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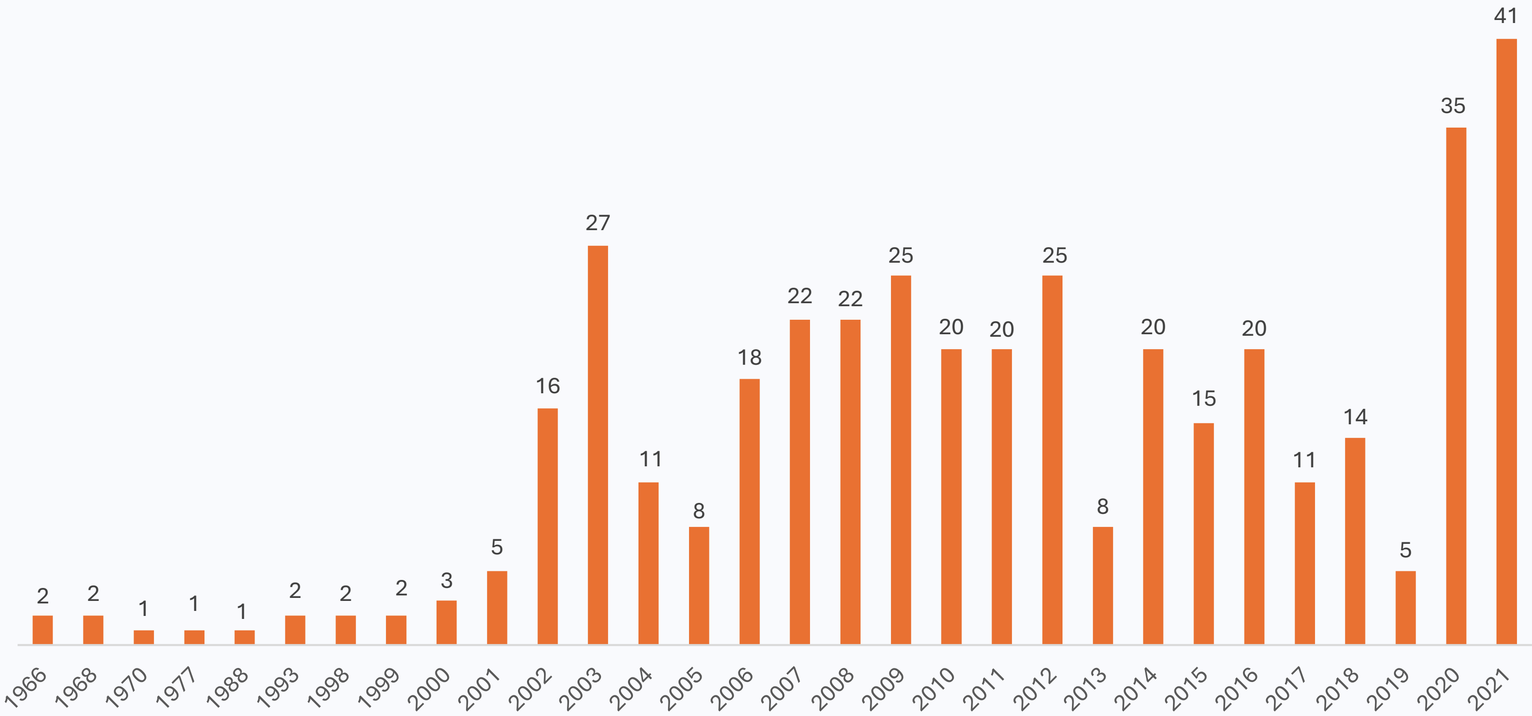

CLIMATE CHANGE VULNERABILITY INDEX LANKARAN-ASTARA ECONOMIC REGION

MAY 2024

Project implemented by WEglobal and its consortium partners

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ACKNOWLEDGEMENT

This is the first report that has developed a detailed Climate Change Vulnerability Index for a region of Azerbaijan. The Lankaran-Astara Economic Region is one of the 14 economic regions of Azerbaijan and comprises 6 districts of Lerik, Yardimli, Jalilabad, Masalli, Lankaran and Astara. It has several agroclimatic zones and agriculture is the main occupation of the population. Climate change is already impacting the region. This index and the recommendations made by the team could help policy makers make informed decisions on the investments needed to increase the region's resilience to climate change.

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EU4Lankaran Project Team

1. GEOGRAPHIC AND SOCIOECONOMIC CONTEXT

1.1. Country and regional background

Azerbaijan is located in the South Caucasus with an area of 86.6 min km^2. Forests cover 12.0 percent of its territory, arable lands cover 55.2 percent and 28.0% of these are meadows and pastures. Land subject to floods constitute 4.6 percent, while, 28.2 percent are other lands. Azerbaijan has varied topographic features throughout the country. The Greater Caucasus Range runs through the north, with the highest peak Bazardyuzyu located within this range at 4,466 meters. The Lesser Caucasus range runs through the western and south-western portions of the country. The Kura-Araz Lowland covers much of central Azerbaijan and abuts the Caspian Sea[1].

The Lankaran economic region is located in the south-east of Azerbaijan. This region is divided according to relief features into two parts consisting of the Lankaran plain and the Talish mountains. Agriculture plays a major role in the economy of this region, with vegetables, melon, and tea as the main crops, although grapes for wine, cereals, cattle, fisheries are also important.. The economic region is the only citrus growing zone in the country. There are 6 districts, 8 cities, 13 settlements, 642 villages and 182 municipalities in the Lankaran-Astara economic region. The Head of the District Executive Authority is appointed by the President of Azerbaijan and is responsible for the overall development of the district

The region is increasingly vulnerable to current and future climate change impacts and climate-related hazards. This takes the form of increased water stress as well as an increase in flood events and heatwaves. Lives, livelihoods, assets and infrastructure are threatened by these climate-related hazards. Sectors such as agriculture, tourism and health are increasingly affected by climate risks. These changes reduce harvests, increase damage to tourism infrastructure and heat-related health problems. Communities in mountain areas and coastal zones are particularly vulnerable due to their exposure to floods.

The climate change vulnerability indexes developed for each district and the region overall will support the Government of Azerbaijan and regional authorities to significantly upscale and strengthen climate change adaptation activities and develop and implement an effective and sustainable adaptation strategy. It will facilitate necessary action at the regional and local levels and will critically enhance resilience against climate change and

[1] Britannica. Azerbaijan. Last Accessed 06 December 2020.

related hazards of the most vulnerable sectors and people. This will contribute to improved well-being, human and environmental health, and food and water security.

1.2. Geography of the region

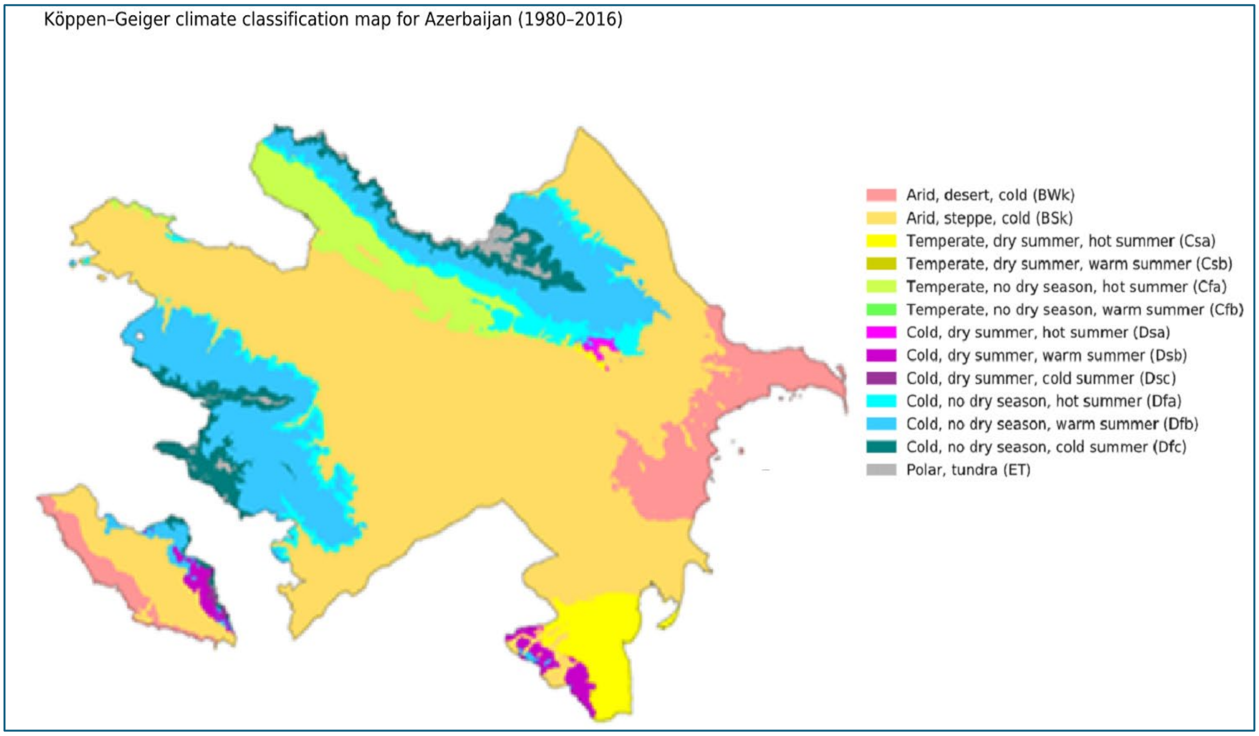
The region covers an area of 6,070 square kilometers or 14.26% of the country. Forests cover 26% of the region and it's the wettest region in Azerbaijan. The region is characterized by damp subtropical climate and differs from other economic regions of Azerbaijan due to its natural conditions.

The region is divided into two parts. the Lankaran lowland and the Talysh mountains. The mountainous part of the region is composed of the Talysh, Peshtasar, and Burovar ranges. The Talysh Mountains in the western part and the proximity of the Lankaran lowland to the Caspian Sea results in a diverse climate in the region. Summer is hot and mostly dry. The average July temperature is 24–26 °C and the absolute maximum temperature is 33–35 °C. Winter is mild. The average January temperature is −2 to −4 °C, the absolute minimum temperature is −5 to −11 °C. The number of snowy days is between 10 and 30. The subtropical climate gradually disappears in areas where the elevation exceeds 500 m and the precipitation is between 400–600 mm. In mountainous areas, summer is relatively cool; the average July temperature is 19–20 °C.

The region has a dense river network. The rivers of the district are fed mainly by rainwater. Several water reservoirs have been built on the rivers in order to supply the drinking and irrigation water. Khanbulanchay reservoir,built in 1977, is the region's largest water reservoir.

Lankaran economic region has a diverse soil cover. In the Lankaran lowlands glacial-yellow soil is dominant. The plains-foothill zone is covered with forest soil. In the Talysh mountains, brown mountain-forest and mountain meadows are found. The brown mountain-forest lands are formed in dry and warm climates with total precipitation of 400 mm, and average annual temperature of 12 °C. These lands cover the mid-mountainous and foothill zones at altitudes from 600–1200 m. Yellow soils in the foothills occupy 157,100 hectares or 1.8% of all the region's lands. These lands have humid subtropical climate with an average annual temperature of 14 °C and an annual rainfall of 1300–1900 mm, Most of the rainfall falls in the autumn and winter seasons. Yellow soils cover the Hirkan-type forests of chestnut and oak trees.

Figure 1: Climate classification map of Azerbaijan



In order to adapt to climate change impacts and respond to climate-related hazards, there is need to develop a comprehensive people-centred adaptation strategy.

The historic climate profile for the country is summarized below:

- Average temperature has increased by an estimated 1.09 °C with the greatest changes occurring between February and August.
- Total rainfall varies significantly, but has generally been decreasing, particularly in the wetter months (March to May) and the driest months (July to August). There is a change in the seasonality of rainfall.
- The has seen a general decline in river flow of 10 to 15%.
- The Caspian Sea has seen a general decline in the sea level.
- More extreme wind events have been recorded in recent years, with an acute increase in the maximum wind velocities.
- From 1900 to 2020, floods were the most frequently occurring hazard with earthquakes, drought, landslides, and extreme temperatures as the other significant hazards.
- The number of extreme weather events have been increasing and over the last 20 years, water shortages and droughts have become more common in the region.
- The intensity of hailstorms has increased 5-6 times in the last 30 years

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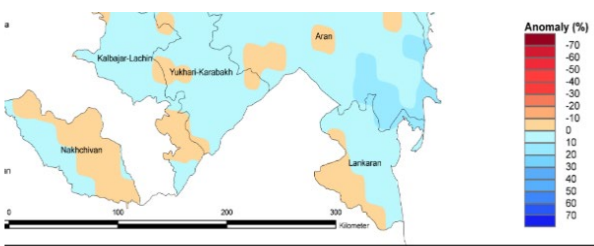
During the last 20 years, the average temperature anomaly in the region was observed at about +0.9°C, while the maximum anomaly at +1.9°C (Lankaran, 2010, +1.9°C).

Total rainfall has varied significantly, but has generally been decreasing, particularly in the wetter months (March to May) and the driest months (July to August). There is a change in the seasonality of rainfall. According to FNC, rainfall indicators analyzed for 2010-2020 showed that the amount of precipitation is lower in the region. There is an increase in the number of dry days. High variability in the trend for the annual single day maximum rainfall is observed.

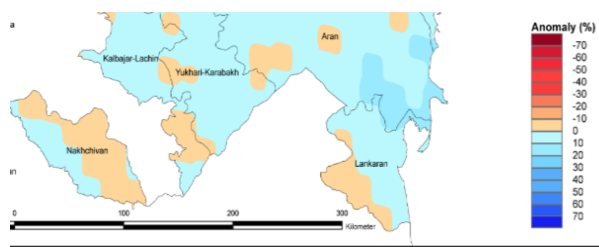
2. CLIMATE SCENARIOS FOR TEMPERATURE AND PRECIPITATION

According to the RCP4.5 scenario for 2020-2040, the average annual temperature in the country is expected to increase by 1-1.5°C. From 2020-2040 compared to the base period of 1971-2000 the amount of precipitation in the country is expected to decrease by 10-20%. By During 2041-2070,rainfall will continue to fluctuate. During the same period average annual temperature will increase by 2-3°C and by 2071-2098 the increase will be 3-4°C.

2020-2040 YEARLY TOTAL PRECIPITATION ANOMALIES (GFDL - RCP4.5)



2020-2040 YEARLY TOTAL PRECIPITATION ANOMALIES (GFDL - RCP4.5)



According to RCP8.5 climate scenario for 2020-2040 the average annual temperature will increase by 1.5°C-2°C in the country between 2020-2040. By 2041-2070 an average annual temperature increase of 2-3°C is expected in the country. The amount of precipitation will fluctuate . By 2071-2098 the average annual temperature increase in the country will be 3.5-5°C and the amount of precipitation will again vary.

2.1. Extreme Temperatures

At the national level the increase in temperature will lead to an increase in the number of days with high heat (>35 °C), an increase in the probability of annual heat waves and an increase in the warm spell duration index, all of which can cause increased strain and impact on human life, energy costs, crops, and infrastructure.[2] An extreme heat event is declared in the region if the temperature is above 35 ºC. In terms of climate change projections an increase in the number of days over 35 and 45 ºC is projected.

[2] Data pulled from World Bank Climate Change Knowledge Data Platform; Available at: https://climateknowledgeportal.worldbank.org/country/azerbaijan

2.2. Flooding

The extreme event analyses takes into account the whole period on record for precipitation and the whole projected data for the RCP8.5 and RCP 4.5 projections.

The increase in the severity and the frequency of floods will continue and this will have a direct impact on most of the sectors noted above, increasing the vulnerability of agriculture, water resources and public health. As noted, floods as well as landslides that are also associated with an increase in the severity of extreme precipitation events, damage to critical infrastructure in all of these sectors, while also having an impact on the livelihood of the general population are likely/ The predicted increase in water depths associated with floods will also led to more damage. Land cover can also be degraded adversely impacting agriculture.

2.3. Droughts

There are several drought indices available to quantify, monitor or predict drought occurrences. They depend on the type of drought (meteorological, agricultural, or hydrological) and on data availability. The SPI (Standardized Precipitation Index) and the SPEI (Standardized Precipitation-Evapotranspiration Index) are two of the most common drought indicators used worldwide.

The severity and the frequency of the droughts is predicted to increase under RCP8.5 for many stations. The predicted increase in the frequency, duration and severity of droughts throughout the whole territory of Azerbaijan has direct implications for the vulnerability of agriculture, public health and water resources as noted above.

3. SECTORAL IMPACTS OF CLIMATIC CHANGES

The expected regional and sectoral climate change impacts are summarized in the following two tables.

Table 2: *Summary of Climate Vulnerability on Priority Sectors*

GCFS Priority Sector	Description of Climate Vulnerability
Agriculture	The key climate change risks arise from increasing temperatures, intensification of droughts and floods and intensification of wind and sea-waves. The already observed trends and projected changes in climate pose an increased threat to agriculture and livestock. Increasing temperatures, coupled with reducing average rainfall and increasing evapotranspiration, may increase aridity in some locations, and more importantly, reduce water availability and increase the erodibility of soils, further reducing the capacity of soils to retain water. Also, the increase in the number and severity of floods, and landslides will have an impact on the irrigation infrastructure. The increased frequency of extreme events may cause changes to the growing season and crop patterns, posing significant implications to yields and national revenues. Increased temperatures will bringsrisks such as increase in plant diseases and the possibility of forest-fires. According to the CFDL and MPI models of the RCP4.5 climate scenario, an increase of 1-2^{o}C is expected in 2041-2070 compared to the base period (1971-2000). According to the HADGEM model, the temperature rise is expected to be 2-3^{o}C. Consequently, during the growing season, the duration of days with air temperatures above 10^{o}C is expected to increase significantly, heat reserves composed of the sum of these temperatures during the growing season are expected to increase to 400-450^{o}C according to CFDL and MPI models, and 600-700^{o}C according to HADGEM model. This creates favorable conditions for the cultivation of higher quality long-staple varieties. However, the lack of moisture may increase, which will create a greater need for optimal irrigation of plants. As a result of global warming in 2041-2070, the actual vegetation period of winter wheat is expected to be shortened, needing faster grain harvesting. Consequently, it will be possible to get 2-3 crops a year by

GCFS Priority Sector	Description of Climate Vulnerability
	re-sowing (fodder, orchard crops, vegetables) in those areas. In 2041-2070, rising temperatures may lead to drought, which may result in lower productivity. A number of measures are required to increase productivity. These include the application of new technologies in cultivation (no-till technology), the use of modern methods of irrigation and, most importantly, the creation of heat-loving varieties with a long growing season, more resistant to adverse environmental factors (drought, salinity). Amid the climate change, one of the most important issues is the optimization of the optimal sowing time and periods of plants. According to CFDL and MPI models, the boundaries of industrially important vineyards may increase by 200-400 m in elevation in 2041-2070, depending on the region, compared to the base period due to favorable temperature conditions. According to the HADGEM model, the expected temperature increase may make it possible to further expand the area of viticulture towards the mountains, but at certain heights there is a factor of limitation of lands suitable for viticulture. Warming of the climate can also have a positive effect on the quality of grape juice. Rainfall is expected to decrease in summer, which increases the need for additional irrigation of vineyards.
Water Resour-ces	In addition to the flood/drought risks described above, the change in the precipitation pattern and the increased frequency and severity of droughts will pose significant stress on water resources. The reduced capacity of soils to retain water in conjunction with the reduced average precipitation and the increased evapotranspiration (associated with the increase in temperature) will reduce water resources. This will have an impact on both agriculture and industry. According to GFDL, HADGEM and MPI models, if air temperature rises 2^0C and precipitation does not change: water resources in the rivers of the Lankaran-Astara economic region are expected to decrease by 5% in 2020- 2040, 10% in 2041-2070, and 15% in 2071-2098. If the temperature rises by 4^0C and precipitation decreases by 10% by the end of the century, then water in the rivers is expected to decrease by 15% in 2020-2040, 25% in 2041-2070, and 35% in 2071-2098.

GCFS Priority Sector	Description of Climate Vulnerability
Coastal Zones	The main risk to coastal activities, including fishing is caused by the increased severity of winds and waves in recent years, and the possible increase in the severity of these events in the coming years. The increase in wind speed and the associated increase in the height of waves pose several issues to the fishing industry both in terms of safety and resilience to these conditions. Extreme winds and waves can cause destruction of infrastructure as well as limit the possibility of undertaking coastal activities due to harsh conditions. The region's Caspian Sea coastline is particularly vulnerable to global climate change. Rising sea levels pose a major risk to the coastline, which is home to a large portion of the population and key infrastructure. Rising sea levels result in flooded settlements, forced migration of people living in lowlands, destroyed roads and railways, damaged industrial infrastructure and beaches, with significant economic loss. Currently different forecasts show that the decline in the level of the Caspian Sea which started in the beginning of this century will continue to the end of the century.
Public Health	Heat waves have already increased in frequency five times since 1990 in Azerbaijan and Lankaran Astara region as well.[3] Projected increases in average temperatures in the coming decades (including a projected increase of between 3.64 – 5.80 °C from 2080 – 2099 and projected increases in dangerously hot days over 35ºC (projected increase of approximately 50 days a year from 2020 to 2049) will increase the incidence of heat stroke, heat exhaustion and aggravate cardiovascular and respiratory diseases. The increased incidence of flooding, and landslides due to changing precipitation patterns will result in additional loss of life throughout vulnerable areas of the country.

[3] USAID. Climate Change Risk Profile Azerbaijan. Last Accessed 29 December 2020.

4. CLİMATE CHANGE VULNERABİLİTY İNDEX ASSESSMENT METHODS

4.1. Background

A vulnerability index is important to assess climate change vulnerability of any country or region. The goal is to assess the vulnerability of regions according to their sensitivity to climatic changes and adaptive capacity in the region. Azerbaijan National Communications to UNFCCC on climate changes and results of other studies conducted in the last 20-30 years show that Azerbaijan and its regions including Lankaran–Astara economic region are highly vulnerable to climate change. According to assessments the last 5-6 years have been the warmest years in Azerbaijan and other regions of the globe. This has led to increase in the severity of droughts in dry regions and significant reduction of water resources.

The region is vulnerable to the adverse effects of climate change. It is dependent upon agriculture not only as a source of revenue and employment but also in terms of ensuring the availability of food. Given the fact that most agricultural land is rain-fed and the country at present is water stressed means that any climatic variations that affects the pattern of rainfall are likely to have dire consequences with such problems as water scarcity, droughts, significant fluctuation of the Caspian Sea level will impact agriculture and the associated parameters of food, employment and income. Due to insufficient technological and scientific base of agriculture in the region, there is low capacity to adapt to changes related to climate change.

In order to plan and implement adaptation strategies, the first crucial step is to group geographical areas depending on the degree of impact of climatic changes on the basis of their vulnerability to climate change. This study is the first ever attempt to rank the districts of the region according to their vulnerability to climate change. This was done by constructing an index of vulnerability to climate change that takes into account both the ecological exposure of these regions to climate change as well as the socio-economic vulnerability and the coping capacity of its inhabitants.

4.2. Existing methods and methodology for assessing climate risks

In many international and national publications such as IPC guidelines, WB and ADB reports climate change vulnerability index for different regions of the world. The index can be constructed using different models. The main methods are listed here.

4.2.1. Methodology of Heltberg and Osmolovskiy

A Climate Change Vulnerability Index can be constructed and estimated for various regions following the methodology of Heltberg and Osmolovskiy [3] used in Central Asia, Pakistan and other regions where climate change impacts on different sectors is similar to Azerbaijan as the un-weighted average of three sub indices consisting of:

- the ecological exposure of each region to climate change,
- sensitivity of the population and sectors to climate change and
- the adaptive capacity of the population and sectors within a particular region

Exposure depends upon long term changes in temperature and precipitation; the frequency of extreme weather events; and weather related disasters in each ecological zone. In this index, long term changes in temperature are measured by the standard deviation of temperature as well as by the range between maximum and minimum temperature. The long term changes in precipitation are measured by the standard deviation of precipitation; and the exposure to weather related disasters due to climate variability are measured by the percentage of flood prone and drought prone districts in each ecological zone.

Sensitivity is assessed depending on the extent of the reliance of the region's population on the natural resource base for their livelihoods; the demographic structure (e.g. children and adults are more susceptible); the current health status of the population; and the health and sanitation facilities available to the population. Agriculture was assessed as the source of their livelihoods by share of crop income in total income and irrigated land as percentage of the total cultivable land. The demographic structure of the population was gauged by the share of population below 5 and above 65 years of age. The general health status of the population is measured by the percentage of children suffering from diarhoea and the percentage of population that is food insecure. The health and sanitation facilities available to the population are measured by the percentage of population without access to an improved water source and improved toilet facility. The selection of these variables is guided both by relevance as well as the availability of data.

Coping capacity refers to the ability of the population to adapt to changes in the circumstances, brought about by climate change. It depends upon the socio-economic conditions of the population exposed to climate change as well as public and private institutions. Socio-economic conditions of the population can be measured by household consumption per capita, the employment rate as well as the literacy rate. The quality of institutions is measured by some governance variables such as lack of corruption, accountability, and transparency etc. However, since data on such variables is not available at sub-national level, focus was on one measurable and relevant aspect of institutions from the point of view of study: the provision of public goods and its coverage by use of data on public provision of basic health needs such as immunization services and the availability of skilled health personnel.

Based on the methodology, the sub indices can be computed. The Climate Change Vulnerability Index is = 1/3[(Exposure + Sensitivity + (1-Coping Capacity)]. A higher degree of exposure and sensitivity leads to higher vulnerability. However, a higher degree of coping capacity depicts lower vulnerability.

4.2.2. World Bank climate change vulnerability index for the Europe Central Asia (ECA) Region

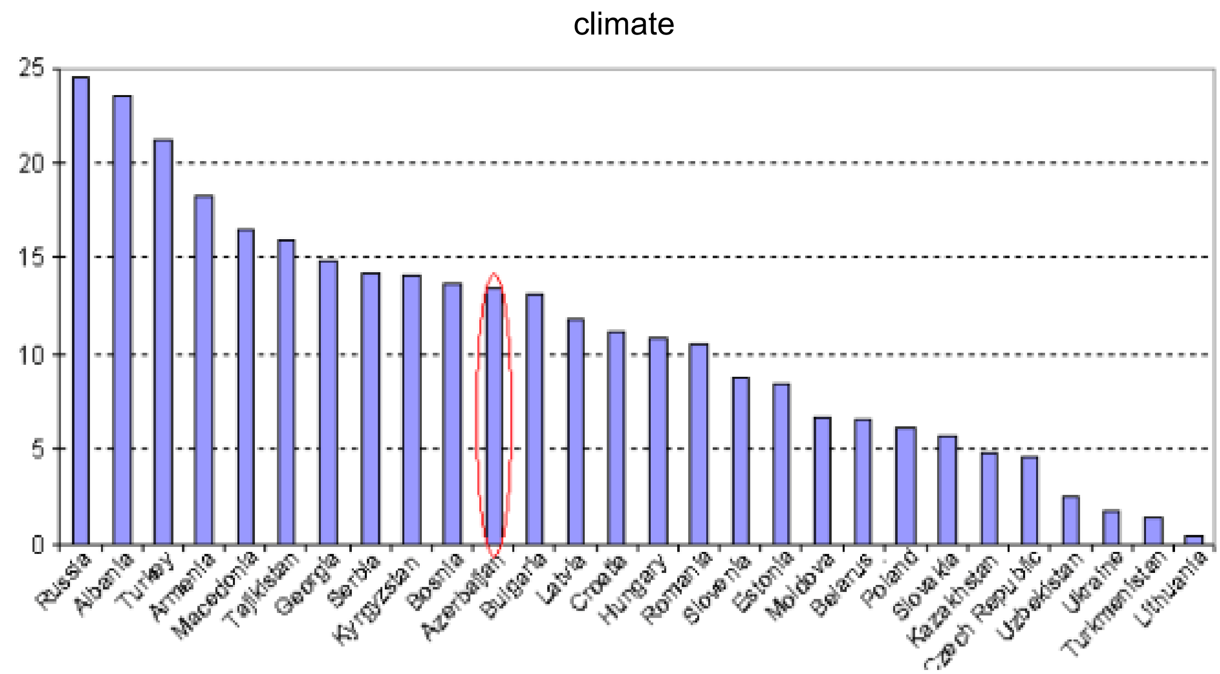
A World Bank developed a series of indices to assess the exposure, sensitivity and adaptive capacity of countries to climate change in the Europe Central Asia (ECA) Region. Vulnerability index combines three sub-indices, capturing a country's exposure, sensitivity, and adaptive capacity[7] The first, *exposure,* is based on an index measuring the strength of future climate change relative to today's natural variability. The index is available on a country basis and includes both annual and seasonal temperature and precipitation indicators. It combines the number of additional hot, dry, and wet years; hot, dry, and wet summers; and warm, dry, and wet winters projected over 2070–2100 relative to 1961–1990. The index suggests that the countries most exposed to future climatic change are the Russian Federation, Albania, Turkey, Armenia, and, to a lesser extent, North Macedonia and Tajikistan. Azerbaijan is in the middle (Figure 3).

The second sub-index, a country's *sensitivity* to climate change, is based on indicators likely to increase the impact of climate shocks. These include physical indicators, such as the available renewable water resources per capita, economic indicators capturing the importance of agriculture in the economy (share of employment and value of assets) and the share of electricity derived from hydroelectric plants. It also included a measure of the overall quality of infrastructure since infrastructure in poor condition is more likely to fail during an extreme event. The share of population over age 65 is also an indicator, since people in this group tend to be more sensitive to climate shocks. The results suggest that Central Asian countries are particularly sensitive to climate change along with Albania, Armenia, and Georgia.

The third sub-index, *adaptive capacity,* is estimated by combining social (income inequality), economic (gross domestic product [GDP] per capita), and institutional measures. The adaptive capacity index differs from the other two in that higher values are good as they denote higher adaptive capacity.

Combining the three components into a single index of vulnerability yields the ranking shown in Figure 3.

Figure 3: *Climate change Vulnerability Index, ECA Region (World Bank, 2012)*



The World Bank report uses several climate change vulnerability indicators and compares Azerbaijan to the Europe and Central Asia (ECA) Region average for transition economies. Although Azerbaijan is near the ECA average for several indicators, the country has a significantly higher percentage of population employed in the agricultural sector, a larger fraction of the population living in poverty, and a higher percent of land degradation. European countries have on average 4.5% of their population employed in agriculture,[2] as opposed to 39.7% in Azerbaijan,[34] and the average GDP derived from agriculture for high income European countries is 2%, significantly lower than Azerbaijan's 5.4%. Additionally, 7.6% of the Azerbaijan population lives under the national poverty line.[31] These factors make the nation particularly vulnerable to climate change.

4.2.3. University of Notre Dame Global Adaptation Index

The Notre Dame-Global Adaptation Index (ND-GAIN) is a free open-source index that shows a country's current *vulnerability* to climate disruptions. ND-GAIN brings together over 74 variables to form 45 core indicators to measure vulnerability and readiness of 192 UN countries from 1995 to the present (Due to data availability, ND-GAIN measures vulnerability of 182 countries).

ND-GAIN measures vulnerability as exposure, sensitivity and adaptive capacity, and the measure of readiness into economic, governance and social components. The construction of the framework is based on published peer-reviewed material, the IPCC Review process, and feedback from corporate stakeholders, practitioners and development users. Most of the vulnerability and readiness measures (except indicators of exposure are said to be actionable, meaning that these represent actions or the result of actions taken by national governments, communities, civil society organizations and other stakeholders.

ND-GAIN assesses the vulnerability of a country by considering six life-supporting sectors: food, water, health, ecosystem services, human habitat and infrastructure. Each sector in turn is represented by six indicators that represent three cross cutting *components*: the *exposure* of the sector to climate-related or climate-exacerbated hazards; the *sensitivity* of that sector to the impacts of the hazard and the *adaptive capacity* of the sector to cope or adapt to these impacts.

Exposure: The extent to which human society and supporting sectors are stressed by changing climatic conditions. Exposure captures the physical factors external to the system that contribute to vulnerability.

Sensitivity: The degree to which people and the sectors they depend upon are affected by climate related perturbations. The factors increasing sensitivity include the degree of dependency on sectors that are climate-sensitive and proportion of population sensitive to climate hazards due to factors such as topography and demography.

Adaptive capacity: The ability of society and its supporting sectors to adjust to reduce potential damage and to respond to the negative consequences of climate events. Adaptive capacity indicators seek to capture means readily deployable to deal with sector-specific climate change impacts.

Table 3 below summarizes indicators measuring both vulnerability and readiness. Vulnerability is composed of 36 indicators. Each component has 12 indicators, across 6 sectors.

Table 3: ND-GAIN Vulnerability Indicators

Sector	Exposure component	Sensitivity component	Adaptive Capacity component
Food	Projected change of cereal yields	Food import dependency	Agriculture capacity (fertilizer, irrigation, pesticide, tractor use)
	Projected population change	Rural Population	Child malnutrition
Water	Projected change of annual runoff	Fresh water withdrawal rate	Access to reliable drinking water
	Projected change of annual groundwater recharge	Water dependency ratio	Dam capacity
Health	Projected change of deaths from climate change induced diseases	Slum population	Medical staffs (physicians, nurses and midwives)
	Projected change of length of transmission season of vector-borne diseases	Dependency on external resource for health services	Access to improved sanitation facilities
Ecosystem services	Projected change of biome distribution	Dependency on natural capital	Protected biomes
	Projected change of marine biodiversity	Ecological footprint	Engagement in International environmental conventions
Human Habitat	Projected change of warm period	Urban concentration	Quality of trade and transport-related Infrastructure
	Projected change of flood hazard	Age dependency ratio	Paved roads
Infrastructure	Projected change of hydropower generation capacity	Dependency on imported energy	Electricity access
	Projection of Sea Level Rise impacts	Population living under 5m above sea level	Disaster preparedness

5. METHODOLOGY TO ASSESS CLIMATE CHANGE VULNERABILITY FOR REGIONS OF AZERBAIJAN, WITH A FOCUS ON THE LANKARAN-ASTARA ECONOMIC REGION

In this report the climate change vulnerability assessment is based on the ND-GAIN methodology as it contains many indicators. to select and assess vulnerability indexes. For each sector (food, water, health, human habitat, ecosystem) exposure, sensitivity, adaptive capacity and vulnerability. Has been assessed. Food security in country and regions has been assessed.

5.1. Agriculture

5.1.1. EXPOSURE INDICATOR 1: Projected change in cereal yield

Climate change is predicted to change food supply by mid-century for three staples: rice, wheat and maize. The projections of yield in ND GAIN assessment are obtained from five crop models (EPIC, GEPIC, LPJmL, pDSSAT, PEGASUS), and it assumes effect of CO2 fertilization but does not adjust for changes in farming systems or irrigation.

As the projected change is calculated by the percent change from the baseline projection of annual average of actual cereal yield in 1980-2009 for a future projection in 2040-2069 under the RCP4.5 emission scenario (see IPCC, 2014). There is no data for regions on future yield production for the five crop models therefore for regions of Azerbaijan this index was taken as an average calculated by ND Gain which is equal to 0.82. This figure will be used in all regions as no other modelling of crop changes in regions exist.

5.1.2. EXPOSURE INDICATOR 2: Projected population change

Currently average population growth compared to 1990 is calculated by the percent change from the baseline population in 1990 to the average population in 2021

Table 4: Population change

№	Population of regions	1990	2021	Change by 2021	Projected by 2041-2069
1.	**Azerbaijan Republic**	7131.9	10119.1	0.42	0.50
2.	**Lankaran-Astara**	613.2	953.6	0.56	0.66
3.	**Lerik**	54.7	87.3	0.60	0.70
4.	**Lankaran**	165	226.6	0.37	0.44
5.	**Jalilabad**	136	214.9	0.58	0.67
6.	**Yardimli**	40.7	67.7	0.66	0.77
7.	**Masalli**	146.4	225.3	0.54	0.64
8.	**Astara**	70.8	110.9	0.57	0.66

According to ND Gain average value of this index for the region modelled for period 2040-2069 is equal to 0.18, which was taken into account.The value of this index by 2040-2069 is expected to be 0.50

5.1.3. SENSITIVITY INDICATOR 1: Food import dependency

Countries highly dependent on food imports are susceptible to food price shocks. Climate change and its impacts on the agriculture sector may accentuate price volatility. The definition of cereal is from FAO as “crops harvested for dry grain only”, including wheat, rice, barley, maize, popcorn, rye, oats, millets, sorghum, buckwheat, quinoa, triticale, canary seed, mixed grain, and remaining types. Cereal consumptionis equal to production and imports minus exports.

For ND-GAIN this is 0.25 by 2069. According to AzSTAT in 2020 import of food products totaled 1.31 billion USD and export 0.713 billion USD. In total annual amount of agricultural products was equal to 9,448,909,000 AZN. In total import rate was 11%. The ratio of imported products per person was 100 AZN. If we add this figure equally to amount of used products by each person in region and to give it in normalized units we can get agricultural production ratio of imported products for regions by 2020. For Azerbaijan in total this will be 0.11

This ratio for the region for 2041-2069 was equal to 0.25. In this case total agricultural products per person is supposed to be 1112 AZN and share of imported products 278 AZN. The agricultural production ratio of imported products for regions by 2069 is given (Table5).

Table 5: *Dependency on imported agricultural products index (Source: stat.gov.az).*

Region	Area th. Sq.km kv.km.	Population th, person	Agricul-tural crop production th. azn	Produc-tion per capita AZN/N	Amount of used agricultural products p.person	Ratio of imported product (1991-2020)	Projected by 2041-2069
Azerbaijan Republic	86.6	10119.1	8428909	834	934	0.11	0.25
Lankaran-Astara region	6.07	953.6	810736	788	888	0.11	0.26
Lerik	1.08	87.3	60766	696	797	0.25	0.45
Lankaran	1.54	226.6	137134	605	782	0.31	0.56
Jalilabad	1.44	214,9	142013	661	765	0.18	0.36
Yardimli	0.67	67,7	47127	696	960	0.38	0.66
Masalli	0.72	225,3	142013	630	730	0.18	0.36
Astara	0.62	110,9	88377	797	1030	0.31	0.56

5.1.4. SENSITIVITY INDICATOR 2: Rural population

This measure includes all people living in the rural regions of a country as a percentage of total population of the region

Table 6: *People living in the rural regions of a country as percentage of total population of the region (Source: stat.gov.az)*

№	Population of regions	Population th. persons	Rural population in percent
1	Azerbaijan Republic	10119.1	0.47
	Rural population	934760.6	
2	Lankaran-Astara Economic Region	953.6	0.73
	Rural population	699.2	
3	Lerik	85.2	0.93
	Rural population	76.6	
4	Lankaran	226.6	
	Rural population	139.3	0.61
5	Jalilabad	214,9	
	Rural population	157.2	0.73
6	Yardimli	67,7	
	Rural population	60.5	0.89
7	Masalli	225,3	
	Rural population	174.1	0.77
8	Astara	110.9	
	Rural population	77.4	0.70

Therefore, a high proportion of rural population is indicative of a strong dependency on subsistence, or near subsistence, farming. Subsistence farmers are more vulnerable to climate shocks.

5.1.5. ADAPTIVE CAPACITY INDICATOR 1: Agriculture capacity

Agricultural capacity is the ratio of cultivated arable lands to total area. For Azerbaijan this index is equal to 0.15. Results are in the table below.

Table 7: *Ratio of total agricultural production area to area of region*

№	Region	Area, th sq.km	Agricultural cultivated lands. ha	Agricultural crop production area Index
1.	**Azerbaijan Republic**	86.6	**1630935**	0.19
2.	**Lankaran-Astara**	6.07	**114624**	0.19
3.	**Lerik**	1.08	**5128**	0.05
4.	**Lankaran**	1.54	**7456**	0.05
5.	**Jalilabad**	1.44	**74199**	0.52
6.	**Yardimli**	0.67	**5211**	0.08
7.	**Masalli**	0.72	**16897**	0.23
8.	**Astara**	0.62	**5733**	0.09

5.1.6. ADAPTIVE CAPACITY INDICATOR 2: Child malnutrition

Malnutrition is the percent of under 5 year-oldswith a low weight to height ratio. This is very low in Azerbaijan according to ND-Gain indexes (0.13). There is no data for the Lankaran region so this figure was taken as the same for all regions.

5.2. Water

5.2.1. EXPOSURE INDICATOR 1: Projected change of annual runoff

An indication of how climate change will bring changes to annual surface water resources by the mid of the century, surface water resources are considered susceptible to climate change because of the impact of temperature and precipitation variability on rainfall, snow evaporation, etc. The projected change of annual runoff due to climate change takes into account impacts on precipitation, evaporation, transpiration and soil moisture, which are the key factors impacting the volume of runoff.

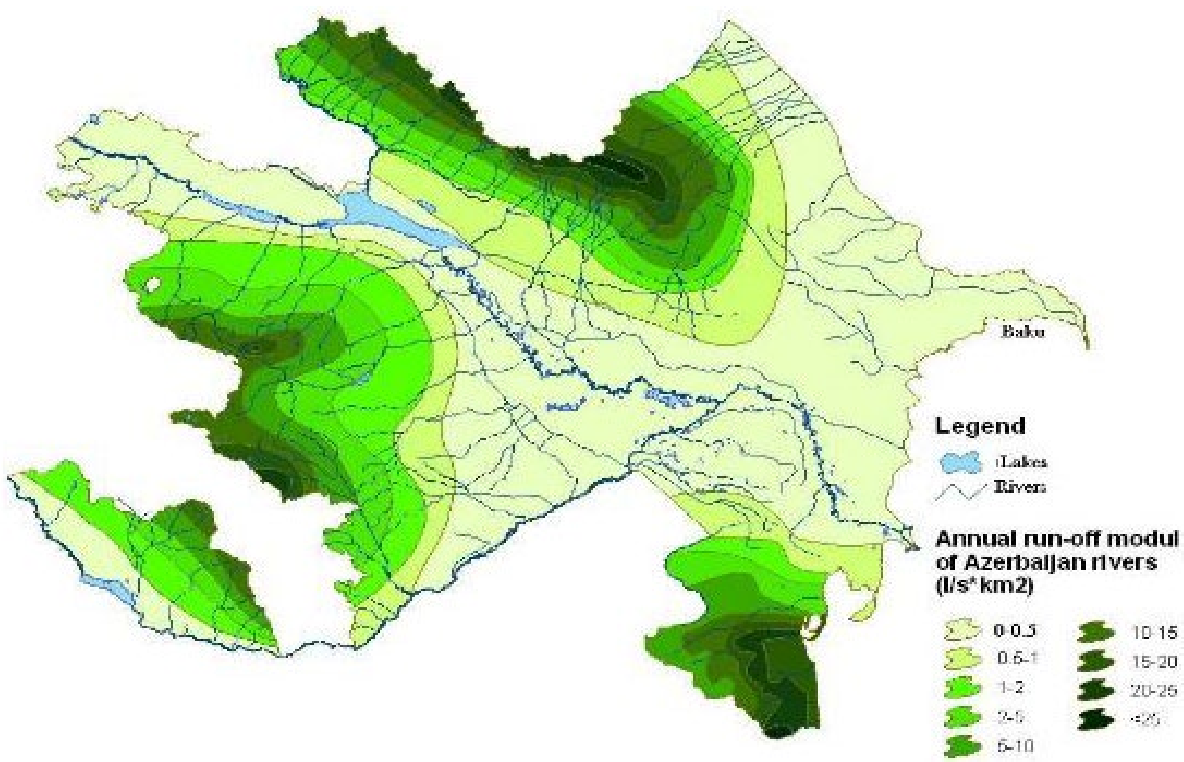
ND-GAIN uses the projected change of annual runoff as a proxy to measure the climate impacts on surface water resources. The projected change is the percent change in annual runoff from the baseline projection (1961-1990) to the future period (2040-2069) using RCP4.5 emission scenario. For Azerbaijan and Lankaran region this index equal to "0. The changes to water resources from 1961-1990 to 1991-2020 is in Table 8. Flow change index showing percentage of water resources in the last period to the previous is expressed here as the sector's vulnerability index.

Change of water resources in period of 2014-2069 was assessed by use of national climate change sceneries given in the 4th National Communication.

__Table 8.__ Change of water resources of regions of Azerbaijan Republic

№	Region	Territory, th, sq .km	Local water resources (1961-1990)	Local water resources (1991-2020)	Current flow change index	Water resources change index by 2041-2069
1.	**Azerbaijan Republic**	86.6	10.3	8.81	0.15	0.30
2.	**Lankaran-Astara**	6.07	1.26	1.09	0.13	0.26
3.	**Lerik**	1.08	0.19	0.17	0.11	0.22
4.	**Lankaran**	1.54	0.42	0.36	0.11	0.22
5.	**Jalilabad**	1.44	0.15	0.12	0.11	0.22
6.	**Yardimli**	0.67	0.18	0.15	0.11	0.22
7.	**Masalli**	0.72	0.27	0.22	0.11	0.22
8.	**Astara**	0.62	0.11	0.10	0.11	0.22

Map 4: *Run-off of rivers of Azerbaijan*



5.2.2. EXPOSURE INDICATOR 2: Projected change in annual groundwater recharge (GWR)

An indication of how climate change will bring about changes in annual groundwater resources by mid-century. As noted in ND-GAIN report the projected change in groundwater recharge due to climate change takes into account the climatic impacts on total runoff, precipitation intensity, relief, soil texture, aquifer properties, and the occurrence of glaciers and permafrost. ND-GAIN uses the projected change in annual groundwater recharge as a proxy to measure the climate impacts on freshwater resources, complementing the surface water runoff indicator. The ND-Gain report determined this indicator for Azerbaijan by using RCP4.5 emission scenario.

The projected change is the percentage decrease in annual groundwater recharge from the baseline projection of 1961-1990 to the future projection of 2040- 2069. In this report it is assessed as the change in the drought or SPI index, based on data on reduction of annual precipitation, increase in temperature and change in river flow.

As shown in Table 9 this index is 0.47 for 1991-2020 and 0.69 for the projected period of 2041-2069 in Azerbaijan and a bit higher for the region.

***Table 9**: Drought index (SPI) for Azerbaijan, LAER and districts*

№	Region	Temperature increase index	Precipitation change index	Current flow change index	Water resources change index by 2041-2069	Exposure Index (1991-2020)
1.	**Azerbaijan Republic**	0.73	0.53	0.15	0.30	0.47
2.	**Lankaran-Astara**	0.8	0.53	0.13	0.26	0.49
3.	**Lerik**	0.8	0.30	0.11	0.22	0.4
4.	**Lankaran**	0.75	0.23	0.11	0.22	0.31
5.	**Jalilabad**	0.67	0.28	0.11	0.22	0.
6.	**Yardimli**	0.65	0.25	0.11	0.22	0.30
7.	**Masalli**	0.65	0.25	0.11	0.22	0.30
8.	**Astara**	0.68	0.27	0.11	0.22	0.31

5.2.3. SENSITIVITY INDICATOR 1: Freshwater withdrawal rate

In this report the ratio of fresh water abstracted as percentage of existing local water resources is projected from 2020 to 2041- 2069 (Table 10).

Table 10: *Freshwater withdrawal rate in Azerbaijan regions*

№	Region	Territory, th, sq .km	Water Abstraction cub.km	Available amount of local water	Current water withdrawal index	Future water withdrawal rate index (2041-2069)
1.	**Azerbaijan Republic**	86.6	12.6	8.83	1.00	1.00
2.	**Lankaran-Astara**	6.07	0.17	1.09	1.00	1.00
3.	**Lerik**	1.08	0.001	0.17	0.01	0.02
4.	**Lankaran**	1.54	0.049	0.36	0.13	0.14
5.	**Jalilabad**	1.44	0.041	0.12	0.3	04
6.	**Yardimli**	0.67	0.001	0.15	0.01	0.2
7.	**Masalli**	0.72	0.059	0.22	0.3	0.4
8.	**Astara**	0.62	0.021	0.10	0.10	0.1

5.2.4. SENSITIVITY INDICATOR 2: Water dependency ratio

The proportion of total renewable water resources originating from outside the country to total water resources was used as transboundary (outside) flow index in this report.

Table 11: *Water dependency indicators*

Region	Total volume of currently abstracted water resources	Ratio of over abstracted (compared to amount of local water resources) to the total volume of abstracted waters (1991-2020)	Ratio of over abstracted (compared to amount of local water resources) to the total volume of abstracted waters (2041-2069)
Azerbaijan Republic	12.6	0.30	0.40
Lankaran-Astara	0.17	0.00	0.1
Lerik	0.001	0.00	0
Lankaran	0.049	0.00	0
Jalilabad	0.041	0.00	0
Yardimli	0.001	0.00	0
Masalli	0.059	0.00	0
Astara	0.021	0.00	0

In the ND-GAIN this index for Azerbaijan is equal to 0.77 . It seems that when determining transboundary water, they didn't take into account transboundary water reduction due to climate change and water abstraction by upstream countries.

5.2.5. ADAPTIVE CAPACITY INDICATOR 1: Dam capacity

Adaptation to greater water scarcity and variability in flows could include both the establishment of an efficient water market and an increase in water storage capacity through the construction of dams. The construction of dams and reservoirs are an example of a country's capacity to build infrastructure thatmay reduce climate change impact.

Ratio of dam capacity to total available water resources was used as a dam capacity index and its value for Azerbaijan Republic was 0.46 (Table 12). This was the value for this index in the ND-GAIN report. In Lankaran-Astara region this figure is very low as there are less dams.

Table 12: *Dam capacity to ratio of available water resources*

Population of regions	Population th. persons	Reservoir capacity (mln cubic meters)	Available water flow, mln. cub.m	Reservoir capacity index
Azerbaijan Republic	10119.1	12390	26500	0.46
Lankaran-Astara	953.6	105	1,110	0.09
Lerik	87.3	0	170	0
Lankaran	226.6	52	360	0.16
Jalilabad	214.9	4.0	120	0.33
Yardimli	67.7	45	150	0.3
Masalli	225.3	0.5	220	0.02
Astara	110.9	5	100	0.05

5.2.6. ADAPTIVE CAPACITY INDICATOR 2: Access to reliable drinking water

The commonly used indicator is the capacity to deliver reliable domestic water supplies. The drinking water sources are considered reliable if there is a household connection, public standpipe, borehole, protected well or spring, orrainwater collection.

This report has used the change in centralized drinking water supply per person by region and district. The results are in Table 13. In the ND-Gain report the projected figure for Azerbaijan is 0.27, which is close to current value. For the Lankaran-Astara economic region this figure is 0.11. In order to increase adaptive capacity the central water supply needs to be increased.

Table 13: *Centralized drinking water per person.*

Regions	Population (persons)	Centralised drinking water supply cub.m/person/year	Normalized value	Regions
Azerbaijan Republic	10119.1	31,9	0.28	10119.1
Lankaran-Astara	953.6	12.3	0.11	953.6
Lerik	87.3	2	0.02	87.3
Lankaran	226.6	16	0.15	226.6
Jalilabad	214.9	1.7	0.02	214.9
Yardimli	67.7	4	0.04	67.7
Masalli	225.3	4.1	0.04	225.3
Astara	110.9	3.7	0.04	110.9

5.3. Health

5.3.1. EXPOSURE INDICATOR: Projected change in vector-borne diseases due to changes in length of the transmission season (LTS)

This indicator takes the projection of malaria LTS as an indication of the impact of climate change on vector-borne diseases. In this indicator the WHO estimate of the number of cases of malaria per 1000 population per month of the current LTS is used. The effectof public health in limiting the incidence of cases of the disease is assumed to remain at the current (2010-2012) level of effectiveness. The projected change is the absolute increase in malaria LTS from the baseline projection (1980-2010) to the future projection in 2050, using RCT4.5 emission scenario. For Azerbaijan and Lankaran region this index is taken from ND-GAIN report and is equal to 0.65

5.3.2. SENSITIVITY INDICATOR: Age dependency ratio

The indicator is the size of the vulnerable population in terms of age. This indicator considers the percentage of population under 14 or above 65 of the total population. Vulnerable age groups under 14 or above 65 are susceptible to climate change impacts through direct and indirect channels. The direct effects of extreme weather may disproportionately affect the old and the young. These groups may be indirectly affected by the impacts of climate change through socio-political structures or the economy. In the ND-GAIN report this figure for Azerbaijan is equal to 0.41 by 2069. Results for this indicator are in Table 14.

Table 14: *Age dependency index*

Region/ District	Population	Of which						
		Number			Percent of total population			
		0-14 years	65 years and higher	Total	0-14 years	65 years and higher	Total by 1991-2020	Total by 2041-2069
Azerbaijan Republic	10119133	2260760	756232	3016992	0.22	0.07	0.3	0.41
Lankaran-Astara	953609	236497	57692	294189	0.25	0.06	0.31	0.42
Lerik	87300	21500	5200	26700.00	0.25	0.06	0.31	0.41
Lankaran	226600	51642	17328	68970.00	0.23	0.08	0.30	0.41
Jalilabad	214900	53530	14855	68385.00	0.25	0.07	0.32	0.42
Yardimli	67700	19487	3530	23017.00	0.29	0.05	0.34	0.44
Masalli	225300	56408	14742	71150.00	0.25	0.07	0.32	0.42
Astara	110900	27330	7721	35051.00	0.25	0.07	0.32	0.42

5.3.3. ADAPTIVE CAPACITY INDICATOR 1: Medical staff

This indicator is taken as the number of physicians, nurses and midwives per 1000 population in the country. For the period, 2041-2069 this indicator for Azerbaijan as provided by the ND-GAIN index was 0.16. By multiplying the regional and district values of this index in the ratio 0.16/0.09 we can get relevant indexes by 2041-2069.

Table 15: *Medical staffs*

Regions	Population th. persons	Number of doctors per 1000 person	Medical staff for 100 th. persons	Medical staf index
Azerbaijan Republic	10119.1	8.70	0.09	0.16
Lankaran-Astara	953.6	4.03	0.04	0.07
Lerik	87.3	4.4	0.04	0.07
Lankaran	226.6	15	0.15	0.30
Jalilabad	214.9	7.8	0.08	0.15
Yardimli	67.7	5.5	0.05	0.08
Masalli	225.3	8	0.08	0.15
Astara	110.9	7	0.07	0.12

5.3.4. ADAPTIVE CAPACITY INDICATOR 2: Level of employment

The ND-GAIN was used as a proxy for access to improved sanitation facilities, the level of employment. As there is no data for the region we used the same indicator. It is assumed that employment makes it possible for people to access better sanitation. To assess the capacity to have reliable sanitation we look at the number of employed persons per 1000 persons in the age group of 19-65 years.

Table 16: *Number of employed per 1000 person in age group of 19-65 years*

Region	Area sq.km	Population th. Person by 01.01.2021	Number of employed people (th)	Number of employed per 1000 persons (19-65 years age group)	Normalized (in percent)
Azerbaijan Republic	86.6	10119.1	1698.7	263	0.26
Lankaran-Astara	6.07	953.6	69.7	114	0.11
Lerik	1.08	87.3	5.4	90	0.09
Lankaran	1.54	226.6	21.8	140	0.14
Jalilabad	1.44	214,9	13	90	0.09
Yardimli	0.67	67,7	4.6	100	0.1
Masalli	0.72	225,3	15.3	97	0.1
Astara	0.62	110,9	8.5	110	0.11

5.4. Human habitat

5.4.1. EXPOSURE INDICATOR 1: Projected change of warm periods

5.4.1 As an indicator of the probability of extreme heat due to climate change, in this report the ratio of the number of days with maximum temperatures during the period 1991-2020 that are higher than the 50th percentile of daily maximum temperatures in the base period of 1961-1990 has been used.

Comparison of daily maximal temperatures in period of 1991-2020 with their values in previous period (1961-1990) shows significant increase in their values and frequencies. A further increase was taken into account when normalizing this indicator for the period till 2069.

Table 17: *Hot weather exposure index*

Region	Number of daily maximum temperatures exceeding during last 30 years their average values for (1961-1990)	Hot weather exposure index By 2020	Hot weather index by 2069
Azerbaijan Republic		0.74	0.79
Baku	26	0.73	0.78
Lankaran-Astara	24	0.6	0.65
Lerik	24	0.6	0.65
Lankaran	24	0.6	0.65
Jalilabad	25	0.66	0.72
Yardimli	23	0.53	0.57
Masalli	24	0.6	0.65
Astara	24	0.6	0.65

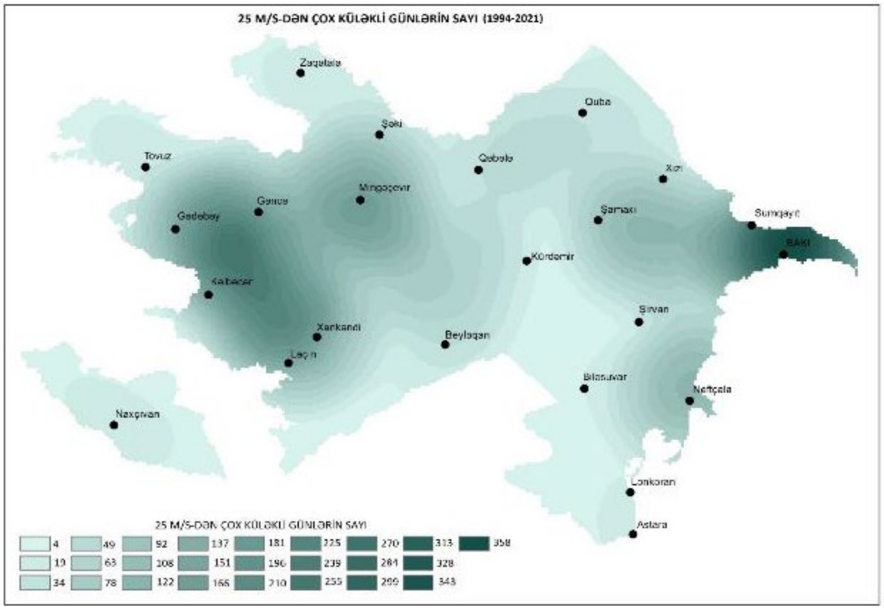
5.4.2 EXPOSURE INDICATOR 2: Winds over 25m/s

This indicator is the number of days with winds over 25m/s velocity for the country, region and then normalizing them for the districts.

Table 18: *Number of windy days over 25m / s (1994-2021)*

Region	Normalized wind exposure index (1991-2020)	Normalized wind exposure index (2041-2069)
Azerbaijan Republic	0.56	0.70
Lankaran-Astara	0.45	0.56
Lerik	0.4	0.5
Lankaran	0.50	0.62
Jalilabad	0.51	0.63
Yardimli	0.40	0.5
Masalli	0.48	0.60
Astara	0.45	0.60

__Figure 5:__ Number of windy days over 25m / s (1994-2021)



5.4.3. SENSITIVITY INDICATOR: Flood sensitivity

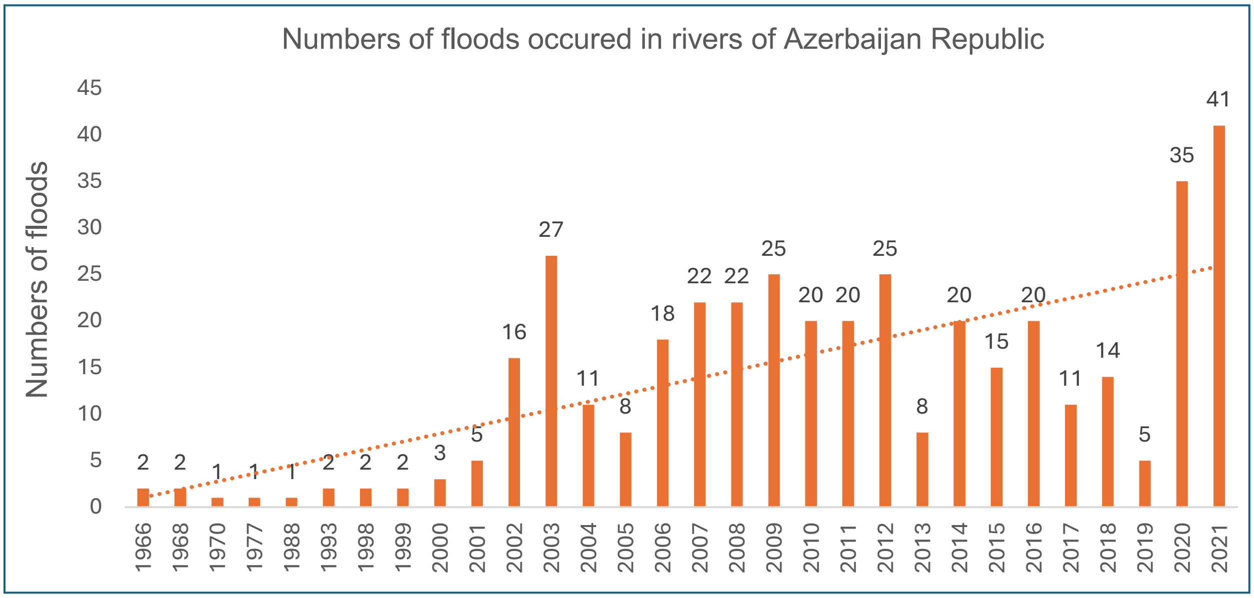
During last 30 years the increase of frequency and intensity of maximal rainfall is seen as a result of climate change. For the flood hazard index assessment the ratio of the increase in the period 1991-2020 number of annual daily maximum precipitation higher than the 50th percentile of daily maximum precipitation and information about the severity of floods In different districts was taken into account. (Table 19, Figure 6).

Comparison of daily maximal precipitation in 1991-2020 with their values in previous period (1961-1990) show significant increase of their values and frequencies in most of the districts..

__Table 19:__ Projected change of floods

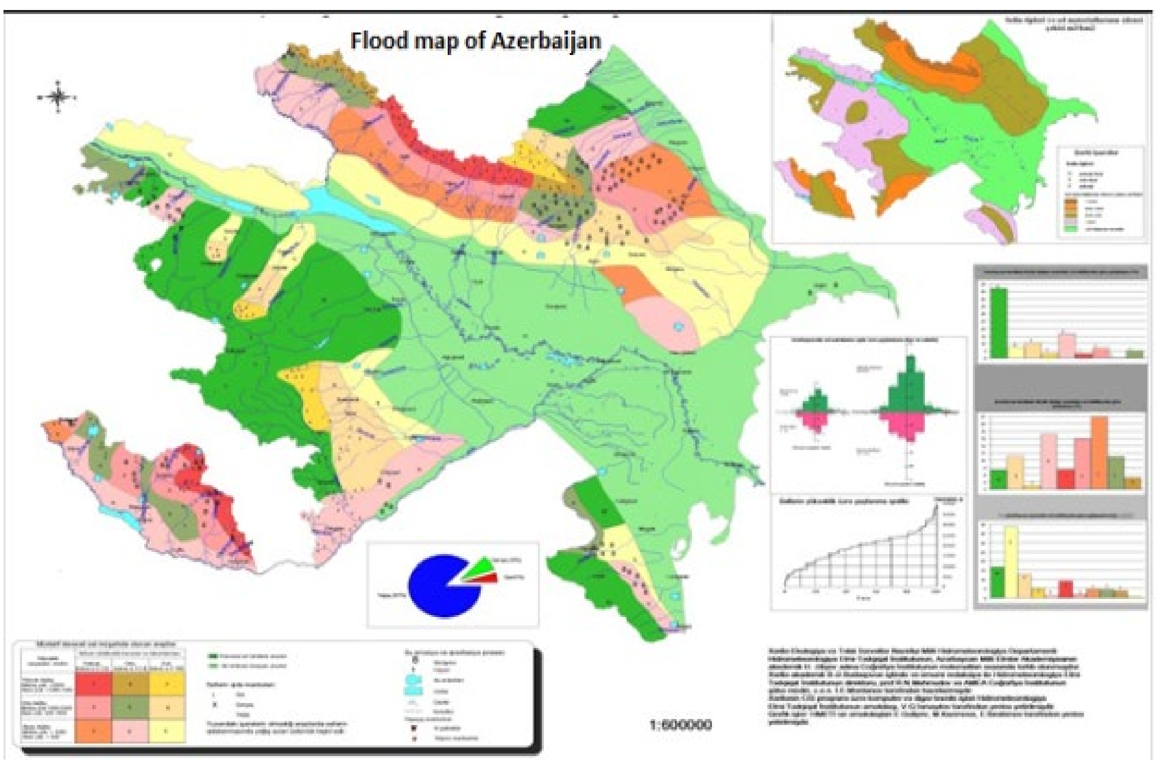
Region	Number of daily maximum precipitations exceeding during last 30 years their average values for (1961-1990)	Percentage of increase in number daily maximum precipitations exceeding during last 30 years their average values for (1961-1990)
Azerbaijan Republic	21	0.36
Lankaran-Astara	20	0.33
Lerik	25	0.67
Lankaran	24	0.60
Jalilabad	27	0.56
Yardimli	24	0.51
Masalli	25	0.56
Astara	24	0.51

Figure 6: *Change in number of floods in Azerbaijan*



At the same time in order to assess flood index in each region flooded areas with different flood hazard category indexes have been multiplied to corresponding indexes (changing from 1 to 9) and divided to total area of region (see map in figure 7).

Figure 7: *Flood map of Azerbaijan*



Then their sum divided by 9 have been taken in capacity of flood hazard category index during the period 1991-2020).

Based on above increase in numbers and magnitude of floods compared to 1991-2020, the sensitivity index for period 2041-2069 was proposed to be 1.25 times higher its values in 1991-2020. Results are given in Table 19.

Table 19: *Flood hazard indexes.*

Region	Area	Flood Sensitivity index 1991-2020	Flood Sensitivity index 2041-2069
Azerbaijan Republic	86.6	0.57	0.67
Lankaran-Astara	6.07	0.40	0.47
Lerik	1.08	0.44	0.51
Lankaran	1.54	0.46	0.55
Jalilabad	1.44	0.36	0.45
Yardimli	0.67	0.45	0.54
Masalli	0.72	0.45	0.54
Astara	0.62	0.41	0.49

5.4.4. ADAPTIVE CAPACITY INDICATOR 1: Quality of trade and transport infrastructure

Transportation infrastructure has been shown to be important for migration and development. Migration from challenging climates is important for improving human health. The quality of trade and transport infrastructure shows the capacity to effectively supply and manage essential infrastructure by the public and private sectors. In the ND-GAIN report this index is 0.58 by 2041-2069 for the country. The calculated values of transportation vehicles have been transferred to this value (by multiplying to 0.58/0.51)

Table 20: *Number of transport per capita is given in table below*

Regions	Population th.persons	Transportation vehicles per 1000 person	Normalised values	Transport related adaptive capacity index by 2041-2029
Azerbaijan Republic	10119.1	147	0.51	0.58
Lankaran-Astara	953.6	83	0.29	0.33
Lerik	87.3	55	0.17	0.20
Lankaran	226.6	103	0.36	0.42
Jalilabad	214,9	108	0.37	0.46
Yardimli	67,7	57	0.20	0.26
Masalli	225,3	104	0.36	0.42
Astara	110,9	95	0.30	0.32

6. CLIMATE CHANGE VULNERABILITY PROJECTIONS BY 2041-2069 FOR LAER

In order to assess climate change vulnerability for Azerbaijan and Lankaran region first the results of exposure, sensitivity and* adaptation capacity indexes is summarized for the indicators mentioned earlier for the period 2041-2069. The average values of these indexes for each sector was calculated for 2041-2069 and then climate change vulnerability index was calculated according to the formula:

$$\mathbf{I_v = \frac{I_e + I_s + 1 - I_{ac}}{3}}$$

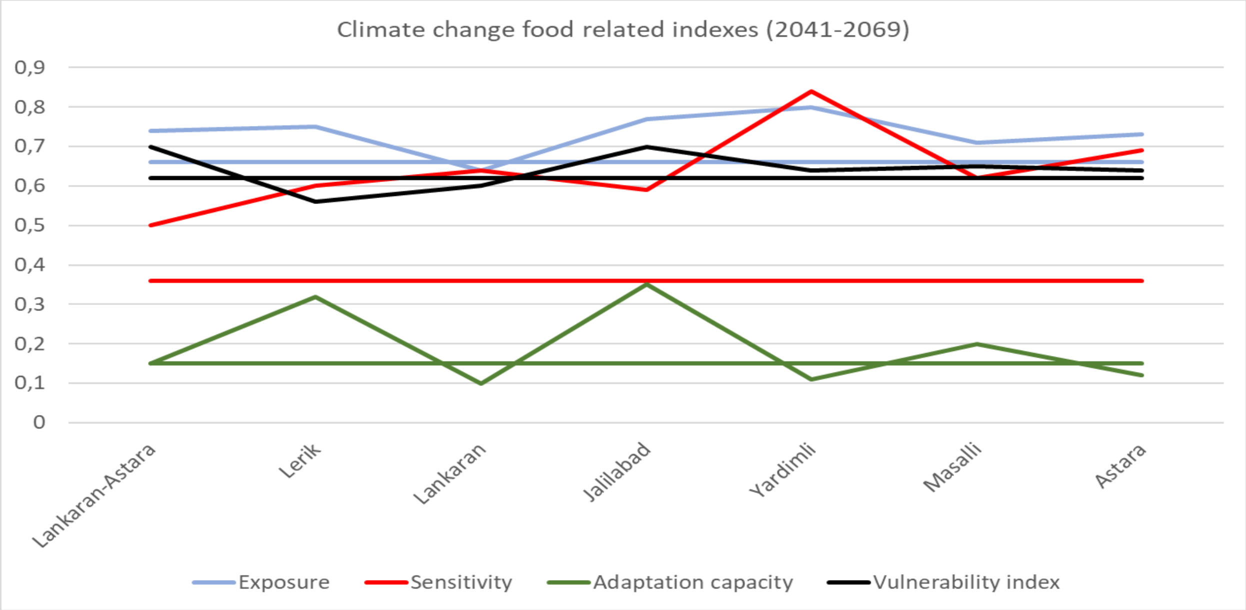
Where I_v, I_e, I_s and I_{ac} are the vulnerability, exposure, sensitivity and adaptation capacity indexes.

Based on the results for different sectors the average values of exposure, sensitivity and adaptation capacity indexes was derived and then the vulnerability index for each sector was arrived using the formula. In table 22 and figure 8 are shown climate change vulnerability index in relation to food security by region and districts.

Table 22: *Climate change vulnerability index in relation to food security by region and districts*

Regions	Exposure		Sensitivity		Adaptation capacity		Vulnerability index	
	2020	2041-2069	2020	2041-2069	2020	2041-2069	2020	2041-2069
Azerbaijan Republic	0.62	0.66	0.29	0.36	0.15	0.15	0.59	0.62
Lankaran-Astara	0.69	0.74	0.42	0.50	0.15	0.15	0.65	0.70
Lerik	0.71	0.75	0.52	0.60	0.32	0.32	0.51	0.56
Lankaran	0.60	0.64	0.59	0.64	0.09	0.10	0.55	0.60
Jalilabad	0.70	0.77	0.55	0.59	0.325	0.35	0.64	0.70
Yardimli	0.74	0.80	0.78	0.84	0.105	0.11	0.59	0.64
Masalli	0.66	0.71	0.57	0.62	0.18	0.20	0.60	0.65
Astara	0.67	0.73	0.63	0.69	0.11	0.12	0.59	0.64

Figure 8: Climate change food related indexes



Though the adaptation capacity of the region in terms of food security is near the average value for Azerbaijan, the climate vulnerability index is high as exposure and sensitivity indexes are high as well. This shows that in the future the environmental conditions and natural resources of the district can play an important role in adapting to climate change if relevant investments are made in infrastructure and modern agricultural methods.

Table 23 and figure 9 show the climate change vulnerability index in relation to water security for the region and districts.

Table 23: *Climate change vulnerability index in relation to water security by region and districts*

Regions	Water indexes							
	Exposure		Sensitivity		Adaptation capacity		Vulnerability index	
	2020	2041-2069	2020	2041-2069	2020	2041-2069	2020	2041-2069
Azerbaijan Republic	0.31	0.50	0.65	0.70	0.37	0.37	0.53	0.61
Lankaran-Astara	0.31	0.49	0.50	0.55	0.1	0.1	0.57	0.65
Lerik	0.25	0.41	0.01	0.01	0	0	0.42	0.47
Lankaran	0.21	0.37	0.07	0.07	0.16	0.16	0.50	0.55
Jalilabad	0.22	0.37	0.15	2.00	0.18	0.18	0.48	0.52
Yardimli	0.21	0.36	0.01	0.10	0.17	0.17	0.52	0.57
Masalli	0.21	0.36	0.15	0.20	0.03	0.03	0.47	0.52
Astara	0.21	0.37	0.05	0.05	0.05	0.05	0.51	0.56

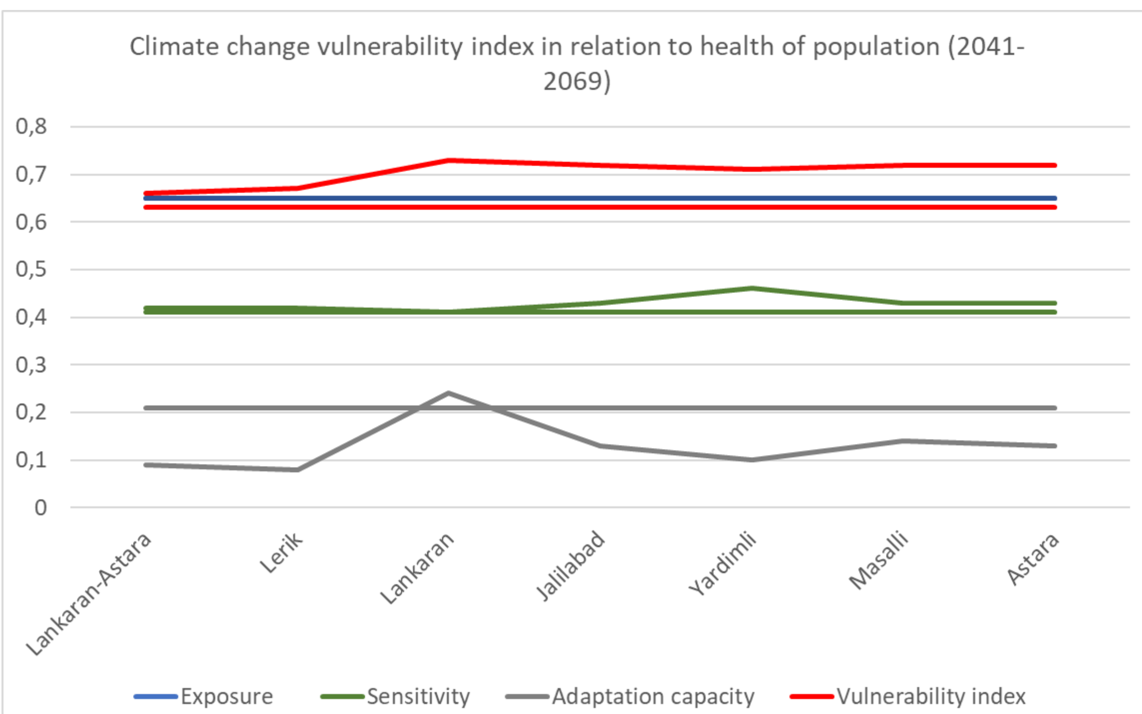
The construction of reservoirs and other infrastructure to collect river water and through rainwater harvesting, the adaptive capacity of the region to climate change can be enhanced.

Table 24 and figure 10 show the climate change vulnerability index in relation to health of population.

Table 24: *Climate change vulnerability index in relation to health of population by regions*

Regions	Health							
	Exposure		Sensitivity		Adaptation capacity		Vulnerability index	
	2020	2041-2069	2020	2041-2069	2020	2041-2069	2020	2041-2069
Azerbaijan Republic	0.65	0.65	0.3	0.41	0.21	0.21	0.58	0.63
Lankaran-Astara	0.65	0.65	0.31	0.42	0.09	0.09	0.62	0.66
Lerik	0.65	0.65	0.31	0.42	0.07	0.08	0.63	0.67
Lankaran	0.65	0.65	0.30	0.41	0.22	0.24	0.67	0.73
Jalilabad	0.65	0.65	0.32	0.43	0.12	0.13	0.66	0.72
Yardimli	0.65	0.65	0.34	0.46	0.09	0.10	0.65	0.71
Masalli	0.65	0.65	0.32	0.43	0.13	0.14	0.66	0.72
Astara	0.65	0.65	0.32	0.43	0.12	0.13	0.66	0.72

Figure 9: *Climate change vulnerability index in relation to health of population*

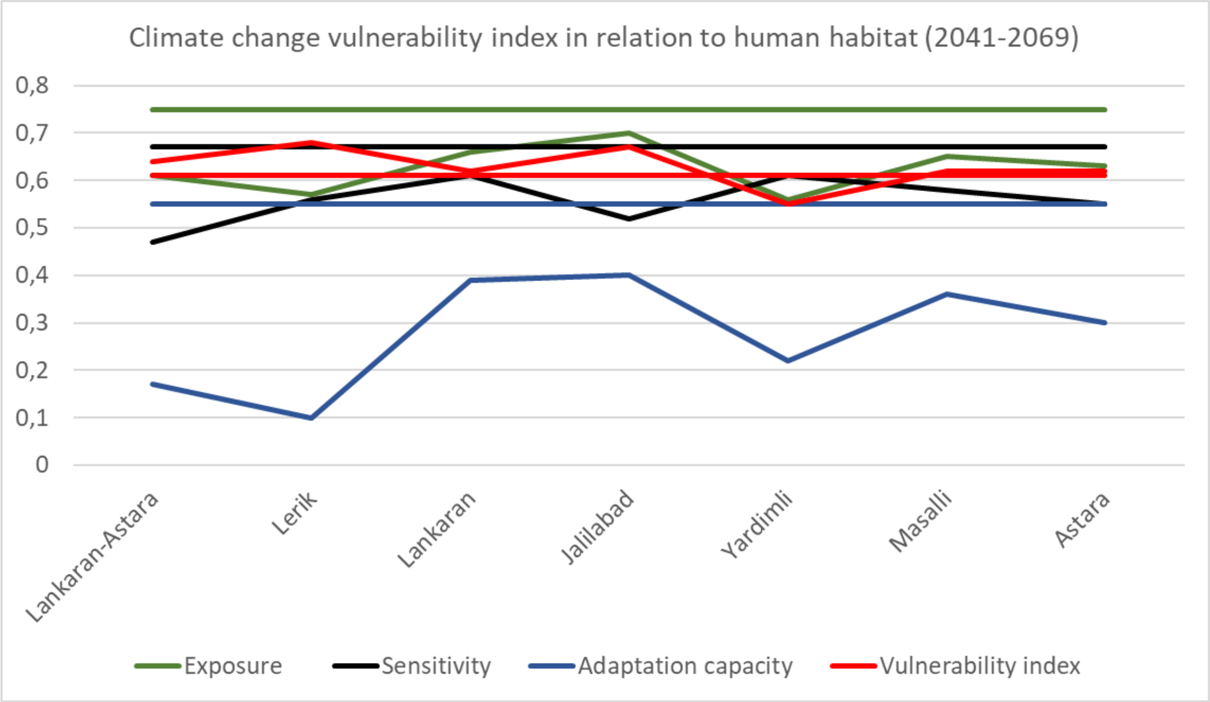


It should be noted that age dependency index for the region doesn't differ significantly from other regions according to statistical data. As natural conditions and resources in Lankaran -Astara region create good condition for human health, therefore low values of health care services and employment issues need to be addressed.

Table 25: *Climate change vulnerability index in relation to human habitat by regions and districts*

Regions	Human habitat indexes							
	Exposure		Sensitivity		Adaptation capacity		Vulnerability index	
	2020	2041-2069	2020	2041-2069	2020	2041-2069	2020	2041-2069
Azerbaijan Republic	0.65	0.75	0.57	0.67	0.53	0.55	0.56	0.61
Lankaran-Astara	0.53	0.61	0.40	0.47	0.29	0.31	0.63	0.66
Lerik	0.50	0.57	0.52	0.56	0.17	0.19	0.64	0.68
Lankaran	0.55	0.66	0.51	0.61	0.36	0.39	0.57	0.62
Jalilabad	0.59	0.70	0.44	0.52	0.37	0.4	0.62	0.67
Yardimli	0.47	0.56	0.51	0.61	0.20	0.22	0.51	0.55
Masalli	0.54	0.65	0.48	0.58	0.36	0.36	0.57	0.62
Astara	0.53	0.63	0.46	0.55	0.3	0.3	0.57	0.62

Figure 10: *Climate change human habitat related vulnerability index*



In relation to human habitats it should be noted that high temperature increases of wind patterns aren't creating serious problems here. Through installation of facilities for collection of rain water, planting of trees in river basins, its slopes and banks, taking anti erosion measures are important adaption measures. The income of the population should be increased according to development plans to increase adaptive capacities and resilience.

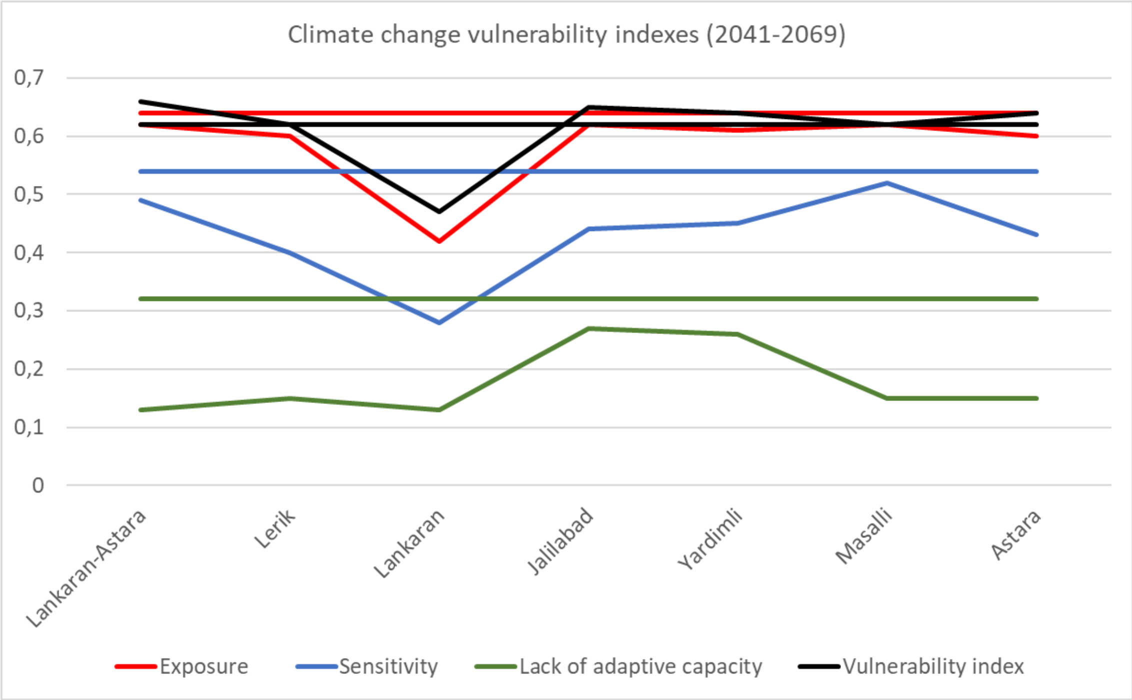
7. CLIMATE CHANGE VULNERABILITY INDEX

Next the average values for these sectors of exposure, sensitivity and lack of adaptation capacity (difference between 1 and adaptation capacity index) indexes for Azerbaijan and the region was calculated. Using the formula the climate change vulnerability index was computed. Table 26).

Table 26: *Climate change exposure, sensitivity, adaptation capacity and vulnerability index in Azerbaijan, region and districts*

Regions	Climate change vulnerability indexes							
	Exposure		Sensitivity		Adaptation capacity		Vulnerability index	
	2020	2041-2069	2020	2041-2069	2020	2041-2069	2020	2041-2069
Azerbaijan Republic	0.56	0.64	0.45	0.54	0.32	0.32	0.56	0.62
Lankaran-Astara	0.55	0.62	0.43	0.49	0.13	0.13	0.62	0.66
Lerik	0.50	0.60	0.34	0.40	0.13	0.15	0.58	0.62
Lankaran	0.37	0.42	0.24	0.28	0.12	0.13	0.43	0.47
Jalilabad	0.54	0.62	0.37	0.44	0.25	0.27	0.60	0.65
Yardimli	0.53	0.61	0.38	0.45	0.25	0.26	0.59	0.64
Masalli	0.54	0.62	0.44	0.52	0.15	0.15	0.57	0.62
Astara	0.52	0.60	0.37	0.43	0.15	0.15	0.58	0.64

Figure 11: *Climate change exposure, sensitivity, adaptation capacity and vulnerability indexes*



The forecasted values of these climate change indexes by 2041-2069 by region and by Azerbaijan Republic(straight lines) are shown in figure 13.

As per the assessment shown in Table 26 and figure 13, by 2041-2069 , the total exposure index for the region is 0.62 and for Azerbaijan 0.64. The sensitivity index for the region is 0.49 and for Azerbaijan 0.54 . The lack of adaptation capacity index for the region is 0.13 and for 0.32 The vulnerability index is 0.66 and 0.62 respectively.

8. RECOMMENDATIONS FOR CLIMATE CHANGE ADAPTATION

The climate change exposure, sensitivity, adaptive capacity and vulnerability indexes for the Lankaran-Astara economic region by 2041-2069 are slightly higher than the values in the WB, and ND-GAIN assessments.

Table 27: *Climate change vulnerability index in Azerbaijan and Lankaran -Astara economic region*

Method\Region	Exposure	Sensitivity	Adaptation capacity	Vulnerability index
ND-GAIN/ Azerbaijan	0.35	0.40	0.41	0.45
WB/Azerbaijan	0.45	0.45	0.07	0.61
Azerbaijan	0.64	0.54	0.32	0.62
Lankaran- Astara region	0.62	0.49	0.13	0.66
Lerik	0.60	0.40	0.15	0.62
Lankaran	0.42	0.28	0.12	0.47
Jalilabad	0.62	0.89	0.25	0.65
Yardimli	0.61	0.90	0.25	0.64
Masalli	0.62	0.52	0.15	0.62
Astara	0.60	0.43	0.15	0.64

In the WB assessment conducted in 2009 Azerbaijan is near the middle among 28 countries of Eastern Europe and Central Asia. As one can see from the table exposure and sensitivity indexes according to this study is higher than the WB and ND-GAİN reports. This report has used more recent data with higher temperatures, lower precipitation. scare water resources, higher drought indexes. Accordingly in both mountain zones and plain areas serious droughts in the last years has made Azerbaijan (including the region) the country most vulnerable to climate change in the South Caucasus.

The values of the adaptation capacity index is low in the WB report compared to the other reports because in the last 10 years the economy of Azerbaijan has developed significantly compared to the period when the WB assessment was done In the region this increase is almost 2 times Despite this due to increased exposure and sensitivity to climate change in the last 10 years Azerbaijan remains the most vulnerable to climatic changes in comparison with other countries in the overall region. Therefore, assessments by this report for the country and region can be considered acceptable for future projections of the (2041-2069) climate change vulnerability index.

The climate change exposure and sensitivity indexes for the region are lower than the average for Azerbaijan, and if adaptive capacity is increased then the risk as per the climate change vulnerability index can be reduced.

The climate change adaptation measures for the future can be planned depending on significance of values of climate change indexes changing from region to region. In order to categorize these changes from region to region their values were divided into 3 group according to their significance (high, medium and lower) as shown in Table 28.

Table 28: *Climate change indexes high (yellow color), high and very high (in different sectors) (red color) and very high (brown color) severity characteristics by regions of Azerbaijan (2041-2069)*

Region	Exposure	Sensitivity	Adaptive capacity	Vulnerability index
Azerbaijan Republic	0.64	0.54	0.32	0.62
Lankaran-Astara	0.62	0.49	0.13	0.66
Lerik	0.60	0.40	0.15	0.62
Lankaran	0.42	0.28	0.12	0.47
Jalilabad	0.62	0.44	0.25	0.65
Yardimli	0.61	0.45	0.25	0.64
Masalli	0.62	0.52	0.15	0.62
Astara	0.60	0.43	0.15	0.64

Adaptation measures to mitigate and reduce the negative effects of expected climate change are given below starting with agriculture:

- For agriculture preference should be given to the cultivation of long-growing, heat-loving, drought-resistant agricultural crops and the creation of new climate smart varieties:
  - application of advanced irrigation methods in case of water shortage, use of alternative water sources;
  - aking into account widespread water and wind erosion the establishment of field-protective forest strips around the soils, registration of eroded and saline soils, mapping, etc.
  - creation of artificial water basins to capture atmospheric precipitation and use them for irrigation;
  - improving irrigation and drainage systems to combat salinization on farms;
  - establishment of small processing enterprises for perishable products in rural areas;

- continue the works on improvement of storage systems for agricultural products (warehouses, refrigerators, etc.) and create new ones.

➢ Adaptation measures to mitigate and reduce the negative effects of expected climate change to water resources:
- Reconstruction of existing water facilities in order to reduce water loss;
- Involving additional water sources such as use of rainwater and treated seawater, etc.;
- Use of recirculated water, including groundwater and water reuse;
- Flow regulation and economical use of water in times of scarcity;
- Conduct reforestation measures in flood prone areas;
- Implementation of protective engineering measures in basins and in floodplains of rivers;
- Construction of HPPs on mountain rivers and new reservoirs;
- Construction of small HPPs on existing irrigation canals;
- Purify and reuse water;
- Use of modern irrigation technologies and methods.

➢ For Caspian Sea level, falling the following adaptation measures are recommended:
- no major construction work should be carried out in the coastal zone;
- protective engineering of coastal zone should be developed.

➢ Measures to adapt to the negative effects of intense heat and heat waves:
- improve the level of preparedness of the health system in all regions;
- establish and expand green areas in cities;
- design and construct buildings by taking into account the strong summer heat expected against the background of climate change;
- install air cooling systems in buildings and all public transport;
- take into account the strong summer heat when building bus stops in cities; improve the warning system for strong heats and heat waves;
- raise awareness about first aid in the case of heatstroke and sunstroke;
- inform the population through the media about the lifestyle (activity, nutrition, clothing, etc.) appropriate for extreme heat and heat waves.

➢ Adaptation measures against diseases transmitted through water and food:
- water treatment and quality improvement;
- improve and strengthen the water quality control system;
- accelerate the work on providing all settlements with drinking water;
- develop strategy for proper and efficient use of drinking water sources in the

context of climate change;

- improve and strengthen the control system over the implementation of food storage standards;
- broaden sanitary-epidemiological awareness of the population in this issue;

The other group of sector specific measures can be implemented for regions with high values of one or 2 of these indexes. In remaining regions where climate change indexes are medium and lower there will be also needed to undertake measure identified in FNC to adapt to the future,

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Annex 1

Change of long term annual average and maximal air temperature and precipitation in Lankaran region for period 1991-2020 compared to 1961-1990.

Station	Period	Average for period before 1991 and number of cases exceeding it during 1991-2020				Value corresponding to 50th percentile of range for period before 1991 and number of cases exceeding it during 1991-2020			
		T_{ave}	T_{max}	X_{max}	X_{annual}	$T_{50\%}$	$T_{max,50\%}$	$X_{50\%}$	$X_{max,50\%}$
Astara	1961-1990	14,7	32,9	74,5	1303,8	**14,8**	**32,6**	**63,1**	**1269,7**
	1991-2020	26,0	26,0	25,0	9,0	26,0	27,0	29,0	9,0
Lankaran	1961-1990	14,1	34,2	70,3	1218,1	**14,3**	**34,1**	**69,8**	**1175,8**
	1991-2020	28,0	24,0	24,0	10,0	27,0	24,0	24,0	0,0
Average for Lankaran region	1991-2020	27	25	24	10	26	25	27	4
Average by 2 methods	1991-2020	27	24	25	7				