered roads and 723 km long country roads. Looking on statistical data for the last 10 years, we can see that in average, 117 thousand passengers as well as 10,4 thousand ton of cargo were conveyed by motor transport annually. Inundations that happened in 2003, 2006, and 2010, seriously damaged highways of Yevlakh-Aghjabadi (81 km long), Shirvan-Salyan (45 km), Ujar-Zardab (34 km), Shirvan-Sabirabad (51 km), Hajigabul-Shirvan-Salyan (45 km), Salyan-Neftchala (50 km), Agsu-Kurdamir (60 km), Barda-Alpout-Nazirli (26 km), Hajihasanli-Varvara-Salahli (16 km), Barda-Nazirli (32 km), Barda-Yeniayrija (16 km), Parkovka-Hashimkhanli (12 km), Salyan-Kurgaragashli-Khilli (54 km), Sabirabad-Javad-Garasu (35 km), Seydan-Parcha-Xalaj (2 km), Tazakand-Kursanga (12 km), Sugovushan-Shikhlar (14 km), Sarikhanbayli-Osmanli (35 km), Highway-Azadkand (10 km), Saatli-Novruzlu (19 km) and others. The economic region includes 807 settlement clusters. Many clusters lack developed roads, needing measures on prevention of natural disasters.

In average, rural settlements in Aran are located 20-25 km away from the cities-administrative centers. As many roads are not asphalt-covered, inundations turn to be serious impediment for the transport system during winter and autumn, creating great problems for urban and rural clusters. Country roads that belong to municipalities but not the Ministry of Transport particularly experience harm caused by inundation. Part of country roads in Aran region has become unusable as a result of influence by inundations. Total length of them makes 2317,5 km of which 333 km or 14,4% are in Neftchala, as well as 196 km or 8,5% in Hajigabul, 232 km or 10% in Sabirabad, 160 km or 7,0% in Saatli, 43 km or 1,9% in Salyan, 14 km or 0,7% in Bilasuvar, 320 km or 13,8% in Kurdamir, 492 km or 21,3% in Yevlakh, 358 km or 15,5% in Agdash, 115 km or 5,0% in Zardab, 40 km or 1,7% in Imishli, and 8 km or 0,3% in Beylagan. All these roads need being reconstructed. After inundations of 2010, the total length of highways and country roads becoming unusable in Aran region made 2317,5 km.

Areas of *social infrastructure* are also being exposed to inundation in Aran. In this regard, protection of water pipes, irrigation channels, water-distributing sluices, collector and drainage system in Aran where inundations happen regularly, seems to be very important. Inundations in 2003, 2006 and 2010 seriously damaged water pipes in the region total length of which was 225 km, or 23% of all water pipes in Aran, including 5 km in Beylagan, 4 km in Barda, 10 km in Yevlakh, 20 km in Mingachevir, 40 km in Ujar, 6 km in Zardab, 37 km in Imishli, 30 km in Neftchala, 25 km in Bilasuvar, 36 km in Salyan, 25 km in Saatli, 13 km in Sabirabad, 6 km in Hajigabul, 35 km in Shirvan, and 16 km in Kurdamir. In the meantime, 45,6% of irrigation channels, 10,5% of pumping stations, 37% of hydrotechnical installations, and 62,2% of collectors became unusable in the region. Recovery of such manufacturing infrastructures in time should be under the control of Water and Melioration JSC as well as the Ministry of Emergency Situations and the Ministry of Agriculture.

For achieving the dynamic development of economy in the researched area, it is necessary to give special attention to improvement of social infrastructure. Necessity of development and rational territorial organization of areas of social infrastructure in the economic region of Aran is also an important issue to-day. Incorrect forming of the territorial organization of social infrastructure in the region was responsible for weakening of distribution of population in settlements as well as increase of movement of rural population from areas affected by floods to the cities and foreign countries for a long time. Areas of social infrastructure need protection from influence of natural processes.

Being significant constituent part of social infrastructure, enterprises of *health care* suffer from inundation. Taking into account a factor of natural disaster is crucial factor in keeping and recovery of human health as well as effective realization of medical service. For the present, up to 3200 doctors, and about 1000 nurses working at 390 outpatient hospitals serve to people in the region. The number of hospital beds is 13250. The average supply of doctors is 18.2 per 10 thousand people, and the average supply of medical staff is 57.1 persons. The supply of hospital beds in average is 75.7 whereas provision in the treatment clinic makes 113.3 units. In average, about 4-6% medical enterprises suffer from inundation. The natural disaster hardly implicates rendering a primary medical service to people. In the region, it is important to realize projects on protection of existing medical enterprises, rendering first aid to people and creation of specialized groups of nurses for this purpose as well as designing centers of health with seriously taking into account potential threat by natural disasters.

In this connection, construction of new buildings must be regulated also with participation of Ministry of Emergency Situations and other governmental institutions.

*Educational buildings* also have been being a 'target' for destructive inundations in recent years. 638 pre-school educational institutions and 921 secondary schools are functioning in the region. Total number of the pupils is 545,2 thousand. 28 pre-school institutions and 34 secondary schools consecutively experience inundation whereas 33 kindergartens and 32 secondary schools locate in areas of high risk of inundation, and may see less damage. For a long time, designing, location, and construction of secondary schools and other educational institutions have been conducted ineffectively. Most of educational institutions need fundamental reconstruction works with exception of those situated in the cities. Bridges and highways still sometimes become unusable after natural disasters, including inundations, and condition is adverse for pupils going to schools. Educational institutions even may be closed for 10-15 days.

It has been defined that 22 libraries of public use, 12 clubs (cultural centers) and 6 museums are located in areas that potentially may be inundated in the future. Natural disasters of 2003 and 2006 years damaged 2-4% of *cultural and enlightenment buildings* in Aran region whereas in 2010, up to 40% of the overall territory, including tens of those institutions were inundated.

*Objects of commercial service* are also being exposed to attacks of inundations in the researched area. In 2003, 78 large and small commercial buildings have become unsuitable after hard inundations. The corresponding figures by 2006 and 2010 were 34 and 200 at least.

In the researched area, buildings of so-called welfare and public catering, namely repair- and construction shops, household machinery and equipment repair services, repair of metal products, chemical cleaning and painting, hairdressing service, restaurants, cafes, canteens and etc. are also being damaged because of inundations. In 2010, 140-150 buildings of domestic service as well as 45-50 public catering enterprises in average became unusable after inundation.

### **Recommendations**

As the carried research shows, negative influence of inundations to social and economic development of the economic region of Aran should be regarded much more seriously. The related situation necessitates conducting a number of measures part of which was noted above. The main needed management activity in the region as well as recommendations on prevention of destructions caused by inundation may be formulated as follows.

- Observation and control of origins of risk through conducting monitoring;
- Applying of up-to-date technological methods in process of developing territorial organization of economy and using natural reserves for the purpose of weakening destructive influence of inundation;
- Developing scientific conception on protection of food production from inundations for achieving sustainable development in agriculture as well as creation of optimal model of marketing structures;
- Definition of manufacturing and service areas located below bed of rivers with inundation regime and the sea level, and use of laws, methods and ways applied in developed countries for fundamental protection from inundations;
- Construction of dikes and sluices of water supply, and other protective devices in transport- and communication network-located areas with taking into account relief condition as well as collectors and drainage lines for escaping rise of ground water level.

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