Strengthening Climate Information and Multi-Hazard Early Warning Systems for Increased Resilience in Azerbaijan

Annex 2

Pre-Feasibility Study

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1 Introduction

1.1 Objective of Study

This pre-feasibility study is developed to support the Green Climate Fund (GCF) project "Strengthening Climate Information and Multi-Hazard Early Warning Systems for Increased Resilience in Azerbaijan". The objective of the study is to provide the baseline climate and socioeconomic context in Azerbaijan, analyze specific climate vulnerabilities in Azerbaijan and how they are likely to evolve with future climate change, assess existing climate information and early warning services systems and institutions in Azerbaijan, detail the proposed project interventions for improving climate information and early warning services in Azerbaijan, assess economic and technical feasibility of proposed solutions, and frame stakeholder engagement and implementation arrangements for the project. The proposed project consists of the following four result areas – the Project Outputs:

1. Strengthened delivery model for climate information and multi-hazard early warning systems
2. Strengthened observations, monitoring, modelling and prediction of climate and its impacts
3. Enhanced dissemination and communication of climate risk information and multi-hazard early warnings
4. Increased climate risk management capacity

1.2 Methodology

The pre-feasibility study was developed based on extensive review of existing scientific literature, available climate analysis, information from past projects, as well as original analysis for climate indicators. On the ground stakeholder consultation and research in Azerbaijan through a national consultant was undertaken to detail and assess project interventions and collect primary data. In addition, expert missions were undertaken by the Finnish Meteorological Institute (FMI) and the French International Office for Water (OIEau) to assess the baseline status of the National Hydrometeorological Service (NHMS).

The ability to undertake on the ground research and in-person consultations was limited by COVID-19, which prevented international travel and larger gatherings. Further, the political conflict in Azerbaijan limited collaboration and research with stakeholders however, many virtual meetings with stakeholder groups took place over the course of project development. In addition, the government and national consultant for the project were also able to hold several in-person consultations. Details of the stakeholder consultations for the project are included in Annex 13: Summary of consultations and stakeholder engagement plan.

The pre-feasibility study was developed based on extensive peer review of existing scientific literature and available climate analyses primarily from the World Bank Climate Change Information Portal, existing hydrometeorological stations in Azerbaijan, and the Intergovernmental Panel on Climate Change (IPCC). The methodology draws on internationally agreed concepts in climate change assessment and projections – as recommended by the World Meteorological Organization (WMO) and its scientific and technical network – and references the best available and accessible climate data, methods and tools. This includes global and regional climate datasets, and best practices for using climate indices and indicators.

1.3 Data

Climate baseline and projections utilise historical observed climate data from weather stations across Azerbaijan as well as other existing meteorological sources. This data was supplemented by national reports and assessments gathered from the National Hydrometeorology Service of the Ministry of Ecology and Natural Resources (MENR) and other national agencies. Additional research on the proposed technologies and approaches is sourced from a variety of secondary literature and other hydromet projects.

Most of the supplementary data was obtained through direct consultations and inquires conducted by a national consultant, while the weather station data was pulled directly from the stations where possible as well as through CORDEX.

For the most part the data was of good quality and adequate for assessing the potential feasibility of the proposed project interventions. The baseline climate data had some issues with the recorded observations due to the limited baseline hydromet capacity, technology, and institutions which this project is working to enhance. These limitations are discussed in more detail in the sections below.

2 Overview

Developing improved climate information and multi-hazard early warning systems is one of the main approaches that can be taken to mitigate the increase in climate and hydro-meteorological related disasters due to climate change. The number of these disasters, and their associated impacts on Azerbaijan's population and key sectors, has increased in the last few decades. Climate projections in the South Caucasus area indicate that hydro-meteorological and climate related hazards will increase in number and severity, increasing therefore the impact they may have unless actions are taken to prevent or mitigate that foreseen impact.

Climate Information Early Warning Systems (CIEWS) help society to prepare for, and respond to, all types of disasters, including those related to climate and hydro-meteorological hazards. The implementation of CIEWS yields several benefits, such as saving lives and minimising potential economic and environmental damages, but they also produce and record important information from a Disaster Risk Management (DRM) perspective. The Sendai Framework for Disaster Risk Reduction 2015–2030 specifically highlights the need to "substantially increase the availability of and access to multi-hazard early warning systems and disaster-risk information and assessments to the people by 2030." It urges efforts to make forecasting and CIEWSs more efficient, integrated and sustainable.

Azerbaijan has experienced an increase in the number of floods, mudflows, strong-winds, landslides, mudflows, droughts, extreme temperature events, hail, sea-waves and a deteriorating air quality in the recent years. Climate change projections in Azerbaijan predict an increase in the number and severity of these hazards in the coming years. **The number of**

casualties and the direct economic damage caused by these events in the last three decades is 1,500 and 300 M USD respectively (WB, 2012).[1]

The present CIEWS and institutional arrangements in Azerbaijan, however, are not at a sufficient level to mitigate future impacts of climate change. There are several reasons for this including the lack of appropriate legal framework, poor collaboration among relevant stakeholders, an insufficient risk knowledge and monitoring resources, lack of forecasting capabilities and little resources dedicated to the communication of disasters in a timely manner and the associated response to them. Investment in CIEWS and resources for the operation of the existing system in Azerbaijan are limited, and therefore the current system does not produce the desire benefits. Also, it should be added that the present CIEWS does not meet the product requirements, because the user requirements are not fully considered by the system and the data produced by the existing CIEWS is not shared sufficiently or in an appropriate manner. All of these issues will be considered by this project.

If the Köppen climate zone classification is considered, nine out of the existing eleven zones are present in Azerbaijan, indicating the wide range of climatic variability in the country. Thus, there are several disaster hot-spots in the country, such as the Kura-Aras lowlands for floods and drought hazards; the Greater and Lesser Caucasus for flash-floods, mudflows and landslides; Baku and the Absheron peninsula, the most populated area of the country, for heat-waves, air quality and strong-winds; the coastal area for strong-winds and sea-waves; and the whole country for hail, strong-winds, droughts and heat-waves.

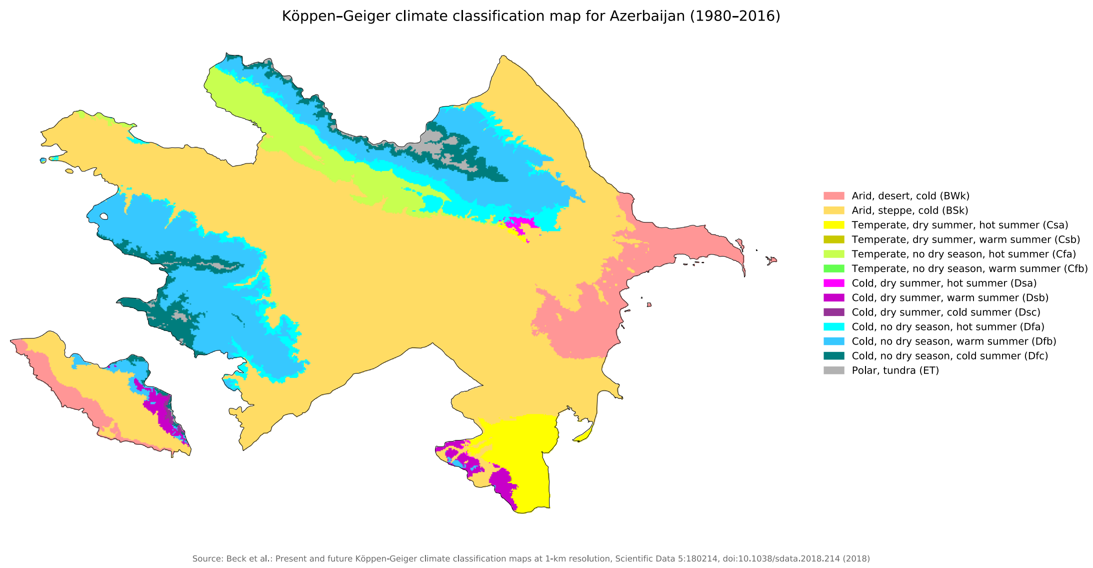

Figure 1: Climate classification map of Azerbaijan.[2] Disclaimer: The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of

[1] World Bank. The Republic of Azerbaijan. CLIMATE CHANGE AND AGRICULTURE COUNTRY NOTE. (http://www.worldbank.org/eca/climateandagriculture)

[2] Beck et al.: Present and Future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214 (https://upload.wikimedia.org/wikipedia/commons/4/40/Koppen-Geiger_Map_AZE_present.svg, last visited in 12/01/2021)

the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The Absheron Peninsula and Baku are a hub for economic activity, urbanisation and infrastructure, both at the regional and national levels. Together they are home to about 40 percent of the country's population and 70 percent of the country´s industrial production. For this reason, the area is highly vulnerable to potential climate-induced hazards. The economy of the peninsula is driven by oil and gas production, chemical and petrochemical industries, metallurgy, textiles and food industry. Absheron has also been massively exposed to industrial activities in the past, with associated air quality issues. The peninsula suffers from land contamination from oil extraction works, the persistent contamination of small water bodies, inadequate sewage treatment systems and discharges of untreated wastewater from industrial activities. Baku has been identified by the World Bank and the United Nations International Strategy for Disaster Reduction (2010) as one of the highest risk cities among selected cities in Central Asia and the Caucasus region[3]. It is vulnerable to sea-waves, heat-waves, strong-winds, and in the outskirts of the city (which is rapidly growing) there is an increase in the vulnerability to landslides and mudflows. All of those climatic events are expected to increase in frequency and severity in the coming years, and have direct and indirect impact on human health and livelihoods. For example, in Baku, the number of dangerously hot days (over 35º) due to climate change is expected to dramatically increase to about 50 days a year from 2020 to 2049. Coupled with a rapidly growing population, this likely will result in serious implications for public health.

Water access and droughts are also a growing concern in Azerbaijan, and especially in the Absheron Peninsula due to its high population density. This is likely to deteriorate in future climate change scenarios (section 2.4.3) exposing human health to further risk. It should be noted, however, that the capacity of Baku and the Absheron Peninsula to adapt to water shortages would be higher than in other remote areas of Azerbaijan, because the peninsula benefits from strong support of central government and higher rates of investment.

The Kura-Aras lowlands is an important agricultural area, relying heavily on irrigation. The area is affected by ongoing salinisation and desertification, droughts and flooding in the Kura River basin. Climate change will have implications for remote communities as access to potable water and sanitation services is limited in rural areas of Azerbaijan. Infectious and parasitic diseases, related to potable water and food quality, coupled with hazardous events such as flooding, will have serious human health security implications. Due to the limited financial and human resources of local governments, the districts of the Kura-Aras lowlands have a limited capacity to respond to climate induced disasters or risks.

The Kura-Aras lowlands are highly vulnerable to floods and droughts, with serious implications for economic activities and livelihoods as well as human security. The frequency of flooding in the Kura-Aras lowlands is increasing. Settlements, villages and agricultural areas as far as 200 km from the river-bed were flooded (MoES, 2010[4]). Exposure levels are high as approximately 15 percent of the population lives under the risk of flooding. Agricultural productivity is also

[3] Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI), World Bank 2008.
[4] Ministry of Emergency Situations. https://www.fhn.gov.az/index.php?aze/pages/33. Last accessed 10 December 2020.

affected by more severe and frequent droughts that have had a nationwide impact, as well as by hail and other climatic hazards.

The Greater and Lesser Caucasus are highly vulnerable to flash-floods, mudflows, landslides and droughts. The 2015 Shekhi drought caused significant economic damage, while floods, landslides and mudflows are common in this area, due to the topographical features present and climatic changes. These disasters have direct implications in the livelihood of the rural communities, including agriculture and infrastructure. The lack of response mechanism and the lack of funding for robust risk knowledge and for robust monitoring and forecasting systems increases the vulnerability of local communities.

In Azerbaijan there is lack of comprehensive disaster management mechanisms such as end-to-end CIEWS, but also there are no agricultural insurance schemes that could help farmers or households respond to natural hazards. Regarding the CIEWS, in Azerbaijan there is a lack of capacity for gathering robust and necessary climate information; and there is a lack of capacity for forecasting and decision support systems for resilient development planning and investment decisions. Therefore, it is evident that transformational solutions are needed to reduce disaster risk through the implementation of an integrated impact-based multi-hazard early warning system.

The existing monitoring infrastructure in Azerbaijan is inadequate for either Climate Information or for Early Warning System purposes. There is an insufficient number of stations, telemetry capacities are limited, maintenance and operation procedures for the stations are not implemented and there is no multi-hazard early warning system (MHEWS) approach to the observations. It should be added that the number of stations in the hydro-meteorological network suffered a great decline following the Soviet Union collapse in the 1990s. The existing monitoring and observation network, therefore, is not useful for forecasting purposes. In addition to that, there is a lack of global data ingested by relevant stakeholders, leading to a lack of coverage and scale.

The current CIEWS policy context will be described in more detail below. There are three main policies to consider, namely the "Law on Hydrometeorology", regulating hazard forecasting and management in Azerbaijan, establishing legislative grounds for carrying out hydro-meteorological and environmental observations and analysis; the article 11 of the Law on Environmental Safety, establishing that the "elimination of consequences of natural disasters" should be undertaken by the relevant executive authorities; and the order of the President of the Republic of Azerbaijan (1182, 16/12/2005) "On the establishment of the Ministry of Emergency Situations of the Republic of Azerbaijan" establishing the Ministry of Emergency Situations (MOES) and its operations.

While the existing policy context envisions the involvement of the executive authorities in the collection of data, the forecasting of warnings, and the response, there is a lack of provisions for undertaking hazard and risk assessments, as well as a lack of appropriate regulatory context to ensure a fruitful coordination and cooperation among relevant stakeholders. It should be noted that the existing policy context does not contemplate a multi-hazard approach and that the regulations are outdated.

One of the main interventions proposed within the framework of this project is the strengthening of the hydro-meteorological network of Azerbaijan. This proposed network expansion has been designed considering the current and projected disaster risk profile in Azerbaijan, the existing capacities and regional cooperation. One of the key aspects of the strengthened monitoring network will be the collection of data through upgraded telecommunication systems that will ensure regional cooperation and data sharing in the South Caucasus region.

The proposed interventions will transform the existing climate information and early waring capacities of Azerbaijan, considering:

- The existing policy and institutional frameworks in Azerbaijan are not adequate. The project will address this issue through several activities, in particular Result 1 and activities dedicated to the establishing adequate "institutional, policy and financial frameworks for climate services and early warning".
- Knowledge of existing risks in Azerbaijan is insufficient, which prevents the CIEWS from properly addressing the areas at most risk and from considering the risk information in order to design and implement CIEWS components. The project includes a dedicated component (Activity 1.2) to address this.
- The existing monitoring and warning system in Azerbaijan is insufficient and inadequate. This has, as noted above, relevant implications from a CIEWS perspective, because there are not resources and capacities to undertake a hazard forecasting for warning purposes. The project will address this issue through the implementation of a full monitoring and warning component, including the expansion and strengthening of the CIEWS monitoring network (including a telecommunication upgrade), the implementation of a Numerical Weather Prediction model, the implementation of forecasting for all of the considered hazards and the definition of warning procedures and criteria.
- Through the existing system, the communication and dissemination of warnings is not timely and does not reach all of the relevant users and stakeholders. Within this project several activities are dedicated to the enhancement of the communication and dissemination component, including the implementation of a Common Alerting Protocol, the development of Decision Support Systems, and other activities designed to address the timely dissemination of impact-based warning information.
- The current preparedness and response mechanisms at the national level are not fully compliant with the expected and required levels. The response capabilities at local and community levels are poor, and there is a lack of Community-Based Early Warning Systems (CBEWS) implemented in Azerbaijan. Within this project, preparedness and response capabilities at both levels will be addressed.

The proposed integrated impact-based multi-hazard climate information and early warning services will reduce risks in areas where the vulnerability is higher and where private sector investments are focused, leading to resilient cities, avoided costs and job creation.

The proposed interventions will ensure that robust climate information and early warning services are made widely available and used to support dynamic, long-term planning and decision-making processes at all levels. The proposed interventions will also ensure sustainable financing of the monitoring network as a public good by cost-effectively enhancing the quality and coverage of observational infrastructure to improve forecast quality and applications in investment decisions.

3 Adaptive Context in Azerbaijan

3.1 Geography

Azerbaijan is located in the Caucasus and is bordered by the Caspian Sea and five countries in the region: Iran, Armenia, Georgia, Russia and Turkey in the Nakhchivan region. The country is composed of 86,600 square kilometres (sq. km), 82,629 of which are land and 3,971 of which are water.[5] The mean elevation of the country is 384 meters above sea level.

Azerbaijan has varying topographic features throughout the country. The Greater Caucasus Range runs through the northern part of the country, with the highest peak (Bazardyuzyu) located within this range at 4,466 meters.[6] The Lesser Caucasus range runs through the western and southwestern portions of the country. South-eastern Azerbaijan includes the Talish Mountains near its border with Iran. The Kura-Aras Lowland covers much of central Azerbaijan and abuts the Caspian Sea. There are a number of canals between the Kura and Aras rivers, which allows for the irrigation of the lowland areas (Figure 2).

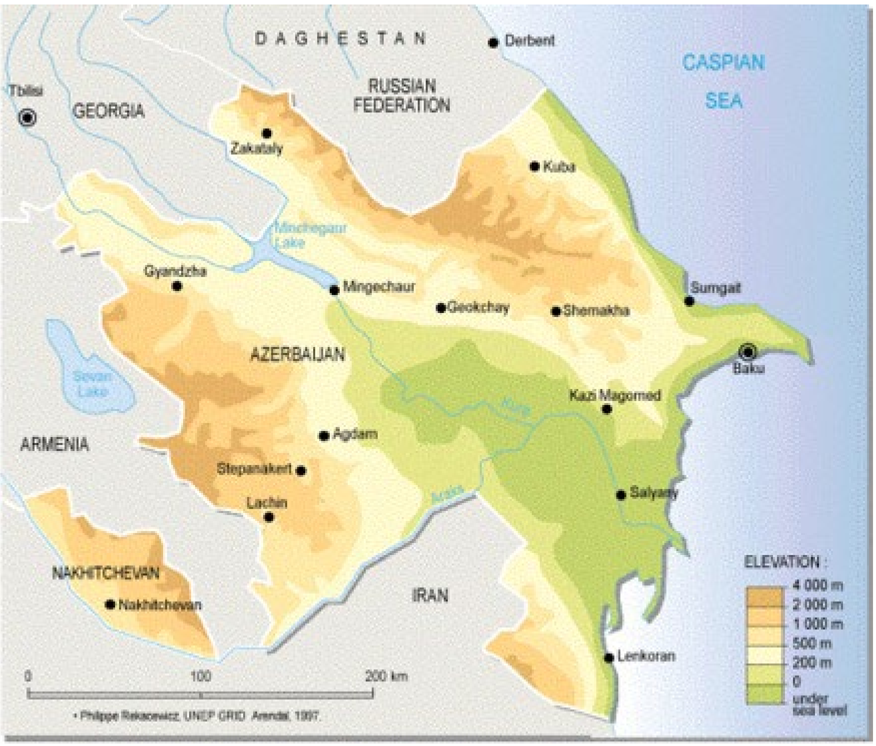

Figure 2: Topographic map of Azerbaijan.[7] Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

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[5] CIA World Factbook. Azerbaijan. Last Accessed 06 December 2020.
[6] Britannica. Azerbaijan. Last Accessed 06 December 2020.
[7] UNEP/GRID-Arendal. Azerbaijan, topographic map. Last Accessed 06 December 2020.

3.2 Population

The total population of Azerbaijan in 2020 is approximately 10,006,710 of which 49.9% are men and 50.1% are women.[8] Urban areas constitute approximately 53% of the population and rural areas constitute approximately 47% of the population. The capital city of Baku has the largest population of any city or region with 2,293,100 residents. The population of the additional economic regions include Absheron with a population of 576,500, Ganja-Gazakh with a population of 1,294,100, Shaki-Zagatala with a population of 626,700, Lankaran with a population of 946,700, Guba-Khachmaz with a population of 554,700, Aran with a population of 2,046,300, Yukhari Karabakh with a population of 687,700, Kalbajar-Lachin with a population of 259,500, Dakhlik Shirvan with a population of 322,200 and the Nakhchivan Autonomous Republic with a population of 459,600.

As of 2019, the annual increase in population was 0.9% and net migration was approximately 0.4%.[9] A slight majority of the population increase can be attributed to urban (52.8%) versus rural areas (47.2%).

3.3 Socioeconomic Context

The Republic of Azerbaijan was formerly part of the Soviet Union and became an independent state in 1991. Azerbaijan is considered a democratic and secular republic. The national government includes three distinct branches of government: legislative, executive and judicial.[10]

Azerbaijan is divided into fourteen economic regions. The Nakhchivan Autonomous Republic, however, is an autonomous state and exclave of Azerbaijan. The country is further divided into 66 administrative districts (rayons) and 11 cities (sahars).

[8] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 06 December 2020.

[9] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 06 December 2020.

[10] Republic of Azerbaijan. General Information on the Political System of AR. Last Accessed 06 December 2020.

Figure 3: Map of Azerbaijan economic regions (Source: Wikimedia Commons, 2021). Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Table 1. Economic Regions of Azerbaijan (Source: State Statistical Committee of the Republic of Azerbaijan, 2022)

Economic Region/ *Autonomous Republic*	Area (thousand km^2)	Population (thousands)
Baku	2.14	2303.1
Nakhchivan	5.50	463.0
Absheron-Khizi	3.73	579.9
Central Aran	6.69	743.2
Eastern Zangezur	7.47	345
Ganja-Dashkasan	5.27	612.1
Karabakh	8.99	907.9
Lankaran-Astara	6.07	959.4
Mil-Mughan	5.67	526.4
Dakhlik Shirvan	6.13	326.8
Qazakh-Tovuz	7.03	690.6

Economic Region/ *Autonomous Republic*	Area (thousand km^2)	Population (thousands)
Quba-Khachmaz	6.96	561.8
Shaki-Zagatala	8.84	632.9
Shirvan-Salyan	6.08	504.3

As of 2018, Azerbaijan had a total GDP of $46.94 billion USD and is considered a middle-income country.[11] As of 2022, the country had a GDP per capita of $8,840 USD.[12] The oil and gas industry is the main economic driver in the country. The country experienced strong economic performance in the period 2000-2010, predominantly driven by natural resources. However, since 2015, economic performance has stalled. Macroeconomic and structural challenges are systemic, and a significant proportion of the population is socially and economically vulnerable.[13] Azerbaijan's economy is insufficiently diversified and is reliant on oil and gas as the main economic drivers. GDP increased by 1.4% in 2018, which was supported by an increase in oil production and a modest increase in domestic demand.[14] The global recession and decrease in fossil fuel demand due to the ongoing COVID-19 pandemic is likely to have a major impact on the oil and gas industry within Azerbaijan and the country's economy as a whole.

The official national poverty rate in Azerbaijan in 2018 was 5.1% and was estimated to have decreased further in 2019.[15] In 2019, the average monthly nominal wage for employees in Azerbaijan was approximately $374 USD. [16] In 2018, for state sector employees the average monthly wage was approximately $256 USD and for non-state sector employees the average monthly wage was approximately $406 USD. The mining industry (which includes fossil fuel extraction) had the highest monthly nominal wage at approximately $1,744 USD average across both state and non-state sector employees.

Across all economic regions, the public sector has the highest percentage of hired workers (for both men and women) compared to other economic activities. However, most workers work outside of the public sector. The agriculture, forestry and fishing sectors have the largest number of employed persons with 1,777,700 individuals (36% of employed workers) working in this sector in 2019.

Average household size in 2018 was 4.5 individuals per household. Household size is somewhat consistent across all regions, with Baku City having the smallest average household size (3.86)

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[11] World Bank. GDP per capita (current US$) – Azerbaijan. Last Accessed 06 December 2020.
[12] IMF, 2023. DataMapper – Azerbaijan Datasets. Available at: https://www.imf.org/external/datamapper/profile/AZE. Accessed: 30 March 2023
[13] The World Bank, 2021. Azerbaijan COVID-19 Emergency Response Project (P176503) – Project Information Document
[14] World Bank. The World Bank in Azerbaijan. Last Accessed 06 December 2020.
[15] World Bank. The World Bank in Azerbaijan. Last Accessed 06 December 2020.
[16] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 06 December 2020.

and Lankaran having the largest average household size (4.96).[17] Across Azerbaijan urban average household sizes tend to be smaller (4.21) than that of their rural counterparts (4.83).

In 2018, Azerbaijan's Human Development Index (HDI) value was 0.754.[18][19] This valuation puts the country in the category of high human development and it was ranked 87 out of 189 countries and territories. Azerbaijan's HDI has increased continuously since its first evaluation in 1995. In 2018, Azerbaijan's Inequality-adjusted HID (IHDI) value was 0.683, which equates to a loss of 9.4% due to inequality in the distribution of the indices used to evaluate the HDI.[20][21]

An assessment of the political, economic, socio-cultural, legal, and environmental (PESTLE) factors in Azerbaijan that have the potential to impact on the proposed project are presented in the table below.

Table 2. PESTLE Analysis for Azerbaijan

Political	Economic
• Azerbaijan signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995, the Kyoto Protocol in 2000, and the Paris Agreement in 2017 • Azerbaijan shares good relations with most of its neighbours, including Turkey, Russia and Georgia,[22] but is involved in a long-standing conflict with Armenia[23] • Nagorno-Karabakh is a disputed territory between Armenia and Azerbaijan, officially recognised as part of Azerbaijan. The situation remains heated with a possibility of further escalation.[24] • Azerbaijan is considered "Not free" by the Freedom House, with civil liberties scoring 7/60 and political rights scoring 2/40[25]	• Annual GDP growth of 2.5% projected in 2023[26] • Long-term growth prospects are not especially favourable due to the country's narrow economic base and dependence on the energy sector[27] • War in Ukraine is expected to have a modest negative effect on economic activity in Azerbaijan in 2023 due to the country's high energy export revenue[28] • Majority of SMEs are concentrated in relatively low value-added activities (e.g., trade and repair of vehicles, transportation and storage, accommodation, restaurants)[29]

[17] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 06 December 2020.
[18] UNDP. Human Development Report 2019 – Azerbaijan. Last Accessed 07 December 2020.
[19] The HDI is a summary measure for assessing long-term progress in three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living.
[20] The IHDI is the HDI discounted for inequalities present within a given country.
[21] Gender indices are discussed in the gender assessment, which is Annex 8 to the Funding Proposal.
[22] Azerbaijan, Foreign Relations. Available at: Azerbaijan - Foreign Relations (countrystudies.us)
[23] International Crisis Group. The Nagorno – Karabakh Conflict: A Visual Explainer. Available at: https://www.crisisgroup.org/content/nagorno-karabakh-conflict-visual-explainer
[24] https://globalvoices.org/2023/03/29/prospects-for-peace-loom-as-much-as-prospects-for-another-war-in-nagorno-karabakh/
[25] Freedom House, 2023. Azerbaijan. Available at: Azerbaijan: Freedom in the World 2023 Country Report | Freedom House
[26] IMF, 2023. Republic of Azerbaijan. Available at: https://www.imf.org/en/Countries/AZE
[27] The Economist Intelligence Unit, 2023. Azerbaijan. Available at: https://country.eiu.com/azerbaijan
[28] The Economist Intelligence Unit, 2023. Azerbaijan. Available at: https://country.eiu.com/azerbaijan
[29] EU4Environment, 2023. Azerbaijan. Available at: https://www.eu4environment.org/where-we-work/azerbaijan/

Socio-cultural	Technological
• Population of 10.1 million in 2021, with growth rate of 0.4%[30] • Poverty rate has remained stable at around 5-6 percent over the past decade, although households remain vulnerable to shocks[31] • Azerbaijan was ranked 91 out of 191 countries on the Human Development Index (HDI) in 2021, which corresponds to a 'high' level of development • Azerbaijan scored 0.974 on the Gender Development Index (GDI) in 2021, placing it in Group 2, which corresponds to 'medium-high equality in HDI achievements between men and women'[32]	• Mobile connection penetration in Azerbaijan was 117% and mobile broadband connection penetration was 99% in 2021[33] • 95% of the population of Azerbaijan is covered by 3G[34] • Lack of modernised hydrometeorological infrastructure and technologies needed to provide timely and reliable assessment of the current state and future impacts of climate change
Legal	**Environmental / Ecological**
• No specific law on climate change • National law on hydrometeorological activities (passed in 1988 and amended in 2018) identifies how Azerbaijan collects and monitors meteorological, hydrological and oceanographic data	• Azerbaijan has a highly diverse geography and climatology, containing nine of the world's eleven climate zones[35] • Water supply is a major challenge due to uneven spatial and seasonal distribution[36] • Main pressures on Azerbaijan's biodiversity include land degradation, habitat fragmentation, unsustainable levels of natural resource use, pollution, invasive species, and climate change[37]

3.3.1 *Agriculture Sector Baseline*

The agricultural sector (agriculture, forestry and fishing) employs the most individuals of any sector of the economy and in 2019, the agricultural sector comprised 5.7% of the country's GDP.[38] It is considered to have the greatest potential for diversification away from oil and, accordingly, is increasingly a target for both public and private investment.[39] Of the total agricultural land available in 2019, 43% was arable land, 0.8% was fallow land, 5.5% was permanent crops and 50.7% was hayfields and pastures. In 2019, plant-growing products (including cereal and legumes, industrial crops, potatoes, vegetables, market-garden crops,

[30] The World Bank Group, 2023. Data – Azerbaijan. Available at: https://data.worldbank.org/country/azerbaijan
[31] IBRD / The World Bank, 2022. ECA Economic Update – Fall 2022
[32] UNDP, 2023. Human Development Reports – Azerbaijan. Available at: https://hdr.undp.org/data-center/specific-country-data#/countries/AZE
[33] GSMA, 2023. GSMA Mobile Connectivity Index. Available at: https://www.mobileconnectivityindex.com/connectivityIndex.html#year=2021&zoneIsocode=AZE
[34] GSMA, 2023. GSMA Mobile Connectivity Index. Available at: https://www.mobileconnectivityindex.com/connectivityIndex.html#year=2021&zoneIsocode=AZE
[35] The World Bank Group and ADB, 2021. Climate Risk Country Profile – Azerbaijan
[36] UNDP, 2020. Supporting Azerbaijan to advance their NAP process. Available at: https://www.adaptation-undp.org/projects/supporting-azerbaijan-advance-their-nap-process
[37] CBD, 2023. Country Profile – Azerbaijan. Available at: https://www.cbd.int/countries/profile/?country=az
[38] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 09 December 2020.
[39] USAID, 2020. USAID/Azerbaijan Country Development Cooperation Strategy

fruits and berries, grapes and tea) comprised nearly 48% of all agricultural products and livestock products (including cattle and poultry, milk, eggs and wool) comprised approximately 52% of agricultural products. Between 2015 and 2019, total agricultural production increased nearly 20%; plant-growing products increased by nearly 30% and livestock products increased by 12%.

The total sown area for all agricultural plants in Azerbaijan in 2019 were 1,717,100 hectares. Cereal and legumes comprised 1,072,300 hectares, industrial crops comprised 130,200 hectares, potatoes, market-garden crops and vegetables comprised 147,700 hectares and forage crops comprised 366,900 hectares. [40] Please see Table 3 below for the total crop production and yield of dominant crops in Azerbaijan.

Table 3: 2019 production and yield of dominant crops in Azerbaijan

Crop	Production (thousand tons)	Yield (100 kg/hectare)
Cereals and dried pulses	3,025.4	32.7
Cotton	271.1	30.0
Tobacco	6.0	19.3
Sugar beets	123.5	251
Sunflower for seed	31.2	22.6
Potatoes	990.9	169
Vegetables	1,615.7	174
Watermelons and melons	444.3	210

Around 1.4 million hectares of the country's arable land are irrigated. Due to the hot and dry climate, especially in the plains and lowlands of Azerbaijan, sufficient irrigation is necessary to achieve good yields. According to information contained in the Draft of the National Water Strategy from 2016, 85-90% of agricultural products are produced on irrigated lands. Irrigation infrastructure, often dating back to the Soviet Union, is of crucial importance to maintain productivity in these areas. Nevertheless, a substantial part of this infrastructure degraded significantly over the last decades – especially secondary and third level irrigation channels. As a result of this, and in combination with improper irrigation management in other areas, more than 600.000 hectares of land experience some form of degradation, including salinization.[41]

Regarding livestock, as of 2020, there are 2,601,900 heads of beef cattle, 1,259,200 heads of dairy cows and buffaloes, 7,990,600 sheep and goats, 5,400 pigs and 18,086,600 poultry, as well as other various, less common livestock in Azerbaijan. [42] The main animal products that the country produces are meat, milk, eggs and wool.

Regarding forestry, fishing and hunting in Azerbaijan, the 2019 value of gross output for these subsectors were $6,348,823, $148,061,881 and $100,529 USD respectively. The total area of

[40] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 09 December 2020.
[41] CTC-N Strengthening Capacities to Assess Climate Change Vulnerability and Impacts to Shape Investments in Adaptation Technology for Azerbaijan's Mountain Regions (2020); Available at: https://www.ctc-n.org/system/files/dossier/3b/Final_report_Impact_Chains_AZ_0.pdf
[42] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 09 December 2020.

forested land in 2019 was 10,403,000 hectares, which is 12% of the country's total land area. The total quantity of fish caught in 2019 was 63,084 tons. Additionally, as of 2019, there are 13 hunting farms in Azerbaijan with an estimated 34,054 fur animals (squirrels, fox, badger, etc.) on these farms.

A 2012 assessment of the agriculture and rural development sectors in Azerbaijan by the European Union and FAO identified key weaknesses in the sector.[43] These include the following (among others):

- Poor infrastructure, both social and economic in remote rural areas are inhibiting development;
- Underdeveloped agricultural markets and disorganized market chain;
- Lack of skills and knowledge on modern technology or requirements of export market of private entrepreneurs and farmers;
- Low fertility of lands (persisting erosion and salinization) leading to low productivity in agricultural crop production;
- Degradation and low productivity of pastures and under-developed fodder sector leading to low productivity of livestock production; and
- Agricultural insurance not available causing huge constraints for agricultural producers, especially during unfavourable seasonal conditions.

3.3.2 *Disaster Risk Reduction Baseline*

Azerbaijan is vulnerable to several hazards, including floods, landslides, droughts, waves, extreme temperatures and winds, hail, air pollution ad mudflows. The Ministry of Emergency Situations of the Republic of Azerbaijan (MoES) is the central executive body of the national government that is responsible for emergency management within the country.[44] The MoES is headquartered in Baku City and has ten regional district centres. The main activities and responsibilities of the MoES include the following:

- Protection of population and territories from fires and disasters;
- Prevention of emergency situations and elimination of their consequences;
- Ensuring of safety rules at water basins, building sites, industrial and mining enterprises and safe movement of small ships in state waters;
- Establishment and proper management of the State Resource Fund;
- Organization of protection of strategic objects exposed to natural, man-made and terror threats and neutralization of radioactive wastes;
- Organization of quick response to emergency situations and management of humanitarian aid;
- Organization and implementation of rescue-searching and first aid, aviation and other transport life-saving operations in case of emergency; and

[43] EU/FAO. Assessment of the Agriculture and Rural Development Sectors in the Eastern Partnership countries – The Republic of Azerbaijan. Last Accessed 09 December 2020.
[44] Asian Disaster Reduction Center. Azerbaijan – Country Report. Last Accessed 28 December 2020.

- Organization of awareness-raising activities among population regarding life safety rules and measures, methodical guidance over respective work done in this field by state bodies and public organizations etc.

In 2016 the MoES responded to 59 natural and 5,058 man-made disasters.[45] [46] These disasters resulted in 22 deaths, 95 injuries, 34 individuals rescued, and 451 individuals evacuated.

3.3.3 *Health Baseline*

The healthcare system in Azerbaijan includes 570 hospitals and approximately 44,300 hospital beds. [47] Additionally, the country has 1,726 outpatient clinics throughout the country. In 2019, approximately 3.6% of the country's budget was spent on healthcare. As of 2020, Azerbaijan has approximately 31.8 physicians per thousand individuals. Baku City has a much higher physician population compared with the other economic regions, with approximately 91.6 physicians per thousand individuals.

The most commonly diagnosed diseases in 2019 in Azerbaijan include diseases of the respiratory system (771,571), diseases of the digestive system (169,225) and diseases of the circulatory system (149,330). As further discussed in Section 7, bad air quality is a major health concern in the country that additionally contributes to non-communicable diseases and mortalities.

In 2018, the mortality rate in Azerbaijan was approximately 5.8 per thousand individuals.[48] Since the early 1990s, life expectancy in the country has been steadily increasing. As of 2018, life expectancy in the country is approximately 72.9 years; 70.3 years for males and 75.3 years for females.

3.3.4 *Water Resources Baseline*

It is estimated that there are a total of 32.52 cubic kilometres per year (km^3/year) in surface water and 6.51 km^3/year in groundwater resources in Azerbaijan.[49] The country has nearly 250 lakes, 60 reservoirs, 24 rivers that are greater than 100 kilometres long and several glaciers.[50] There are rivers than run through the Kur-Araz basin, as well as rivers that originate from the Greater Caucasus and flow directly into the Caspian Sea. As previously mentioned, canals are commonly used through the lowlands of the country to funnel water for irrigation. Please see Figure 4 below for a map of surface water features in Azerbaijan.

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[45] Ministry of Emergency Situations of the Republic of Azerbaijan. Statistics. Last Accessed 28 December 2020.
[46] 2016 is the most recent date for which these statistics are available.
[47] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 28 December 2020.
[48] World Bank. Death rate – Azerbaijan. Last Accessed 28 December 2020.
[49] FAO. AQUASTAT – Azerbaijan. Last Accessed 09 December 2020.
[50] Republic of Azerbaijan. Inland Waters. Last Accessed 09 December 2020.

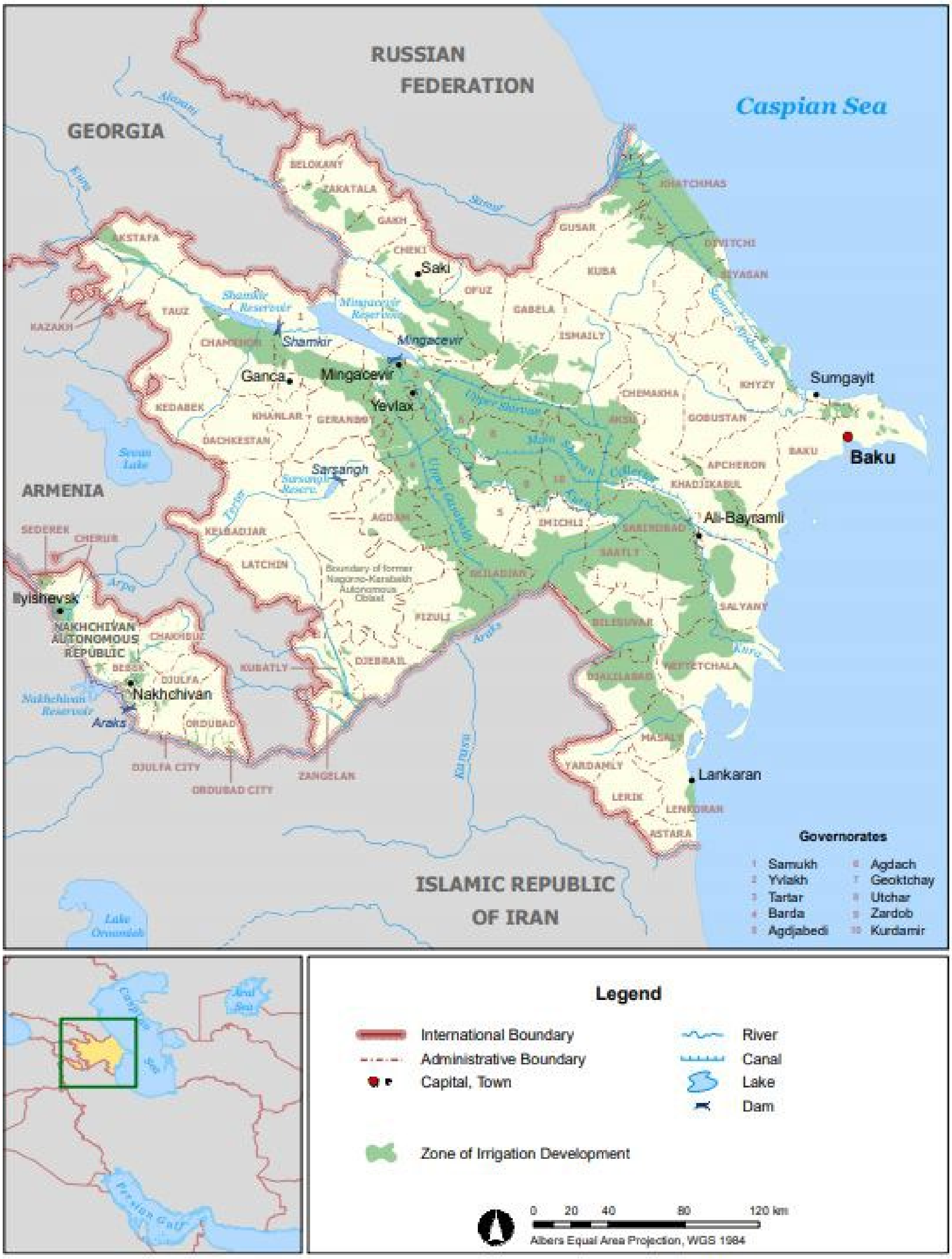

Figure 4: Dominant surface water features in Azerbaijan.[51] Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Around 71.7% of the water abstraction from natural resources is consumed, out of which almost three quarters (73%) are used for irrigation and agriculture. 23% are used by industrial needs, and around 3.3% are being consumed as drinkable water for domestic purposes. A very significant amount, namely almost 40%, is being accounted for as "water loss during

[51] FAO. [AQUASTAT – Azerbaijan.]() Last Accessed 09 December 2020.

transportation". There is, thus, significant potential to increase the efficiency of Azerbaijan's current water management system. [52]

The amount of water taken from natural sources as well as water consumption have decreased, however, since the 1990s – by 32.7% and 34.1%, respectively. This is likely due to the combination of the degradation of water management infrastructure and practice after the collapse of the Soviet Union and the actual lack of water sources and its imbalance condition compared to the water demand. Today, the management of water resources for irrigation purposes is to a large extent being undertaken by 479 Water Users Associations (WUAs), with the total irrigated area served by them is 1.329.044 hectares. [53]

In 2019 in Azerbaijan, the average daily water consumption for personal needs for the population was 61.3 litres per day; 109.9 litres per day for urban populations and 6.9 litres per day for rural populations. [54] Total water usage from natural resources (groundwater and surface water) in 2019 was 13,227,000,000 cubic meters (m^3). Total water use from recycled water was 2,358,000,000 m^3. Please see Table 4 below for a breakdown of water resource indicators by types of economic activities in 2019.

Table 4: Water resource indicators (million m^3) by economic activity for 2019

Economic Activity	Water Abstraction from Natural Resources	Freshwater Consumption	Volume of Recycled and Consequently Used Water	Water Losses during Transportation	Discharge of Sewage Waters	Untreated Wastewater (from sewage discharge)
Agriculture, hunting and forestry	11,617.8	7,004.1	-	3,641.3	3,283.3	0.4
Industry	1,595.6	2,425.4	2,333.6	110.8	1,243.2	58.0
Transport, storage and communication	7.4	11.9	9.8	3.2	9.9	9.6
Other service activities	6.7	30.8	14.2	0.0	326.8	150.4

3.3.5 *Energy Baseline*

A large amount of Azerbaijan's infrastructure as well as the oil and gas sector are to a large degree concentrated along the Caspian Sea coastal areas (please see **Error! Reference source not found.** and **Error! Reference source not found.** below). The major population centre of Baku has an elevation of approximately 28 meters below sea level and is considered the world's lowest-lying capital city, making it extremely vulnerable to saltwater inundation. [55]

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[52] CTC-N Strengthening Capacities to Assess Climate Change Vulnerability and Impacts to Shape Investments in Adaptation Technology for Azerbaijan's Mountain Regions (2020); Available at: https://www.ctc-n.org/system/files/dossier/3b/Final_report_Impact_Chains_AZ_0.pdf
[53] CTC-N Strengthening Capacities to Assess Climate Change Vulnerability and Impacts to Shape Investments in Adaptation Technology for Azerbaijan's Mountain Regions (2020); Available at: https://www.ctc-n.org/system/files/dossier/3b/Final_report_Impact_Chains_AZ_0.pdf
[54] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 09 December 2020.
[55] BBC. Baku. Last Accessed 10 December 2020.

In 2019, the oil and gas sector made up approximately 37% of the country's GDP and accounted for more than 90% of the country's exports.[56] [57] 37,452,000 tons of crude oil (including gas condensate) was extracted and 24,514,000,000 m^3 of natural gas was extracted in 2019. In 2018, Azerbaijan was the 24th largest oil producing country in the world.

The energy sector in Azerbaijan is predominantly owned and controlled by the national government.[58] The State Oil Company of the Azerbaijan Republic (SOCAR) is the largest oil and gas producing entity in the country and is headquartered in Baku. SOCAR is involved in exploring oil and gas fields, producing, processing and transporting oil, gas and gas condensate, marketing petroleum and petrochemical products in domestic and international markets and supplying natural gas to industry and the public in Azerbaijan.[59] SOCAR owns and operates the only oil refinery plant in Azerbaijan (located in Baku). The plant is capable of producing 15 different petroleum products, including gasoline for cars, aviation kerosene, diesel fuel, black oil, petroleum coke, among others. The company also owns and operates the dominant gas processing plant in Azerbaijan (also located in Baku).

In 2019, oil accounted for approximately 63% of the Azerbaijan's energy supply and natural gas accounted for approximately 37% of the energy supply.[60] Renewables and other energy sources accounted for only 0.4% of the energy supply. Renewable energy in Azerbaijan is primarily generated from hydropower and biomass/waste, with wind and solar contributing a small percentage to the overall renewable energy production in the country.

As of 2019, energy consumption in Azerbaijan was approximately 1.7 thousand tonnes of oil equivalent per person.[61] The dominant energy product consumed for key sectors in 2019 include the following: industry (natural gas), construction (bitumen), transport (gasoline), agriculture (diesel) and commerce and public services (natural gas). Additionally, electricity is the dominant energy type used for households.

3.3.6 *Tourism Baseline*

In 2019, tourist flow into Azerbaijan increased by 11.4% from the previous year to approximately 3.17 million individuals.[62] Close neighbours to Azerbaijan (including Russia, Georgia, Turkey and Iran) made up the largest percentage of tourists. Tourists come to the country for a variety of reasons including cultural, natural landscapes, shopping and sporting and other major public events.

As of 2019, there are 642 hotels or similar establishments in Azerbaijan, with a combined capacity of approximately 50,000 beds per night.[63] A large portion of these hotels are located

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[56] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 10 December 2020.
[57] IEA. Azerbaijan energy profile. Last Accessed 10 December 2020.
[58] IEA. Azerbaijan energy profile. Last Accessed 10 December 2020.
[59] SOCAR. About-SOCAR. Last Accessed 10 December 2020.
[60] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 28 December 2020.
[61] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 28 December 2020.
[62] AZERNEWS. Azerbaijan welcomes over 3 million tourists in 2019. Last Accessed 10 December 2020.
[63] Republic of Azerbaijan. The State Statistical Committee of the Republic of Azerbaijan. Last Accessed 10 December 2020.

in Baku, with less hotels located in rural regions. There are approximately 12,500 individuals staffing these hotels. Total income for the hotel industry in 2019 was approximately $1.7 billion USD. Additionally, most tourists spend their time and money in coastal regions (mainly Baku).

4 Climate risk profile for Azerbaijan

4.1 Overview and Methodology

A detailed climate risk profile for Azerbaijan has been developed to outline the main vulnerabilities and risks that Azerbaijan faces due to climate change and also to show the gaps and needs from a climate information and early warning context to highlight the necessity of interventions proposed in this project.

Each climate indicator explored below starts with a high-level discussion of the observed trends over the last few decades. Following this, data from hydro-meteorological stations have been gathered, analyzed and processed to further illustrate the current climate context in Azerbaijan. Climate change projections have also been collected and processed; as well as information about extreme events and their impact on the main economic sectors of Azerbaijan, and the envisaged impact these events will have in the future.

The climate risk profile for Azerbaijan was drafted following these main steps discussed individually in detail below:

(1) Identify suitable relevant national/regional state of the climate indicators.
(2) Identify main climate variables/phenomena and their impacts of interest to the proposed project (e.g. warming, drought, sea level rise etc.).
(3) Identify the socio-economic information needed to assess climate impacts.
(4) Collect data and information, and then assess their adequacy.
(5) Assess quantitatively the impacts that have occurred and are likely to occur in the future if possible. The assessment and analysis of all of the data has been undertaken using the GCF suggested tools for climate rationales, such as the Royal Netherlands Meteorological Institute (KNMI) Climate (https://climexp.knmi.nl/), or the Climpact v3.1.5/v3.1.6 R tool. Therefore, the plots, graphs and information outlined is based on those tools.

4.1.1 *Climate Indicators*

The following climate indicators have been selected for the climate risk profile.

- Temperature
- Precipitation
- CO_2
- Sea level
- Waves
- Wind

Each of these indicators are discussed in detail in the sections below.

Data has been obtained from existing repositories and studies. Data from eight meteorological stations (Figure 5 and Table 5), with more than 25 years of daily data for temperature (minimum and maximum), precipitation and wind, have also been collected and processed. While a longer time span for data would be desirable for the climate analysis, it should be noted that in old-Soviet Union countries, there is a gap in the data after the collapse of the Soviet Union, and therefore 28 years of data is the best that can be achieved at this stage. While the acquisition of other sources of data could be considered, from a consistency and reliability point of view, the use of local data is recommended.

The stations above are widely distributed across the country, covering most of the ecological zones and located at different altitudes. While the stations in the Greater Caucasus are located at a higher altitude (Sheki, Quba, Gedebey, with altitudes above 500m in all of the cases, and over 1400m for Gedebey), the stations in the Caspian Sea (Baku, Lankeran and Sumqayit) are close to sea-level values. As will be described below, the Baku and Sheki stations have been focused on in more detail due to their location in key risk areas.

Figure 5. Azerbaijan Meteorological stations. Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Table 5. Azerbaijan Meteorological Stations

Station	Longitude (degrees)	Latitude (degrees)	Estimated Elevation (mAoD)
Baku	40.4093	49.8671	-28
Gance	40.6879	46.3723	408
Gedebey	40.57	45.8107	1467
Sumqayit	40.5855	49.6317	26
Lankeran	38.7529	48.8475	76
Sheki	41.1975	47.1571	700
Qobustan	40.0878	49.403	-13
Quba	41.3643	48.5261	600

The state of the water resources is also paramount for this project, and therefore daily data from six hydrological stations was collected for more than 20 years. The data from one of the stations (Zaqatala) was not fully available for this period, and therefore this was discarded from the analysis.

Figure 6. Azerbaijan Hydrological stations. Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Table 6. Azerbaijan Hydrological stations

Station	Longitude (degrees)	Latitude (degrees)
Kura Qıraqkəsəmən	45.49	41.22
Zaqatala	46.64	41.60
Kür – Surra	48.84	39.99
Lənkərançay – Sifidor	48.72	38.72
Zəyəmçay – Ağbaşlar	45.66	40.64
Vəlvələçay - Təngəaltı	48.63	41.21

4.1.2 *Temperature*

From 1961 to 1989, average temperature in Azerbaijan was 11.81 °C with an average January-February temperature around -0.25 °C and an average July – August temperature around 24.13 °C. In the decades following, average temperature has increased by an estimated 1.09 °C with the greatest changes occurring in February and August (Table 7, Figure 7).[64]

Table 7: Comparison of Average Temperature Values °C 1990-2016 with Historical Norms (1961-1989)

Year	Decade Average (Overall)	Change Compared to Norm (Overall)	Decade Average (Jan-Feb)	Change Compared to Norm (Jan-Feb)	Decade Average (Jul-Aug)	Change Compared to Norm (Jul-Aug)
Historical Norm (1961 - 1989)	11.81	0.00	-0.25	0.00	24.13	0.00
1961 - 1969	11.91	0.10	0.11	0.36	23.99	-0.14
1970 - 1979	11.67	-0.15	-0.90	-0.65	24.10	-0.03
1980 - 1989	11.88	0.06	0.08	0.33	24.29	0.16
1990 - 1999	11.96	0.14	0.22	0.47	24.33	0.20
2000 - 2009	12.50	0.69	0.72	0.97	24.93	0.79
2010 - 2016	12.90	1.09	1.59	1.84	25.51	1.38

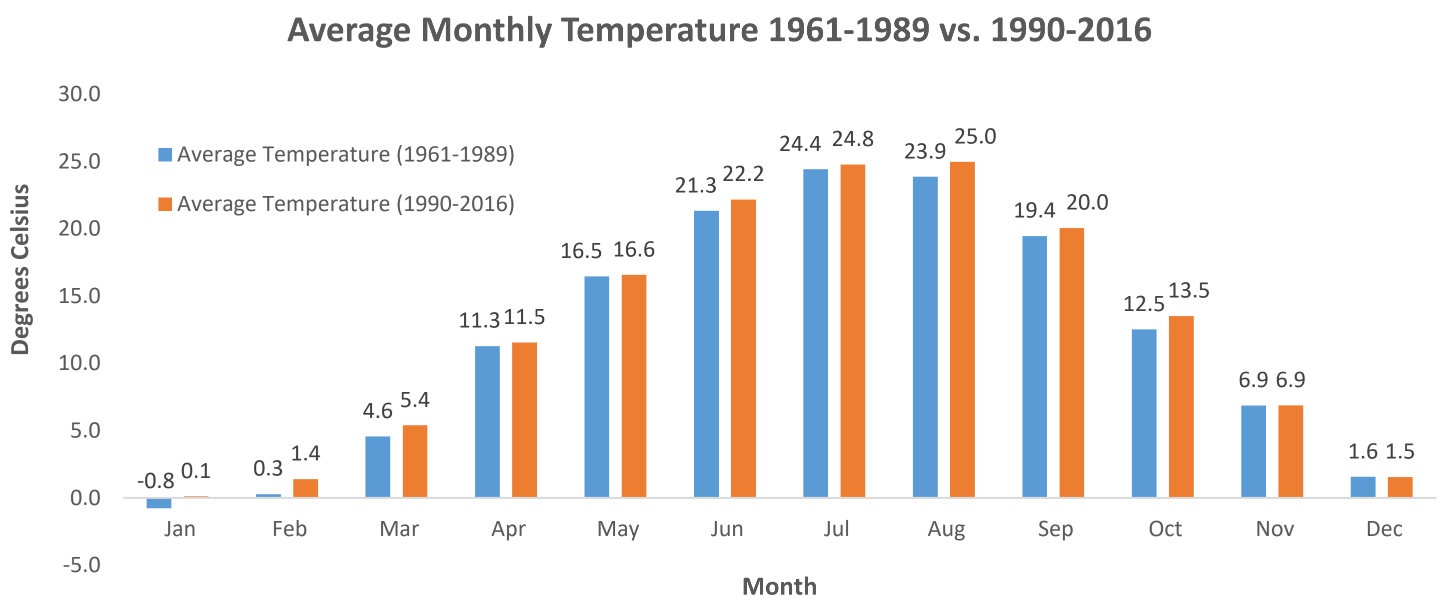


Figure 7: Average Monthly Temperature 1961-1989 vs. 1990-2016

The Third National Communication further highlights differences in temperature change at differing elevations across the country. The highest increase occurred in the Lesser Caucasus region during the spring season. Increase of temperature was observed mainly during summer season which was about 0.90 °C in the Absheron-Gobustan region, 1.10 °C in the Lesser

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

Caucasus region, 0.80 °C in the Lankaran-Astara region and 0.90 °C in the Kura-Araz region. Increase of temperature in Nakhchivan region was observed in summer and autumn seasons (0.80 °C). Annual anomaly of temperature was observed mainly in Ganja (1.10 °C) and Dashkasan (1.20 °C) stations of Lesser Caucasus.

The Fourth National Communication indicates that the northern and central regions have experienced the highest average warming (+1.1–1.5 °C), with the district of Zardab in the central Aran region experiencing the greatest maximum temperature anomaly (+6.7 °C in 2012). In the period 1991-2020, the total number of days in June – August with maximum temperatures of 35 °C and higher increased from 86 days to 365 days in Baku (semi-desert and arid steppe climate) and from 67 days to 203 days in Sheki (temperate-hot climate), compared to the base period 1960-1990. In the same time periods, the number heatwave events increased from two to 27 during the summer months in Baku and from six to 34 in Sheki. [65]

Assessment of Individual Temperature Stations

Temperature data from the eight stations for 25 years were utilized to assess the mean temperature, minimum temperature and maximum temperature. The maximum daily temperature was observed to be increasing slightly across the eight stations (see additional climate graphs in the annex.

Due to the high impact of extreme temperature events, and the recurrence of those, this has been analysed in more detail. If, for instance, the maximum temperature data from Baku station is considered, it can be observed that the recorded data show an increase in temperature in the recorded years.

The difference in the trend per station is showed in the table below. All of the stations are showing an increase of 2ºC but the Gedebey station, where an increase in 3ºC is observed for the 1992-2019 period.

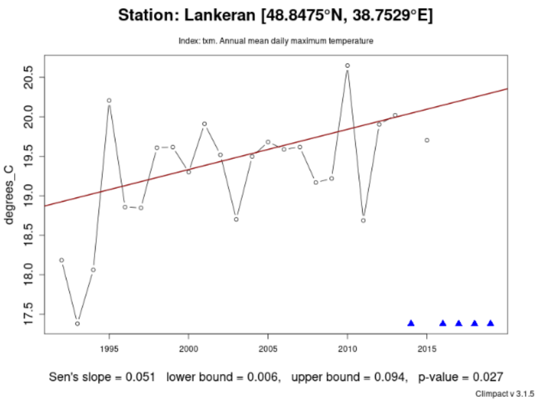
Table 8. Mean Maximum Temperature

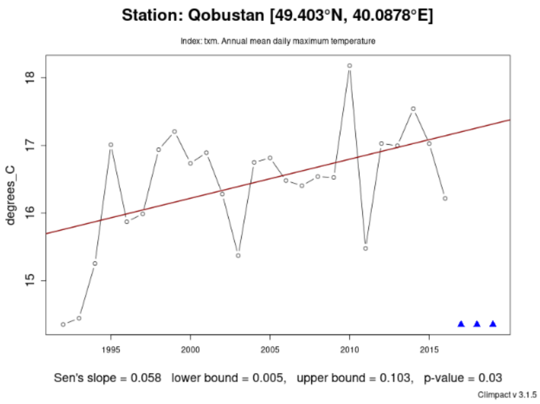
Station	1992 Mean Annual Temperature (ºC)	2019 Mean Annual Temperature (ºC)	Increase in Mean Maximum Temperature (ºC)
Baku	18.38	20.42	2.05
Gedebey	15.49	18.56	3.07
Gance	20.44	22.49	2.05
Lankeran	19.01	21.06	2.05
Qobustan	15.06	17.10	2.05
Quba	16.29	18.33	2.05
Sheki	16.60	18.64	2.05
Sumqayit	18.67	20.72	2.05

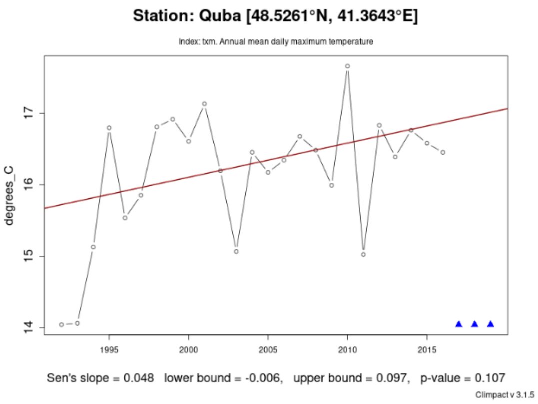
[65] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change

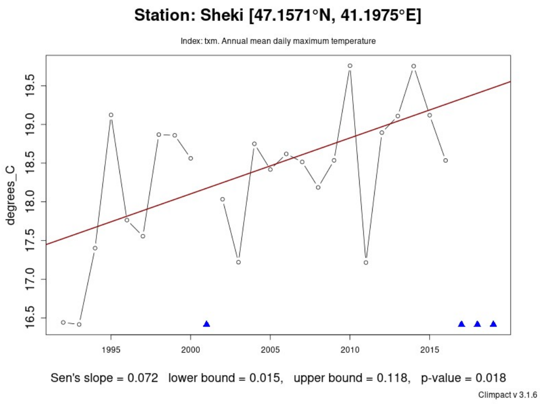
Further analyses have been undertaken for the maximum temperature with the observed data from all of the stations in Azerbaijan.

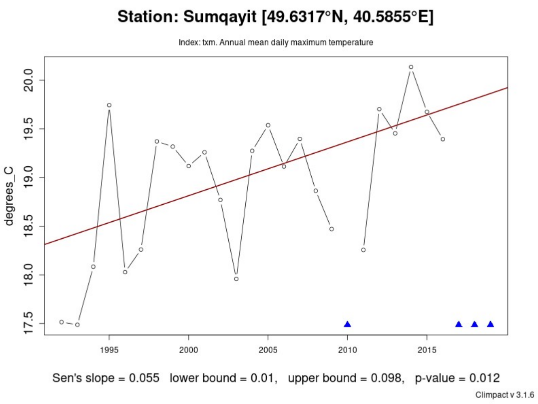
The annual maximum temperature per station is shown in the figures below, showing a significant increase in all of the stations at the 95% confidence level.

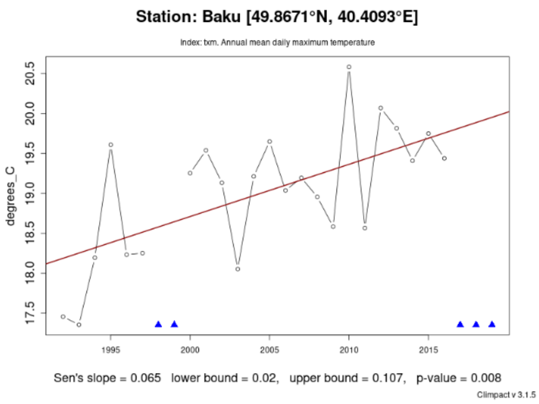












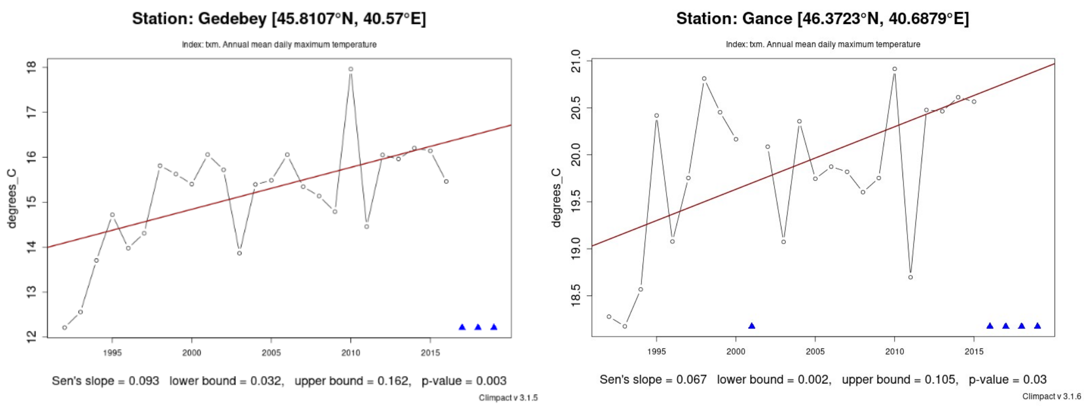


Figure 8. Annual Maximum temperature per station (1992-2019)

The increases and trends are similar for all of the stations, with a maximum peak in 2015, a minimum in 2016, and a clear increase for all of the locations analysed. This increase is quantified in the table below (Table 9), and there is an increase in the annual maximum trend by about 1.4 degrees in Gance, Lankeran, Quba and Sumqayit and 2.7 degrees in Gedebey. This is in line with the trend for the mean maximum temperature showed in Table 9, with Gedebey showing the greater increase in temperature.

Table 9. Annual Maximum Temperature, trend assessment

Station	Annual Mean Daily Maximum Temperature in 1992 (ºC)	Annual Mean Daily Maximum Temperature 2019 (ºC)	Difference in Annual Mean Daily Maximum Temperature between 1992 and 2019 (ºC)
Baku	18.1	19.7	1.6
Gance	19.1	20.5	1.4
Gedebey	13.8	16.5	2.7
Lankeran	18.6	20.0	1.4
Qobustan	15.6	17.2	1.6
Quba	15.4	16.8	1.4
Sheki	17.4	19.2	1.8
Sumqayit	18.2	19.6	1.4

Further analysis for the maximum temperature has been undertaken, particularly for the anomalies and the annual variability. This has been undertaken for all of the stations, results are shown for Baku, Gedebey and Sheki. Baku and Sheki are located in the highest risk areas (as noted in the introduction) due to the hazards faced at this location and to the population (Baku). The Gedebey station has been included because it shows the highest change in all of the variables analysed.

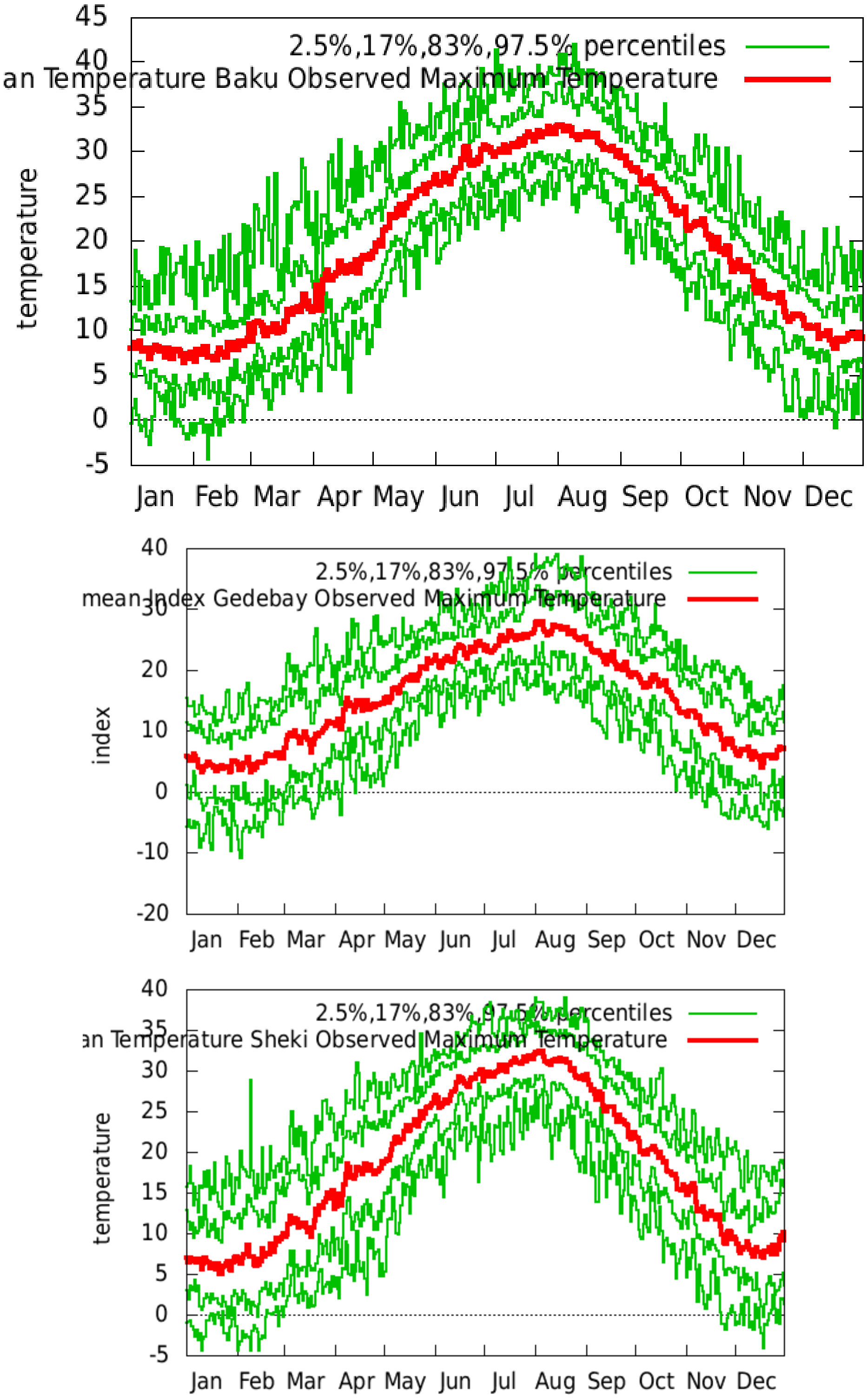


Figure 9. Mean Index, variability for the Baku, Gedebey and Sheki stations

Higher variability can be observed during the winter and spring months in the Baku, Sheki and Gedebey stations. This is especially important for the stations located at a higher altitude, and in the Greater and Lesser Caucasus, because this increases the potential for erosion in these areas, as will be described below. The stations in Qobustan and Lankeran, also show great variability in April and May. The stations of Quba and Ganja show a similar trend, although with a higher variability during summer than the stations in Gedebey and Sheki. All of the data and figures are available in Appendix B.

The station anomalies help to understand how the maximum temperature is deviating for the climate norm (Figure 10).

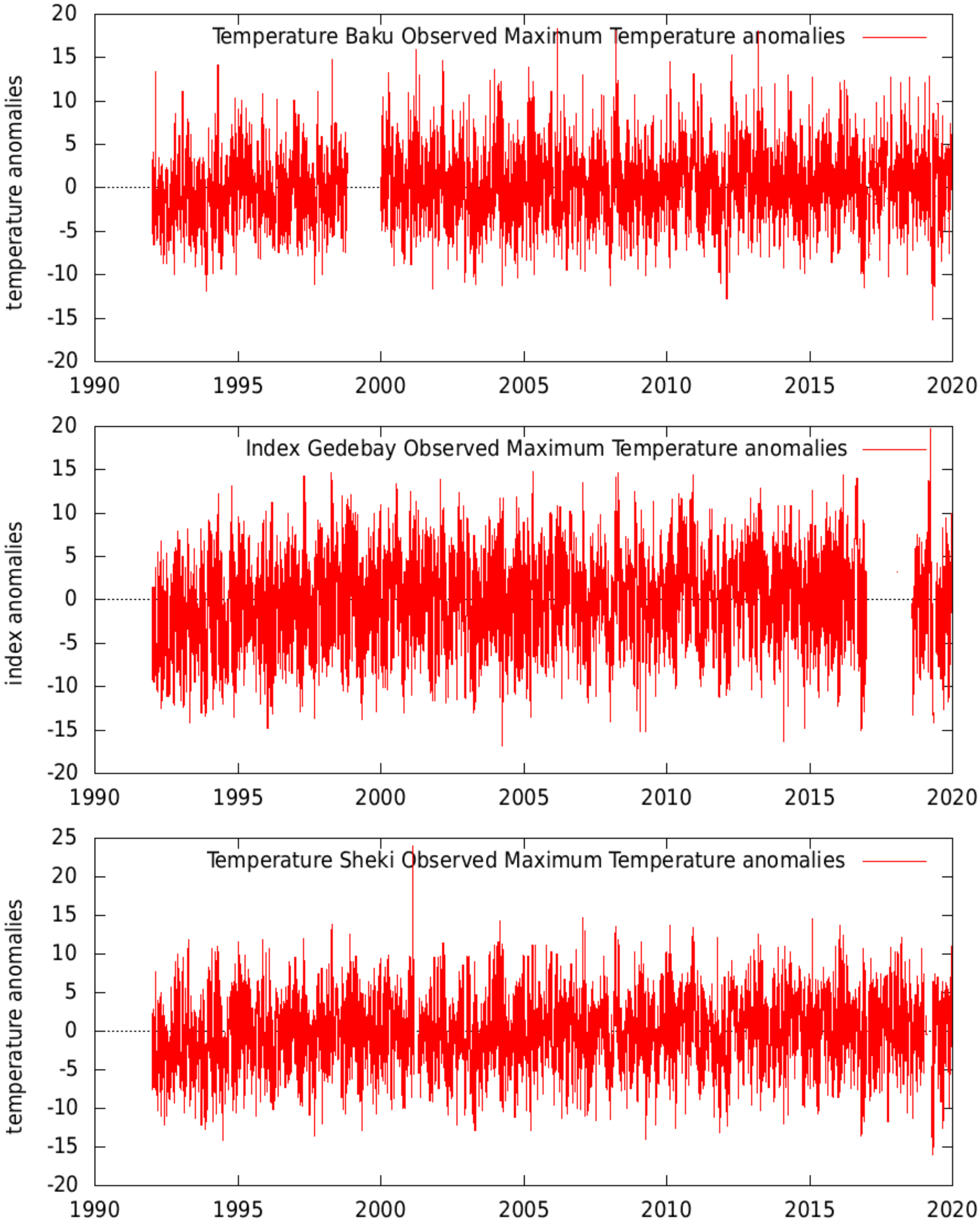
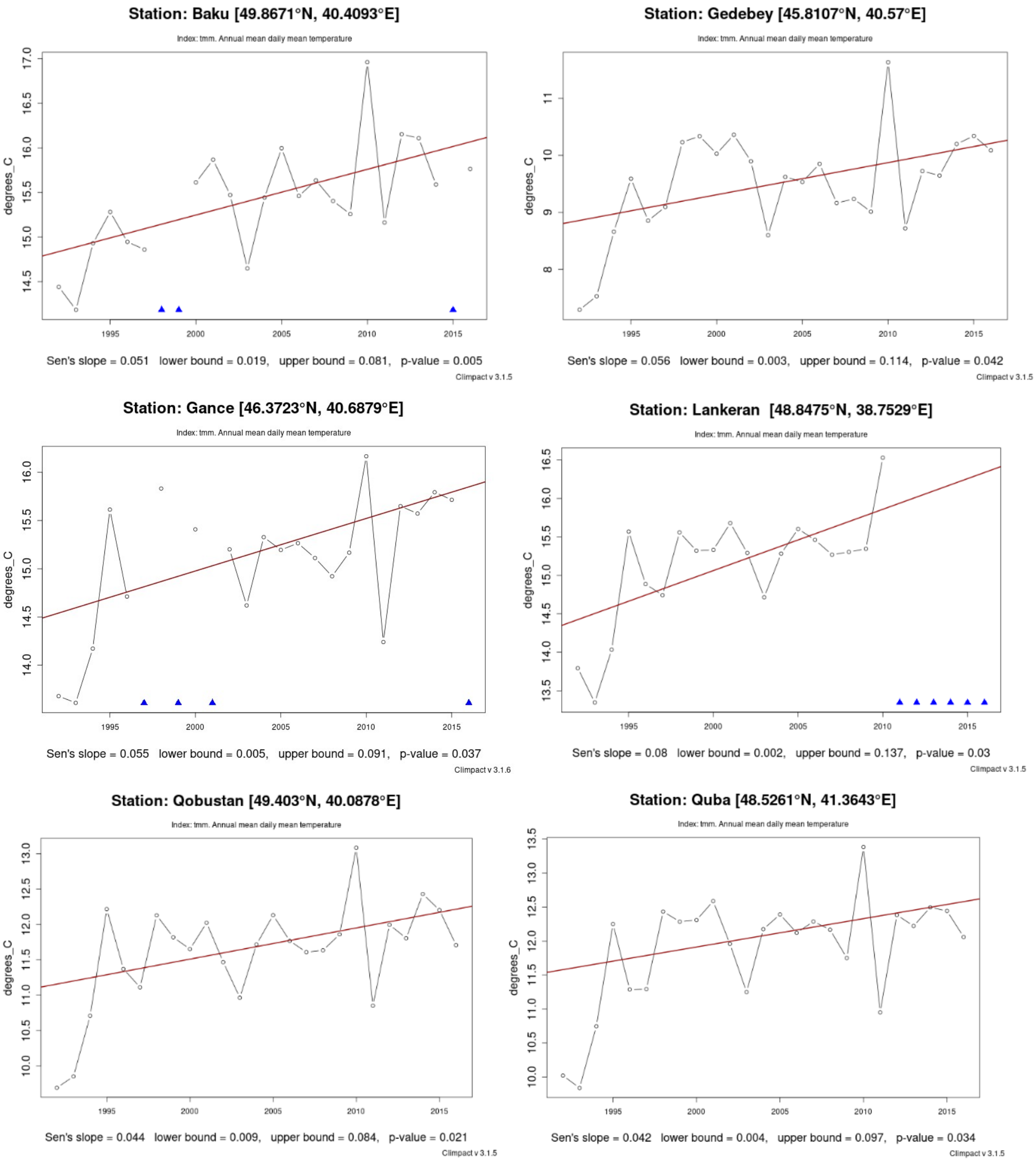


Figure 10. Anomalies for Baku, Gedebey and Sheki stations

Sumqayit, Lankeran and Gedebey are showing the greater anomalies, especially positive ones, with values up to 20 (Gedebey), 22 (Lankeran) and 30 (Sumqayit). It should be noted that in some cases data can be questionable. Spurious data and outliers have been removed when possible, but in some cases, it is not possible if some of the values are due to incorrect measurements or to actual recorded values. It should be noted that all of the data from these stations come from manual measurements. The anomalies in the Sheki, Gedebey and Baku station are higher in the 2015 period, as noted above by the higher values recorded during this period, with maximum anomaly values around 15 degrees. The Quba, Qobustan, Gance showed a similar trend in the anomalies, although with values under 15 degrees.

Mean Temperature

The mean temperature has also been assessed in all of the stations. The annual mean temperature per station is shown in Figure 11. As observed, there is an increase in this variable for all of the stations. The highest increase in the mean temperature is observed in the Sheki (1.6 ºC) and Lankeran station (1.5 ºC) while the other stations showed values just under 1.4 ºC. In general, the increase in mean temperature is similar in all of the stations (from 1 to 1.6 ºC).



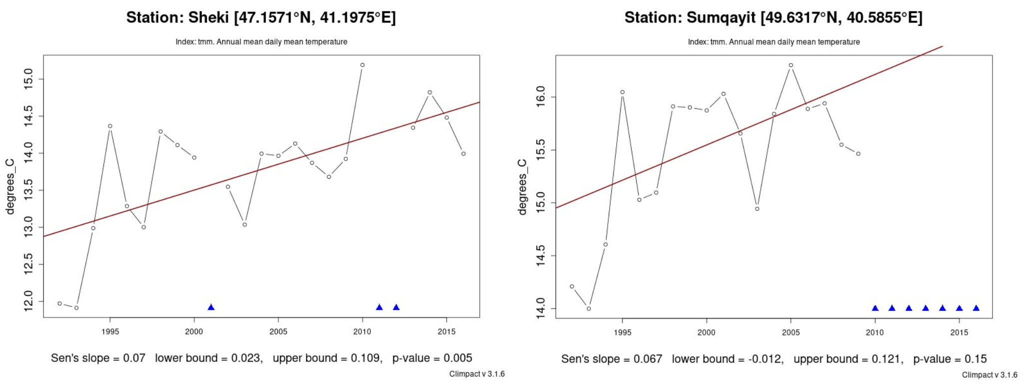
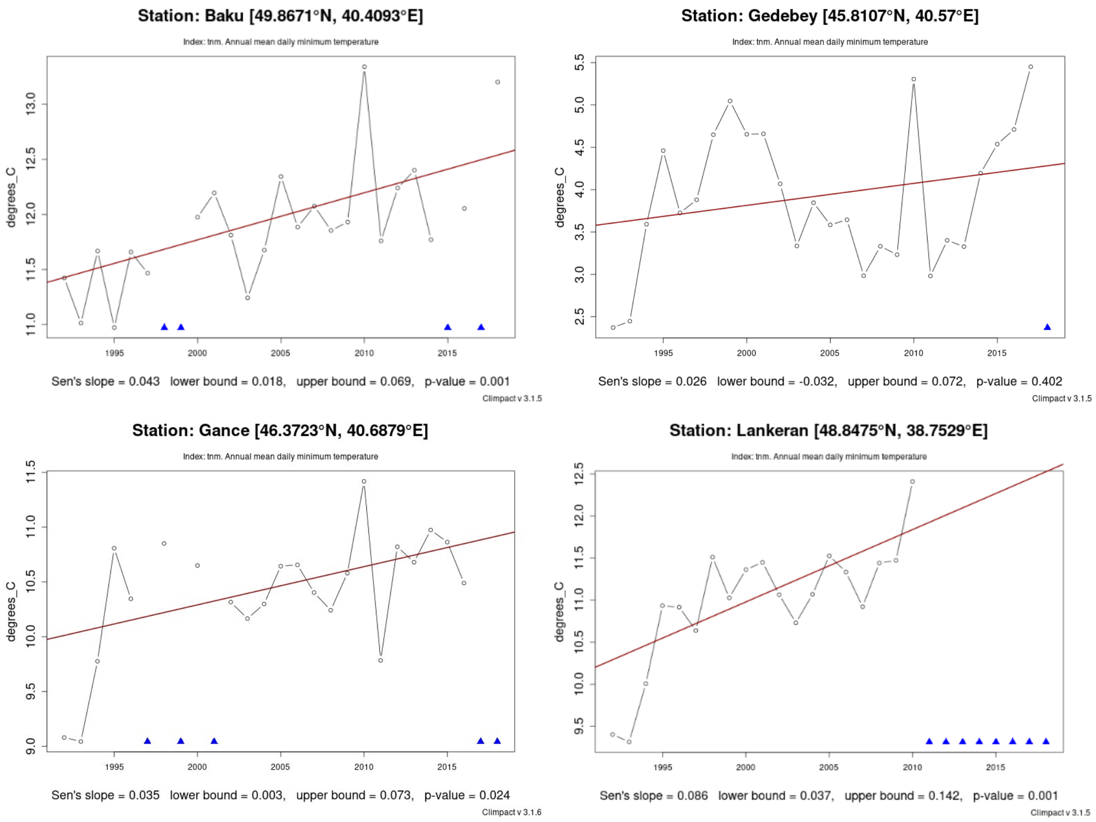


Figure 11. Annual Mean temperature per station (1992-2016)

Minimum Temperature

The minimum temperature in all of the stations in Azerbaijan in the recorded period has also increased. The annual minimum temperature is showed in Figure 12. The trend is similar to the mean annual temperature, with an increase shown by all of the stations, and the highest values in 2015 and the lowest in 2016. The trend is slightly more acute in Lankeran, with values around 2 ºC increase in the annual minimum temperatures from 1992 to 2019. All of the other stations show values around 1-1.5 ºC.



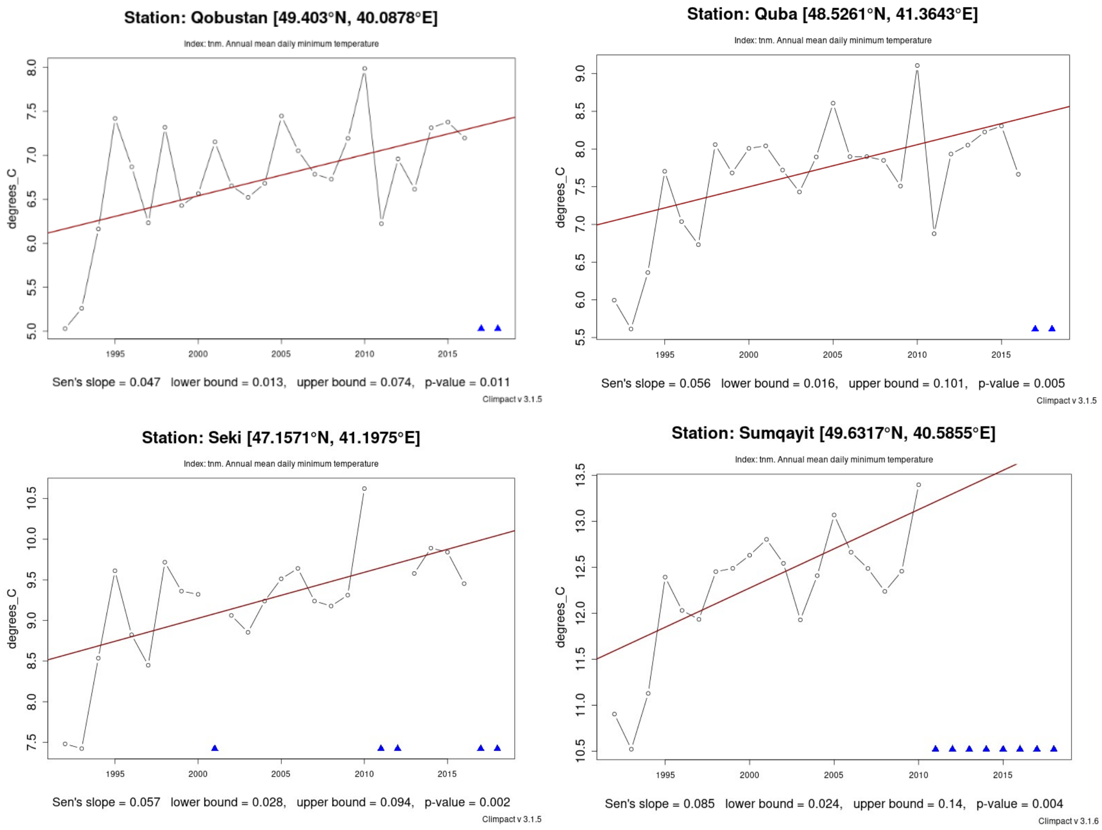


Figure 12. Annual mean daily minimum temperature (1992-2018)

Excess Heat Factor

The Excess Heat Factor (EHF) has also been assessed and calculated for each station. The EHF is an index providing a comparative measure of intensity, load, duration, and spatial distribution of a heatwave events (Perkins et al, 2013)[66]. The EHF has been calculated using the Climpact v3.1.5/v.3.1.6 tools, as recommended by the GCF. The EHF is a combination of two excess heat indices (EHI) representing the *acclimatization* to heat and the climatological *significance*.

The duration, magnitude, frequency, and number of EHF on an annual basis in all of the stations with available data was assessed. The frequency (the number of days contributing to heatwave events) and the number of the EHF events per station is provided in this section. All of the data and figures are available in Appendix B. It should be noted that for all stations, a growing trend line has been observed for at least one parameter, and most cases – for several parameters. At the same time, in many cases trendlines were not observed due to the limited data availability.

The Baku station shows that the frequency of EHF periods increased from almost 0 days in 1992 to more than 30 days in 2010, and the number of EHF events grew from almost 0 to 8 days in the same period.

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[66] Perkins S E and Alexander L V 2013 On the Measurement of heatwaves J. Clim. 26 4500–17 Online: http://dx.doi.org/10.1175/JCLI-D-12-00383.1

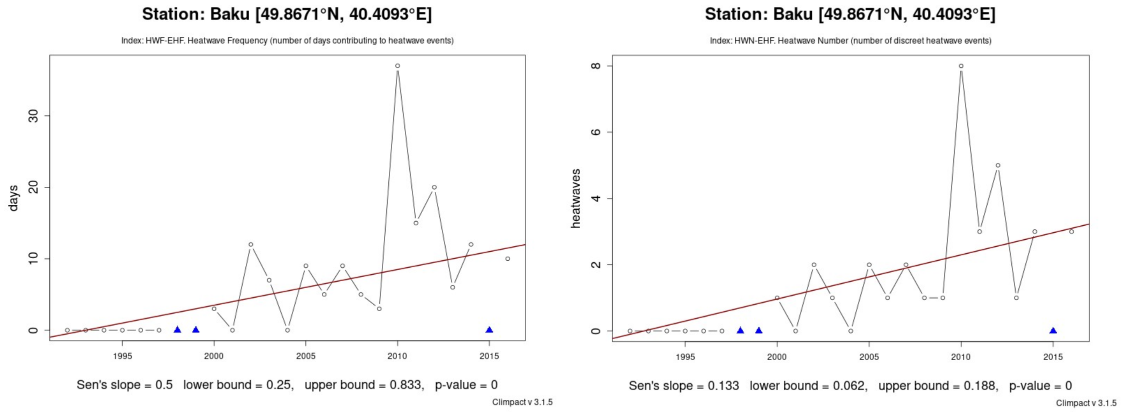

Figure 13. Baku frequency and number of EHF from 1992 to 2016

In Gance, the frequency of the heatwave periods changed from less than 5 to 25 days in 2010, while the number grew from 0 in 1992 to 5 in 2010 and in 2015.

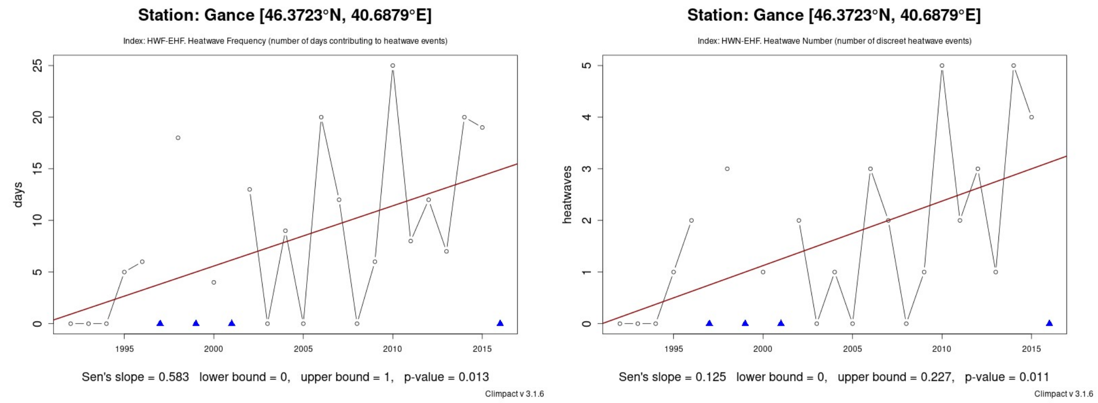

Figure 14. Gance frequency and number of EHF from 1992 to 2016

Despite the location of Gedebey at more than 1,400m of altitude, the frequency of heatwaves has increased, with the year 2000 showing the largest number of days contributing to a heatwave event (more than 40). The trend for the heatwave number has remained neutral.

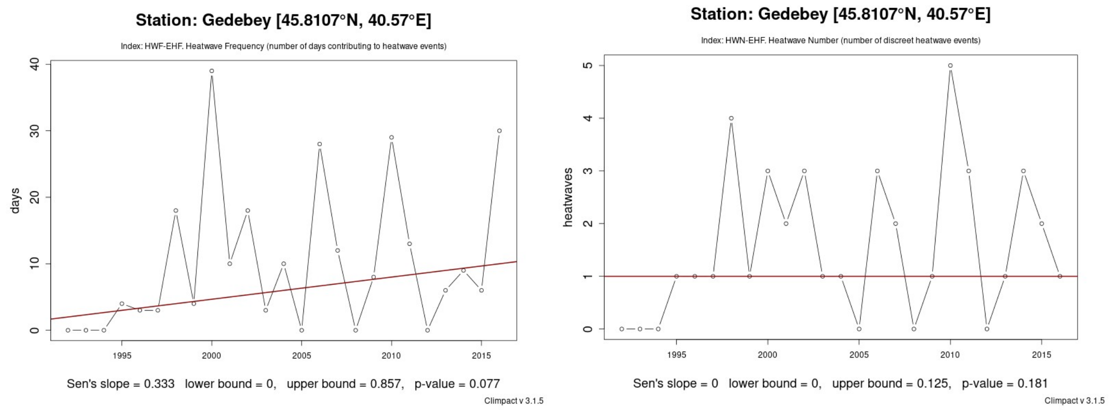

Figure 15. Gedebey frequency and number of EHF from 1992 to 2016

The Lankeran station, in the south of the country, recorded a significant increase in both variables during the observational period, though data after 2010 was not available.

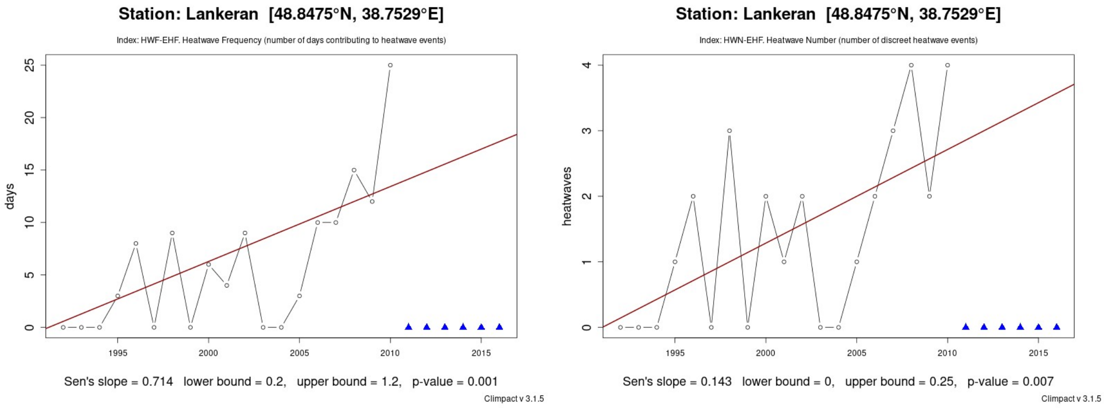

Figure 16. Lankeran frequency and number of EHF from 1992 to 2016

The Qobustan station, south of Baku and in the Caspian Sea coastline, also showed a marked increase in the frequency and number, from zero to 30 days in 2014 and from zero to 5 days in 2014 respectively.

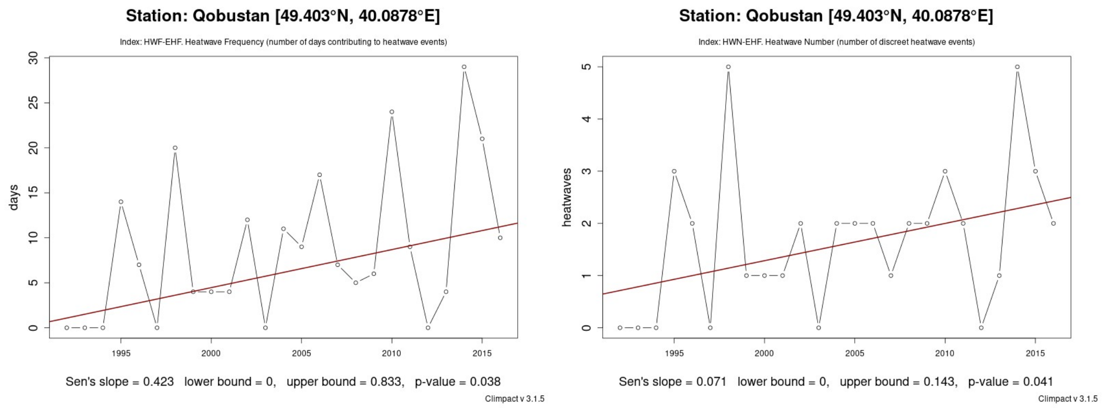

Figure 17. Qobustan frequency and number of EHF from 1992 to 2016

The Quba station, in the northeast of the country, also showed an increase in the frequency (from zero to 25) and number (from 0 to 6) of heatwaves.

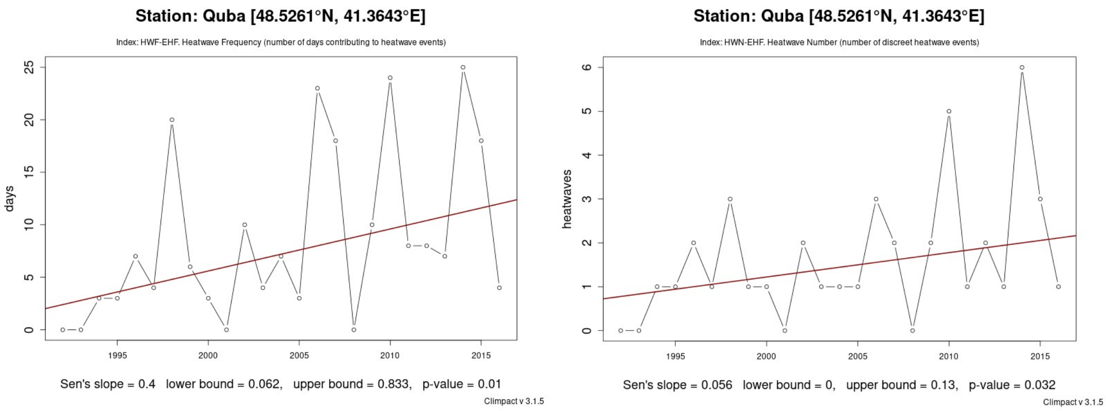

Figure 18. Quba frequency and number of EHF from 1992 to 2016

The Sheki station, in the Greater Caucasus, showed a notable EHF period in 2014-2015, with frequency exceeding 30 days and the number being 6 during both years. For both parameters, a growing trendline was observed despite data gaps.

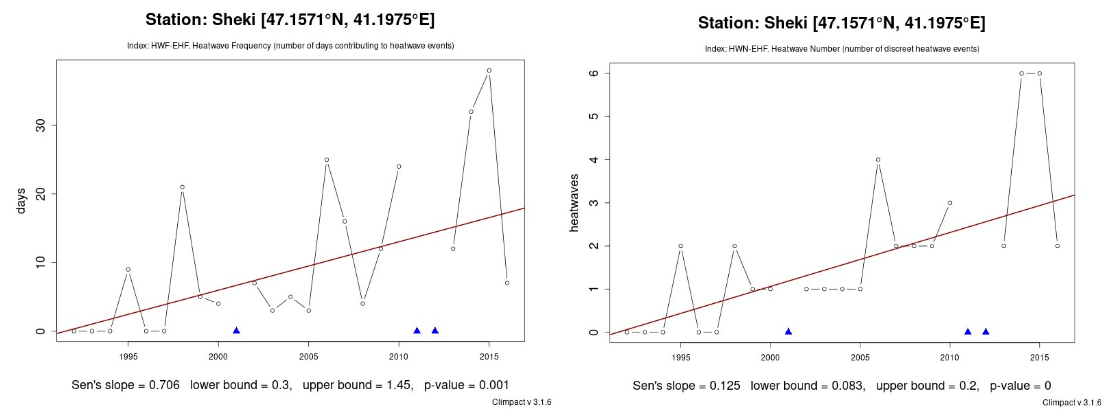

Figure 19. Sheki frequency and number of EHF from 1992 to 2016

For the Sumqayit station, in the Absheron Peninsula, north of Baku, frequency dramatically increased from 0 to more than 15 in 2006, and the number grew from 0 to 3 in 2005-7. A positive trend was observed for both stations even though after 2009 no data was available.

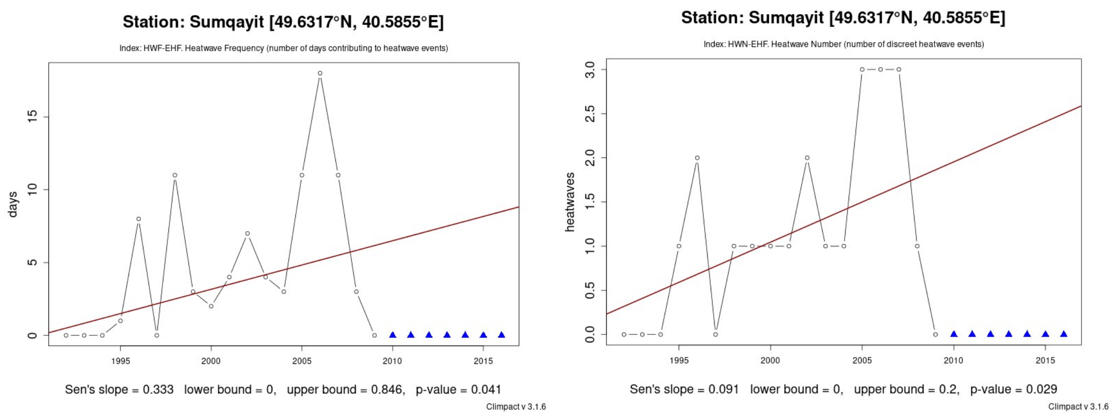

Figure 20. Sumqayit frequency and number of EHF from 1992 to 2016

In summary, all of the stations in Azerbaijan are showing an increase in the maximum temperature, mean temperature, minimum temperature and the Excess Heat Factor (heatwaves). These increases vary geographically, with the higher increase in the maximum temperature observed in the Lesser Caucasus. The number, frequency, magnitude and duration of heatwave periods have increased in all of the stations, with Baku and Gedebey showing the highest increase in both the duration and the frequency of these events.

4.1.3 *Precipitation*

Historically (1961 – 1989), annual precipitation in Azerbaijan averaged 440 mm per year with 51.5 mm in the driest months (July to August) and 148.9 mm from March to May. In more recent decades, 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). The monthly changes have also indicated a change in the seasonality of rainfall Figure 21, Table 10). [67]

In the period 2010-2020, annual precipitation was lower across most of Azerbaijan compared to the reference period 1971-2000. However, an increase in precipitation was observed in Baku and Gadabay (located in the Lesser Caucasus in the west). Overall, precipitation across Azerbaijan decreased by about 3.4 % over the past decade.[68]

Surface water resources in Azerbaijan are mainly concentrated in rivers. Water levels in the Kura, Araz and Ganikh rivers, which are the main transit rivers, have decreased in recent decades. In the period 1991-2020, the annual decline was between 4% and 24% compared to the reference norm 1961-1990.[69] The decline in river flow can be attributed to increasing temperatures (leading the increased evaporation) and decreases in precipitation.[70]

Table 10: Comparison of Precipitation Patterns from 1961 - 2016

Year	Decade Yearly Average (Overall)	Decade Yearly Average (Jul-Aug)	Decade Yearly Average (Mar-May)	Decade Monthly Average (Overall)	Change Compared to Norm (Overall)	Decade Monthly Average (Mar-May)	Change Compared to Norm (Mar-May)	Decade Monthly Average (Jul-Aug)	Change Compared to Norm (Jul-Aug)
Historical Norm (1961 - 1989)	440.4	51.5	148.9	36.70	0.00	49.63	0.00	25.77	0.00
1961 - 1969	460.3	52.4	154.3	38.36	1.66	51.44	1.82	26.20	0.43
1970 - 1979	426.6	43.5	148.0	35.55	-1.14	49.33	-0.29	21.75	-4.03
1980 - 1989	436.2	58.8	144.9	36.35	-0.35	48.29	-1.34	29.41	3.64
1990 - 1999	409.2	45.2	128.8	34.10	-2.60	42.93	-6.70	22.62	-3.15
2000 - 2009	447.1	55.3	147.8	37.26	0.56	49.28	-0.35	27.63	1.86
2010 - 2016	437.7	48.8	142.9	36.48	-0.22	47.65	-1.98	24.41	-1.36

[67] Data from World Bank Climate Change Knowledge Data Platform; Available at: https://climateknowledgeportal.worldbank.org/country/azerbaijan
[68] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change
[69] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change
[70] Republic of Azerbaijan, 2015. Third National Communication to the United Nations Framework Convention on Climate Change

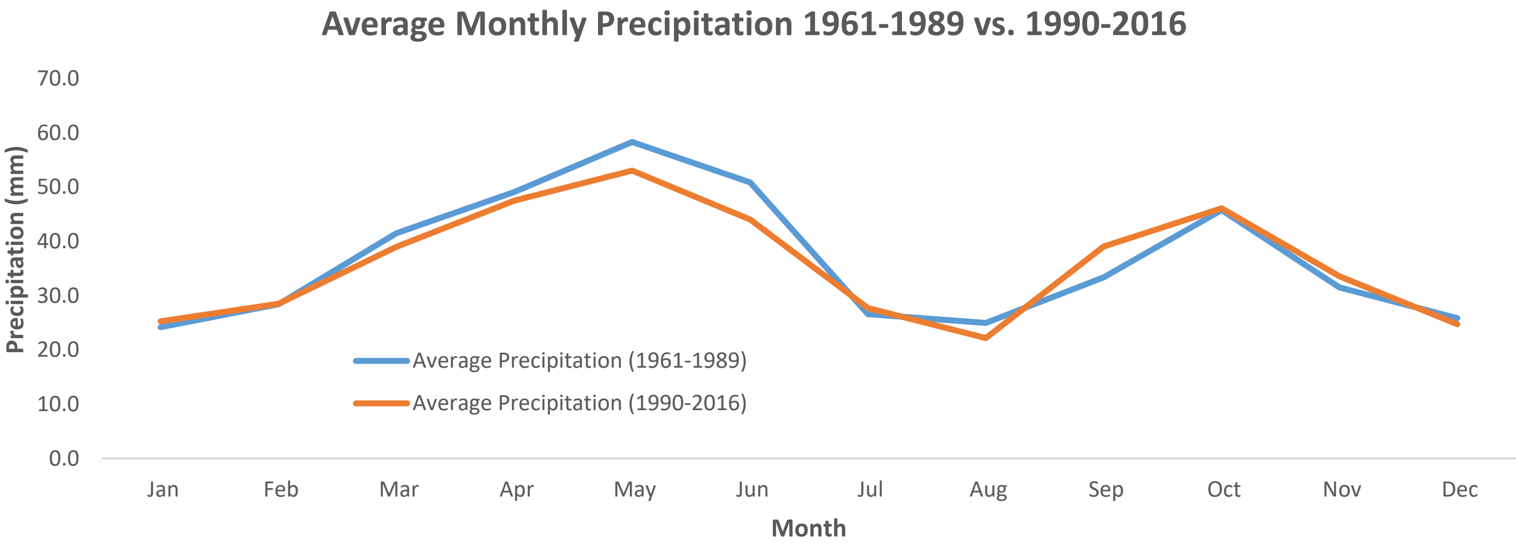

Figure 21: Average Monthly Precipitation 1961-1989 vs. 1990-2016

Assessment of Individual Precipitation Stations

Precipitation data from the eight different stations have been processed and analysed (Figure 22). Total precipitation and the seasonality of the precipitation varies significantly across the different stations.

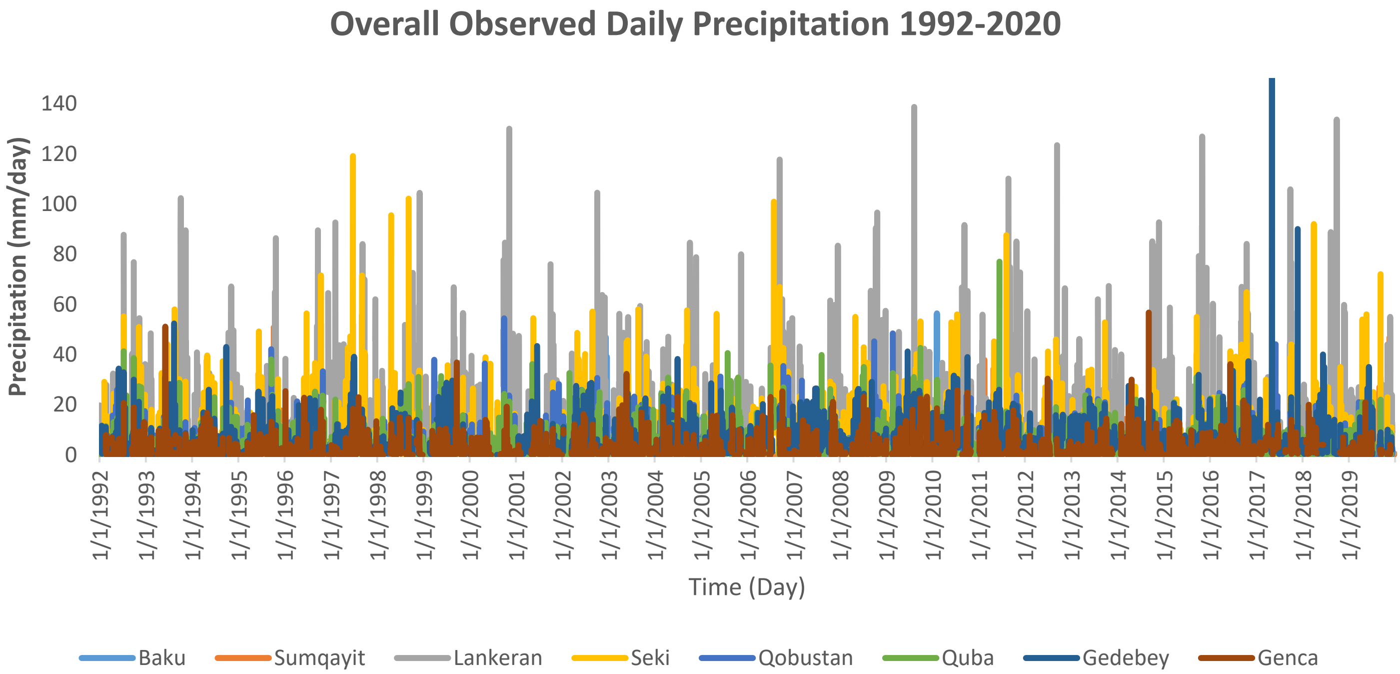

Figure 22. Observed Daily Precipitation from the Eight Rainfall Stations (1992 – 2020)

Due to the climate variability in Azerbaijan, the stations in Baku and in Sheki (in the Greater Caucasus) have been analysed in more detail. This is because these stations are located in the most populated areas in Azerbaijan (Baku) and in areas at the higher risk (both Baku and Sheki).

The Sheki precipitation records (Figure 23), show a constant trend in precipitation for Sheki, while the precipitation has increased during the 2000s, it has decreased again in the 2010s, with a similar mean value at the beginning and at the end of the recorded period.

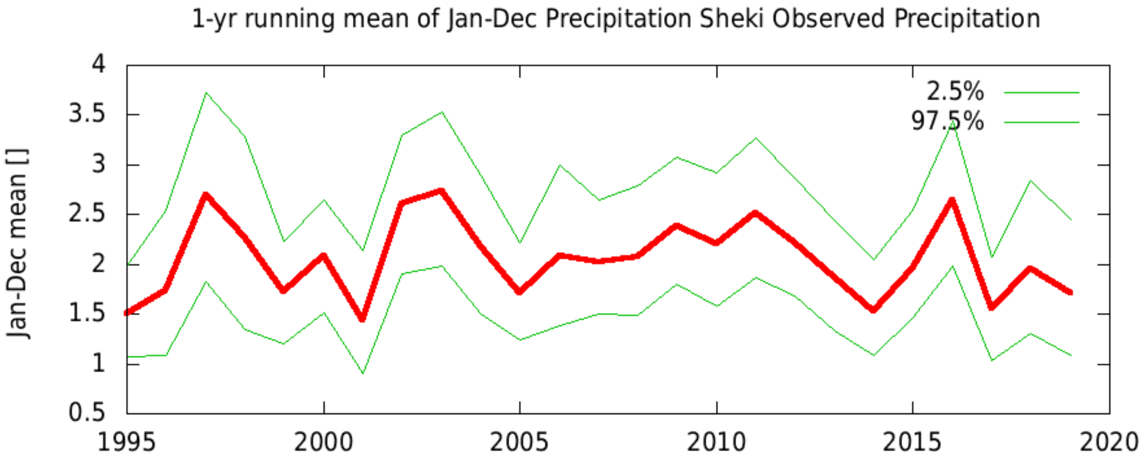

Figure 23. Sheki precipitation trend

As shown in Figure 24, the trend in Baku is also similar, showing significant variability, but with mean values similar at the end and at the beginning of the observation period.

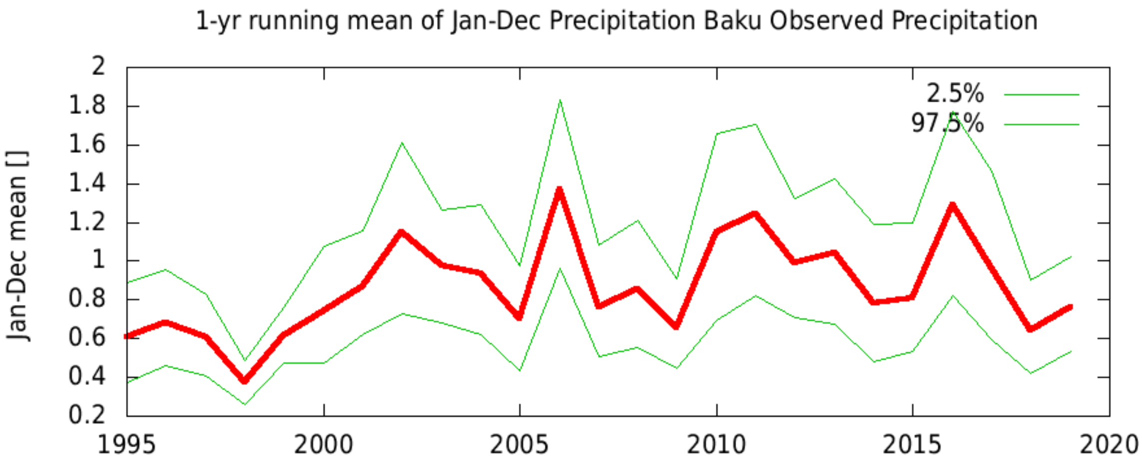

Figure 24. Baku precipitation trend

The cumulative data frequency (CDF) analysis for 1992 and 2019 can be observed below for the two stations. In terms of extreme events, the precipitation in Sheki during extreme events has not changed much during this period.

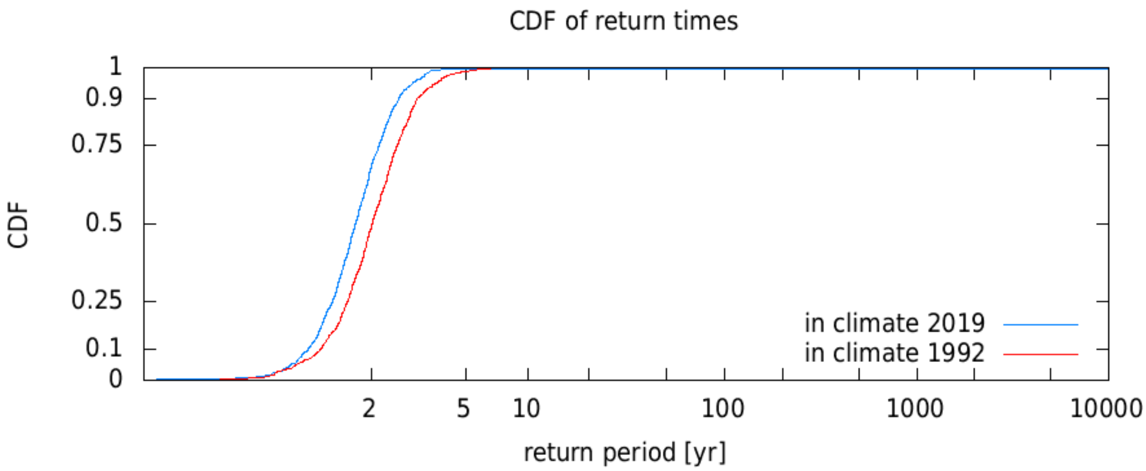

Figure 25. CDF Analysis for Sheki for 1992 and 2019

In the case of Baku, however, the return period events for extremes have been reduced between 1992 and 2019. This is a result of more intense precipitation during extreme rainfall days.

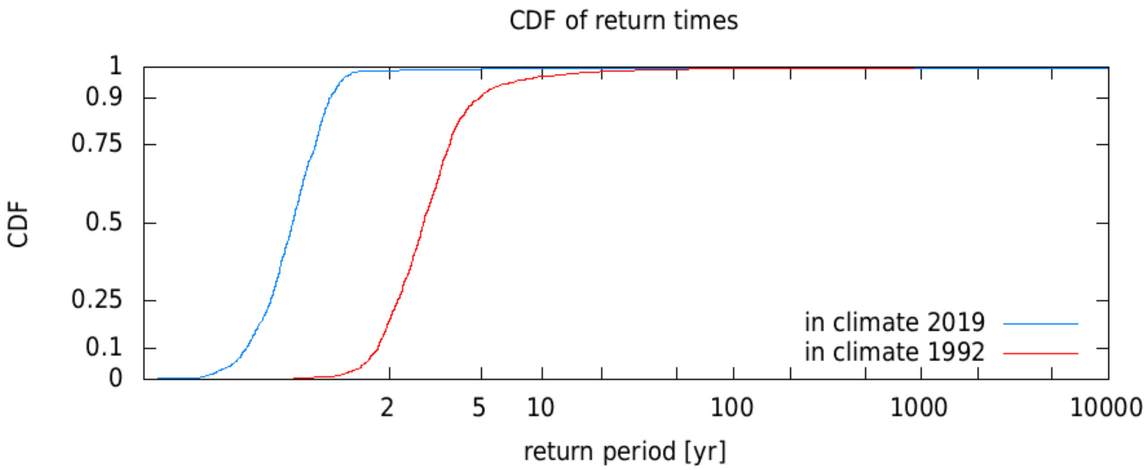

Figure 26. CDF Analysis for Baku for 1992 and 2019

As can be inferred, while the extreme and return period analysis yield similar values for Sheki, the values in Baku are different, and in 2019 the calculated precipitation for a 1:10 year event is 75mm, while in 1992 it was 50mm.

All of the data from the stations have been populated and analysed with the Climpact tool v.3.1.5/3.1.6. The number of consecutive dry days (precipitation less than 1 mm) have been processed (Figure 27). Due to the lack of precipitation data, this indicator was only available for four stations (Baku, Gance, Quba, Sheki). An increase in the number of dry days was observed in Gance and Sheki stations, while there was a decrease in Baku and Quba.

In Baku, the decrease is very minor, and actually in 2017 there were more than 100 consecutive dry days recorded in this station. In this case, the reliability of the network should be considered.

Out of the four stations, the highest number of consecutive dry days is observed in Baku with 100 days in 2015. The lowest maximum of consecutive dry days is observed in Quba, with 47 in 2010.

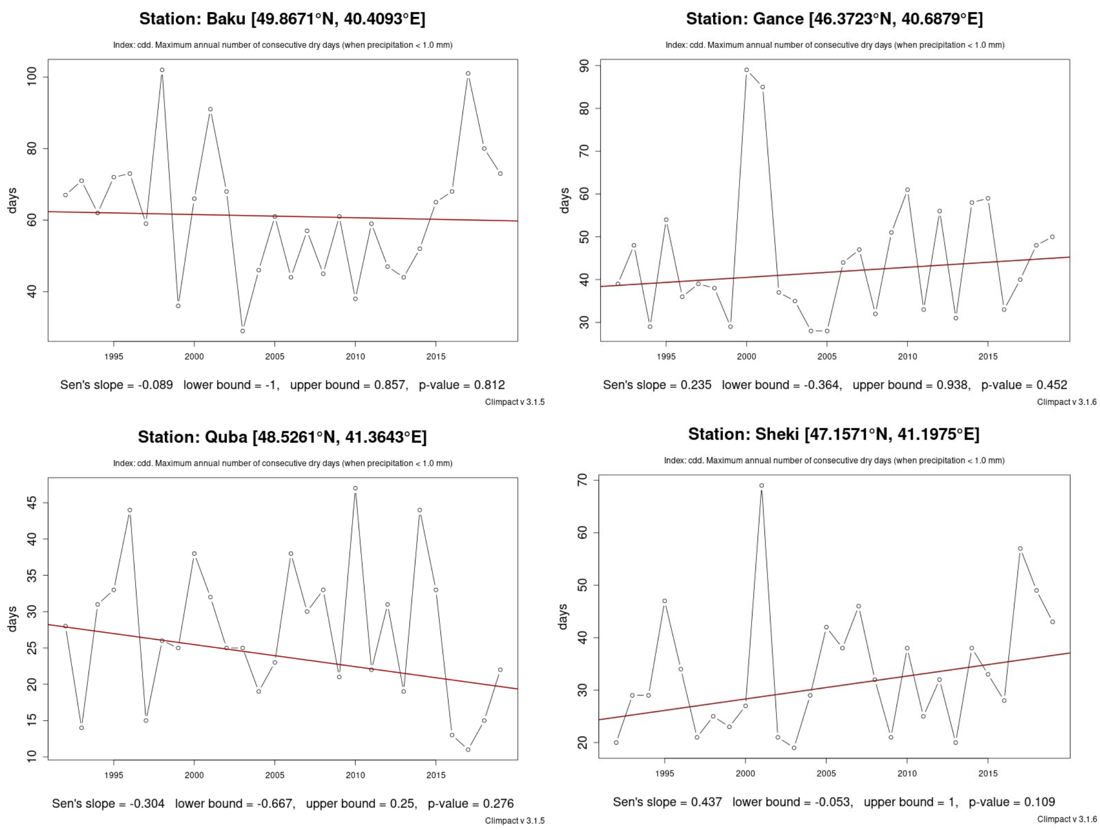

Figure 27. Maximum annual number of consecutive dry days (when precipitation <1.0 mm) (1992-2019)

The maximum annual single day precipitation event per station has also been analysed. As with the number of consecutive dry days, this indicator was only available for four stations (Baku, Gance, Quba, Sheki) due to low availability of precipitation data for other stations. This is very relevant for flood purposes, as it indicates if there has been an increase in extreme precipitation.

High variability in the trend for the annual single day maximum rainfall is observed, with Baku, showing an increase and Gance, Quba and Sheki showing slight decreases.

The Baku station showed the only significant change (this is why Baku is considered "high-risk") with an increase from 20mm to around 40mm on average, with values over 50 mm in 2017 and 2018. For Gance and Sheki, the decrease in the daily totals is minor – in both cases less than 5 mm; while the Quba station showed a higher decrease (7 mm). The observed decreases are not statistically significant.

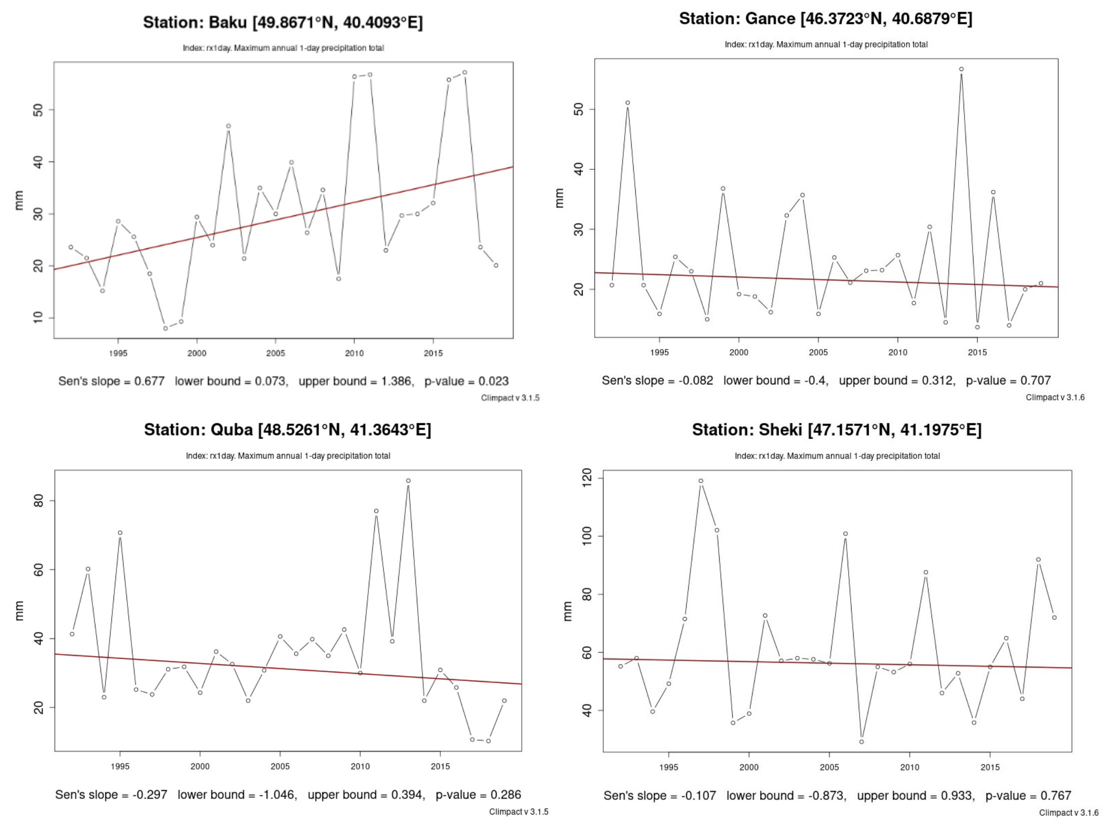

Figure 28. Maximum Annual Daily Precipitation (1992-2019)

4.1.4 *River Flow and Discharge*

River flow and discharge data for 25 years for five different stations have been analysed. These stations have been selected to cover a wide range of situations. The river basin with a higher influence in Azerbaijan is the Kura River, as it is the longest river in Azerbaijan and the country's main source of water.[71] Data from two stations in the Kura River have been processed in order to get a better understanding of the water quantity dynamics in this river, one in the upstream side of the river in Azerbaijan (Qiraqkesemen – blue line), directly after the border with Georgia, and the second one closer to the mouth of the River to the Caspian Sea (Surra – grey line) (secondary axis). Three stations in smaller rivers have been selected too (primary axis) (Figure 29).

[71] Eurasianet. Azerbaijan faces growing water shortage. Last Accessed 14 December 2020

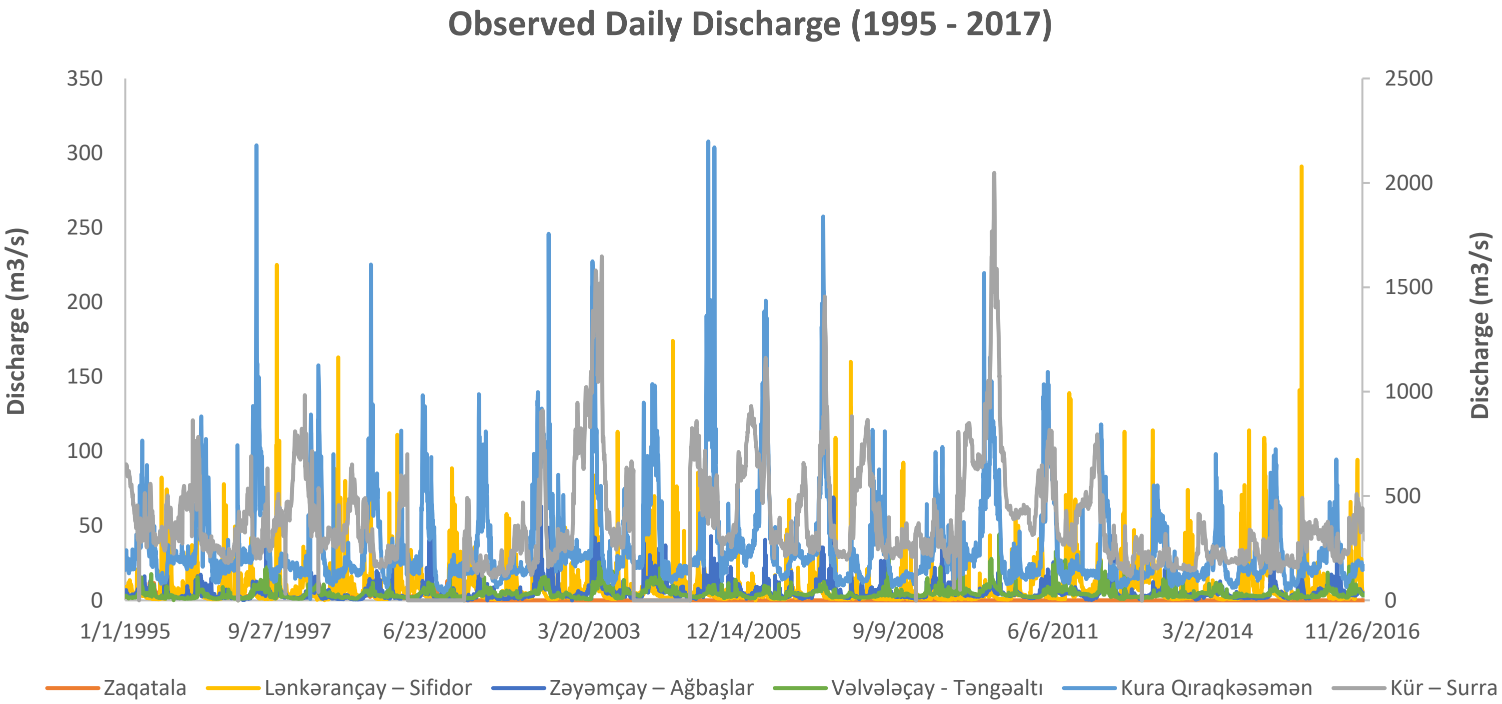

Figure 29: Observed Flow and River Discharge (1995 - 2017)

Two different aspects have been analysed from these data, the year around dynamics and flow trend, and the occurrence of flood-related disasters. The latter is easier to be assessed in the data from the three smaller rivers, while the former is more evident in the Kura River flow.

A reduction in the flow in the Kura River can be observed (Figure 30), with an average reduction in the flow of 5-7% in both stations. It should be noted that this river is highly regulated, both in Georgia and in Azerbaijan. While high variability can be observed, even with the peak flows in the historical flood in 2010, there is an overall negative trend in the flow data.

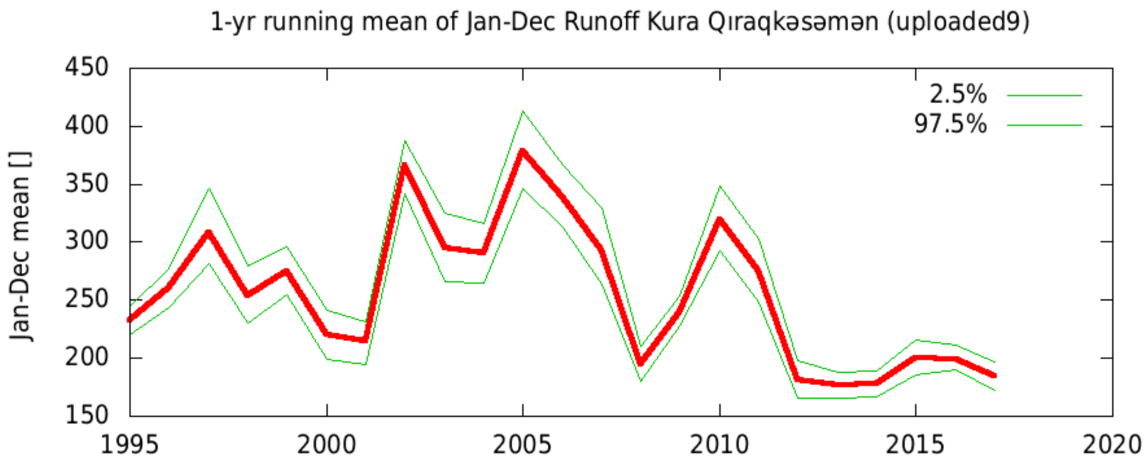

Figure 30. 1 year running mean discharge for the Kura River in Qiraqkasama

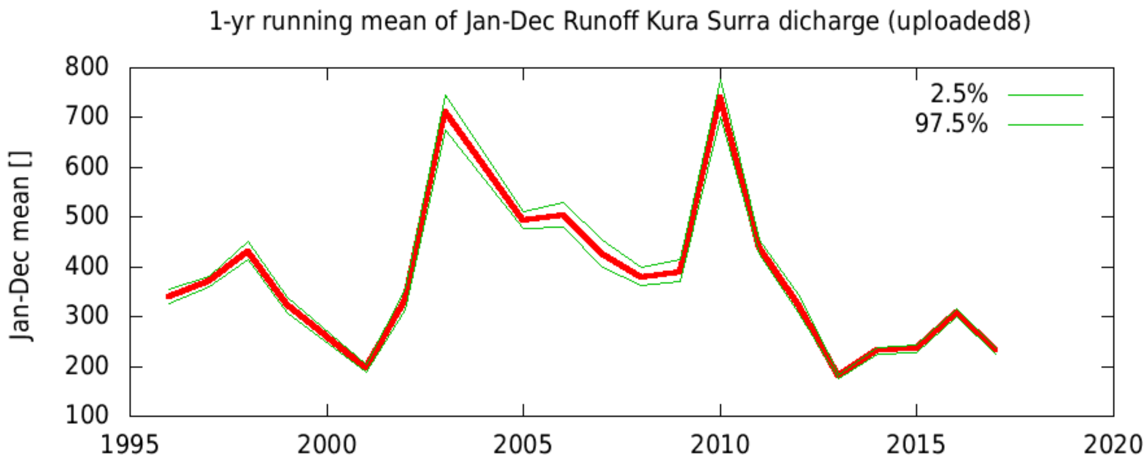

Figure 31. 1 year running mean discharge for the Kura River in Surra

For the three smaller river catchments, no significant decrease in water flow year dynamics is observed in the last 20 years, and actually, a small increase in flow is observed for the Lənkərançay – Sifidor station (3%).

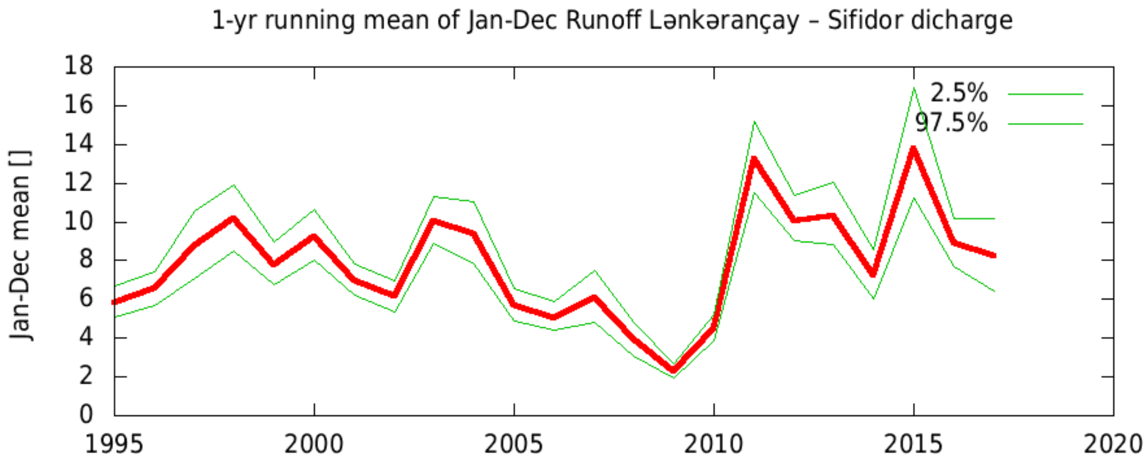

Figure 32. 1 year running mean discharge for Lənkərançay – Sifidor

Water resources management in Azerbaijan is mostly controlled by direct rainfall and river flow in the Kura. A decrease in the flow in the Kura River stems from a reduction of precipitation in the upstream catchment and also from human modifications.

While extreme event impacts in the Kura are being reduced, the number and intensity of the extreme events in the Lənkərançay and other rivers has been increasing in the last years (Figure 35).

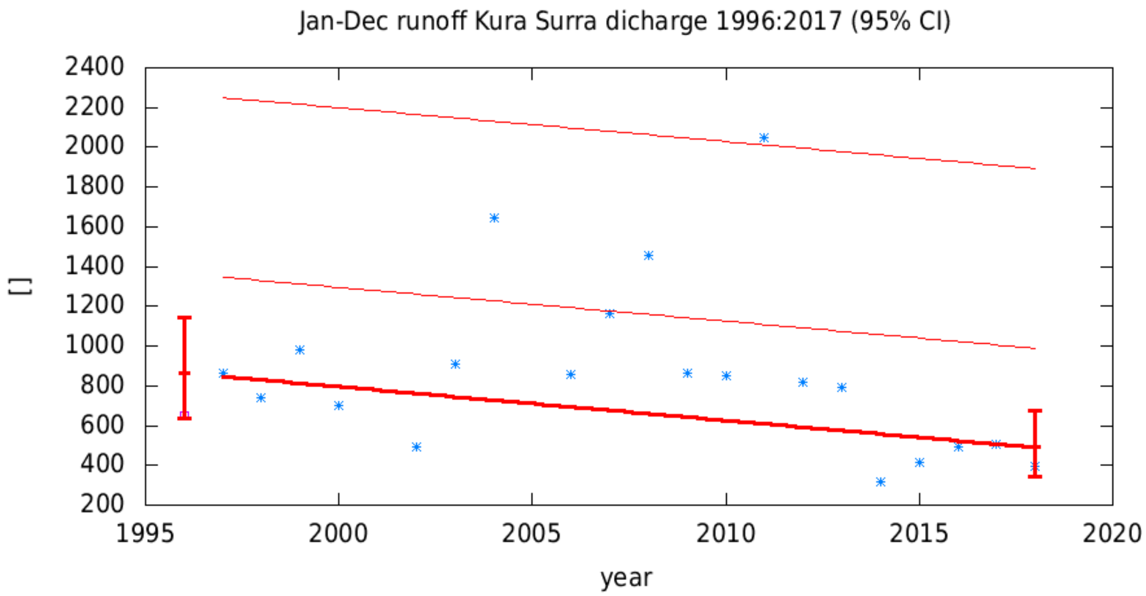

Figure 33. Extreme events evolution in the Kura in Surra

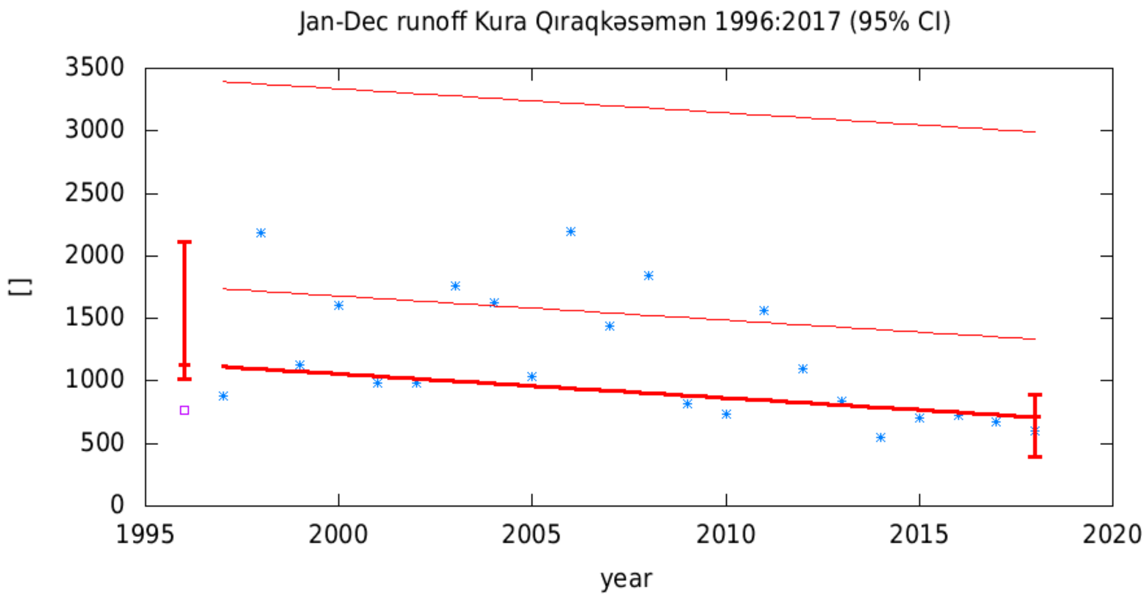

Figure 34. Extreme events evolution in the Kura River in Qiraqkasama

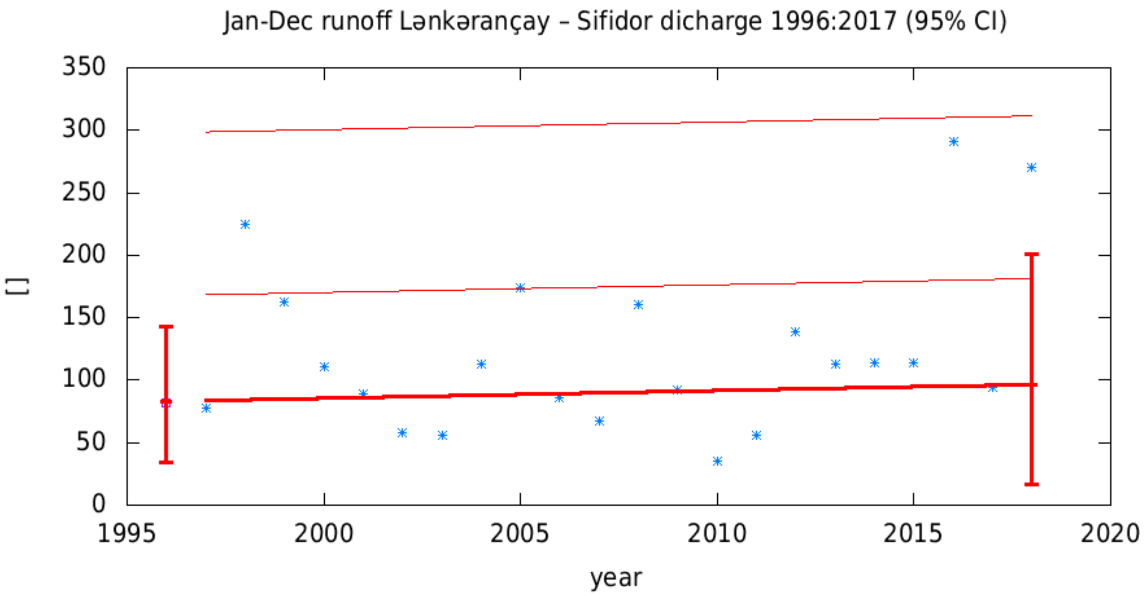

Figure 35. Extreme events evolution in Lənkərançay rivers

4.1.5 Sea-Level and Waves

Information about sea-level and waves in the Caspian Sea was also collected. Data from two tide gauges and four wave buoys was analysed. The dynamics in the sea-level in the Caspian Sea are not fully understood, and it varies depending on continental inflow (mainly from the Volga River), precipitation and evapotranspiration, with a very fine balance. In the last 15 years a decrease in the sea-level in the Caspian Sea has been observed (Figure 36).

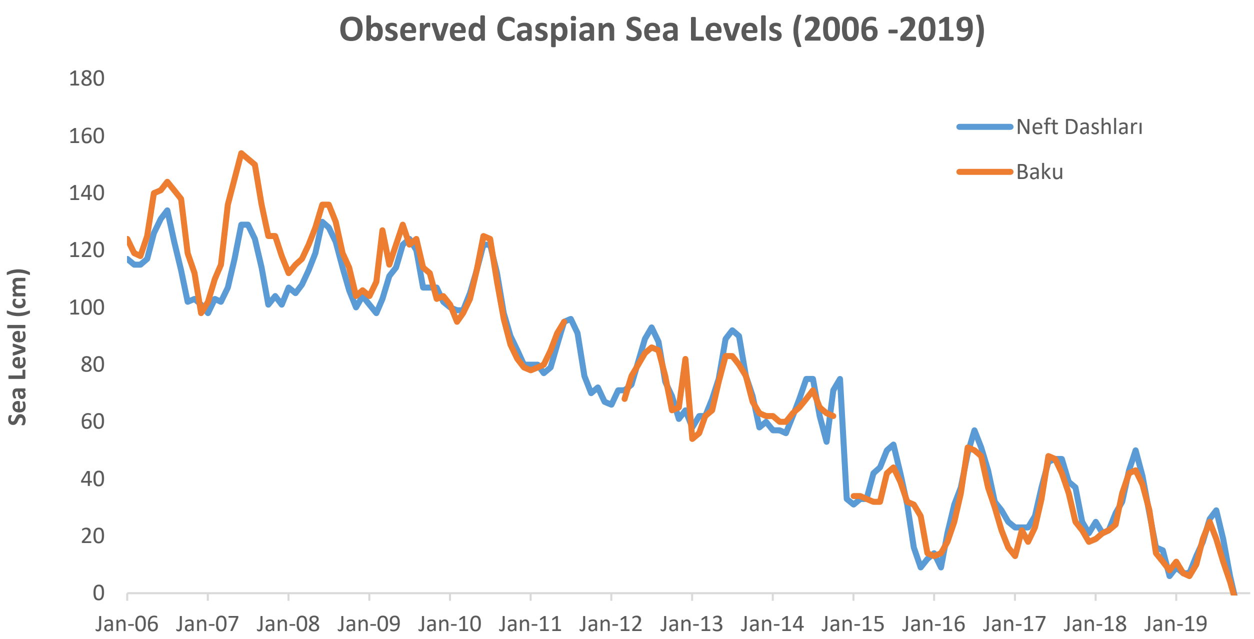

Figure 36. Caspian Sea-level (2006 – 2019)

Sea-waves have also caused an impact on Azerbaijan, especially related to activities in the Caspian Sea, such as fisheries and oil extraction. The monthly data for these wave buoys are available (Figure 37).

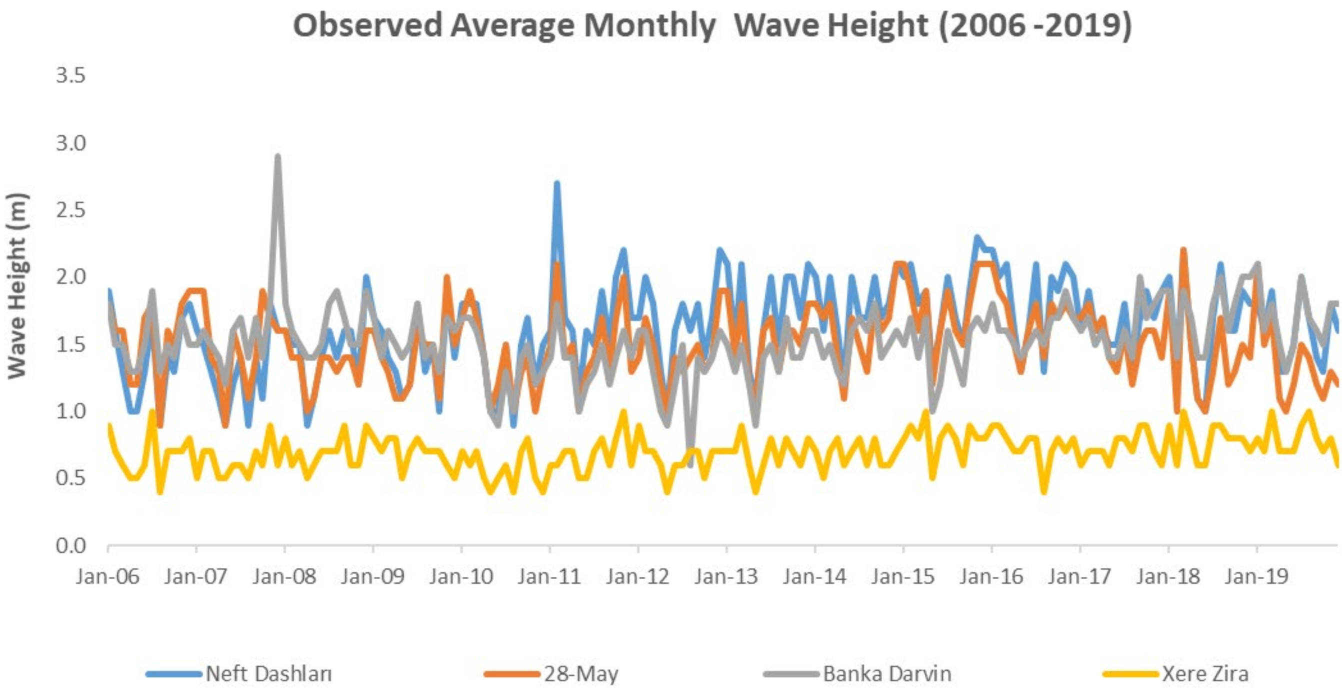

Figure 37. Sea waves in the Caspian Sea (2006 – 2019)

For the Neft Dashları wave buoy, an increase in the severity of the wave events have been observed (Figure 38). The graph shows the return period and severity of wave height in meters.

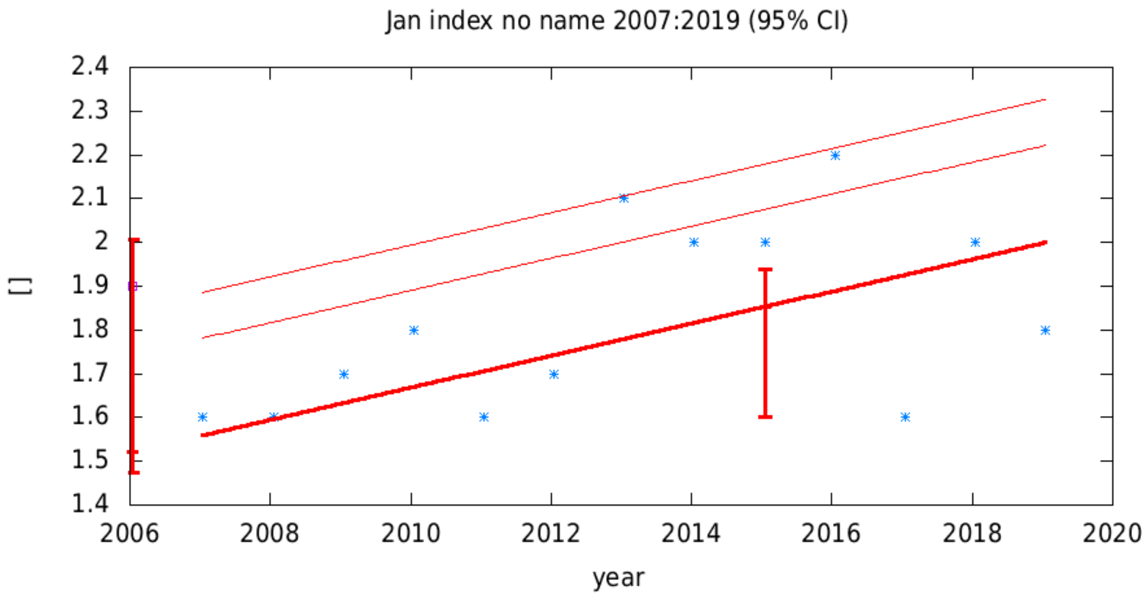

Figure 38. Return period analysis in Neft Dashları Wave buoy.

Wind data for the eight noted stations was also processed and analysed (Qobustan station isn't included because it was not recording wind data) (Figure 39).

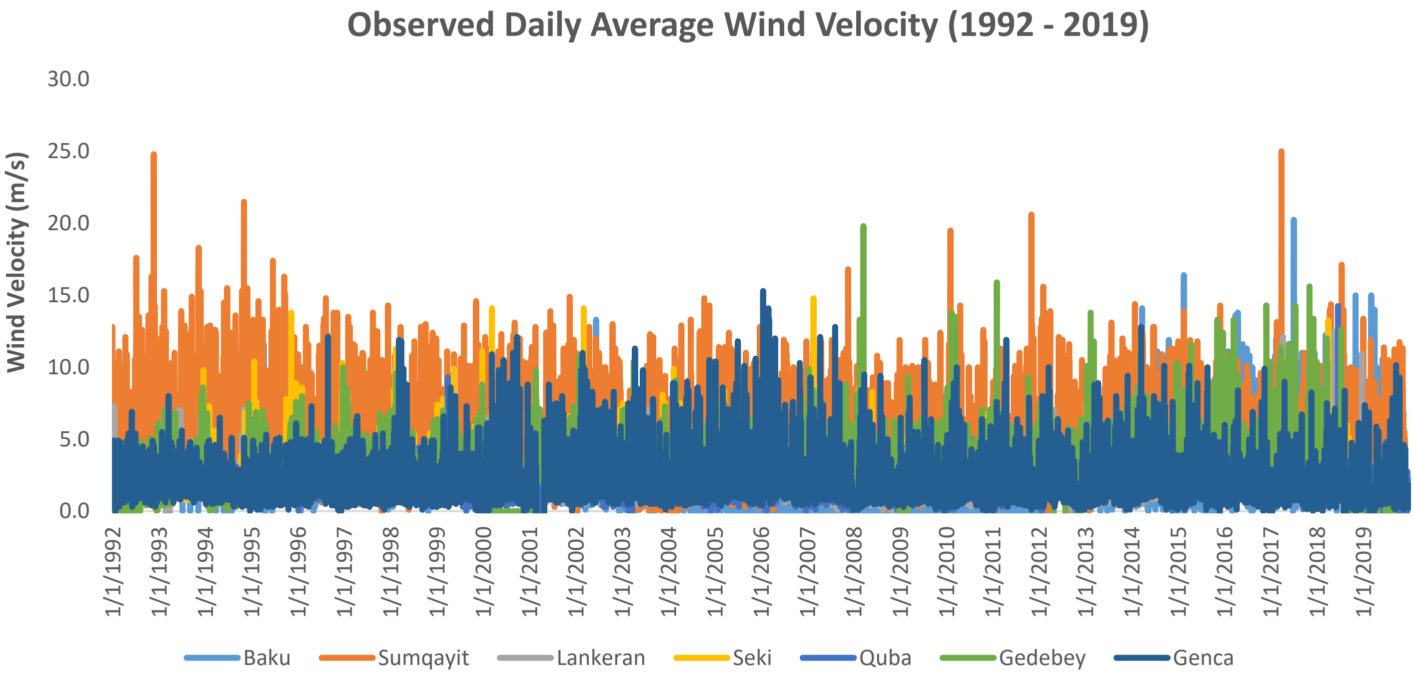

Figure 39: Observed Average Daily Wind Velocity (1992 - 2019)

Figure 40 shows both the wind recorded data during this period and the analysis of extremes. More extreme events have been recorded in the last years, with an acute increase in the maximum wind velocities, as can be observed in the figure below, where the long record of wind velocity is displayed. A significant increase it has been recorded on the last 4 years, with velocities in the excess of 35m/s.

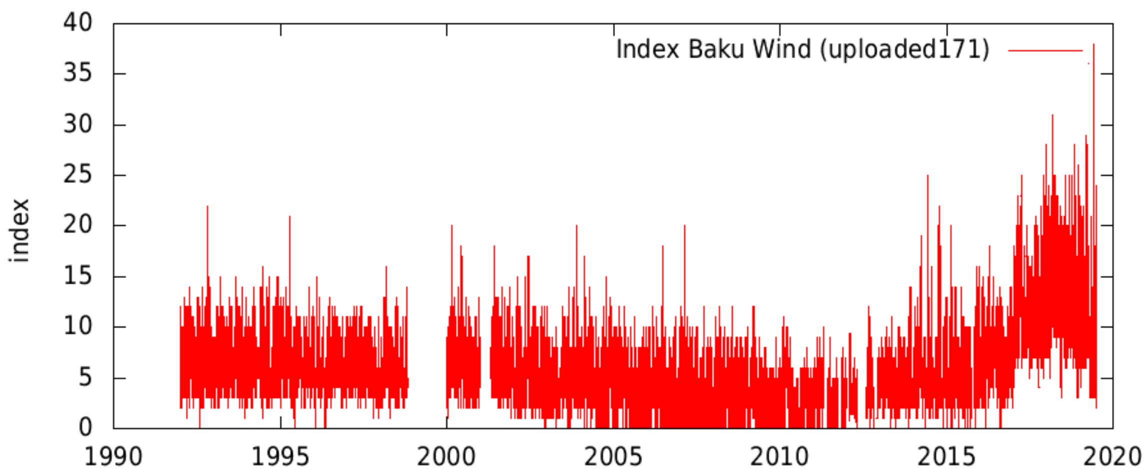

Figure 40. Wind data for Baku (in m/s)

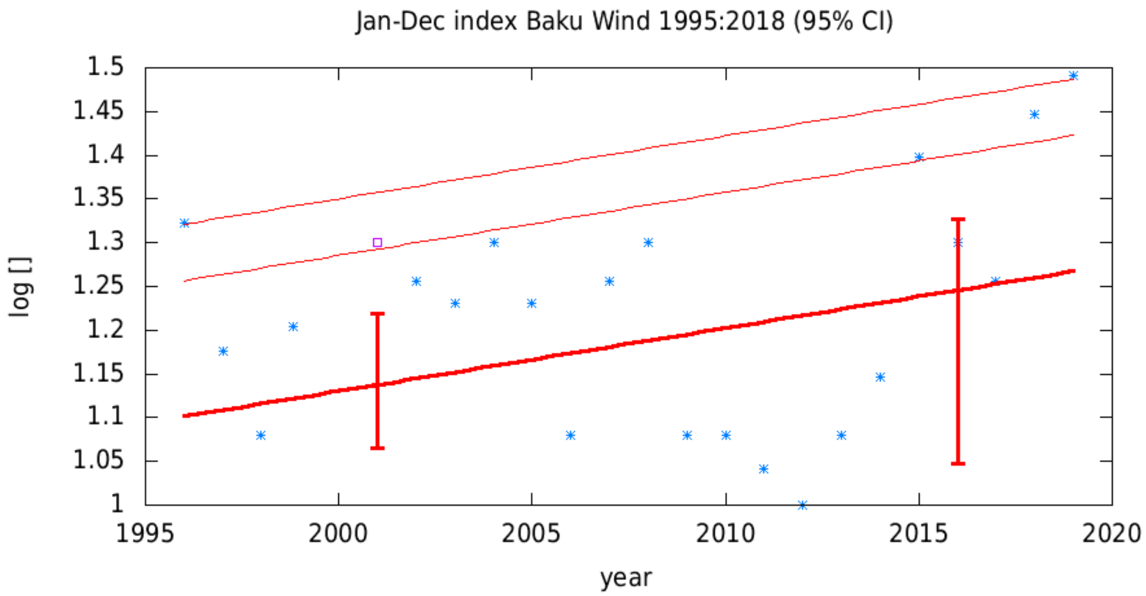

Figure 41. Return period analysis for Baku

The return period analysis in the above figure highlights that the magnitudes of extreme wind events have been increasing with a significant increase seen in the last few years.

4.1.7 *Disaster Records*

The number of dangerous hydro-meteorological events has increased worldwide, and this dynamic has also been observed in Azerbaijan. From 1900 to 2018, floods were the most frequently occurring hazard with earthquakes, drought, landslides, and extreme temperatures as the other significant hazards Figure 42.

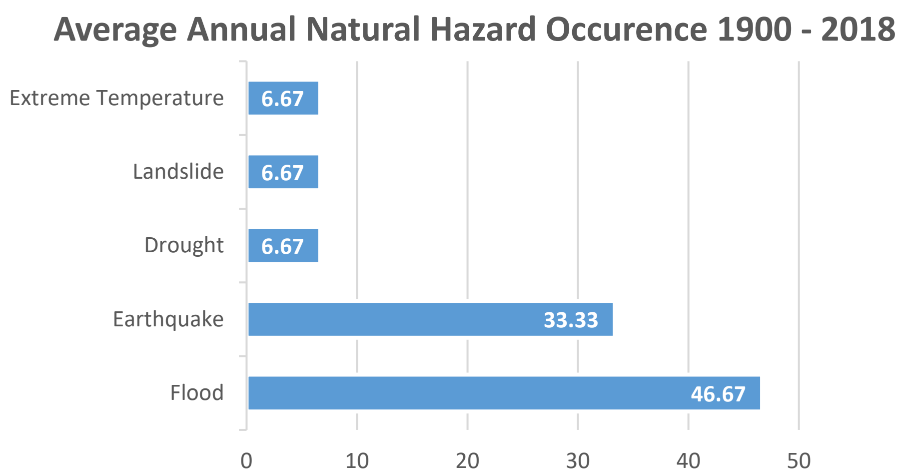

Figure 42: Average Annual Natural Hazard Occurrence (1900 - 2018)

For this project, the following type of events are explored:

- Extreme temperature
- Floods
- Droughts
- Strong Winds
- Hail
- Landslides
- Mudflows
- Air Quality
- Sea-Waves

Extreme Temperature

Extreme temperature can have significant impact on human health and in agriculture. It has been observed that the number of extreme temperature days (above 35 degrees) is increasing, and while the duration of those events was previously 1-2 days, in recent times these extreme temperature periods last up to a week, with resultant impacts on human health. At its extreme, temperatures can reach a maximum of 46 °C, and in winters can get harsh at -33 °C. [72]

Floods

Azerbaijan is one of the countries, worldwide, at a higher risk of flooding. There are flood events related to high precipitation events in the Greater and Smaller Caucasus (covering about half part of the territory of the republic), and also flood events related to high discharge events in the Kura River Basin. Nonetheless, although most flood events take place in the southern slopes of the Greater Caucasus and mountains of Nakhchivan (85-87 % of floods are caused by intense precipitation), the most damaging ones, from an economic point of view, can be the ones recorded in the Kura River.

The most significant flood in the Kura River occurred in 2010, resulting in flooding in Salyan, Neftchala, Sabirabad rayons and some parts of Shirvan city with flood damages in industrial factories, farmer plants, yards and residential areas. Other significant flood events were observed in 1967, 1969, 1976, 1979, 1982, 1989, 1997, 2002 and 2003. The increasing trend of floods observed in the rivers of the Republic during 1966-2020 is given below. As can be seen from the graph, the highest number of flood events was recorded in 2020.[73]

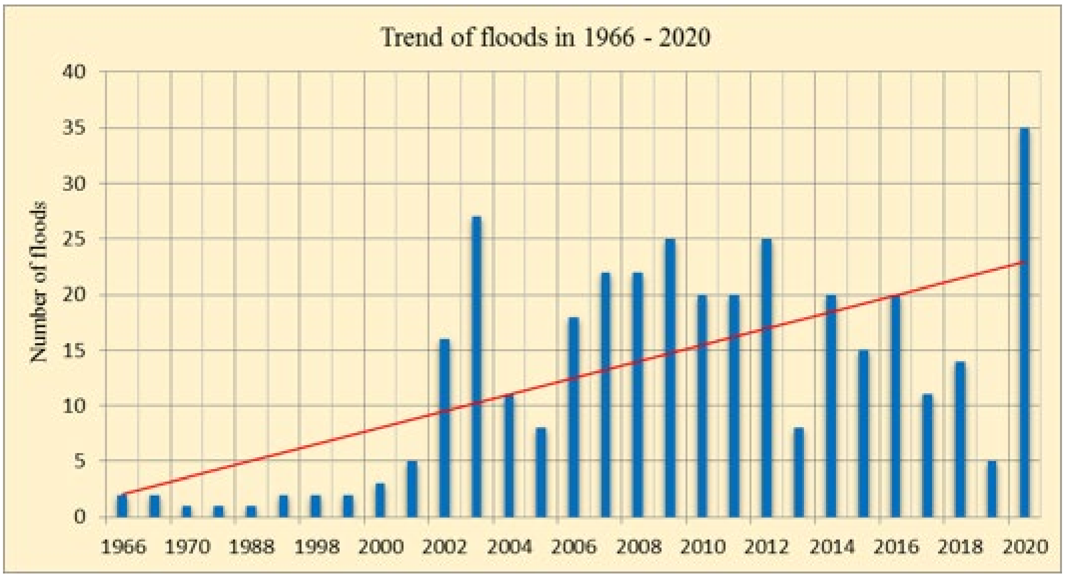

Figure 43. Trends in floods observed in the rivers of the Republic during 1966-2020

Since 1993, poor dam and watershed management has exacerbated the impacts of flooding. It is estimated that floods in the Azerbaijan affect 200,000-250,000 people on average per year.

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[72] https://unfccc.int/sites/default/files/resource/azenc3.pdf
[73] Ministry of Emergency Situations. https://www.fhn.gov.az/index.php?aze/pages/33. Last accessed 10 December 2020.

For instance, in the Kura River flood in May 2010, more than 240,000 people were affected, with tens of thousands of homes flooded or destroyed and 50,000 hectares of farmland inundated. The damage was estimated at $591 million, and a sharp decline in agricultural production in Azerbaijan was observed; more than 50,000 hectares of land were flooded, which seriously damaged grain production in the central regions of Azerbaijan (Figure 44).[74]

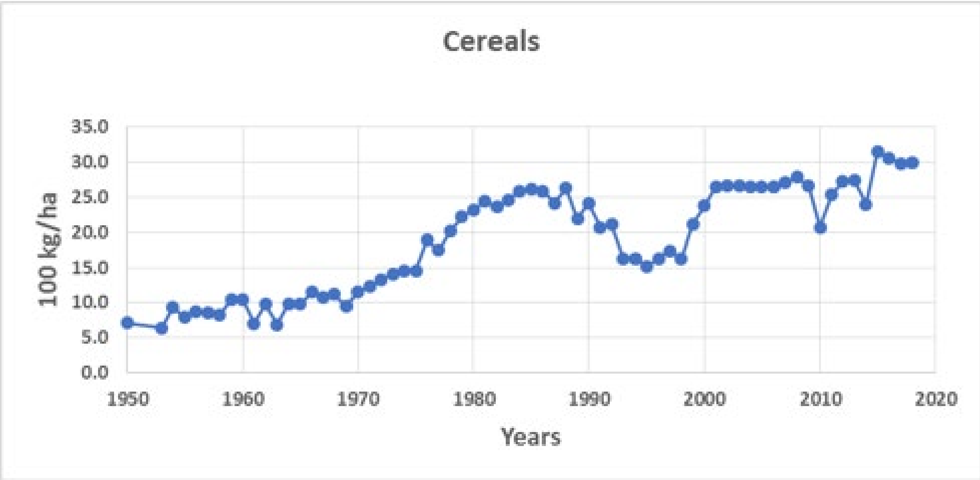

Figure 44. Cereal Production in Azerbaijan

Droughts

Drought events are common across the whole territory of Azerbaijan. Both meteorological and hydrological droughts are observed in the country, with notable effects on agricultural production.

Over the last 20 years, water shortages and droughts have become more common in the region. In the period 2008-2017, drought intensity increased up to 10%. This is mainly attributed to rising temperatures, although precipitation deficits – particularly in the Lesser Caucasus region – also play a role.[75] Due to increased extreme temperatures (as described above), many small watercourses can become dry during summer periods, precisely when intense irrigation is needed. The increased duration of dry periods causes considerable damage to local agriculture in downstream regions of Gabala, Sheki, Tovuz, and Zagatala. The 2014 drought and resulting period of water shortage was an extreme event from this point of view. Wheat and barley fields in Sheki district remained waterless for more than one month when irrigation was required. Estimated damage from 2014 droughts only in Sheki was nearly $6,500,000.[76]

The Aran Economic District is the biggest producer of meat, wheat and cotton.[77] However, there are several concerns related to land management, water supply and loss in market value. This is a result of the traditional approach in Azerbaijan that does not allow long-term and

[74] Azerbaijan National Hydrometeorological Service; Available at: www.meteo.az
[75] Republic of Azerbaijan, 2020. National Drought Plan
[76] ETSN. https://www.meteo.az/az/home
[77] Siemen Van Berkum. Market and competitiveness analysis of the Azerbaijan agricultural sector: an overview. Azerbaijan Master Plan for Agricultural development. 2018

sustained use of resources. The area cultivated with cotton has reduced from 254,000 ha in 2009 to 197,000 in 2012.[78]

Most of the territory of Azerbaijan has rather dry climate where the average amount of rainfall is not more than 300 mm/year. This pattern makes irrigation very important in the Kura-Araks plain that occupies nearly 40 % of the country's territory. Therefore, irrigation water management with advances dam development has significant economic implications in Azerbaijan.

The biggest agricultural region of Azerbaijan is the Aran Economic District which completely depends on irrigation, primarily from the Mingechaur reservoir. Water shortages in this area are a common issue faced by farmers. Other big economic districts in the Kura basin that largely depend on irrigation are Absheron, Nakhichevan, Shaki-Zaqatala and Ganja-Gazakh. All of these districts produce important agricultural goods, such as wheat, grape, cotton, fruits and vegetables.

Strong Winds

The number of strong windy days in the Absheron Peninsula, which have exceeded 25 meters for the last 30 years, is increasing; with one day in 2014, 4 days in 2017, 13 days in 2018 and 9 days in 2019. The orographic features of Azerbaijan enable west winds to become stronger along the Kura River Basin and mainly in the Caspian Sea coastline[79] (Figure 45). The strong winds in this area also have a direct impact on the severity of the sea-waves, as noted above.

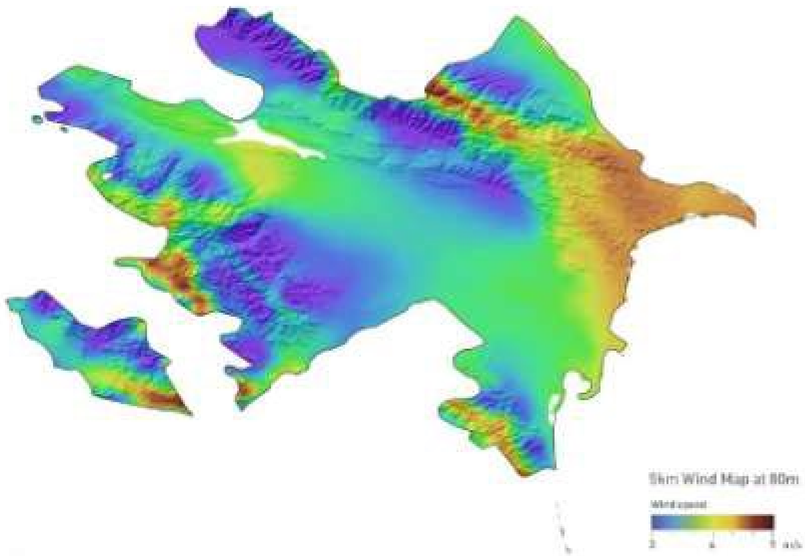

Figure 45. Azerbaijan Wind Hazard map at 80m elevation[80]

[78] ETSN. https://www.meteo.az/az/home
[79] Azerbaijan Country Report. Emin Nazarov. ADRC. 2011.
[80] Azerbaijan Country Report. Emin Nazarov. ADRC. 2011.

Hail

The intensity of hailstorms has increased 5-6 times in the last 20 years in Azerbaijan.[81] Hail is a common natural phenomenon in Azerbaijan and occurs mainly in mountainous, foothill and plain areas, resulting in a decline in grain and fruit production.

Hailstorms cause significant damage to local agriculture. Every year, hailstorm events result in damages on fruits, wheat and barley fields. Hailstorms are mainly observed in Gabala, Gakh, Zagatala, Sheki and Belokan districts. In 2015 hailstorms damaged fruit yards, wheat and barley fields in Sheki and Zagatala districts. According to the information provided by the Ministry of Agriculture, estimated damage from hailstorms in 2015 for the total region was about $15,000,000. In 2016, hailstorms in Shamakhi, Shamkir and Sheki districts damaged fruit yards, with estimated associated damages of $3,500,000.[82]

Landslides

In the subalpine meadow along the valleys of rivers, the risk to forest zones from flooding, landslides and soil erosion has increased as a result from overgrazing, forest degradation and changes in land use (for purposes of irrigation, road constructions, residential areas, etc.). As a result, the borders of high mountain meadow landscape (at 2200-2800 m) have changed and the width of forest area has decreased. Degradation of plants and productive soil layer also increase the incidence of erosions, floods and mudflow.

The situation in downstream areas of rivers in the region is even more catastrophic. The majority of plants have become like those typical of arid and semiarid areas, the process of desertification has increased, and soil salinity has raised, also as an impact of irrigation. Many landslide zones exist in Lerik, Yardimli (south-east) and the Absheron peninsula.[83]

El Niño-Southern Oscillation

El Niño-Southern Oscillation (ENSO) is the most prominent mode of inter-annual climate variability on Earth. It results from large-scale coupled ocean-atmospheric interactions in the tropical Pacific and alternates between anomalously warm (El Niño) and cold (La Niña) sea surface temperature (SST) conditions.[84] ENSO exerts significant influence on the weather and climate of extratropical regions of the world; the manifestations of which are heterogeneous from region to region. The mechanism of El Niño impact on hydrometeorological conditions in the European region is still being determined.[85] The IPCC AR6 reported that there is "*low confidence* in projected changes in ENSO variability in the 21st century due to a strong component of internal variability".[86] As such, potential changes in ENSO due to global warming

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[81] Azerbaijan National Hydrometeorological Service; Available at: www.meteo.az
[82] World Bank. Climate Change and Agriculture Country Note. (2012) Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/21832/954070WP0Azerb00B0x391416B00PUBLIC0.pdf?sequence=1&isAllowed=y
[83] AZERNEWS, 2017. Landslides intensity in Azerbaijan. Available at: https://www.azernews.az/nation/120714.html
[84] Yeh, S-W *et al.*, 2018. Reviews of Geophysics. ENSO Atmospheric Teleconnections and Their Response to Greenhouse Gas Forcing
[85] Vyshkvarkova, E. and Sukhonos, O., 2020. Earth and Environmental Sciences. Changes in climatic extremes of the south of Russia associated with El Niño events
[86] IPCC, 2021. Climate Change 2021: The Physical Science Basis

and the impact on future climate change in Azerbaijan are not considered further in this climate analysis.

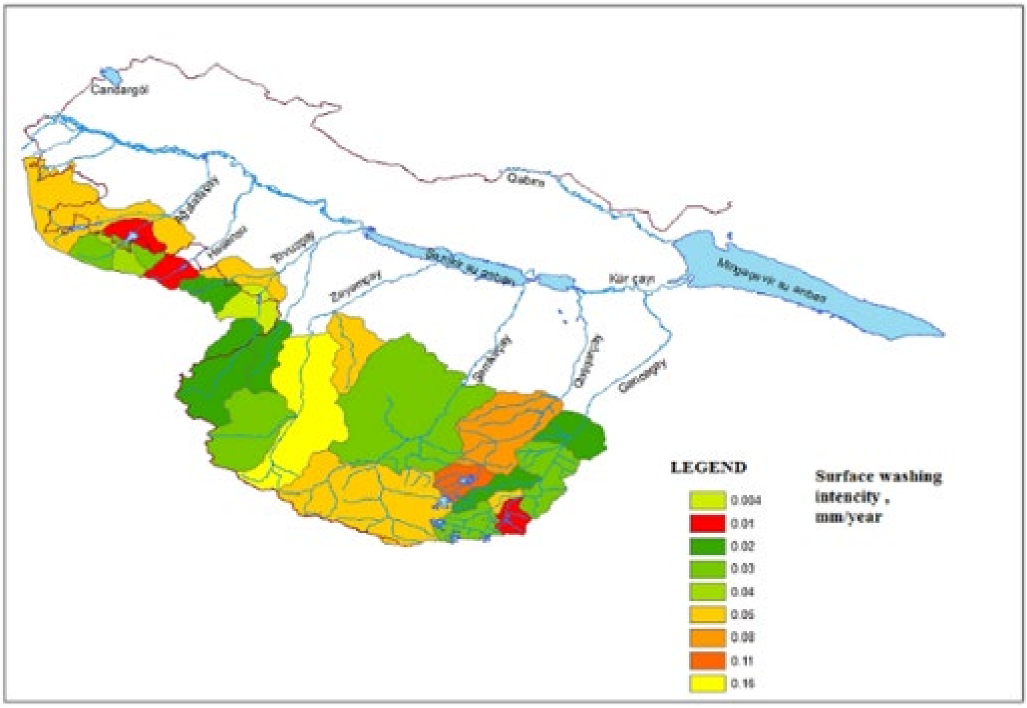

Figure 46: Surface washout intensity in Ganja -Gazakh region

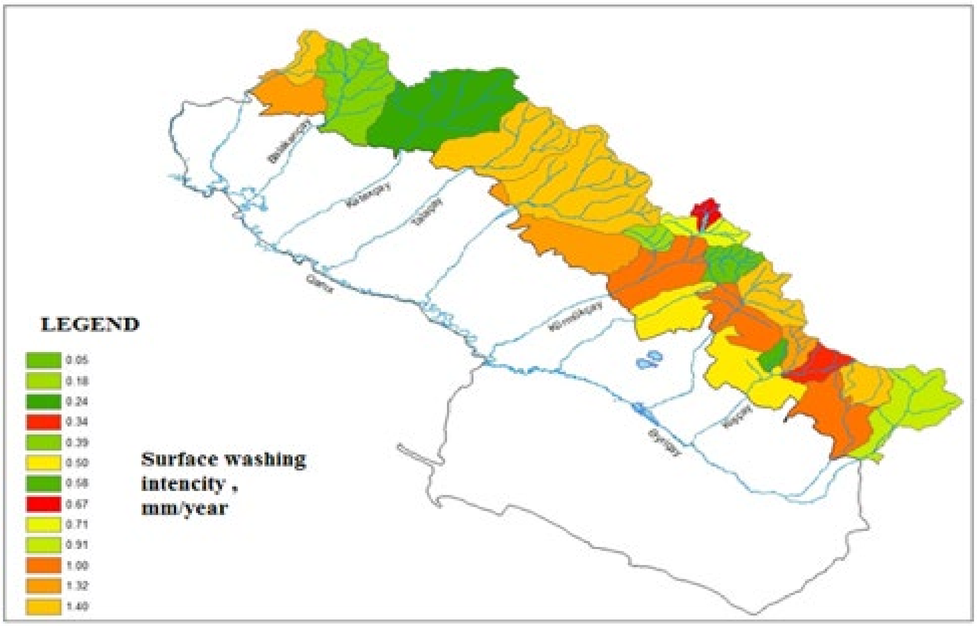

Figure 47:Surface area washout intensity in Sheki Zagatala region

In general, deterioration of physical characteristics of soils, rarefying and loss of the vegetation at considerable areas will reduce resistance of the topsoil to erosion processes, and expected summer precipitation as rain falls will considerably aggravate these processes, which will result in the increased areas of eroded lands (by 10-15%).[87]

Scientific research has revealed that the number of areas that are prone to landslides in Azerbaijan has increased by four times in the past 24 years. Many landslide zones exist in Lerik, Yardimli and in the Absheron peninsula.[88]

For example, as noted above, in March 2000, a major landslide involving an area of 15ha occurred in the Bayil zone of the Sabayil district, south of Baku city centre. Analysis of the landslide mechanism and its causes revealed that it was a single compound slide with one slip surface, which was triggered by intense rainfall.

Mudflows

Due to the nature of flood events in Azerbaijan, the records of floods do consider mudflows, especially when flash-floods in the Greater and Lesser Caucasus is considered.

For example, in the Kura Upstream area of the Mingachevir river basin Significant increase in the number of floods and landslides has been observed in recent years. This has to do with the increase of human activity and the impact of climate change, with overgrazing, land cultivation, recreational areas, etc. In high mountain areas, these processes are less affected by human activity than in downstream areas. Although there are human impacts on plants and land cover in alpine meadow areas (in the watershed of Murovdag and Shahdag massives, which are sources of Shamkirchay, Ganjachay and Kurakchay rivers), the ecosystem is still able to self-restore to its original state.[89]

Flooding occurs in the spring – due to snowmelt in the basin and heavy rains, and often in the autumn – during heavy rainfall. Mudflow in the region is divided into turbulent and structured. In turbulent mudflow, sediments transported are less than in structured mudflow. Structured mudflow settles sediments in areas surrounding rivers and river cones and so becomes more powerful. In addition to rainfall, river slope and type of dry material in the basin also play important role in the formation of mudflow.

Air Quality

Air quality in Azerbaijan is a major source of public health concern.[90] Based on World Health Organization (WHO) guidelines, air quality in the country is considered moderately unsafe. Recent data indicates that the country's annual mean concentration of $PM_{2.5}$ is 20 micrograms/m^3 (μg/m^3), which is above the WHO recommended maximum of 10 μg/m^3.[91] The cities of Baku and Sumqayit have consistently high levels of air pollution. In 2008, it was estimated that ambient air pollution resulted in 3,800 premature deaths annually.[92] The

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[87] Azerbaijan First National Communication on Climate Changehttps://unfccc.int/sites/default/files/resource/Azerbaijan%20INC.pdf
[88] https://www.azernews.az/nation/120714.html. Last accessed 10 December 2020
[89] Kura Upstream of Mingachevir river basin RBMP Chapter 1: Description of the river basin characteristics. www.euwipluseast.eu
[90] WHO. Highlights on Health in Azerbaijan. Last Accessed 10 December 2020.
[91] IAMAT. Azerbaijan General Health Risks. Last Accessed 10 December 2020.
[92] UNEP. Azerbaijan Air Quality Overview. Last Accessed 10 December 2020.

increase in average temperatures in Azerbaijan as a result of climate change is expected to further reduce air quality and further aggravate cardiovascular and respiratory diseases.[93]

Ambient air quality in Azerbaijan is regulated through the Law of the Azerbaijan Republic on Protection of Ambient Air, which was adopted in 2001.[94] However, air quality standards for pollutants such as particulate matter, SO_2 and NO_2, among others, were established when the country was part of the Soviet Union and have not been fully updated since independence.

4.2 Climate projections

4.2.1 *Temperature and Precipitation*

Under a high emissions scenario (RCP 8.5) Azerbaijan is expected to see an increase in monthly temperatures (over the observed norm 1986 – 2005) of 0.95 – 1.75 °C in 2020 – 2039, 1.72 – 3.07 °C in 2040-2059, 2.75 – 4.54 °C in 2060 – 2079, and 3.64 – 5.80 °C in 2080 – 2099 (Table 11). [95]

Table 11: Median Ensemble Projections for Temperature Change under Different Emissions Scenarios (2020 - 2099)

Projected Temperature Change °C (RCP 4.5)				
Month	**2020-2039**	**2040-2059**	**2060-2079**	**2080-2099**
Jan	0.74	1.34	1.57	1.73
Feb	1.08	1.60	1.67	1.94
Mar	1.04	1.67	1.94	2.12
Apr	0.93	1.43	1.92	2.10
May	0.85	1.66	2.06	2.16
Jun	1.47	1.85	2.25	2.30
Jul	1.40	2.26	2.46	3.03
Aug	1.40	2.06	2.63	3.08
Sep	1.30	2.35	2.52	2.77
Oct	1.10	1.93	2.73	2.31
Nov	1.00	1.31	1.93	1.86
Dec	0.93	1.34	1.81	1.70
Projected Temperature Change °C (RCP 6.0)				
Month	**2020-2039**	**2040-2059**	**2060-2079**	**2080-2099**
Jan	0.85	1.24	1.54	2.15
Feb	0.93	1.36	2.05	2.41
Mar	0.69	1.35	2.03	2.76
Apr	0.95	1.69	1.94	2.65
May	0.84	1.58	2.15	2.76
Jun	1.25	1.74	2.27	3.35
Jul	1.39	1.92	2.39	3.47

[93] USAID. Climate Change Risk Profile – Azerbaijan. Last Accessed 29 December 2020.
[94] EU/MWH. Air Quality Governance in the ENPI East Countries National Pilot Project – Azerbaijan. Last Accessed 10 December 2020.
[95] Data pulled from World Bank Climate Change Knowledge Data Platform; Available at: https://climateknowledgeportal.worldbank.org/country/azerbaijan

Aug	1.41	1.97	2.95	3.41
Sep	1.35	1.78	2.52	3.42
Oct	1.10	1.59	2.42	2.97
Nov	0.66	1.39	1.74	2.47
Dec	0.77	1.13	1.94	0.00
Projected Temperature Change °C (RCP 8.5)				
Month	**2020-2039**	**2040-2059**	**2060-2079**	**2080-2099**
Jan	0.95	1.72	2.75	3.64
Feb	0.99	1.82	2.99	3.58
Mar	1.17	2.09	2.66	4.07
Apr	0.89	1.62	2.96	3.67
May	1.10	2.17	3.27	4.16
Jun	1.36	2.74	3.77	5.19
Jul	1.59	2.91	4.43	5.72
Aug	1.75	3.07	4.54	5.80
Sep	1.66	2.96	4.06	5.10
Oct	1.30	2.43	3.36	4.33
Nov	1.15	1.94	2.70	3.86
Dec	1.27	1.79	2.76	3.69

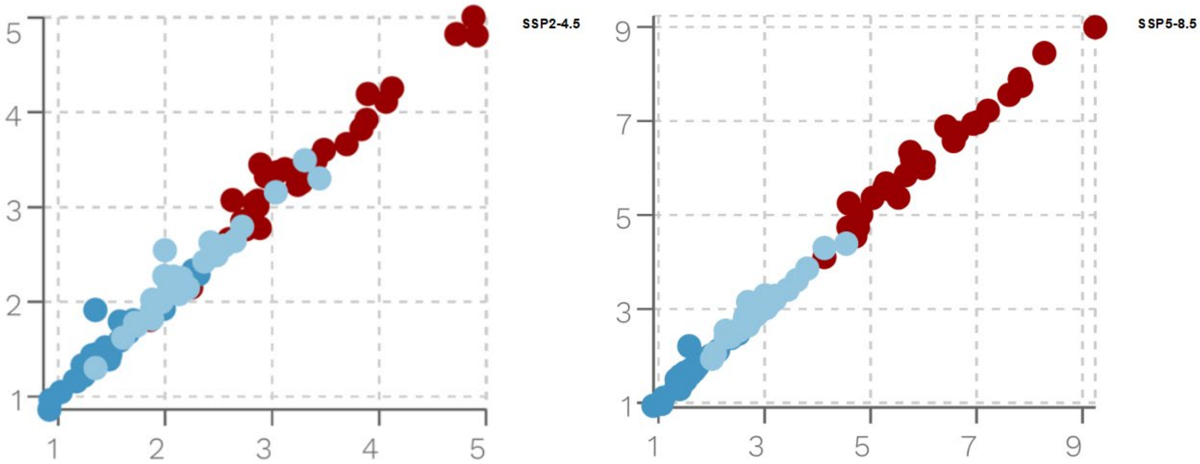


Figure 48. Projected change in mean temperature (°C) (x-axis) and maximum temperature (°C) (y-axis) in the near term (2021-2040 – dark blue), medium term (2041-2060 – light blue) and long term (2081-2100 – red) under SSP-2-4.5 (left) and SSP5-8.5 (right) relative

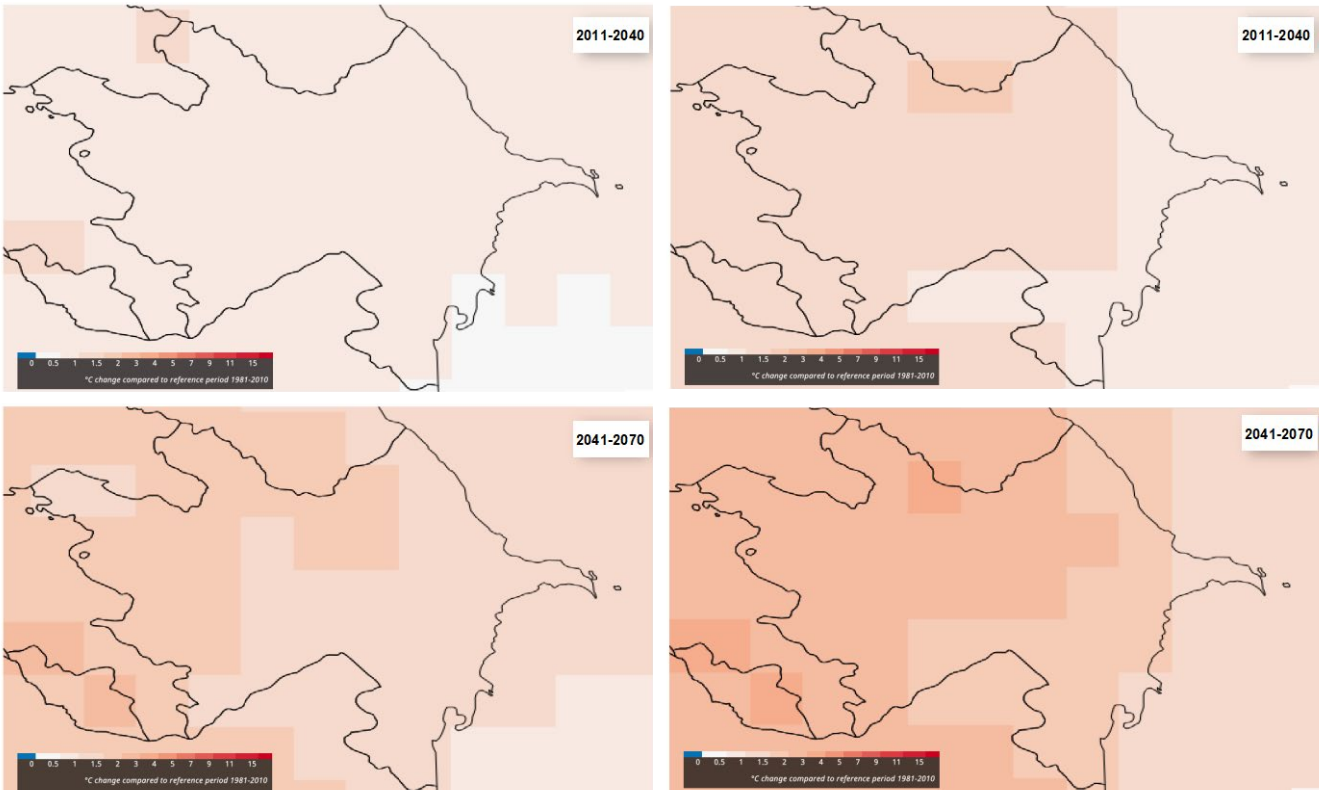


Figure 49. Projected change in annual mean temperature (°C) in the periods 2011-2040 and 2041-2070 under RCP4.5 (left) and RCP8.5 (right) relative to the reference period 1981-2010. Model: CORDEX Middle East North Africa; Bias adjusted. (Source: ClimateInformation.org, 2022)

Projected increases in average temperature are more pronounced during the summer months. The median number of summer days (days with temperatures above 25 °C) is projected to increase from 95 to 151 days per year by the end of the century, under RCP8.5. Climate model projections suggest that the western regions of Azerbaijan will experience a greater increase in annual temperatures, compared with the eastern coastal areas located by the Caspian Sea, including the capital Baku.[96]Precipitation is also likely to be significantly impacted by climate change with rainfall becoming more variable with extended drier seasons and increased heavier precipitation months. The months of June – August, where there are already precipitation shortfalls, are likely to experience a particularly big decline (Table 12). Sub-daily extreme rainfall is expected to increase as temperatures increase, with more intense heavy rainfall events likely to be experienced in the central and northern areas.[97] In terms of daily extremes, annual maximum 1-day precipitation is projected to increase by 6.2% and 6.0% in the near-term, and by 13.4% and 24.8% by 2100 under the SSP2-4.5 and SSP5-8.5 scenarios respectively.[98]

[96] The World Bank Group and Asian Development Bank, 2021. Climate Risk Country Profile: Azerbaijan
[97] The World Bank Group and Asian Development Bank, 2021. Climate Risk Country Profile: Azerbaijan
[98] IPCC, 2023. IPCC WGI Interactive Atlas: Regional Information. Available at: https://interactive-atlas.ipcc.ch/

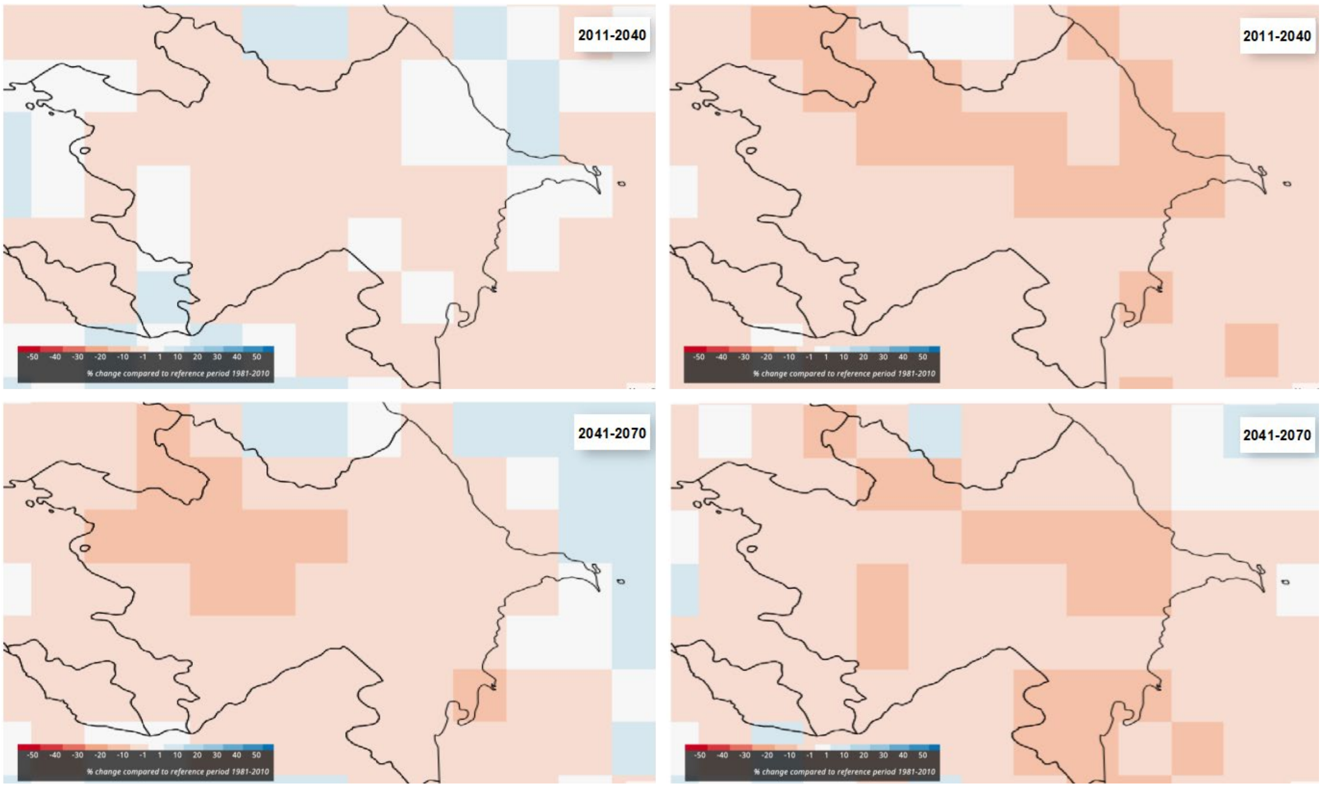


Figure 50. Projected change in annual mean precipitation (%) in the periods 2011-2040 and 2041-2070 under RCP4.5 (left) and RCP8.5 (right) relative to the reference period 1981-2010. Model: CORDEX Middle East North Africa; Bias adjusted. (Source: ClimateInformation.org, 2022)

Table 12: Median Ensemble Projections for Precipitation Change under Different Emissions Scenarios (2020 - 2099)

Projected Precipitation Change mm (RCP 4.5)				
Month	**2020-2039**	**2040-2059**	**2060-2079**	**2080-2099**
Jan	2.65	2.41	2.73	0.30
Feb	1.28	1.62	2.25	3.53
Mar	5.05	4.70	2.72	3.62
Apr	-0.20	0.87	-2.83	-1.35
May	-0.16	-0.08	-2.92	-3.35
Jun	-4.94	-8.97	-7.38	-7.44
Jul	-1.38	-2.47	-1.67	-2.82
Aug	0.65	-1.34	-1.97	-1.77
Sep	-0.01	-3.88	-2.25	-2.63
Oct	0.15	-2.75	-1.70	-0.79
Nov	1.26	3.11	2.85	4.08
Dec	1.58	2.62	4.82	3.61
Projected Precipitation Change mm (RCP 6.0)				
Month	**2020-2039**	**2040-2059**	**2060-2079**	**2080-2099**
Jan	0.22	-0.63	1.75	4.38
Feb	0.87	-0.36	-0.53	2.86
Mar	5.85	1.57	6.68	4.18
Apr	1.63	-1.35	-1.04	-0.73

May	0.78	-1.88	0.38	-3.38
Jun	-4.36	-6.09	-4.75	-10.06
Jul	-1.39	-1.19	-1.73	-2.39
Aug	-1.08	-0.47	-1.95	-3.38
Sep	-0.42	-0.13	-3.12	-4.87
Oct	1.25	1.02	0.40	-1.36
Nov	2.94	1.29	1.50	2.47
Dec	1.07	1.16	2.30	1.84
Projected Precipitation Change mm (RCP 8.5)				
Month	**2020-2039**	**2040-2059**	**2060-2079**	**2080-2099**
Jan	0.71	2.06	1.80	3.07
Feb	1.27	0.79	2.31	-0.49
Mar	4.18	4.34	7.42	1.51
Apr	-1.01	3.12	-3.40	-5.52
May	1.61	0.87	-3.93	-10.74
Jun	-3.83	-6.20	-12.11	-11.87
Jul	-1.45	-2.87	-4.36	-5.29
Aug	0.08	-2.64	-3.75	-1.97
Sep	-0.55	-7.10	-6.98	-7.14
Oct	0.28	0.03	-0.87	-0.14
Nov	0.80	2.94	7.38	4.02
Dec	1.47	4.26	0.83	3.12

Downscaling of the temperature and precipitation projections can be seen below. The climate change projection data for the downscaling has been obtained from the Central Asia Coordinated Regional Downscaling Experiment (CORDEX), which is a CMIP6 regional climate downscaling. The CORDEX Central Asia downscaled products cover the whole territory of Azerbaijan and it has been assessed that the products can provide the most accurate downscaling available, with grid sizes of 25 km in the area of interest. The climate change data for Azerbaijan for both precipitation and temperature across a variety of scenarios are presented below.

The figures below show the RCP4.5 and the RCP8.5 scenarios with the highest horizontal resolution available. The spatial projections for the 2090s have been compared for both RCPs for the daily maximum temperature, the daily minimum temperature and the daily precipitation.

The results for the RCP4.5 for the minimum temperature shows a slight increase in the minimum temperatures in the east side of the country (1-2 degrees), and a higher increase in the west, and north, in the Greater and Lesser Caucasus areas, with values around 2 and 3 degrees.

The projections show an increase in the maximum temperature around the country, with the highest increase in the west, but with values over 3 degrees in all cases. The mean daily precipitation does not show a significant variation.

The RCP8.5 values show a similar trend to the RCP4.5, with higher increase in the minimum temperature, and more widespread around the country, with values over 4 degrees in the West and 3 degrees in the East. The maximum temperature is higher in the Lesser Caucasus in this case, with values over 5 degrees. The mean daily precipitation showed a slight increase country-wide. Additional spatial plots for precipitation and temperature can be seen in Appendix C.

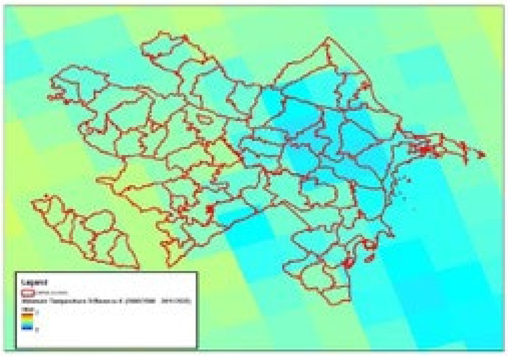
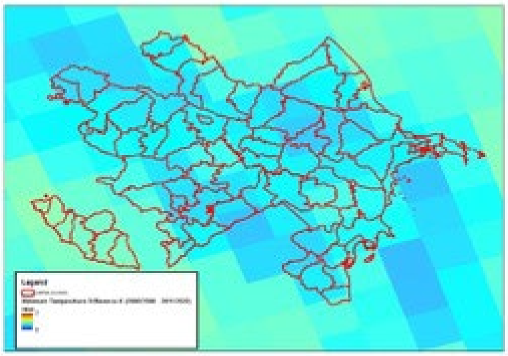
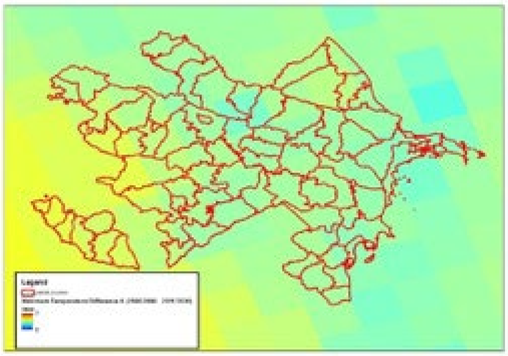
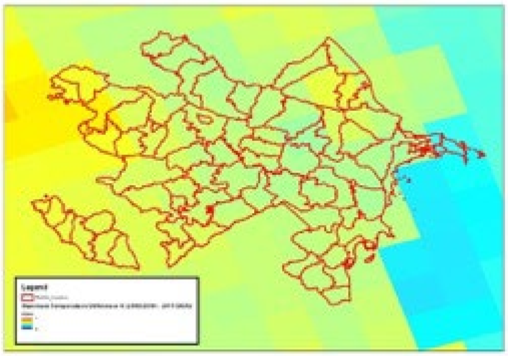
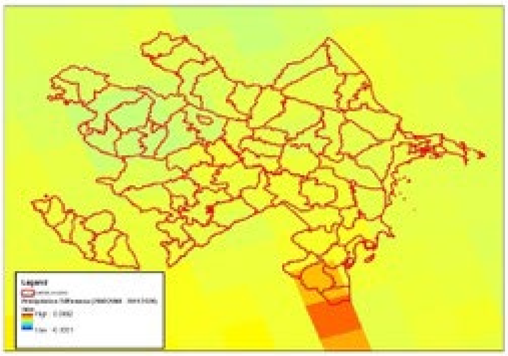
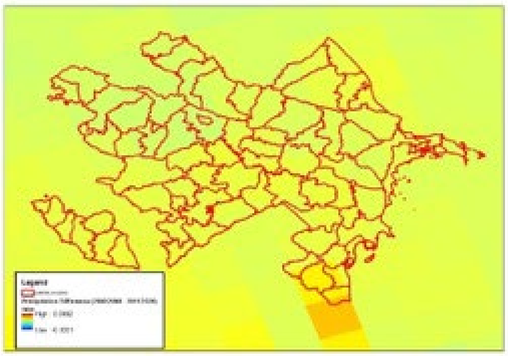
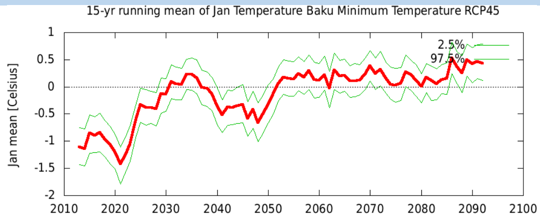
RCP 4.5	**RCP 8.5**
	
Average Minimum Temperature January (2090-2099)	Average Minimum Temperature January (2090-2099)
	
Average Maximum Temperature July (2090-2099)	Average Maximum Temperature July (2090-2099)
	
Average Precipitation (2090-2099)	Average Precipitation (2090-2099)

Figure 51. Average spatial RCP4.5 and RCP 8.5 differences between projections for the 2090-2099 and 2011-2020.

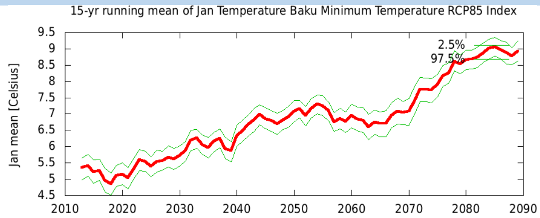
A comparison of data from the projection models and the observations has been used in order to provide a better understanding of the results. The plots below show information for these variables for selected stations.

The mean yearly values for Baku are presented in the Figure 52 for the two scenarios for maximum, minimum and mean precipitation. Baku is presented here because it is where most of the Azerbaijani population resides. An increase in minimum temperature can be observed for both the RCP4.5 (0.5 ºC by 2050 and 1.5 ºC by 2090) and the RCP8.5 scenario (2 ºC by 2050 and 4 ºC by 2090) and in the maximum temperature (1.5 ºC by 2050 for the RCP4.5, 1.5 ºC by 2050 for the RCP8.5 and 3 ºC (RCP4.5) and 4 °C (RCP8.5) by 2090). The precipitation is not expected to change much in Baku.

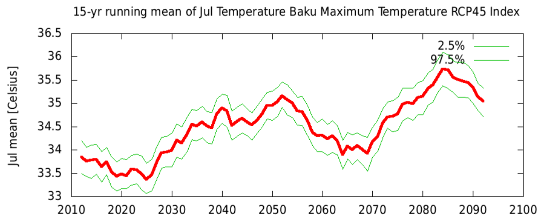
RCP 4.5	RCP 8.5



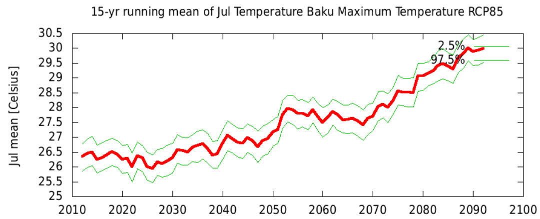
Baku Minimum Temperature RCP4.5



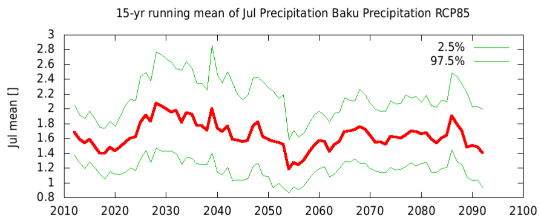
Baku Minimum Temperature RCP8.5



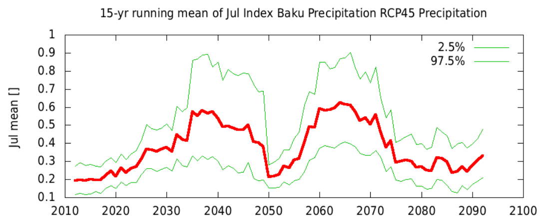
Baku Maximum Temperature RCP4.5



Baku Maximum Temperature RCP8.5



Precipitation in Baku RCP4.5



Precipitation in Baku RCP8.5

Figure 52. 15 years sliding average for RCP4.5 and RCP 85 projections for the 2010-2099 in Baku.

The annual maximum temperature per station for both scenarios have been assessed for all of the stations. Overall, the maximum temperatures are predicted to increase in all 8 stations in Azerbaijan for the RCP4.5, with values ranging from 1.5 to 2 ºC in all of the cases.

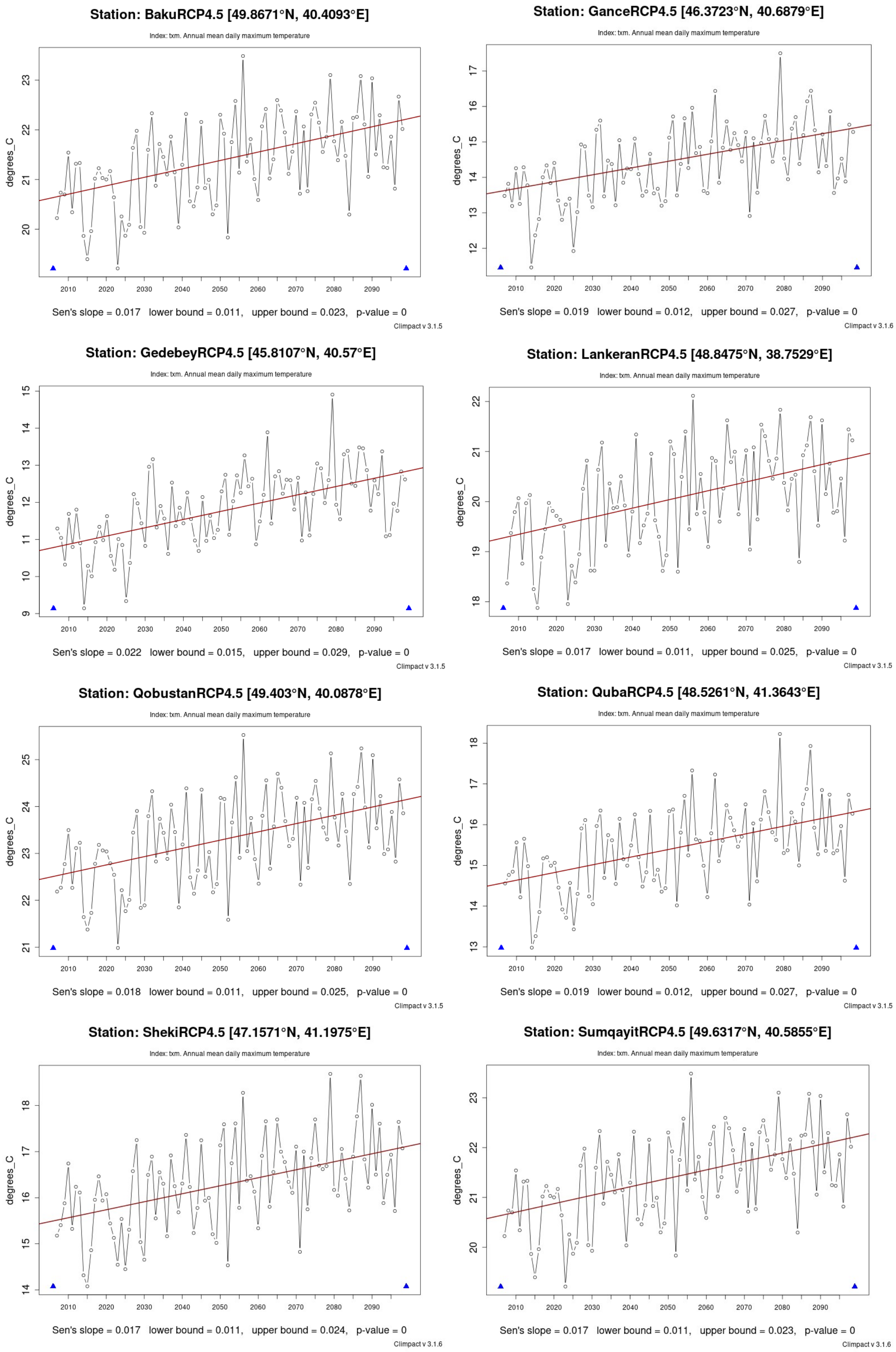
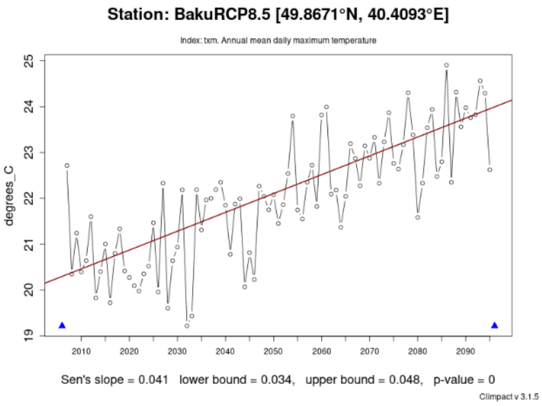
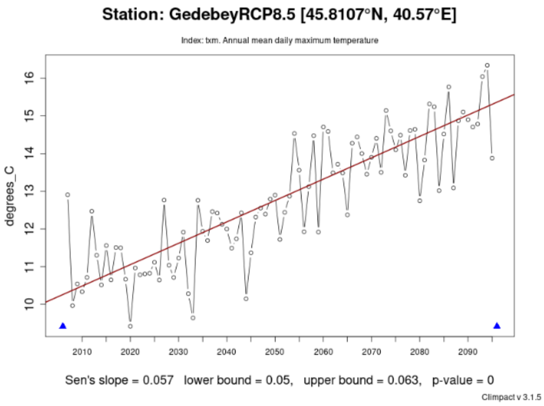
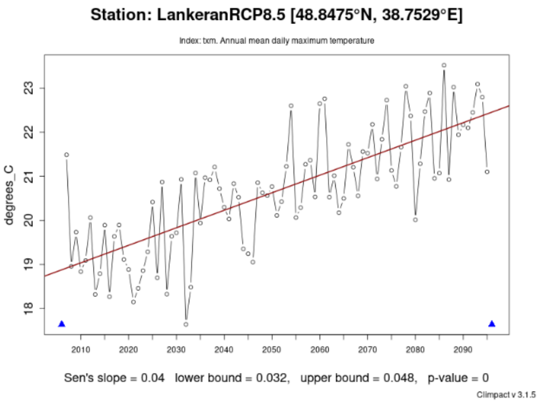


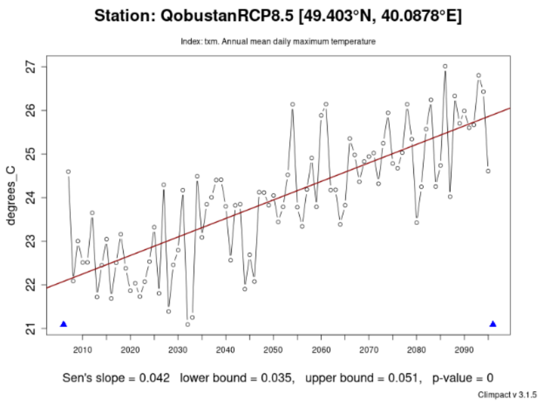
Figure 53. Annual Maximum Temperature for RCP4.5 (2006-2099)

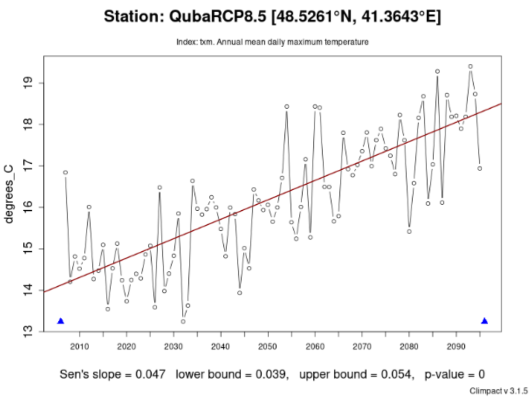
The maximum annual temperature in the RCP8.5 shows a higher increase in all of the locations, with values over 3 ºC in Lankeran, over 4 ºC in Baku, Gance, Qobustan, Quba, Sheki and Sumqayit, and over 5 degrees in Gedebey. As with the observed data, the highest increase is predicted in the Lesser Caucasus area.

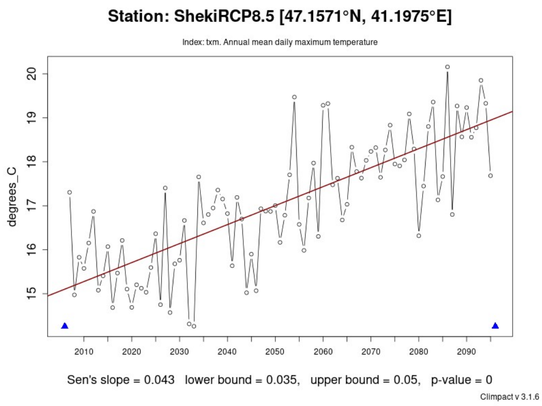












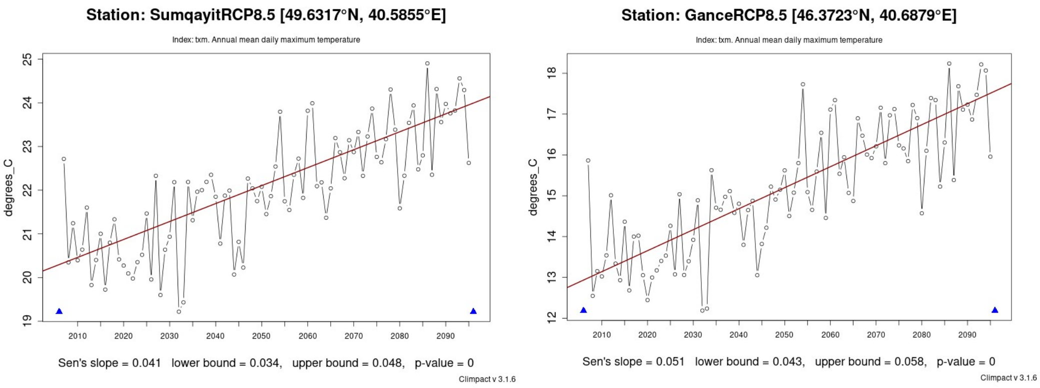
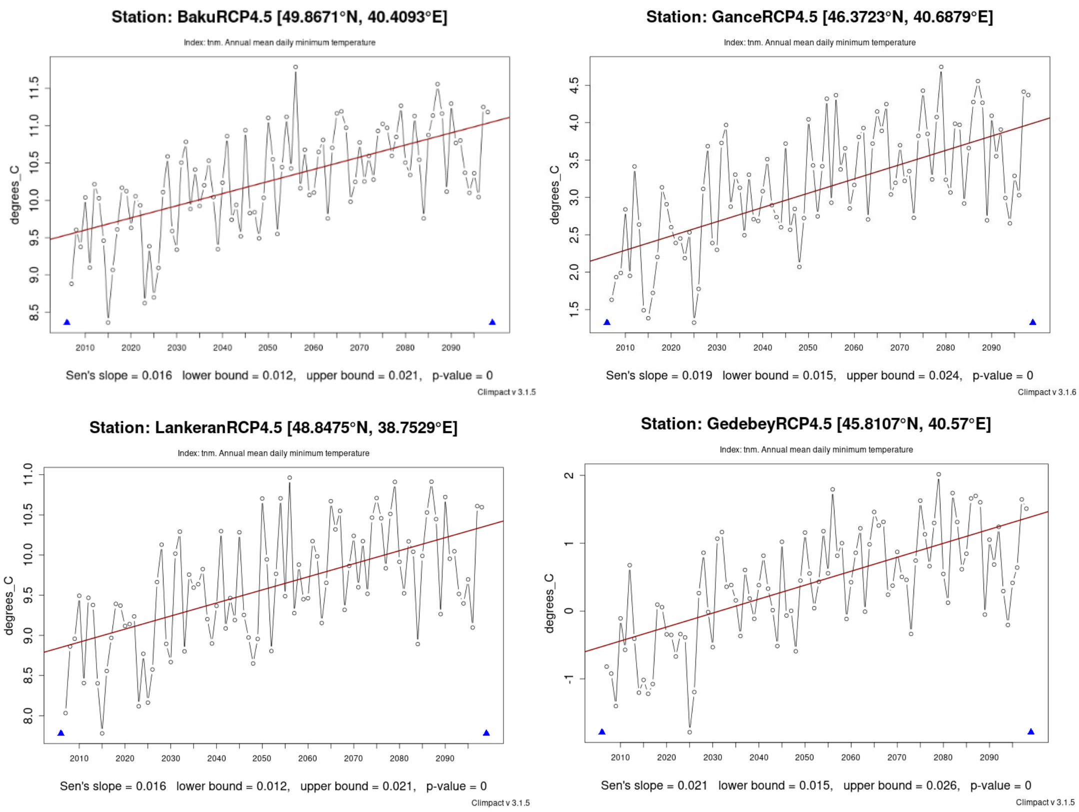


Figure 54. Annual Maximum Temperature for RCP8.5 (2006-2096)

The annual minimum temperature for the 8 station locations have been assessed too, and in this case, the increase for the RCP4.5 for all of the stations is around 1.5 ºC but in the Qobustan station, south of Baku, the increase is closer to 2 ºC.



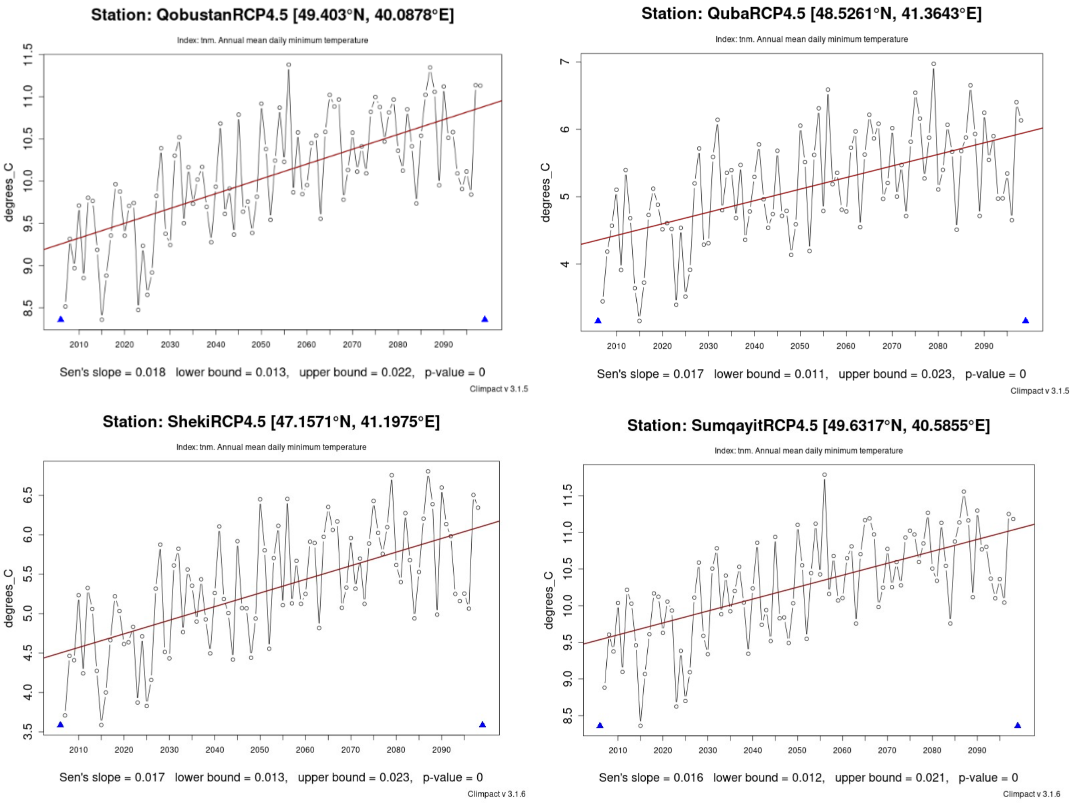


Figure 55. Annual Minimum Temperature for RCP4.5 (2006-2099)

The annual minimum temperature for RCP8.5 shows an increase of around 4 degrees in all of the stations. The increase in the minimum temperature by the 2050 is around 2 degrees in all of the locations assessed.

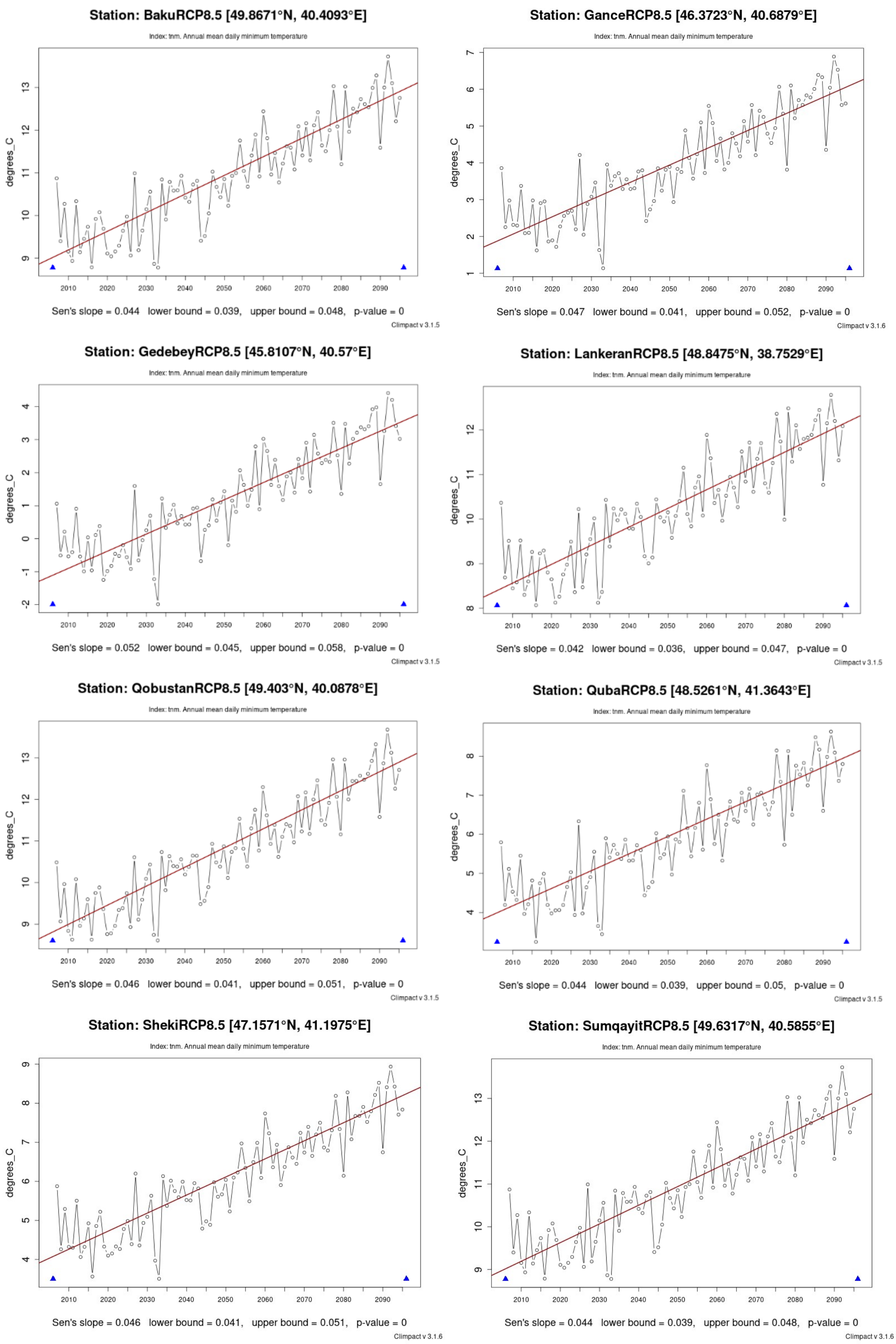


Figure 56. Annual Minimum Temperature for RCP8.5 (2006-2096)

Heatwave data, through the EHF, has also been assessed and the frequency of heatwave events is shown in the figures below. The frequency of heatwave events increases with both projections, showing an increase to more than 10 days by the end of the century in all of the stations for the RCP4.5, with the highest values of more than 40 days projected for Sheki and Qobustan around 2085-90.

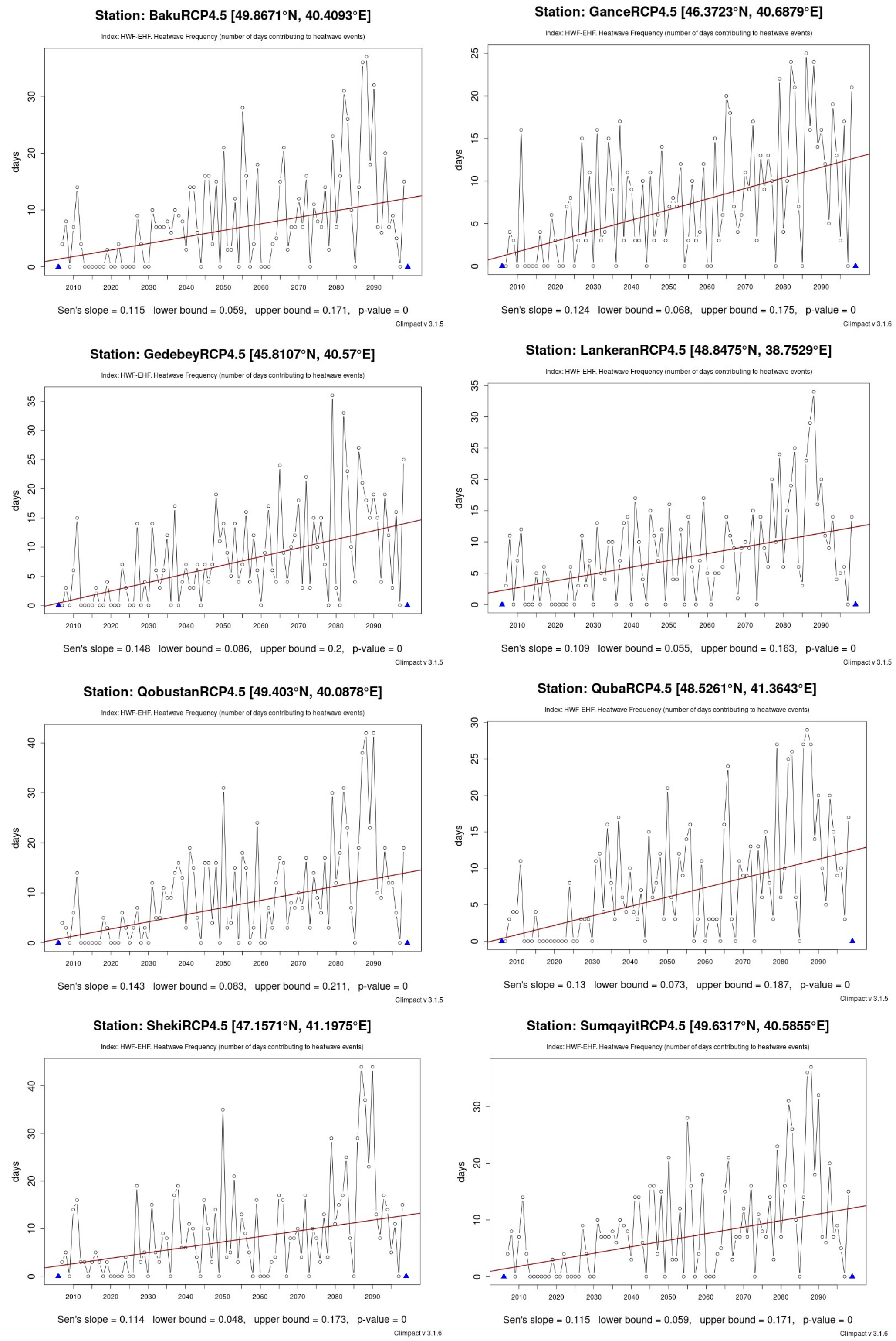


Figure 57. Heatwave Frequency for RCP4.5

The increase in the frequency of heatwaves for the RCP8.5 is significantly higher, with the maximum of 50 days increase in Baku, Gedebey, and Sumqayit; 45 days in Genca, Qobustan, Quba and Sheki; and 30 days in Lankeran.

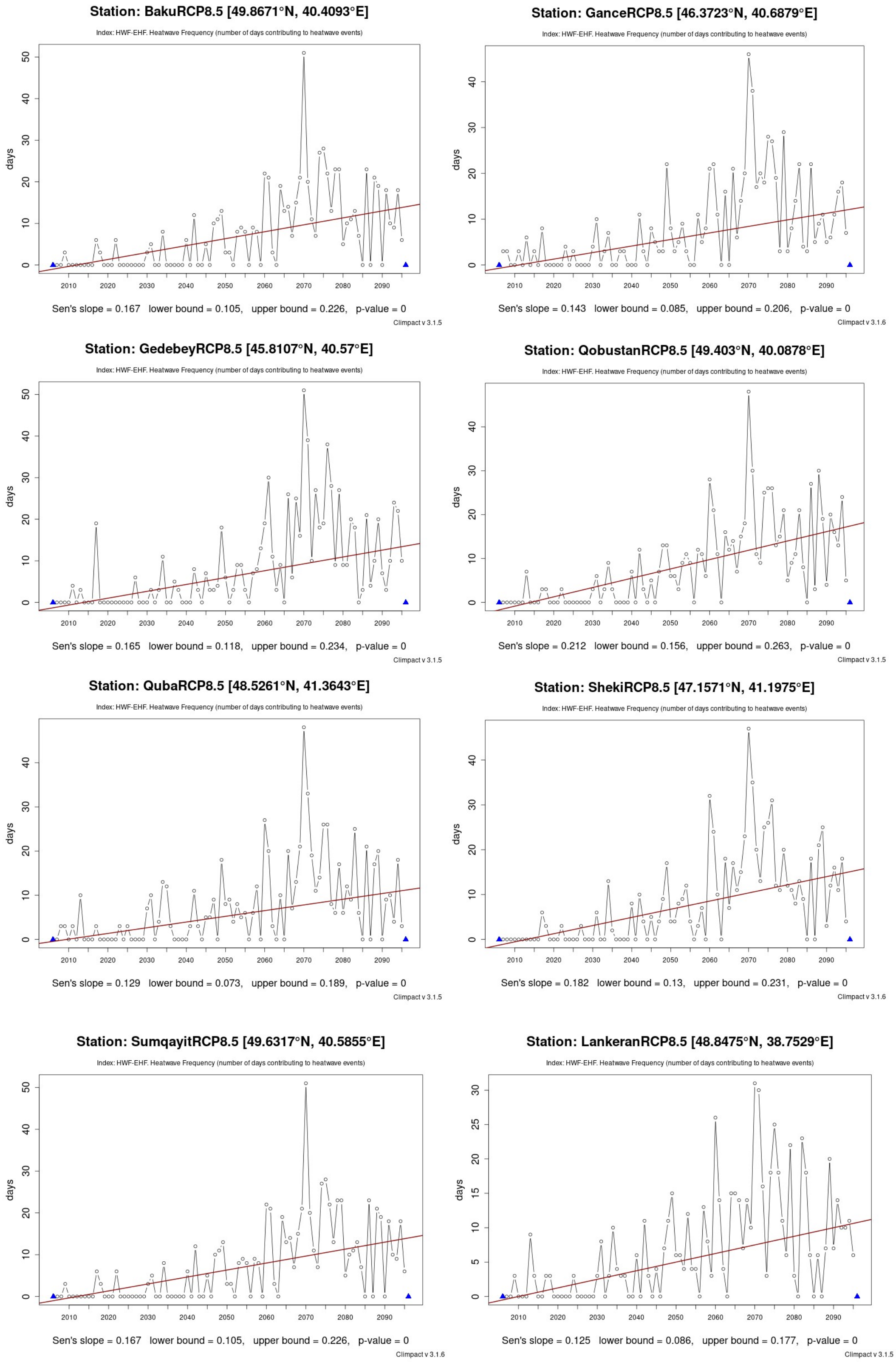


Figure 58. Heatwave Frequency for RCP8.5

The number of consecutive dry days has also been assessed. The RCP4.5 projections in the 8 locations do not show a significant variation in this parameter.

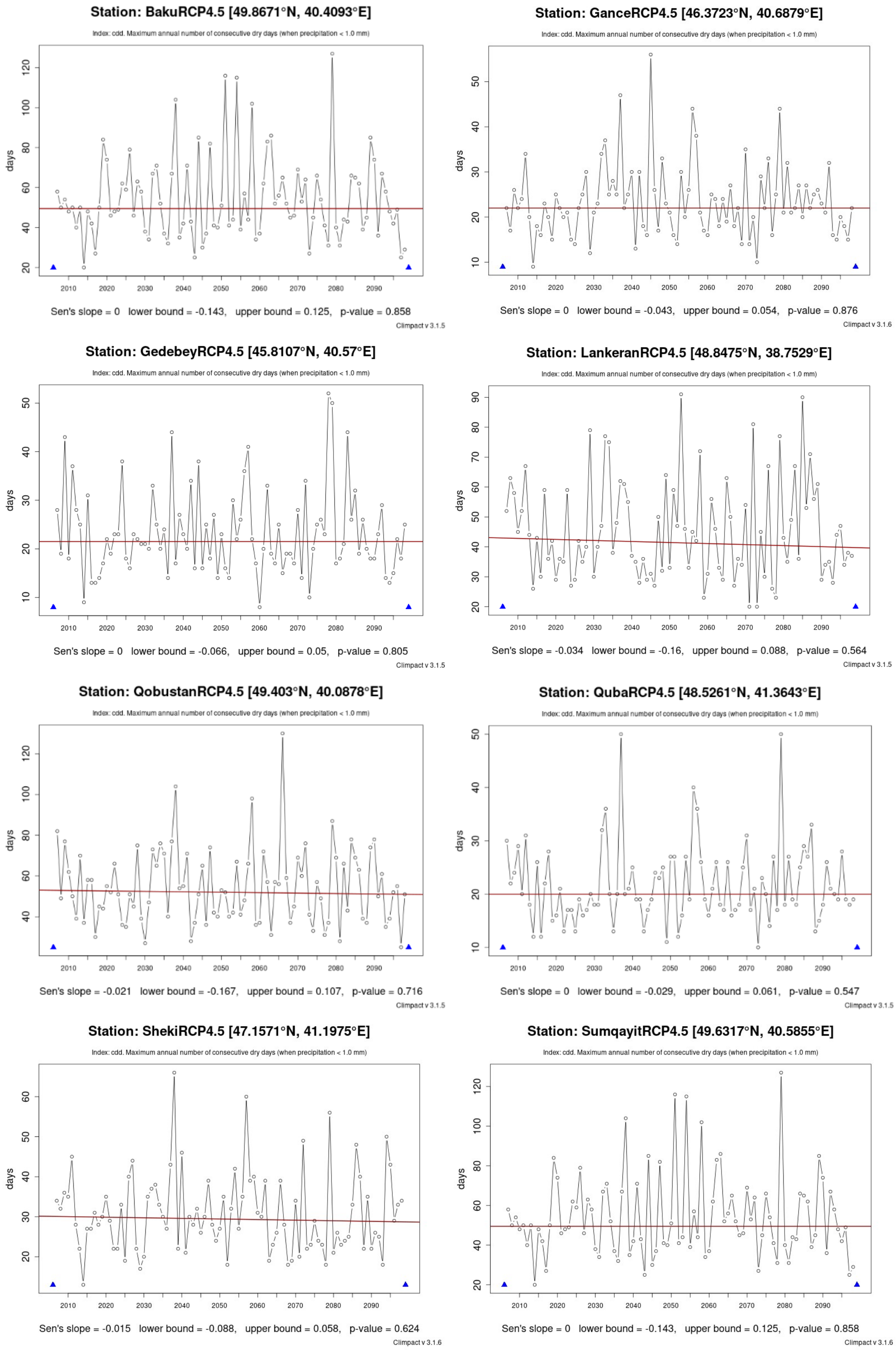
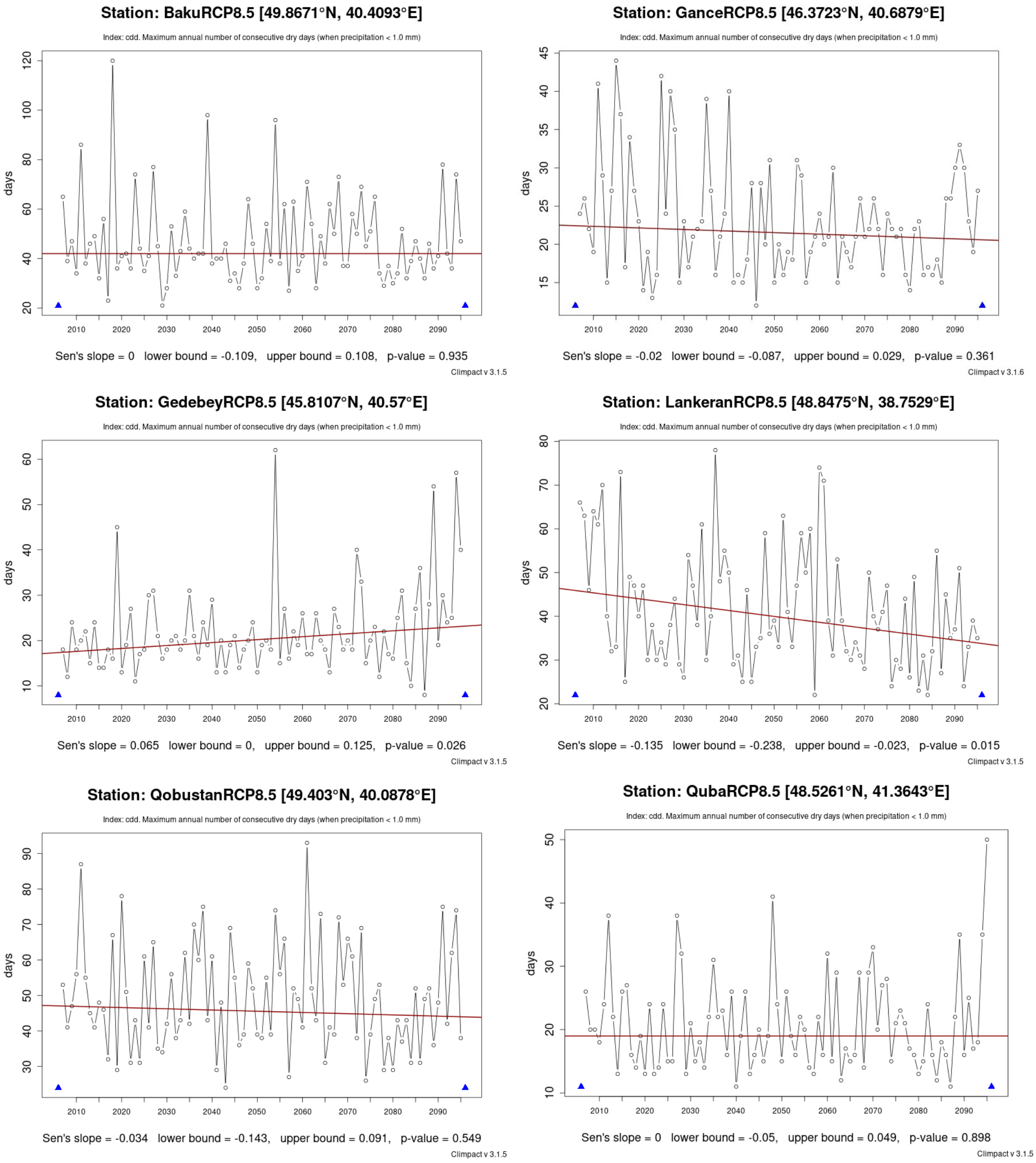


Figure 59. Maximum annual number of consecutive dry days (when precipitation <1.0 mm) for RCP4.5 (2006-2099)

In the RCP8.5 scenario, however, there is a high variability in the number of consecutive dry days depending on the station. While in Lankeran there is a significant reduction with a change in the average number of dry days from 46 to 36 days), in the other stations there is no significant variation (Baku, Sheki and Sumqayit), slight decrease (Gance, Qobustan) or a slight increase (Gedebey). Only Lankeran and Qobuston show trends of statistical significance.



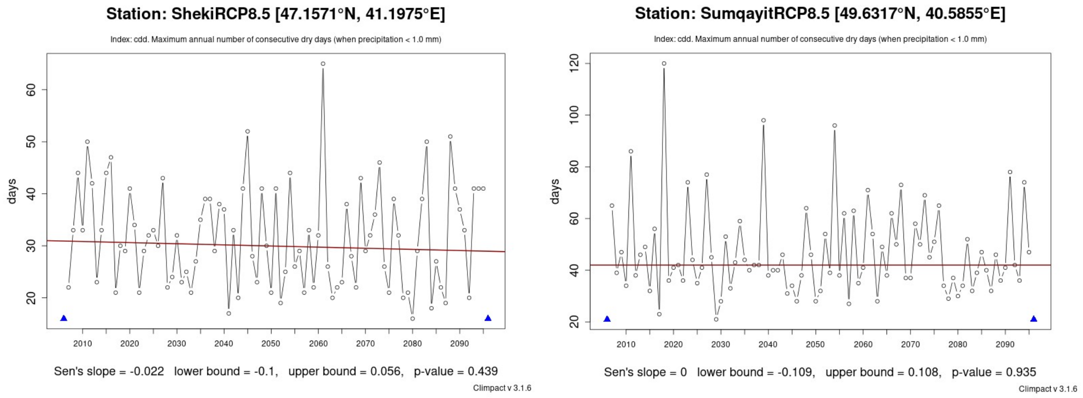


Figure 60. Maximum annual number of consecutive dry days (when precipitation <1.0 mm) for RCP8.5 (2006-2096)

4.2.2 *Extreme Temperatures*

At the national level the increase in temperature will also lead to an increase in the number of high heat days (>35 °C), an increase in the annual heat wave probability, 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. An overview can be seen in Table 13, but additional detail is provided in the downscaled discussion below.[99]

Table 13: Median Ensemble Projections for Changes in High Heat Days, Heat Wave Probability, and Warm Spell Index for Different Emissions Scenarios (2020 - 2099)

Projected Increase in the Number of High Heat Days (Additional Days >35 °C)				
Emissions Scenario	2020-2039	2040-2059	2060-2079	2080-2099
RCP 4.5	7.45	13.07	16.72	18.25
RCP 6.0	5.18	10.69	15.62	24.72
RCP 8.5	8.16	17.53	30.56	44.59
Projected Increase in Annual Heat Wave Probability (Increased Probability)				
Emissions Scenario	2020-2039	2040-2059	2060-2079	2080-2099
RCP 4.5	0.03	0.05	0.07	0.09
RCP 6.0	0.03	0.05	0.08	0.12
RCP 8.5	0.04	0.08	0.13	0.18
Projected Increase in Annual Warm Spell Duration Index[100] (Additional Days)				
Emissions Scenario	2020-2039	2040-2059	2060-2079	2080-2099
RCP 4.5	7.04	12.49	20.82	21.51
RCP 6.0	6.08	10.84	21.38	35.16
RCP 8.5	6.20	18.07	38.61	68.83

[99] Data from World Bank Climate Change Knowledge Data Platform; Available at: https://climateknowledgeportal.worldbank.org/country/azerbaijan
[100] A warm spell duration index is measured by the consecutive occurrence of 6 or more days warmer than the 90th percentile of daily maximum temperatures.

A downscaled analysis of the number of high heat days over the pre-defined temperature climatic norm was undertaken. This value has been adjusted in recent years, but from a hazard and impact point of view, an extreme heat event is determined in Azerbaijan if the temperature is above 35 °C. In terms of climate change projections, this analysis has been undertaken for all of the stations too, in the same locations for consistency purposes. The results are outlined in Table 14. For all locations except Gance, an increase in the number of days over 35 and 45 °C is projected. The results in some locations, such as Qobustan, Baku or Sumqayit reflect several days over 45 °C per year.

The extreme temperature will increase the vulnerability of agriculture, public health and water resources, through increases in the evapotranspiration.

Table 14. Days over 35°C and 45°C for observational and climate change projections

Location	Dataset	Over 35°C	Over 45°
		Number of Days Per Year	Number of Days Per Year
Baku	Obs	12	0.1
	RCP4.5	43	0.1
	RCP8.5	56	0.4
Gance	Obs	17	0.0
	RCP4.5	6	0.0
	RCP8.5	10	0.0
Gedebey	Obs	1	0.0
	RCP4.5	1	0.0
	RCP8.5	5	0.0
Sumqayit	Obs	11	0.2
	RCP4.5	43	0.1
	RCP8.5	56	0.4
Lankeran	Obs	3	0.0
	RCP4.5	19	0.2
	RCP8.5	29	0.4
Sheki	Obs	5	0.0
	RCP4.5	6	0.0
	RCP8.5	14	0.0
Qobustan	Obs	4	0.0
	RCP4.5	82	2.0
	RCP8.5	95	4.8
Quba	Obs	3	0.0
	RCP4.5	7	0.0
	RCP8.5	12	0.1

4.2.3 *Flooding*

An analysis of the extreme events regarding precipitation and flooding has been undertaken in three locations, Baku, the Turyanchay catchment in the Greater Caucasus, and the Kura lowlands. The first two locations (Baku and Turyanchay) have been chosen because of their representativeness from an economic point of view (Baku) and because of the high number of flood events recorded in the past (Turyanchay catchment). The main town in the Turyanchay catchment is Gabala. The data from the Sheki station has been used for this location, because despite being located in a different catchment, it the closest station and both are located in the Greater Caucasus. The Kura Basin has been selected because of its risk and the impact caused by the 2010 event.

The extreme event analyses have been undertaken analysing the whole period on record for precipitation and the whole projected data for the RCP8.5 and RCP 4.5 projections (Table 15) for the Baku and Turyanchay (Sheki) cases. The approach for the Kura differs and is outlined further below.

Table 15. Precipitation daily total for extreme events

Return Period (1: years)	Baku			Sheki		
	Obs	RCP4.5	RCP8.5	Obs	RCP4.5	RCP8.5
5	47.19	48.56	48.96	51.17	68.52	72.48
10	53.50	56.22	57.00	61.47	75.15	80.30
50	60.10	62.20	65.20	73.80	80.14	88.36
100	69.20	74.21	76.30	94.60	96.78	99.50

The value of the return period is higher for all probabilities for the RCP8.5 and RCP 4.5 projections in both Sheki and Baku. This information has been used to run flood inundation models for the 1:100-year event, to assess the different flood impacts that these changes would cause. It should be noted that these flood modelling implementations are based on existing global resources and a "2D rain-on-grid" modelling approach has been followed.

The comparison of the flood extent showed in Figure 61 is an example of the flood dynamics in the Greater Caucasus. As noted in the caption, the red polygons correspond to the present precipitation, while the blue polygons correspond to the 2090s precipitation. The blue polygon flood extent is much greater than the red one. This is due to the hydro-morphological features of this area, in some cases when the water level (or discharge) reaches a certain level, the water follows additional paths and then the inundation impact is much higher. Therefore, the impact of the precipitation with regard to flooding under RCP8.5 is predicted to be significantly higher.

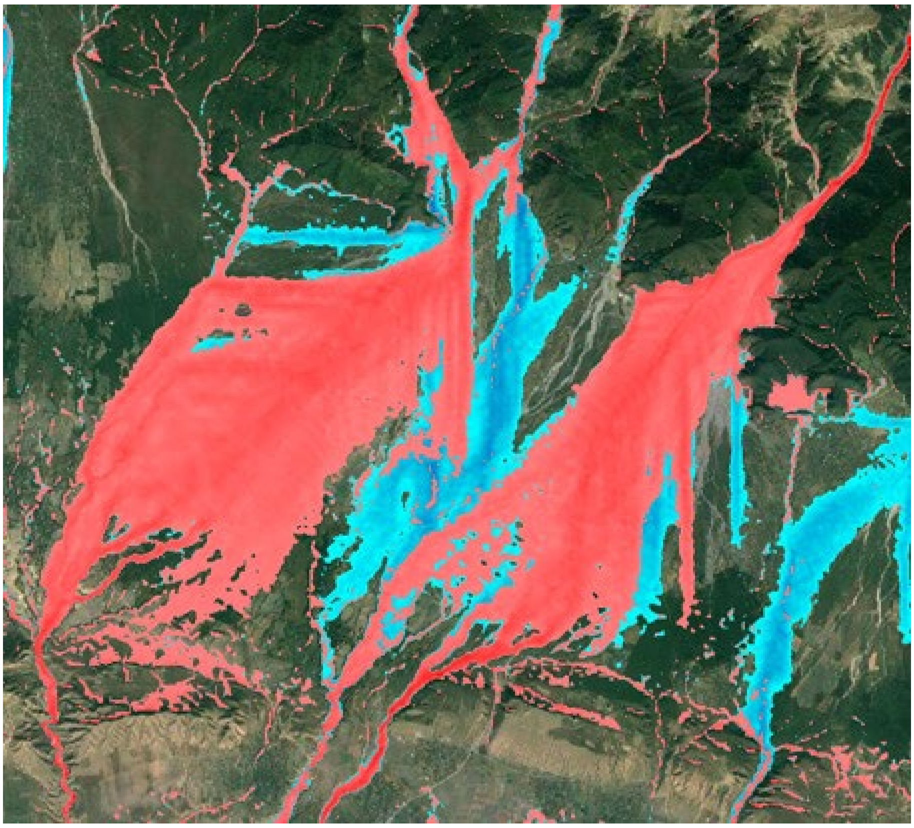


Figure 61. 1:100yr modelling results for Turyanchai catchment. Red polygons represent the results for the observational data while blue polygons represented the results for the RCP8.5 projection

Figure 62. 1:100yr modelling results for Baku. Red polygons represent the results for the observational data while blue polygons represented the results for the RCP8.5 projection

While the results in the Turyanchai catchment show that a significant increase in the inundation area is predicted, in the case of Baku, the inundation area is very similar for both scenarios. This is due to the topographical features of the city and to a lesser extent the increase in the precipitation extreme events projected. However, if the water depth in the inundation areas is analysed (Figure 63), it can be seen that the RCP8.5 project flood water depths are higher than the ones from the observational data simulation. The predicted increase in water depth ranges from 10 to 50 centimeters.

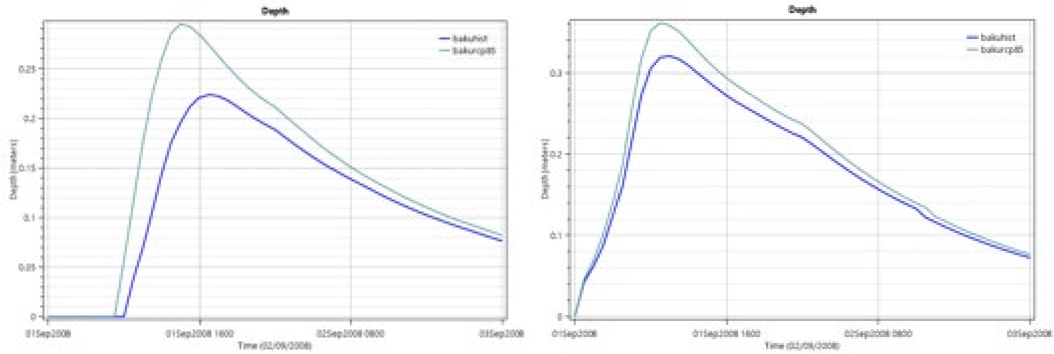


Figure 63. Water depths for the observational data (blue) and RCP8.5 projection (green) simulations in two locations.

In the case of the Kura, due to the large catchment size, a precipitation approach cannot be followed. Also, the discharge data available does not ensure a proper return period analysis. In order to analyse the possible impact that climate change may have on the Kura Basin and Kura lowlands, a different approach has been followed. An assessment has been undertaken regarding the increase in resulting flows in the Turyanchay and Baku catchments due to the increase in precipitation. This has been assessed as 17% and 24% for the RCP4.5 and RCP8.5 projections. respectively. The Kura 2010 event was assessed as a 30-year return period event, and due to the complexity of the flow dynamics in this basin, two different simulations have been undertaken, one for the 2010-year event with the recorded flows; and a second one for a 2010 event with RCP8.5 flow increase allowances (24%). It should be noted that, because of the size of this catchment, the flood modelling undertaken has to span for 45 days in order to fully account for the flood wave to travel throughout the whole catchment area included in the model domain.

Figure 64. Kura flood extent for the 2010 event

Figure 65. Kura flood extent for the 2010 event plus RCP8.5 allowance (24% increase in flow).

As seen in Figure 64 and Figure 65, the predicted increase in the flood impacts for an event with the same probability (1:30 years event) is marked in the RCP8.5 scenario, particularly in the centrally located districts. The 2010 event had an associated cost of 400M USD, with 20,000 properties and 80,000 hectares of agricultural land flooded in 40 regions. The predicted increase in the extent of flooding (and the associated increase in water depth in the locations previously flooded) is from 805,629 hectares to 840,466 hectares.[101] It is estimated that this increase in area would increase the number of properties to 20,900, the number of hectares of agricultural land to 83,500 and the damages to 417M.

The increase in the severity and the frequency of floods have a direct impact on most of the sectors noted above, increasing the vulnerability of the agriculture, water resources and public health. As already highlighted, floods (as well as landslides and mudflows, that are also associated with an increase in the severity of extreme precipitation events) damage critical infrastructure in all of these sectors, while also having an impact on the livelihood of the general population. The predicted increase in water depths associated with flood events will also increase the damages from flood events. Land-cover can also be damaged by these events, increasing the vulnerability of agriculture.

4.2.4 *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 (Standardised Precipitation Index) and the SPEI (Standardised Precipitation-Evapotranspiration Index) are two of the most common drought indicators used worldwide. These indicators have been used to process recorded monitoring data and to characterise:

- The frequency of droughts events per decade for the recent years and the two climate change projections;
- The duration of the drought events in both cases;
- The severity of these events.

While the SPI considers just precipitation input, the SPEI uses temperature information to calculate the evapotranspiration, and it is therefore considered a more meaningful indicator for Azerbaijan, especially considering the predicted increase in temperature. The results can be observed in Figure 66 for Baku, Sheki and Sumqayit stations. These stations have been selected because they are located in the highest area of drought risk,[102] and in the Absheron Peninsula where most of the Azerbaijani population is located.

The severity and the frequency of the droughts is predicted to increase under RCP8.5 for Baku and Sumqayit. In Sheki, the observed severity and frequency of droughts is already increasing – likely influenced by the significant drought event recorded in 2014 – and is projected to continue under RCP8.5.

The lower the value, the more significant the drought predicted is (the duration is being estimated by the duration of the negative period). In the three locations, and for the two projections, the severity and the duration of the droughts are expected to increase. The highest impact is predicted in Sumqayit and Baku for the RCP8.5 projection.

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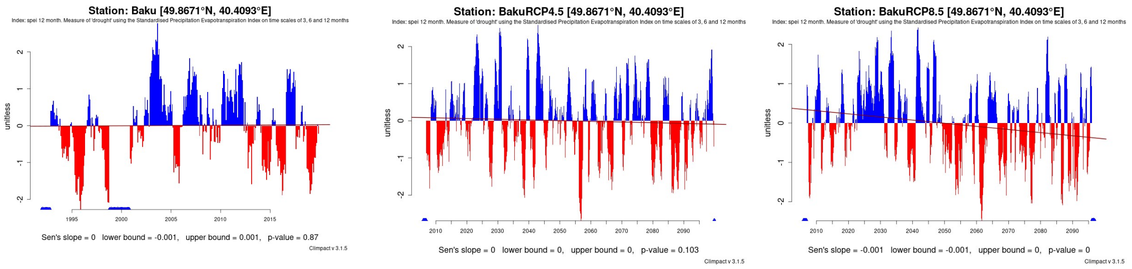
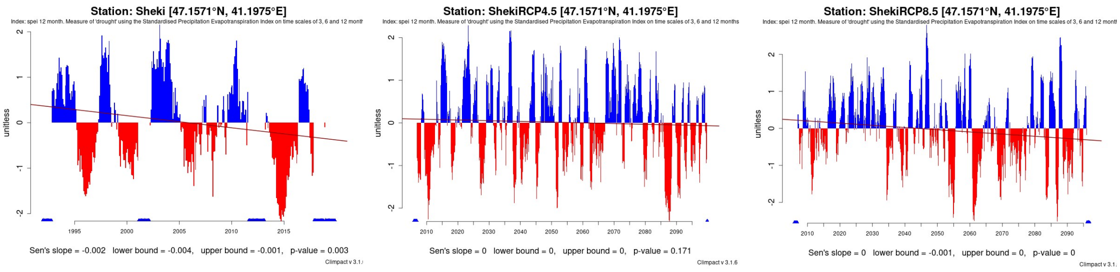
[101] Ministry of Emergency Situations. https://www.fhn.gov.az/index.php?aze/pages/33. Last accessed 10 December 2020.

[102] Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI), World Bank 2008.

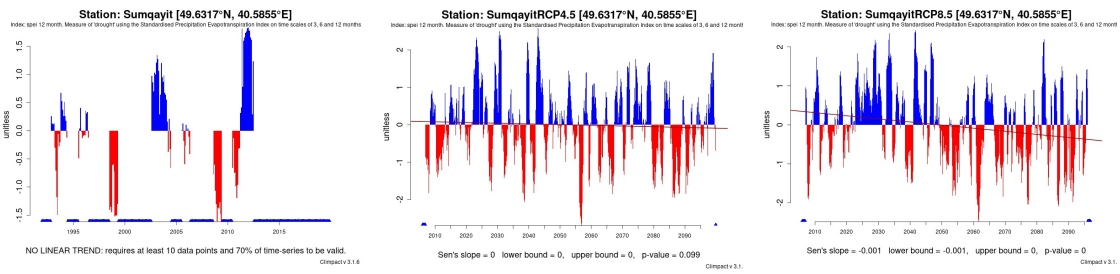
Observation Data	RCP4.5	RCP8.5



Baku 12M



Sheki 12M



Sumqayit 12M

Figure 66. SPEI for the observations, RCP4.5 and RCP8.5

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.

Additional spatial projections for drought frequency, duration, and severity were developed by CTCN as part of their study on agriculture and water resources in two communities in Azerbaijan.

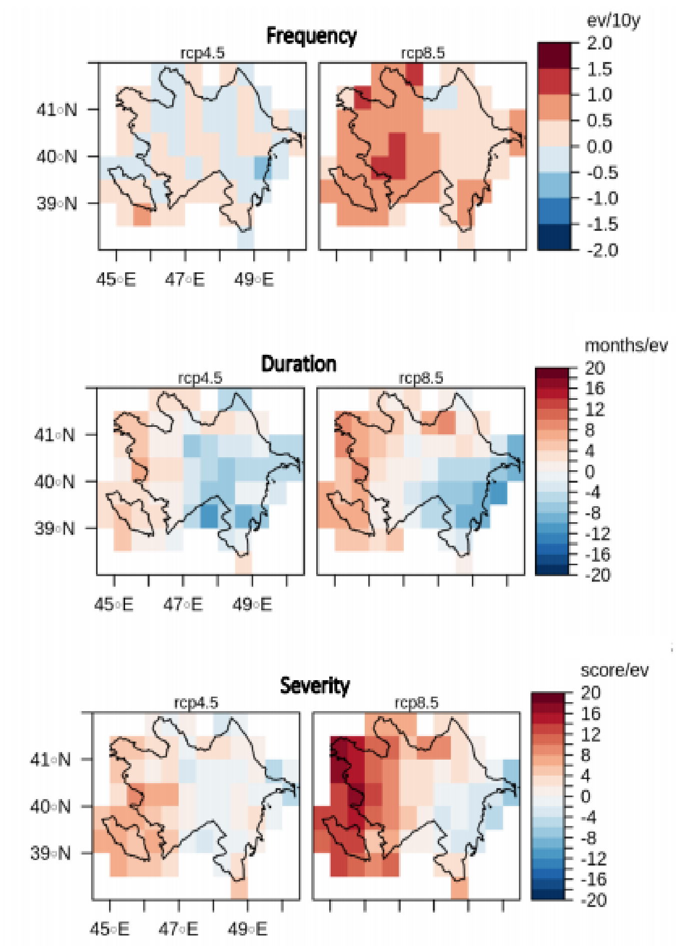


Figure 9 - Changes in drought frequency (number of events per 10 years), duration and severity in far future (2070 – 2099) with respect to the reference period (1971 – 2000) under both RCP scenarios. Drought spells are computed from SPI-12 series and depend on precipitation only

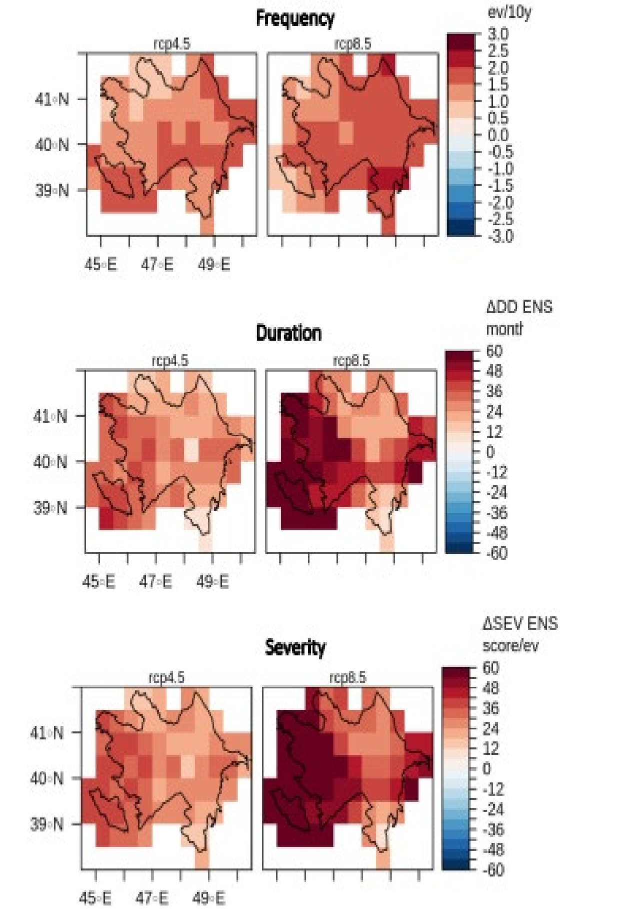


Figure 10 - Changes in drought frequency (number of events per 10 years), duration and severity in far future (2070 – 2099) with respect to the reference period (1971 – 2000) under both RCP scenarios. Drought spells are computed from SPEI-12 series and depend on precipitation and evapotranspiration balance.

Figure 67: CTCN Projections for Drought in Azerbaijan 2070 – 2099 (precipitation only – left; precipitation and ET balance – right)

Model ensemble projections for Azerbaijan predict a significant increase in the annual probability of experiencing severe drought by the end of the 21st century under all four RCP scenarios. The median probability is projected to rise from 2% per year (1986-2005) to 85% per year under RCP8.5. As such, many regions in Azerbaijan are expected to become chronically drought-affected due to climate change, with resultant impacts on expansion of arid ecosystems and desertification.[103]

4.2.5 *Other hazards*

The impact that projected climate change will have on another hazards is difficult to quantify. In the case of geological hazards, such as mudflows and landslides, there are several things to consider, such as the increase in extreme precipitation, but more importantly the projected increase in the number of consecutive days above a certain threshold. Precipitation-triggered

[103] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change.

landslides and mudflows can be linked to an increase in the soil water content, and this is related to the rainfall depth recorded (or predicted) through several days.

Project precipitation-triggered landslides and mudflows have been assessed through the return period associated precipitation for 3 and 5 days and also through the number of cases where consecutives days have greater precipitation than a pre-defined threshold, and in both cases the projected values for RCP4.5 and RCP8.5 show an increase. There are some other factors to consider for mudflows and landslides, such as deforestation, land-use, and material availability. Regarding the latter, for instance, in the Greater Caucasus sediment availability has started to become a significant problem due to change in temperature dynamics. While the maximum temperatures are increasing (and projected to increase even more in the future), the minimum temperatures are also increasing. The number of days where freezing and thawing occur is increasing, leading to a greater erosion in the Greater Caucasus (water in cracks is freezing and thawing more often, leading to greater erosion) and more loose material is available during extreme events, increasing the impact of those events (Tsyplenkov et al., 2020[104]).

Decline in river flow attributed to increasing temperatures will be exacerbated under future climate change. For example, model projections indicate that river flow will fall by 26-35% in the Alazani basin on the Georgian border, and by 59-72% in the Aghstev basin on the Armenian border.[105]

While the number of strong-wind events has increased in Azerbaijan in the recent years, climate change impacts may exacerbate this further. However, there is no consensus as to how climate change will affect the wind speed intensity. The wind hazard is directly connected to the sea-wave hazard, as previously explained. There is also uncertainty about the effects of climate change on the frequency and severity of hailstorms and associated economic losses. Few studies conducted indicate that hailstorm damage may increase in the future if global warming leads to further temperature increase, and the number of hailstorms has increased in Azerbaijan in recent years too. [106]

5 Vulnerability Assessment for Key Sectors

5.1 Vulnerability and Challenges

Azerbaijan is vulnerable to several hazards, including floods, landslides, droughts, waves, extreme temperatures and winds, hail, air pollution and mudflows.

5.1.1 *Flooding*

Azerbaijan is susceptible to heavy flooding because of its topography and climatic conditions with the population at risk mainly along the southern slope of the Greater Caucasus, in the high mountain zone of Nakhichevan and the floodplains of the Kura and Araz rivers. This area

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[104] A. Tsyplenkov, M. Vanmaercke, V. Golosov, S. Chalov. Suspended sediment budget and intra-event sediment dynamics of a small glaciated mountainous catchment. Geology Journal of Soils and Sediments. 2020
in the Northern Caucasus

[105] Republic of Azerbaijan, 2015. Third National Communication to the United Nations Framework Convention on Climate Change

[106] Azerbaijan Third National Communication. https://unfccc.int/resource/docs/natc/azenc3.pdf

contains infrastructure (such as roads and irrigation systems), communities and a large percentage of the country's agricultural land. On average, approximately 100,000 individuals are affected by flooding in Azerbaijan each year.[107] Additionally, flooding impacts GDP by approximately $300 million annually (see Figure 68 for a map of how GDP per district is impacted by flooding).

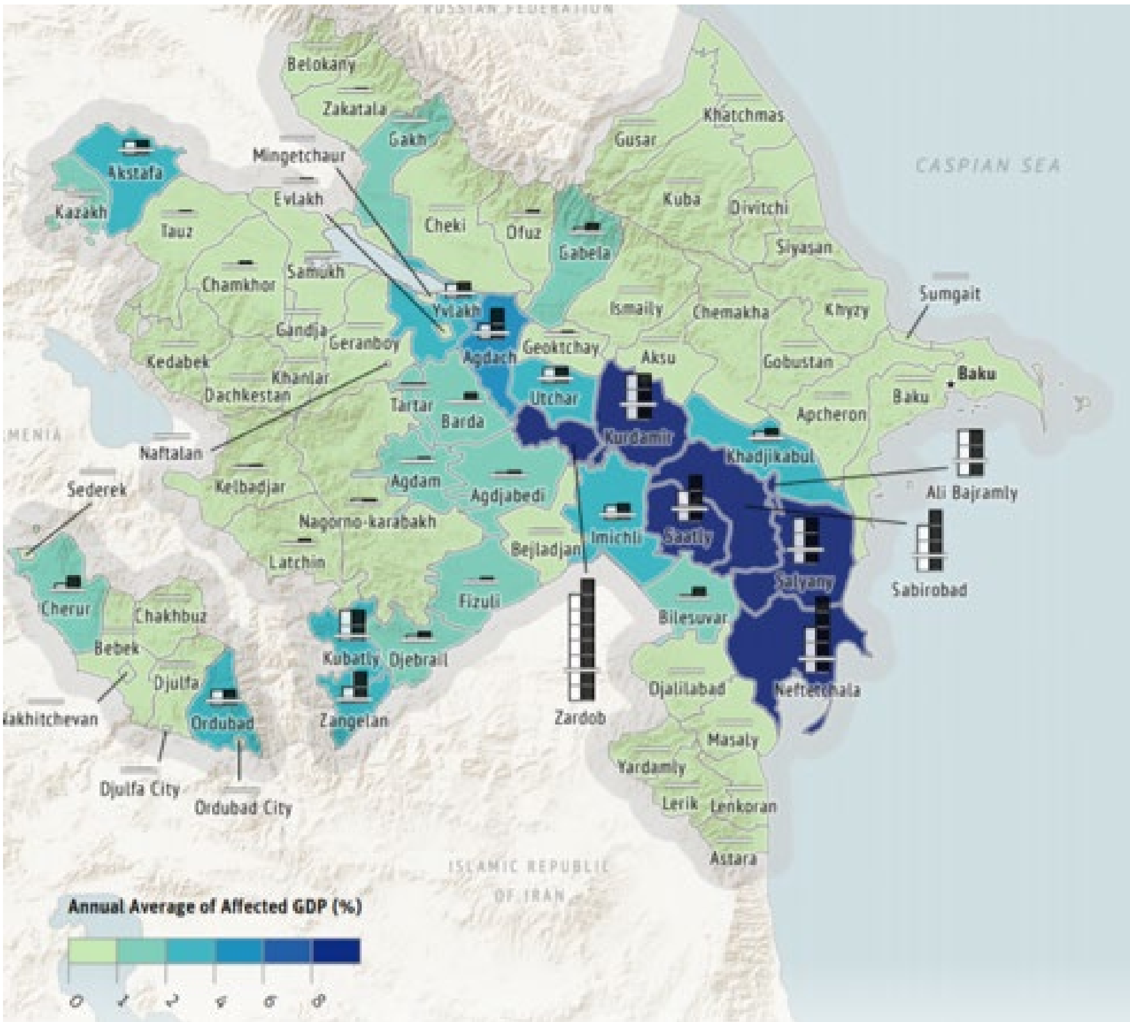

Figure 68. Map of flooding impacts on GDP in Azerbaijan per district. Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Analysis of the disaster data show that floods have significantly affected the general population and have caused significant economic losses in the past 20 years. For example, the April 2003 flood in the Ismayilli- Gobustan region alone affected 31,500 people and caused an economic loss of $55 million. Earlier, in June 1997, a flood in the Tovuz-Khanlar region affected 75,000 people and caused an economic loss of $25 million. The 2010 Kura flood affected 20,000 homes in 40 districts in Southern Azerbaijan, which destroyed and damaged 300 and 2,000 homes, respectively, flooded more than 80,000 hectares of agricultural plantations and decreased the

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[107] GFDRR. Azerbaijan. Last Accessed 29 December 2020.

transportation ability of the Kura river in downstream areas (please see Figure 69 for a map of the 2010 flood inundation). [108]

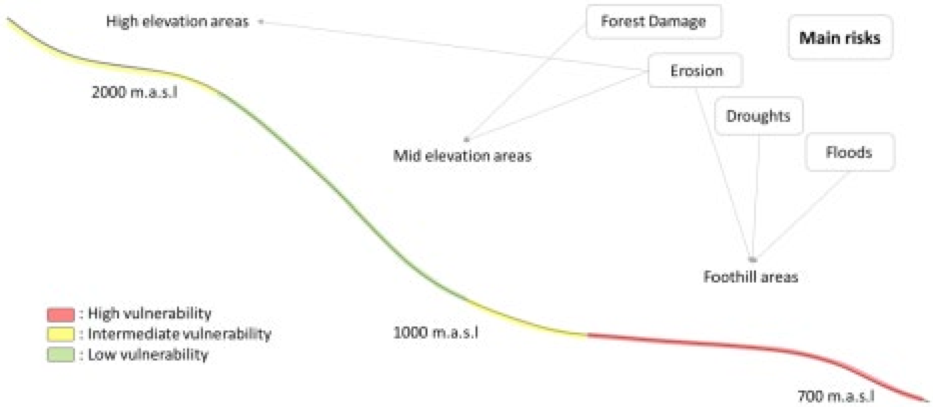
Figure 69. Inundation map for 2010 flood event[109]

5.1.2 Landslides

Occurrences of landslides during heavy rains cause significant damage to human settlements, industry, farms and roads in Azerbaijan. Average annual economic losses from landslides are estimated at $0.3 million USD.[110] A landslide in April 2000 in the Bayil zone of the Sabayil district south of Baku city centre caused 11 casualties and an economic loss of $4 million. Other occurrences of landslides during heavy rains have caused significant damage to human settlements, industry, farms and roads.

5.1.3 Droughts

Drought in Azerbaijan mostly occurs in the arid lowlands.[111]



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[108] ADRC. Azerbaijan – Country Report. Last Accessed 29 December 2020.
[109] ADRC. Azerbaijan – Country Report. Last Accessed 29 December 2020.
[110] CAC DRMI. Risk Assessment for Central Asia and Caucasus Desk Study Review. Last Accessed 29 December 2020.
[111] World Bank. Drought – Management and Mitigation Assessment for Central Asia and the Caucasus. Last Accessed 29 December 2020.

Figure 70: Generalized Drought Risk Profile in Azerbaijan

With approximately 74% of cropland in the country irrigated, droughts cause major damage to the agricultural sector and result in approximately $6 million USD in average annual economic losses.[112] Between 1988 and 2007, droughts caused approximately $100 million USD in economic losses in the country. During this drought period, some of the rivers in the Kuru-Araz basin received as little as one-third of their normal flow of water. The extremely low river levels required the modification of downstream pump stations and inlets. In drought affected areas, a significant portion of the farming communities' lost crops and livestock. Additionally, fisheries in the country were severely impacted. The reduced river flows disrupted sturgeon and salmon breeding, which resulted in a at least four generations of fish stocks being decimated. The 2015 drought in Sheki additionally resulted in significant damages.

5.1.4 *Wind and Hail*

Orographic features of the area enable west winds to become stronger along Kura River basin and the west coasts of the Caspian Sea as well as east winds in the territory of Nakhichevan Autonomous Republic. An increase in the number of very strong windy days (more than 25m/s) has been observed in the republic over the last few years. Strong winds have contributed to the erosion of millions of hectares of land in Azerbaijan, including agricultural land.[113]

Most recurrence of hail precipitations is observed in uplands and foothills of Great and Lesser Caucasus. Agriculture plants mostly suffer from frequent hail-hits.

5.1.5 *Extreme Temperature*

Temperature stress adversely effects wildlife and vegetation. Exceedance of absolute maximums and minimums of air temperature were observed within past 15 years in the last century. Declining of minimum temperature in a considerable extent in winter led to damages for subtropic plants. From 2002 – 2008, maximum air temperature in territory of the republic reached 40-4 3°C heat (July 2005, August 2007) in some Central Lowland regions, and minimum temperatures reached 14-17 °C frost (February 2005, March 2006) in uplands.

Droughts are the dominant risk in Azerbaijan, with an economic annual average loss of $6 million, followed by floods ($5.7 million), earthquakes ($1.6 million) and landslides ($0.3 million). The 20-year return period loss for all hazards is $71 million (0.23 per cent of GDP), while the 200-year return period loss is $179 million (0.57 per cent of GDP).[114]The impacts that these disasters are causing are expected to increase with climate change, as described in detail below. A summary of the expected social impacts are:

- Increase in water demand and expected decrease in water resources
- Decrease in land/agricultural productivity
- Increase in the number and severity of extreme temperature events

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[112] CAC DRMI. Risk Assessment for Central Asia and Caucasus Desk Study Review. Last Accessed 29 December 2020.
[113] Ministry of Ecology and Natural Resources Republic of Azerbaijan. Second National Communication to the United Nations Framework Convention on Climate Change. Last Accessed 29 December 2020.
[114] Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI), World Bank 2008.

- Increase in the number and severity of extreme hydrological events, such as floods (and flash-floods), mudflows, rainfall-triggered landslides, hail and droughts
- Increase in the number and severity of strong-winds and waves.

From an economic perspective, the main vulnerability is identified in the agricultural sector, although other industries should be considered:

- Impact on the agriculture and food industries
- Impact on oil and gas industries
- Impact on the hydroelectric industry
- Impact on tourism and public health

5.1.6 *Economic Regions*

The location of the hydro-meteorological stations from which data were collected relative to the economic regions, should also be noted (Figure 71). Most of the economic regions of Azerbaijan are covered by the hydro-meteorological station data collected within the framework of this study, including part from regions in conflict. Details on the vulnerability of the individual (pre-2021) economic regions is included below.[115]

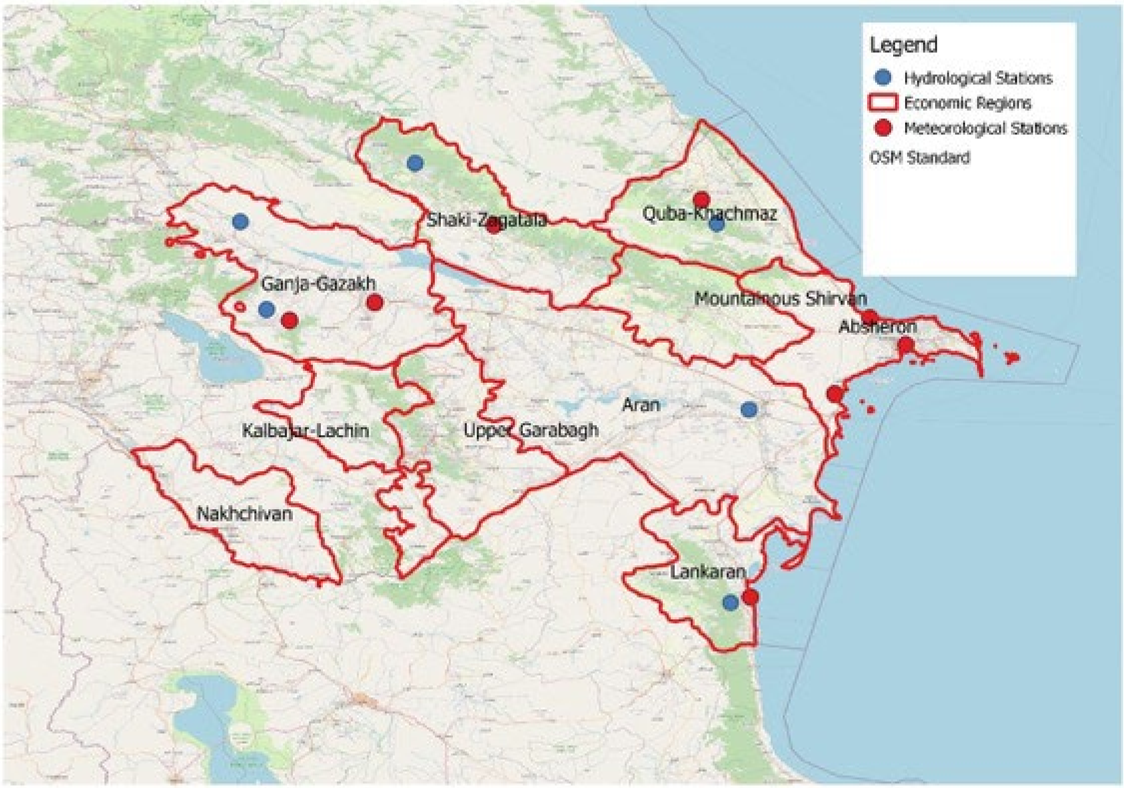

Figure 71. Economic Regions and hydro-meteorological stations. Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

[115] https://www.azerbaijans.com/content_434_en.html#:~:text=Northern%20region%20covers%20economic%20regions,of%20the%20Greater%20Caucasus%20Mountains. Last visited in 12/01/2021

Absheron: the Absheron economic region consists of hills, foothills plains and low mountains with a dry subtropical climate. This region has more significant presence of developed infrastructure with important railway, road, marine and air lines of Azerbaijan passing through the region. Baku has a wide network of scientific-research institutes, higher schools, big sport centers, country-wide important medicine establishments and other social infrastructure. The main expected climate risk identified in this region have been discussed above, especially considering that due to the vulnerability in the region, Baku stations have been selected for deep analysis. Strong-winds and extreme temperature disasters are expected to increase in the coming years, as described above. Several precipitation-triggered landslides have also occurred in the Absheron Peninsula in recent years.[116] A fluvial flood analysis in Baku considering climate change projections has also been undertaken, outlining an increase in the impact of flooding in the city. Air quality and sea-waves are also expected to cause increased issues in the coming decades, due to the reliance in fossil fuels and the increase in the severity of sea-waves (linked to the increase in wind severity).

Aran: More than half of the territory of this region consists of plains located below the sea level. Dry subtropical climate is mostly characteristic for the region[117]. Some of the most the important highways of the country (railway and road) are located in this region, with transport lines connecting Baku city and the main economic regions of the country, Georgia, Iran and Turkey. The main climate risks in this economic region are related to the Kura River which passes through this region, including flooding and droughts; especially considering, as previously outlined, the increase in the severity of both hazards and the fact that this region is the most significant agriculture and livestock region in the country.[118] Due to its topographical features, the impact of hail and strong-winds should also be considered.

Ganja-Gazakh: the territory of the region is divided into 4 zones: sloping plains, foothills, middle upland zone (at height of 1000-2000meters above the sea level), and high upland zone (at height of 2000m from the sea level), with different climate conditions in each of these zones. This is the second most important economic region of the country (after Absheron), as it is the second industrial region of Azerbaijan, with roughly 13% of the industry output of the country. In addition to that, several ski resorts are also in the region, which outlines its tourism importance. The location of some research institutes and universities in this region should be noted too. The Ganja-Gazakh region is located within the main Kura Basin, and also within the Lesser Caucasus. Therefore, this region faces most of the climate hazards analysed within this study, including an increase in landslides and mudflows (due to an increase in the severity of extreme precipitation events), an increase in flooding from the Kura and from the Lesser Caucasus, an increase in the severity and duration of drought events and more importantly an increase in the severity of extreme temperature events. As noted above, this is the region that faces, based on the projections, a higher increase in the maximum temperatures (more than 4 degrees in the RCP85 by 2099).

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[116] ADRC. Azerbaijan – Country Report. Last Accessed 29 December 2020.

[117] https://www.azerbaijans.com/content_434_en.html#:~:text=Northern%20region%20covers%20economic%20regions,of%20the%20Greater%20Caucasus%20Mountains. Last visited in 12/01/2021

[118] https://www.azerbaijans.com/content_434_en.html#:~:text=Northern%20region%20covers%20economic%20regions,of%20the%20Greater%20Caucasus%20Mountains. Last visited in 12/01/2021

Lankaran: 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 (lowland) and Talish Mountains. Seven of the thirteen climatic zones existing in the world can be found in this economic region, although mostly a humid subtropical climate can be found. Agriculture plays a major role in the economy of this region, with vegetables, melon, and tea as the main crops, although wine, citrus, cereals, cattle, fisheries and tobacco-cultivation are important too. The economic region is also an important citrus fruit-growing zone. The climate conditions of the region have led to the development of health resorts and tourism too. The Lankaran climate projections are slightly different to the ones in the rest of Azerbaijan. It is the only region where a slight increase in the average precipitation is projected, and therefore, the drought impact in this region would be limited. The increase in extreme temperatures, strong-winds, sea-waves and flooding would have a significant impact on Lankaran considering the climate change projections and the existing risk profile.

Sheki-Zaqatala: the Sheki-Zaqatala region is in the Greater Caucasus and the Qanıx River Basin (a major tributary to the Kura River coming from Georgia (Alazani)). The relief of the region is divided into upland and high upland foothills. The population in this region lives mainly at the foothills of the Greater Caucasus, with mineral extraction and tourism being the main economic sectors. As noted above, Sheki experienced a significant drought in the last decade, and in addition to that, flooding/flash-floods, mudflows, landslides and strong-winds are the main hazards experienced in this region. The increase in erosion, as outlined above, may also lead to an increased need for irrigation area, resulting in higher stress on water resources[119].

Guba-Khasmaz: the region is located in the north-east part of Azerbaijan, on the border with Russia and on the Caspian Sea coastline. The region's topographical features are divided into 4 height zones (from 26 to 4466 metres): plains foothills, middle upland and high upland zone. Climate conditions of the region are related to the topography, with hot climate in the plain area, cold-humid in the upland zone and cold weather conditions in the high-upland zone. The strategic location of this region gives it high importance in the transport, energy distribution and tourism sectors. These sectors can be severely impacted by disasters, including mudflows, landslides, strong-winds, hail and sea-waves. The analysis undertaken in the Quba station also outlines an increase in the severity of extreme temperatures and droughts.

Garabagh: the basic natural wealth of the Upper Garabagh economic region includes metal ores, oil, and natural gas, and various construction materials (marble, cement, and construction stones). This region has been severely affected by the ongoing conflict with Armenia, and therefore no hydro-meteorological stations in the area are present in this analysis. Nonetheless, due to its topographical features and existing risk profile, strong-winds, extreme temperatures, droughts, hail and floods are considered to be the most significant hazards in this region.

Kalbajar-Lachin: the Kalbajar-Lachin economic region has been affected by the ongoing conflict with Armenia, since the region is not under the control of the Azerbaijani Government.

[119] Strengthening Capacities to Assess Climate Change Vulnerability and Impacts to Shape Investments in Adaptation Technology for Azerbaijan's Mountain Regions. CTC-N. 2020

Agriculture, especially cattle-breeding comprises the base of the economy of this region. The main hazards to be considered in this region are floods, extreme temperatures and droughts.

Upland Shirvan: this economic region is located in the slopes of the Greater Caucasus and in the plain of the Shirvan. Relief of the economic region is divided into upland and plain territories. Oil and natural gas are the main resources in this region, although the tourism of the upland zone should also be noted. The Upland Shirvan economic region also has a wide transport network, including the Baku-Tbilisi railway. As per the Sheki-Zaqatala region, hazards associated with the Greater Caucasus should be noted, such as flash-floods, mudflows, landslides, droughts and strong-winds.

Nakhchivan: the Nakhchivan region is an enclave located outside the main territory of Azerbaijan, in the territory of the Nakhchivan Autonomous Republic. Nakhchivan economic region is under blockade by Armenian policy, and presently has very unsuitable economic and geographical conditions. There are rich natural reserves in the Nakhchivan economic region: molybdenum, semimetal ores, rock salt, dolomite, marble, construction material (travertine, construction stones, gypsum). Presently there are no direct transport links between Nakhchivan economic region and the other regions of Azerbaijan Republic apart from airway links and road links through the Republic of Iran. Due to these features, no hydro-meteorological or disaster risk information could be obtained for this region.

5.2 Sectoral Impacts

The sectors that show a higher vulnerability to climate change include agriculture, water resources, coastal activities (including oil and gas industry), and public health. A summary of these impacts include decreased winter precipitation and snow-melt water; a reduction in both surface and groundwater resources, increased drought periods; reduced precipitation for irrigation and subsequent loss of agriculture productivity and increased pasture degradation; destruction of forest cover due to an increase in the flooding, mudslides and landslides; and shifts in forested areas to higher altitude zones; an increase in the severity and the number of strong-wind and sea-wave events; an increase in the number of hailstorms, etc. Specific sectoral impacts are summarized in Table 15 and discussed below.

Table 16. Climate stressors, risks and impacts for vulnerable sectors in Azerbaijan

Sector	Stressors	Risks	Historical impacts
Agriculture and food security	Increased temperatures; increased rainfall variability; drought; flooding; landslides and mudflows	• Reduced crop yields and/or crop failure • Increased crop water demand, with a 16% increase in potential demand projected by the 2030s in eastern Azerbaijan[120]	• In 2003, heavy rainfall and snowmelt caused flooding of the Kura and Araz rivers in eleven districts in south-eastern Azerbaijan and triggered landslides in some regions. Around 3,000 hectares of agricultural land was submerged, destroying crops. In

[120] Sadat, A.P. *et al.*, 2013. Journal of Irrigation and Drainage Engineering. Climate Change Impact on Reservoir Performance Indexes in Agricultural Water Supply

		• Changes to the growing season, crop patterns, and locations at which crops are most productive – for example, vineyards and winter wheat are expected to become viable at higher altitudes leading to reduced overall productivity due to shortage of land • Increased aridity and soil erosion • Exacerbated regional and sectoral inequalities due to disproportionately severe effects on rain-fed agriculture[121] • Increased incidence of damaging pest populations and animal diseases • Damage to irrigation infrastructure due to floods, landslides and mudflows • Diminished fishing grounds and drying up of aquaculture facilities • Productivity of winter wheat could fall by 3% and 4%; of dry-farmed vines could fall by 10% and 12%; of winter pastures could fall by 2% and 3%; and of spring pastures could fall by 1% and 2% (under RCP4.5 and RCP8.5 respectively)[122]	addition, over 6,000 families were affected, and 2,000 houses were damaged.[123] • In the period 2003-2010, fluvial flooding is estimated to have destroyed 30% of agricultural land, including 238,600 hectares of harvested land, 187,000 hectares of cotton fields, 772,000 hectares of grain, 10,000 hectares of garden vegetables, and 7,407 hectares of pastures.[124] • Prolonged drought in 2014 rendered the annual harvest of winter grain to be ineffective, particularly in mountainous areas and arid zones. Damage to the farm was estimated at USD 1 million in some regions and productivity dropped to as a low as 5.2 centner per hectare.[125]
Biodiversity	Increased temperatures; increased rainfall variability	• Reorganization of coastal ecosystems and emerging dead zones leading to reduced ecosystem health, biodiversity and productivity • Migration or displacement to locations with more suitable environmental conditions • Direct physical damage to terrestrial ecosystems	• In 2000-2001, drought across Central Asia caused desertification and deforestation processes to intensify. In Azerbaijan, this led to degradation of high alpine meadows.[126]

[121] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change
[122] ENVSEC, 2016. "Climate Change and Security in Eastern Europe, South Caucasus and Central Asia" project
[123] IFRC, 2003. Azerbaijan: Floods – Information Bulletin No. 2. Available at: https://reliefweb.int/report/azerbaijan/azerbaijan-floods-information-bulletin-n-2
[124] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan
[125] Republic of Azerbaijan, 2020. National Drought Plan
[126] The World Bank, 2005. Drought – Management and Mitigation Assessment for Central Asia and the Caucasus

		• Destruction of aquatic freshwater ecosystems due to lower water levels in rivers and reservoirs	
Disaster risk reduction	Increased frequency and/or intensity of extreme climate events, such as drought, floods, landslides and mudflows	• Increased incidence of injury and deaths • Displacement due to flooding • Reduced water and food security, resulting in impacts to hygiene and health • Increased damage to natural resources	• In 2010, severe flooding inundated 70,012 hectares of land and left over 5,000 homes partially or completed destroyed. Around 70,000 people were affected and 40 people lost their lives.[127] • In 2014, hot and dry weather (record high temperatures were observed in several regions) during the summer months led to prolonged drought. In turn, the drought conditions led to forest fires, resulting in 58.8 hectares of burned forest.[128]
Energy	Increased temperatures; increased frequency and/or intensity of extreme rainfall; drought	• Damage to critical infrastructure due to floods, landslides and mudflows • Reduced energy supply due to disrupted operations and distribution – for example, reduced electricity generation at hydropower plants by 10-15% in 2020-2040, 15-25% in 2041-2070, and 30-35% in 2071-2098[129] • Increased electricity consumption due to increased demand for cooling and refrigeration – for example, research indicates that electricity demand increases between 0.5 – 8.5% on average per degree of temperature increase.[130] • Number of cooling degree days (when cooling systems would be needed) is projected to increase significantly in Azerbaijan by the 2090s[131]	• In 2000-2001, major drought caused hydroelectric power generation to fall well below capacity. In response to the erratic hydropower supply, inhabitants of Nakhchivan used organic fuel for cooking and heating, leading to increased deforestation.[132]

[127] CAREC, 2022. Country Risk Profile: Azerbaijan
[128] Republic of Azerbaijan, 2015. Third National Communication to the United Nations Framework Convention on Climate Change
[129] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change
[130] Santamouris, M. *et al.*, 2014. Energy and Buildings. On the impact of urban heat island and global warming on the power demand and electricity consumption of buildings – A review
[131] The World Bank Group and Asian Development Bank, 2021. Climate Risk Country Profile: Azerbaijan
[132] The World Bank, 2005. Drought – Management and Mitigation Assessment for Central Asia and the Caucasus

Health	Increased temperatures; increased frequency and/or intensity of extreme climate events such as heatwaves, drought, floods, landslides and mudflows; increased air pollution	• Increased incidence of injury and deaths • Increased risk of food supply shocks (leading to malnutrition) and water shortages • Increased incidence of heat stress and dehydration, particularly in urban areas where impacts of rising temperatures are compounded by the Urban Heat Island effect • Increased risk of respiratory, cardiovascular and neurological diseases • Increased prevalence of vector-borne diseases, including potential reintroduction of malaria – for example, increased geographic spread and lengthening of the epidemic period of malaria are expected to occur once temperature rises exceed 1.5-1.6 °C[133] • Increased incidence of water-borne diseases and infections	• Extreme temperatures in Baku during the summer period (April – September) in 2003-2006 correlated with an increase in first-aid calls and complaints relating to blood, respiratory and neural diseases increased by 20-34%.[134] • Rising temperatures and flooding of human settlements have been identified as contributing to a resurgence in gastrointestinal infections, which were previously on the decline[135]
Water resources	Increased temperatures; increased rainfall variability; drought; flooding	• Increased water stress – Azerbaijan already faces severe water stress conditions, with an average Water Exploitation Index[136] about 40%[137] • Increased evaporation of water resources and reduced river flows • Reduced availability of water for irrigation	• The glacial area of the Gusarchay Basin, a major water source, has decreased by approximately 50% over the past century due to rising temperatures.[139] • The water level of the Kura and Ganig rivers decreased by 29% in 2019 and 46% in 2020 compared to historical norms.[140]

[133] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change
[134] Ministry of Ecology and Natural Resources, 2016. Inputs for OHCHR's Analytical Study on the Impacts of Climate Change on the Right to Health (Human Rights Council Resolution 29/15). Contribution by Azerbaijan. Available at: https://www.ohchr.org/sites/default/files/Documents/Issues/ClimateChange/Impact/Azerbaijan.pdf
[135] Republic of Azerbaijan, 2010. Second National Communication to the United Nations Framework Convention on Climate Change
[136] Defined as the annual total abstraction of freshwater divided by annual freshwater resources
[137] European Environment Agency, 2020. Water availability, surface water quality and water use in Eastern Partnership countries
[139] The World Bank Group and Asian Development Bank, 2021. Climate Risk Country Profile – Azerbaijan
[140] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan

		• Damage to water resource management infrastructure due to flooding, landslides and mudflows • Temperature rise of 2 °C and no change to precipitation is projected to cause water resources to decrease 5-10% in 2020-2040, 10-15% in 2041-2070, and up to 20% by the end of the century[138]	
Coastal zones	Increased temperatures; increased frequency and/or intensity of extreme rainfall events	• Reduced health, diversity and productivity of coastal ecosystems and fisheries • Loss of cultural services associated with recreation and tourism[141]	• In the period 1996-2015, evaporation due to rising temperatures played a dominant role in causing the level of the Caspian Sea fell by an average of 6.7cm per year.[142]

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 the 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, landslides and mudflows 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 also cause risks such as increasing the likelihood of plant diseases and the possibility of forest-fires. It is estimated that the productivity in the dry-farming zone of winter wheat yield to fall by 3% and 4% (RCP4.5 and RCP8.5 respectively). The productivity of dry-farmed vines could fall by 10% and 12% (RCP4.5 and RCP8.5 respectively). The productivity of winter pastures is expected to decrease by 2% and 3% (RCP4.5 and RCP8.5 respectively) and of spring pastures by 1% and 2%.[143]

Water resources: In addition to the risks described above, the change in the precipitation pattern and the increased frequency and severity of droughts events will pose significant stress on the water resources. The already mentioned 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 the water resources availability. This will have an impact on both agriculture and industry. Based on the analysis conducted here, it is estimated that reduction in stream flows will be in between 10% and 15% for RCP4.5 and

[138] Republic of Azerbaijan, 2021. Fourth National Communication to the United Nations Framework Convention on Climate Change
[141] Prange, M. *et al.*, 2020. Communications Earth & Environment. The other side of sea level change
[142] The World Bank Group and Asian Development Bank, 2021. Climate Risk Country Profile – Azerbaijan
[143] EnvSec. Climate Change and Security in the South Caucasus. 2016.

RCP8.5 respectively.[144] Additional future projections indicate that by 2100, streamflow will reduce by 26-35% in the Alazani basin on the Georgian border, and by 59-72% in the Aghstev basin on the Armenian border. Given the expected increase in water demand in line with rising temperatures and population growth, water shortfalls are projected during the summer months in the Alazani basin.[145]

Tourism: The tourism sector is emerging in Azerbaijan, contributing to more than 8% to national GDP in 2015 (although it has been decreasing in recent years). The tourism sector would be affected by extreme temperatures and the decrease in precipitation (affecting ski resorts), and also by the increased number of hazardous events (mudflows, flash-floods and landslides) in the Greater and Lesser Caucasus, where hiking activities are popular. Ski resorts need approximately 20-30 cm of snowpack to operate; however, early snow melt has been increasing and the snow line in the Southern Caucuses region has increased in elevation from between 1,300 to 1,500 meters to between 1,800 to 2,000 meters.[146] Additionally, major tourism hubs are located on coastal areas along the Absheron Peninsula, which is under threat of inundation from sea level rise.

Coastal activities and energy: The main risk to coastal activities, including oil and gas industry and other industries (fisheries) is caused by the increase severity of winds and sea-waves in recent years, and the possible increase in the severity of these events in the coming years. The increase in the wind speed and the associated wave height poses several issues to these industries, 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. Azerbaijan's Caspian Sea coastline is particularly vulnerable to global climate change. Rising sea levels pose a major risk to Azerbaijan's Caspian Sea coastline, which is home to 40% of the population and 75% of industrial infrastructure. Rising sea levels have resulted in flooded settlements, forced migration of people living in lowlands, destroyed roads and railways, damaged industrial infrastructure and destroyed beaches, with economic losses totalling and estimated $2 billion. Sea level is projected to rise another 1.5–2 meters in the next 40 years, resulting in an additional $4.1 billion in damages.[147] As noted above, however, the dynamics of the Caspian Sea Level are uncertain, an immediate rise in sea-level is not expected if the latest sea-level dynamics are considered. Nonetheless, the possibility of a sea-level raise should not be discarded.

A dangerous situation develops annually on the coast of the Caspian Sea. This occurs when high winds cause waves of heights up to 2.5 -2.7 meters. Low territories are exposed to flooding for distances up to 20-25 km from the sea. This results in the breaking of protective dams and levees of petroleum storage areas, isolation of settlements, and damage to communications. The threat of this type of flooding has grown with the drastic rise of the level of the Caspian Sea.[148] Between 1978 and 1995 the Caspian Sea level has risen by 2.5 m and achieved -26.42

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[144] Author's projections based on data analysis
[145] Republic of Azerbaijan, 2015. Third National Communication to the UNFCCC
[146] Sylven, et al. Climate Change in Southern Caucuses: Impacts on nature, people and society. Last Accessed 29 December 2020.
[147] USAID. Climate Change Risk Profile Azerbaijan. Last Accessed 29 December 2020.
[148] Kazakhstan Country Report 1999. https://www.adrc.asia/countryreport/KAZ/KAZeng99/Kazakhstan99.htm

m.[149] This is the most intensive and prolonged rise of the level for the whole period of instrumental observations. Having risen during this period the sea level caused damage to a number of industrial facilities and infrastructure of Azerbaijan. This is first of all associated with the fact that during the whole 20th century (up to the 1980s) development of the coastal area took place under the regressive phase of the variation. Therefore, many current problems are consequences of flooding of the previous shelf zone of the sea. For the time being, 485 km^2 of coastal areas have been flooded. The damage area covers 50 settlements, 250 industrial enterprises, 10 thousand hectares of irrigated lands, and recreation facilities, affecting approximately 200 thousand people. As a result of flooding of the coastal area critical situation has emerged at the Lenkoran-Astara section of the coastal zone and the Apsheron peninsula, where settlements have been flooded and secondary contamination of the sea from oil fields is taking place.

The hydropower sector in Azerbaijan should also be considered, and although it plays a minor role in the energy sector, contributing just 1% of the electricity produced,[150] the potential of rivers in Azerbaijan for hydropower should be considered. While the country has been successful in constructing new thermal power plants over the last 10 years, the importance of hydropower generation is increasing[151]. From 2005-2009 large investments were made in the hydropower sector, including new and advanced generators installed in several existing plants. Contribution of these new generators rapidly increased electricity production, however, over the last two years a considerable reduction of the electricity produced is noticeable.

The figure below illustrates economic losses in electricity production for the period of 2003-2012. It shows that the actual production of hydropower plants in Azerbaijan is much lower than the installed capacities of all hydropower plants (HPP). For example, the installed capacity of the Mingechaur HPP is 402 Mw, while actual production in 2012 was only 159 Mw. This difference may be explained by the impact of various climate and political factors.

[149] Azerbaijan First National Communication. https://unfccc.int/sites/default/files/resource/Azerbaijan%20INC.pdf
[150] International Energy Agency. EU4Energy. https://www.eu4energy.iea.org/countries/azerbaijan. Last accessed 12 January 2021.
[151] AzarEnerji. http://azerenerji.gov.az/index/page/13?lang=en. Last accessed 12 January 2021

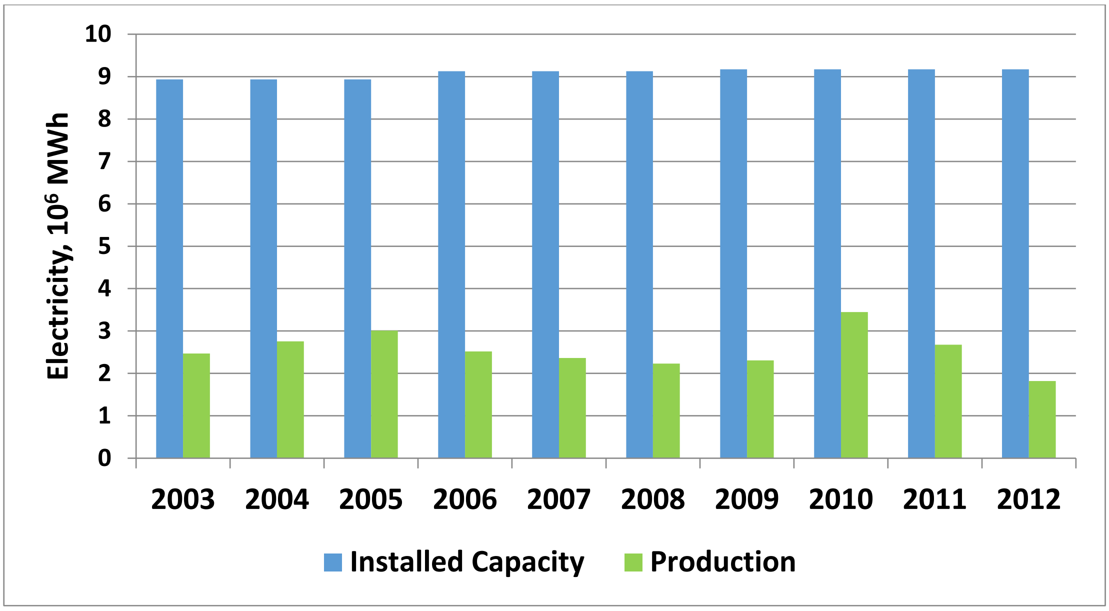

Figure 72. Economic losses in electricity production for the period of 2003-2012

The hydropower plant crisis in Azerbaijan started in the end of 2012 and continued in 2013. According to the information, power generation at HPPs for January-October 2013 reached only 106KW/h that is by 24.5% below that for the 2012 term. According to estimations, this makes additional economic loss equal to USD 184,292 in 2011-2012. Estimated total economic loss in the hydropower sector over the period of 2002-2012 is nearly USD 4.5 billion. The estimated reduction in the amount of water flow in the main rivers in Azerbaijan, as outlined above, is expected to have a higher impact on the figures above. It should be noted that this will also have wider impacts, such as an increase in the reliance of fossil resources for energy production. [152]

Public Health: Heat waves have already increased in frequency five times since 1990 in Azerbaijan.[153] Projected increases in average temperatures in the coming decades (including a projected increase of between 3.64 – 5.80 °C in 2080 – 2099) and projected increases in dangerously hot days over 35 °C (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, mudflows and landslides due to changing precipitation patterns will result in additional loss of life throughout vulnerable areas of the country. Additionally, as previously outlined, the link between air quality and climate change should be considered too. The main causes of CO_2 emissions (i.e. burning of fossil fuels) are also a major source of air pollutants[154]. Many air pollutants contribute to climate change by affecting the amount of incoming sunlight that is reflected or absorbed by

[152] Rovshan Abbasov. Assessment of the Freshwater Ecosystem Services of Reservoirshpp Dams in the Kura-Aras River Basin. https://www.researchgate.net/publication/329754237
[153] USAID. Climate Change Risk Profile Azerbaijan. Last Accessed 29 December 2020.
[154] Institute for Advanced Sustainability Studies. https://www.iass-potsdam.de/en/output/dossiers/air-pollution-and-climate-change. Last accessed 12 January 2021

the atmosphere[155]. These short-lived climate-forcing pollutants (SLCPs) include methane, black carbon, ground-level ozone, and sulfate aerosols. They have significant impacts on the climate: black carbon and methane in particular are among the top contributors to global warming after CO_2.[156] It should be added that Black carbon (BC, also known as soot) is a component of fine particulate matter (PM2.5). Particulate matter is the air pollutant that is most harmful to human health and the primary driver of air pollutant-induced mortality. The previously outlined reduction in water flow (limiting the hydropower generation) will increase the reliance in fossil fuels, and therefore posing further problems in human health.

6 Policy Context

Although, Azerbaijan does not yet have a formal national policy or plan focused on climate change adaptation, the country has identified a number of climate vulnerabilities and adaptation measures through development plans, laws and reports to the United Nations Framework Convention on Climate Change (UNFCCC). These documents identify the need for extended capacity within the country's existing CIEWS framework as an integral piece of the country's overall adaptation strategy.

Relevant policies, plans and other frameworks and a description of how this project aligns with these frameworks are identified in the table below.

Table 17: Project alignment with existing Azerbaijan policies, plans and frameworks

Policy/plan	Overview and key strategy	Project alignment
Third National Communication to the United Nations Framework Convention on Climate Change – Republic of Azerbaijan (TNCCC)[157]	Azerbaijan's TNCCC identifies current greenhouse gas emissions from the country, mitigation measures that have been put in place to reduce emissions, current vulnerability of the country to climate change impacts and adaptation measures and priorities. As a major oil and gas producing country, most of Azerbaijan's greenhouse gas emissions are identified as coming from the country's energy sector. However, in recent years Azerbaijan has prioritized the development of low carbon-emission production as part of its mitigation strategy. For example, the national oil company (SOCAR) has adopted greenhouse gas emission reduction measures. Key climate effects identified by the TNCCC include a reduction in water resource availability, rising sea levels of the Caspian Sea and an increase in temperature and frequency of heat waves. These effects subsequently result in impacts on agriculture and forests, public health, tourism, coastal zones and other important sectors to Azerbaijan's economy.	One of the key components of the project is the strengthening of the hydro-meteorological network of Azerbaijan and the subsequent dissemination and communication of climate risk information and early warning to relevant beneficiaries throughout the country.

[155] Institute for Advanced Sustainability Studies. https://www.iass-potsdam.de/en/output/dossiers/air-pollution-and-climate-change. Last accessed 12 January 2021
[156] Institute for Advanced Sustainability Studies. https://www.iass-potsdam.de/en/output/dossiers/air-pollution-and-climate-change. Last accessed 12 January 2021
[157] Republic of Azerbaijan. Third National Communication to the United Nations Framework on Climate Change – Republic of Azerbaijan. Last accessed 06 December 2020.

	The TNCCC outlines the existing hydrometeorological network in Azerbaijan, which is carried out by 63 meteorological observation stations every three hours and more limited observations are carried out by a further 75 stations. Observations include temperature, precipitation, sea level, waving regime, water temperature and other indicators. The report, however, references the need to improve the warning systems for extreme hydro-meteorological events as a means of increasing the country's adaptive capacity to climate change.	
Azerbaijan 2020: Look into the Future[158]	Azerbaijan 2020 broadly outlines the country's national development strategy. The strategy first details Azerbaijan's economic and development situation and key challenges facing the country. The strategy goes on to identify measures and tasks needed to reach economic goals and improve sectors and facets of the country such as transportation infrastructure, information and communication technologies, human capital, legislation and institutional potential and environmental protection and ecological issues. As part of the improvement to environmental protection and ecological issues, the strategy indicates that in zones that are expected to be inundated by floods, forecasts should be made regularly and utilized by relevant organizations and institutions.	The project will result in the strengthening of impact-based forecasting, which will increase the capacity of the NHMS to forecast climate risk events such as floods.
Nationally Determined Contribution (NDC) of the Republic of Azerbaijan[159]	Azerbaijan's updated document on Nationally Determined Contribution (NDC) was submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2023 and identifies the country's greenhouse gas emission reductions targets. The country targets a 40% reduction in the level of greenhouse gas emissions compared to its 1990 base year by 2050, if international support is provided through financing, technology transfer and capacity building. The NDC additionally indicates that the country will continue planning and implementing appropriate adaptation measures by mobilising local and international funds for sectors particularly vulnerable to climate change, as well as exploring preventive measures and adaptation opportunities for various economic sectors.	Enhancement of climate services and early warning systems in Azerbaijan will underpin adaptive capacity building at multiple levels.
Law of Azerbaijan Republic – Hydrometeorological Activities[160]	The national law on hydrometeorological activities (passed in 1998 and amended in 2018) identifies how Azerbaijan collects and monitors meteorological, hydrological and oceanographic data. The law additionally identifies how the main activities of the NHMS are governed.	Output 1 of the project includes strengthening the institutional and policy framework for climate information services and early warning in Azerbaijan.
Azerbaijan National Adaptation Plan (under development)[161]	GCF Readiness Support was approved in 2019 for the development of Azerbaijan's National Adaptation Plan (NAP). Development of the NAP is currently underway with UNDP acting as the country's Delivery Partner for the project. The approved NAP proposal identified three areas in which the NAP will focus in order to improve the climate change adaptation planning	The project will increase the availability of hydrometeorological data and enable policy makers and technical staff to utilize the additional data for adaptation purposes. Additionally, the

[158] Republic of Azerbaijan. "Azerbaijan 2020: Look into the Future" Concept of Development. Last accessed 06 December 2020.
[159] UNFCCC. Azerbaijan Second NDC. Last Accessed 12 December 2024.
[160] CIS Legislation. Law of Azerbaijan Republic – About hydrometeorological activities. Last Accessed 06 December 2020.
[161] GCF. Readiness Proposal – National Adaptation Plan (NAP) Support Project for adaptation planning and implementation in Azerbaijan. Last Accessed 06 December 2020.

	process in Azerbaijan: i) improved data availability, access and sharing for decision making ii) enhanced institutional and technical capacity for climate change adaptation in water, agriculture and coastal areas, and iii) increased mainstreaming of climate change adaptation considerations into planning at national, regional and local levels in priority sectors.	increased capacity of hydrometeorological services in Azerbaijan will facilitate the adoption of adaptation considerations into national, regional and local policies, plans and frameworks.
Law of Azerbaijan Republic – Civil Defence[162]	The National Law on Civil Defence (passed in 1997 and amended in 2018) presents legal grounds and principles for civil defence in Azerbaijan, such as actions in emergency situations which including natural or other disasters. Provisions of the Law stipulate that the government is responsible for, i.e., forecasting and assessing the consequences of emergencies; informing the population about emergencies and dangers to life and health of people, as well as providing comprehensive and objective information on the consequences of such situations and measures taken to eliminate them; explaining to and training the population in the ways and means of protection from emergencies during both peace and wartime situations.	Output 2 of the project will facilitate the generation of timely forecasts and warning of climate-related risks and hazards. Output 3 will address the need to improve communication and dissemination of climate information and multi-hazard early warnings. Moreover, Output 4 will address the need to improve capacities at all levels for disaster preparedness, including through targeted awareness-raising and education on climate-related hazards, early warning systems and risk management.
National Socio-Economic Strategy 2022-2026[163]	The National Socio-Economic Strategy 2022-2026 outlines the key development priorities for Azerbaijan based on a new socio-economic model prioritising diversification and digitalisation of economy, increasing transparency and accountability, as well promoting technological progress and sustainable growth. As a part of its strategic framework for clean environment and "green growth country", the Government aims to modernise and automate weather surveillance and environmental monitoring systems, including for atmospheric air pollution.	The project will directly contribute to the strategic aims through upgrade of the weather surveillance and air pollution monitoring systems.

The Hydrometeorology Development Program has been developed in the Republic of Azerbaijan and serves to improve the hydrometeorological situation in the country. Ensuring the hydrometeorological safety of the population, its property and various sectors of the economy in the country is always in the focus of the state. In this regard, a number of normative legal acts in the field of hydrometeorology have been adopted in recent years, and concrete measures have been taken to strengthen hydrometeorological activities. There are three main regulations for EWS in Azerbaijan:

[162] Ministry of Internal Affairs of Republic of Azerbaijan. Law of the Republic of Azerbaijan on Civil Defence. Last accessed 13 February 2024.
[163] Republic of Azerbaijan. 2022-2026 Social and Economic Development Strategy. Last accessed 13 February 2024.

- Law on Hydrometeorology: is the law regulating flood forecasting and management in Azerbaijan. This Law establishes legislative grounds for carrying out hydro-meteorological and environmental observations and analysis[164].
- Article 11 of the Law on Environmental Safety: This article is dedicated to the elimination of consequences of natural disasters. According to this law, all state control over co-ordination and implementation of activities for the elimination of harmful impact upon the environment shall be carried out by the relevant executive authorities[165].
- The Order of the President of the Republic of Azerbaijan (1182, 16/12/2005) "On the establishment of the Ministry of Emergency Situations of the Republic of Azerbaijan[166]":
  - Establishing the Ministry of Emergency Situations (MOES)
  - Stating that the Civil Protection Department of the Ministry of Defence, the Fire Department of the Ministry of Internal Affairs, the State Water Rescue Service, and some more organisations are under the authority of the MOES.
  - Allows the MOES to carry out policies in the field of civil protection, rescue and rehabilitation of central and local executive body agencies, and other enterprises and organisations to ensure coordination of the emergency activities.

Details for these laws and other relevant plans can be seen in the table below. Additional gaps for the implementation of these laws/plans are discussed in the baseline EWS section below.

Table 18: Azerbaijan Hydromet Legislation and Other Relevant Laws/Plans

Legislation	Overview	Additional work is required to increase the impact of the legislation.	Measures taken to date	Project adaptation (what recommendations can the project make)
Law of the Republic of Azerbaijan on Hydrometeorological Activity	Among the activities included in this law are the following: • to inform on catastrophic hydrometeorological events and extreme levels of environmental pollution - provision of factual and predictive information on emergencies in the atmosphere, land and water bodies and high environmental pollution • to organize observations and researches on	Global climate change in recent years has increased the intensity of dangerous hydrometeorological events (floods, hurricanes, storms, droughts, etc.), further actualized hydrometeorological activities, and set important tasks for the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan. At the same time, there are still a number of	The Republic of Azerbaijan became a member of the World Meteorological Organization (hereinafter - WTO), hydrometeorological stations and stations equipped with new devices and equipment were opened. In order to ensure the automated exchange of hydrometeorological data at the national, regional and international levels, the Data Switching Center for the purpose of operative	The early warning system to be established by the project can play an important role in addressing existing shortfalls in hydrometeorological services

[164] https://www.ecolex.org/details/legislation/law-no-485-ig-on-hydrometeorological-activity-lex-faoc047222/
[165] http://www.cawater-info.net/library/eng/az_env_saf.pdf
[166] http://www.fao.org/faolex/results/details/es/c/LEX-FAOC117070/

	hydrometeorology and pollution of the natural environment in case of natural disasters, man-made accidents and emergencies, preparation of information and submission to the relevant authorities; • to organize the preparation of operational forecasts on the onset, intensification and duration of dangerous hydrometeorological events and to notify the relevant authorities; • to provide relevant government agencies, the population, the media and various sectors of the economy with information on the regime, surveys, factual and forecast data, expected natural hazards and high levels and threats of environmental pollution;	problems in the field of hydrometeorology. The vast majority of observation stations and stations, operating devices and equipment, hydrometric devices for hydrological observations on rivers are obsolete and do not meet modern requirements. The country's hydrometeorological forecasting and warning system needs to be improved. To implement all this, first of all, it is necessary to train qualified personnel. In general, the identification of existing problems in the field of hydrometeorology and ways to overcome them can be considered as an important factor that will stimulate future development in this direction.	implementation of hydrometeorological services, to check the measuring instruments used in the hydrometeorological system of the republic, In order to improve inspection systems, data analysis systems and create automated workplaces, computers and other equipment were purchased and installed, the quality of hydrometeorological services provided to the population and various sectors of the economy was improved.	
Environmental Safety Law	Article 11 of this law is devoted to the elimination of the consequences of natural disasters. According to this law, all state control over the coordination and implementation of activities to eliminate harmful effects on the environment is carried out by the relevant executive authorities.	For the implementation of Article 11 of the Law on Environmental Safety, a special action program should be established, inter-agency coordination and information exchange should be strengthened, and joint coordinating bodies should be established.	Currently, in order to eliminate the consequences of natural disasters, individual executive bodies are carrying out relevant activities within their powers and in accordance with work plans.	The project will help the establishment of a mechanism to strengthen the inter-agency coordination to address the harmful effects of natural disasters.
Law of the Republic of Azerbaijan "On Environmental Protection"	Articles 11,12,13 of Chapter 3 of the Law regulate the use of nature, permits and rights and responsibilities in this field.	In this case, illegal settlement on the river and sea coast, any economic activity, agriculture, etc. The requirements of the legal framework must be complied with in order to prevent such activities. As a result of non-compliance with the law, for example, the development of erosion and floods is accelerated	Although the relevant orders and decisions issued by the Cabinet of Ministers and relevant ministries, local executive bodies are directed against the expansion of these processes, it is still impossible to completely prevent the process.	In order to avoid negative impact on human health, housing and economic activities, it will be important for the project to develop a mechanism for the implementation of legislation in this area in accordance with international principles.

		as a result of overuse of riverbeds and transportation of impurities (sand, gravel).		
	Chapter 6 of the law deals with the ecological balance of the environment and the fact that it is not allowed to replace the established quality standards with reduced standards.	Unfortunately, this article, which deals with the ecological balance of the environment, is violated, so floods and so on. processes intensify. Non-compliance with the law causes significant damage to the environment, human health and the economy. For the implementation of this article of the law, a special action program should be created, inter-agency coordination and information exchange should be strengthened, and joint coordinating bodies should be established.	Although the relevant orders and decisions issued by the Cabinet of Ministers and relevant ministries, local executive bodies are directed against the expansion of these processes, it is still impossible to completely prevent the process.	Appropriate mechanisms can be developed by the project to achieve the elimination of illegal activities that increase the impact of dangerous events and violate the ecological balance of the environment.
	Chapter 7 of the law defines the environmental requirements for economic and other activities, the use of natural resources. At the same time, the law stipulates environmental requirements and obligations for the construction of enterprises and facilities.	It is often allowed that the requirements of the law are not fully complied with. To prevent such cases, the legislative framework needs to be further improved and operational.	Although the relevant orders and decisions issued by the Cabinet of Ministers and relevant ministries, local executive bodies are directed against the expansion of these processes, it is still impossible to completely prevent the process.	It would be important for the project to develop mechanisms for the implementation of legislation in this area in accordance with international principles in order to protect natural resources and prevent the further increase of dangerous events as a result of human activities in this area
	Chapter 8 of the law deals with the importance of environmental expertise for the implementation of any activity (urban planning, construction of enterprises, use of land).	It should be noted that although this process is generally followed by large projects, such activities are carried out in the coastal areas of rivers and large reservoirs where natural disasters occur without the consent of the population and individual farms. For	Although the relevant orders and decisions issued by the Cabinet of Ministers and relevant ministries, local executive bodies are directed against the expansion of these processes, it is still impossible to completely prevent the process.	In order to comply with environmental expertise and other environmental requirements in different areas, the project may developneeded bylows and regulatory acts.

		example, such activities are common on any river bank and river protection zones are interfered with. To prevent such cases, the legislative framework needs to be further improved and operational.		
	Chapter 9 of the law envisages work such as education, enlightenment, research and information. The application of this law helps people to learn more about the environment and its protection.	Although the application of this law will help people to learn more about the environment and its protection, there is a need to continue work to raise awareness about participation in environmental protection. To prevent such cases, the legislative framework needs to be further improved and operational.	A lot of work has been done in this area. A national law on access to information on the state of the environment has been adopted, and Azerbaijan is also working to obtain information in accordance with international principles by acceding to the Aarhus Convention.	Of course, the project may considers it appropriate to develop awareness rising strategies and also some activities in sphere of involvement stakeholders in this process.
	Article 65 of Chapter 20 of the Law deals with the requirements for emergency ecological conditions and ecological disaster zones.	Violation of the ecological situation and the emergence of disaster zones have a direct impact on human health and the economy, and therefore in the event of natural disasters, it is important to analyze the ecological situation in the areas and determine the ecological disaster zones in accordance with the law. Restrictions should be placed on activities in those areas.	Although the relevant orders and decisions issued by the Cabinet of Ministers and relevant ministries, local executive bodies are directed against the expansion of these processes, it is still impossible to completely prevent the process. Legislation is often violated by the population, illegal economic entities are created, and the placement of these facilities in ecological disaster zones often creates serious problems.	To eliminate the problems that may arise in the sphere of environmental disaster tt is advisable for the project to support to develop guidances for identification of areas where various levels of environmental disasters can occur and the development of an appropriate mechanism for compliance with the legislation in those areas.
	Chapter 21 of the law is about control over environmental protection. The damage caused to the environment as a result of natural and anthropogenic impacts and the importance of their prevention are discussed.	Due to the lack of compliance with environmental legislation, natural disasters (floods, landslides, landslides) are exacerbated and the damage they cause is great. In order to comply with the requirements of the legislation, an appropriate action plan should be developed, inter-agency	Although the relevant orders and decisions issued by the Cabinet of Ministers and relevant ministries, local executive bodies are directed against the expansion of these processes, it is still impossible to completely prevent the process.	There is a need by support of the project to develop a mechanism for joint action between environmental control agencies and other entities cooperating in these projects to minimize disasters.

		coordination and information exchange should be strengthened, and joint coordinating bodies should be established.		
Regulations on the Ministry of Emergency Situations of the Republic of Azerbaijan	The Ministry of Emergency Situations of the Republic of Azerbaijan (hereinafter the Ministry) is responsible for civil defense, natural (geophysical, geological, meteorological, hydrological, marine-hydrological, natural fires, etc.), prevention and elimination of the consequences of emergencies, etc. Central Executive Office, which develops policy and regulation, manages, coordinates and supervises in these areas, organizes rapid response to emergencies or emergencies, and protects strategically important enterprises, facilities and installations exposed to natural, man-made and terrorist threats. is a body of power. 2. The Ministry is guided by the Constitution of the Azerbaijan Republic, laws of the Azerbaijan Republic, decrees and orders of the President of the Azerbaijan Republic, decisions and orders of the Cabinet of Ministers of the Azerbaijan Republic, international agreements to which the Azerbaijan Republic is a party. 3. In performing its duties and exercising its rights, the Ministry shall interact with other executive authorities, local self-government bodies and non-governmental organizations.		The activities of the Ministry are as follows: • develops and ensures the implementation of state policy and regulation in the field of civil defense, protection of the population and territories from emergencies, etc .; • Coordinates the activities of central and local executive authorities in the field of civil defense, protection of the population and territories from emergencies, etc., as well as within the framework of a unified state system for the prevention and elimination of the consequences of emergencies • organizes and implements civil defense, protection of the population and territories from emergencies and fires, prevention and elimination of the consequences of emergencies;	Supported by the project can relate to strengthening of eforts in below spheres: • To ensure the implementation of the National Concept of the Republic of Azerbaijan and other state programs related to the prevention and elimination of the consequences of emergencies; • Organize the development of the general scheme of construction (location) of protection against natural disasters of geological and hydrogeological nature; • Establishment of a material resource fund in order to ensure efficiency in dealing with the consequences of emergencies; • Organize the design and control of the construction of flood protection zones in order to identify flood and flood zones and carry out shore protection works; • Organize the preparation of mobilization measures for civil defense of central and local executive

	4. The Ministry has an independent balance sheet, state property, treasury and bank accounts at its disposal in accordance with the legislation, a stamp with the image of the State Emblem of the Republic of Azerbaijan and its name, relevant stamps and forms, flags and symbols. 5. Maintenance costs and activities of the Ministry are financed from the state budget of the Republic of Azerbaijan and other sources that do not contradict the existing legislation.			authorities, local self-government bodies; • Ensure the establishment of a local warning system in areas where potentially hazardous facilities are located; • To ensure the creation of a special purpose automated electronic information system for mass forecasting of emergencies, taking preventive measures, operative informing of the population and implementation of other complex measures; • To ensure the establishment of the "Geographical Information System for Emergency Management" (GIS) covering the entire territory of the Republic of Azerbaijan in order to organize the prevention and elimination of the consequences of emergencies; • Establish and manage a rapid response corps to deal with the consequences of emergencies; • Implement necessary measures to establish an emergency forecasting and monitoring system; • To use television and radio broadcasting channels in

				accordance with the legislation for the purpose of operative informing of the population in case of natural emergencies • To ensure the application of modern techniques and technologies in the field of prevention of emergencies and elimination of the consequences of emergencies, taking into account international experience;
Azerbaijan Water Code	Regulates relations related to the use and protection of water bodies and their water resources. Article 92. On prevention of harmful effects of water and elimination of its consequences. It is noted that the relevant executive authority and users of water bodies: floods, inundation and flooding; take appropriate measures to prevent soil erosion, landslides and subsidence, floods and other harmful events and eliminate their consequences. In order to prevent the harmful effects of water and eliminate its consequences, special commissions shall be established by the relevant executive authorities in cases provided for by the legislation of the Republic of Azerbaijan. Decisions made by these commissions within their competence are binding on individuals and legal entities. Relevant executive authorities and	It should be noted that such activities are exacerbated by floods in the coastal areas of rivers and large reservoirs, where natural disasters occur, without the consent of the population and individual farms. For example, settlements, economic activities, etc. are common on any river bank, and river protection zones are invaded. To prevent such cases, the legislative framework needs to be further improved and operational.	Article 17 states that the management system in the field of use and protection of water bodies includes the relevant executive authorities of the Republic of Azerbaijan, users of water bodies and municipalities authorized by them in accordance with the legislation, and they carry out relevant activities in this field. Article 27 states that in order to determine the compliance of construction and reconstruction projects of economic and other facilities affecting the condition of water bodies with the relevant standards, technical conditions and requirements, construction projects in accordance with the Law of the Republic of Azerbaijan "On Environmental Impact Assessment" An environmental impact assessment (EIA) document is prepared and the state environmental review of this document is carried out by the relevant executive authorities in accordance with the Law of the Republic of Azerbaijan "On	The project can support to determin the steps to be taken in accordance with Article 17 of the Water Code to create a management system to prevent and eliminate the harmful effects of water and to conduct environmental assessments in accordance with the law on activities that may affect the extremal events connected with water

	municipalities shall organize the prevention and elimination of accidents caused by floods and heavy floods in the territory of territorial units. [49] In the event of a natural disaster or accident at water bodies, water body users must take part in measures to prevent the harmful effects of water and eliminate its consequences. These measures are taken in coordination with the relevant executive authorities and municipalities. Relations related to the use and protection of water bodies and their water resources (water relations) are regulated by the water legislation of the Azerbaijan Republic.		Environmental Protection". [12]	
Draft National Water Strategy	The Draft National Water Strategy includes three, six-year periods and addresses the main water management issues based on integrated water resource management (IWRM) principles. It stress the necessity of improvement of monitoring and forecasting system as the main chain in the area of water security. Planning and management of water resources in the draft strategy is based on the basin approach of EY Watter Framework Directive	In order to apply IWRM approach, it is important to adopt the National Water Strategy and Water Strategy Action plan and implement it accordingly. Lack of a basin approach mechanism creates numerous problems in water resources management in reneral and flood impact reduction in particular.	Article 10 of the strategy is about flood risk reduction. It indicates that increasing institutional capacity for disaster risk management related to the implementation of flood risk management is critically important. Effective management relates to better management and reduction of the effects of water-related disasters. High-risk areas should be identified, and an early warning system should be set up in response to floods and landslides. A disaster response plan should be developed for each priority area, and there is need to conduct public awareness campaigns. The aim is to minimize the material damage caused by floods and other water-related disasters and to ensure human safety. In addition to flood relief and assistance to population damaged by floods, the	The project can help to apply IWRM approach to adopt and implement the National Water Strategy and Water Strategy Action plan. It can also help to develop a basin approach mechnaism to manage water resources and floods. It would be important that the National Early Warning System to be developed by the project pay due consideration to flooding.

			strategy outlines a range of activities to mitigate the effects of water-related disasters.	
National Drought Policy	The ultimate goal of a National Drought Policy is to create efficient drought-resilient societies that would make it mandatory to provide safety nets, such as insurance for the victims of droughts and financial assistance. It is important to initiate such policies as climate change is unfolding, resulting in drought becoming more intense and frequent. The concern regarding lack of preparedness, mitigation and inappropriate drought management policy around the world is now a serious issue. An effective risk management strategy combines natural (hazard) and social (vulnerability) factors, which are considered during drought management. A risk management approach focuses on predisaster activities predicting hazard and vulnerability of drought for preparedness and mitigation measures. The approach is believed to increase resilience of drought in the society, if the strategies are followed. It is also important to develop a drought management plan in order to have a concrete plan for responding to drought events. Risk management as a strategy helps to undertake actions by preparing for the disaster through prediction and early warnings. In addition, the risk management method is	Lack of drought forecasts and actions to respond to droughts in different sectors that take into account drought impacts leads to serious drought related water shortages, crop reduction, desertification and additional economic and environmental damages. The impact, frequency and spread of droughts in Azerbaijan have intensified in the past decades, and a recent drought in the 2014 crop growing season caused severe food shortages. Drought management requires attaching a high priority to sustainable water management and taking a step forward toward mitigating and addressing the issues of water insecurity and drought. The ultimate goal should be to create efficient drought-resilient societies that would make it mandatory to provide safety nets, such as insurance for the victims, financial assistance and provide lost items. It is necessary to initiate such policies as climate change is unfolding, resulting in drought becoming more intense and frequent. As the concern regarding lack of preparedness, mitigation and inappropriate drought management policy is now a serious issue. It is also necessary to specify courses of action	Section 5 of the draft drought management policy is focused on forecasting of droughts based on precipitations prediction. Section 6 of the draft policy is about drought early warning. According to the policy, one of the main objectives of the NHMS of MENR is to establish a reliable early warning system based on appropriate indicators and thresholds that classify drought stages according to drought intensity and impact severity. It is shown that the main objective of the early warning system is to provide timely warnings about the following: • Actual drought status in real time to enable decision-makers (Drought Committee) to take adequate measures (e.g. arrange a meeting of the Drought Committee) • Drought severity for stakeholders (e.g. farmers) that could be potentially affected by drought, currently or in the near future, enabling them to take appropriate measures (e.g. activation of irrigation systems) Early warnings should be provided according to time period (adjusted according to stakeholder requirements): ○ short-term warnings (1-7 days) ○ medium-term warnings (10-15 days) ○ seasonal forecasting (3-6 months)	To obtain timely information and a sufficient amount of spatial data about the actual drought situation, this project can help to analyze the existing monitoring network for drought indicators that can be sufficient for efficiency of the drought early warning system. Additionally, this project can help to develop agricultural drought monitoring methods by use of remote sensing data for the appropriate early warning of droughts before irreversible crop yield loss and/or quality degradation occur. This project will develop a mechanism to deliver early warnings to the general public, by use of existing technical means that are being applied to other types of warnings (e.g. floods).

	for protection and to mitigate future occurrence.	and a concrete plan for responding to drought events. Risk management is a very important facet of drought planning as it is a strategy to help to undertake actions by preparing for the disaster through prediction and early warnings. In addition, the risk management method is for protection, to mitigate future occurrence.		
To accomplish UN SDGs, the government of Azerbaijan published "Azerbaijan 2020: Look into the Future" Action: Environmental protection and ecological issues which included flood forecasts to respond emergencies	It is important to strengthen institutional and technical capacity on climate change adaptation regarding flood reduction. To prevent flood damage frequently occurred by climate change, it is important to establish advanced regulation and implement better disaster management strategy. This action within the strategy is focused on designation and regulation of flood risk zones and design of levee and reservoir detention.	Azerbaijan is known as a region where floods and inundations occur frequently due to climate change. Floods are concentrated in the Caucasus Mountains, which account for nearly half of the country's territory. Currently because of a lack of flood regulations and economic and population safety threats, the amount of flooding is very high.	Flood management is part of the national water strategy as well. Past and on-going efforts to address the problem include the following: establishing the Ministry of Emergency Situations in 2005, the UNDP project (2012-2017) titled "Integrating Climate Change Risks into Water and Flood Management by Vulnerable Mountainous Communities in the Greater Caucasus Region", the establishment of 12 weather stations including the highland weather station (six locations), the highland water level station (three locations), and the area-based early warning station (3 locations), the CTCN pilot study (2019-2020) titled "Strengthening Capacities to Assess Climate Change Vulnerability and Impacts to Shape Investments in Adaptation Technology for Azerbaijan's Mountain Regions", indicator-based climate change assessment for Azerbaijan's mountain regions to support decision making in adaptation planning was developed, construction of concrete barriers for flood protection through	In order to prevent flood damage frequently occurred by climate change, this project can help to establish advanced flood forecasting, regulation and management strategy. The national strategy will be needed, specifically, focused on designation and regulation of flood risk zones, design of levee and detention reservoirs, among other strategies.

			Multilateral Development Banks and the installation of concrete barriers around dangerous areas.	
Strategic Roadmap on production and processing of agricultural products in the Republic of Azerbaijan	The strategic vision by 2020 regarding development of the agricultural sector in the country, long-term vision for the period by 2025 and target vision for the period after 2025 have been reflected in the Strategic Roadmap which implies the country has a clear roadmap to be implemented in consecutive steps in order to achieve strategic development targets in the agricultural sector for both the short-term and long-term period.	The Strategic Roadmap is currently needed to increase efficiency of agricultural production and the entire agricultural sector. Actions are needed in the following areas: • Strengthen institutional capacity for provision of sustainability of the food security; • Increase production capacity of agricultural products along the value chain; • Upgrade financing mechanisms in agricultural field, develop agrarian insurance, promote attracting investments in agrarian field; • Develop the market of production means in agricultural field and upgrade provision with services; • Develop the system of science, education and extension services in the agricultural field; • Increase employment and raise welfare in rural areas; • Develop the market infrastructure of agricultural products and facilitate the access of the producers to the markets; and Environmental protection, sustainable use of natural resources and	One of the most important elements of the Strategic Roadmap is environmental protection, sustainable use of natural resources and management of the impacts of natural factors on agriculture. It is important to elaborate the mechanisms to reduce the side effects of climate change and other natural factors on agriculture, improve the mechanisms of environmental protection in the agrarian field, improve the mechanisms of sustainable use of agricultural lands and water reserves and develop environmentally friendly agricultural production In this regard, the Strategic Roadmap covers environmental protection, sustainable use of natural resources and managing the impacts of natural factors on agriculture through the following: • Development of mechanisms for minimisation of negative impacts of climate change and other natural factors on agriculture; • Improvement of mechanisms for environmental protection in the agrarian field; • Improvement of mechanisms for sustainable use of agricultural lands and water reserves; and Developing production of ecologically pure agricultural products	This project can help support the following actions outlined in the Strategic Roadmap: • Environmental protection, sustainable use of natural resources and managing the impacts of natural factors on agriculture; • Development of mechanisms for minimisation of negative impacts of climate change and other natural factors on agriculture; • Improvement of mechanisms for environmental protection in the agrarian field; and Improvement of mechanisms for sustainable use of agricultural lands and water reserves

		management of the impacts of the natural factors on environmental protection, sustainable use of natural resources and management of the impacts of natural factors on agriculture.		

Further, consultations with environmental and disaster management policy experts within the Parliament of Azerbaijan outlined the fact that most disaster management related policy, especially regarding early warning systems, were outdated, and that a significant effort should be undertaken in order to refine existing policies to be able to address the current climate and disaster profile of Azerbaijan. One key aspect of this discussion is the lack of cooperation among key stakeholders. This is not fully regulated within the existing policy in Azerbaijan, and that will have to be reviewed to ensure that cooperation and collaboration among organisations, especially related to data and activity exchange, is fostered. Also, the roles and responsibilities within the framework of an Early Warning System, are not explicitly detailed within the existing regulation, especially related to the monitoring and warning and to the communication and dissemination components. The current policy context is not harmonised with the requirements set up by the WMO MHEWS checklist.

7 Past and Ongoing Projects

There are several CIEWS initiatives that have recently being implemented in Azerbaijan. The GEF project "Integrating climate change risks into water and flood management by vulnerable mountainous communities in the Greater Caucasus region of Azerbaijan" [167] (2011-2018) worked to address the impact of climate change on risks from water stress and flooding to the vulnerable mountain communities of the Greater Caucasus Region. The project was implemented by UNDP and the main national stakeholder was the Ministry of Emergency Situations (MOES) through the State Water Agency. The project developed flood risk maps for the whole study area through the implementation of hydrological and hydraulic models; implemented flood EWS in communities at risk in the study area; and enhanced capacities of the main stakeholders related to the operation and implementation of the systems. The project's terminal evaluation recommended that the government and development partners should "continue to invest in a state-of-the-art hydro-meteorological monitoring system in Azerbaijan, in order to increase the coverage and reliability of hydrological and meteorological data collection in the country to support adaptation to climate risks in the future." The proposed GCF project will benefit greatly from some of the enhanced capacities by the GEF project, as well as by the already deployed and implemented monitoring stations and CBEWS.

[167] GEF. Integrating climate change risks into water and flood management by vulnerable mountainous communities in the Greater Caucasus region of Azerbaijan. https://www.thegef.org/project/integrating-climate-change-risks-water-and-flood-management-vulnerable-mountainous. Last accessed 10 December 2020.

The GCF Readiness project "National Adaptation Plan (NAP) Support Project for adaptation planning and implementation in Azerbaijan" (2020-2024) is supporting the Government of Azerbaijan to develop its NAP and increase capacity in climate resilience and adaptation in three priority sectors: water, agriculture, and coastal areas. Key activities of relevance to the proposed project include development of the following: web-based platform for climate information and data sharing; institutional framework for data collection, management, sharing, and use; Private Sector Participation Forum for Climate Change Adaptation (CCA); climate change risk screening tool; and financing strategy for CCA.

The CTCN project *"Strengthening capacities to assess climate change vulnerability and impacts to shape investments in adaptation technology for Azerbaijan's mountain regions"* (2018-2020) developed climate change indicators and conducted Vulnerability Impact Assessments (VIAs) for two pilot areas in Azerbaijan. The proposed project could use the established indicators for risk assessment and mapping and expand the implementation of VIAs to other locations. Furthermore, the lessons learned from the EU-funded "Prevention, Preparedness and Response to Natural and Man-made Disasters in the Eastern Partnership Countries" (PPRDEAST2)[168] will be relevant in this regard.

The current air quality monitoring network in Azerbaijan is based on outdated post-Soviet technology and does not provide real-time air quality information and thus not allow the provision of reliable air quality forecasts and early warnings. Currently, there is no air quality forecasting models in use in Azerbaijan. There have only been a few projects addressing air quality issues in Azerbaijan. The EU funded project "Upgrading the National Environmental Monitoring System (NEMS) of Azerbaijan on the base of EU best practices" [169] (November 2016 - April 2019) has enhanced the basic institutional capacity of MENR in air quality monitoring and management. Several stations have been deployed through this project, and needs assessments and plans for air quality monitoring system modernization have been undertaken, including the proposed requirement for 23 new monitoring stations, new calibration laboratory, upgrade of chemical laboratory and institutional support for modernization. The new stations deployed within the framework of this project will be incorporated into the Climate Information System and also will be paramount for the project air quality forecasting.

The EU4Climate Project [170], launched in 2019 as a response to the direct and existential threat of climate change, aims at supporting six countries (Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova, and Ukraine) to develop and implement climate-related policies based on the countries' commitments under the 2015 Paris Agreement on Climate Change, the Association and Partnership Agreements with the EU, the Eastern Partnership policy initiative "20 Deliverables for 2020" and the UN 2030 Agenda for Sustainable Development. The project is funded by the European Union and implemented by the United Nations Development

[168] EU "Prevention, Preparedness and Response to Natural and Man-made Disasters in the Eastern Partnership Countries" (PPRDEAST2), Available at: http://pprdeast2.eu/en
[169] Upgrading the National Environmental Monitoring System (NEMS) of Azerbaijan on the base of EU best practices. https://www.syke.fi/projects/nemsazerbaijan. Last accessed 10 December 2020
[170] EU4Climate Project. https://eu4climate.eu/azerbaijan/. Last accessed 10 December 2020

Programme. The project will establish concrete industry-specific guidelines for the implementation of the Paris Agreement across various sectors of the economy, including agriculture, construction and energy in each partner country. These climate-related policies will ensure that some of the climate change policies required within the framework of this project are already laid out.

The EU-funded programme *"Prevention, Preparedness and Response to natural and man-made disasters in Eastern Partnership countries – phase 3 (PPRD East 3)"* (2020-2024) aims to strengthen disaster risk reduction and crises management in the Eastern Partnership countries and to promote regional cooperation with the EU Civil Protection Mechanism. Relevant activities include improving emergency preparedness capabilities, strengthening the network of national correspondents and operational 24/7 contact points for sharing early warning information, increasing awareness on natural disasters, and strengthening engagement of civil society and academia in disaster prevention, preparedness and response.

The EU-funded project *"Upgrading the National Environmental Monitoring System (NEMS) of Azerbaijan on the bases of EU best practices"* (2016-2019) aimed to improve environmental performance in Azerbaijan, especially regarding air quality, through strengthening the NEMS to provide high-quality information for strategic policy, planning and compliance control. The project conducted a needs assessment and developed plans for modernising the air quality monitoring system. This resulted in a proposal for adding 23 new monitoring stations, the need for a new calibration laboratory, and the need to upgrade and modernise the chemical laboratory. The needs assessment has informed the design of the proposed GCF project, particularly in relation to the air quality monitoring and forecasting proposed.

The GEF Kura project, with two different phases (Kura I and Kura II)[171] (2009-2017 and 2016-2022), worked to enhance collaboration among the different countries in this transboundary river, as well as increasing integrated water resource management (IWRM) practices in the Kura River, with the priority of prioritising institutional strengthening and updating for improved, sustainable IWRM; undertaking capacity building for professional water managers across multiple sectors, increasing stakeholder awareness, education and empowerment; and improving the use of science for governance.

The World Bank funded "Azerbaijan's Second Water Supply and Sanitation Project" aimed to rehabilitate and reconstruct the water services cycle in the country, including water supply and storage systems, the sewage network and wastewater treatment in selected districts.[172] The project concluded in 2019 and provided 324,000 Azerbaijanis with improved water supply and sanitation services between 2008 and 2019. The project aligns with Azerbaijan's development policies and goals and, therefore, project outcomes are expected to achieve sustainability and impact at scale. Increased data and analysis regarding precipitation indices in Azerbaijan as a

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[171] UNDP - GEF Kura Project "Advancing Integrated Water Resource Management (IWRM) across the Kura River basin through implementation of the transboundary agreed actions and national plans".

[172] The World Bank. [Bringing Safe, Reliable and Sustainable Water Supply and Sanitation to Azerbaijan: Azerbaijan's Second Water Supply and Sanitation Project.]() Last Accessed 07 December 2020.

result of the proposed project will assist in continuing to improve Azerbaijan's sustainable management of water resources.

Regarding urbanization and climate change adaptation in Azerbaijan, the Adaptation Fund project "Urbanisation and Climate Change Adaptation in the Caspian Sea Region" is a regional adaptation project in the development stage, which includes the countries of Azerbaijan and Iran.[173] The project is comprised of four main objectives: 1) Strengthened technical and institutional capacity of regional entities, national and local governments to develop integrated coastal zone management planning with special focus on climate change adaptation planning for sustainable development of the Caspian Sea region, 2) Strengthened technical and institutional capacity of national and local governments in selected locations in Azerbaijan and Iran to develop, monitor and manage projects for resilience and climate adaptation, 3) Strengthened community and private sector awareness and capacity to implement climate change adaptation and resilience strategies and priority projects, promoting business development and employment as well as municipal revenue-generation based on adaptation measures, and 4) Improved regional and national partnerships, institutional and legal frameworks, research cooperation and knowledge management mechanisms in the Caspian region for evidenced-based localization of climate change adaptation and resilience strategies. The additional monitoring capacity that will result from the proposed CIEWS project will help facilitate the ability of the national and local governments in Azerbaijan to incorporate adaptation planning into sustainable development.

The UN-Habitat proposal to the Adaptation Fund on *"Urbanisation and Climate Change Adaptation in the Caspian Sea (Azerbaijan and Iran)"* aims to enhance climate change adaptation and resilience of local communities in the project countries through strengthened capacities and knowledge from regional to local level. Relevant proposed activities include public awareness and education on climate change risks, establishment of an early warning dashboard system in Neftchala, and establishment of a regional Climate Change Information and Knowledge Clearing House. The GCF project will complement and expand the reach of the aforementioned activities outlined in the UN-Habitat proposal.

There are some other projects that may have an impact on this project even if they are not based on Azerbaijan, particularly the GCF "Scaling-up Multi-Hazard Early Warning System and the Use of Climate Information in Georgia"[174] project. Within the framework of this project, a MHEWS is being implemented in Georgia for floods, mudflows, landslides, droughts, hail, strong-winds and avalanches. There are several synergies with this project and the Georgia GCF project, highlighting the improvement of the hydro-meteorological network and the enhancement of the local forecasting capabilities, including weather forecasting. Due to the transboundary nature of some of the watercourses in the region and also some of the hazards, this Georgia project implementation will have significant influence on the proposed project for

[173] Adaptation Fund. Urbanisation and Climate Change Adaptation in the Caspian Sea Region. Last Accessed 07 December 2020.
[174] GCF. Scaling-up Multi-Hazard Early Warning System and the Use of Climate Information in Georgia. https://www.greenclimate.fund/project/fp068. Last Accessed 10 December 2020.

Azerbaijan. Knowledge sharing and cooperation will be sought to ensure that the proposed project in Azerbaijan leverages good practices and lessons learned from the project implementation in Georgia.

8 Baseline CIEWS Arrangements, Provision, and Usage

Building on the PESTLE analysis (Section 3), a situational analysis of existing climate information and early warning systems (CIEWS) in Azerbaijan identified current strengths and weaknesses, as well as opportunities and threats that can affect the future CIEWS value chain. The results are provided in the table below.

Table 19. SWOT analysis for CIEWS in Azerbaijan

STRENGTHS	WEAKNESSES
• Extensive history of bringing environmental and societal development issues into the legislative context[175] • Existing partnerships with international institutions that can support capacity development of NHMS staff • Existing hydromet strengthening projects and initiatives that can inform and scale up CIEWS efforts through the proposed project	• Insufficient institutional and technical capacity and coordination for CIEWS – or climate adaptation in general • Insufficient hydrometeorological observation network telemetry, coverage and operational capacities • No modelling and forecasting capabilities in line with international best practices exist • Lack of integrated database/system for collection, management, and use of climate-related data • Limited downscaled data/information to determine specific baseline vulnerabilities and needs • No formal warning criteria or procedures exist
OPPORTUNITIES	**THREATS**
• Membership of the World Meteorological Organization (WMO) facilitates access to weather, water and climate data and information and related capacity development to optimise the production of hydrometeorological services • Support and commitment towards the Paris Agreement and Sustainable Development Goals at national, institutional, and individual level presents the opportunity to accelerate strengthening of CIEWS • Government of Azerbaijan has formally recognised the need to modernise NHMS and strengthen early warning systems (e.g.,	• Significant near-term and evolving vulnerability to climate-related hazards and extreme weather events • Limited financial capacity to implement climate adaptation and resilience-building interventions • Highly varied topographical and climatological context necessitates equipment, products, and services to be tailored to a vast range of locations and user groups

[175] Ernst and Young AG, 2021. GCF Readiness and Preparatory Support Proposal – Gap assessment and action plan for the International Bank of Azerbaijan to meet the GCF requirements

Fourth National Communication to the UNFCCC, Third Voluntary National Review)	• Supply chain and other market disruptions driving up the cost and/or procurement timelines of specialised hydrometeorological and early warning systems equipment

As noted above, Azerbaijan's economic sectors are highly vulnerable to climate and meteorological hazards. Floods, droughts, strong-winds, landslides, mudflows, hailstorms, extreme temperatures, air quality and high sea-waves pose a significant threat and risk to economic sectors, especially to agriculture, coastal activities, water resources and public health. As will be discussed in detail in the section below, the existing climate information and early warning systems in Azerbaijan are not able, at the moment, to provide information that can improve the resilience of these sectors to impending disasters.

One of the key resilience actions that can be undertaken is to strengthen the climate information available in Azerbaijan, in order to provide better information about the current situation; and also, to improve the existing early warning system for all of these hazards implemented in Azerbaijan. The provision of timely and accurate warnings to key actors will enhance the response capability of these actors to cope better against these disasters. It should be added, as described above, that the number of disasters is expected to increase, both in number and in severity, in the coming years due to climate change effects. It is expected that the annual average precipitation will decrease, that intense precipitation will become more severe, that droughts will become more frequent and more severe, that landslides and mudflows will occur more frequently, and that extreme temperatures will also increase. In the last years, it has been observed an increase in the magnitude of the strong-winds and in the sea-waves (caused by the strong winds), as well as an increase in the number of hailstorms.

The climate information services and early warning system in Azerbaijan has been assessed in detail. This has been undertaken through several consultations with key stakeholders and through a review of key documents and information. Also, previous initiatives in the country and in the region have been considered to analyse the gaps of the systems and to provide an assessment of needs and recommendations.

The baseline assessment for the existing early warning system in Azerbaijan have been organised following the four components of a people-centred early warning system, namely:

- **Risk Knowledge:** risk assessment exercise provides essential information to set priorities for mitigation and prevention strategies and designing early warning systems.
- **Monitoring and warning:** systems with monitoring and forecasting capabilities provide timely estimates of the potential risk faced by communities.
- **Dissemination:** communication systems are needed for delivering warning messages to the potentially affected locations. Messages need to be reliable, synthetic, and simple to be understood by authorities and the public.
- **Response:** coordination, good governance and appropriate action plans are key points in effective early warning. Likewise, public awareness and education are critical aspects of disaster mitigation.

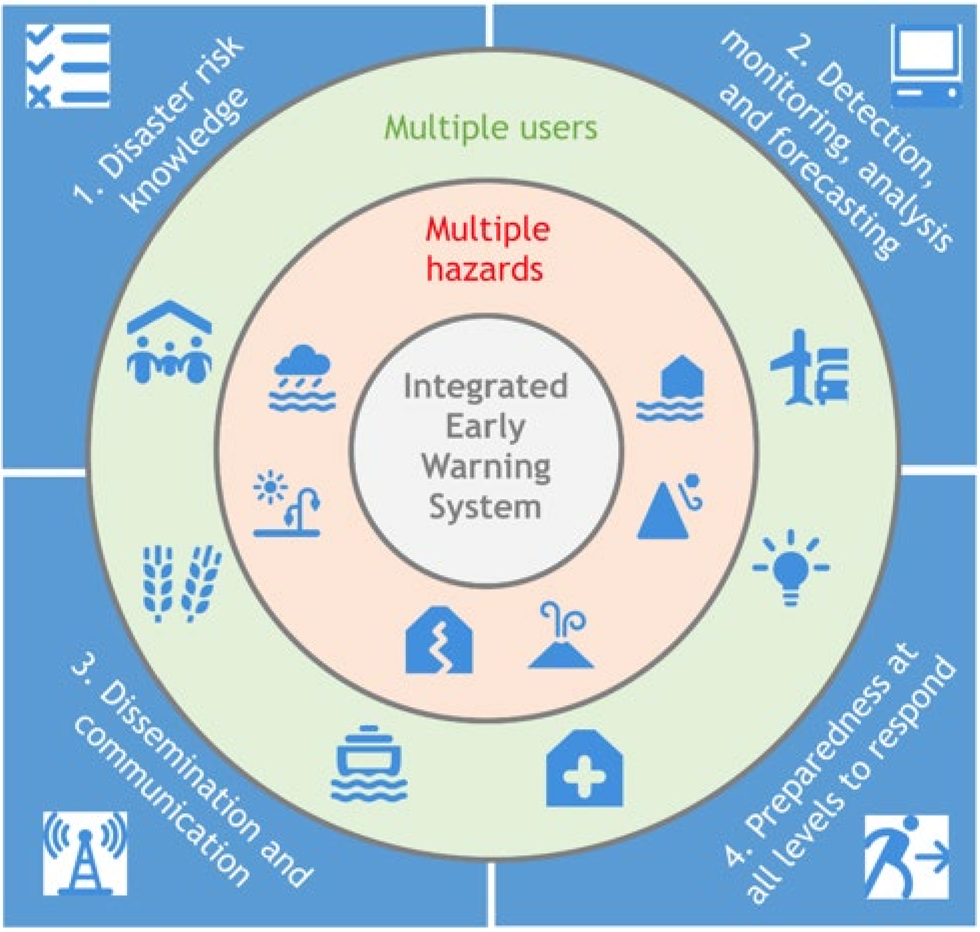

Figure 73. MHEWS four components[176]

By using this four-component approach, all of the main issues and problems will be described and assessed in a systematic way. It should be noted that in order to complement this assessment, the "Multi-hazard Early Warning Systems: A Checklist", as prepared by the partners of the International Network for Multi-hazard Early Warning Systems, was used to assess the capabilities of stakeholders in Azerbaijan for each component and each hazard. The National Hydrometeorological Service (NHMS) applied this checklist to assess their own capacities, and the results are also outlined in this section.

This checklist has been used to develop all of the activities listed below in the project activities and it is behind the main project rationale.

8.1 Institutional Arrangements

The National Hydrometeorological Service (NHMS), under the Ministry of Ecology and Natural Resources (MENR), is the main institution responsible for providing weather, climate and water information, forecasts and warnings, and relevant services for the public and key economic

[176] WMO MHEWS Components

sectors in Azerbaijan.[177] In addition, the Ministry of Emergency Situations (MoES) is the main focal point for disaster risk reduction and management in Azerbaijan. This work is carried out through the Crisis Management Center,[178] with regional centres supporting nationwide implementation.[179] The national EWS can be schematically presented as shown in Figure 74. It should be noted that, depending on the severity and geographic coverage of the emergency, the responsibility of the response will fall within the Ministry of Emergency Situations regional/local office or within its headquarters.

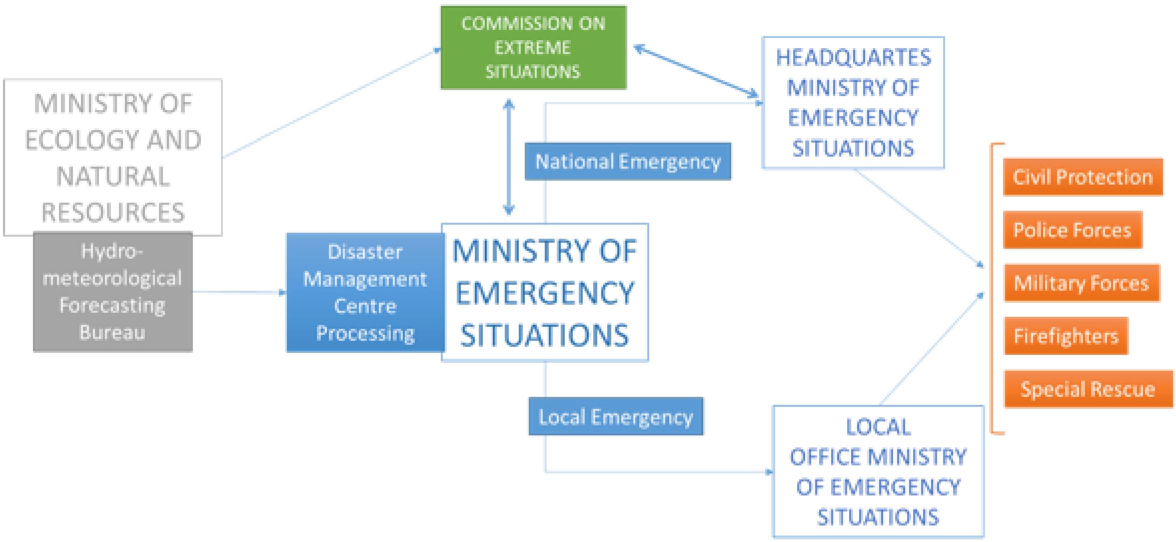

Figure 74. EWS Institutional Scheme

8.1.1 *Risk Knowledge*

From an institutional point of view, the National Hydrometeorological Service (NHMS) is the main organisation responsible for risk knowledge and management in Azerbaijan. However, no information has been found regarding risk assessment or knowledge activities by NHMS. There are some academic institutions undertaking hazard research in Azerbaijan, especially for geological hazards (mudflows and landslides). Special attention should be paid to the work of the Institute of Geography of Azerbaijan National Academy of Sciences on the landslide and mudflow hazard assessment (Figure 75).

[177] Republic of Azerbaijan, 2020. Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan
[178] Ministry of Emergency Situations, 2023. Crisis Management Center. Available at: https://bvim.fhn.gov.az/organizations.php
[179] CAREC, 2022. Country Risk Profile – Azerbaijan

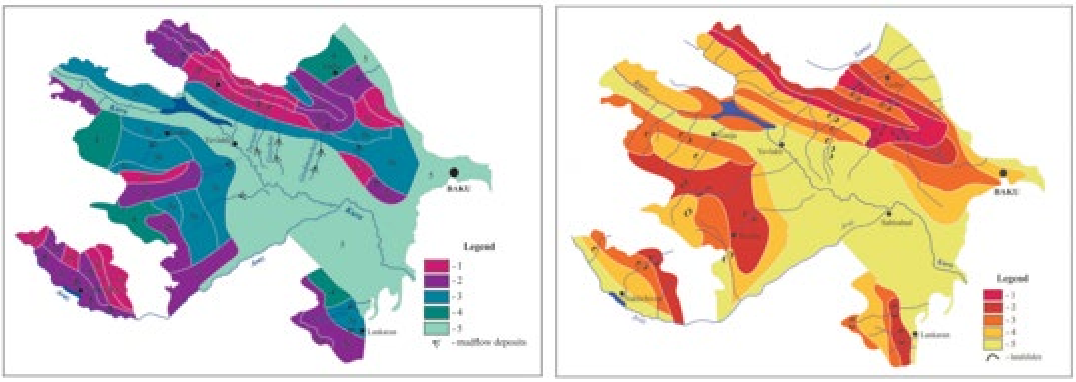

Figure 75. Azerbaijan mudflows and landslide hazard maps.[180] Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

8.1.2 *Monitoring and Forecasting*

The Ministry of Ecology and Natural Resources (MOENR), supported by the NHMS, is the main organisation responsible for the provision of monitoring and forecasting information in Azerbaijan. The basic functions of the NHMS are studying and forecasting of the hydro-meteorological phenomena and processes.

8.1.3 *Communication and Dissemination*

The dissemination responsibility falls within both the MOES and the MOENR. The MOENR, through its NHMS, delivers a daily bulletin with forecasting and warning information directly to:

1. Crisis Management Centre of the MOES
2. Commission of Extreme Situations (CES)
3. Mass Media

In the other hand, the MOES also has a significant role within the dissemination component. When emergencies, both at regional or national level, regional MOES centres (Figure 76) are notified by the MOES headquarters in Baku. From these regional centres, regional dissemination is undertaken. Within every community there are two designated people to be contacted by the MOES regional centres (by mobile phone) when required.

[180] Natural and anthropogenic factors in hazard assessment of the Alpine–Himalayan montane ecosystems (at the example of the Azerbaijan Caucasus). Elina KarimovaIrina KuchinskayaIrina KuchinskayaStara TarikhazerStara Tarikhazer. Comptes rendus de l'Academie Bulgare des Sciences. Tome 72, No 9, 20192019.

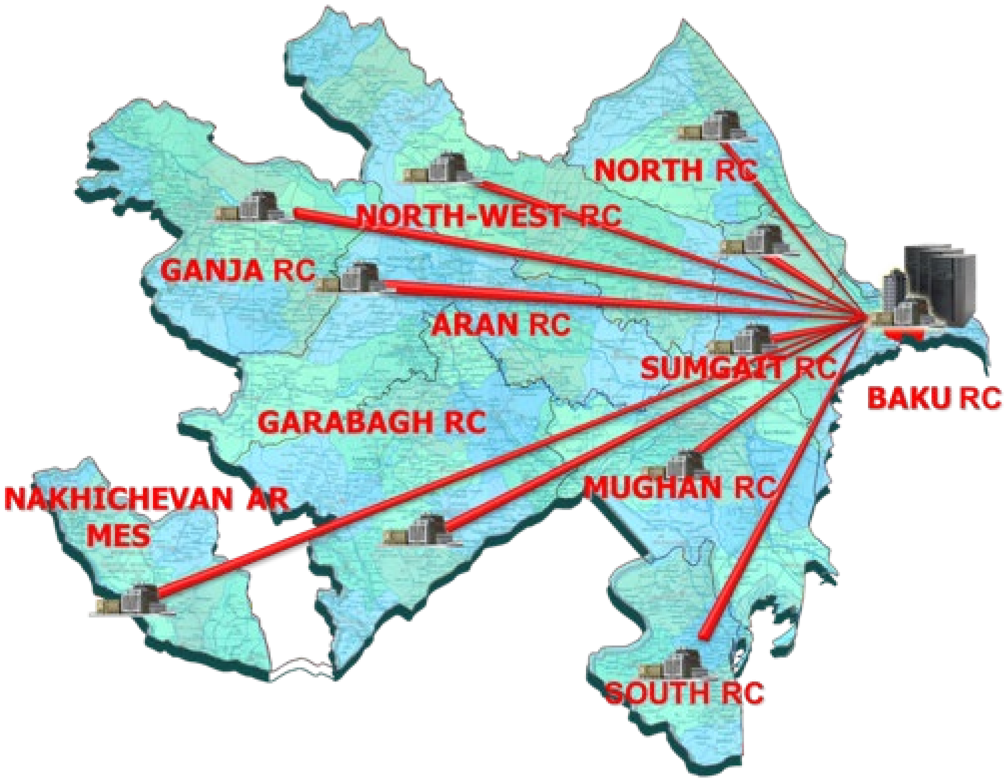

Figure 76. MOES regional centres. Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

8.1.4 *Response*

The responsibility for the response component falls entirely within the MOES. The scale of the response depends on the severity of the event, with the involvement of regional offices for minor events, while the MoES headquarters are involved in extreme events and when the event impacts on more than one region. There is also a code of ethics for all MOES employees to be followed during these events too.

The action plan stipulates several stages in the response to disasters, as follows:

1. Ministry of Emergency Situations informed: including the following list of actions:
    a. Extraordinary events have occurred, and the Ministry is informed.
    b. Information about the expected weather conditions and forecasts is gathered.
    c. If this is related to a flood event, hydrological information is gathered too.
    d. Information about exogenous geological processes is gathered in case of geological disasters.
    e. Information about the geodynamic conditions of the country's territory is gathered too if pertinent.
    f. Formation of the Crisis Management Centre within MOES.
2. Information being sent to the Ministry of Ecology and Natural Resources
    a. Information about the extraordinary events that took place is being sent to the Ministry of Ecology and Natural Resources, including information about the property damages, accidents and other relevant information

3. Remedial actions in the field of prevention of emergency situations: including actions such as:
    a. Forecasting of the current situation, notification of the disaster, and mitigation and/or elimination of the impact of the natural disasters, conducting research on the engineering-geological and hydro-meteorological aspects of the disaster.
4. Measures to eliminate the consequences of emergency situations: including actions such as
    a. Analysis of the available forces and means for the elimination of the impact of the disaster
    b. Natural and man-made actions necessary to gather data in the impacted area
    c. Weather conditions during the disaster event and reasons for the failure to provide necessary information in a timely manner

Also, contact telephone numbers for all of the key stakeholders are listed in the action plan, including:

- Ministry of Emergency Situations:
    1. General administration of the emergency prevention
    2. Crisis Management Center
    3. Department of elimination of consequences of emergency situations
    4. Special Risk Rescue Service
- Ministry of Ecology and Natural Resources:
    1. The National Geological Exploration Service
    2. National Hydrometeorological Service
    3. National Environmental Monitoring Department
    4. Caspian Complex Environmental Monitoring Department
    5. Department of Forestry
    6. Emergency Response Center

8.2 Risk Knowledge

The risk knowledge assessment should collect information about the existing and predicted hazards, ensure that this information is fully distributed to key stakeholders and to the general population, and that institutional arrangements are suitable for the maintenance and revision of this component. Unfortunately, no systematic risk assessments for any of the hazards considered are available in Azerbaijan. Detailed and up-to-date information on all dimensions of disaster risk, including hazards, exposure, vulnerability, and coping capacity, in Azerbaijan is highly limited. There are no established methodologies for disaster risk analysis, assessment, and mapping. Roles, responsibilities, and coordination of relevant institutions remain unclear. There are also gaps in capacity of institutions to conduct multi-hazard assessments based on internationally recognised tools and methodologies. Moreover, there is no single system for recording disaster risk data and information that would facilitate the exchange and access of data to the general public and relevant institutions and stakeholders. There is also a lack of data standardization.

The current legal and institutional framework supports the collection and recording of disaster losses. However, there is no standardisation of loss indicators and the currently adopted classification on hazards and loss indicators differ from the minimum international requirements. The sharing of disaster loss data is limited both nationally and internationally. Furthermore, there is no unified methodology for collecting and recording economic losses associated with disaster events or for indirect economic losses for different sectors.[181] As a result of the above, risk knowledge is not embedded in forecasting and warning processes in Azerbaijan.

Both, the Ministry of Emergency Situations (MOES) and the Ministry of Environment and Natural Resources (MENR) have recently started some initiatives on systematic risk assessments. For instance, a collection of a flood catalogue has started, and some projects have addressed some of these gaps in certain regions in Azerbaijan.

In this respect, for instance, the GEF project in the Greater Caucasus undertook flood hazard mapping for the whole area of the project, including some locations at high risk of flooding. However, the results from this flood mapping exercise have not be disseminated, the flood hazard maps were not processed to derive flood risk maps, and the models and outputs have not been updated recently. The Academy of Science of Azerbaijan has also recently undertaken some initiatives on this respect, including the mapping of the landslides and mudflow risk areas. However, these are limited in scale and need to be updated and elaborated with a common approach in line with international standards.

In order to expand cooperation with the Ministry of Agriculture, within the framework of implementation of clause 8.3 of the "Measure Plan for 2020-2022 on ensuring the efficient use of water resources", identification of risk areas that are sensitive to climate change and showing signs of desertification and creation of a database, mapping and integration into the Electronic Agricultural Information System (EKTIS) are planned. For this purpose, multi-year agrometeorological data of Ismayilli, Goychay, Shabran, Sabirabad, Imishli, Gabala regions were analyzed, meta data of agrometeorological services were prepared and presented to the Ministry of Agriculture.

8.3 Observations, Forecasting and Warning Dissemination and Communication

The following baseline assessment of Azerbaijan National Hydrometeorological Service (NHMS) was prepared by experts from the Finnish Meteorological Institute and the French International Office for Water (OIEau), who conducted country missions in December 2022 and January 2023 respectively. The missions were supported by the EU-funded Twinning project *"Strengthening hydrometeorological and climate services in Azerbaijan".*

[181] PPRD East 2, 2016. Country Profile – Azerbaijan

8.3.1 *Observation Network*

Hydrometeorological and climate observations

Table 20. Hydrometeorological and climate observations

Hydrometeorological and climate observations (OSCAR/Surface)		
Station type	**No. stations**	**Operational status**
Automatic Weather Station (AWS)	51/73 stations are AWS (Vaisala)	AWS are operational 24/7 - reporting frequency 3 h
Aircraft meteorological station	Aviation weather services not included in NHMS's service portfolio	-
Climatological station	13	3 h
Precipitation station	2 (weather radar) reporting to OSCAR	3 h
Radar wind profiler	-	-
Sea profiling station	-	-
Surface land meteorological station (SYNOP)	73	3 h
Surface marine meteorological station (SYNOP)	4	3h
Upper air / PILOT station	-	-
Upper air / Radiosonde station	1*	-
Weather radar (specify type)	3 old, 2 new (C-Band, Doppler, Dual radars, Baron)	24/7 operational

** Existing radiosounding system capable of operational observations. No observations are made due to lack of sensors and balloons.*

In-situ observation and monitoring network:

- The hydrometeorological observation network consists of 73 operational surface land meteorological stations (SYNOP) – including 51 automatic weather stations (AWS), 13 climatological stations, 4 surface marine meteorological stations, and 88 hydrological stations. There is one existing upper-air radiosonde station capable of operational observations; however, not observations are made due to lack of sensors and balloons.
- There are 5 reference-level air quality stations and one mobile air quality laboratory. The NHMS is capable of measuring and monitoring variables such as $PM_{10,2.5}$, SO_2, NO and organic substances. Air quality information is used by the Ministry of Health and MENR to assess the impact of air pollution on health and mortality, and to prepare reports for international organisations.

Remote sensing:

- There are five operational weather radar systems, including two C-band Doppler radars with dual-polarisation capability. The remaining three radars are old Soviet MRL-5 systems, which have no dual-polarisation capacity and are poorly maintained.

- Remote sensing information for cloud cover and atmospheric water vapour content is obtained from EUMETSAT. In addition, snow cover satellite images are used for qualitative information. No satellite precipitation estimates, satellite soil moisture, satellite land cover or satellite snow cover information are currently used for forecasting. Remote sensing information is used by NHMS in a qualitative manner for rudimentary forecasting purposes and is therefore not useful in the context of an early warning system.

- The Space Agency of the Republic of Azerbaijan (Azercosmos), under the Ministry of Digital Development and Transport, operates an Earth observation satellite and has access to data from several partner satellites. Satellite data from Azercosmos is not used by the NHMS, which relies on data from EUMETSAT.

The NHMS of Azerbaijan has a functional radiosounding station with manual balloon launch. Today, the soundings are not made operationally due to lack of radiosensors and balloons. In addition to investment in observational infrastructure and capability, sustainable utilization of radiosounding stations depends on appropriate budget for consumable parts such as balloon and sensors. The NHMS is advised to include procurement of a small storage of consumable parts to ensure the operation of radiosounding stations.

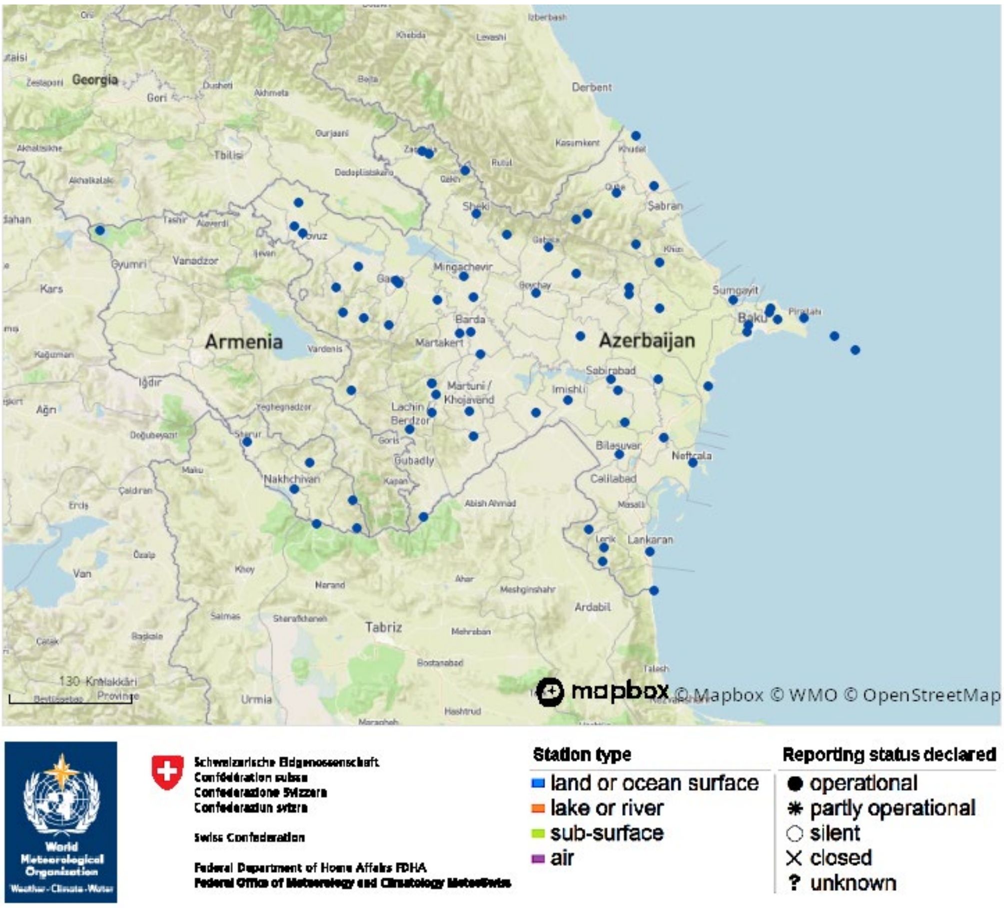

Figure 77.75 observation stations registered to provide synoptic observation data to WMO OSCAR database. 23 stations report 3h SYNOP observations to the database. (Source: WMO OSCAR, 2022)

Figure 78. Radiosounding system in a test use in Mashtaga

Agrometeorological observations

Agrometeorological data are obtained in 16 hydrometeorological and 13 agrometeorological stations located in the agriculturally important regions of the country, both with traditional devices and automatic stations. Agrometeorological observations include average, maximum, minimum air temperatures; soil surface temperatures and information about temperatures of different soil depths; soil moisture; amount of precipitation; snow height; wind speed and direction; relative humidity; lack of humidity.

Starting from 2020, with the aim of implementing measure 7.1.2 (Improvement of the agrometeorological database) of the Strategic Roadmap for the production and processing of agricultural products in the Republic of Azerbaijan, approved by the Decree of the President of the Republic of Azerbaijan No. 1138 dated December 6, 2016 , 10 agrometeorological stations have started to operate across the Guba, Shamakhi, Ganja, Goranboy, Gabala, Jafarkhan, Imishli, Beylagan, Goytepe, and Lankaran regions. In 2022, 1 automatic agrometeorological station was installed in the area where the "Smart Village" project was implemented in the village of Agalı, Zangilan district.

Hydrological and hydrometric observations

Table 21. Hydrological and hydrometric observations

Hydrological and hydrometric observations		
Station type	**No. stations**	**Operational status**
Streamflow station	40 (automatic) 48 (manual)	TBC

Snow gauge	-	-
Evaporation station	-	-
Mobile discharge meter	-	-

Air quality monitoring

Table 22. Air quality monitoring

Air Quality Monitoring (AQM)		
Station type	**No. stations**	**Operational status**
Reference-grade AQM	5	24/7
Mobile AQM	1	Operational on demand
Low-cost AQM sensors	-	-
Satellite AQM	-	-

During years 2016-2019, an EU-funded Twinning project aiming to build air quality monitoring and service capacity was carried out together with the Department of Monitoring, (Ministry of Ecology and Natural Resources – MENR) which was later, after the Twinning project was finalized, merged into the National Hydrometeorological Service of Azerbaijan (NHMS). After the project implementation, 5 reference level air quality stations and one mobile air quality laboratory were procured and installed. Today, NHMS of Azerbaijan is capable of measuring and monitoring variables such as $PM_{10,\ 2.5}$, SO_2, NO_x and organic substances. All air quality activities (services and monitoring) will be transferred to Caspian ecological monitoring complex by the end of year 2022.

Table 23. Location and measured parameters for automatic reference-grade air quality monitoring stations

Location	Station coordinates		Measured parameters
	Latitude	Longitude	
Baku city, Sabail district, Bayil slope	40° 20 58.8	49° 40 38.0	Carbon monoxide,CO Sulfur gas,SO_2 Hydrogen sulfide,H_2S Nitrogen oxide,NO, NO_2, NO_X Dust (PM2.5) Ozone,O_3
Baku city, Babek Ave. 66	40° 23 30.5	49° 55 07.7	Carbon monoxide,CO Sulfur gas,SO_2 Hydrogen sulfide,H_2S Nitrogen oxide, NO, NO_2, NO_X Dust (PM10) Polycyclic aromatic hydrocarbons (benzol, tooluol, ethylbenzol, xylol)
Baku city, G. Garayev Ave. 71	40° 24 33.9	49° 56 45.4	Carbon monoxide,CO Sulfur gas,SO_2 Hydrogen sulfide,H_2S Nitrogen oxide, NO, NO_2, NO_X

			Dust (PM10)
Sumgayit city, S. Vurgun Street	40° 36 31.8	49° 38 18.1	Carbon monoxide, CO Sulfur gas, SO_2 Hydrogen sulfide, H_2S Nitrogen oxide, NO, NO_2, NO_X Dust (PM2.5) Ozone, O_3
Ganja city, May 28 Street	40° 40 47.0	46° 19 06.2	Carbon monoxide, CO Sulfur gas, SO_2 Hydrogen sulfide, H_2S Nitrogen oxide, NO, NO_2, NO_X Dust (PM2.5) Ozone, O_3

Landslide monitoring

Video cameras are located at measurement stations. Such monitoring information may be used for this purpose. No dedicated monitoring measures are available.

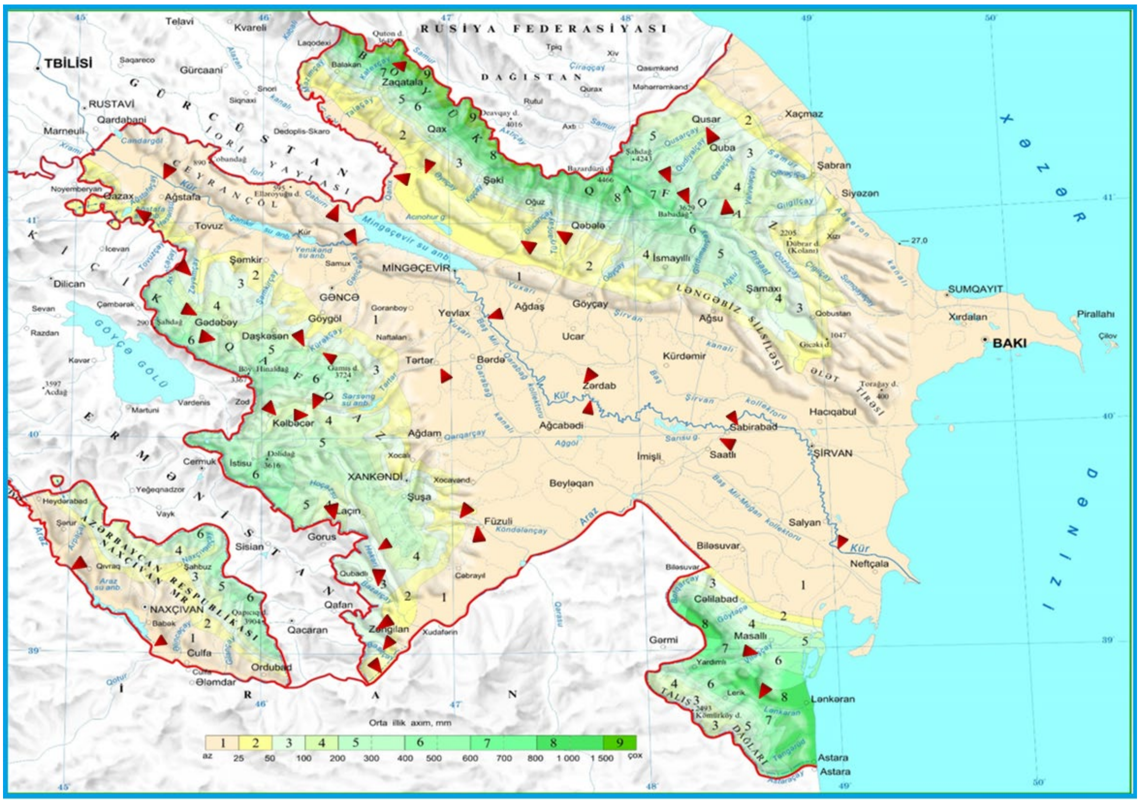

Figure 79. Location of landslide video cameras situated at measurement stations

Overall observation network and capabilities

Maintenance of AWS and weather radars (automated observation infrastructure in general) is based on manuals (translated into Azeri language) provided by manufacturers. No SOPs are available. Subsequently, no maintenance and calibration plan available for automatic weather stations nor weather radars. Currently, only biannual oil change is carried out for radars.

Staff members are trained by the manufacturers during installations. One training session can be sufficient when a person has relevant technical pre-skills. However, one training on maintenance is not considered sufficient when job profile changes from manual observation to maintenance of automated observation sensors. Developing the required capacity and confidence level on weather radar maintenance and calibration requires a couple of years of practicing. Such long-lasting training can, as an example, be gained through mentor-trainee hands-on working methods. Benchmarking AWS and weather radar maintenance and calibration procedures, SOPs and staff training (including mentor-trainee method) will be beneficial in building understanding how to organize maintenance and training for staff members responsible for automatic observations.

Change management and life cycle planning are non-existent for automated observation infrastructure (including AWS, radars). Data quality control of automated observations is missing as there are no guidelines in place nor sufficiently skilled personnel. The NHMS has no storage for spare parts for weather radars nor spare sensors for AWS. It is recommended to contact Baron, the weather radar manufacturer, to get a list of required spare parts for 1, 5, and 10 years preventive maintenance if such work is done by NHMS itself. The procurement process for spare parts is relatively long due to procurement legislation in Azerbaijan and delivery times once the order has been received. Once maintenance and life cycle plan for automated observations is in place, procurement of spare parts and sensors may be included in development projects.

8.3.2 *Data collection practices and capabilities*

There is no existing policy for data management of automatic sensors, and subsequently, they are not stored at all. The required storage IT infrastructure is missing.

Station metadata is not collected and is non-existent. A database for such information is non-existent. This issue is reflected as an inability to provide information on sensors at each station, and thus, it is not possible to report the level of automatization per station.

Manual data control procedures are available for SYNOP observation. Observations from modern automatic stations are stored only as SYNOP information. No higher resolution data is stored due to old-fashioned software for data collection at stations, non-existing infrastructure and database, and the capacity of staff. No data quality assurance for modern AWS exists.

All historical data is stored in digital format in 3 h frequency in templates including 23 (manual) / 26 (automatic) variables.

Forecasters at NHMS use a web-based portal for data visualisation, which requires a commercial contract. The portal contains external model data (e.g., ECMWF and WRF), but does not include observational data. Local observations are collected manually by technicians and plotted into sheets for the forecasters.

Weather radar data is visualized in the newly established Hydromet Situation Centre. No composites are available, but rather, observations from each radar are monitored separately. Near-real time data is not available in the forecasting centre. The operational status of weather radars is monitored in the Situation Centre. The NHMS has no capacity to process weather radar data by itself and thus depends on the manufacturer in those terms.

Data sharing practices

NHMS of Azerbaijan has a written regulation for data sharing. The regulation supports sharing observational information. As an example, state organizations can get observational data (3 h SYNOP) free of charge. Infrastructural (modern IT hardware and software are non-existent) and staff member capabilities for data sharing, however, are limited. All data transfer (from stations to NHMS, to national or international partners) is done manually. Only 3 h SYNOP data is shared. Main data handling software is Microsoft Excel programme.

Data (3 h SYNOP) from 23 meteorological stations is manually provided to international sharing.

Vaisala NM10 software is used with the four marine automatic weather stations. NHMS is recommended to extend NM10 license to include all Vaisala automatic weather stations on land. This would increase the capability and capacity to transfer near-real time data, monitor the status of the network and receive alerts from stations as well as visualize the observations by using one software tool.

NHMS has an on-going procurement process for 12 OTT AWS including the network managing and visualizing software tool. Currently, neither the OTT nor Vaisala AWS/other automated sensors are compliant with other manufacturer's network software. Thus, the NHMS has/will have two separate network management software in use. This requires sufficient capacity building for the staff to effectively use such software tools.

Discussions about data management and transfer indicated that NHMS has an urgent need for ICT skilled personnel. It is recommended to establish a dedicated department for ICT to support modernization of observation infrastructure, and subsequently, to fully deploy the benefits from automated observations.

Under the MENR-Ministry of Agriculture Joint Action Plan for 2020-2023, item 7.1 states "Ensuring integration of inter-institutional databases, establishment of electronic information exchange on agro-meteorological data". Work on the implementation of this is ongoing.

Data and products received from external sources

No ground-based observational data available from other countries nor between authorities in Azerbaijan. Weather radar composite are available from Turkey's network through an online web page.

Communication systems used to access data and products

Data sharing to international distribution is done manually from 23 weather stations. Data is delivered to Turkey, Russia and the WMO OSCAR database.

8.3.3 *IT Infrastructure*

Existing IT infrastructure and internet connection

IT infrastructure required for automated data transfer, sharing and storing high frequency data are non-existent. There is a lack of computers in the NHMS, and thus, all staff members do not have a computer/laptop available in their shift. There is no centralized data management system and database.

IT hardware and software systems used

Vaisala NM10 at 4 marine AWS. OTT network management software to be installed along with 12 OTT AWS.

8.3.4 *Modelling and Forecasting*

The Hydrometeorological Forecasts Office (Bureau) of NHMS produces short-range and monthly weather forecasts for seven regions and Baku City and short-range marine hydrometeorological forecasts for the Caspian Sea. The products produced by the Bureau are outdated by international standards.

The NHMS does not have numerical weather prediction (NWP) capabilities, and thus no local NWP model is implemented in Azerbaijan. Presently NHMS is making use of numerical modelling weather forecasting information from the Turkish Meteorological Service (TMS) and the European Centre for Medium Weather Forecast (ECMWF). However, the information received by NHMS is just images, and there isn't any forecast model data downloaded to NHMS systems. This causes an issue in developing of modern forecast products and services, since all products needs to be manually made.

In addition, no formal model-based forecasting exists for floods, droughts, mudflows, landslides, strong winds, hailstorms, or waves. Hydrological forecasting is undertaken, but this is based on hydrological calculations and limited local expertise. No hydrological or hydraulic modelling capabilities exist within NHMS. Information from snow surveys is being used to calculate snow water equivalent (SWE) and added to the basic hydrological calculations. There is no flood forecasting system installed or used in NHMS. Some flood awareness information is provided by the European Joint Research Centre through the GloFAS website. This is an experimental and automatic product, but with some relevant information. GloFAS uses the LISFLOOD model to provide flood forecasting.

According to information gathered during the FMI expert mission and those available on http://eco.gov.az/az/hidrometeorologiya/fealiyyet-istiqametleri and http://meteo.az, the NHMS provides a range of hydrological forecasting:

- Daily flow forecast to large reservoirs (Mingachevir, Shamkir)
- 2-3 day level forecast for Kura-Surra, Shirvan and Salyan stations in the lower reaches of the Kura River
- Ten-day forecast for rivers
- Monthly forecast for rivers
- Seasonal flow forecast to large reservoirs
- Spring/summer (April-June) peak season forecast

However, most of these forecasts are qualitative or based on observed water level or discharge, with a comparison to seasonal norms. As such, they do not make it possible to precisely assess the expected flood impacts.

For Kura-Surra, Shirvan and Salyan, the level forecasts are produced based on a water-level to water-level relationship. This tool is sometimes faulty when heavy rain is observed on the intermediate basins. No hydrological (rain-flow) or hydraulic (flow-flow) modelling capabilities exist in NHMS.

There is no formal water resources/drought forecasting in Azerbaijan. Based on temperature information, information from hydrological stations, snow information and information from other ministries (Irrigation and Water Management, Azersu), the NHMS includes warnings about possible water shortages in its daily bulletin.

Currently the Hydro-meteorological Center of NHMS produces weather forecasts for 1 -3 days, 2 weeks and one month, short- range daily and medium range (2 days) weather forecasts for 7 regions of Republican Azerbaijan and Baku City and marine forecast for 2-3 days for the Caspian Sea. Forecast information about hazardous and extreme hazardous nature phenomena (strong wind, expected flood events, strong snowfall, fog and so on). Moreover, the NHMS provides information on soil moisture before spring sowing. Short- range daily and medium range (2 days) weather forecasts are made for 7 regions of Republican Azerbaijan and Baku City.

Weather bulletin is issued daily that includes the meteorological diagnosis for the last 24 hours, the detailed weather forecast for the following 24 hours, and the weather forecast for the following 5 days. Also, warnings are issued in this bulletin as well as the description previous days extreme weather-related phenomena. There are also several other products that are made either routinely or by request.

Taking into account the importance of agrometeorological observation data in determining the sowing and planting time of agricultural plants, adjusting the irrigation rate during the growing season based on temperature and precipitation, determining agrotechnical measures and harvesting time, the NHMS prepares agrometeorological bulletins for decades, multi-year climate of air temperature and precipitation indicators comparison graphs with the norm, monthly agrometeorological reviews, agrometeorological forecasts, and advice for farmers. These are posted on www.meteo.az.

The Hydro-meteorological Center products mainly consist of tables, texts, or maps but they are by western standards outdated. All the products are disseminated manually with email, facsimile etc.

The forecast products are mainly based on global and regional NWP model charts produced by bigger international forecasting centers and received through agreements with WMO or other agreements. The main system for the forecasters for viewing of data is a web-based portal provided by Turkey (TURKMETCAP), based on commercial contract. This tool enables the viewing of different model parameters over a map with zooming and moving functionalities. The portal includes for example model data from ECMWF and WRF. It doesn’t have any observation data. The local observations are collected manually in the NHMS forecast office by technicians through an email and plotted into sheets for the forecasters.

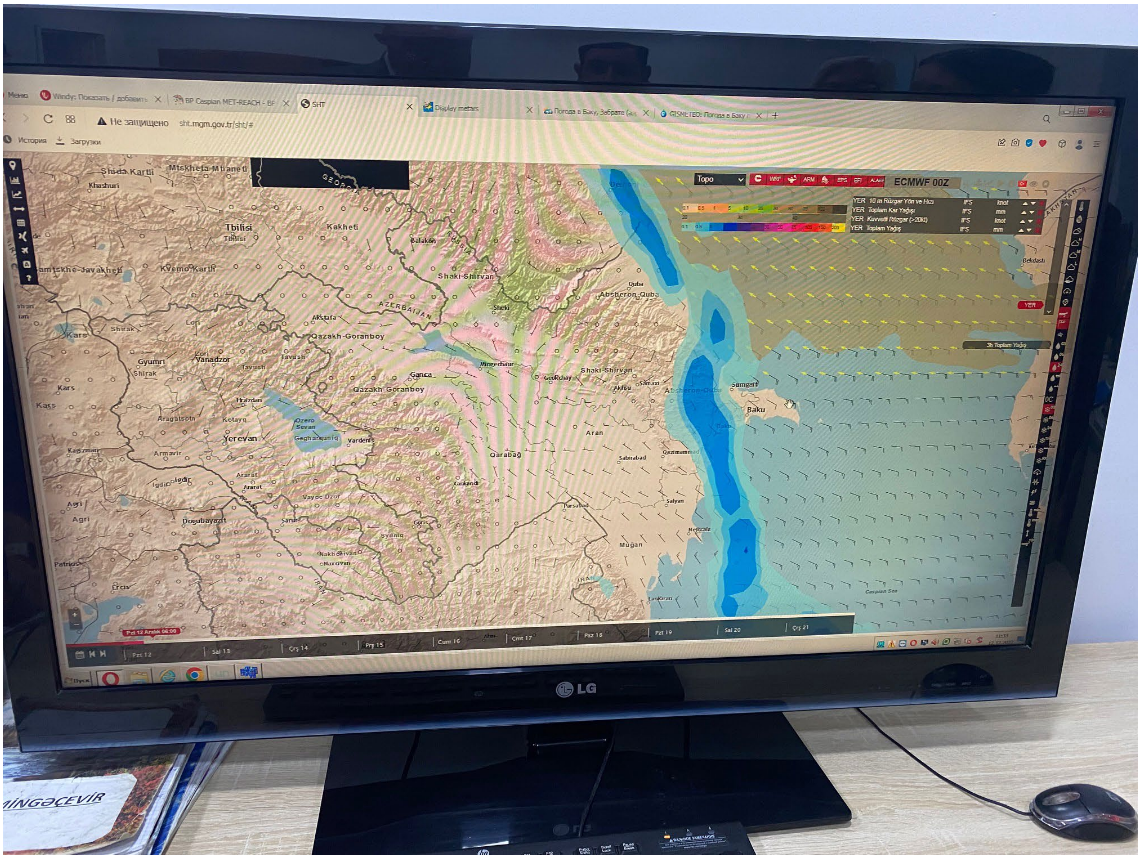

Figure 80. Web-based portal used by forecasters for model data viewing

Because the model data isn't ingested for example in GRIB-format in NHMS systems, there are only pre-defined model fields or products that forecasters use. This is also a limitation for the end user production. Any modern weather forecast production software requires numerical model data as a background data in order to automatize the forecast production. Currently especially in areas of weather forecasting and hydrology the experts need to use too much time of their work for manual tasks.

8.3.5 *Warning and advisory services*

Availability of warnings/advisories on hydrometeorological and air quality hazards

The NHMS issues weather warning from the following severe weather phenomena:

- Heavy precipitation
- Strong wind
- Wave height
- Temperature (heat and cold)

The warnings are done manually and issued together with the daily forecast. The products consist of word or pdf files, which are mainly disseminated via email / letters on a daily basis. If required, dissemination is also carried out by telephone. There is a web page for NHMS under the Ministry of Ecology and Natural Resources where simple weather forecasts are available for a few locations. However, there is no information on weather warnings. There is currently no capacity in NHMS to produce for example CAP (Common Alerting Protocol) formatted warning messages in digital platforms. Due to the lack of real-time observations (especially radiosoundings and radars) and forecaster workstation with full model data, the forecasters are incapable of producing real-time/near real-time weather warnings in rapidly developing situations such as thunderstorms and heavy showers.

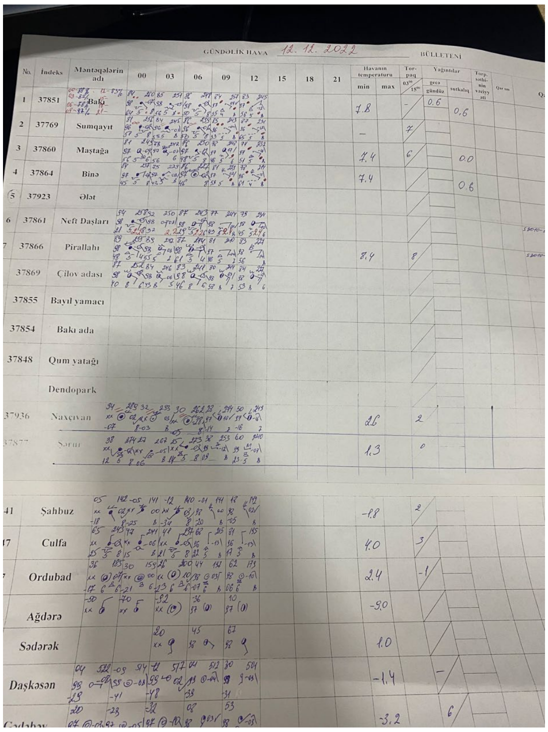

Figure 81. Observations plotted by technicians for forecasters

The overall production process for weather forecasts and early warnings is fully manual and the products consist of word or pdf etc files. Most of the products are disseminated through email or similar dissemination channels. However, the is a web page for NHMS under the ministry for ecology and natural resources, where simple weather forecasts are available for a few locations. However, it doesn't have the information on weather warnings. The website is updated manually. The forecasters fill up an excel sheet a few times per day and the website is updated from this excel sheet.

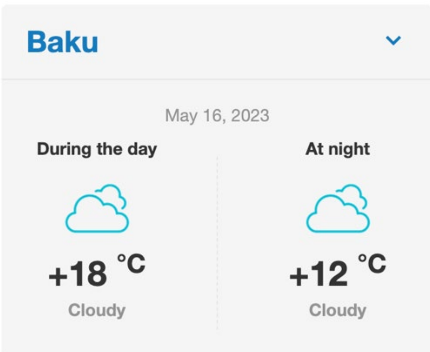

Figure 82. Weather forecast from the website of the Ministry of Ecology and Natural Resources (http://eco.gov.az)

Videos are available to observe the daily situation at rivers. However, it is unknown whether the videos are taken at the site by hydrometers of the local centre and sent via WhatsApp, or if they are being taken by camera on automatic hydrological stations (first hypothesis is preferred).

In addition, automatic hydrological station measurements can be accessed at the following link: http://azhydromet.port-log.net:23000/live/.

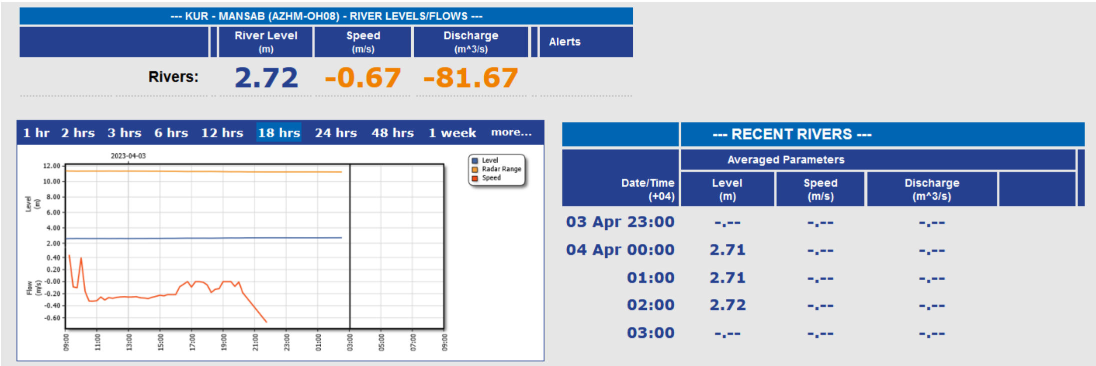

Figure 83. Automatic hydrological station measurement viewer

Use of hazard, exposure and vulnerability information to develop impact-based warnings and advisories

There is no impact-based forecasting currently undertaken in NHMS.

8.3.6 *Climate services*

Provision of climate products and services

The climatological normal maps and agrometeorological services based on the observations are done by the data archive center. The staff receives the "regime" observation station data through email and the data includes 41 automatic observation stations and 67 manual stations. 26 parameters are collected from the manual stations and 22 from the automated stations. The data is received 15 days after the end of the month. In addition, the data archive center utilizes data from 11 hydrological stations. The climatological maps (such as normal and anomalies) are calculated with the Arcgis -software.

The center staff also has a web-based service available from the company DTN for viewing the agro-meteorological observations and it has also agro-meteorological predictions.

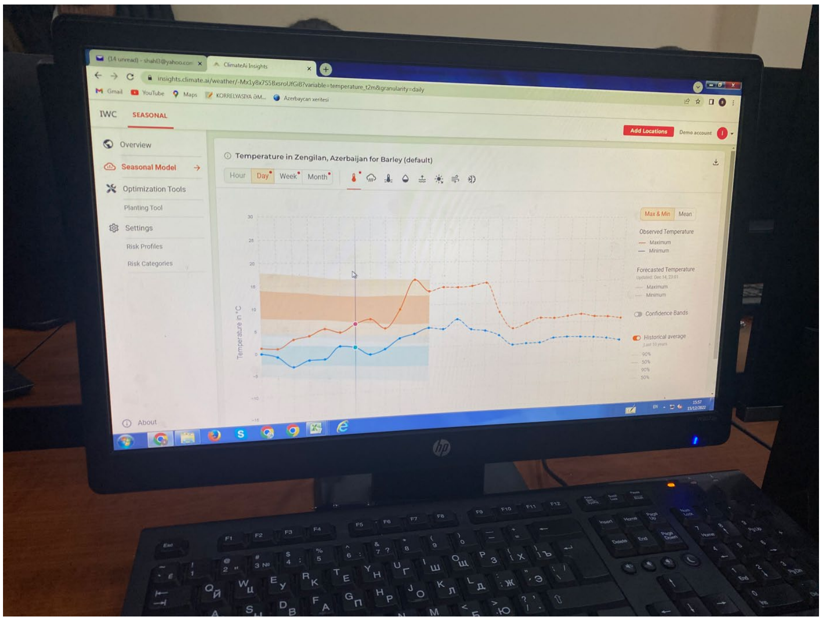

Figure 84. Agrometeorological portal tool available from DTN

8.3.7 *Hydrological services*

The TURKMETCAP system gives access to ECMWF models, but without ability to download digital information. Meteorological forecasts visualise and analyse the situation. Rainfall forecasts only indicate the type and location of expected precipitation.

The bureau receives data from automatic meteorological stations every 3 hours. This data is visualised and entered into an Excel file, which is managed and stored by the centre on a specialised server. Data received by email from local centres is transcribed onto paper sheets.

Each data collection system appears to have its own storage system in differing formats.

Some information related to anticipated flood situations is disseminated via the meteo.az website. Similarly, a current situation bulletin is available containing some information on water level or discharge.

Information about the expected weather conditions for the next week

in the regions of Azerbaijan

During the next week, the weather conditions are expected to be changeable with intermittent rain. The first process will last from April 10 to 12 in the morning, and the second process will last from April 13 to 14 in the afternoon. Mainly in the northern and western regions, there is a possibility of intense precipitation, lightning, hail, and snow in mountainous areas.
The western wind will increase to 15-18 m/s on April 10, and occasionally to 20-25 m/s on April 13 in mountainous and foothill regions.

There is a possibility that water level in the rivers will increase, and some rivers of the Greater and Lesser Caucasus will experience short-term flooding.

Figure 85. Flood information derived via the meteo.az website

On April 12, the water level in the Valvalachay-Tangaalti station, which flows through the territory of the Greater Caucasus, was 148 cm, water consumption was 5.15 m^3/s, in Gudiyalchay-Gymil 48 cm, water consumption was 3.63 m^3/s, in Katekhchay-Gabizdara 119 cm, 9 ,08 m^3/s, 139 cm in Ayrichay-Agyazi, water consumption 5.94 m^3/s, 37 cm in Alijanchay-Bayan, water consumption 0.20 m^3/s, 106 cm in Garasuchay-Zardab, water consumption 12.7 m^3/s, 37 cm in Pirsaatchay-Poladli, water consumption 0.57 m3/s,
103 cm, water consumption 8.70 m^3/s in Zeyamchay-Aghbash, 126 cm, water consumption 0.74 m^3/s, in Ganjachay-Zurnabad 182 cm, water consumption 2.77 m^3/ s and the water level in Lankaranchay-Sifidor station flowing from Lankaran-Astara region is 78 cm, water consumption is 2.50 m^3/s, in Vilashchay-Shikhlarda 50 cm, water consumption is 1.05 m^3/s, and in Tangerudchay-Vago station, the water level is 24 made cm.

The water level in Kura-Girakgaseman station is 319 cm, water consumption is 327 m^3/s, which is 44% of the ten-day norm.

In the Kanikh-Jalayir station, the water level is 650 cm, the water consumption is 68.0 m^3/s, which is 40% of the ten-day norm.

The situation in the lower reaches of the Kura River in

the Kura-Surra station, the water level is 394 cm, the water consumption is 150 m^3/sec, which is 21% of the ten-day norm.

The water level in Kur-Shirvan district was 171 cm.

Figure 86. Hydrological situation bulletin

Some flood hazard maps appear to be available or partially complete. According to staff interviewed, a statement of high-water marks is done after a major flood event. Based on this, it is probable that some maps of past floods exist or can easily be made.

Outside of NHMS production, the European Joint Research Centre has developed EFAS and GloFAS. On GloFAS it is possible to find a flood hazard 100-year return period map for the Kura River based on satellite analysis and modelling.

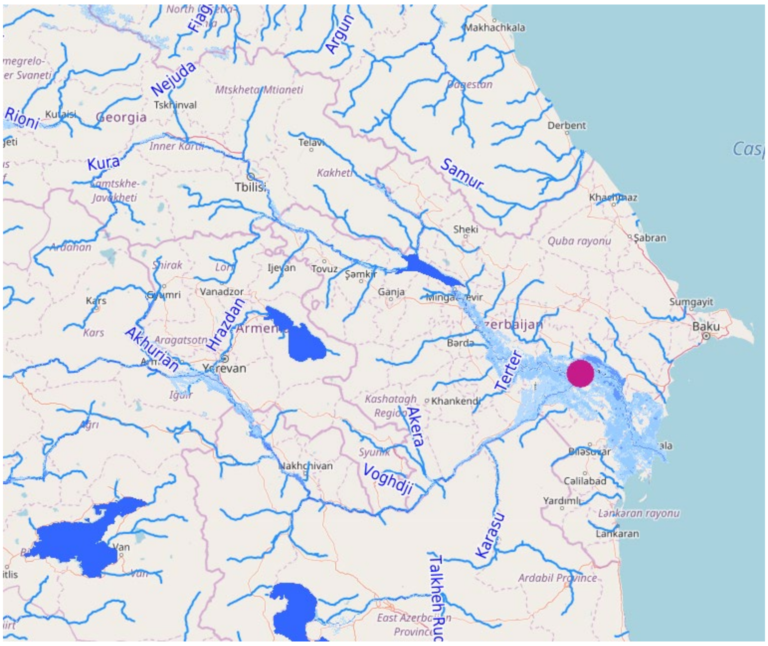

Figure 87. Flood hazard 100-year return period map for the Kura River

In addition, several maps relating to hydrological data or statements are available on meteo.az, which provide an overview of existing hydrological knowledge data developed by the national administration.

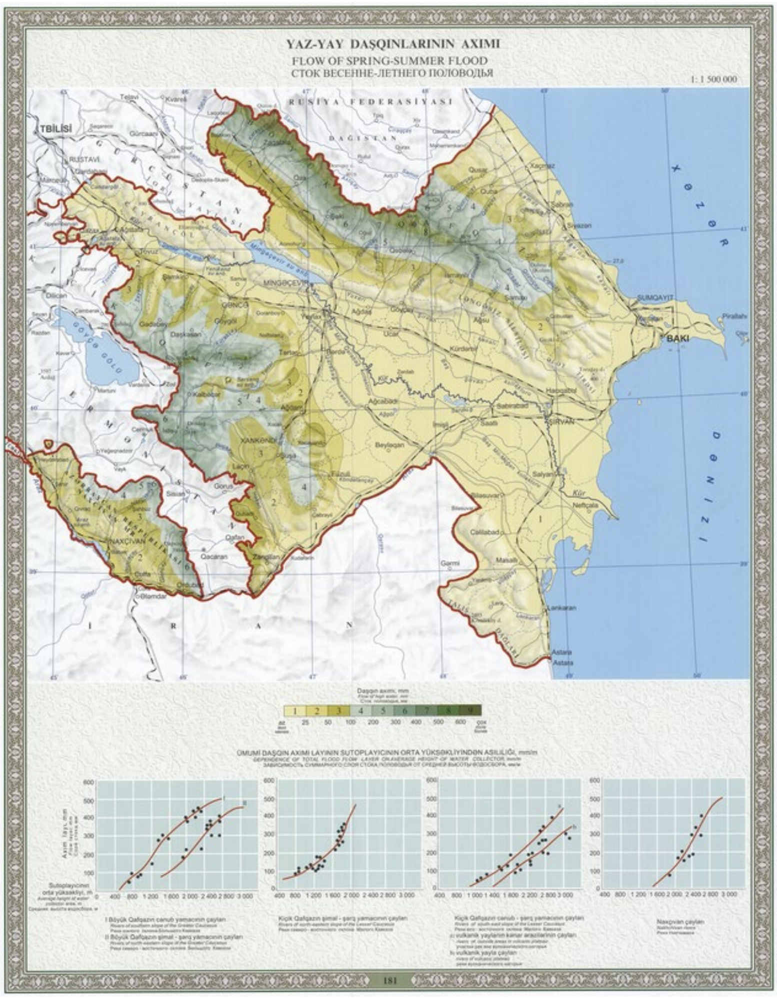

Figure 88. Example map relating to spring-summer floods

8.4 Preparedness and Response Capabilities

The response component of the early warning system in Azerbaijan is mostly the responsibility of the MOES. As noted, the scale of the response component depends on the severity of the event, with the involvement of regional offices for lesser events, while the MOES headquarters are involved in extreme events and when the event impacts more than one region. It should be added that, while in a response component public awareness plays a major role, no significant awareness campaigns have been identified related to disaster management or to EWS. Also, while disaster preparedness measures and response plans exist at the national level [182], they rarely exist at local level. The national disaster preparedness measures are implemented by external donors with the collaboration of the Government of Azerbaijan.

Public awareness plays a major role in effective responses; however, no significant awareness campaigns have been conducted related to early warning systems or disaster risk management.

[182] Preparing for disasters and reducing risk in Azerbaijan. https://reliefweb.int/report/azerbaijan/preparing-disasters-and-reducing-risk-azerbaijan. Last accessed 7 December 2020.

While disaster preparedness measures and response plans exist at the national level,[183] they rarely exist at local level. National disaster preparedness measures are implemented by external donors with the collaboration of the Government of Azerbaijan. There is an 'Action Plan' for emergencies within the MOES stating all of the procedures to follow during emergencies.

9 Gaps and Needs

The gaps and needs for CIEWS in Azerbaijan have been assessed using the "Multi-hazard Early Warning Systems: A Checklist" methodology, as prepared by the partners of the International Network for Multi-hazard Early Warning Systems. The NHMS applied this checklist to assess their own capacities, and the results are also outlined in this section. This checklist has been used to develop all of the project activities listed below.

9.1 Risk Knowledge

Within the risk knowledge pillar, the following gaps have been identified:

- There is no formal hazard knowledge in Azerbaijan. Also, while there is some information about previous disasters, there is no unified hazard catalogue/database to record this information.
- There is no formal vulnerability and risk knowledge in Azerbaijan. No risk assessments are undertaken following international best practices for most of the hazards.
- There is no platform for sharing data or hazard/risk information.
- There is a lack of coordination among relevant stakeholders.
- There are no procedures for the revision of existing risk information.
- There are no procedures for the dissemination of risk information to the general population.
- Risk knowledge is not embedded in the existing EWSs.

Therefore, considering the climate risk profile and the gaps outlined above, the following needs are identified:

- The hazards, vulnerabilities and risks are not well known, and therefore full risk knowledge assessment should be undertaken in Azerbaijan. The first task would be to develop a unified methodology for hazard and risk mapping and assessments for all of the hazards considered. This methodology should be undertaken with the collaboration of all of the relevant stakeholders with the support of international experts.
- Hazard assessments for the noted hazards should be undertaken for the whole territory of Azerbaijan following the unified methodology described above.
- Risk assessments for the noted hazards should be undertaken for the whole territory of Azerbaijan following the unified methodology described above.

[183] Preparing for disasters and reducing risk in Azerbaijan. https://reliefweb.int/report/azerbaijan/preparing-disasters-and-reducing-risk-azerbaijan. Last accessed 7 December 2020.

- Within the methodology outlined above, mechanisms should be described for the periodic review of the hazard and risk assessments.
- Dissemination and awareness should be enhanced, and mechanisms should be implemented for the correct dissemination of the risk results to the general population.

Addressing these needs and recommendations will produce a better knowledge of the risk situation in Azerbaijan through the implementation of the unified methodology.

9.2 Observations and Forecasting

The state of observations and forecasting in Azerbaijan is poor. Considering the existing hazard and risk profile of Azerbaijan, the identified vulnerabilities in the agriculture, human health, coastal activities and water resources sectors; and the projected impacts due to climate change, there is an urgent need to enhance this component in Azerbaijan. For instance, as identified by the World Bank in its "Reducing the Vulnerability of Azerbaijan's Agricultural Systems" [184] assessment, there is a requirement to enhance and strengthen the monitoring systems in Azerbaijan to collect more detailed climate information to reduce agriculture vulnerability to floods, mudflows, landslides, droughts, hailstorms and other hazards, and to also provide sufficient information to feed the forecasting and warning systems. At the moment, however, these forecasting and warning systems are also inefficient, there are no modelling and forecasting capabilities, and these types of systems should be implemented for Azerbaijani stakeholders to be able to provide timely and meaningful warnings to reduce the vulnerability of these sectors. In summary, no formal monitoring and warning component exists for any of the hazards considered above in Azerbaijan and thus the following gaps have been identified:

- The roles and responsibilities for the monitoring and warning of some of the hazards are not clear.
- The existing monitoring systems are in extremely poor condition, with a limited number of automatic stations, and few of them complying with the expected level of service for an early warning system.
- Data collection systems, both for observational and remote sensing data, are insufficient from a forecasting point of view. Data collection should be an activity developed to gather the necessary high-quality information to be able to run the different models within the forecasting framework and to provide the needed climate information to reduce the vulnerability in the identified sectors. These data are also needed for the implementation of the hazard forecasting system.
- No data management system is implemented to make use of the information from the automatic stations and most of them are not operational.
- No formal hazard forecasting or modelling systems are implemented. The NHMS makes use of information from weather numerical models implemented in other organisations, such as the Turkish Meteorological Service (TMS) or the European Centre for Medium Weather Forecasting (ECMWF).

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[184] Reducing the Vulnerability of Azerbaijan's Agricultural Systems. https://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-0184-6. WMO 2014. Last Accessed 7 December 2020

- No hydrological, hydraulic, or water resources modelling for forecasting purposes is undertaken.
- No formal system or criteria exist for warning purposes. Warnings are issued based on all of the information compiled from the stations and forecasting with no apparent formal system.
- There is no impact-based forecasting. The information from the risk knowledge is not embedded into the monitoring and warning component.
- The existing EWS in Azerbaijan does not provide sufficient lead time and/or warning information.

Therefore, the following needs are identified:

- There is need for the clarification of roles and responsibilities in the monitoring and warning component.
- There is a need to include the multi-hazard approach in the EWS in Azerbaijan, for the whole system, but especially for the monitoring and forecasting.
- There is a need to strengthen the monitoring systems in Azerbaijan for all of the considered hazards. This should be undertaken considering both the number of stations and their telemetry and operational capacities.
- There is a need to implement suitable data collection and management systems for the observational data. This should be a system that integrates all of the collected observational data from the upgraded monitoring network and combines this with remote sensing and forecasting data.
- There is a need to strengthen the forecasting system in Azerbaijan for all of the hazards. There are two different aspects to discuss on this regard.
    - Numerical Weather Prediction (NWP): there is a need to implement a local meteorological forecasting model in Azerbaijan. Further collaboration with neighbouring countries is also highly recommended.
    - Hazard forecasting systems for all of the considered hazards should be implemented. The meteorological forecasting will be one of the key elements within the hazard forecasting, but the forecasting of floods, sea-waves, droughts, landslides or mudflows would need additional forecasting tools. It should be noted that, for instance, the forecasting of hail or strong winds can be a direct output of the meteorological forecasting. Also, it should be added that it is common practice to adapt the models implemented for the risk assessment for the forecasting systems.
- There is a need to integrate impact-based forecasting into the forecasting systems
- There is a need to include climate change in the monitoring and warning component.
- There is a need to establish warning criteria and warning levels common among all of the different stakeholders for all of the different hazards.
- MOES (including the Water State Reserve), Irrigation Joint Stock Company, Ministry of Agriculture and other stakeholders require tailored CIEWS products for their operations.

These needs and recommendations are in line with the gaps outlined above and they have been developed considering the identified vulnerabilities (existing and predicted). Activities addressing all of these recommendations and needs will be described in the project activities below.

Table 24. Gaps and needs for Azerbaijan NHMS identified during FMI and IOEau expert missions

Gaps and needs for Azerbaijan National Hydrometeorological Service		
Category	**Gaps**	**Needs**
Observation network	Only partial automatization of observation infrastructure. No life cycle, maintenance nor calibration plans and SOPs for automated observations. No metadata available nor data quality assurance for AWS data. Insufficient precipitation observation network for hydrological purposes. No homogeneous hydrological observation network.	Establishment of observation department for maintenance, calibration, life cycle and quality assurance of automated observation infrastructure. More automatic stations, especially on small watersheds. Distributed rainfall observation with timestep in adequacy with the dynamics of phenomena.
Data collection practices and capabilities	No automated nor near real-time data transfer, all data transfer is done manually. No archiving of AWS data.	Sufficient software, IT hardware and staff capacity needed. Data gathering needs to be simplified and data storage unified.
IT infrastructure	Lack of modern forecaster tools for production, and infrastructure for data transfer and archiving. Insufficient maintenance of the IT equipment and systems.	Development/acquisition of observation database Qualified IT experts and establishment of an IT department. The whole value chain of service production (from observation to services) needs to be modernized, with sufficient organizational transformation.
Modelling and forecasting	Forecast production from numerical weather prediction data. Knowledge in numerical weather prediction. Inadequate data and forecaster tools in use for forecasters. No flood forecasting, rain-flow, flow propagation (hydraulic or otherwise) models exist. Water-level to water-level relationship exists only between two hydrological stations.	Capacity to operate and handle numerical weather prediction data. Small scale modelling can be considered for area of Azerbaijan (However this is not the primary need) Implementation of modern forecaster software with relevant model and observation data. Development of a simple model to link water or discharge upstream data to downstream data with rainfall (with modulation by a precipitation parameter) Capacity to operate and handle numerical weather prediction data.

Warning and advisory services	Incapacity in producing weather warnings in international standard format. Limited number of hazards in weather warnings. Insufficient data available for analysis of severe weather.	Tool and software for producing digitalized weather warning products. Multiple weather phenomena in warnings. Implementation of modern weather observation systems with forecaster tools. Follow international standards for alert dissemination with a colour code for flood risks (e.g., by colouring the stretch of river depending on the expected flood level) Need to define the way to disseminate alerts and the intended beneficiaries.
Climate services	Lag with observation collection (15 days) and costly tools. Development of automated analysis and calculations for climatological values and parameters.	Automating the data collection procedures. Acquisition of an automated climatological workstation software.
Hydrological services	Rainfall data are insufficient to quantitatively assess the evolution of the hydrological situation in small watersheds or develop more efficient flood forecasting tools	Need to simplify the process of data collection and develop expertise on the impact of floods Need to improve rainfall data (especially from radars) to improve the hydrological assessment of flood situations Need to consolidate databases in order to produce expert hydrological data (e.g., flood return period)
Dissemination and outreach	Lack of modern production and dissemination system and lack of modern product formats	Implementation of a semi-automated/automated forecast production system. Need to make a correlation between water level measurement and what level of danger or damage to expect

9.3 Communication and Dissemination

The communication and dissemination component in Azerbaijan should be enhanced too. As noted, this has been found to be one of the most significant issues in worldwide EWS implementations, and therefore, great care has been undertaken in the revision and assessment of this component, considering the existing vulnerabilities in the key sectors and the activities that will be associated with addressing these gaps. The main gaps identified in the communication and dissemination component are:

- The roles and responsibilities within this component should be clarified. At this stage, there are several organisations with communication responsibilities or activities, and this may lead to some issues in the dissemination of warnings.
- The timely delivery of warning messages is key for the successful operation of an EWS. This may not be the case in some areas, especially for local communities (last-mile communication).
- There is no Common Alerting Protocol (CAP) implemented in Azerbaijan.

The following recommendations are made to address these gaps and to ensure that the communication and dissemination component complies with the MHEWS checklist and that the implemented communication and dissemination component to be implemented ensures the timely dissemination of warnings:

- There is need for the clarification of roles and responsibilities in the communication and dissemination component. Therefore, a full institutional assessment should be undertaken, and a new institutional arrangement should be recommended.
- There is a need to implemented decision-making processes in the communication and dissemination component.
- There is a need for ensuring that timely warning messages are delivered. These messages should contain meaningful information for the general population, and they should also include impact-based forecasting information.
- Different communication means should be explored and implemented to ensure messages are received.
- A CAP should be implemented in Azerbaijan.
- There is a national demand for accurate and timely impact-based forecasting and warnings to the general population and to stakeholders.
- There is a need to develop risk mapping and modelling, based on climate hazard information, to facilitate local and regional planning.

Activities addressing all of the above-outlined needs have been included in the project activities discussed below.

9.4 Preparedness and Response Capabilities

The main purpose of the preparedness and response component is to ensure that institutions and the general population of Azerbaijan have the capacity to act early and to respond to warnings from the communication component through enhanced risk education. Public awareness is key in this component. The following gaps have been identified:

- There is a Crisis Management Unit within MOES that is in charge of the response component. However, it is not clear that the key stakeholders are involved in the response component. Within the response action plan, the MoES and the NHMS are involved, and there are contact details for other departments within MoES or the Ministry of Ecology and Natural Resources, but the Ministry of Health, the Ministry of Energy, the regional authorities and other relevant stakeholders are not involved. Also, regarding the information for response, data regarding the flood hazard for flood depth, water velocity and access and egress access to flood areas would be especially useful for rescue purposes. It should be added that at the moment, Azerbaijan is not part of the 'International Charter for Space and Major Disasters'. This charter provides remote sensing information about current disasters that can be useful from a response point of view.

- There are some communities that have implemented community emergency plans (CEP). These communities, however, are limited, and the CEPs are usually implemented for particular hazards. In general, no disaster management plans are implemented at local level, and the plans at national level are outdated.
- There are many international remote sensing resources that are very useful from a response point of view. This is the case of the 'International Charter of Space and Disaster' and the 'Emergency Copernicus System'; and their use in Azerbaijan during disasters is currently limited.
- There are limited public awareness campaigns in Azerbaijan regarding disaster risk management and reduction, and more specifically to CIEWSs.

Therefore, the following needs and recommendations are identified:

- There is a need for all relevant stakeholders to be involved in the response component and to clarify the roles and responsibilities. The Ministry of Health, the Ministry of Energy, the Ministry of Agriculture, Regional Authorities among others, should be included in the response component.
- There is a need for the implementation of community emergency plans, including evacuation routes and centres.
- There is a need to use international remote sensing resources for response purposes.
- There is a need to undertake public awareness campaigns, for warning communication and response actions for vulnerable groups, such as elderly, children and women.

In this respect, several activities have been designed within this project to tackle these gaps and address the recommendations. Community-based EWS will be implemented, and also the needs of vulnerable groups will be addressed through the project activities. It should be noted that public awareness campaigns will be fostered through several activities too.

9.5 Adaptive Capacity

Azerbaijan ranks 70th out of 176 countries on the ND-GAIN index (2020) for adaptive capacity, but its score has been generally declining over the past two decades . The following key gaps have been identified:

- The "adaptation deficit" is large for the agriculture sector in Azerbaijan. Agriculture capacity is at its lowest, having notably decreased since 2000 and remaining at its poorest over the past decade. At the national level, low adaptive capacity stems from i) inadequate/lack of ability to collect, generate, and provide meteorological data to farmers; ii) inadequate scale and quality of agriculture extension services; and iii) limited access to rural finance. Lack of availability and access to hydrometeorological data is also cited as a key gap at the local level.
- Almost all forest zones in Azerbaijan have demonstrated limited adaptive capacity
- There are insufficient institutional, technical, and individual adaptive capacities in the water, agriculture, and coastal sectors
- There is limited climate-related data sharing and lack of data consistency between institutions.

- There is also lack of awareness on how adaptation is and can be incorporated into sectoral decision-making processes.
- There is a challenge of weak institutional development of local authorities on climate change adaptation issues.

Therefore, the following needs have been identified:

- To enhance availability of and access to good-quality hydrometeorological information for climate-sensitive sectors (e.g., agriculture)
- To strengthen institutional arrangements and protocols for data sharing, quality assurance, and consistency
- To develop sector-specific forecasting, early warning, and decision-support services
- To strengthen capacities to incorporate climate information and knowledge into government, sectoral and local level decision making

9.6 Commitment for Strengthening CIEWS

Despite the current overall gaps and needs, there is strong commitment for improving the supply of climate information and integrating it into sectoral decision making, thereby improving utilisation and demand for climate information over time. This is evidenced by the policy context, existing projects, committed co-financing, and the outcomes of stakeholder consultations outlined below. At the sectoral level:

- State Water Reserves Agency, under the MoES, needs to undertake planning activities regarding water reserves and allocation. Climate information and early warning systems (CIEWS) as a whole, as well as drought monitoring and forecast information in particular, will facilitate these activities.

- MoES voiced the need for more accurate information on the possibility of hazardous event occurrence

- Land Reclamation and Water Management OJSC highlighted the need for comprehensive risk mapping, which would assist their activities in limiting the impact of hazardous events

- Ministry of Agriculture requested additional information on hazardous events for their operations.

Stakeholder consultations at the community level broadly indicated the following:

- Many communities do not receive adequate information regarding an impending disaster event

- Climate-related disaster events such as heavy rains and mudflows have impacted communities in recent years and resulted in damage to residences and infrastructure

- Although some disaster risk information is disseminated at the local level, community members are not fully aware of disaster risks

- Mobile phones are the most commonly used means of communication during a disaster event.

Additionally, communities indicated that there is demand for monitoring equipment located within the community and for greater CIEWS integration.

10 Recommendations

The following table provides the summary of key recommendations to strengthen the NHMS based on the expert missions conducted by the Finnish Meteorological Institute and the French International Office for Water (OIEau), and the modernized production value chain for NHMS is shown in the image following the table. It must be noted that regardless of a relatively short table of recommendations, the transformation and implementation of the proposed changes and modernizations is time-consuming. It can be estimated that completing all recommendations sustainably takes at least 5-10 years and the technical modernization must be accompanied with the organizational transformation and a continuous training and capacity building of the staff.

Table 25. Recommendations for Azerbaijan NHMS

Recommendations for Azerbaijan National Hydrometeorological Service	
Category	**Recommendations**
Observation network	WMO guidelines and ISO 9001 standard Automatisation of observation network; automatization of the entire hydrometric station network and development of a maintenance plan On hydrological stations with camera, possibility of setting up image analysis software to improve the use of videos Identify measurement sites to meet the need for both measurement of water resources and for flood alerts
Data collection practices and capabilities	Procure license for manufacturer's data management system to include all AWS. Vaisala and OTT have their own management systems, and currently, sensors are not compliant with other manufacturer's data management system. Improve the automation of the stations and to have a frequency of collection in line with the speed of the phenomena observed (especially for mountain rivers). Prior to developing the station network, develop a robust communication network covering new measurement sites. Conduct coverage studies (telephone or satellite) to identify the best means of fast and secure data gathering. Consider the redundancy of data collection systems to ensure that data is always available for crisis managers
IT infrastructure	Sufficient ICT infrastructure to support data collection software and storage (i.e., database), and forecasting. No legacy systems.

	Establishment of an ICT Department to develop and maintain the data management, forecast and early-warning production systems. Upgrade flood forecasting centre equipment with a hydrometeorological data visualisation platform and a hydrological modelling platform Consider merging the situation centre and forecast centre in order to have an overview of all data available to run flood models and critique uncertainties according to input data
Modelling and forecasting	Acquisition of automated forecast production tool, preferably an open-source application. Implementation of a WRF model in the domain of Azerbaijan. For hydrological modelling and forecasting: 1st step: Start building a conceptual hydrological model in excel sheet format that links upstream flow to downstream flow, with include automatic correlation system with rain observed between both. 2nd step: Once staff have been trained in hydrological modeling, build global rain-flow model on medium watershed. 3rd step: When radar rainfall data is available, start building a flood forecast spatialized model on the watershed where flash flooding occurs.
Warning and advisory services	Implementation of CAP (Common Alerting Protocol) formatted early warning services. Re-evaluating the relevant phenomena from which the warnings are issued (Thunderstorms, Snowfall and driving conditions, etc.) Develop an automatic warning system based on hydrological criteria / water-level threshold exceeded Share data/information with crisis management stakeholders to help anticipate relief deployment Link information to a warning standard level (e.g., Green: Normal flow; Yellow: High flow with local overflowing; Orange: Significant flow with overflowing; Red: Very high flow with larger-scale overflowing)
Climate services	Automating the data collection procedures. Acquisition of an automated climatological workstation software or shifting into an open-source solutions (from ArcGis-to QGis for example).
Hydrological services	Unification of the hydrological and meteorological database, enabling rain data to be linked to hydrological data, which in turn can improve understanding of hydrological processes, support flood risk studies and improve water resources management Develop hydrological forecasts with more quantitative data Set up a post-flood recording and evaluation process in order to recover as much information as possible. Create for each hydrological (water level) measurement station, a grid which allows, according to the height of water measured, to

	position oneself in relation to a past flood and the probability to observe loses or damages. Sharing with crisis management stakeholders in order to help anticipate the need for relief deployment.
Dissemination and outreach	Implementation of an automated forecast and early warning production and dissemination system. Implementation of digital formats and mobile application. Disseminate available data as a combined observed/forecast chart Disseminate flood warning information related to the international standard of warning colour graduation (G, Y, O, R) Make for each hydrologic station a gravity scale linking the water level measured and the presence or not of overflow and damages

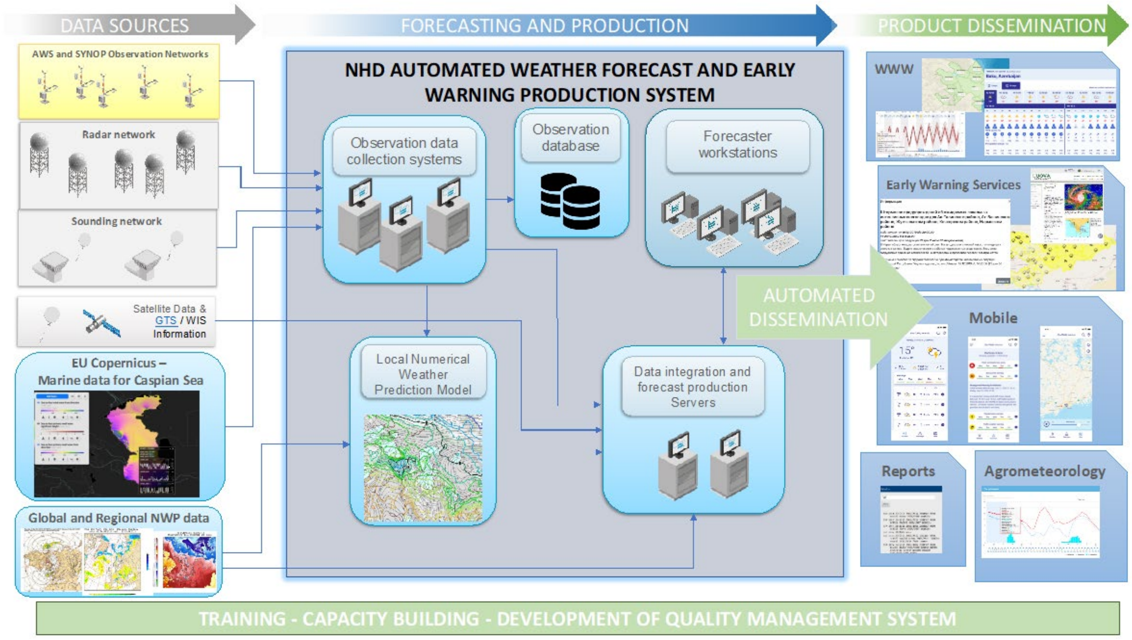

Figure 89. Recommended modernised production value chain for NHMS

11 Barriers and Challenges

The present barriers and challenges for Azerbaijan to respond to the current disasters and to the predicted increase in those, due to climate change, have been alluded to in previous sections.

The broader socio-economic, political and environmental barriers and challenges that Azerbaijan faces include the following:

- The reliance of the oil and natural gas sector for economic growth;[185]

[185] Republic of Azerbaijan. "Azerbaijan 2020: Looking into the Future" Concept of Development. Last Accessed 07 December 2020.

- Increased regional competitiveness in the production of goods due to ongoing globalizing forces;
- The need to improve the education system and offer lifelong education opportunities to help citizens adapt to a changing economy;
- Widespread damage and destruction of ecosystems in the country;
- Contamination of freshwater reserves from local and regional pollution;
- Impacts from natural disasters and the exacerbation of these events from climate change processes;
- Stability of Armenia-Azerbaijan relations; and[186]
- Prosecution of government opposition and restrictions on journalists[187]

Further, as highlighted above, the existing Climate Information and Early Warning System in Azerbaijan is limited and the challenges to address include:

- No suitable institutional and policy framework for coordinating multi-hazard early warning systems and tailored weather and climate information products;
- Dearth of data for monitoring and forecasting purposes.
- Limited telemetry capacities in the deployed stations;
- Inadequate data management, data quality and data processing systems for monitoring of past, present and future climate data;
- Insufficient capacities, tools, and technologies for risk and hazard assessment, hazard forecasting and impact-based forecasting;
- Absence of a comprehensive, nation-wide, and people-centred multi-hazard early warning system;
- Lack of tailored, appropriately-packaged, and communicated climate information for end-users;
- Lack of decision-support systems to ensure appropriate and timely decisions during hazardous events;
- No suitable communication and dissemination procedures to ensure that warnings are received by relevant users and the general population on a timely manner;
- No coordinated response during events, and the capacities for response are limited.
- Limited capacity of vulnerable communities to use climate information services and early warning, respond to climate risks and develop alternative livelihood strategies that are less vulnerable to specific climate change shocks.

12 Proposed Solution

The proposed project aims to increase the resilience and reduce the vulnerability of government, sectors and communities in Azerbaijan to climate change and climate-related hazards through the establishment of science-based, data-driven climate information services and a people-centred, impact-based multi-hazard early warning system (IB-MHEWS). Reliable climate information services will equip decision-makers at all levels in Azerbaijan with relevant

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[186] Republic of Azerbaijan. Second Voluntary National Review. Last Accessed 07 December 2020.
[187] Human Rights Watch. Azerbaijan – Events of 2018. Last Accessed 07 December 2020.

information to make evidence-based decisions to better manage climate-related risks. People-centred IB-MHEWS will empower individuals and communities with the knowledge and forewarning to take timely and appropriate actions to protect lives and livelihoods so as to reduce the impact of extreme weather and climate change.

Specifically, this will be achieved through the following four project Outputs:

- **Output 1** will provide an enabling environment for increasing adaptive capacity and reducing vulnerability by strengthening institutional frameworks and coordination for climate services and early warning systems, including through development of a financial strategy and business model for long-term sustainability. By enhancing inter-institutional collaboration and knowledge management, the project will reduce the risk of maladaptation resulting from inadequate risk knowledge and failure to account for varying capacities and needs of different stakeholders.
- **Output 2** addresses the need for modernised hydrometeorological observation networks that provide foundational data underpinning localised weather, water and climate predictions. In turn, this will facilitate the generation of timely forecasts and warning of climate-related risks and hazards and targeted climate analytics tailored to climate-sensitive sectors (e.g., agriculture, health, disaster risk reduction, water resources management). Moreover, Output 2 will strengthen urban climate services through improved coordination, expanded air quality monitoring, and development of health sector-specific analytics and decision support.
- **Output 3** addresses the need to improve communication and dissemination of climate information and multi-hazard early warnings through the establishment of a people-centred IB-MHEWS, with targeted capacity building for community MHEWS. This will be guided by the co-development of a socially inclusive, child- and gender-responsive communication strategy, which will inform people-centred approaches that consider specific information and access needs particularly of the most vulnerable population groups.
- **Output 4** addresses the need to improve capacities at all levels for disaster preparedness, including through targeted awareness-raising and education on climate-related hazards, early warning systems and risk management. A key focus of Output 4 will be to establish capacity for Forecast-based Financing (FbF) in Azerbaijan, whereby MHEWS-linked FbF leverages shock-responsive social protection (SRSP) as an enabler. SRSP is an innovative mechanism through which national social protection systems are adapted to climate change. In this context, SRSP has the potential to increase the coping, adaptive and transformative capacities of vulnerable groups in Azerbaijan and serve as an enabler in scaling up anticipatory action for climate shocks.

The proposed interventions are designed to address the key barriers to delivering reliable climate information services and people-centred IB-MHEWS that provide data, information and knowledge underpinning better preparedness and resilience, which in turn reduces climate change vulnerability.

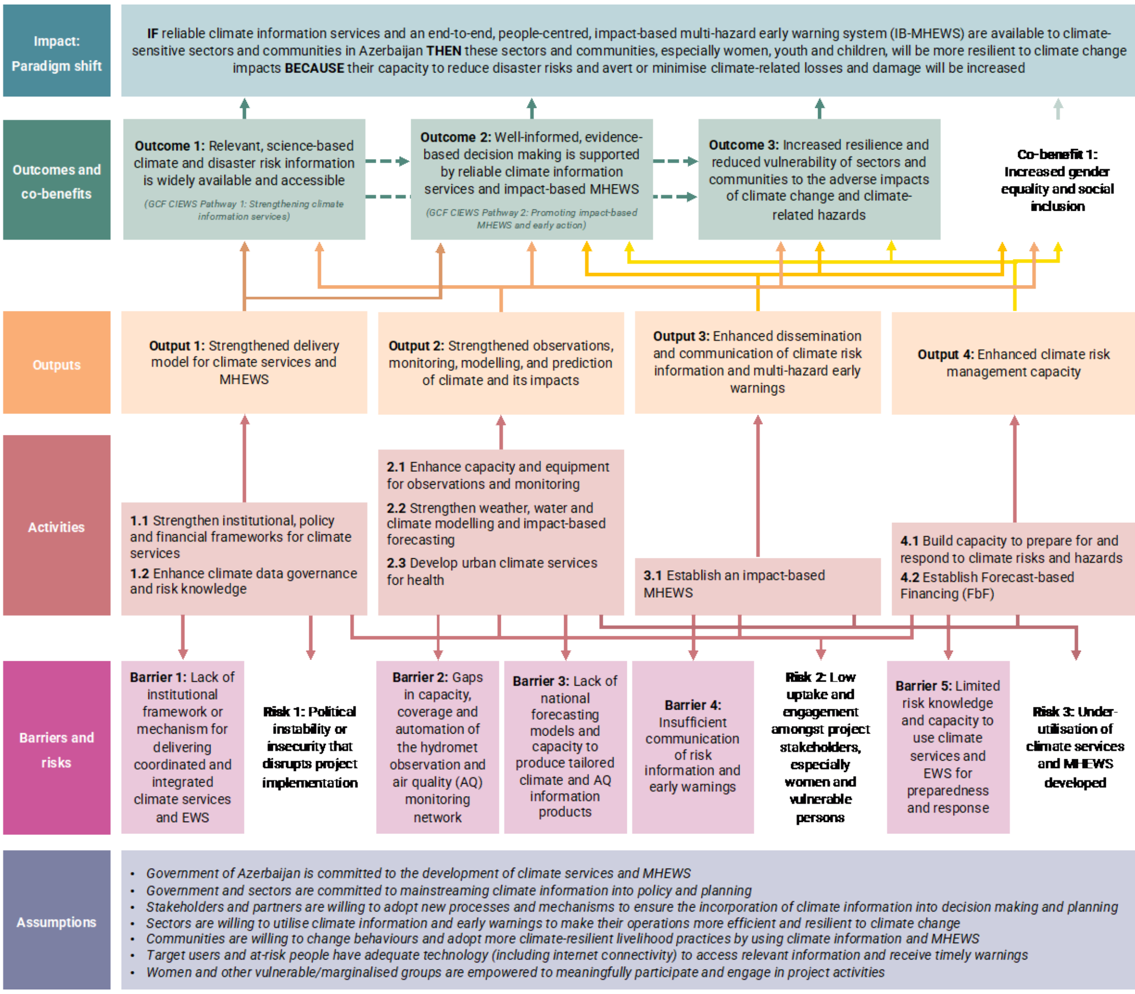

Figure 90: Theory of Change

13 Proposed Approaches

The proposed CIEWS approach is detailed in relation to the four critical pillars of CIEWS discussed in detail in the preceding sections (risk knowledge, observations and forecasting, communication and dissemination, response). The description of the system, and of the activities, will be undertaken considering the gaps and needs previously identified and using the MHEWS checklist information.

13.1 Risk Knowledge

Enhancing risk knowledge is paramount to ensure a successful implementation of the CIEWS. A unified methodology for hazard and risk assessment and mapping will be implemented to ensure that hazard and risk assessments are undertaken using common procedures for all the hazards to be considered. Risk knowledge is critical to the success of the CIEWS because it will (i) provide information regarding risk and vulnerabilities; (ii) provide site-specific information about the geographical areas to be targeted by the CIEWS; and (iii) provide the basis for the modelling tools and forecasting systems to be implemented. Under the project, hazard and vulnerability assessments will be combined to produce the risk information.

The following will be undertaken during the implementation of this component:

- A unified methodology will be developed. This methodology will:
    - Map the existing institutional arrangements within the risk knowledge component and the climate information.
    - The methodology will also provide an assessment of the existing data availability, existing modelling procedures and assessment of the stakeholders' capabilities
    - The methodology will set up the main methodological approach to undertake hazard and risk assessments for multiple hazards considered (namely floods, droughts, strong-wind, hailstorms, waves and air quality).
- Hazard assessments will be undertaken for all of the types of hazards considered, in summary:
    - Key stakeholders, with the support of the international experts, will implement hazard models for hazard assessment purposes. These hazard models will be implemented following international best-practices and WMO and EU standards.
    - The hazard models implemented within this stage will be the basis for the hazard forecasting.
- Risk profiling will be undertaken for all of the hazards, considering:
    - Elements at risk, including exposed population, infrastructure,
    - Vulnerability
    - Impacts to critical infrastructure and secondary
    - Gender, elderly and vulnerable groups

The multi-hazard risk profiling will be undertaken based on socio-economic information to be collected and through the implementation of a risk model. This risk model will provide the base for the impact-based forecasting.

- Within the project there will be mechanisms to ensure that the results of the risk knowledge activities are fully embedded into the monitoring and forecasting component, in order to:
    - Ensure that the results of the hazards will be used to select strategic locations for monitoring purposes;
    - Deploy models in areas of interest for forecasting purposes.
  - Strong links will be formed with academic institutions, in order to foster the cooperation between key stakeholders and research, and to ensure that the latest scientific and local knowledge is incorporated into the risk assessments and knowledge.

In summary, the implementation of the risk knowledge component will address all of the elements of the MHEWS checklist:

- Key hazard and related threats will be identified through the multi-hazard risk profiling (Sub-Activity 1.2.2)
- Exposure, vulnerabilities, capacities, and risks will be assessed during this risk knowledge exercise (Sub-Activity 1.2.2)
- Roles and responsibilities of key stakeholders will be clearly articulated (Sub-Activity 1.1.1)
- Risk information will be consolidated through the unified methodology and also through the establishment of the User Interface Platform (Sub-Activity 1.1.2) and integrated data visualization and analytics system (Sub-Activity 1.2.2)
- Risk information will be fully incorporated into impact-based forecasting processes (Activity 2.2) and during the detailed design of the impact-based multi-hazard early warning system (Activity 3.1).

13.2 Observations, Forecasting and Warning

Within the monitoring and warning component there are several aspects that will be explored individually in detail in Appendix A:

- Monitoring network
- General forecasting and modeling
- Flood forecasting
- Drought monitoring and forecasting
- Hail forecasting
- Strong-wind forecasting
- Wave forecasting
- Extreme temperature forecasting
- Air quality forecasting
- Multi-hazard approach
- Impact-based forecasting
- ICT Platforms
- Warning

13.2.1 *Observation Network*

Strengthening of the observation and monitoring system is required to underpin the implementation of a CIEWS effective enough to address the climate hazards that Azerbaijan is facing and the predicted increase in the severity of some extreme climate events in the future. Therefore, the following is proposed:

- The number of meteorological stations will be increased. The new stations to be acquired will be automatic weather stations.
- Additional stations will be acquired, such as snow depth sensors.
- The newly acquired stations will enlarge the monitoring capacities of NHMS and they will serve monitoring and forecasting purposes for several hazards, following a multi-hazard approach.
- Additional data sources will be considered, such as weather radar inputs and other remote sensing information that will add value to *in-situ* data sources.
- The data infrastructure for data collection, data sharing, data management and data operation will also be upgraded. This is particularly important for the monitoring and forecasting tool. The infrastructure upgrade will consider new data sources and will be capable of combining data from different manufacturers and type of devices and data. Further forecasting tolls will be included in the system upgrade.

13.2.2 *General forecasting and modelling*

There are several activities to be undertaken from a forecasting point of view:

- An NWP model will be implemented in Azerbaijan. As previously noted, presently there is no local meteorological forecasting being undertaken in Azerbaijan, and to rely on external data sources is not the best approach, especially considering the topographical features of Azerbaijan. The horizontal resolution of an external forecast will not be sufficient to forecast some of the local hazards observed, especially if flash-flooding, landslides and mudflows in the Greater and Lesser Caucuses are considered. To implement and operate the NWP model, High Performing Computing (HPC) will be acquired. For costing and planning purposes, an initial assessment of the computing capacity required for running the NWP has been undertaken considering:

    - Three different model layouts, each one with increasing resolution and nested to each other
    - Assimilation procedures implemented
    - A 7-day forecast for the two coarser model implementations and a 24-hour forecast for the finer model implementation.

  The total computational resources have been estimated at 40 teraflops

- Forecasting systems for all of the considered hazards will be implemented. The basis for these systems will be the models implemented during the hazard and risk knowledge stage. Most of these hazard models will have to be customised for operational purposes.
- In addition to this, impact-based forecasting will be implemented. This will be based on the risk modelling undertaken in the risk assessment stage too.

13.2.3 *Multi-Hazard Approach*

Within the framework of the project, multi-hazard impact-based forecasting will also be implemented. As detailed above, the implementation of a local NWP model will be the cornerstone of this hazard implementation. In addition to providing direct information to some hazard forecasting, such as for strong-winds and hail (by-products of weather forecasting), it will also provide the necessary input data for the forecasting of other hazards, in combination with other data sources. The forecasting approach per hazard will be described in detail in the sections below.

Multi-hazard early warning systems (MHEWS) provide a single, cost-effective channel for addressing all types of hazards. Also, three of the common EWS components (Risk Assessment, Communication/dissemination and Preparedness/Response Capabilities) have similarities in functions across hazards. If an EWS is developed independently for each hazard, capabilities/expertise developed in these components may not be transferred to other systems. Also, a multi-hazard approach is important because different hazards can influence one another or occur simultaneously.

There are several examples of MHEWS worldwide. Countries that are exposed to several hazards often devise a generic EWS which can be used to communicate warning and danger in order to avoid confusion. For example, China, United States (US), and Japan long history for experiencing natural disasters. Thus, China developed a Multi-Hazard EWS in reaction to improve response to natural disasters. A component of the Chinese MHEWS is the cooperation and coordination among multiple agencies at all levels in order to build regional capabilities and jointly decide to provide an optimal joint response to hazards. The system integrates diverse technologies to provide an advanced early warning hazard process and enables multiple agencies including emergency response and rescue to communicate and coordinate across a common communication platform. Within the framework of this proposal, the same approach for Azerbaijan will be proposed, to ensure that information from all different hazards and from different stakeholders are integrated, especially considering the role of the MoES, NHMS and the State Water Agency.

One of the main reasons behind a multi-hazard approach is the relationship among different hazards (Figure 91).

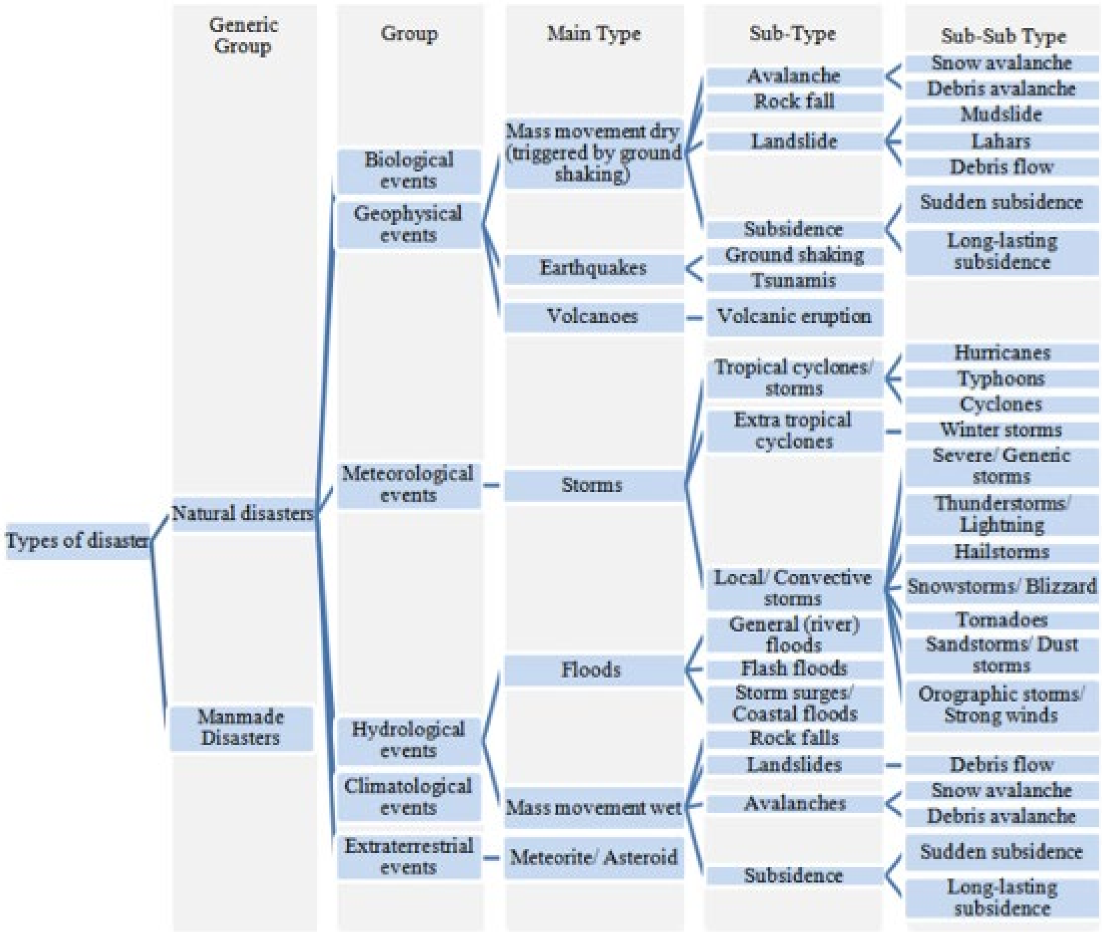

Figure 91. Hazard classification

The relationships among all of the different hazards are in some cases evident, while other are not apparent. There are several research studies analyzing those relationships (Figure 92), some of them based on actual events while some other are based on the expected impact.

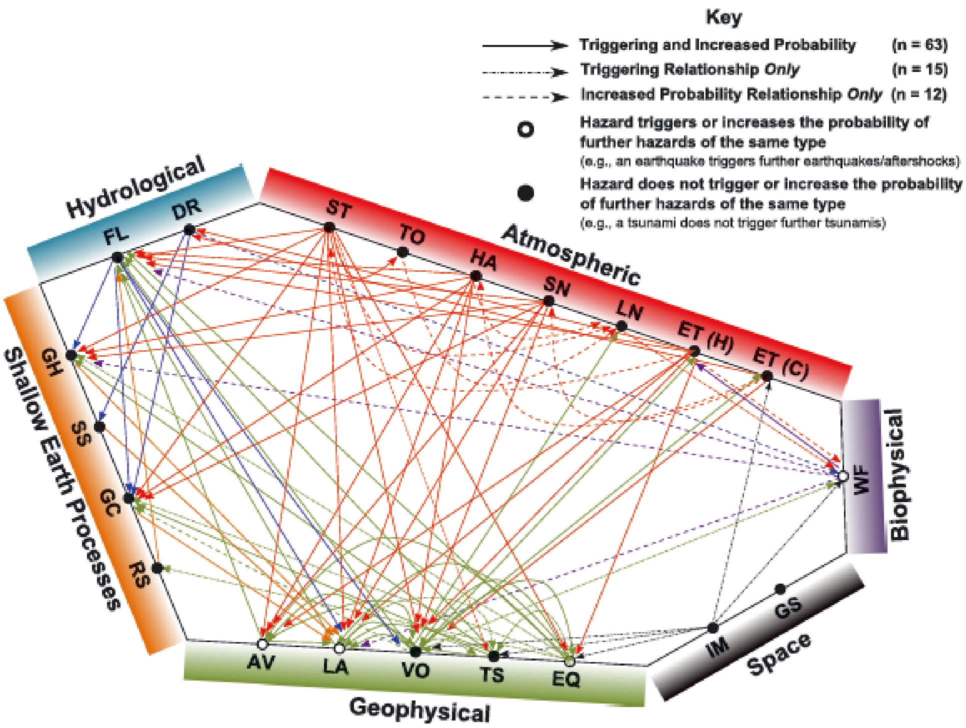

Figure 92. Hazard Interactions (source: Duncan, 2014[188])

There are several examples of hazards that occur simultaneously, cascading or cumulatively over time, such as the Nepal earthquake of April 2015. The main shock and aftershocks rapidly triggered snow avalanches and thousands of landslides, with some of the landslides blocking rivers, which in some cases triggered upstream flooding. The earthquake sequence also increased the probability of further landslides, triggered by subsequent monsoon rains. This leads to the identification of several hazard interaction types:

1. Interactions where a hazard is triggered.
2. Interactions where the probability of a hazard in increased.
3. Interactions where the probability of a hazard is decreased.
4. Events involving the spatial and temporal coincidence of natural hazards.

In order to properly assess the hazard situation, hazards interaction and interaction networks in a particular area, it would be important to undertake a thorough historical and desktop analysis of all of the possible hazards and identify the different interaction possibilities (Figure 93).

[188] Duncan, M. 2014. Multi-hazard assessments for disaster risk reduction: lessons from the Philippines and applications for non-governmental organisations. EngD Thesis, University College London.

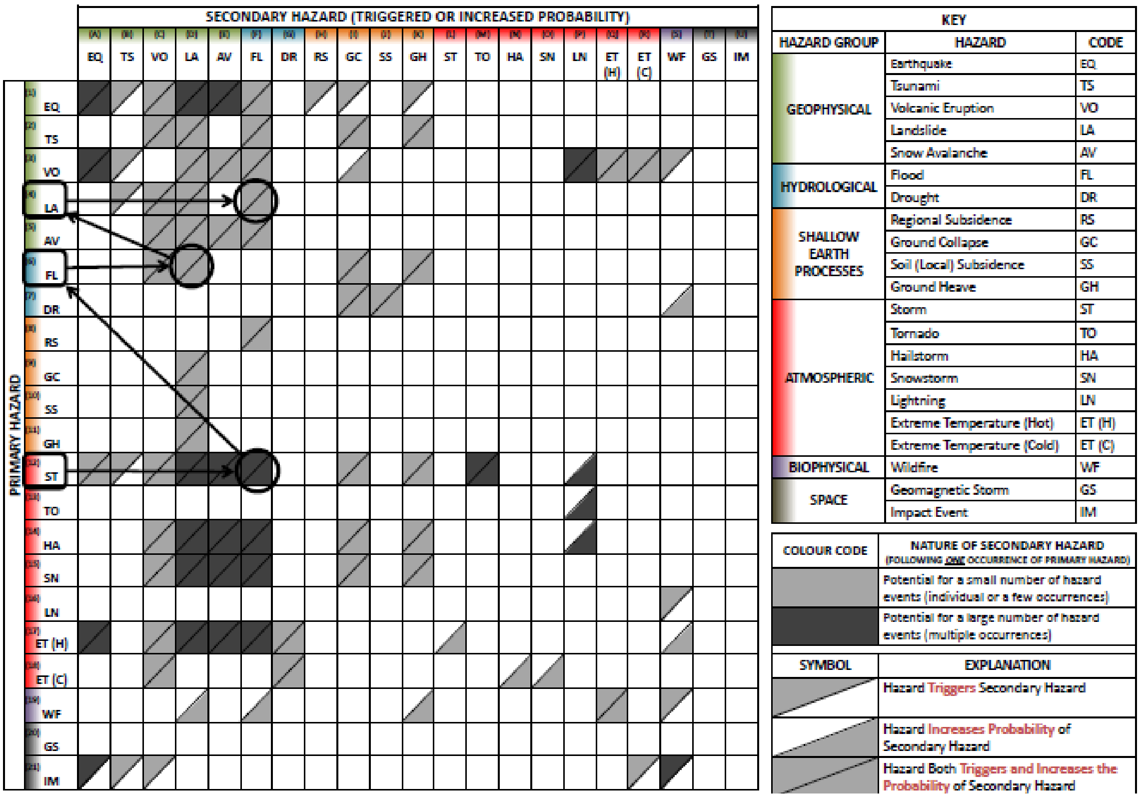

Figure 93. Hazard Interaction Matrix (Source: Gill and Malamud, 2014[189])

Therefore, during the implementation of the proposed activities, these interactions, from a historical and desktop review point of view, will be analysed in detail in Azerbaijan. In addition to the identification of the different hazard interaction, it is important, especially within the framework of this project, to understand the possibilities of a secondary hazard being forecasted, considering the spatial location and the timing of the secondary hazard.

13.2.4 *Impact-Based Forecasting*

The risk knowledge component (Activity 1.2) will be the first stage underpinning the implementation of impact-based forecasting. This risk model to be implemented will be the main tool used to quantify the cost and the severity of the different hazards from different points of view, and it will contain information about the exposure and the vulnerability.

The observations, forecasting, and warning component will implement, in an operational mode, the models developed for the assessments for the different hazards and, in conjunction with other operational model and monitoring data, will provide detailed hydro-meteorological information and warnings for all of these hazards. These warnings will be produced depending on pre-defined thresholds. For instance, the flood forecasting early warning system will yield water level information in pre-defined locations along the rivers at risk, and if those water levels are greater than certain thresholds, then a warning will be issued. Those warnings are usually defined at three different levels in order to discriminate between the severity of the predicted warning. Therefore, one of the results of the flood forecasting early warning system would be that the water level in a certain location is going to be 1m above the level 3 threshold, and therefore, a level 3 warning will be issued.

[189] Gill, J. C., and B. D. Malamud (2014), Reviewing and visualizing the interactions of natural hazards, Rev. Geophys., 52, 680–722, doi:10.1002/2013RG000445.

In order to enhance the value of these predictions, and in order to facilitate the communication of the warning to the general population and to the decision-makers, an impact-based forecasting approach will be adopted. The previously described risk model will be coupled with the forecasting framework for all of the hazards in an operational mode. Therefore, following the flood forecasting example outlined above, in addition to providing a level 3 warning, utilizing the impact-based approach, information about the anticipated impacts of the level 3 event in that particular location will be possible. Thus, information about the economic damage that event is expected to cause and the critical infrastructure that will be affected will be automatically yielded by the system.

13.2.5 *Data collection and management*

The associated data management infrastructure within any national meteorological and hydrological service (NMHS) is critical to ensuring the proper functioning of the whole climate information and MHEWS. The ICT upgrade within this project will comprise the following layers:

- **Observation data collection system:** the observation data collection system will facilitate streamlined data ingestion and extraction and quality control. It will ensure that observational data from all monitoring stations is collected and fed into the overall climate services and multi-hazard early warning system to be established. Moreover, the system will provide information on the status of the observing network in order to monitor network performance and allow potential to detect and alert of possible issues.
- **Database management system (DBMS):** the project will establish a centralised WMO-compliant DBMS for cross-cutting analysis of weather, water, and climate phenomena. The DBMS will be built and localised on existing open-source solutions and will provide the ability to store, analyse, and generate reports on large amounts of real-time and historical meteorological, climatological, and hydrological data. The DBMS will have functionality for data rescue, quality assessment, export and import interfaces, customisable user access/role, and metadata management. Moreover, the system will facilitate data exchange between national service providers, as well as contributions to broader data sharing initiatives at the regional or global level.
- **Automated Message Switching System (AMSS):** To advance international real-time data exchange, the project will support the deployment of an AMSS connected to relevant international networks, including WMO GTS and SADIS. The AMSS will facilitate the switching of all types of data and products, including traditional alphanumeric codes, satellite and radar image files, binary products, and WMO monitoring.

13.2.6 *Forecasts and Warnings*

Although impact-based forecasting will be implemented within this project, in order to disseminate warnings to the general population and to the communities in particular, warning criteria will be defined within the project. The criteria and warning levels will be agreed upon by relevant stakeholders.

Therefore, the main elements within the monitoring and warning component MHEWS checklist will be addressed:

- While monitoring systems are now in place, these are not deemed sufficient to cover all of the hazards and all of the territory of Azerbaijan. Therefore, as noted, this will be reviewed and expanded within the framework of this project (Sub-Activity 2.1.1).

- No former forecasting and warning services are currently in place in Azerbaijan and this will be fully addressed within this project proposal, enhancing the modelling and forecasting processes and also the warning mechanisms and criteria (Activity 2.2).
- As noted above, the project will address institutional mechanisms for all of the components, including the monitoring and warning ones (Sub-Activities 1.1.1 and 1.1.2).

13.3 Communication and Dissemination

The communication and dissemination component will be addressed through several activities. At the national level, new procedures will be implemented to ensure that information is appropriately shared among key stakeholders. The implementation of a Common Alerting Protocol will be paramount in ensuring this. This will be implemented through the national Multi-Hazard Alert System to be established. This component will also consider the inclusion of decision-making protocols for every hazard warning.

The integrated data visualization and analytics system, to be implemented within the risk knowledge component, will also play a major role in the dissemination of risk information.

The warnings produced by the CIEWS will be carefully analysed to ensure that the messages are distributed and received by the relevant stakeholders and by the population in danger in a timely manner. In addition to that, last-mile communication and dissemination will be fully addressed. Capacity building for community MHEWS will be implemented, training will be undertaken, and the project will ensure that the warning reach community members in a timely manner. It should be added that in this case, for most of the hazards, the monitoring and warning components will not be based at community level. This is because for some of the hazards, the community does not have the capacity (or there is no led time) for the operation and maintenance of monitoring and forecasting devices.

The description of the tasks associated with the communication and dissemination component, and mainly regarding the last-mile communication, are undertaken in the activity sections above.

In summary, the implementation of the communication and dissemination knowledge component will address all of the elements of the MHEWS checklist:

- The implementation of the communication and dissemination component will ensure that the institutional arrangement for the communication or warning is adequate, and that there are decision-making processes in place and operational (Sub-Activity 3.1.1)
- The project will ensure that new communication systems and equipment are deployed and operational. This will be undertaken also, from a last-mile perspective, in the communities that will participate in capacity building for community MHEWS (Sub-Activity 3.1.4).
- Thanks to the implementation of the impact-based forecasting in the monitoring and warning component, this information will be available for proper distribution. Informed by the socially inclusive, child- and gender-responsive communication strategy, the messages to be communicated will contain meaningful information, tailored to the receivers, in order to ensure that prompt action can be taken by target groups (Sub-Activity 3.1.2).

13.4 Preparedness and response capabilities

The preparedness and response capabilities component will be strengthened within the framework of this project. There are several activities within this project that will ensure this, including an Output fully dedicated to the improvement of preparedness capacities of Azerbaijani stakeholders and communities. The project will ensure that key stakeholders, such as the National

Hydrometeorological Service (NHMS), are fully involved to provide valuable information for preparedness and early action capacity purposes.

In summary, the implementation of the preparedness and response capabilities component will address all of the elements of the MHEWS checklist:

- Standard operating procedures and disaster preparedness plans will be developed at national, sectoral and community levels (Sub-Activity 4.1.1)
- Public awareness and education campaigns will be conducted, both at community and at national level. Mechanisms will be implemented to ensure that these campaigns will be undertaken periodically (Sub-Activities 4.1.2, 4.1.3, 4.14)
- Capacity for Forecast-based Financing will be established (Activity 4.2)

14 Project interventions

The proposed project will support the establishment of science-based, data-driven climate information services and a people-centred, impact-based multi-hazard early warning system (IB-MHEWS) in Azerbaijan, contributing to the operationalisation of the five components of the Global Framework for Climate Services (GFCS): i) Observations and Monitoring (through Activities 2.1 and 2.3); ii) Climate Services Information System (through Activities 1.2, 2.1 and 2.2); iii) Research, Modelling and Prediction (through Activities 2.2 and 2.3); iv) User Interface Platform (through Activity 1.1); and v) Capacity Development (strengthening in-country capacities for climate services is a cross-cutting focus throughout all activities).

The project will employ a value-chain approach to climate services delivery and establishment of an end-to-end early warning system that incorporates the four key elements of efficient, people-centred MHEWS: i) Disaster risk knowledge based on the systematic collection of data and disaster risk assessments; ii) Detection, monitoring, analysis and forecasting of hazards and possible consequences; iii) Dissemination and communication of timely, accurate and actionable impact-based warnings; and iv) Preparedness for disaster risk response at all levels.

The project aims to increase the resilience and reduce the vulnerability of Azerbaijani people and sectors to climate change impacts and related hazards through the interventions outlined below.

14.1 Output 1: Strengthened delivery model for climate services and multi-hazard early warning systems (MHEWS)

The project will develop a National Framework for Climate Services based on the GFCS to coordinate, facilitate and strengthen collaboration among national institutions for enhanced use of climate information and provision of best-practice climate information services, and to facilitate a long-term sustainable business delivery model for the National Hydrometeorological Service (NHMS). Moreover, it will strengthen climate data management and e-infrastructure and build capacity for multi-hazard risk profiling underpinning enhanced risk knowledge.

Activity 1.1: Strengthen institutional, policy and financial frameworks for climate services

Sub-Activity 1.1.1 – Develop a National Framework for Climate Services

This sub-activity will facilitate the integration of climate services into key policies, strategies, plans and budgets, thereby providing a foundation for the uptake of climate information in well-informed, science-based decision-making. The development of a National Framework for Climate Services

(NFCS) will provide the overarching framework for the enhancement and delivery of best practice climate services across Azerbaijan.

The NFCS is an institutional mechanism to coordinate, facilitate and strengthen collaboration among national institutions to improve the co-production, tailoring, delivering and use of science-based climate predictions and services at the national level. The NFCS will focus on improving climate science and services focused on the five priority sectors of the Global Framework for Climate Services (GFCS): agriculture and food security, disaster risk reduction, energy, health, and water.

The NFCS will put into practice the five pillars of the GFCS in Azerbaijan as follows:

- User Interface Platform (UIP): a structured means for climate services users and the National Hydrometeorological Service (NHMS), as the main climate information provider, to interact at all levels (to be delivered under Sub-Activity 1.1.2)
- Climate Services Information System: the mechanism through which information about climate (past, present, and future) is routinely collected, stored, and processed to generate products and services that inform science-based decision-making across a wide range of climate-sensitive activities and enterprises (to be delivered under Output 2)
- Observations and Monitoring: the hydrometeorological and air quality monitoring networks will be expanded and strengthened, including through optimization, gap-filling, and upscaling (to be delivered under Output 2)
- Research, Modelling and Prediction: the project will strengthen capacity for weather, water, climate and air quality modelling and multi-hazard impact-based forecasting, including the implementation of a local Numerical Weather Prediction (NWP) model (to be delivered under Output 2)
- Capacity Development: to be implemented as a cross-cutting priority across all four project Outputs.

Once established, the NFCS will serve the following functions:

- A platform for institutional coordination, collaboration, and co-production of user-oriented climate services, among technical departments from line ministries at national and sub-national levels, NHMS and technical experts. This will give different ministries and relevant stakeholders the opportunity to articulate what information they need, and how it can be provided in a relevant and actionable format.
- A framework for collaboration at national level to generate and share user-oriented climate services for use by social and economic sectors. This will help stakeholders to identify and agree on specific functions, relationships, and services to ensure that their operations are resilient to climate variability and climate change impacts.
- A vehicle for coordination of scientific monitoring of the state of Azerbaijan's climate and for disseminating science-based climate information to policy- and decision-makers. The National Climate Outlook Forum (NCOF) delivered as part of the User Interface Platform (Sub-Activity 1.1.2) will help public sector agencies (including ministerial departments for the five GFCS priority sectors – agriculture, disaster risk reduction, health, water, and energy) to identify and articulate how they need to use climate information.
- A functional chain for linking climate knowledge with action on the ground to maximize the application of climate services, including the identification and removal of bottlenecks for improved delivery of climate services.

- An authoritative source of climate science to inform the development of National Adaptation Plans, Nationally Determined Contributions, disaster risk reduction strategies, national development plans, and shock-responsive social protection mechanisms.

Sub-Activity 1.1.2 – Establish a User Interface Platform

The project will establish and promote the use of institutional collaborative platforms to enhance knowledge on climate services and identify good practices and lessons learned to scale up success. Specifically, a User Interface Platform (UIP) will be established as a structured means to strengthen interaction between NHMS – as climate information provider – and the stakeholders and users of climate services, with the overall aim of promoting risk-informed, science-based decision making in relation to climate variability and change. The UIP is a critical pillar of the National Framework for Climate Services (NFCS), developed under Sub-Activity 1.1.1, and will be maintained by NHMS in cooperation with Ministry of Emergency Situations (MoES).

To achieve its overall aim, the UIP will focus on delivering outcomes in four priority areas: Feedback, Dialogue, Outreach, and Monitoring and Evaluation. The operationalisation of a regular National Climate Outlook Forum (NCOF) will be a key component of the UIP. Monthly meetings will be conducted with relevant institutions and sectors, with particular focus on engagement with the GFCS priority sectors – agriculture and food security, disaster risk reduction, energy, health, and water.

The NCOF will facilitate delivery of the intended outcomes of the UIP, as outlined below:

- Feedback – The NCOF will provide a regular platform for NHMS to obtain feedback on the effectiveness of its products and services in addressing user needs. The Forums will facilitate NHMS to receive and respond to user requests for the development of additional climate information products and services
- Dialogue – The NCOFs will facilitate dialogue between climate service users – including government stakeholders, NGOs, and private sector representatives – and technical institutions responsible for the observation, research, and information system pillars of the NFCS – in particular, NHMS and academic institutions.
- Outreach – The NCOFs will support improved climate literacy amongst climate information users, as well as improved literacy of the climate information providers in user needs.
- Evaluation – The NCOFs will provide a mechanism to monitor and evaluate the development and delivery of climate services in Azerbaijan, as well as the overall effectiveness of climate services in promoting science-based decision making on climate change issues.

The NCOF will contribute to addressing the key issue of lack of cooperation and coordination among climate services stakeholders. Participants in the NCOF will include members of the State Commission on Climate Change and the Water Commission. The provisional composition of the NCOF is shown in the figure below.

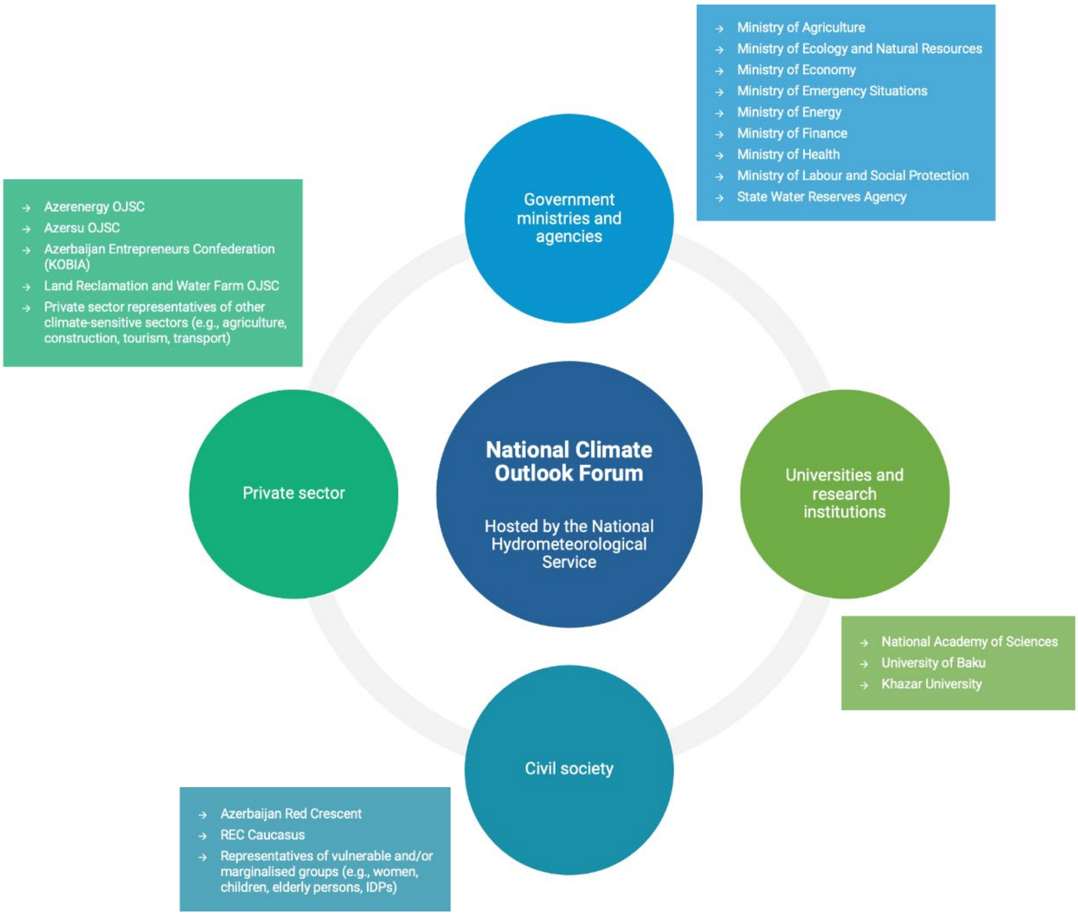

Figure 84. Provisional composition of the National Climate Outlook Forum (NCOF)

Alongside operationalisation of the NCOF, the project will promote partnership building with regional/international institutions and initiatives, with the aim of enhancing regional cooperation and support for climate-related knowledge transfer and data sharing. This sub-activity will enable members of the NCOF to participate in relevant fora, such as Regional Climate Outlook Forums (RCOFs), which bring together experts in various fields, local meteorologists and end-users in an environment that encourages interaction and learning. Meteorological events are not restricted by territorial borders and there are several transboundary rivers in Azerbaijan that have a direct impact on flood and drought hazards. Fostering of strategic partnerships with other institutions in the regional will contribute to creating an enabling environment for improved coordination and communication with neighbouring countries. For example, multi-hazard early warning systems are currently being scaled up in Georgia through a GCF-funded UNDP project (FP068), with several activities that are directly relevant to the outcomes of the proposed project in Azerbaijan – in particular, the enhancement of Numerical Weather Prediction (NWP) models.

The water sector – a priority area of the GFCS – will be strongly engaged through the NFCS and NCOFs, recognising the critical importance of climate data for ongoing assessment of fluctuations and trends and the risks arising from exposure and vulnerability to water-related hazards (namely, floods and droughts) as well as for effective integrated water resource management. Increased dialogue and joint action facilitated by the NCOFs will help to maximise the usefulness of climate services and foster development in new and improved applications of climate information for the water sector. Moreover, dialogue facilitated through the NCOFs will simultaneously support improved water literacy among the weather and climate services community, enabling NHMS personnel to better understand the decision-making context of water resource managers.

Sub-Activity 1.1.3 – Develop a national financial strategy for sustainable climate services

Building on the NFCS established under Sub-Activity 1.1.1, the project will support the Government of Azerbaijan to develop a financial strategy for sustainable climate services to ensure that the NHMS has the means to sustain and ensure the ongoing operation of its mandated services, as capacity to deliver climate analytics with commercialisation potential is developed. In order to prepare the ground for increased private sector engagement and resource mobilisation in the longer term (beyond the project's duration), the project will support the NHMS to scope viable opportunities for sectors and business segments to utilise the improved climate services, and identify opportunities to develop value-added climate products and services (e.g. targeting a particular sector such as agriculture, health or social protection, or related to a particular climate-related hazard) and potential for public-private partnerships and private investment in climate services.

The project will build on capacity development efforts under the EU-funded hydromet twinning project, which is working with NHMS to strengthen its capabilities to deliver demand-based and commercialised services. Operational know-how in marketing and sales techniques established within NHMS through the twinning project will be leveraged and further enhanced. A key emphasis of this sub-activity will be to enable NHMS to shift to a user-informed service model and strengthen the capacity of NHMS staff to demonstrate and promote the value addition of climate information and early warning systems (CIEWS) – this being a critical factor in increasing demand and concurrent willingness to pay amongst users. Moreover, this sub-activity will contribute to the creation of an enabling environment in Azerbaijan for the application of CIEWS for investment and financial decisions that can reduce long-term disaster risks.

The national financial strategy will cover the following elements:

- Identification of the elements of a sustainable business model for NHMS based on the climate services value chain (see below figure), which identifies the two key output streams: basic "public good" services (i.e., public communication of general weather forecasts and warnings) for which predictable national budget allocations need to be ensured; and specialised services tailored to specific users in both public and private sectors. The financial strategy will identify opportunities for NHMS to provide specialised, value-added services, which may offer options for cost recovery from governmental and non-governmental sources beyond the project lifespan.
- Opportunities for greater cooperation between the public and private sectors and academia, thereby delivering win-win situations that fulfil public sector responsibility to provide weather and climate services as a public good, while also meeting the need of economic sectors that increasingly require weather and climate analytics for safe, efficient operations and better management of financial risks.
- Coordination and/or integration of financing for climate services and disaster risk management to establish adequate and reliable funding for disaster risk reduction and preparedness activities.
- Opportunities for mobilisation of finance at scale, including innovative financing solutions (e.g., blended finance), enhanced resource mobilisation from global funds, ring-fenced funding, and scale-up of national budget allocation for CIEWS. The project will explore the potential to establish a national CIEWS fund as a mechanism to enhance the ability of Azerbaijan to ensure predictable and sustainable financing for CIEWS beyond the project's lifespan. Functions of the national CIEWS fund could include: i) support goal setting and the development of programmatic strategies for climate resilience ii) fund capitalisation; iii) management of strategic partnerships; iv) CIEWS project support mechanisms, including

project pipeline development; v) support for policy assurance; vi) provide financial control; vii) performance measurement; and viii) provide and support knowledge and information management.

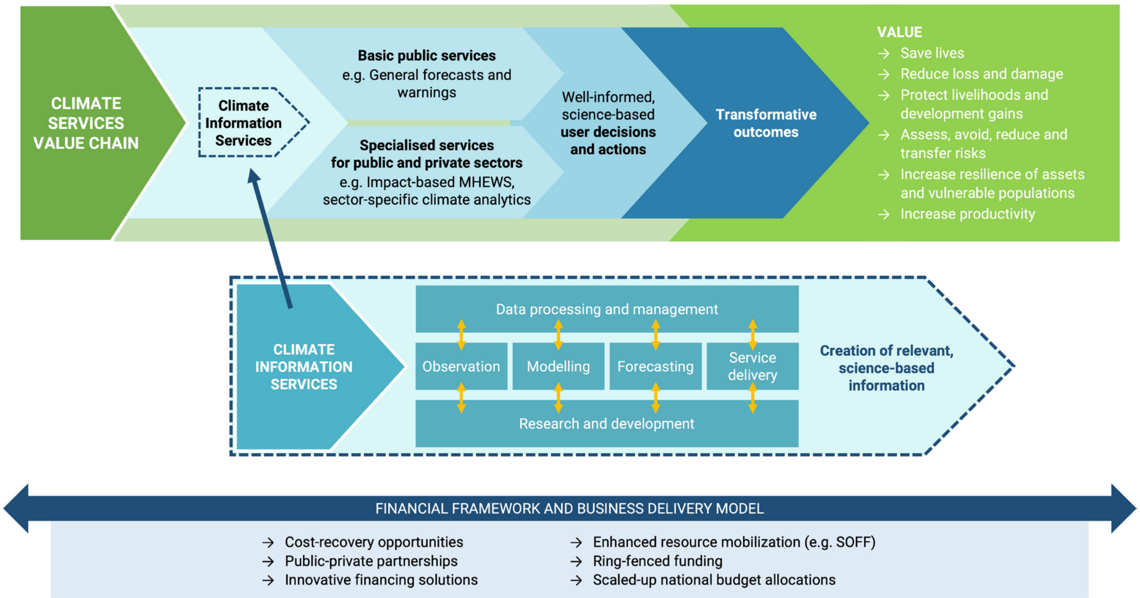

Figure 85. Climate services value chain (top section) and example elements of a financial framework and business model for sustainable weather, water, and climate services (lower section). The production and delivery of climate services is supported by the Climate Services Information System (middle section). (Source: Adapted from the GFCS: Value Proposition, WMO)

Activity 1.2: Enhance climate data governance and risk knowledge

<u>Sub-Activity 1.2.1 – Develop a National Climate Data and Information Management Strategy</u>

This sub-activity will support the Government of Azerbaijan and NHMS to improve management of climate-related data and information, to promote the sharing of climate-related data, and for enhancing the use of climate data in conjunction with data from other sectors in order to mainstream climate considerations into the work of those sectors. This is particularly important for the highly climate-sensitive sectors of water, health, agriculture, disaster risk management, and social protection. Strengthened data sharing and coordination among NHMS and other key stakeholders will maximise the value of existing datasets and advance the integration of multi-sectoral data for improved modelling, forecasting and early warning for early action.

As recognised in the WMO Unified Data Policy Resolution (Res. 1), "data sharing creates mutual benefits for all stakeholders". Accordingly, this sub-activity will develop a National Climate Data and Information Management Strategy outlining standards and protocols for sourcing, securing, managing, assessing, and cataloguing climate-related data, as well as the infrastructure and responsibilities for data exchange, analysis, service provision, and governance between NHMS and relevant agencies. The objective of the strategy is to provide a robust data foundation for the provision of climate products and services through the Climate Services Information System pillar of the NFCS. The strategy will be developed in alignment with WMO guidance and recommended practices, such as the High-Quality Global Data Management Framework for Climate (HQ-GDMFC).

Moreover, the project will promote cooperation between NHMS and the private sector to include open data policies – or well-managed data access – which can contribute to improved decisions and higher efficiencies in operations, as well as growth in user demand for data, products, and value-added services.

Sub-Activity 1.2.2 – Build capacity for multi-hazard risk profiling and vulnerability assessments

The project will build capacity NHMS and the Ministry of Emergency Situations (MoES) to undertake multi-hazard risk profiling and vulnerability assessments as a fundamental means to improve risk knowledge in Azerbaijan. In turn, this will enhance capabilities to deliver on one of the four pillars of an effective multi-hazard early warning system: Disaster Risk Knowledge. It will strengthen national capacity to implement GIS analytics within multi-hazard risk profiling as a powerful tool to map and visualise hazards. GIS can assist location, identification, and understanding of relationships between areas of vulnerability and potential hazard exposure and contributes to improved knowledge and understanding of systemic risk. Moreover, GIS can form the basis for EWS-based triggers for shock-responsive scale-ups of existing social protection programmes and rules-based financial disbursement to implement them.

This sub-activity will support identification, mapping and quantification of risks in relation to climate-related hydrological hazards (i.e., floods and droughts). This will be facilitated by analysis of Earth Observation (EO) data, application of hydrological models (developed under sub-activity 2.1.1), and use of existing tools from UNEP-DHI Centre on Water and Environment for accessing and analysing publicly available remote-sensing data. The resulting GIS-based hazard and risk analytics will be made available through a digital portal/dashboard, with the aim of providing an opportunity for relevant stakeholders to interact with the analytics in simple and intuitive ways, without the need to be familiar with GIS software.

In addition, this sub-activity will support local governments to conduct child-centred multi-hazard risk and vulnerability assessments to inform preparedness actions in the short- to medium-term, as well as integration of child-sensitive approaches to longer term planning, policies and programmes. This will cover all dimensions of disaster risk, including analysis of hazards, exposure, vulnerability (including socio-economic and gender factors), and coping capacities. Improving local understanding of specific risk levels and exposure of children to climate-related hazards and associated vulnerabilities is essential to underpin more inclusive approaches to the strengthening of early warning systems.

This sub-activity will complement the higher-level vulnerability assessments proposed under the GCF-funded National Adaptation Plan (NAP) Readiness project led by UNDP. Specifically, this sub-activity will build on "Development of a comprehensive analysis of existing data and information on climate change adaptation" through the collection and analysis of more localised data and vulnerability indicators. Accordingly, this sub-activity will add depth to the NAP Readiness project's more generalised analysis of climate change adaptation data in Azerbaijan.

14.2 Output 2: Strengthened observations, monitoring, modelling and prediction of climate and its impacts

The project will modernise hydromet services in Azerbaijan, including through expansion and optimization of the observation and monitoring network; infrastructural and technical capacity development and e-infrastructure for local Numerical Weather Prediction (NWP) and multi-hazard impact-based forecasting; and co-production of sector-specific climate analytics for improved management of risks in public and private sector markets. Urban climate services for health will be established as a priority to address increasing climate-related health risks – including development of an Integrated Urban Services Framework and establishment of air quality forecasting capacity.

Activity 2.1: Enhance capacity and equipment for observations and monitoring

Sub-Activity 2.1.1 – Expand and optimise the hydrometeorological observation network

This sub-activity will enhance the hydrometeorological observation and monitoring network in Azerbaijan through gap-filling, automation, and optimisation. This will include the installation of 20 automatic weather stations, two weather radar systems, one upper air sounding system, 10 snow depth sensors, and four mobile discharge meters. The project will also ensure compliance with the WMO Global Basic Observing Network (GBON) technical regulations.

Expansion of the hydrometeorological observation network in Azerbaijan will facilitate enhanced data coverage and availability, including wider coverage of meteorological observations across Azerbaijan and better representation of hydrological features. It will also facilitate a multi-hazard approach to early warning systems development by improving the availability of high-quality weather and climate data associated with multiple hazards. In order to maximise the utility of the monitoring network, individual sensors will be used for several hazards.

A critical consideration in the optimisation of the observation network is to ensure that all data recorded by the stations is transmitted in real-time to the operational centre in Baku. To enhance telemetry and transmission of data, all new stations will have data loggers with the capability of transmitting data via multiple channels, including GSM and satellite.

To ensure the sustainability of the expanded observation network, the project will support NHMS to develop a long-term operation and maintenance (O&M) plan, which will outline how specific O&M needs will be addressed and budgeted for both during and beyond the project implementation period.

Sub-Activity 2.1.2 – Strengthen the Quality Management System (QMS) in NHMS and develop an Operation and Maintenance (O&M) Plan

The project will support NHMS to implement a robust quality management system (QMS) for weather, water, and climate services with the overall aim of achieving compliance with the ISO 9001 standard. The project will cover the total value chain of climate services – institutional, operational infrastructure, human resources, systems, and processes – to facilitate sustainable high-quality service delivery to WMO and ISO standards beyond project term.

This sub-activity will provide expert technical advisory and capacity development for NHMS to utilise a process approach, whereby strengthening of the overall QMS is broken down into smaller processes with clearly defined standards and structured formats. The overall goal of the QMS is to improve quality and performance so that user expectations can be met or exceeded, taking into account the NHMS context as well as stakeholder expectations and requirements.

The QMS will contribute to strengthening the overall climate services value chain by providing process approach to direct and assist NHMS towards meeting quality management objectives. The use of a process approach facilitates more efficient management of resources and activities for the delivery of products and services. Knowledge transfer from international experts will enable NHMS to implement identified good practices and leverage lessons learned from more advanced operational service providers. Strengthening of the QMS in NHMS will have several benefits, including the optimisation of the processes undertaken by NHMS and enhancement in the data management procedures.

Additionally, the project will work with NHMS to co-develop an Operation and Maintenance (O&M) Plan, which will outline how specific O&M needs will be addressed both during and post implementation of the project. The O&M Plan will consider all existing and required financial, human, technological and logistic resources to ensure continuity of observations in the long term, including planning for staffing, maintenance of equipment, and data management.

In line with the guidance tool developed by WMO under the intra-ACP climate services and related applications programme (ClimSA) [190], the O&M Plan is expected to cover the following key sections:

- Objectives of the plan, including targets and key performance indicators
- Potential risks and challenges for implementing the O&M Plan
- Scope of the observing network components to be covered under the Plan
- Existing and required resources to implement the Plan
- Operational status and principles for each type of observing system and IT equipment
- Planned maintenance activities (including preventative maintenance, corrective maintenance, calibration for each component/subsystem)
- Metadata management in accordance with the WMO Integrated Global Observing System (WIGOS) Metadata Standard
- Quality monitoring procedures using WIGO Data Quality Monitoring System (WDQMS) and Regional WIGOS Centres
- Spart parts inventory
- Safety and security precautions
- Training plan for staff responsible for O&M

Sub-Activity 2.1.3 – Upgrade the Hydromet Situation Centre

The project will transform NHMS' capacity for data collection, management, analysis, and exchange through ICT investments, technical upgrades, and capacity development within the existing Hydromet Situation Centre in Azerbaijan. This will include establishing an automated observation data collection system, centralised database management system (DBMS) and a message switching system. A vulnerability and exposure data monitoring tool will also be developed, which will feed into the impact-based forecasting models to be established under sub-activity 2.2.2. The deployment of new software will be complemented by comprehensive technical training for NHMS staff on utilisation of the new systems, including targeted training on hydrological data management and quality assurance (e.g., automatising and integrating acquired data from new stations and developing workflows for quality assurance).

The observation data collection system will facilitate streamlined data ingestion and extraction, and quality control. It will ensure that data from all monitoring stations is automatically collected and fed into the overall climate services and multi-hazard early warning system to be established. Moreover, the system will provide information on the status of the observing network in order to monitor network performance and facilitate detection and alert of possible issues.

The centralised DBMS provide data analysis functions and climatological workstation software for local analysis of weather, water, and climate phenomena. The DBMS will be built and localised on existing open-source solutions and will provide the ability to store, analyse, and generate reports on large amounts of real-time and historical meteorological, climatological, and hydrological data. The DBMS will have functionality for data rescue, quality assessment, export and import interfaces, customisable user access/role, and metadata management. Moreover, the system will facilitate data exchange between national service providers, as well as contributions to broader data sharing

[190] WMO, 2023. The Intra-ACP Climate Services and Related Applications Programme – WMO Implemented Activities 2023. Available at: https://wmo.int/sites/default/files/2024-01/Final%20Activities%20Report%20CLIMSA%202023.pdf

initiatives at the regional or global level. The DBMS will be compatible and integrate with the SmartMet system to be established under sub-activity 2.2.1. The introduction of a simple, customisable, and license-free system will afford significant efficiency gains within NHMS, by reducing the amount of staff time required to manage data and enabling resources (including financial resources due to lack of license fees) to be allocated to other activities.

To advance international real-time data exchange, the project will support the deployment of an automated message switching system (AMSS) connected to relevant international networks, including WMO GTS and SADIS. The AMSS will facilitate the switching of all types of data and products, including traditional alphanumeric codes, satellite and radar image files, binary products, and WMO monitoring. The system will be fully compliant with WMO and ICAO standards.

<u>Sub-Activity 2.1.4 – Establish Internet of Things (IoT) approaches</u>

The project will build capacity within NHMS to utilise Internet of Things (IoT) to enhance data collection and coverage in areas with limited connectivity and/or power supply. In partnership with the International Centre for Theoretical Physics (ICTP), which is a global leader in advancing the application of IoT for weather monitoring, the project will provide equipment and training to support the development of innovative and cost-saving technologies for weather and climate observations suited to the unique context of Azerbaijan.

As part of this sub-activity the project will pilot the use of low-cost weather stations based on IoT technology. The aim of the pilot will be to develop and demonstrate the potential of low-cost and low-power IoT sensors to provide weather data at high resolution in data-sparse locations. This will be achieved through the integration of three technologies into a common data processing platform:

- LoRaWAN -enabled weather stations and water-level sensors sending data to a solar-powered GSM-compatible gateway.
- Infrastructure for remote data collection, with the possibility of future extensions (e.g., air quality monitoring, landslide detection, drought monitoring)
- Local server to collect data and enable user-friendly data visualisation.

The IoT pilot will be complemented by workshops, peer learning, and hands-on training both in Azerbaijan and at ICTP. Three workshops will be conducted in-country on the use of wireless connectivity and IoT for climate services and disaster risk management. A further two workshops will be organised at ICTP on policy-related aspects of IoT planning and development. Moreover, the project will help to cultivate and strengthen permanent scientific expertise in Azerbaijan through associateship(s) and attachment training at ICTP’s Marconi Lab, which specialises in wireless communications and IoT, using approaches that are responsive to local needs and resources as well as to the frontiers of science and technology. Strengthening of local capacities in this regard will contribute to long-term sustainability.

Activity 2.2: Strengthen weather, water and climate modelling and impact-based forecasting

<u>Sub-Activity 2.2.1 – Establish local Numerical Weather Prediction (NWP) and modelling processes</u>

A key contributor to the project’s paradigm shift potential is the establishment of in-country capacity to implement Numerical Weather Prediction (NWP), which is the basis on which all weather and climate services are built. This sub-activity will build on the substantial NWP capacity development efforts supported under the EU-funded hydromet twinning project, leveraging the improved probabilistic and impact-based forecasting capabilities developed therein.

Under the EU Twinning Project, Azerbaijan NWP will be developed and pre-installed in FMI hardware and NHMS staff will undertake both theoretical and practical hands-on training to implement NWP, with the support of experts from FMI and the University of Helsinki. The proposed project will subsequently fill a critical investment gap by providing the hardware needed to enable operational installation of NWP in Azerbaijan.

Building on the hardware investment, the project will provide technical support to NHMS for the following:

1. Implementation and configuration of NWP
2. Collection and operationalisation of data required for model operation
3. Development of programmes and procedures for verification of results
4. Inclusion of assimilation procedures
5. Inclusion of ensemble techniques.

In enabling NHMS to undertake ensemble prediction, the project will facilitate the generation of probabilistic forecasts as well as optimised deterministic forecasts with greater reliability and utility for decision-makers and end-users. Ensemble forecasting is essential to improving forecast skill and providing more accurate forecasts at longer lead times.

In addition to supporting enhanced weather and climate modelling, the project will establish capacity within NHMS to develop, use and understand the outcomes of hydrological and hydraulic models. This sub-activity will support operationalisation of hydrological and hydraulic models to feed into climate change predictions and serve as a basis for multi-hazard impact-based forecasting tools (to be developed under sub-activity 2.2.2). The introduction of hydrological and hydraulic models will be underpinned by a targeted trainings and hands-on exercises. Long-term capacity retention will be facilitated by access to online training courses for new staff and/or those that require retraining.

In combination with NWP, hydrological and hydraulic models are critical for the implementation of localised, real-time flood and flash-flood forecasting. The ability to implement local NWP, hydrological and hydraulic modelling will have transformational impact for Azerbaijan by facilitating the production and dissemination of tailored weather, water and climate forecasts that are more accurate, reliable, and applicable to the local context.

<u>Sub-Activity 2.2.2 – Establish multi-hazard impact-based forecasting tools and capabilities</u>

The project will support the operationalisation of a state-of-the-art forecast production and verification system for Azerbaijan – SmartMet. Built on open-source code, the SmartMet system will provide an e-infrastructure platform for NHMS to access, generate and use all relevant information and analytics on weather, water, and climate. This includes functionality for the visualisation of all observational data; acquisition and visualisation of forecasting data from both global/regional sources and from the local NWP model; verification of NWP results against observational data; and the possibility of creating different weather products derived from the NWP outputs.

NHMS staff will be trained on all aspects of the system operation, including data ingestion, visualisation, and product development. As forecasting capacity within NHMS is advanced over the course of the project, NHMS forecasters will be supported to exploit a unique capability of SmartMet: modification of NWP model outputs taking into account available observations and local expertise to generate impact-based and tailor-made forecasts for an unlimited number of users.

Moreover, the project will enable Azerbaijan to implement a multi-hazard impact-based forecasting approach that translates information on weather, water and climate hazards into sector- and location-specific impacts. The project will establish in-country capacity to integrate hazard modelling (Sub-Activity 2.2.1) with risk and vulnerability information (Sub-Activity 1.2.3) to generate impact-based forecasts for multiple hazards, including floods, droughts, extreme heat, and air pollution. The introduction of risk matrices, combining likelihood with estimated impact, will enable NHMS to better understand the relationship between spatial and temporal variations in vulnerability and exposure associated with climate-related hazards, and in turn, better communicate the level of risk experienced by different sectors and communities. It will also allow the potential for government to include shock-responsive social protection in the national annual planning and budgeting cycle by providing advance information on the risk of climate-driven shocks in particular communities or geographical areas.

<u>Sub-Activity 2.2.3 – Co-produce sector-specific climate analytics and information products for public and private stakeholders</u>

Building on the establishment of impact-based forecasting capacity (Sub-Activity 2.2.2), the project will support the NHMS and key stakeholders to co-produce sector-specific climate analytics and actionable information products for agriculture, disaster risk reduction, ecosystem services, energy, health, shock-responsive social protection, and water resource management, amongst others. Both public and private sector stakeholders will be engaged.

The availability and use of tailored impact-based climate analytics and information products, incorporating socio-economic and sectoral impact data, will facilitate risk-informed, science-based decision making and planning for increased resilience of key sectors in Azerbaijan. It will also contribute to establishing an enabling environment for enhanced use of climate analytics for managing risks in both public and private sector markets.

The development of sector- and customer-specific tailored services will be facilitated by joint stakeholder and customer consultation workshops to map out and elaborate sectoral customer needs. The project will leverage and build on capacity development activities under the EU-funded hydromet twinning project, which includes a focus on strengthening the demand-based and commercialised service delivery capacity of NHMS. New products will be created and operationalised through the modernised production system (SmartMet) established under Sub-Activity 2.2.2.

Activity 2.3: Develop urban climate services for health

<u>Sub-Activity 2.3.1 – Develop an Integrated Urban Services Framework</u>

To complement the National Framework for Climate Services (Sub-Activity 1.1.1), an Integrated Urban Services Framework (IUSF) will be developed. The IUSF will define institutional mandates, roles and responsibilities and include a comprehensive strategy for service delivery in relation to urban weather, climate, hydrological and air quality services. In addition, the Project will engage with and establish collaborative partnerships with relevant national agencies and stakeholders for delivering Integrated Urban Services and urban data sharing. The development of the IUSF will follow the guidelines as proposed by the WMO. The main components of an IUSF are shown in the figure below.

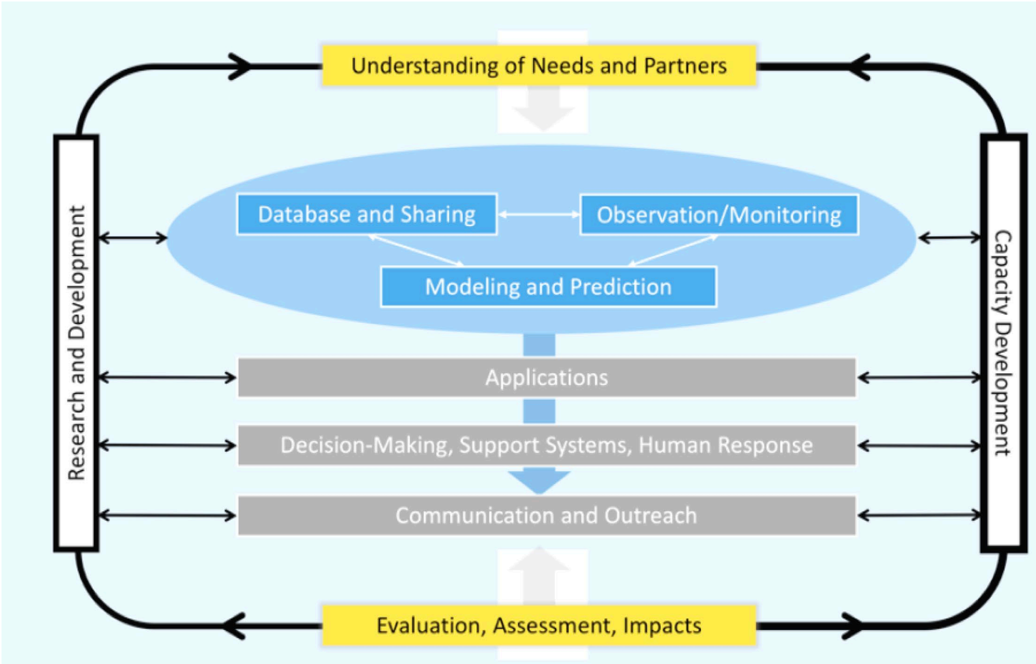

Figure 86. Key elements of an Integrated Urban Services system (Source: WMO, 2018)

The establishment of Integrated Urban Services in Azerbaijan will be supported by linkages to several other project activities, in particular: the Database and Sharing component will be facilitated by the National Climate Data and Information Management Strategy (Sub-Activity 1.2.1) and centralised observational database management system (Sub-Activity 2.1.3); the Observation/Monitoring component will be underpinned by enhancement of the observation and monitoring network (Sub-Activities 2.1.1 and 2.3.2); and the Modelling and Prediction component will be supported by strengthened weather, water and climate modelling and impact-based forecasting (Activity 2.2), which will play a key role in enhancing the capabilities of both NHMS and MoES to produce analytics and products that are suitable for users in urban areas.

In addition to developing the IUSF, potential urban services Applications will be conceptualised for further development through the modelling and forecasting interventions (Activity 2.2). A Decision-Making and Support System for health will be developed under Sub-Activity 2.3.3, while Communication and Outreach will be implemented under Outputs 3 and 4.

<u>Sub-Activity 2.3.2 – Enhance the air quality monitoring system</u>

Air quality is a significant concern in Azerbaijan, particularly in urban areas. As per World Health Organization (WHO) guidelines, air quality in Azerbaijan is considered "moderately unsafe". The most recent data indicates the country's annual mean concentration of PM2.5 is 20 µg/m3, which exceeds the recommended maximum of 5 µg/m3. The issue of severe air pollution is expected to be exacerbated by climate change.

Accordingly, the project will ensure that reliable, real-time data on particulate matter (PM) and greenhouse gas (GHG) concentrations is captured to enable comprehensive assessment and forecasting of air pollution levels. The project will enhance the air quality monitoring system through the provision of technical guidance and hands-on training for operation and maintenance of existing stations to sustain the results. The audience for the training will be technical staff at NHMS and partner agencies.

Data from existing stations will be ingested into the centralised observational database management system in the Hydromet Situation Centre (Sub-Activity 2.1.3) for subsequent analysis and product generation.

The project will enable NHMS to implement air quality forecasting as part of the local NWP implementation (Sub-Activity 2.2.1). Air quality forecast products will be based on data from both the AQM network and meteorological forecasts. Historical information pertinent to air quality/pollution forecasting will also be collected and validation (and calibration, if required) of existing air quality products against observational data will be implemented.

Sub-Activity 2.3.3 – Co-produce targeted analytics and decision support for health

This sub-activity will address the need for increased access, understanding and use of weather and climate information for risk-informed decision making in the health sector. The project will support the co-development and co-production of targeted analytics and tools that will provide decision-makers with relevant, science-based information to proactively manage climate-related health risks. Working with NHMS and the Ministry of Health (MoH), the project will support the integration of weather, climate, epidemiological, and other relevant data (e.g., disease prevalence/incidence, models, indices, and assessments) to generate health risk forecasts that anticipate when and where changes in key parameters – humidity, temperature, particulate matter (PM) concentration – may increase the likelihood for climate-related health impacts to occur. Targeted analytics will be produced and made accessible through SmartMet (Sub-Activity 2.2.1). Workshops will be conducted to support capacity building of the MoH, TABIB[191], and other related authorities to identify the required data to assist with analysis, modelling and decision making and integrate climate information into health service provision, including digital integration where needed. As part of the knowledge exchange, the project will organise a study tour for key stakeholders to a country where the EWS is already linked with the health sector to facilitate knowledge transfer and sharing of good practices.

14.3 Output 3: Enhanced dissemination and communication of climate risk information and multi-hazard early warnings

The project will strengthen national and local capacity to establish a people-centred, impact-based MHEWS based on the priorities for early warning systems and disaster risk reduction, as set out in the Paris Agreement, Sendai Framework and Sustainable Development Goals (SDGs). The project will support the effective and coordinated delivery of MHEWS covering Azerbaijan, including through strengthened organizational and decision-making processes and establishment of a national Multi-Hazard Alert System, underpinned by a socially inclusive and gender-responsive approach. Moreover, it will enhance community MHEWS through capacity building at the local level. This will contribute to the outcomes of the 2019 UN Climate Action Summit, in particular targets 3 and 4 of the Risk-informed Early Action Partnership (REAP) on investment in "early warning infrastructure and institutions to target early action in 'last/first mile' communities" and "more people are covered by new or improved early warning systems…".

[191] TABIB is the Azerbaijani Management Union of Medical Territorial Units, responsible for managing medical institutions related to the application of compulsory medical insurance and carrying out control in this field.

Activity 3.1: Establish an impact-based multi-hazard early warning system (MHEWS)

Sub-Activity 3.1.1 – Strengthen MHEWS organisational and decision-making processes

The project will facilitate the effective and coordinated delivery of MHEWS in Azerbaijan through strengthened organisational and decision-making processes of NHMS, MoES, Ministry of Labour and Social Protection (MLSP), and other disaster risk management actors and stakeholders, including civil society organisations (CSOs). In conjunction with the establishment of the National Framework for Climate Services (NFCS), the project will work with national stakeholders to define the functions, roles and responsibilities of key EWS actors and include them in SOPs.

Warning communication protocols will be developed to ensure coordination between NHMS – as warning issuers – and downstream dissemination channels. Local government and CSOs, including women's groups, will play a key role in the dissemination of climate and air quality information and early warnings to communities. The protocols will include development of two-way feedback loops between NHMS, institutional users, and end-users to verify that warnings have been received and to alert NHMS to potential gaps in the communication system. To ensure that warning messages reach communities in a timely manner, community representatives could be appointed with responsibility for receiving communications from the Hydromet Situation Centre (Sub-Activity 2.1.3). In development of the protocols, the project will seek to establish new partnerships with the private sector to expand information dissemination channels and feedback mechanisms.

Furthermore, the project will support local administrations to strengthen existing public broadcasting and reporting mechanisms to ensure that updated risk information is disseminated to vulnerable children, youth, and families (e.g., through translation into local languages), ensuring at the same time the participation of targeted vulnerable groups in the process. The project will strengthen local government efforts to make risk information freely available to and accessible by the public, including by increasing opportunities for children's and community-based organisations to disseminate risk information in the most vulnerable neighbourhoods.

Sub-Activity 3.1.2 – Co-develop a socially inclusive, child- and gender-responsive communication strategy

The project will engage a full-time Gender Equality and Social Inclusion (GESI) expert who will be responsible for overall child rights and gender mainstreaming and ensuring that child and gender needs are integrated into the MHEWS. As part of this sub-activity, the GESI expert will engage in multi-stakeholder dialogue to analyse the effectiveness of existing warning communication and dissemination systems and identify the ways in which child rights and gender and other intersectional vulnerabilities impact on the accessibility, reach and understanding of early warning. This will be facilitated through dedicated consultations with community representatives – with a proactive focus on meaningful participation of marginalised and/or vulnerable groups, such as women, children and youth, elderly people, LGBTQIA+, indigenous peoples, and people with disabilities.

Based on these consultations, this sub-activity will co-develop a social inclusive and gender-responsive communication strategy for MHEWS based on understanding of last-mile connectivity (which population groups can be reached by different communication channels) and tailored to the differential vulnerabilities and needs of specific population groups. The project will employ an inclusive and intersectional approach – acknowledging the interaction of childhood and gender with other potentially socially excluding factors – to build trust between stakeholders and ensure that MHEWS communication and dissemination mechanisms work effectively for all members of the community.

The proposed strategy will build on and complement the communication and dissemination strategy for weather, water and climate information to be developed under the EU-funded hydromet twinning project.

Sub-Activity 3.1.3 – Establish a national multi-hazard alert system

This sub-activity will support the establishment of a national multi-hazard alert system for the communication and dissemination of authoritative information related to high-impact weather, water, climate and air pollution events across Azerbaijan. The Alert system will be integrated within SmartMet (established under Sub-Activity 2.2.1) and will be adapted to the conditions and forecasts that NHMS issues and the services developed through the project. The integration of all available weather, water, climate and air quality monitoring and forecasting outputs, including NWP and impact-based forecasts, will support the seamless integration of forecasting and warning processes. The Alert system will have the capability of encoding information in Common Alert Protocol (CAP) format. Implementation of CAP will ensure that this information is available in a compatible format across multiple networks. Appendix A (Annex 15) provides example warning criteria, messages, and potential alert processes for a variety of hazards in Azerbaijan including floods, drought, hail, strong-wind, waves, extreme temperature, and air pollution.

The purpose of the Alert system will be to better connect impact-based forecasts and warnings to critical decision points and decision-makers in key climate-sensitive sectors. This will facilitate scientific forecasts to be translated into a user-friendly, actionable, and understandable format to inform evidence-based preparedness actions that reduce the impact of climate hazards and protect life, property and assets. For example, impact-based flood forecasts will utilize monitoring and modelling data (including from the overall hydraulic model) to create warning criteria based on critical thresholds in different basins and issue timely and actionable communications to "at risk" communities, as well as to government institutions and researchers to support proactive preparedness actions. The Alert system can also serve as the basis for triggers for the scale-up of social protection programmes in response to climate-driven shocks, to be supported under Activity 4.2.

The establishment of a national Multi-Hazard Alert System for Azerbaijan will contribute to the achievement of priorities and objectives of the WMO Global Multi-hazard Alert System (GMAS) Framework, which aims to enhance capabilities to close the EWS coverage gaps; and strengthen connections between EWSs and decision-making processes across a range of time and spatial scales. This sub-activity will scale up capacity development efforts under the EU-funded hydromet twinning project, which will demonstrate the use of SmartMet Alert and initiate its localisation with Azeri hazards and warnings.

Sub-Activity 3.1.4 – Build capacity for community MHEWS

A key challenge in delivering end-to-end, people centred MHEWS is implementing and sustaining it at the community level. Ensuring the meaningful engagement and participation of people in remote communities with MHEWS aims to increase the effectiveness of such systems. Learning through participation will enable these communities to better understand the value of MHEWS and increase local ownership in operating and sustaining the system.

This sub-activity will deliver targeted capacity building and training for community MHEWS that link to the national system and extend its reach to the local level, with a focus on ensuring the dissemination of climate information and multi-hazard early warning messages targeted to the needs of marginalised and/or vulnerable groups. This sub-activity will focus on working with communities that are at relatively high risk, have short lead times for extreme events, and have technical constraints for national systems to effectively service. Selection criteria for the target communities is provided in Section 16.3).

The project will work with communities to strengthen local communication and dissemination systems to reach the last mile. This could include participatory approaches to assess the resilience and coverage of available communication channels, identification of appropriate last-mile communication channels (e.g., satellite and mobile-cellular networks, social media, flags, sirens, bells, public address systems, door-to-door visits, community meetings), and establishment of back-up systems and processes in the event of failure. The project will also seek to establish two-way communication processes that bridge the gap between communities and authorities (namely NHMS and MoES) and help to maintain both top-down and bottom-up information flows. As with the other end-user serviced developed and operationalised through the proposed project, the community-level MHEWS will be integrated with the modernised production system (Sub-Activities 1.2.2 and 2.1.3). This will also enable the introduction of modern and new formats in product and service delivery, such as mobile applications.

Moreover, the project will work with NHMS and MoES to train communities (in a socially inclusive, age- and gender-responsive manner) on the use of climate and air quality information, impact-based forecasts and early warnings, as well as on the co-development of EWS products for "last-mile" users. Community representatives will also be guided on how to request data and products to be generated from the climate data management system operated by NHMS.

Capacity building for community MHEWS will be informed by consultations with GESI experts, relevant policymakers, women's groups, and community representatives on how to best design and implement MHEWS that are socially inclusive, age- and gender responsive. It will be complemented by targeted training and capacity building focused on enhancing community understanding of climate-related hazards, vulnerability and exposure (delivered under Sub-Activity 4.1.2).

Sub-Activity 3.1.5 – Engage children and youth in MHEWS

Recognising the potential for children and youth to be powerful agents of change, the project will facilitate youth engagement in MHEWS at all levels – in families, with peers, at school, in communities, and at the national level. This sub-activity aims to engage 5,000 adolescents and young people in MHEWS through various national and local platforms (e.g., Youth Houses and schools) and outreach methods – including workshops, peer education, and youth-led community initiatives. Specifically, this sub-activity will conduct a series of community-based workshops to promote innovative and results-based thinking approaches in the context of MHEWS. Targeted support and mentoring will be provided to facilitate the implementation of the most promising solutions, with the overall aim being to maximise the involvement and child-responsiveness of MHEWS at the local level. This sub-activity will also support a peer education program, whereby young people are trained to become advocates within their communities on MHEWS and climate resilience issues. Collectively, these interventions will facilitate scale-up of the UPSHIFT programme[192] in Azerbaijan in the context of climate change and disaster risk reduction. Additionally, this sub-activity will help to create and strengthen networks among young people and other stakeholders involved in early warning systems and climate resilience. It will also equip national informal platforms with the necessary tools and

[192] UPSHIFT is a social innovation and social entrepreneurship programme of UNICEF that empowers disadvantaged youth by providing them with the skills and resources needed to identify and deal with local community issues – in this case, focusing on the impacts of climate change.

resources to engage adolescents and young people in these fields, ensuring the transfer of skills and experience to the next generation, supported by youth champions from the project.

14.4 Output 4: Enhanced climate risk management capacity

The value of climate services and early warning systems in supporting DRR is clearly acknowledged in the resilience agenda of post-2015 international agreements and frameworks – in particular, the Sendai Framework for Disaster Risk Reduction, which explicitly highlights climate services under Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction. This Output is therefore designed to increase coherence and mutual reinforcement between disaster risk management – defined as the application of DRR policies and strategies – and climate services and MHEWS, which will be strengthened under Outputs 1 – 3.

The project will build capacities at all levels (from national government services to communities at the last mile) for better preparedness in response to climate-related hazards and longer-term climate change. This will include delivering targeted and gender-responsive public awareness and education campaigns and establishing capacity for Forecast-based Action (FbA) and Forecast-based Financing (FbF) by embedding linkages between impact-based MHEWS and shock-responsive social protection. FbA – also known as anticipatory or early action – an innovative mechanism whereby early actions at community and government level are pre-planned based on in-depth forecast and risk analysis, and resources are automatically allocated when a specific threshold is reached. Forecast-based action been shown to minimise losses and damages caused by climate-related hazards and reduce the need for humanitarian assistance in their aftermath.

Social protection is a set of interventions designed to reduce socio-economic risk and vulnerability, and to alleviate extreme poverty and deprivation. Shock-responsive social protection (SRSP) refers to the leveraging or scaling-up of government-implemented social protection programmes to respond to shocks. SRSP is the main vehicle through which national social protection systems are adapted to climate change. In this context, SRSP has the potential to increase the coping, adaptive and transformative capacities of vulnerable groups and serve as an enabler in scaling up anticipatory action for climate shocks. Linking impact-based MHEWS to FbA and FbF in the national social protection system (i.e., SRSP) through the co-development of thresholds, triggers, and protocols in collaboration with the Government of Azerbaijan and other key stakeholders will support improved preparedness and early action by triggering timely scale-ups before or immediately after a climate shock. Through Activity 4.2, the project will support the ongoing efforts of the Government of Azerbaijan under the National Socio-Economic Development Strategy 2022-2026 to establish SRSP mechanisms covering climate-driven shocks.

Activity 4.1: Build capacity to prepare for and respond to climate risks and hazards

<u>Sub-Activity 4.1.1 – Strengthen national, sectoral and community preparedness capabilities</u>

The project will build in-country capacities for enhanced preparedness from national to sectoral to community level for better preparedness in response to extreme climate events and long-term climate variability and change.

This sub-activity will develop standard operating procedures (SOPs) and plans for disaster preparedness, as well as strategies to maintain preparedness for longer return-periods and cascading hazard events. At the sectoral level, the Project will focus on building preparedness capabilities for key climate-sensitive sectors – including agriculture, disaster risk reduction, energy, health, tourism, and water resources. At the community level, the Project will utilize participatory co-development approaches to ensure that SOPs and plans are appropriate to local contexts, including differential vulnerabilities and capacities, as well as simultaneously build local ownership. Understanding differential vulnerabilities and capacities is an integral part of disaster preparedness and contributes to the development of community-based initiatives that are mutually supportive and responsive to the needs of the people most closely concerned.

Community-based disaster management units present in the Azerbaijani communities will play a key role in identifying vulnerable areas and evacuation routes, overseeing the (future) implementation of SOPs and disaster preparedness plans, and disseminating forecasts and warnings. Regular interactions between communities and national stakeholders will be an integral part of the SOPs.

Sub-Activity 4.1.2 – Increase public awareness and education on climate-related hazards, early warning systems and risk management

The project will conduct a nationwide awareness-raising and education campaign through workshops, seminars and multi-media communications to improve the public risk knowledge that underpins enhanced preparedness to climate-related hazards. The campaign will have several objectives, including:

- Improve climate change literacy: the campaign will seek to increase overall public awareness of the scientific basis on climate variability and change affecting Azerbaijan.
- Inform about the new multi-hazard early warning system (MHEWS): for the MHEWS to be successful, it must be accessible to and used by stakeholders and actors from national to local level. The campaign will educate potential users on new system, including availability of climate services, warning criteria and warning levels, and how information can be accessed.
- Enhance risk knowledge: the campaign will raise awareness on the multi-hazard risk profiling and vulnerability assessments (supported under Sub-Activity 1.2.3) to improve understanding on hazards that could impact the population, vulnerabilities, and relative exposure. In the longer term, this will contribute to better informed disaster risk management.

Sub-Activity 4.1.3 – Conduct a targeted risk awareness and education program for women

This sub-activity aims to empower women and other potentially marginalised gender groups through enhanced awareness and understanding of climate-related hazards and risks, to support increased participation in disaster risk management and decision making for climate resilience. The project will establish localised women's networks – through linkages with women's groups and local NGOs/CBOs – to disseminate IECs tailored to gender-specific needs and capacities, as well as deliver climate risk education workshops. The networks will enhance women's roles in disaster risk awareness-raising and support increased engagement in peer-to-peer learning.

Given the disproportionate effects of climate change on women's health, the campaign will seek to educate women on how to use climate risk information to take actions at the household and individual levels to protect health. Training of trainers (ToT) workshops will support women's group facilitators to expand the disaster risk awareness and education campaigns to other communities, thereby developing local educators and enhancing sustainability beyond the project implementation period. These interventions will support implementation of the socially inclusive and gender-responsive communication strategy developed under Sub-Activity 3.1.2.

Sub-Activity 4.1.4 – Disseminate targeted education materials for children and youth

Building on the nationwide awareness-raising and education campaign (Sub-Activity 4.1.2), the project will produce and disseminate targeted educational materials for different age groups in collaboration with the Ministry of Education, MENR and MoES. This sub-activity targets younger children through formal education channels to build foundational knowledge and capacity in relation to climate resilience and disaster risk management.

As part of this sub-activity, the project will also provide guidance on mainstreaming the latest knowledge and science on climate change into national curricula and educate on the role that MHEWS can play in reducing climate-related vulnerabilities and risks. The project will advocate for a skills-based learning approach, through action-oriented pedagogies, recognising that such approaches can empower children, adolescents and teachers to participate in climate resilience activities and encourage children to become part of the solution to climate change.

Face-to-face interventions will be used to disseminate knowledge to children and young people, through schools and communities. With at least 97% of youth and 91% of children under 15 years old having access to internet and universal access to TV among the population,[193] TV and digital channels will be widely used. The project will measure the effectiveness of the intervention through both qualitative and quantitative measures – e.g., pre- and post-intervention surveys, feedback channels (online, suggestion boxes), and observation studies during the face-to-face interactions.

Activity 4.2: Establish Forecast-based Financing (FbF)

<u>Sub-Activity 4.2.1 – Develop a Roadmap for FbF</u>

This sub-activity will develop a Roadmap for Forecast-based Financing (FbF) in Azerbaijan – an innovative mechanism whereby anticipatory actions are pre-planned based on in-depth forecast information and risk analysis, and resources are automatically allocated when a specific threshold is reached. Forecast-based financing – also known as Forecast-based Action (FbA) – has been shown to enhance preparedness and reduce loss and damage caused by climate-related disasters and the need for humanitarian assistance in their aftermath. Critically, FbF saves lives.

The roadmap will present a pathway for delivering and scaling up FbF/FbA, linked to impact-based MHEWS, whereby shock-responsive social protection (SRSP) is leveraged as an enabler. A key consideration in the development of the roadmap and the recommended actions therein will be to ensure a people-centred approach that accounts for the specific needs and perspectives of the most vulnerable population groups. In development of the roadmap, the following components will be addressed:

- Stakeholder mapping and coordination mechanism: Key stakeholders to be involved in the development and implementation of FbF will be identified, including international, national, regional, and local actors. An appropriate mechanism for coordination of FbF will be identified, with core roles for the NHMS (as the mandated agency for the provision of hydrometeorological information and forecasts) and the Ministry of Labour and Social Protection of the Population (MLSP) (as the institutional actor with the mandate for social protection).
- Legal Framework Analysis: Engagement of the Ministry of Justice and other key ministerial focal points to analyse the legal framework and requirements for the establishment of FbF linked to the national social protection system.
- Risk Assessment: The assessment will utilize a participatory approach to analyse risk factors, key hazards, past impact, exposure and vulnerability. Based on the analysis, the priority

[193] See Gender Assessment and Action Plan (Annex 4)

impacts to be addressed will be identified. The assessment will provide an overview of the different types of early actions that could be taken to mitigate risk by the identified stakeholders via the national social protection system.

- Financing Strategy: Elaboration of a country-driven SRSP financing strategy that addresses the identification and establishment of pre-positioned and sustainable (i.e., not project-based) national funding (e.g., special contingency funds in the national budget for more frequent, predictable, and slower-onset shocks) and pre-positioned international financing instruments (e.g., catastrophic deferred drawdown – Cat DDO – for less frequent, high-impact shocks). This will include scoping of potential national level funds and international instruments for anticipatory action, disaster risk financing options, and private-sector funding options. The financial mechanism will be included in and linked to the overarching national financial strategy for sustainable climate services (Sub-Activity 1.1.3).
- Technical mechanisms and tools: Identification of the key steps required to develop the technical means for delivering and scaling up FbF (e.g., impact-based forecast triggers, protocols for scale-up of social protection, capacity of data and alerting systems).

This sub-activity will be informed by dedicated consultations with child- and gender experts, relevant policy makers and women's groups on how to best incorporate actionable gender-responsive actions into FbF.

<u>Sub-Activity 4.2.2 – Strengthen capacities for climate shock-responsive social protection (SRSP)</u>

The project will strengthen capacities within the government and national social protection system to mainstream increased resilience to climate-driven shocks through the timely scale-up of social protection mechanisms triggered by impact-based forecasts and MHEWS. This sub-activity will focus on building capacity of the MLSP and other key actors at the national and local levels (identified through the stakeholder mapping under Sub-Activity 4.2.1) to institutionalise MHEWS-linked FbF delivered through SRSP, including development of an appropriate and robust financing strategy.

Capacity development activities will cover both the establishment of technical mechanisms to enable MHEWS-linked FbF, as well as the strengthening of an enabling environment to support the successful implementation of FbF at national and local levels. This will include improving understanding of key concepts and linkages between SRSP and climate-driven shocks, FbF and FbA; identifying potential legal reforms; tailored training and skills development; advocacy and social mobilisation; and creating opportunities for international experience sharing (e.g., facilitated study tours) to enable government actors to learn from international good practices.

The project's support to enhance knowledge and capacity around MHEWS, FbF, and flexible and pre-positioned financing mechanisms and instruments through a risk-layering approach will also extend to key partners, such as the Ministries of Agriculture, Environment and Natural Resources, Finance, Economy, and Emergency Situations. In improving knowledge of SRSP and the value of SRSP interventions in relation to climate-driven shocks among decision-makers beyond the MLSP, the project intends to create 'champions' of SRSP within other key institutions.

<u>Sub-Activity 4.2.3 – Create a national registry for enhanced community- and household-level targeting for FbF</u>

Adequate data and management information systems (MIS) are a key component of enabling FbF through SRSP, particularly in relation to identifying affected populations and accessing the data required to deliver programs rapidly – and especially those that seek to cover shock-affected populations that are excluded from or inadequately covering by existing social protection interventions. Whilst MIS are readily available and relatively advanced in the national social protection system in Azerbaijan, there is a need to strengthen the capacity of MIS for targeting a range of climate-driven shocks, particularly at the household level within communities identified as high-risk or shock-affected.

Accordingly, this sub-activity will establish a 'virtual national registry' within the existing data management ecosystem, including the MIS within MLSP, to enable the analysis and targeting of FbF through SRSP at the community and household level. This will enhance the capacity of MLSP to:

- Analyse the distribution of FbF-SRSP benefits by geographical location, gender, disability, and other relevant factors depending on the availability of data for cross-referencing
- Conduct flexible targeting of FbF-SRSP benefits based on improved understanding of group profiles to ensure more equitable distribution of benefits
- Scale up social protection interventions both vertically and horizontally in response to climate shocks
- Support humanitarian organisations to target additional assistance and deploy complementary interventions to groups affected by climate-driven shocks who cannot be covered by SRSP
- Cross-reference the data with other climate change interventions to both ensure complementarity of interventions as well as to assess their overall effectiveness
- Rapidly target MHEWS-linked FbF/FbA interventions through the national system, based on geographical areas/community risks (e.g., in areas at risk of or affected by floods or drought).

The development of a virtual national registry will provide a key technical tool to enable anticipatory and preparedness actions in the form of rapid scale-up of SRSP in response to multiple climate-related hazards.

<u>Sub-Activity 4.2.4 – Develop a model for FbF linked to SRSP</u>

Building on the Roadmap for FbF, this sub-activity will support the development of a model, triggers, and protocols for the scale-up of the national social protection system in Azerbaijan to climate-driven shocks. A model for FbF will be identified based on analysis of preparedness measures that can be undertaken through the national system to lessen the time required to deliver SRSP following a climate shock, as well as explore options to link with the impact-based MHEWS. In addition, the project will identify specific triggers/thresholds, based on impact-based forecast indicators, that would necessitate an SRSP intervention and develop protocols for activation. The FbF model, triggers and protocols will be developed through a participatory stakeholder engagement process, supported by convening an SRSP scale-up committee. The committee will set key design parameters, provide inputs, and contribute to validation and refinement processes.

14.5 Alignment with the GCF Business Model for CIEWS

The GCF Secretariat has developed a 'Business Model Canvas' for CIEWS for use in identifying, integrating, and presenting the activities and metrics used for the measurement of maturity levels of the WMO dashboard. The Business Model Canvas has been customised for the proposed project in Azerbaijan and it presented in the figures below.

Key Partners

- Meteorological agencies: National Hydrometeorological service
- Government agencies: Ministry of Ecology and Natural Resources (National Hydrometeorological Service), Ministry of Emergency Situations, Ministry of Labor and Social Protection
- NGOs: REC Caucasus
- Local Communities
- International Organizations & technology providers: UNEP, UNICEF, UNEP-DHI, Finnish Meteorological Institute (FMI), International Centre for Theoretical Physics (ICTP)

Key Metrics

- Accuracy of climate forecasts
- Service user satisfaction and feedback through User Interface Platform
- Self-assessed hazard monitoring capacity level
- Observational infrastructure status
- Utilization of remote-sensing data
- Establishment and utilization of NWP models and forecasting tools
- Performance of warning services & MHEWS operations
- Financial and technological enablers

Cost Structure

- Research and development costs
- Operational expenses (staff, facilities, utilities)
- Partnership and collaboration costs
- Community engagement costs
- Technology infrastructure investments

Value Proposition

- Improved maturity levels
- Accurate climate information for informed decision-making at all levels
- Tailored climate services for various industries (agriculture, disaster risk reduction, health, etc.)
- Climate risk assessment methodologies
- Support for climate resilience building

Key Activities

- Risk knowledge and assessment (activity 1.2)
- Climate data collection and analysis (activity 2.1)
- Developing climate models and forecasts (activity 2.2)
- Partnerships and collaborations for research and innovation (activities 1.1)
- Capacity building and training to empower local stakeholders (activities 3.1, 4.1, 4.2)
- Develop an institutional framework and mechanisms for sustainable climate services (activity 1.1)
- Expand and optimize the hydrometeorological observational infrastructure (activity 2.1)
- Hazard monitoring (activities 1.2, 2.1)
- Remote-sensing data (activities 1.2, 2.1)
- Establish NWP model and forecasting tool application (activity 2.2)
- Establish impact-based forecasting tools and capacity (activity 2.2)
- Establish warning services & MHEWS operations (activity 3.1)

Partner Relationship

- Consultative approach to understanding client needs though ongoing stakeholder engagement
- Continuous support and updates on climate data and forecasts
- Customized information and analytics for specific climate challenges
- Building long-term partnerships for ongoing support and collaboration (User Interface Platform)
- Knowledge management (UIP)
- Local community engagement

Revenue Stream

- Enabling environment for revenue generation beyond the project

Partner Segments

- Government agencies: NHMS
- State-owned enterprises and private sector
- NGOs and international organizations: UNEP, UNICEF, UNEP-DHI, FMI, ICTP, REC Caucasus
- Local communities

Channel

- Online platforms: SmartMet system
- Partnerships with sectors and communities
- Media (radio, TV, print, social media, cellular network)

Key Resources

- Climate data sets
- Advanced modeling software
- Expertise in meteorology and climate science (through partnerships)
- Data quality assurance (capacity building and trainings)
- Operational Infrastructure

Figure 94. GCF Business Model Canvas for CIEWS in Azerbaijan

Legal Framework and Institutional Mechanisms

- Development of a National Framework for Climate Services (NFCS)
- NHMS (National Hydrometeorological Service) involved in the National Climate Outlook Forum
- Roles/responsibilities of all organizations generating warnings defined
- NHMS officially recognized as national alerting authority
- Interagency observation data exchange agreements/protocols

Observational Infrastructure

- Number of surface observation stations (status 05/2024: 73)
- Frequency of surface observations (status 05/2024: every 3 h)
- Number of upper-air observation stations (status 05/2024: 2)
- Number of GBON reporting stations (status 05/2024: 7)
- Number of inoperable stations (status 05/2024: 0 declared, 7 assessed silent, 2 assessed party operational, 61 unknown)
- Percentage of the surface observing network which has been automated (status 05/2024: 69.9%)
- Automatic weather stations deployed in the last 5 years
- Real-Time delivery of observational data to the Hydromet Situation Centre
- Regular calibration, quality control, and maintenance of observing systems
- Use of observational data from other governmental agencies, private sector, etc.
- Status of observations transmitted to GTS/WIS

Hazard Monitoring

- Self-assessed hazard monitoring capacity level
- Variables monitored
- Missing variables needed to monitor

Remote-Sensing Data

- Use of radar data
- Means of access to satellite data
- Use of satellite data for hazard monitoring
- Staff are trained on remote sensing data access/use for hazard monitoring and forecasting

Figure 95. GCF Business Model for CIEWS in Azerbaijan - Activity Detail (I)

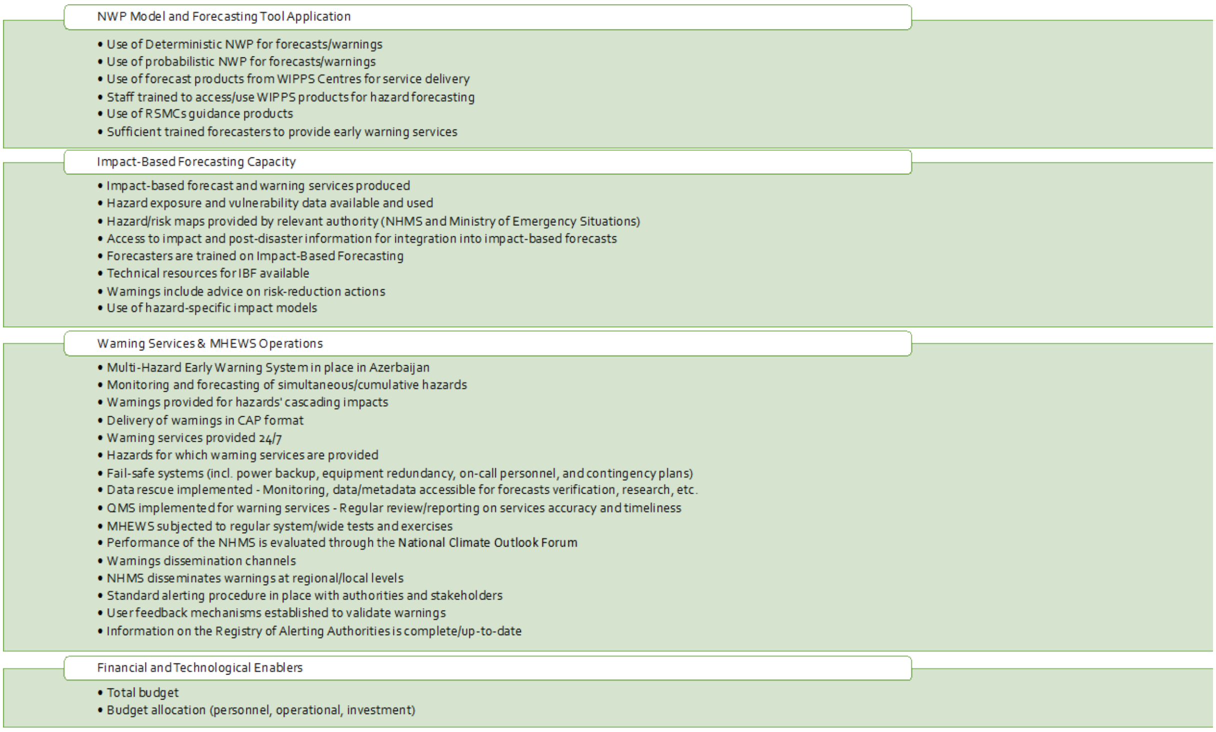

Figure 96. GCF Business Model for CIEWS in Azerbaijan - Activity Detail (II)

15 Data, Technology, and Other Requirements

This section highlights specific data and technology requirements for the proposed intervention.

15.1 CIEWS Implementation

The implementation of the CIEWS will require different equipment and data throughout the four different CIEWS pillars as detailed below.

15.1.1 *Risk Knowledge*

The envisaged data and technology requirements for the risk knowledge element are detailed below in Table 26. This includes the following information and requirements:

- **Software requirements:** The software requirements to undertake the hazard and risk modelling have been included. It should be noted that in some cases there is no associated cost to the acquisition of a particular software package, but it has been included nonetheless for clarification purposes. The use of open-source package has been given preference when there are suitable options. That is not the case for all of the hazard modelling, but for flood, drought, NWP and waves that is possible.
- **Data requirements:** Several key data sources have been included. Data collection activities have been included for each hazard, while the acquisition of a LiDAR is envisaged for the flood hazard modelling. An estimation area coverage of 2,600km^2 has been drawn. In addition to that, for the flood modelling especially, topographical surveys have been allocated for channel information.
- **Human and technical resources requirements:** The human and technical resources associated with the drafting of the unified methodology and the undertaking of the specific hazard and risk assessments have also been included.

Table 26. Risk Knowledge requirements and estimated cost

No.	Type of equipment	Cost per item, US$	Quantity	Total cost	Purpose Type of monitoring/hazard	Beneficiary / Responsibility for O&M
1	LiDAR	200	2,600	520,000	Floods/Flash-floods, mudflows, landslides	NHMS
2	Other orthographic data and surveys	1,000,000	1	1,000,000	Floods/Flash-floods, mudflows, landslides	NHMS
4	NWP Software	1	1	0	All hazards	NHMS
Flood Hazard Assessment						
5	Hydrological Modelling Software	1	0	0	Floods/Flash-floods, droughts	NHMS, SWA
6	Hydraulic Modelling Software	1	0	0	Floods/Flash-floods	NHMS
7	Hazard Assessment	1	500,000	500,000	Floods/Flash-floods	NHMS
Landslide Hazard Assessment						
8	Geotechnical and geomorphological survey	1	150,000	150,000	Landslide	NHMS, Institute of Geography
Wave Hazard Assessment						
9	Data Collection and Surveys	1	35,000	35,000	Wave	NHMS
10	Wave Modelling Software	1	0	0	Wave	NHMS
11	Hazard Assessment	1	35,000	35,000	Wave	NHMS
Drought Hazard Assessment						
12	Data Collection and Surveys	1	45,000	45,000	Droughts	NHMS, SWA
13	Drought Modelling Software	1	0	0	Droughts	NHMS, SWA
14	Hazard Assessment	1	25,000	25,000	Droughts	NHMS, SWA
Hail Hazard Assessment						
15	Data Collection	1	22,000	22,000	Hail	NHMS
16	Hazard Assessment	1	30,000	30,000	Hail	NHMS
Wind						
17	Data Collection	1	22,000	22,000	Wind	NHMS
18	Hazard Assessment	1	30,000	30,000	Wind	NHMS

Air quality						
19	Modelling	1	45,000	45,000	Air pollution	NHMS
Multi-hazard Risk Assessment						
20	Data Collection	1	35,000	35,000	All hazards	MOES
21	Survey	1	95,000	95,000	All hazards	MOES
22	Risk Assessment Modelling	1	83,460	83,460	All hazards	MOES
22	GIS Software	3	10,000	30,000	All hazards	MOES

15.1.2 *Monitoring and Warning*

The equipment, data and resources required for the implementation of the monitoring and warning component is described in Table 27.

Table 27. Equipment and estimated costs for the monitoring and warning component

No.	Type of equipment/ Action	Cost per item, US$	Quantity	Total cost[194]	Purpose/Type of monitoring/hazard	Beneficiary / Responsibility for O&M
Equipment						
1	Automatic water level measuring system	15,000	50	750,000	Floods/Flash-floods, mudflows, droughts	NHMS
	Installation cost	2,000	50	100,000		
2	Automatic meteorological station	22,275	20	445,500	Floods/Flash-floods, mudflows, droughts, landslides, sea-waves, hail-storms, windstorms	NHMS
	Installation cost	1,500	20	30,000		
3	Automatic meteorological posts (precipitation, temperature, pressure)	14,625	30	438,750	Floods/Flash-floods, mudflows, droughts, landslides, sea-waves, hail-storms, windstorms	NHMS
	Installation cost	1,000	30	30,000		
4	Radar	1,750,000	3	5,250,000	Floods/Flash-floods, mudflows, precipitation induced landslides, hailstorms, strong-winds, droughts	NHMS

[194] Note that costs are based on 2020 estimates. The Detailed Budget Plan (Annex 4) includes the most up-to-date costings.

5	Upper air sounding equipment (receiver, hydrogen generator, radiosondes and balloons)	300,000	4	1,200,000		NHMS
6	Snow Measurement equipment	30,000	10	300,000	Floods/Flash-floods, mudflows, droughts, landslides	NHMS
	Installation cost	1,500	10	15,000		
7	Mobile discharge meters	30,000	4	120,000	Floods/Flash-floods, mudflows, droughts	NHMS
8	Automated inclinometers	20,000	20	400,000	Landslides	NHMS
	Installation costs	800	20	16,000		
9	Drones	50,625	2	101,250	Landslides and mudflows	NHMS
10	HPC	500,000	1	500,000	NWP Forecasting	NHMS
11	Modernization of the telecommunication system	1,800,000	1	1,800,000	All hazards	NHMS
12	O&M (per year)			150,000	All hazards	NHMS
13	Flood Forecasting Server	1	12,000	12000	Floods	NHMS
14	Individual Server for forecasting and management	4	3,000	12000	All other hazards	NHMS
NWP Implementation						
15	Model Implementation	250,000	1	250,000		NHMS
16	Data Sources Processing	100,000	1	100,000		NHMS
17	Verification	50,000	1	50,000		NHMS
18	Assimilation	75,000	1	75,000		NHMS
19	Ensemble modelling	125,000	1	125,000		NHMS
Flood Forecasting						
20	Initial system design	20,000	1	20,000		NHMS/SWA
21	Historical Information	10,000	1	10,000		NHMS/SWA
22	Product development - Adaptation of hazard models	85,000	1	85,000		NHMS/SWA

	for operational purposes					
23	Forecasting Implementation	15,000	1	15,000		NHMS/SWA
24	Warning Procedures	10,000	1	10,000		NHMS/SWA
Drought Forecasting						
25	Initial system design	25,000	1	25,000		NHMS/SWA
26	Historical Information	15,000	1	15,000		NHMS/SWA
27	Product development - Adaptation of hazard models for operational purposes	15,000	1	15,000		NHMS/SWA
28	Forecasting Implementation	15,000	1	15,000		NHMS/SWA
29	Warning Procedures	10,000	1	10,000		NHMS/SWA
Wave Forecasting						
30	Initial system design	10,000	1	10,000		NHMS
31	Historical Information	10,000	1	10,000		NHMS
32	Product development - Adaptation of hazard models for operational purposes	25,000	1	25,000		NHMS
33	Forecasting Implementation	15,000	1	15,000		NHMS
34	Warning Procedures	5,000	1	5,000		NHMS
Wind Forecasting						
35	Initial system design	5,000	1	5,000		NHMS
36	Historical Information	10,000	1	10,000		NHMS
37	Product development	5,000	1	5,000		NHMS
38	Forecasting Implementation	5,000	1	5,000		NHMS
39	Warning Procedures	5,000	1	5,000		NHMS
Hail Forecasting						
40	Initial system design	5,000	1	5,000		NHMS

41	Historical Information	10,000	1	10,000		NHMS
42	Product development	15,000	1	15,000		NHMS
43	Forecasting Implementation	10,000	1	10,000		NHMS
44	Warning Procedures	5,000	1	5,000		NHMS
Extreme Temperature Forecasting						
45	Initial system design	250,000	1	250,000		NHMS
46	Historical Information	100,000	1	100,000		NHMS
47	Product development	50,000	1	50,000		NHMS
48	Forecasting Implementation	75,000	1	75,000		NHMS
49	Warning Procedures	125,000	1	125,000		NHMS

15.2 Capacity requirements

The implementation of this project requires a high level of technical expertise. An assessment of the current capacities has been undertaken using the MHEWS checklist, consultations and existing products. There are several capacity requirements for this project, to ensure the sustainability of the proposed activities. It should be added that it is envisaged that most of the activities will be implemented by local stakeholders in close cooperation with international experts. The project will work to ensure that capacity building activities are undertaken while activities are being implemented. On the other hand, there will be a significant effort dedicated to training and enhancement of the capacities of NHMS, especially in monitoring and modelling.

The capacity requirements identified are as follows:

- **Automatic Weather Station Training:** This training will include practical sessions guided by international experts on the maintenance and operation of stations.
- **Automatic Hydrological Station Training:** A similar training to the one described for the meteorological stations will be undertaken for the hydrological stations too.
- **Other Equipment Training:** A similar training to the one described for the meteorological stations will be undertaken for the other monitoring station observers too.
- **Satellite Data Processing:** As described in the modernisation of the forecasting section, the use of new satellite data sources will be fostered within this project through several activities. The use of satellite data is very demanding technically speaking, and therefore training in the acquisition, processing and analysis of satellite data will be undertaken.
- **Meteorological Modelling and Forecasting Training:** There are no identified meteorological modelling and forecasting capacities in NHMS. Therefore, training for meteorological modelling is included in the proposal to ensure that the NHMS personnel have NWP forecasting capacities and they are up to the latest developments in meteorological modelling.
- **Hydrological and Hydraulic Modelling and Forecasting Training:** Presently, there are no hydrological or hydraulic modelling capacities in NHMS. There would be a requirement for the inclusion of capacity building activities on this respect. Presently, NHMS is not capable of undertaken the hydrological or hydraulic modelling required for the implementation of the recommended flood forecasting framework. Very intensive training on this will be undertaken to facilitate this.
- **Risk Profiling Training:** there are limited capacities within NHMS and the MOES to undertake risk assessments. Training on standard procedures to undertake hazard and risk assessments is included.
- **Communication Protocols Training:** training in the implementation of Common Alerting Protocols is also included in the project.

15.3 End user suitability

There are several end-users to consider within this project. The interventions planned are mainly focusing on the implementation of a CIEWS, a multi-sectoral activity with many stakeholders involved. Given the nature of the project, the main stakeholder of the project will be the National Hydrometeorological Service (NHMS). The capacities of this department have been assessed using a MHEWS checklist. As noted in several sections, these capacities must be enhanced to ensure the sustainability of the implemented systems.

From an institutional arrangement point of view, and considering the baseline situation in Azerbaijan, the NHMS should be the main beneficiary from this project. NHMS has the responsibility to undertaken hazard assessments, to monitor hydro-meteorological hazards, to produce hazard forecasting and to initially disseminate this information. Therefore, most of the activities outlined above fall within NHMS's responsibility.

The role of the Ministry of Emergency Situations (MoES) should also be considered. MoES is responsible for the public communication of warnings and the response to disasters. Also, MoES has several regional centres with strong links to municipalities. Therefore, the role of MoES within the framework should be considered in detail. MoES capabilities in the response component are strong, but there is a significant gap on their public awareness, as outlined above.

15.4 Dissemination strategy and approach for tailoring climate information services to end users, particularly last mile users

As noted above, gaps have been identified in the communication and dissemination component of the EWS and climate information. To ensure that suitable information is received in a timely manner by local communities, a last-mile communication plan has been drawn. The information within this section should be considered in parallel with the information provided in the new institutional arrangements.

There will be several dissemination levels defined in the communication and dissemination strategy:

- **First dissemination:** The first dissemination of the warning message should come from the NHMS, as it will be the stakeholder with forecasting and warning capabilities. This warning will be produced per hazard considering all of the information outlined above for the forecasting of each hazard. This first dissemination will be directly driven by the implementation of the national Multi-Hazard Alert System. The Multi-Hazard Alert System will collect the collect the warning information and it will ensure, through the CAP implemented, that this warning is disseminated through the MHEWS and to MoES. The communication with MoES will be through several means, to ensure redundancy, namely by email, telephone call, mobile phone call and through SMS.
- **National government level dissemination:** Subsequently the warning will be disseminated to other relevant stakeholders, and especially to the Commission on Extreme Situations (chaired by the President and MoES) through the integrated data visualization and analytics system and through alternative communication means. It should be noted that the mobile application associated with the platform would allow for notifications to be sent to specific users of the platform.
- **From national to community dissemination:** The most relevant link between the communication strategy will be the communication between the national level and the local level. Several communication means will be proposed. In addition to the visualization system dissemination, the warning message will be disseminated to the regional MoES centres and to local representatives identified in the regional authorities and in communities. Considering the geographical information provided by the warning, regions (rayons) and communities will be automatically identified. Also, contact details for each of these organisational levels will be automatically selected and contacted, to ensure that this information is disseminated.
- **Community level dissemination:** The design of the warning message dissemination within a particular community will be undertaken with care, and depending on the existing practices in any particular community. This design will be undertaken for the communities

that participate in the community MHEWS capacity building. The use of sirens, bells, loudspeakers, walkie-talkie, drums, door to door, will be evaluated and assessed per community in order to identify the best approach per community.

There are several other things to consider within the dissemination strategy:

- The messages should be tailored to the type of hazard and to the receiver and they should provide:
    - Information about the event, its predicted initiation and finalisation
    - Its magnitude and the expected impact (from the impact-based forecasting), considering the geographical expected impact
- The message should be provided in a clear and concise manner.
- The message should provide information about recommended actions to be taken
- The message should provide information about where to provide feedback and/or contact details
- A message regarding the finalisation of the event should also be sent.

It should be added that within vulnerable communities, factors including age, gender, ethnicity, literacy levels, physical capacity and poverty affect the needs, priorities and abilities of people to access, understand, and respond to warning information. Therefore, the warning information will consider the different needs of different groups.

Different feedback mechanisms will be available, depending on the communication strategy finally adopted. In addition to the inclusion of recommended action information in the warning message, contact details will be provided for all of the recipients to acknowledge the receipt of the message and/or to provide feedback through different means.

The communication of the messages will follow CAP protocols, and therefore, the recipients will be geographically targeted. In case of nation-wide warnings, the information will be sent to the general population through several communication means.

From a community perspective, different communication means have been assessed, considering local conditions in Azerbaijan, warning requirements, lead time, and the type of disasters. Further information has bene gathered from the communities through consultations. The following communication means have been considered:

From national to community dissemination
The central Hydromet Situation Centre will notify the communities of the incoming warning as soon as possible after the warning has been identified to ensure that the lead-time is maximised. This notification has to be undertaken through reliable means and redundancy has to be considered to avoid potential issues. At least two contact people per community will be identified, but means to warn communities remotely will also be proposed.

To reduce the possibility of issues, the communication with the communities will be carried out through the Hydromet Situation Centre, through the Local MoES office and through the local contact. Also, the Local MoES office will contact the local representative.

The following means of communication have been considered.

- **Mobile phone-SMS** - Mobile phones can be used as communication devices to and within the community. In the case of communication between the operational centre and a local contact in the community, this can be really useful, but it has some drawbacks, because the mobile phone has to be always available and working, and the contact person has to keep his/her mobile phone always available. Also, SMS can be sent to all groups of people registered in the community-based scheme, facilitating the distribution of information to a large number of people. Mobile network reliability can be comprised during some weather conditions, and therefore back-up systems are being considered.

- **Radio HF** – High Frequency radio is considered as a suitable communication mean with the communities, providing the necessary infrastructure is provided. Radio HF can work under harsh weather conditions, and therefore is an excellent redundancy system if the mobile network is not operating.
- **Email/Internet** - In communities sufficiently developed whereby a large percentage of individuals have email and web access, communication via email is extremely effective; especially as smartphones also have 3G/ 3GS or 4G capability, meaning that users can check their email accounts and surf the web anywhere there is cell phone access. Websites are quickly and easily updated, and emails can be mass disseminated to huge numbers of users simultaneously via the appropriate email software program. However, despite the positive aspects of using the internet for knowledge dissemination, in rural areas in Azerbaijan, email and website communications methods have very limited applicability. Although 3G access is fairly widespread and consistent, most rural residents do not possess smartphones. Computers are not common; in some communities, they are hard to locate even in the commune offices. There are doubts about digital equity in the study area, from a gender and age perspective, and therefore email and web-based forms of communication cannot be recommended as an effective early warning tool in this scheme. It cannot be relied upon for direct communications of warnings or evacuations.
- **Sirens (Remote Control for Siren Systems)** – There are some siren systems that can either be local or remotely activated. The remote activation can be triggered through radio, GSM or wire. This siren system is suitable for this type of scheme, and it does allow for several types of messages or alerts. The remote activation feature will be highly useful when the warning is produced at night and/or the local contact cannot be reached.

Community level dissemination

There are different options for communication within communities. These options have been proposed to the consulted communities, and while some preferences have been shown, the final decision on what communication means to use will be based on the hazard assessment, risk assessment, lead time, community preferences and existing practices, reliability and the international expert advice.

- **Bells** – Bells and/or drums are an effective, low-tech means of sounding an alarm to the community. Bells are inexpensive and easy to install; as they do not rely on electricity or batteries for operation; they are resistant to damage due to flooding; and there is no upkeep or maintenance cost. During the EWS implementation phase, the community would be asked to come up with a set of signals - a rhythm to communicate a particular response or action. When creating the signals, it is important that they be clear, easy to replicate, and also that each signal be significantly different from the next so that the listener does not get the messages mixed up. The creation of effective signals and the dissemination of their meaning to all community members are of the utmost importance; the creation and dissemination best occurs through community-wide workshops and training sessions.
- **Wireless Alert Sirens' System** – In addition to the sirens noted above, wireless siren systems are being proposed. This system can be useful to alert people in small communities. Because it does not require any interconnecting (backbone) cabling or a central control panel, it is

quicker and far less costly to install than traditional hard-wired emergency warning siren or PA (public address) systems.

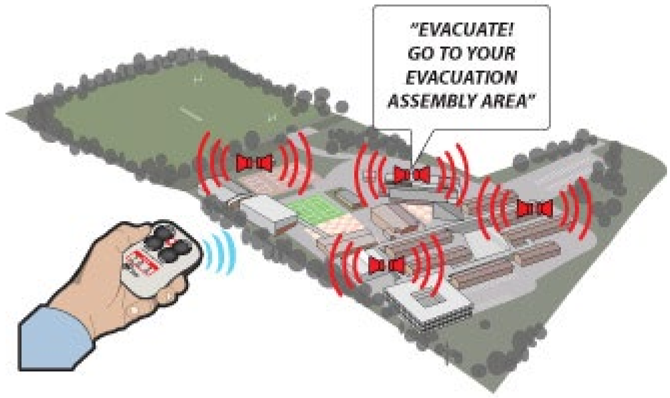

Figure 97 – Wireless sirens

This could be easily activated by the local scheme representative, and again, several types of messages can be pre-coded.

- **Loudspeaker** – Loudspeakers are very effective at transmitting relevant information to a local audience via announcements. There are two main types of loudspeakers; the handheld, portable battery-operated loudspeaker, and the hardwired system, whereby loudspeakers are posted in various areas throughout the community. The wired system has a larger reach due to the multiple speakers set up, and therefore has the ability to transmit information to entire communities at once, thereby saving time, which, in some emergency situations, is crucial. The drawback to the wired system is its propensity for breakdown due to technical issues, as well as its ability to be damaged in the event of a disaster. The handheld system is very effective in a crisis situation, as it is transportable and can be hand carried by the announcer during an evacuation. As it is battery-operated, it can be used during blackouts, which, in the event of a severe storm, can be prolonged, lasting for several days. However, some drawbacks of the handheld loudspeaker include its limited broadcasting range. After consultation with communities, the possibility of deploying loudspeakers in minarets is being explored, providing that the agreement from all of the religious authorities in the community is obtained. Minarets are a good location for loudspeakers, as the mosques usually have generators to ensure electricity at all times; and also, the minaret altitude ensures a wide dissemination of messages.
- **SMS** – SMS has proven to be one of the most reliable and inexpensive means of mass communication in several EWS implementations. Transmission of information from one village to the next, from the village to the commune office, or the village to the Hydrometeorology department, or vice versa, can be done via SMS. Mobile phones are widely available in Azerbaijan, even in rural areas; most adults have a simple cell phone or have a family member with one. In Azerbaijan generally service, even in the uplands areas, is steady, although some isolated mountainous regions contain areas where reception is spotty or minimal. Despite their usefulness, there are some drawbacks. Phones must also be kept charged, and in the event of a prolonged power outage, communication ability might be disrupted if the mobile phone's battery runs out and no backup power generator can be found. Lastly, even though mobile communication towers usually have backup generators, in the

event of a serious disaster, these systems might also fail, resulting in a prolonged telecommunications outage.

- **Walkie talkie** – Walkie Talkies are excellent EWS devices and have proven especially effective in evacuation situations in implemented EWS. They can be used to create a communication chain in order to relay information from one community to the next if necessary. This is necessary in communities that occupy a large geographic territory, as some villages are too far away from the commune office to communicate directly with the authorities via walkie talkie. Another benefit is that walkie talkies are not dependent on the grid for power, as they are battery-operated or rechargeable; this makes them suitable for use during serious disasters where the infrastructure might be wiped out (obviously, they must be maintained – either recharged on a regular basis, or a stockpile of fresh, high-quality batteries must be kept on hand for use during emergency situations). Therefore, within the project, 2 walkie-talkies per community have been included.
- **TV** – Television and other forms of broadcast communications are a good source of general news and weather information. The fact that not every household has a television set should be considered. National TV weather broadcasts are general in nature and not localised; this information is usually provided by the local news station; therefore, the information may be out of date or irrelevant to the region in which the viewer resides. The existence of local television channel should be explored. Nonetheless, due to the short lead time in the area, this mean of communication is not considered adequate.
- **Radio** – The existence of local radio stations in the different communities has to be fully investigated. These stations can broadcast up to date weather forecasts on local weather conditions. It should be noted that age plays a factor in the listener demographic; older members of the community tuning in to radio, whilst the younger generation tend to rely on television and/or SMS messaging for topical information.

Communication Strategy

The communication strategy will depend on the type of event and on the lead time available. If a flash-flood event is considered, as it is frequent in the Greater and Lesser Caucasus, the weather and flood forecasting will be predicting the event about 72 hours in advance. Alerts will be produced 48 and 24 hours in advance, and disseminated to the communities and relevant stakeholders. A warning will be disseminated at 0 hours lead time, when the monitoring network has observed the conditions that will lead to a disaster event (Figure 98).

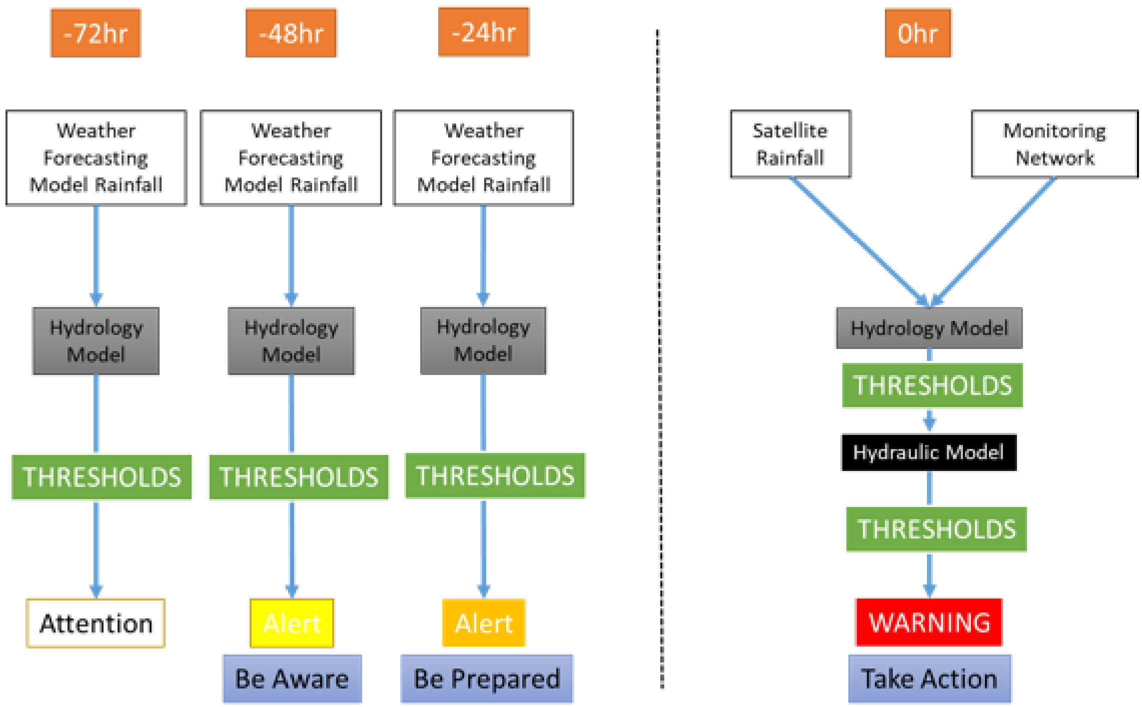

Figure 98. Flash-Flood Forecasting strategy and lead time

The communication strategy will depend then on the lead time, and subsequently on the confidence on the warning accuracy. As a general rule, the shorter the lead time, the higher the accuracy (and *vice-versa*). Therefore, a compromise has to be found between the lead time and the warning accuracy.

The forecast for flash-floods, as predicted 24 hours in advance, will not be as accurate if the flash-flood forecast is based on actual observations from the monitoring network and satellite. Therefore, two different communication strategies are devised, depending on the warning level.

For an alert issued 48 hours in advance, the communication strategy will have the main purpose of informing the population and relevant stakeholders that there is a possibility of an event occurring within the next 48 hours, and therefore the population should be aware.

For an alert issued 24 hours in advance (Figure 99), the communication strategy will have the main purpose of informing the population and relevant stakeholders that there is a high possibility of an even occurring within the next 24 hours, and therefore the population should be prepared. In this case, the accuracy of the warning will be higher than at 48 hours in advance.

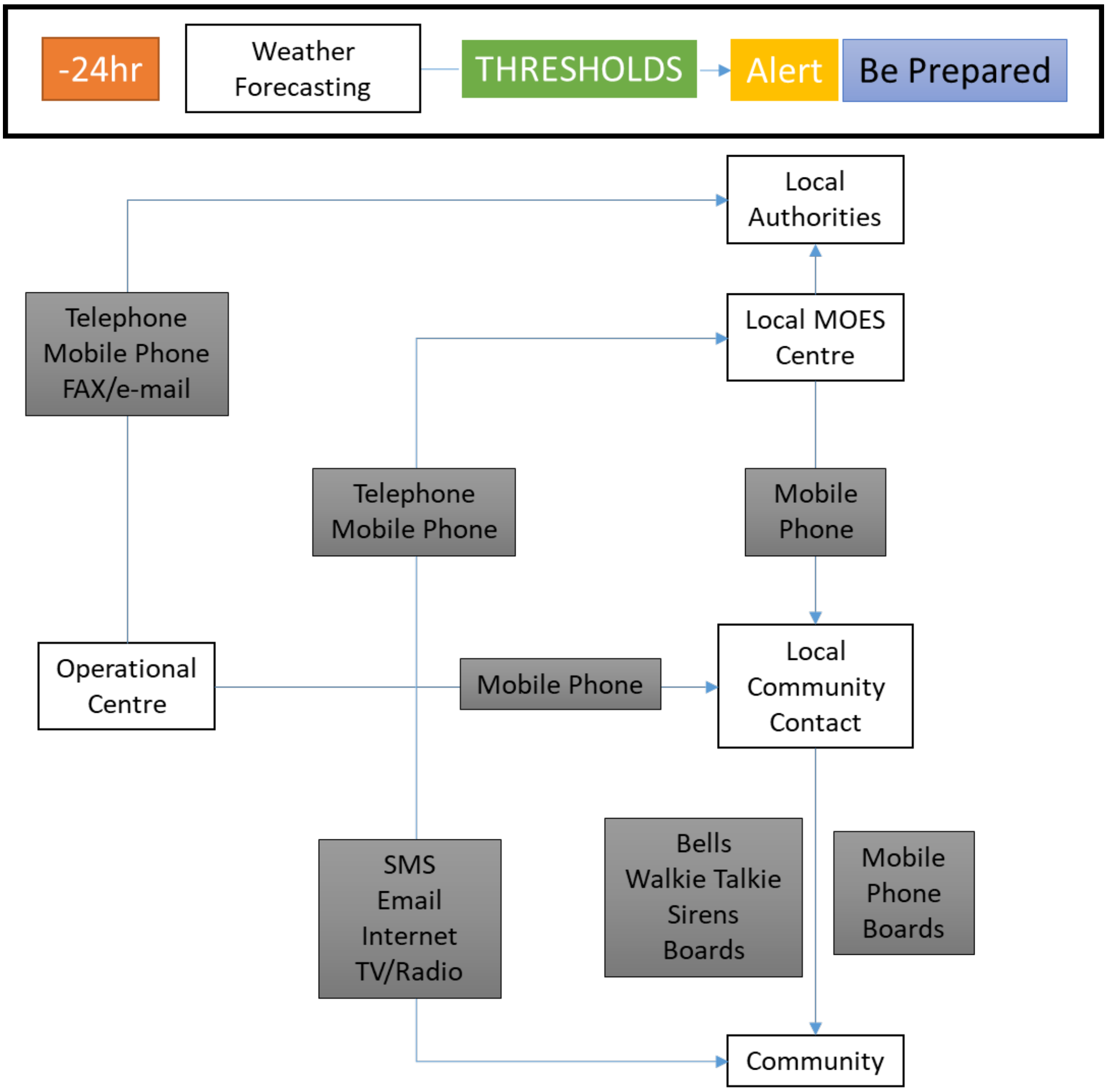

Figure 99. Communication strategy 24 hours in advance

For a warning (take action) message and level, the accuracy of the warning is extremely high, the monitoring network has detected the conditions that will eventually lead to a flash-flood event, and therefore the purpose of the warning is to provide information about what actions to take by the general population. The communication strategy devised in this case consider alternative communication means in order to provide redundancy to the system and to ensure that the warning reaches in a timely manner all of the population groups (Figure 100).

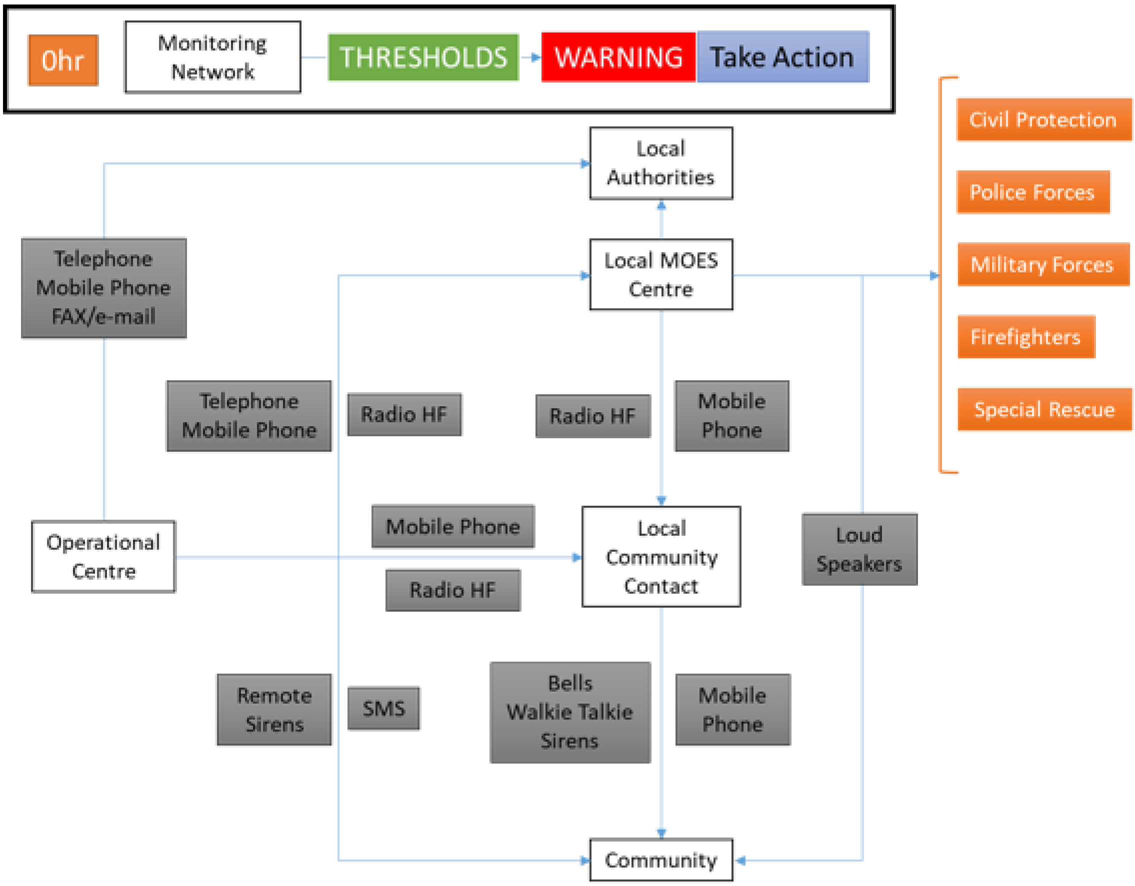

Figure 100. Communication Strategy at lead time 0hr

16 Implementation Arrangements

16.1 Overview of the Implementation Arrangements for the project

Accredited Entity

UNEP will be the Accredited Entity for the project and will be responsible for managing the implementation, financial management, evaluation, reporting and closure of the activities under the project. UNEP will monitor and supervise the execution of the project and ensure the proper management and application of GCF Grant Proceeds. UNEP will ensure that the Grant Proceeds are utilised in accordance with the terms of the Funded Activity Agreement, to be entered into between GCF and UNEP, and the Accreditation Master Agreement. UNEP will also assume the role of Executing Entity (EE) through its Regional Office for Europe, as outlined, in the sub-section below.

UNEP brings more than 25 years' experience working on climate change issues and is an established GCF Accredited Entity. It brings a comprehensive approach to climate change mitigation and adaptation that is grounded in both natural science and economics and is tied to the environmental and development concerns of countries.

Through its Early Warning and Assessment Division, UNEP has longstanding expertise in environmental and climate change information management and early warning systems. For example, with GEF and EC funding it is currently supporting over 50 countries in establishing or strengthening their environmental information management systems and using them for reporting progress on SDGs and MEAs. Its Early Warning and Assessment Division manages the CLIMWARN and Country Level Impacts of Climate Change (CLICC) projects, the Global Environment Monitoring System for Air (GEMS Air), and UNEP also convenes and facilitates regional environmental information networks and the World Adaptation Science Programme (WASP – former PROVIA). Through its work on climate information, early warning and foresight, UNEP enables stakeholders to respond to the latest emerging issues related to environment and climate change. Concrete examples are the approved GCF Pacific SIDS programme on "Enhancing Climate Information and Knowledge Services for resilience in 5 island countries of the Pacific Ocean" (FP147)[195] and the GCF Timor-Leste project on "Enhancing Early Warning Systems to build greater resilience to hydro-meteorological hazards in Timor-Leste" (FP171).[196]

UNEP is also a key player in the "One Health" approach – a cross-cutting and systematic approach to health that recognizes the interdependence of human, animal and environmental health as critical for addressing the three planetary crises: the climate crisis, the nature and biodiversity crisis, and the pollution and waste crisis. As a member of the One Health High-Level Expert Council, UNEP is supporting the collection, distribution and publicizing of reliable scientific information on the links between human, animal and environmental health, which in turn aims to assist public officials to make appropriate decisions to address future crises and to inform citizens.

Project Management Unit (PMU)

At the request of the NDA, UNEP will set up and manage a Project Management Unit (PMU) in Baku, Azerbaijan, working with its sister agencies in line with the UN Delivering as One modality and drawing on its Global Support Services Agreement with the UN Office for Project Services (UNOPS), where necessary. The PMU will undertake day-to-day operations of managing the project. In addition to this role, the PMU will also assume liaison functions with national government entities and stakeholders and will coordinate with the Technical Partners throughout project implementation and reporting, in line with their obligations under the respective legal instruments and will coordinate to ensure that reports are received.

The PMU will consolidate all half-yearly progress reports and quarterly financial reports, including co-financing reports and annual audit reports, from the Technical Partners and submit these to the AE. The PMU will provide guidance and source expertise as needed on project management, financial management, procurement and technical issues. It will establish contact with other development partners working in Azerbaijan to ensure that activities in related fields are complementary, and to seek opportunities for collaboration. The PMU will also provide secretariat services to the Project Steering Committee (PSC).

The PMU will also comprise work capacity at the level of the UNEP (through its Regional Office for Europe). A UNEP Project Coordinator will provide overall guidance and support for executing the project and will be assigned to this role by UNEP as EE. The cost of the Project Coordinator will be borne by UNEP as co-financing to the project.

At the national level, the project will hire a National Project Manager who will oversee day-to-day project execution at the country level. The Project Manager will have overall responsibility for coordinating and supporting the PSC process; executing the project in line with the budget and workplans, and in accordance with GCF and UNEP guidelines; responsibility for financial management

[195] https://www.greenclimate.fund/project/fp147
[196] https://www.greenclimate.fund/project/fp171

and disbursements; ensuring liaison between the national authorities and other relevant stakeholders; and ensuring completion of reports required for the GCF and UNEP to the AE. The PMU at the national level will also be staffed by a Fund Management, Monitoring and Procurement Officer (FMMPO), who will provide financial, administrative, and operational support to the PMU. The FMMPO will report directly to the National Project Manager.

Executing Entity (EE)

UNEP will also assume the role of Executing Entity (EE) through its Regional Office for Europe to provide technical and implementation guidance and will facilitate cooperation and coordination among the partners and stakeholders engaged in project implementation. The AE will put in place an internal arrangement to allow it to perform its function as EE. UNEP, in its role as EE, will undertake fund management, coordinate reporting and ensure compliance with UN rules and procedures and GCF reporting requirements.

UNEP will execute the project in line with its programme manual and standard business procedures and will contract international and local consultants and Technical Partners to undertake relevant activities as appropriate. UNEP will leverage the services of other UN partners, such as UNOPS or ICAO, for reasons of efficiency and effectiveness. In this regard, it is noteworthy that UNEP has a Global Support Services Agreement with UNOPS enabling UNEP to operate at the country level without necessarily having a country office. UNEP also has a Memorandum of Understanding with ICAO. UNEP in its EE capacity, through its Regional Office for Europe, will be accountable to UNEP Early Warning and Assessment Division in its role as AE for project execution at the national level and for efficient and effective use of resources.

Technical Partners

The project will benefit from the expertise of a coalition of Technical Partners who have long-standing experience and expertise on-the-ground in Azerbaijan, thereby enhancing coherence and complementarity. Technical Partners will be sub-contracted by UNEP in its capacity as EE, in line with UNEP's procedures and policies. Technical Partners will include the Danish Hydraulic Institute (DHI) (through the UNEP-DHI Centre on Water and Environment, the Finnish Meteorological Institute (FMI), the International Centre for Theoretical Physics (ICTP), the Regional Environmental Centre for the Caucasus (REC Caucasus), and UNICEF. In line with the priorities of Azerbaijan, Technical Partners will lead or provide support for the implementation of specific interventions that require highly technical or scientific expertise and are in line with their mandates and comparative advantages. Technical Partners will have no discretion in implementing activities, and any discretion, decision-making, and responsibility for delegated activities will always be retained by UNEP as EE.

UNEP in its EE capacity will enter into cooperation agreements – Project Cooperation Agreement (PCA) or UN-to-UN Transfer Agreement, as relevant – with each Technical Partner. The Agreements will establish clear roles and responsibilities for the delivery of specific project activities, the schedule and conditions for installments, the determination of the prevailing fiduciary standards, and the terms and conditions for arbitrations and termination of contract. The Agreements will include specific obligations for the Technical Partners on project delivery, financial management, personnel administration, and reporting, as well as arbitration and liability terms.

Table 28. Proposed role of Technical Partners in project sub-activities

Technical Partner	Proposed role in project sub-activities
Danish Hydraulic Institute (DHI)	DHI will support delivery of **sub-activity 1.2.2:** Technical support to conduct multi-hazard risk profiling and vulnerability assessments for water-related hazards; **2.1.3:** Technical support for hydrological data management and quality assurance; **sub-activity 2.2.1:** Technical support to implement local hydrological and hydraulic modelling; and **sub-activity 2.2.3:** Technical support to co-produce sector-specific climate analytics and information products for the water sector.
Finnish Meteorological Institute (FMI)	FMI will support delivery of **sub-activity 2.1.2:** Technical support to strengthen the Quality Management System (QMS) in NHMS; **sub-activity 2.1.3:** Technical support to upgrade the Hydromet Situation Centre; **sub-activity 2.2.1:** Technical support to establish local Numerical Weather Prediction (NWP) and modelling processes; **sub-activity 2.2.3:** Technical support to co-produce sector-specific climate analytics and information products for public and private stakeholders; **sub-activity 2.3.1:** Technical support to develop integrated urban services; **sub-activity 3.1.3:** Technical support to establish a national multi-hazard alert system; and **sub-activity 3.1.4:** Technical support to build capacity for community MHEWS.
International Centre for Theoretical Physics (ICTP)	ICTP will support delivery of **sub-activity 2.1.4:** Technical support to establish Internet of Things (IoT) approaches.
Regional Environmental Centre for the Caucasus (REC Caucasus)	REC Caucasus will support the delivery of national and community-level workshops and awareness-raising (specific sub-activities TBC).
UNICEF	UNICEF will support delivery of **sub-activity 1.2.2:** Technical support to conduct child-centred multi-hazard risk and vulnerability assessments; **sub-activity 2.3.3:** Technical support to co-produce targeted analytics and decision support for health; **sub-activity 3.1.1:** Technical support to strengthen organisational and decision-making processes for MHEWS; **sub-activity 3.1.5:** Technical support to engage children and youth in MHEWS; **sub-activity 4.1.4:** Technical support to disseminate targeted education materials for children and youth; **sub-activities 4.2.1, 4.2.2, 4.2.3, 4.2.4:** Technical support to establish Forecast-based Financing (FbF) using shock-responsive social protection as an enabler.

Project Steering Committee

The Project Steering Committee (PSC) will be established comprising the NDA and UNEP. It will meet at least once per year and will be co-chaired by the NDA and the AE (UNEP). The PSC will provide high-level oversight and guidance towards achieving project objectives. The PSC is a consensus-based[197] decision-making body within the project governance structure and will provide, review and monitor strategic direction and policy guidance to the project team. Among other functions, the PSC will review and approve the annual workplan and budget and approve the project's annual report as prepared by the PMU. The committee will also provide recommendations on project approaches and participate in discussing general strategies and opportunities for project planning and implementation. This will include ensuring the gender-responsiveness of project implementation and that the Gender Action Plan (Annex 4) is being followed and implemented. The PSC will additionally ensure gender balance and include representatives from women's groups and civil society organisations, which will further help to facilitate gender mainstreaming and ensure that gender needs are reflected in project decision making. The PSC will monitor the achievement of targets in the Gender Action Plan.

The functions of the Steering Committee are:

- Providing overall guidance for Project execution to the PMU, especially on cross-cutting issues that require consensus from the various stakeholders involved in the project;
- Ensuring that recommended policy and institutional strengthening undertaken under the project is consistent with the project's overall agenda;
- Ensuring full cooperation of various regional and national stakeholders under their jurisdictions to provide access and support to the project team in carrying out their tasks;
- Representing the interests of civil society and communities in their countries derived from a regular formal dialogue between NDAs and national peak bodies; and
- Reviewing and monitoring progress in project execution.

The members of the Steering Committee will include the NDA, the UNEP AE Representative and national EE representatives. Observers will include:

- the National Project Manager;
- the UNEP Project Coordinator;
- Representatives from the Technical Partner agencies involved in project implementation and others (including the State Committee for Family, Women and Children Affairs), as appropriate;
- Representatives from additional entities involved in project implementation, such as community-based organisations with experience in disaster risk management;
- Representatives of civil society and women's organisations; and
- Representatives of the private sector.

Secretariat services will be provided by the Project Management Unit (PMU). The minutes of the meetings will be provided to the AE by the Project Manager.

National Partners

National partners will include the Ministry of Ecology and Natural Resources (NDA) and the National Hydrometeorological Service (NHMS), Ministry of Emergency Situations, Ministry of Labor and Social Protection, Ministry of Agriculture, Land Reclamation and Water Management OJSC, amongst others. UNEP as EE will engage the National Partners as relevant during project implementation.

[197] If a consensus cannot be reached within the PSC members, the final decision shall rest with the UNEP co-chair.

National Partners will have no discretion in implementing activities, and any discretion, decision-making, and responsibility for delegated activities will always be retained by UNEP as EE.

16.2 Implementation Arrangements for CIEWS

A review of the existing institutional arrangements has been undertaken in previous sections of the feasibility study. One of the key constraints and gaps identified is the lack of clarification regarding stakeholder roles and responsibilities in relation to climate information and early warning systems (CIEWS). The baseline assessment indicated that current institutional arrangements do not comply with some elements of the WMO Multi-Hazard Early Warning Systems (MHEWS) Checklist. There are several reasons for this, including: i) lack of appropriate policy or regulations for the operation and maintenance of the MHEWS; ii) lack of implemented systems; iii) lack of Standard Operating Procedures (SOPs) for most of the hazards; and iv) lack of technical capacities. The main national-level beneficiary of the project will be the National Hydrometeorological Service (NHMS) within the Ministry of Ecology and Natural Resources. Additional key national-level stakeholders include the Ministry of Emergency Situations (MoES), the Ministry of Agriculture (MA) and the Irrigation and Water Management OJSC (IWM). The implementation arrangements will be discussed per component of the MHEWS and following the MHEWS checklist requirements.

16.2.1 *Risk knowledge*

The risk knowledge component has several associated activities, including the multi-hazard risk profiling and vulnerability assessments and the creation of the integrated data visualization and analytics system.

The implementation of the risk knowledge activities has institutional tasks associated, in order to fully review the current institutional set-up, and also to ensure that all of the key stakeholders have their roles and responsibilities clarified, and that there is a sound data sharing mechanism in place.

Regarding the risk knowledge component and the multi-hazard risk profiling, it would be critical that links are created between government stakeholders and academic institutions. This will ensure that the latest local research knowledge is considered in the risk assessments. The role of the Azerbaijan Academy of Sciences should be noted on this respect.

The proposed institutional arrangement for the risk component can be found in Figure 101.

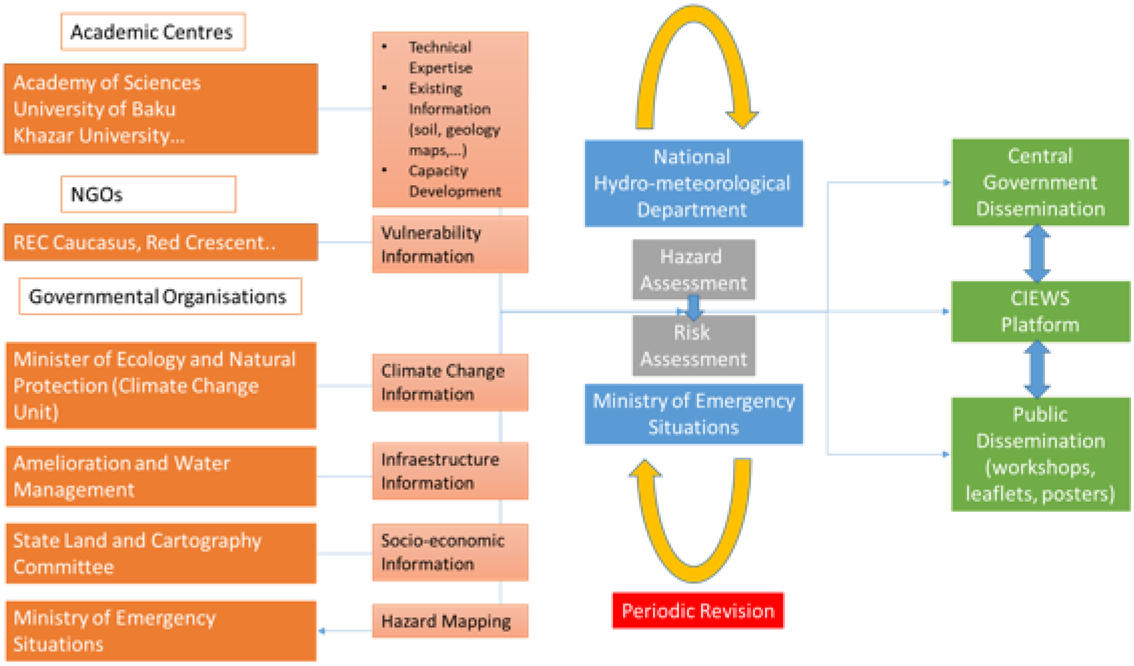

Figure 101. Proposed risk knowledge institutional arrangement

The NHMS is the lead entity responsible for the hazard assessments. However, several institutions will be involved in the provision of data and technical support. For example, the risk assessment will be undertaken in close cooperation with the MoES. Both organisations will provide inputs to the integrated data visualization and analytics system, which will be maintained by NHMS.

16.2.2 *Observations and forecasting*

The NHMS will have the lead responsibility for the observation and monitoring network (including for the expansion, operation and maintenance), forecasting system (for the implementation and the operation), and for the issuance of warnings to MoES.

The use of data sources from external providers will be implemented, where relevant, particularly in the case of input data from meteorological centres. Data from global coverage models (GCM) will be acquired from the U.S. National Oceanic and Atmospheric Administration (NOAA) and/or the European Centre for Medium-Range Forecasts (ECMWF), and from regional models from the Turkish Meteorological Institute, to provide initial and boundary conditions to the local area models that will be implemented under the Project. Cooperation with WMO and other meteorological or space agencies (such as the Japanese Space Agency (JAXA) or MeteoSAT) for data provision or for data exchange will also be paramount. It should be noted that NHMS has reporting commitments to WMO and therefore the Project will ensure that data from the stations are being sent to WMO through the Global Telecommunication System (GTS). In addition, the support of academic institutions and the interaction with the Ministry of Energy and the State Water Reserve Agency will be facilitated for data provision and exchange. Hazard forecasting activities will be undertaken within NHMS, where the warning will be identified based on the agreed criteria and disseminated to MoES for further communication.

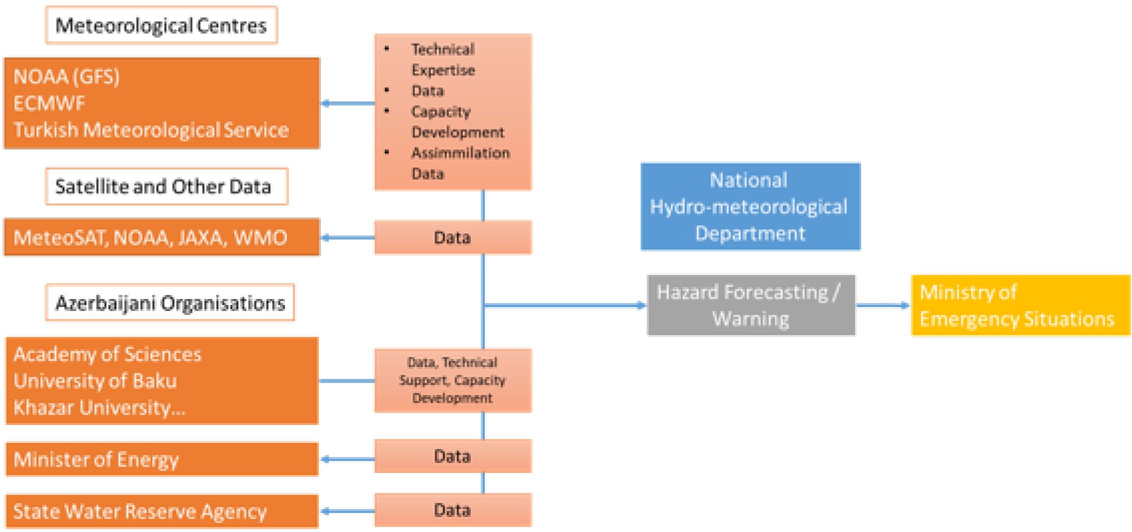

Figure 102. Proposed monitoring and warning institutional arrangement

16.2.3 *Communication, Dissemination and Preparedness*

The communication, dissemination and preparedness component will be organised following a similar arrangement. Effective communication and dissemination have been found to be the weakest link in the implementation of several early warning systems (EWS) worldwide. Even if timely and relevant warnings can be produced, the EWS fails if the warnings are not disseminated to the people in danger and to relevant stakeholders. Accordingly, Output 3 will implement several activities to ensure that warning messages reach the relevant population and stakeholders in a timely manner. With regard to the response capabilities component, this will be the responsibility of MoES – noting that its regional centres are distributed throughout the country to facilitate timely responses to emergency events.

As elucidated from the baseline assessment, communication among relevant stakeholders needs to be significantly improved, particularly with regard to communication between NHMS and MoES. In order to address this, the project will upgrade ICT infrastructure within NHMS, as well as establish a national Multi-Hazard Alert System. Amongst others, this will facilitate that warnings are automatically shared with MoES, thereby facilitating that warnings can be distributed to relevant stakeholders and the general public in a timely manner.

16.3 Selection Criteria for Stakeholders and Beneficiaries

16.3.1 *Methodology for calculating project beneficiaries*

Project goal

As per the Theory of Change presented in the Funding Proposal, the transformative goal of the project is to increase the resilience of climate-sensitive sectors and communities in Azerbaijan by ensuring the availability and access to reliable climate information services and an end-to-end, people-centred, impact-based multi-hazard early warning system (IB-MHEWS) covering Azerbaijan. In supporting the establishment of an end-to-end and people-centred IB-MHEWS covering the whole country, the project aims to deliver adaptation benefits to the entire population of Azerbaijan, directly or indirectly.

Definitions

According to the GCF's Integrated Results Management Framework: Results Handbook[198] an **adaptation benefit** is an outcome derived from a GCF-funded intervention which aims to increase resilience or reduce vulnerability of a specific target system (e.g. communities, ecosystems, local economy) against the adverse effects of climate change when compared to a baseline scenario.

Direct beneficiaries of an adaptation intervention are defined as individuals who receive i) targeted support from a GCF-funded intervention and ii) a measurable adaptation benefit from a GCF-funded intervention. The targeted support refers to the support provided or delivered by a GCF-funded intervention and can be tracked in the actual project/programme records as part of the regular project/ programme monitoring processes.

Indirect beneficiaries refer to individuals who do not receive targeted support from a GCF-funded intervention but are likely to receive a measurable adaptation benefit from the GCF-funded intervention. The number of indirect beneficiaries is usually an estimation calculated based on a formula with conservative assumptions.

Expected adaptation benefits

Adaptation benefits expected to be delivered through the project are as follows:

(1) **Reduced vulnerability, losses of lives, livelihoods and assets caused by the impacts of climate change and extreme climate events**, as a result of established end-to-end and people-centred IB-MHEWS and enhanced capacity of targeted citizens to take precautionary measures upon receipt of early warning messages;

(2) **Enhanced productivity and reduced climate-related losses in climate-sensitive sectors,** as a result of the increased capacity of key stakeholders to co-produce sector-specific climate information for climate-sensitive sectors (agriculture, disaster risk reduction, ecosystem services, energy, health, shock-responsive social protection) and of the population to act upon this information;

(3) **Enhanced climate resilience of children and youth** as a result of their increased knowledge about climate change, climate risks and vulnerabilities and enhanced capacity to take part in climate-resilience activities;

(4) **Enhanced climate resilience of women and other potentially marginalised gender groups** as a result of their increased knowledge about climate change, climate risks and vulnerabilities and enhanced capacity to participate in disaster risk management and decision-making for climate resilience.

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[198] GCF, 2022. Integrated Results Management Framework: Results Handbook. Available at: https://www.greenclimate.fund/sites/default/files/document/draft-results-handbook-v11-01092023.pdf

Key assumptions and implications for mapping beneficiaries to adaptation benefits

While assessing the number of direct and indirect beneficiaries from the project, several key assumptions were made, which resulted in mapping of beneficiaries to adaptation benefits as follows:

Assumption 1: While IB-MHEWS in general benefit the entire population of the country, early warning messages will most probably be received and acted upon only by the inhabitants of the districts[199] with high risks of climate-related hazards.

Implication 1. Direct beneficiaries with regards to Adaptation benefit (1) comprise inhabitants of districts with high levels of riverine flood and extreme heat risks. Information about the districts at risk has been obtained from ThinkHazard! tool developed by GFDRR.[200] Given that no districts have been identified to have high risk of extreme heat, only districts with high risk of riverine floods are included in the calculation of direct beneficiaries. The list of the districts and their populations disaggregated by gender and age is provided in Table 29: Direct beneficiaries with regards to Adaptation benefit (1)

	Economic region	Districts	Population, thousand people (2023)					
			Total	Men	Women	**Total youth (age 14-29)**	Men (14-29)	Wom (14-2
Population vulnerable to riverine floods (high risk)	Lankaran	Astara	**111.9**	56.4	55.5	**26.3**	13.7	12.6
		Lenkeran	**227.5**	114.5	113.0	**51.7**	27.2	24.5
		Masalli	**226.7**	114.1	112.6	**54.3**	28.7	25.6
	Yukhari Garabakh	Jebrail	**73.1**	36.4	36.7	**17.1**	9.1	8.0
		Fuzuli	**130.8**	65.2	65.6	**31.4**	16.4	15.0
	Kalbajar-Lachin	Zangilan	**42.7**	21.2	21.5	**9.1**	4.9	4.2
	Ganja-Gazakh	Gazakh	**96.2**	47.3	48.9	**21.2**	11.0	10.2
		Aghstafa	**86.3**	42.5	43.8	**19.7**	10.3	9.4
		Samukh	**58.6**	29.7	28.9	**12.7**	6.7	6.0
		Goranboy	**101.8**	52.0	49.8	**23.1**	12.5	10.6
	Shaki-Zaqatala	Balaken	**100.7**	49.5	51.2	**21.0**	10.7	10.3
		Zagatala	**130.1**	63.8	66.3	**26.6**	13.4	13.2
		Gakh	**58.2**	28.1	30.1	**12.3**	6.3	6.0
	Absheron	Baku	**2344.9**	1150.0	1194.9	**490.3**	255.2	235.1
		Mingechevir	**102.9**	49.2	53.7	**22.0**	10.9	11.1

[199] Azerbaijan is administratively divided into 66 districts (rayons) grouped into 14 economic regions.
[200] GFDRR, 2020, *ThinkHazard!* Tool. Available at: https://thinkhazard.org/en/report/19-azerbaijan

	Aran	Yevlakh	**129.2**	63.1	66.1	**29.3**	15.0	14.3
		Aghdash	**107.1**	53.5	53.6	**24.5**	12.5	12.0
		Agdjabedi	**136.1**	70.4	65.7	**33.6**	17.9	15.7
		Zardab	**59.4**	29.7	29.7	**14.2**	7.2	7.0
		Ujar	**85.0**	42.0	43.0	**19.1**	9.8	9.3
		Goychay	**118.6**	59.3	59.3	**27.1**	14.1	13.0
		Beilagan	**101.6**	51.3	50.3	**23.3**	12.1	11.1
		Imishli	**131.6**	65.3	66.3	**30.7**	15.7	15.0
		Kyurdamir	**118.4**	59.3	59.1	**28.7**	15.1	13.6
		Bilasuvar	**106.5**	53.5	53.0	**25.4**	13.2	12.2
		Hajigabul	**75.9**	37.4	38.5	**17.8**	8.8	9.0
		Sabirabad	**180.5**	90.3	90.2	**42.3**	21.9	20.5
		Saatli	**110.5**	54.9	55.6	**25.6**	12.9	12.7
		Neftchala	**87.3**	42.3	45.0	**18.8**	9.4	9.4
		Salyan	**139.6**	69.6	70.0	**31.2**	16.1	15.1
	Nakhchivan	Sederek	**23.0**	11.6	11.4	**5.2**	2.7	2.5
		Sharur	**113.0**	56.2	56.8	**25.8**	13.6	12.2
Total			**5715.7**	2829.6	2886.1	**1261.4**	655	606.4

.[201] While no direct community engagement is expected to take place in Nakhchevan economic region due to complicated logistics, the populations of the districts within the region that face high risk of riverine floods will still benefit from the nationwide early warning system established with the project support and are therefore counted as direct beneficiaries.

Assumption 2. As per the *Dissemination strategy and approach for tailoring climate information services to end users, particularly last mile users* presented in Section 15.4, the project will implement various warning disseminations based on the consultation with communities (including SMS, Internet, TV, radio HF, bells, Wireless Alert Siren System, loudspeaker, etc.). Therefore, it is assumed

[201] In 2021, Azerbaijan passed a law on the new division of economic regions, which resulted in splitting of several regions. However, since the *ThinkHazard!* tool uses the former division by economic regions, this division is also used in Tables 29 and 30. For those economic regions that have changed their name and composition, footnotes are provided. The reform has not affected the districts.

that these means will be sufficient to cover the entire population of the affected areas, with no one left behind.

Implication 2. The entire populations of the districts with high risks of riverine floods are counted as direct beneficiaries. Therefore, as per Table 29: Direct beneficiaries with regards to Adaptation benefit (1)

	Economic region	Districts	Population, thousand people (2023)					
			Total	Men	Women	**Total youth (age 14-29)**	Men (14-29)	Wom (14-2
Population vulnerable to riverine floods (high risk)	Lankaran	Astara	**111.9**	56.4	55.5	**26.3**	13.7	12.6
		Lenkeran	**227.5**	114.5	113.0	**51.7**	27.2	24.5
		Masalli	**226.7**	114.1	112.6	**54.3**	28.7	25.6
	Yukhari Garabakh	Jebrail	**73.1**	36.4	36.7	**17.1**	9.1	8.0
		Fuzuli	**130.8**	65.2	65.6	**31.4**	16.4	15.0
	Kalbajar-Lachin	Zangilan	**42.7**	21.2	21.5	**9.1**	4.9	4.2
	Ganja-Gazakh	Gazakh	**96.2**	47.3	48.9	**21.2**	11.0	10.2
		Aghstafa	**86.3**	42.5	43.8	**19.7**	10.3	9.4
		Samukh	**58.6**	29.7	28.9	**12.7**	6.7	6.0
		Goranboy	**101.8**	52.0	49.8	**23.1**	12.5	10.6
	Shaki-Zaqatala	Balaken	**100.7**	49.5	51.2	**21.0**	10.7	10.3
		Zagatala	**130.1**	63.8	66.3	**26.6**	13.4	13.2
		Gakh	**58.2**	28.1	30.1	**12.3**	6.3	6.0
	Absheron	Baku	**2344.9**	1150.0	1194.9	**490.3**	255.2	235.1
	Aran	Mingechevir	**102.9**	49.2	53.7	**22.0**	10.9	11.1
		Yevlakh	**129.2**	63.1	66.1	**29.3**	15.0	14.3
		Aghdash	**107.1**	53.5	53.6	**24.5**	12.5	12.0
		Agdjabedi	**136.1**	70.4	65.7	**33.6**	17.9	15.7
		Zardab	**59.4**	29.7	29.7	**14.2**	7.2	7.0
		Ujar	**85.0**	42.0	43.0	**19.1**	9.8	9.3
		Goychay	**118.6**	59.3	59.3	**27.1**	14.1	13.0
		Beilagan	**101.6**	51.3	50.3	**23.3**	12.1	11.1

		Imishli	**131.6**	65.3	66.3	**30.7**	15.7	15.0
		Kyurdamir	**118.4**	59.3	59.1	**28.7**	15.1	13.6
		Bilasuvar	**106.5**	53.5	53.0	**25.4**	13.2	12.2
		Hajigabul	**75.9**	37.4	38.5	**17.8**	8.8	9.0
		Sabirabad	**180.5**	90.3	90.2	**42.3**	21.9	20.5
		Saatli	**110.5**	54.9	55.6	**25.6**	12.9	12.7
		Neftchala	**87.3**	42.3	45.0	**18.8**	9.4	9.4
		Salyan	**139.6**	69.6	70.0	**31.2**	16.1	15.1
	Nakhchivan	Sederek	**23.0**	11.6	11.4	**5.2**	2.7	2.5
		Sharur	**113.0**	56.2	56.8	**25.8**	13.6	12.2
Total			**5715.7**	2829.6	2886.1	**1261.4**	655	606.4

, the total number of direct beneficiaries with regards to Adaptation benefit (1) is **5.71 million**, which amounts to **56%** of the total population of Azerbaijan as of 2023.

Assumption 3. All climate models for RCP4.5 and RCP8.5 scenarios predict an increase in the average annual temperatures in Azerbaijan in all parts of the country.[202] Furthermore, as demonstrated in Section 4.2.1. of the Pre-Feasibility Study, heatwave frequencies are expected to increase both under RCP4.5 and RCP8.5 for all studied locations, which give a good representation of the Azerbaijan territory. Therefore, it can be assumed that the districts that currently have a medium level of extreme heat risk could face a high level of extreme heat risk in the future. Though the populations of these districts might not directly benefit from the project during its duration (in case there are no hazards, no early warning messages will be sent), they will still receive indirect benefits of strengthened resilience and capacity to respond to future climate-related hazards. Therefore, the populations of these areas will be calculated as indirect beneficiaries (unless they are already calculated as direct beneficiaries). Similar methodologies for calculating indirect beneficiaries have been applied in the approved GCF-funded EWS project in Sierra-Leone,[203] as well as in one of the winning projects under the 2023 UN Global Climate Action Awards of UNFCCC.[204] Since there is some variability in how different climate models forecast future precipitation patterns,[205] populations of the districts with a

[202] Republic of Azerbaijan, 2021. Fourth National Communication to UNFCCC. Available at: https://unfccc.int/sites/default/files/resource/FNC%20report.pdf
[203] Enhancing Climate Information Systems for Resilient Development in Sierra Leone. Available at: https://www.greenclimate.fund/project/sap033
[204] Flood Forecasting and Warning Systems as Climate Change Adaptation Measures through Flood Risk Preparedness – Indonesia. Available at: https://unfccc.int/climate-action/momentum-for-change/activity-database/flood-forecasting-and-warning-systems-as-climate-change-adaptation-measures-through-flood-risk-preparedness
[205] Republic of Azerbaijan, 2021. Fourth National Communication to UNFCCC. Available at: https://unfccc.int/sites/default/files/resource/FNC%20report.pdf

medium level of riverine floods will not be included in the indirect beneficiaries calculation (unless they also face a medium level of extreme heat risk).

Implication 3: Indirect beneficiaries with regards to Adaptation benefit (1) include the population of districts with medium levels of extreme heat risk, except for those that are already included as direct beneficiaries. Therefore, as per Table 29: Direct beneficiaries with regards to Adaptation benefit (1)

	Economic region	Districts	Population, thousand people (2023)					
			Total	Men	Women	**Total youth (age 14-29)**	Men (14-29)	Wom (14-2
Population vulnerable to riverine floods (high risk)	Lankaran	Astara	**111.9**	56.4	55.5	**26.3**	13.7	12.6
		Lenkeran	**227.5**	114.5	113.0	**51.7**	27.2	24.5
		Masalli	**226.7**	114.1	112.6	**54.3**	28.7	25.6
	Yukhari Garabakh	Jebrail	**73.1**	36.4	36.7	**17.1**	9.1	8.0
		Fuzuli	**130.8**	65.2	65.6	**31.4**	16.4	15.0
	Kalbajar-Lachin	Zangilan	**42.7**	21.2	21.5	**9.1**	4.9	4.2
	Ganja-Gazakh	Gazakh	**96.2**	47.3	48.9	**21.2**	11.0	10.2
		Aghstafa	**86.3**	42.5	43.8	**19.7**	10.3	9.4
		Samukh	**58.6**	29.7	28.9	**12.7**	6.7	6.0
		Goranboy	**101.8**	52.0	49.8	**23.1**	12.5	10.6
	Shaki-Zaqatala	Balaken	**100.7**	49.5	51.2	**21.0**	10.7	10.3
		Zagatala	**130.1**	63.8	66.3	**26.6**	13.4	13.2
		Gakh	**58.2**	28.1	30.1	**12.3**	6.3	6.0
	Absheron	Baku	**2344.9**	1150.0	1194.9	**490.3**	255.2	235.1
	Aran	Mingechevir	**102.9**	49.2	53.7	**22.0**	10.9	11.1
		Yevlakh	**129.2**	63.1	66.1	**29.3**	15.0	14.3
		Aghdash	**107.1**	53.5	53.6	**24.5**	12.5	12.0
		Agdjabedi	**136.1**	70.4	65.7	**33.6**	17.9	15.7
		Zardab	**59.4**	29.7	29.7	**14.2**	7.2	7.0
		Ujar	**85.0**	42.0	43.0	**19.1**	9.8	9.3

		Goychay	**118.6**	59.3	59.3	**27.1**	14.1	13.0
		Beilagan	**101.6**	51.3	50.3	**23.3**	12.1	11.1
		Imishli	**131.6**	65.3	66.3	**30.7**	15.7	15.0
		Kyurdamir	**118.4**	59.3	59.1	**28.7**	15.1	13.6
		Bilasuvar	**106.5**	53.5	53.0	**25.4**	13.2	12.2
		Hajigabul	**75.9**	37.4	38.5	**17.8**	8.8	9.0
		Sabirabad	**180.5**	90.3	90.2	**42.3**	21.9	20.5
		Saatli	**110.5**	54.9	55.6	**25.6**	12.9	12.7
		Neftchala	**87.3**	42.3	45.0	**18.8**	9.4	9.4
		Salyan	**139.6**	69.6	70.0	**31.2**	16.1	15.1
	Nakhchivan	Sederek	**23.0**	11.6	11.4	**5.2**	2.7	2.5
		Sharur	**113.0**	56.2	56.8	**25.8**	13.6	12.2
Total			**5715.7**	2829.6	2886.1	**1261.4**	655	606.4

, the total number of indirect beneficiaries with regards to Adaptation benefit (1) is **3.61 million**, which amounts to **36%** of the total population of Azerbaijan as of 2023.

Assumption 4. Direct beneficiaries with regards to Adaptation benefit (2) will include all the stakeholders engaged in climate-sensitive sectors who will be engaged through the project for the production of sector-specific climate information for climate-sensitive sectors. Their number is lower compared to direct beneficiaries with regards to Adaptation benefit (1) and can be considered as negligible. Indirect beneficiaries would include all workers engaged in climate-sensitive sectors. Due to the lack of national statistics, it is not possible to realistically estimate the number and location of these workers. Therefore, a conservative assumption would be to estimate that these indirect beneficiaries would overlap with the indirect beneficiaries with regards to Adaptation benefit (1).

Implication 4. No beneficiaries are added with respect to Adaptation benefit (2).

Assumption 5. Direct beneficiaries with regards to Adaptation benefit (3) will include 15,000 children and youth engaged through *Sub-Activity 3.1.5 Engage children and youth in MHEWS* and *Sub-Activity 4.1.4 Disseminate targeted education materials for children and youth*, to be implemented by UNICEF. In accordance with the Section *16.3.2. Selection criteria for UNICEF-led interventions*, the activities will take place in five economic regions[206] : Ganja-Dashkasan, Karabakh, Mil-Mughan and East Zangezur, and Central Aran, where a large share of the districts is vulnerable to riverine floods. Based on this, the conservative assumption it that the direct beneficiaries with regards to Adaptation benefit (3) will overlap with direct beneficiaries with regards to Adaptation benefit (1).

[206] According to the new administrative division

Implication 5. No beneficiaries are added with respect to Adaptation benefit (3).

Assumption 6. Direct beneficiaries with regards to Adaptation benefit (4) will include around 700 participants of the targeted workshops organised as a part of the *Sub-Activity 4.1.3 Conduct a targeted risk awareness and education program for women.* Indirect beneficiaries (potentially all women in Azerbaijan that are somehow affected by climate-related hazards) would overlap with the number of indirect beneficiaries with regards to Adaptation benefit (1).

Implication 6. No beneficiaries are added with respect to Adaptation benefit (4).

Summary: As a result of the estimation and with all the overlaps eliminated, there will be **5.71 million direct beneficiaries** of the project (56% of the population, with 50% women) and **3.61 million indirect beneficiaries** (36% of the population, with 50% women). The total population of Azerbaijan in the end of 2023 – beginning of 2024 was **10.18 million people**.[207]

[207] Population of the Republic of Azerbaijan https://president.az/en/pages/view/azerbaijan/population (data as per the beginning of 2024); the State Statistical Committee of the Republic of Azerbaijan, 2023: Number of Population, Available at: https://www.azstat.gov.az/webmap

Table 29: Direct beneficiaries with regards to Adaptation benefit (1)

	Economic region	Districts	Population, thousand people (2023)[208]								
			Total	Men	Women	**Total youth (age 14-29)**	Men (14-29)	Women (14-29)	**Total children (age 0-17)**	Boys (0-17)	Girls (0-17)
Population vulnerable to riverine floods (high risk)	Lankaran[209]	Astara	**111.9**	56.4	55.5	**26.3**	13.7	12.6	**31.9**	16.9	15.0
		Lenkeran	**227.5**	114.5	113.0	**51.7**	27.2	24.5	**57.6**	31.0	26.6
		Masalli	**226.7**	114.1	112.6	**54.3**	28.7	25.6	**61.4**	33.0	28.4
	Yukhari Garabakh[210]	Jebrail	**73.1**	36.4	36.7	**17.1**	9.1	8.0	**19.6**	10.6	9.0
		Fuzuli	**130.8**	65.2	65.6	**31.4**	16.4	15.0	**36.0**	19.2	16.8
	Kalbajar-Lachin[211]	Zangilan	**42.7**	21.2	21.5	**9.1**	4.9	4.2	**11.3**	6.0	5.3
	Ganja-Gazakh[212]	Gazakh	**96.2**	47.3	48.9	**21.2**	11.0	10.2	**23.9**	12.8	11.1
		Aghstafa	**86.3**	42.5	43.8	**19.7**	10.3	9.4	**22.5**	12.1	10.4
		Samukh	**58.6**	29.7	28.9	**12.7**	6.7	6.0	**15.4**	8.4	7.0

[208] Data obtained from: The State Statistical Committee of the Republic of Azerbaijan, 2023: Number of Population, Available at: https://www.azstat.gov.az/webmap/index.php?geolevel=iqtisadi&v=off&year=2022&indicator=undefined&section=undefined&colorFrom=edf8fb&colorTo=810f7c&cc=5&ms=method_Q#2023
[209] Renamed to Lankaran-Astara
[210] Split between Karabakh and Eastern Zangezur economic regions
[211] Became a part of Eastern Zangezur economic region
[212] Split into Gazakh-Tovuz and Ganja Dashkasan economic regions

		Goranboy	**101.8**	52.0	49.8	**23.1**	12.5	10.6	**26.9**	14.6	12.3
	Shaki-Zaqatala	Balaken	**100.7**	49.5	51.2	**21.0**	10.7	10.3	**23.4**	12.3	11.1
		Zagatala	**130.1**	63.8	66.3	**26.6**	13.4	13.2	**30.8**	15.7	15.1
		Gakh	**58.2**	28.1	30.1	**12.3**	6.3	6.0	**13.0**	6.7	6.3
	Absheron[213]	Baku	**2344.9**	1150.0	1194.9	**490.3**	255.2	235.1	**519.0**	275.1	243.9
	Aran[214]	Mingechevir	**102.9**	49.2	53.7	**22.0**	10.9	11.1	**28.0**	14.5	13.5
		Yevlakh	**129.2**	63.1	66.1	**29.3**	15.0	14.3	**37.4**	19.1	18.3
		Aghdash	**107.1**	53.5	53.6	**24.5**	12.5	12.0	**28.2**	14.7	13.5
		Agdjabedi	**136.1**	70.4	65.7	**33.6**	17.9	15.7	**39.0**	21.3	17.7
		Zardab	**59.4**	29.7	29.7	**14.2**	7.2	7.0	**15.4**	8.2	7.2
		Ujar	**85.0**	42.0	43.0	**19.1**	9.8	9.3	**22.1**	11.7	10.4
		Goychay	**118.6**	59.3	59.3	**27.1**	14.1	13.0	**32.2**	17.1	15.1
		Beilagan	**101.6**	51.3	50.3	**23.3**	12.1	11.1	**27.9**	15.3	12.6
		Imishli	**131.6**	65.3	66.3	**30.7**	15.7	15.0	**35.8**	19.2	16.6

[213] Split into Absheron-Khizi and Baku economic regions
[214] Split into Central Aran, Mil-Mugan and Shirvan-Salyan economic regions

		Kyurdamir	**118.4**	59.3	59.1	**28.7**	15.1	13.6	**32.9**	17.7	15.2
		Bilasuvar	**106.5**	53.5	53.0	**25.4**	13.2	12.2	**31.7**	16.9	14.8
		Hajigabul	**75.9**	37.4	38.5	**17.8**	8.8	9.0	**23.6**	12.3	11.3
		Sabirabad	**180.5**	90.3	90.2	**42.3**	21.9	20.5	**52.6**	27.9	24.7
		Saatli	**110.5**	54.9	55.6	**25.6**	12.9	12.7	**30.9**	16.4	14.5
		Neftchala	**87.3**	42.3	45.0	**18.8**	9.4	9.4	**23.3**	12.1	11.2
		Salyan	**139.6**	69.6	70.0	**31.2**	16.1	15.1	**38.2**	20.5	17.7
	Nakhchivan	Sederek	**23.0**	11.6	11.4	**5.2**	2.7	2.5	**5.0**	2.6	2.4
		Sharur	**113.0**	56.2	56.8	**25.8**	13.6	12.2	**27.4**	14.3	13.1
Total			**5715.7**	2829.6	2886.1	**1261.4**	655	606.4	**1424.3**	756.2	668.1

Table 30: Indirect beneficiaries with regards to Adaptation benefit (1)

	Economic region	Districts	Population, thousand people (2023)[215]								
			Total	Men	Women	**Total youth (age 14-29)**	Men (14-29)	Women (14-29)	**Total children (age 0-17)**	Boys (0-17)	Girls (0-17)
Population vulnerable to extreme heat (medium risk)	Lankaran	Astara	*Counted as direct*								
		Lerik	**86.1**	42.9	43.2	**22.3**	11.7	10.6	**24.8**	13.6	11.2
		Yardimli	**68.4**	34.3	34.1	**18.3**	9.6	8.7	**21.4**	11.7	9.7
		Jalilabad	**217.1**	111.2	105.9	**50.7**	27.1	23.6	**63.0**	34.0	29.0
		Masalli	*Counted as direct*								
		Lenkeran									
	Yukhari Garabakh	Khojavend	**12.3**	6.3	6.0	**3.0**	1.7	1.3	**3.7**	2.1	1.6
		Jebrail	*Counted as direct*								
		Fuzuli									
		Aghdam	**179.8**	90.2	89.6	**42.3**	22.2	20.1	**50.1**	27.3	22.8
		Terter	**80.5**	40.4	40.1	**19.2**	10.0	9.2	**20.9**	11.3	9.6
	Kalbajar-Lachin	Gubadli	**37.1**	18.4	18.7	**8.4**	4.5	3.9	**10.6**	5.7	4.9
		Zangilan	*Counted as direct*								
	Ganja-Gazakh	Shamkir	**217.4**	109.9	107.5	**50.5**	26.8	23.7	**57.6**	31.5	26.1
		Tovuz	**176.9**	88.8	88.1	**41.9**	22.2	19.7	**46.6**	24.9	21.7
		Goygol	**64.8**	32.8	32.0	**14.3**	7.6	6.7	**16.2**	9.0	7.2
	Shaki-Zaqatala	Balaken									

[215] Data obtained from: The State Statistical Committee of the Republic of Azerbaijan, 2023: Number of Population, Available at: https://www.azstat.gov.az/webmap/index.php?geolevel=iqtisadi&v=off&year=2022&indicator=undefined&section=undefined&colorFrom=edf8fb&colorTo=810f7c&cc=5&ms=method_Q#2023

		Zagatala	*Counted as direct*								
		Gakh									
		Sheki	**184.2**	91.8	92.4	**40.8**	21.1	19.7	**45.1**	23.8	21.3
		Oghuz	**44.5**	22.5	22.0	**9.9**	5.1	4.8	**11.1**	5.8	5.3
		Gabala	**108.9**	55.3	53.6	**25.6**	13.4	12.2	**28.9**	15.1	13.8
	Aran	Barda	**156.9**	80.0	76.9	**36.1**	19.3	16.8	**42.2**	22.9	19.3
	Daghlig Shirvan	Ismailli	**87.1**	43.6	43.5	**20.0**	10.4	9.6	**23.3**	12.5	10.8
		Aghsu	**80.6**	40.7	39.9	**19.2**	10.0	9.2	**22.8**	12.4	10.4
		Shamakhi	**105.7**	53.7	52.0	**26.8**	14.2	12.6	**33.1**	18.0	15.1
		Gobustan	**47.0**	23.7	23.3	**12.0**	6.5	5.5	**14.5**	8.0	6.5
	Absheron	Khizi	**16.7**	8.3	8.4	**3.7**	1.9	1.8	**4.4**	2.4	2.0
		Absheron	**432.8**	218.9	213.9	**100.9**	51.8	49.1	**117.1**	61.3	55.8
		Baku	*Counted as direct*								
		Sumgayit	**427**	208.7	218.3	**97.8**	49.7	48.1	**122.2**	63.4	58.8
	Guba-Khachmaz	Gusar	**102.3**	51.9	50.4	**23.1**	12.0	11.1	**27.2**	14.5	12.7
		Guba	**170.2**	86.3	83.9	**40.2**	21.1	19.1	**47.6**	25.3	22.3
		Khachmaz	**174.4**	86.8	87.6	**39.6**	20.5	19.1	**46.4**	24.4	22.0
		Shabran	**58.4**	29.5	28.9	**13.3**	7.0	6.3	**16.4**	8.8	7.6
		Siazan	**41.8**	20.7	21.1	**9.9**	5.0	4.9	**11.9**	6.3	5.6
	Nakhchevan	Sederek	*Counted as direct*								
		Sharur									
		Kangharli	**33.5**	16.6	16.9	**7.2**	3.7	3.5	**9.4**	5.1	4.3
		Babek	**77.8**	38.8	39.0	**18.8**	10.0	8.8	**23.0**	12.0	11.0
		Shahbuz	**25.4**	12.9	12.5	**5.7**	3.0	2.7	**6.3**	3.5	2.8
		Ordubad	**50.7**	25.3	25.4	**10.7**	5.5	5.2	**12.0**	5.9	6.1
		Julfa	**48.0**	24.1	23.9	**10.7**	5.4	5.3	**13.4**	6.9	6.5

Total	**3614.3**	1815.3	1799	**842.9**	440	402.9	**993.2**	529.4	463.8

16.3.2 *General selection criteria*

Specific communities / beneficiaries will be identified based on the following general eligibility criteria:

- **Exposure and vulnerability to hydrometeorological hazards:** Measured based on historical trends in data reported by the Ministry of Emergency Situations and secondary data analysis (e.g., existing hazard, vulnerability and exposure maps). Geographical targeting is the first level of beneficiary selection and will coordinate with development of the Monitoring and Evaluation (M&E) framework for the Project and will be validated by national stakeholders in the Project Steering Committee (PSC).
- **Dependency of livelihoods in climate-sensitive sectors:** Measured based on the proportion[216] of households in a community for which the main source of income generation is one of the five priority sectors of the WMO Global Framework for Climate Services (GFCS) – i.e. agriculture and food security, disaster risk reduction, energy, health and water. This analysis will be conducted through consultation with government agencies, sector representatives and local government.
- **Potential to support increased livelihood opportunities:** The project will prioritise inclusion of beneficiaries that satisfy at least one of the following criteria –
    - Women / Single parent / Elderly / Widows / Youth / People with Disabilities
    - Not receiving external assistance (i.e., from international organisations, NGOs, community groups, etc.)
    - High levels of debt / no access to credit / no formal savings / limited resources that could be used to (re)start livelihood
    - Previous loss of assets or labour opportunities due to a natural disaster
- **Willingness to participate in project activities**.

At the inception phase, the Project Management Unit (PMU) will further elaborate and refine transparent and just selection criteria in consultation with the PSC, the Gender Equality and Social Inclusion (GESI) Expert and the M&E Advisor. Selection criteria will be made available to all and will be disseminated to affected populations and shared with local government authorities and community-based organisations, including those representing women's interests, for endorsement. A beneficiary feedback mechanism will be established through the PSC to monitor that the selection criteria continue to be appropriate throughout implementation of the project and that the most vulnerable people are being reached.

16.3.3 *Selection criteria for UNICEF-led interventions*

UNICEF proposes to work in five economic regions of Azerbaijan, namely Ganja-Dashkasan, Karabakh, Mil-Mughan, East Zangezur and Central Aran. UNICEF plans to cover up to 10 districts with all interventions, most of them being overlapped. The main criterion for the selection of regions is being prone to multiple climate hazards.

[216] Exact percentile thresholds will be established in the project inception phase

Ganja-Dashkasan is divided into four zones: sloping plains, foothills, middle upland zone, and high upland zone, with different climate conditions in each of these zones and faces multiple climate hazards such as landslides, mudflows, flooding, droughts, and extreme temperature events. It is the second most significant economic region in Azerbaijan after Absheron and the country's second industrial region. **Karabakh** economic region has been severely affected by the conflict with Armenia and experiences various hazards such as strong winds, extreme temperatures, droughts, hail, and floods. **Mil-Mughan and Central Aran economic regions** have dry climates, while **East Zangezur's economic region** is also affected by the conflict with Armenia and mainly relies on agriculture, specifically cattle breeding, facing hazards such as floods, extreme temperatures, and droughts. In total, about 2.5 million people reside in these four economic regions.

UNICEF proposes neighboring economic regions for better integration and coordination of interventions. In addition, UNICEF already has plans to open a field office in Barda district (Karabakh economic region), which can play an important role in UNICEF interventions in this project.

The names of districts (local authorities), communities, and schools will be selected at later stages in close consultation with the government.

17 Conclusion

Overall, this project has strong potential to inform and drive climate resiliency in Azerbaijan by developing technical capacity and systems to provide accurate, timely and actionable climate information that can be leveraged by decision makers in policy, planning and response actions, and can empower sectors and communities in Azerbaijan to adapt to increasing climate variability and change.

The proposed project will enable sustained generation, access to and use of localised climate information in Azerbaijan, which is essential to institute science-based, risk-informed planning for climate change adaptation and sustainable development. This is a cost-effective alternative to reactive approaches to climate-related hazards that focus on ad-hoc recovery and investment in hard infrastructure, and risk expensive maladaptation. The project will significantly enhance the risk knowledge and preparedness capabilities of sectors and communities, as well as contribute to major capacity development of the National Hydrometeorological Service (NHMS). Enhanced risk knowledge will enable proactive responses based on relevant and timely information and reduce the cost of damage to assets and livelihoods. Key elements of the value proposition of this project include:

- A high expected benefit-cost ratio (BCR) on investments in upgrading and modernising the NHMS can only be achieved with a sizeable and multi-year investment such as the proposed project. This is corroborated amongst others by a 2015 economic assessment report by WMO that indicated that improvements in early warning systems and preparedness make it possible to limit losses from hydrometeorological disasters, which would not be possible without the informed use of constantly improving meteorological, hydrological, social, behavioural and related information. The report further stated that economic studies have consistently generated BCRs of greater than one. For example, upgrading the hydrometeorological system and early warning capacity of developing countries to developed countries' standard can yield BCRs from 4 to 1 to 36 to 1.[217]
- Recent studies suggest that implementation of a flood early warning system can reduce mortality rates by 45 percent,[218] depending on the warning time and quality of the forecast. Implementation of a drought early warning system can deliver BCRs in the range of 3:1 to 6:1.[219] The economic efficiency of hydromet funding is high. A World Bank assessment of hydromet services in Europe and Central Asia found that for each dollar spent on the NHMS, Azerbaijan averts USD 1.50 of economic losses. Moreover, the study estimated that modernisation of the NHMS would have a BCR ranging from 4.3 to 14.4 over a seven-year investment period, indicating significant economic efficiency.[220]
- Effective expected impacts from saving of lives, assets, and livelihoods. Based on examples of similar efforts to strengthen climate information and MHEWS, it is

[217] Hallegatte, S., 2012. A cost-effective solution to reduce disaster losses in developing countries and evacuation: Hydro-meteorological services, Early Warning and Evacuation
[218] UNU-INWEH, 2019. Flood Early Warning Systems: A Review of Benefits, Challenges and Prospects
[219] The World Bank, 2018. Assessment of Food Security Early Warning Systems for East and Southern Africa
[220] The World Bank, 2008. Weather and Climate Services in Europe and Central Asia – A Regional Review

estimated that integrated early warning systems can potentially be 60% effective in reducing loss of life by for floods, and 20% effective in case of drought (Teisberg and Weiher 2009).[65]

[65] https://www.gfdrr.org/sites/gfdrr/files/Teisberg_EWS.pdf