UN environment programme

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

Annex 14
Market Assessment for Climate Services

Contents

1 INTRODUCTION

The purpose of this document is to assess the current market for climate services in Azerbaijan, identify the key market gaps and needs, and provide recommendations for creating an enabling environment for private sector engagement in climate services. The document is structured as follows:

- Section 2 describes the legal framework and technical capacity of Azerbaijan National Hydrometeorological Service (NHMS) for providing climate services in Azerbaijan, as well as assesses the current enabling environment for private sector engagement in climate services.

- Section 3 assesses needs for climate information and early warning systems for the five priority climate-sensitive sectors identified by WMO (agriculture, health, energy, disaster risk reduction and water resource management).

- Section 4 identifies key barriers for private sector engagement in climate services in Azerbaijan.

- Section 5 offers recommendations for creating an enabling environment for private sector engagement in climate services in Azerbaijan.

- Section 6 draws overall conclusions of the market assessment.

2 CURRENT OPERATING MODEL OF NHMS

2.1 Overview

The main institution responsible for providing hydrometeorological information and climate services in Azerbaijan is the National Hydrometeorology Service (NHMS)[1] under the Ministry of Ecology and Natural Resources (MENR) of the Republic of Azerbaijan.[2] It was established by a Presidential Decree[3] dated January 16, 2019, comprising the national environmental monitoring department, the National Hydrometeorology Department, the Scientific Research Institute of Hydrometeorology, the Metrology and Standardization Center and the Environmental Laboratory Center. The NHMS consists of central and regional units, however their functions and tasks are not well differentiated.[4]

Based on the Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan adopted on March 27, 2020,[5] the mandate and duties of NHMS include organisation of hydrometeorological observations; registering, analysing and recording the observational data obtained from various producers; providing factual information, forecasts and warnings about dangerous hydrometeorological events to relevant state bodies, general public, mass media and individual sectors; studying hydrometeorological events (floods, torrential rains, drought, hail, avalanches, hurricanes, strong winds and sea waves, level fluctuation, ice cover, etc.) and proposing actions to prevent adverse impacts of such events; providing paid and free services in accordance with the legislation; and organizing training on hydrometeorology.

In addition to NHMS, the Decree also mentions several institutions related to hydrometeorology that are subordinate to the MENR but are not a part of it, namely, Climate Change and Ozone Center, Climate

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[1] National Hydrometeorological Service of Azerbaijan. Available at: https://meteo.az/
[2] Ministry of Ecology and Natural Resources of the Republic of Azerbaijan. National Hydrometeorological Service of Azerbaijan. Available at: http://eco.gov.az/az/nazirlik/tabeli-qurumlar/milli-hidrometeorologiya-xidmeti
[3] Official website of the President of Azerbaijan, 2019. Decree of the President of the Republic of Azerbaijan on measures to improve the structure and management of the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, January 16, 2019. Available at: https://president.az/az/articles/view/31541/print
[4] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf
[5] Official website of the President of Azerbaijan, 2020. Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, March 27, 2020. Available at: https://president.az/az/articles/view/36259/print

Database and Communication Center, Comprehensive Hydrometeorological and Ecological Research Science Center,[6] however, their mode of cooperation with NHMS is not clarified.

2.2   Legal framework

The National Hydrometeorological Service is regulated by the Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan (March 27, 2020).[7] In addition, over the years, measures to strengthen hydrometeorological activities in Azerbaijan have been included in multiple codes and other legal acts: [8]

- Water Code (1997)
- Land Code (1999)
- Law on Land Amelioration and Irrigation (1996)
- Law on Water Supply and Waste Water (1999)
- Law on Safety of Hydrotechnical Plants (2002)
- Law on State land cadastre, monitoring of lands and structure of earth (1998)
- Law of the Republic of Azerbaijan on Hydrometeorological Activity (1998)[9]
- Law on specially protected nature areas and objects (2000).

The Government has also adopted several plans, programmes and strategies for development of key economic sectors and addressing climate change through adaptation, mitigation and resilience, which contain clauses that should guide activities of NHMS, namely:

- Hydrometeorological Improvement Program 2004-2010 (final monitoring and evaluation of the implementation of the programme has not been carried out)[10]

- Fourth National Communication to the United Nations Framework Convention on Climate Change – Republic of Azerbaijan

- Intended Nationally Determined Contribution (INDC) of the Republic of Azerbaijan

- Strategic Roadmap for Development of Utilities Services (electric energy, heating, water and gas) of the Republic of Azerbaijan

- Strategic Roadmap for National Economy Perspective of the Republic of Azerbaijan

- Strategic Roadmap for Agricultural Production and Processing in Azerbaijan

- Strategic Roadmap for Development of Telecommunications and Information Technologies in Azerbaijan Republic

- State Programme on Development of Earth Remote Sensing Services in the Republic of Azerbaijan for 2019-2022[11]

- Azerbaijan National Drought Plan

- Azerbaijan 2030: National Priorities for Socio-economic Development

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[6] Official website of the President of Azerbaijan, 2019. Decree of the President of the Republic of Azerbaijan on measures to improve the structure and management of the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, January 16, 2019. Available at: https://president.az/az/articles/view/31541/print

[7] Official website of the President of Azerbaijan, 2020. Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, March 27, 2020. Available at: https://president.az/az/articles/view/36259/print

[8] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf

[9] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

[10] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

[11] Republic of Azerbaijan, 2018. Decree of the President of the Republic of Azerbaijan 'On the approval of the "State Program for 2019-2022 on the development of remote Earth observation services through satellites in the Republic of Azerbaijan"'. Available at: https://e-qanun.az/framework/40724

- Azerbaijan National Adaptation Plan (under development).[12]

2.3　Data policies

Regulation on the National Hydrometeorological Service under MENR (2020) mandates NHMS to provide both paid and free services. [13] NHMS has a written regulation for data sharing, which supports sharing observational information. State organisations are purportedly able to obtain observational data (3 h frequency, SYNOP format) free of charge. However, consultations with government stakeholders conducted in October 2023[14] found that existing regulation does not allow NHMS to provide information freely to all governmental users. Based on the Decision of the Cabinet of the Republic of Azerbaijan from July 9, 1999, observational data and tailored services are provided to the private sector and state-owned enterprises for a fee. [15],[16] However, the regulation is quite outdated and lacks clarity.

2.4　Technical capacity of NHMS

2.4.1　Observations

The types of observations prepared by NHMS include meteorological, climatological, aeronautical, hydrometeorological, aerological, agrometeorological, hydrological and marine hydrometeorological. Specific observations such as radio-meteorological ozonometric, actinometric and heat balance are also available. The main weather parameters (air temperature, precipitation, visibility, relative humidity, atmospheric pressure, cloudiness, atmospheric phenomena, wind, etc.) are observed at the manual stations and automatic weather stations (AWS) and reported every 3 hours daily. Automated surface marine observing stations provide observations on atmospheric pressure and sea surface temperature and report every 3 hours.

Based on the Regulation on the NHMS under MENR (2020), NHMS should register, analyse and record the observational data obtained from various producers (regardless of their ownership and legal form), however, its technical capacity to do so is limited.

Maintenance of AWS and weather radars is based on manuals provided by manufacturers with no standard operating procedures (SOPs) and data quality control available. Staff members are trained by the manufacturers during installations, which can be sufficient when a person has relevant technical pre-skills, but not enough when job profile changes from manual observation to maintenance of automated observation sensors.

Infrastructural capacity and NHMS staff member capabilities for data sharing are limited. There is no modern IT hardware and software, and all the data transfer (from the stations to NHMS, national and international partners) is done manually. There is no storage IT infrastructure for the data from the automated stations, and the station metadata is not collected. In addition, there is an absence of an openly accessible electronic library or a national data bank of hydrometeorological and climate data. [17] To improve data management and transfer, NHMS has an urgent need for ICT-skilled personnel, as well as additional infrastructure. [18]

In addition to NHMS, some observational data is also provided through the Azerbaijan's space program. The Space Agency of the Azerbaijan Republic (Azercosmos) under the Ministry of Digital Development and Transport of the Republic of Azerbaijan, which operates one Earth observation satellite and has

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[12] GCF, 2019. Adaptation planning support for Azerbaijan through UNDP. Readiness proposal. Available at: https://www.greenclimate.fund/sites/default/files/document/readiness-proposals-azerbaijan-undp-adaptation-planning.pdf

[13] Official website of the President of Azerbaijan, 2020. Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, March 27, 2020; 3.0.21. Available at: https://president.az/az/articles/view/36259/print https://president.az/az/articles/view/36259/print

[14] See Annex 13 – Summary of Stakeholder Consultations and Stakeholder Engagement Plan

[15] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf

[16] The fee structure can be found at: https://e-qanun.az/framework/4876/

[17] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf

[18] Further details are provided in Annex 2 - Feasibility Study

access to data from several partner satellites, provides various environmental data which can be used for monitoring and detecting disaster risks.

MENR signed a Memorandum of Understanding (MoU) with Azercosmos to strengthen the usage of satellite data in environmental monitoring, and it is one of the executive bodies in the State Program for 2019-2022 on the development of remote Earth observation services through satellites in the Republic of Azerbaijan. The mandate of MENR as an executive body under the State Program includes identification of flood and inundation emergency zones using satellite imagery, use of satellite images in monitoring the state of glaciers in the sources of rivers with potential flood risk, etc.[19] However, NHMS currently does not use satellite data provided by Azercosmos but rather relies on data from satellites of the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). [20]

Regarding other international data sharing, there is currently no ground-based observational data available from other countries. Weather radar composite is available from Turkey's network through online web page. Azerbaijan shares data for international distribution manually from 23 weather stations. Data is delivered to Turkey, Russia and the WMO OSCAR database. [21]

2.4.2 Modelling and analytics

NHMS lacks numerical weather prediction (NWP) capabilities, and thus no local NWP model is implemented in Azerbaijan. Presently NHMS uses 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 without underlying data. [22]

There is also no formal modelling and forecasting for floods, droughts, mudflows, landslides, strong winds, hailstorms, or waves. While no hydrological or hydraulic modelling capabilities exist in NHMS, the State Water Reserve Agency (within MoES) has some hydrological routing capabilities, although these are limited and mainly applicable to the management of reservoirs. In addition, information from snow surveys is being used to calculate snow water equivalent (SWE) and added to the basic hydrological calculations.[23]

Azercosmos reports to develop certain AI-based algorithms which can be used for detecting crop and moving objects. [24] However, there is no information on their usage for hydrometeorological analytics and disaster prediction.

2.4.3 Forecasting

Forecast products are mainly based the on global and regional NWP model charts produced by the bigger international forecasting centres and received through agreements with WMO or other agreements. The main system for the forecasters for data viewing is a web-based portal provided by Turkey, based on a commercial contract. The portal includes model data but lacks local observational data.

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, as well as marine forecast for 2-3 days for the Caspian Sea. It also provides forecasts on climate-related hazardous events and on soil moisture. Daily weather forecasts are published on the website https://meteo.az/. NHMS also provides a range of hydrological forecasting, including 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 and spring/summer peak season forecast. Some information on the anticipated floods is also provided via the NHMS website, and a situation bulletin is made available. However, most of these

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[19] Republic of Azerbaijan, 2018. Decree of the President of the Republic of Azerbaijan 'On the approval of the "State Program for 2019-2022 on the development of remote Earth observation services through satellites in the Republic of Azerbaijan". Available at: https://e-qanun.az/framework/40724>

[20] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf

[21] Further details are provided in Annex 2 - Feasibility Study

[22] Further details are provided in Annex 2 - Feasibility Study

[23] Further details are provided in Annex 2 - Feasibility Study

[24] Azercosmos. Artificial intelligence. Available at: https://azercosmos.az/en/about-us/research-development/artificial-intelligence

forecasts are qualitative or based on observed water level or discharge, with a comparison to seasonal norms, and as such they do not make it possible to precisely assess the expected flood impacts. No hydrological or hydraulic modelling capabilities exist in NHMS.[25]

There is no formal water resources / drought forecasting in Azerbaijan. However, based on the temperature and snow information, as well as data from hydrological stations and other entities (Irrigation and Water Management Company, Azersu), the NHMS includes warnings about possible water shortages in its daily bulletin. NHMS also provides an agrometeorological bulletin each 10 days, once a month and once a year, as well as an annual hydrological bulletin. The products provided by NHMS mainly consist of tables, texts, or maps and are outdated by international standards. All the products are disseminated manually via email, fax etc.[26]

Lack of technical capacity and expertise in modelling, especially in hydrology, to a large extent prevents development of more advanced forecasts, such as short-range quantitative precipitation forecasts (QPF) for flood forecasting purposes and water supply operations, seasonal meteorological forecasts for drought and agricultural applications, etc. In addition, centralisation of operation and maintenance of observations reduces the capacity for regional units to prepare local forecasts and warnings.[27] Local authorities also do not have the technical capacity to carry out flood risk assessments,[28] which are needed to support localised forecasting.

2.4.4   Tailored services

NHMS provides some tailored agrometeorological services for farmers based on letters, inquiries and signed contracts, including calculation of the drought coefficient for the area, information about frosty days, information about average wind speed, precipitation, and number of sunny days, etc.[29] However, it is not clear whether these services meet the needs of farmers or that they are willing to pay for them. Informal consultations at the national level indicate a lack of willingness to pay for agrometeorological services, due to the information provided not being considered as useful. There is also an agrometeorological bulletin prepared every 10 days, which is published on NHMS website, [30] however it only contains historical data without forecasts.

A list of rates that apply for various types of hydrometeorological data suggests intention to provide other tailored services. They include hydrometeorological forecasts for railway and road routes, animal husbandry, forest fire safety, mountaineering, and avalanche safety, etc.; hydrometeorological forecasts for "Azerenerji" Joint Stock Company on separate regions, territories and objects, as well as aeronautical forecasts. However, the actual demand for these services is unclear.

Development of more diverse and advanced tailored services for different sectors and users, especially with regards to hydrology, is prevented by low technical capacity in modelling and forecasting. Development of reliable agrometeorological services requires additional monitoring capacity (e.g., new sensors, AWS), improved software and associated technical capabilities, as well as enhanced coordination between the Ministry of Ecology and Natural Resources, Ministry of Agriculture and Ministry of Emergency Situations, amongst others.

2.4.5   Inter-ministerial and inter-sectoral collaboration

Responsibility for providing early warnings is shared between NHMS and Ministry of Emergency Situations (MoES). The NHMS issues early warnings against some hydrometeorological and climate hazards (floods, mudflows, strong winds, etc.) and publishes them on its official website https://meteo.az/.

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[25] Further details are provided in Annex 2 - Feasibility Study
[26] Further details are provided in Annex 2 - Feasibility Study
[27] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf
[28] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
[29] National Hydrometeorological Service. Types of agrometeorological services provided by agricultural institutions, farmers, entrepreneurs and insurance companies on the basis of letters, inquiries, references and signed contracts. Available at: https://meteo.az/index.php?ln=az&pg=224
[30] National Hydrometeorological Service. Agrometeorological bulletin. Available at: https://meteo.az/index.php?ln=az&pg=65

It also shares information and forecasts with the MoES. However, currently there is no multi-hazard early warning system in place, which is one of the key gaps to fill.

The MoES, which is mandated to protect the population and property in case of different hazards including natural ones,[31] notifies the population on potential hazards by SMS via the GSM operator ("Bakcell"). This work is carried out by the relevant departments of the Crisis Management Center[32] of the MoES. The Ministry also posts information about dangers that could arise, as well as rules of conduct, on its website (www.fhn.gov.az)[33]. However, there is an identified need to improve and standardize the alerting system, e.g. by implementation of the Common Alerting Protocol (CAP) as well as by increasing the number of weather phenomena in warnings.[34]

2.4.6   Capacity for engagement with the private sector

Following the dissolution of the Soviet Union in 1991, Azerbaijan has embarked on a turbulent process of economic transition, including oil-driven economic growth and development, privatisation, foreign trade, and advancements in the social security system.[35] Whilst the country achieved marked economic growth and welfare gains in the three decades since independence,[36] the post-Soviet transition of Azerbaijan is considered incomplete.[37, 38]

The economy of Azerbaijan is dominated by the state.[39] State-owned enterprises (SOEs) play a significant role in the economy, with their share of GDP in 2014-2016 estimated between 18% according to ADB[40] and 45% according to the World Bank.[41] The prominence of SOEs – particularly in sectors that are usually dominated by private participation – has been attributed as a potential impediment to private sector growth and deterrence of new competitors. Moreover, SOE performance in Azerbaijan is loss making on a total portfolio basis, although it should be noted that a large degree of various exists among individual SOE performance.[42]

Privatisation is considered the greatest obstacle Azerbaijan's economic transition.[43] The business and investment climate is not considered favourable.[44] Excluding the oil and gas sector, the private sector in Azerbaijan is characterised by low productivity, low investment, and poor integration in global markets. These non-energy sectors are mostly made up of small firms engaged in low value-added activities. This includes climate-sensitive sectors of the economy such as agriculture, health, and water.[45] Azerbaijan's Socio-Economic Development Strategy for 2022-2026 sets out the country's intention to move to a private

[31] Ministry of Emergency Situations of the Republic of Azerbaijan. Activity fields. Available at:
https://www.fhn.gov.az/?eng/menu/20
[32] Ministry of Emergency Situations of the Republic of Azerbaijan. Crisis Management Center. Available at:
https://bvim.fhn.gov.az/organizations.php?aze-14#services
[33] Information of Ministry of Ecology and Natural Resources of the Republic of Azerbaijan on an early warning of hazardous hydro meteorological events for the period of June-December 2016. Available at:
http://agendaforhumanity.org/sites/default/files/Azerbaijan%20Report%20on%20WHS%20Commitments_June2017_0.pdf
[34] Further details are provided in Annex 2 - Feasibility Study
[35] Ibadoghlu, G. and Niftiyev, I., 2022. Journal of Life Economics. An assessment of the thirty year post-Soviet transition quality in Azerbaijan from an economic and social liberalization perspective
[36] World Bank Blogs, 2022. Green Growth: Mirage or Reality for Azerbaijan's Future? Available at:
https://blogs.worldbank.org/europeandcentralasia/green-growth-mirage-or-reality-azerbaijans-future
[37] Ibadoghlu, G. and Niftiyev, I., 2022. Journal of Life Economics. An assessment of the thirty year post-Soviet transition quality in Azerbaijan from an economic and social liberalization perspective
[38] Dabrowski, M., 2023. Russian Journal of Economics. Thirty years of economic transition in the former Soviet Union: Microeconomic and institutional dimensions
[39] The World Bank, 2022. Azerbaijan Country Economic Memorandum
[40] Asian Development Bank, 2020. State-Owned Enterprises in Azerbaijan: What to do? Available at:
https://www.adb.org/news/op-ed/state-owned-enterprises-azerbaijan-what-do-nariman-mannapbekov-and-aimee-hampel-milagrosa
[41] World Bank, 2017. Republic of Azerbaijan: Corporate Governance and Ownership of State-Owned Enterprises. © World Bank. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/30207/AUS0000257-PUBLIC-2018-JUNE-ENG-Final-Technical-Note-AZ-SOEs-FINAL.pdf?sequence=1
[42] The World Bank, 2022. Azerbaijan Country Economic Memorandum
[43] Ibadoghlu, G. and Niftiyev, I., 2022. Journal of Life Economics. An assessment of the thirty year post-Soviet transition quality in Azerbaijan from an economic and social liberalization perspective
[44] Dabrowski, M., 2023. Russian Journal of Economics. Thirty years of economic transition in the former Soviet Union: Microeconomic and institutional dimensions
[45] The World Bank, 2022. Azerbaijan Country Economic Memorandum

sector-led growth model with the agriculture, industry, and services sectors in particular benefiting from job creation.[46]

Participation of the private sector in hydrometeorological services in Azerbaijan is limited for several reasons, the first one being the lack of appropriate regulation. Even though the Regulation on the National Hydrometeorological Service (2020)[47] mentions that NHMS can engage with various legal entities and legislation reportedly allows participation of private sector under certain conditions, [48] there are no formal agreements between public and private sector for service delivery[49] and no clear information on how public-private partnerships could be executed.

Public-private partnerships (PPP) in Azerbaijan are regulated by the Law on the Implementation of Special Financing for Investment Projects in Connection with Construction and Infrastructure Facilities (2016). Currently only the BOT (Build-Operate-Transfer) model is applied, which means that the private partner builds and operates the project, and then transfers it to the government. PPP could largely help government bring additional finance to infrastructural projects; however, lack of other more flexible models prevents private investors from entering into PPP. [50] This law is also limited in scope mostly covering construction and infrastructural projects (roads, bridges, industrial parks etc.). Although it also mentions automated management systems based on high technologies and other systems in the area of information technologies, [51] it is not clear whether it can be applied to hydrometeorological systems. It appears that currently there are not adequate legal arrangements in place to support development of PPP in hydrometeorological sector.

State dominance of the economy constitutes another reason for the limited capacity of NHMS to engage with the private sector. As discussed earlier, SOEs comprise a large share of Azerbaijan's economy and may be impeding private sector growth. The non-energy sector, which includes climate-sensitive sectors such as agriculture, health and water, is underdeveloped, with a low level of private investment. [52] In the longer run, privatization of SOEs in accordance with the Strategic Roadmap for National Economy Perspective in Azerbaijan could create preconditions for larger engagement of private sector in key climate-sensitive sectors of the economy, which might also increase the potential of NHMS to engage with the private sector more actively. [53]

At the same time, there are examples of other governmental bodies successfully engaging with the private sector in the sphere of climate information and early warning systems. One such example is collaboration between the MoES with "Bakcell" mobile operator[54] on dissemination of early warning messages, however, the terms and mode of their cooperation are not clear.

Another example of private sector and community engagement is the Ministry of Agriculture (MoA) Digital Agriculture project launched in 2021. Within this pilot, five climate stations were installed to collect data on air temperature, humidity level, amount of rain, leaf moisture and time of precipitation and wind speed, which were then analysed by MoA. Based on this information, SMS notifications, which included weather forecasts and information on the suitability of the weather for spraying, etc. were sent to more than 5,800 farmers registered based on the Electronic Agricultural Information System (EAIS) on risks in the areas of apple, cherry, nectarine, and peach in the villages covered by climate stations. At the same time, in order to facilitate more detailed and flexible transmission of risk data, the Telegram channel "digital agriculture" (https://t.me/ktnsmart) was created, and regular work carried out to attract farmers to this

[46] Ibadoghlu, G., 2022. An Assessment of Socio-Economic Development Strategy for 2022-2026 of the Republic of Azerbaijan

[47] Official website of the President of Azerbaijan, 2020. Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan, March 27, 2020. Available at: https://president.az/az/articles/view/36259/print

[48] WMO Community members. Azerbaijan, 1.18 https://community.wmo.int/members/aze

[49] WMO Community members. Azerbaijan, 1.17 https://community.wmo.int/members/aze

[50] KPMG Azerbaijan. Public Private Partnership: Alternative Way of Attracting Private Sector to Infrastructure Projects in Azerbaijan. Available at: https://assets.kpmg/content/dam/kpmg/az/pdf/2019/03/az-en-alternative-way-of-attracting-private-sector-to-infrastructure-projects.pdf

[51] Official website of the President of Azerbaijan, 2022. «On Public-Private Partnership». Available at: https://e-qanun.az/framework/32612

[52] The World Bank, 2022. Azerbaijan Country Economic Memorandum

[53] Republic of Azerbaijan, 2016. Strategic Roadmap for National Economy Perspective of the Republic of Azerbaijan.

[54] Bakcell, 2014. Bakcell launches SMS notification tool for emergency situations. Available at: https://bakcell.com/en/03/2014/bakcell-launches-sms-notification-tool-for-emergency-situations

channel. The system reportedly helped to eliminate to a certain extent the risk of water shortages by informing farmers on how much water they should use. [55] While the project demonstrates positive progress towards private sector and community engagement in the field of climate services in Azerbaijan, the project does not appear to have been scaled up and developed further, and the Telegram channel 'Digital Agriculture" only has 226 subscribers as of December 2022. [56] These examples demonstrate useful models of private sector and community engagement that NHMS could learn from and implement. For instance, it could disseminate tailored warnings to the relevant market participants through SMS, Telegram channels or other preferred social media.

Another potentially relevant model of public and private sector collaboration in Azerbaijan is related to IT infrastructure. Azerbaijan Service and Assessment Network (ASAN) platform, which is a one-stop-shop for public services, is implemented in partnership with the private sector, which develops the software and earns revenue from transaction fees. [57] This model could be considered during development or further scaling of digital platforms for hydrometeorological data storage and sharing in Azerbaijan.

2.4.7 Current demand for tailored weather and climate information

Hydrometeorological data and services are stipulated to be provided to private companies and SOEs for a fee. [58] NHMS reports demand from the private sector for various climate services, such as information related to weather and wave forecasts and early warning to assist cargo ships to optimize marine routes; and seasonal hydrometeorological forecasts for planning of activities in agriculture, energy production, industry, reservoir management. However, no official data is available to support this information. NHMS also reportedly collaborates with a range of private companies and SOEs in transportation, mining, water, energy insurance, food production, construction etc. to jointly carry out hydrometeorological and environmental conditions monitoring for the purpose of environmental impact assessment (EIA) or implementation of development projects to ensure that hydrometeorological conditions are considered to avoid any future damages from hydrometeorological hazards. However, roles, responsibilities and terms of cooperation are not clearly defined, and concrete outputs of such collaboration are not available. [59] As for households, a 2008 study suggested that people in Azerbaijan were more willing to pay for insurance against hazards than for climate services provided by NHMS, seemingly because they did not see enough value in the information from NHMS. [60] However, demand for insurance also does not seem to be sufficient – for example, as of 2019, despite government subsidies, farmers (mostly families and households) were reluctant to purchase agricultural insurance having low awareness on its benefits and seeing premiums as too high. [61]

2.4.8 Enabling environment

There is currently no clear enabling policy and environment for private sector engagement in climate services. NHMS is mandated to provide paid services to the private sector, however, the document with the rates has not been updated since 1999, and it is not clear whether it is still relevant. There is also currently no clear regulation on public-private partnerships in hydrometeorological sector. At the same time, Azerbaijan ranks quite high in the ease of doing business (28/190), which could mean that once there is an enabling environment in place, the private sector could embrace opportunities in arising from climate services.

Regarding innovation, the 2023 Global Innovation Index (GII) ranked Azerbaijan 89th out of 132 economies, and below the innovation performance expected for the country's level of development. The 2023 GII indicated Azerbaijan's relative strengths in institutional quality (42nd) and business sophistication (64th). However, the translation of innovation inputs into outputs remains a challenge; the GII rankings for creative outputs and knowledge and technology outputs placed Azerbaijan amongst the lowest performers, at 110th and 114th respectively.[62] Local markets have much to gain from increasing innovation

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[55] Ministry of Agriculture of the Republic of Azerbaijan, 2021. Digital agriculture: SMS notifications are sent to farmers about the risks they may face in their orchards. Available at: https://www.agro.gov.az/az/news/reqemsal-kend-teserruefati-fermerlere-meyve-baglarinda-uezlese-bilecekleri-risklerle-bagli-sms-bildirisler-goenderilir

[56] Digital Agriculture. Available at: https://t.me/ktnsmart, accessed 22/12/2022

[57] ADB, 2019. Azerbaijan: Country Digital Development Overview.

[58] https://e-qanun.az/framework/4876/, last accessed 22/12/2022

[59] Based on consultations with NHMS

[60] World Bank, 2008. Weather and Climate Services in Europe and Central Asia. A regional review.

[61] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.

[62] WIPO, 2023. Global Innovation Index 2023

capacities and adoption of international knowledge and technologies. Analysis by UNECE in 2020 highlighted the value of technology upgrades to encourage private sector development, although the low absorptive capacity of the private sector was recognised as a limitation.[63]

Table 1. Factors contributing to an enabling environmental for private sector engagement

Political and policy context	
Ease of doing business (1 = easiest) out of a total of 190 countries ranked[64]	28
PPP legislation	No specific legislation for hydrometeorological sector
PPP unit	No
Decentralized system / semi-autonomous	No
Permitted to charge for data	Yes
Integration of climate change into national plans and strategies	Yes
Trusted and effective communication channels to disseminate weather information	Limited
NHMS capacity	
Maintenance of historical data	All historical data is stored in digital format in 3-hour frequency in templates including 26 variables. Some data is made available on the NHMS website.
Technical capacity to analyse data	Highly limited
Well-distributed network of weather and climate stations	Partly, needs strengthening
Adequate capacity for forecasting	No, NHMS is generally reliant on external sources
Digitised data	Limited
Accurate weather information	Limited
Motivated staff	Unclear; there is also no education and training department[65]
Coordination and information-sharing with other institutions	Ministry of Emergency Situations, Ministry of Agriculture, Azercosmos, but needs strengthening
Understanding of user needs	Unclear
Ability to provide EWS	Some, but not end-to-end or multi-hazard
Relationship with the private sector	
Supplies data to NHMS from own weather station	No

[63] UNECE, 2020. Sub-regional Innovation Policy Outlook 2020: Eastern Europe and the South Caucasus. Azerbaijan
[64] World Bank Ease of Doing Business. Azerbaijan. Available at:
https://data.worldbank.org/indicator/IC.BUS.EASE.XQ#Accessed#on#18#August#2015.#A#high#ranking#
[65] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf

Willingness to form partnership with NHMS - Aviation - Agriculture - Mobile - Energy - Fisheries / marine - Insurance - Construction	- Yes (based on information from NHMS) - Yes (based on information from NHMS) - Yes, but with MoES - Yes (based on information from NHMS) - Yes (based on information from NHMS) - Yes (based on information from NHMS) - Yes (based on information from NHMS)
Currently purchasing NHMS products and services - Aviation - Agriculture - Mobile - Insurance	- No - Unclear - Unclear - Unclear
Last-mile relationships	
Involvement of local communities in collecting data	No
Provision of targeted information to local communities	Limited to infrequent project-funded activities[66,67]

Climate change adaptation is largely integrated to the national plans and priorities; however, existing capacity is not sufficient to address it. The observational network is not evenly distributed which leads to its low resolution; there is a lack of modern hardware and software, modelling capacity is limited, which in its turn limits the ability of NHMS to provide all the necessary forecasts and deliver high-quality tailored services meeting end users' demands. Even though NHMS reports demand from private sector for its services, overall willingness to pay for the information and services provided by NHMS appears to be low. Stakeholder consultations in October 2023[68] found that key economic sectors (including aviation, energy, and water) are dissatisfied with the price of information from NHMS. Azerbaijan Air Navigation Services (AZANS) has reportedly not paid for services of NHMS since 2000 due to the cost of services provided. Lack of willingness to pay is a major obstacle to private sector engagement in climate services.

Although warnings against some hazards are issued, there is no multi-hazard early warning system (MHEWS) in place. Consultations with key sectors have highlighted the need for additional dissemination channels to be used by NHMS to enable better access to hydrometeorological information. In this regard, there is an opportunity to establish partnerships with private mobile operators. Provision of targeted information directly to communities at risk is limited to infrequent project-funded activities. Coordination and information sharing with other ministries, which is necessary for providing and disseminating tailored services and early warnings, also needs to be strengthened.

Table 2. Summary of overall capacity of NHMS for private sector engagement

Technical capacity	Enabling policy environment	Financial capacity	Potential for PPPs
• Limited capacity for hydrometeorological observations. • No local NWP model and limited modelling and forecasting capabilities. • Some tailored services are provided	• Decision of the Cabinet of the of the Republic of Azerbaijan on the approval of payment rates and rules for the use of data on hydrometeorology and natural	Total annual budget: AZN 6.813.637[71] (approximately USD 4 million)	There is currently no clear regulation on PPPs in the hydrometeorological sector.

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[66] UNDP, 2018. Climate Change Adaptation in Europe and Central Asia
[67] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan
[68] See Annex 13 – Summary of Stakeholder Consultations and Stakeholder Engagement Plan
[71] WMO Community members. Azerbaijan. Available at: https://community.wmo.int/members/aze

	environment monitoring (1999)[69] • Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan (2020)[70] defines key duties and activities of NHMS, as well as mandates provision of paid services		
for sectors, but the quality and demand for such services is lacking.			

3   NEEDS FOR CLIMATE INFORMATION AND EARLY WARNING SYSTEMS

3.1   Agriculture and food security

In 2020, the agricultural sector contributed to 6.9% of GDP and employed around 36% of the Azerbaijan's labour force. [72] As a result of agrarian reforms and privatization led since 1995, the agricultural sector became highly fragmented and dominated by small and medium enterprises (in 2019, 90.9% of gross output of agricultural production came from private owners, family peasant farms and households) [73]. Azerbaijan has favourable conditions for production of many crops, including cereals, potatoes, vegetable, and fruit. Livestock production is dominated by milk, eggs, beef, sheep, goat meat and poultry. [74] Azerbaijan has become self-sufficient with respect to many products, including fruit, vegetables, eggs, and dairy, and does relatively well in meeting demand for production of certain types of meat. [75] It has significantly advanced in achieving ensuring food security - the level of severe insecurity is less than 0.5%. However, the level of moderate food insecurity raised by 3.7% in the recent years. [76]

The main threat to food security in Azerbaijan is climate-sensitive crop production and yields. [77] Temperatures in Azerbaijan are expected to rise at a faster rate than the global average, with potential warming of 4.7 °C by the 2090s over the 1986–2005 baseline, under a highest-level emissions scenario.[78] Rising temperatures are likely to necessitate the relocation of certain crops (e.g. vineyards) to higher altitudes, reducing available land for their production. Drought, which is considered a considerable threat

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[69] https://e-qanun.az/framework/4876/, last accessed 22/12/2022

[70] Official website of the President of Azerbaijan, 2020. Regulation on the National Hydrometeorological Service under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan. Available at: https://president.az/az/articles/view/36259/print

[72] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf, p. VII

[73] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf; State Statistical Committee of Azerbaijan Republic (SSC). 2021b. Agriculture, forestry and fishing. Available at: https://www.stat.gov.az/source/agriculture/?lang=az

[74] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

[75] State Statistical Committee of Azerbaijan Republic (SSC), 2019. Food balances of Azerbaijan Statistical yearbook. Baku. p. 94. Available at: https://www.stat.gov.az/source/food_balances/?lang=en

[76] FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO. Available at: https://www.fao.org/3/cc0639en/cc0639en.pdf, p. 141

[77] FAO, IFAD, UNICEF, WFP and WHO. 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO. Available at: https://docs.wfp.org/api/documents/WFP-0000074343/download/?_ga=2.259204488.300303364.1669977435-1926785973.1669029587, p. 151

[78] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan. Available at: https://www.adb.org/publications/climate-risk-country-profile-azerbaijan

(average annual loss – $7.3 million)[79], is expected to lead to decrease in yield of all key crops, given that 80% of agriculture in Azerbaijan is located in arid and semi-arid parts of the country, and irrigated crops account for over 80% of the value of agricultural production. [80] The increase in the frequency of extreme temperatures over 35°C is a particular threat, likely damaging crop yields when occurring during the growing season. [81] Increased flooding can result in destruction of crops, agricultural land and infrastructure, delayed planting, and death of small cattle. [82]

In recent years there has been significant progress in development of agricultural insurance. To support voluntary insurance, the government launched a single Agrarian insurance Fund (AIF) in 2020, where 50% of insurance fees are subsidized. [83] However, the system does not fully cover the needs of farmers. While it covers some of the natural and climate-related hazards (earthquake, landslides, whirlwind, storm, hail), the AIF does not cover drought risk, which poses the most significant threat to agriculture.[84] In addition, farmers (especially small-scale ones that produce most agricultural products) are still reluctant to buy insurance, having low awareness on the benefits of insurance and considering premiums to be too high. [85]

Azerbaijan's Ministry of Agriculture and the State Service for Administration of Agricultural Projects and Credits under the Ministry are the main players in agricultural policy and food security. In addition to its roles in land reclamation, water management, and irrigation, the Ministry of Agriculture implements common scientific and technical policies. An important role in providing analytics belongs to the Agricultural Economics Research Center under the Ministry of Agriculture, which has a separate monitoring, evaluation and risk analysis division. [86] In addition, the UN Food and Agriculture Organization (FAO) has been providing development and knowledge support to Azerbaijan (e.g. in 2022 it produced a "Comprehensive analysis of the disaster risk reduction for the agricultural sector in Azerbaijan", [87] which identified multiple gaps and needs).

3.1.1 Disaster risk knowledge

Agriculture is identified as one of the most vulnerable sectors to climate change in Azerbaijan, however there is insufficient knowledge on climate change hazards and associated risks, especially among small-scale farmers. Access to knowledge and technologies for female farmers, who make up around 50% of employment in agriculture, [88] is often even more limited due to responsibilities at home. [89] In addition, responsible authorities often lack knowledge on disaster risk assessments and post-disaster needs and damage assessments, [90] as well as capacity to provide relevant information to farmers.

[79] UNISDR and the World Bank, 2009. Central Asia and Caucasus Disaster Risk Management Initiative (CAC DRMI) Risk Assessment for Central Asia and Caucasus Desk Study Review. Available at:
https://www.preventionweb.net/files/11641_CentralAsiaCaucasusDRManagementInit.pdf?_gl=1*mo263t*_ga*NzkyMjk2O TEwLjE2OTY5MTgzMzg.*_ga_D8G5WXP6YM*MTY5NjkxODM1Mi4xLjAuMTY5NjkxODM1Mi4wLjAuMA..
[80] USAID, Climate Change Risk Profile Azerbaijan. Available at:
https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID_Climate Change Risk Profile_Azerbaijan.pdf
[81] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan. Available at:
https://www.adb.org/sites/default/files/publication/707466/climate-risk-country-profile-azerbaijan.pdf
[82]USAID, Climate Change Risk Profile Azerbaijan. Available at:
https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID_Climate%20Change%20Risk%20Profile_Az erbaijan.pdf
[83] Agricultural Economics Research Center, 2017. A Mechanism of Agricultural İnsurance with state support started in Azerbaijan. Available at: https://atm.gov.az/en/news/230/a-mechanism-of-agricultural-insurance-with-state-s/
[84] Huseynov, M., Salahov, E., Jafarov, J., 2022. Current situation, problems and diversification of insurance model in the sphere of crop production in Azerbaijan. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 22, Issue 3, 2022. Available at: https://managementjournal.usamv.ro/pdf/vol.22_3/Art31.pdf
[85] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[86] Agricultural Economics Research Center. Structure. Available at: https://atm.gov.az/en/menu/11/structure/
[87] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[88] Azernews, 2019. Azerbaijan Women in Agriculture Project launched. Available at:
https://www.azernews.az/business/150302.html
[89] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[90] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

Identified needs and opportunities in Azerbaijan include:

- Establish indicators and thresholds for drought classification, including through analysis of past drought events; [91]

- Conduct hazard mapping and crop zonation mapping; [92]

- Systematically collect, consolidate and analyse damage and losses data by the Agrarian Insurance Fund (AIF), [93] and the Agricultural Research Centre (ARC), [94] and ensure that assessments of damage and losses cover all agricultural subsectors;

- Conduct technical training courses focusing on risk assessment and decision making based on a countrywide standardization of risk-assessment methodologies; [95]

- Update the existing methodology for post-disaster damage assessment for the agricultural sector. [96]

3.1.2 Observations and forecasting

To provide high quality agrometeorological services that farmers will be willing to pay for there is a need to increase observational, as well as analytical and modelling and forecasting capacities, which will help better predict climate-related hazards, especially agricultural drought.

Identified needs and opportunities in Azerbaijan include:

- Increase the number of operational meteorological and hydrological stations, especially automatic stations with online transfer capabilities; optimise the hydrometeorological observation network through establishment of stations in mountainous areas, including high-altitude stations; expand the actinometric observation network;

- Develop agricultural drought monitoring methods by use of remote sensing data; [97]

- Provide tailored agrometeorological services (e.g., to inform plant and animal pest and disease control strategies; pesticide and herbicide applications, fertilizer and irrigation management);

- Strengthen capacities for modelling to provide tailored agrometeorological services.

3.1.3 Dissemination and communication

Although NHMS currently provides early warnings against some hazards (e.g. storms, hail and drought), there are no sufficient EWS services and products for agriculture at national and local levels. Warnings and forecasts tend to be generic and not impact-based, and there is a need for more accurate information for planning, decision-making, and response actions. [98]

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[91] UNCCD. National Drought Plan in Azerbaijan. Available at:
https://www.unccd.int/sites/default/files/country_profile_documents/1%20FINAL_NDP_Azerbaijan.pdf
[92] WMO 2014. Agriculture and food security exemplar to the User Interface Platform of the Global Framework for Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-Areas/Agriculture%20and%20food%20security/GFCS-AGRICULTURE-FOOD-SECURITY-EXEMPLAR-FINAL-14147_en.pdf
[93] Agrarian Insurance Fund (AIF) is a new insurance mechanism launched in 2020 to improve voluntary agricultural insurance by providing 50% government subsidies. It covers some natural hazards (earthquakes, landslides, whirlwind, storm, hail) as well as other risks.
[94] Agricultural Economics Research Center (ARC) is a Center under the Ministry of Agriculture which plays a big role in agricultural analytics having a separate monitoring, evaluation and risk analysis division
[95] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[96] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[97] UNCCD. National Drought Plan in Azerbaijan. Available at:
https://www.unccd.int/sites/default/files/country_profile_documents/1%20FINAL_NDP_Azerbaijan.pdf
[98] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

Identified needs and opportunities in Azerbaijan include:

- Strengthen agricultural EWS to ensure appropriate early warning of droughts based on agrometeorological data before irreversible crop yield loss and/or quality degradation occur; [99]

- Improve warning dissemination through the use of digital technologies;

- Develop a feedback mechanism where end users (including farmers' organizations or forums) can provide inputs on whether the forecasts and early-warning products are addressing their needs, which will help to improve dissemination of alerts to local people and communities; [100]

- Expand the use of agrometeorological data in agriculture, prepare a summary of bulletins, disseminate agrometeorological comments and summaries through communication media; [101]

- Mobilise farmers to be more active in the use and dissemination of climate information. [102]

3.1.4 Preparedness and response capabilities

There is a need to strengthen the preparedness and response capabilities of users of climate and agricultural information within the agricultural sector (both farmers and authorities) in order to reduce the vulnerability of farmers to the increased drought and flood events. There is also a need to improve agricultural insurance, which despite government subsidies is still not popular among farmers in Azerbaijan.

Identified needs and opportunities in Azerbaijan include:

- Enhance farmers' knowledge of agrometeorology services and EWS, including through the use of digital technologies (e.g. further develop Telegram channel "Digital Agriculture" and other means of communication);

- Improve access to agricultural knowledge and technologies for female farmers;

- Integrate climate information into insurance, credit provision, crop monitoring and yield forecasting, and humanitarian response; [103]

- Improve agricultural insurance to include drought risk; develop weather-based insurance index;

- Raise awareness about the benefits of agricultural insurance to incentivise farmers to buy it;

- Establish an agrometeorological advisory service in Azerbaijan, which would help farmers obtain and apply relevant meteorological information, [104] such as irrigation scheduling and crop evaporation/transpiration information; [105]

- Establish cross-border exchange of information related to hazard monitoring and forecasting; [106]

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[99] UNCCD. National Drought Plan in Azerbaijan. Available at:
https://www.unccd.int/sites/default/files/country_profile_documents/1%20FINAL_NDP_Azerbaijan.pdf
[100] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[101] Official website of the President of Republic of Azerbaijan, 2016. Strategic Vision and Roadmap for Azerbaijan.
Agriculture. Available at: https://monitoring.az/assets/upload/files/8047fecde10eaf0fd8cb45de716d8267.pdf
[102] WMO 2014. Agriculture and food security exemplar to the User Interface Platform of the Global Framework for
Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-
Areas/Agriculture%20and%20food%20security/GFCS-AGRICULTURE-FOOD-SECURITY-EXEMPLAR-FINAL-
14147_en.pdf
[103] WMO 2014. Agriculture and food security exemplar to the User Interface Platform of the Global Framework for
Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-
Areas/Agriculture%20and%20food%20security/GFCS-AGRICULTURE-FOOD-SECURITY-EXEMPLAR-FINAL-
14147_en.pdf
[104] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[105] UNCCD. National Drought Plan in Azerbaijan. Available at:
https://www.unccd.int/sites/default/files/country_profile_documents/1%20FINAL_NDP_Azerbaijan.pdf
[106] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

- Enhance coordination between relevant state authorities for the development of relevant policies, strategies and plans that support the implementation of disaster risk reduction (DRR), EWS, and agrometeorology services activities (especially for transboundary risks).[107]

3.2 Health

Despite making significant progress over the past 15 years on key health indicators (life expectancy, maternal mortality, and infant mortality), Azerbaijan is one of the lowest performers in the Europe and Central Asia region on all three indicators. Azerbaijan also has one of the lowest percentages of health expenditure out of total government expenditures in the region and the highest share of out-of-pocket payments for medical services driven by prices of pharmaceuticals, fees for diagnostics and the practice of "informal gifts" to medical providers in exchange for care .[108] Key challenges for the health system that especially impact on populations in rural areas include poor infrastructure (including lack of central water supply), absence of medical equipment, shortage of health workers (density of medical doctors in Azerbaijan is lower than, for example, in neighbouring Armenia and Georgia);[109] and lack of training.[110]

Climate change is expected to have a negative impact on public health in four main ways: nutrition, heat-related mortality, diseases (mostly waterborne) and air pollution. Food production and supplies are expected to be mainly affected by water shortages and extreme temperatures, which are likely to lead to higher food prices and might lead to increase in mortality caused by food availability.[111] Heat stress during summer months has been found to correlate with increases in total number of ambulance calls increased, calls for circulatory system diseases and calls for the number of deaths.[112] With rising temperatures this trend might increase, also aggravated by the increasing share of elderly people in the population.[113] The main diseases that might proliferate because of climate change include gastrointestinal infections mainly caused by poor water quality. Currently impacting around 16,000 people yearly, acute gastrointestinal infections might further proliferate due to flooding of human settlements, destruction of sewage systems and contamination of drinking water.[114] Climate change as well as cross-border tensions might also lead to increase and proliferation of various vector-borne diseases in Azerbaijan, including malaria and visceral leishmaniasis.[115,116] Air quality is a significant concern in Azerbaijan, particularly in urban areas. The most recent data indicates the country's annual mean concentration of PM2.5 is 20 μg/m^3,[117] which exceeds the recommended maximum of 5 μg/m^3. The issue of severe air pollution is expected to be exacerbated by climate change.[118]

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[107] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

[108] USAID, 2022. Political economy analysis of the health system in Azerbaijan: a literature review. Revised draft. Available at: https://pdf.usaid.gov/pdf_docs/PA00ZB6Q.pdf

[109] WHO, 2022. World health statistics 2022: monitoring health for the SDGs, sustainable development goals. Available at: https://www.who.int/publications/i/item/9789240051157

[110] WHO, 2021. Azerbaijan strengthens its health workforce to boost primary health care. Available at: https://extranet.who.int/uhcpartnership/story/azerbaijan-strengthens-its-health-workforce-boost-primary-health-care

[111] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan. Available at: https://www.adb.org/sites/default/files/publication/707466/climate-risk-country-profile-azerbaijan.pdf

[112] Republic of Azerbaijan, 2021. Fourth National Communication to the UNFCCC. Available at: https://unfccc.int/sites/default/files/resource/FNC%20report.pdf

[113] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan. Available at: https://www.adb.org/sites/default/files/publication/707466/climate-risk-country-profile-azerbaijan.pdf

[114] Republic of Azerbaijan, 2021. Fourth National Communication to the UNFCCC. Available at: https://unfccc.int/sites/default/files/resource/FNC%20report.pdf

[115] Agayev et al., 2020. Epidemiological situation and spatial distribution of visceral leishmaniasis in the Republic of Azerbaijan. Journal of Parasitic Diseases. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7410948/

[116] Hirschfeld, K. et al., 2022. Ethnic conflict as a risk amplifier for resurgent P. vivax malaria in temperate zones: A case study from the Caucasus region. Global Environmental Change. Available at: https://www.sciencedirect.com/science/article/pii/S0959378022000334

[117] IAMAT, 2022. Azerbaijan General Health Risks: Air Pollution. Available at: https://www.iamat.org/country/azerbaijan/risk/air-pollution#:~:text=In%20accordance%20with%20the%20World,maximum%20of%2010%20%C2%B5g%2Fm3.

[118] USAID, 2017. Climate Change Risk Profile – Azerbaijan. Available at: https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID_Climate%20Change%20Risk%20Profile_Azerbaijan.pdf

Healthcare in Azerbaijan is provided by several government actors. The Ministry of Health (MoH) owns the central institutions and the tertiary level hospitals, research institutes and the Sanitary-Epidemiological Service. Funding for these facilities comes through the Ministry of Health from the Ministry of Finance.[119] MoH is also responsible for digital transformation of healthcare in Azerbaijan and is planning to present a 5-year strategy for digital health strategy in the near future.[120] The State Agency for Compulsory Health Insurance (SAMHI) manages the insurance fund, as well as the Management Union of Medical Territorial Units (TABIB), which in turn manages medical institutions responsible for providing services under compulsory medical insurance, including emergency medical care, primary health care service, laboratory examinations, and surgical operations.[121] There are also around 500 private clinics in Azerbaijan.[122] International partners (World Bank, USAID, Public International Organizations, international financial institutions) have supported the government throughout its health systems reform process, which led to establishment of SAMHI. However, several years back some partners including World Bank and USAID discontinued financing. Other partners such as WHO and European Union partners remained engaged on primary care and health systems financing reforms through the Universal Health Coverage Partnership.[123]

3.2.1 Disaster risk knowledge

The health sector needs comprehensive information on disaster risk with a special focus on nutrition, heat stress and climate-sensitive diseases. Knowledge about how climate-related hazards can exacerbate health-related problems can help the Ministry of Health, other relevant authorities, as well as citizens themselves, take better preventive measures.

Identified opportunities in Azerbaijan include:

- Strengthen the knowledge of health authorities about key climate-related health risks and their climate sensitivity;

- Identify timeframes within which each risk can occur and decisions need to be made; produce risk thresholds; map vulnerable population groups;[124]

- Use GIS for risk mapping (e.g. disease transmission risks) at high spatial resolution to better target vector control interventions;[125]

- Strengthen the knowledge of municipal authorities about the urban heat island effect to ensure its inclusion in urban planning.

3.2.2 Observations and forecasting

In order to take timely preventive measures, there is a need for better prediction of climate extremes that can potentially harm public health. Accurate weather and climate data linked to health data can be used to make forecasts of potential disease outbreaks and other negative impacts on the human health in the short and long run.

Identified opportunities in Azerbaijan include:

- Provide regularly updated observational climate data (including satellite data) at the appropriate spatial scale to match health data and enable development of accurate climate-weather models;

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[119] Ibrahimov, F. et al, 2010. Azerbaijan. Health system review. Health systems in transition, Available at:
https://apps.who.int/iris/bitstream/handle/10665/330333/HiT-12-3-2010-eng.pdf?sequence=5&isAllowed=y
[120] Business media, 2022. Azerbaijan developing strategy for digitalization of health care. Available at:
https://bm.ge/en/article/azerbaijan-developing-strategy-for-digitalization-of-health-care/101586
[121] Azerbaijan.az. Azerbaijani management union of medical territorial units (tabib). Available at:
https://azerbaijan.az/en/related-information/211
[122] USAID, 2022. Political economy analysis of the health system in Azerbaijan: a literature review. Revised draft.
Available at: https://pdf.usaid.gov/pdf_docs/PA00ZB6Q.pdf
[123] USAID, 2022. Political economy analysis of the health system in Azerbaijan: a literature review. Revised draft.
Available at: https://pdf.usaid.gov/pdf_docs/PA00ZB6Q.pdf
[124] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate:
Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254
[125] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate:
Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254

- Develop climate-weather models to identify direct and indirect climate influences on various health determinants (e.g. availability of drinking water, food security, urban heat island effect);

- Improve the air quality monitoring system through modernization of monitoring stations, including installation of small-scale mobile sensors;

- Through partnerships between multiple stakeholders (weather/climate and health organizations, communities, private sector), develop tailored services that will assist in the prediction of future health outcomes and will be easily understood by all end users.[126]

3.2.3 Dissemination and communication

The health sector needs to establish reliable warning dissemination and communication mechanisms that include information on climate-related hazards to health. The health sector also needs communication strategies at the national, subnational and local levels to ensure coordination of warning issuers and dissemination channels. In turn, this will enhance the quality of information delivered to the health community and the actual uptake of climate information within the sector.

Identified opportunities in Azerbaijan include:

- Enhance early warning systems to include information about possible outbreaks of climate-sensitive diseases;

- Provide real-time and customised information for high-risk populations during heat waves;[127]

- Ensure that health sector actors communicate how extreme weather events can impact health outcomes, as well as provide recommendations on preparedness behaviour.

3.2.4 Preparedness and response capabilities

There is a need to strengthen capacity of health services and communities to anticipate and respond to outbreaks of climate-sensitive diseases, take preventive measures against food shortages and prevent negative impacts of extreme heat.

Identified needs and opportunities in Azerbaijan include:

- Train health professionals on health and climate linkages, disaster management, and analytical methods, such as environmental epidemiology and spatial biostatistics;[128]

- Strengthen data-sharing policies between MoH, NHMS, MoA and other relevant stakeholders to allow for regular information exchange[129] and to enable co-production of tailored services for improved preparedness;

- Use weather and climate patterns to inform short-term decision making (e.g. buying vaccines and medications, triggering emergency response plans)[130], as well as long-term policy decisions (e.g. designing urban infrastructure resilient to the urban heat island effect,[131] investing in drought-resistant crops, building appropriate water infrastructure)[132];

- Inform communities about possible climate-health relationships and necessary preventive measures to mitigate risks;

[126] WMO 2014. Health exemplar to the User Interface Platform of the Global Framework for Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-Areas/Health/GFCS-HEALTH-EXEMPLAR-FINAL-14152_en.pdf
[127] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate: Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254
[128] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate: Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254
[129] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate: Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254
[130] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate: Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254
[131] Republic of Azerbaijan, 2021. Fourth National Communication to the UNFCCC. Available at: https://unfccc.int/sites/default/files/resource/FNC%20report.pdf
[132] WMO & WHO, 2019. Climate Services for Health: Improving public health decision-making in a new climate: Fundamentals and case studies. Available at: https://library.wmo.int/doc_num.php?explnum_id=11254

- Conduct public awareness raising and education on improving preparedness to climate-related health risks;

- Strengthen regional collaboration to jointly address cross-border climate-related health risks.

3.3 Energy

The economy of Azerbaijan is driven by the oil and gas sector, which accounts for around 90% of the country's exports and 30-50% of its GDP, depending on oil prices.[133] Thermal power plants generated 92.5% of electricity, while hydropower generated less than 6% in 2019.[134] According to the document "Azerbaijan 2030: National Priorities for Socio-economic Development" Azerbaijan aims to increase the share of renewable energy in line with its decarbonization strategy and started researching areas with high renewable energy potential. In accordance with Presidential Decree No. 1209 of 29 May 2019 "On the acceleration of the reforms in the energy sector of the Republic of Azerbaijan", the development of the draft law on "Use of renewable energy sources in power generation" was initiated,[135] which is expected to provide additional support benefits for renewables.

The main climate risks for the energy sector are linked to water availability, both to supply of cooling water to thermal power plants and for hydropower. Water availability might reduce as a result of decreases in winter precipitation and snow-melt water, diminished surface and groundwater resources, declines in summertime precipitation and increases in length and frequency of drought periods.[136] Other identified threats to the energy sector on the supply side include increase in transmission losses, reduction of overall transmission efficiency, and reduction of viscosity of transported fuels because of high temperatures. In addition, extreme events (e.g., flooding, landslides) and erosion can damage electricity networks as well as oil and gas pipelines. Renewable energy could potentially contribute to mitigating climate-related risks to thermal and hydropower plants, being less dependent on the water availability.[137] On supply side, heat stress is expected to increase cooling demand, which might put significant pressure on the energy generation systems, aggravated with their own increased needs for cooling.[138]

The Ministry of Energy (MoE) is the main government institution involved in the energy sector. Azerbaijan Renewable Energy Agency under the MoE of the Republic of Azerbaijan ensures the arrangement and regulation of activities in the field of renewable energy sources and their efficient use.[139] The State Oil Company of Azerbaijan Republic (SOCAR), the largest electricity producer Azerenergy, Baku electrical grid operator Azerishiq and heat supply company Azeristiliktejhizat are the main state-owned energy companies.[140] MoE cooperates with multiple international organizations including OPEC, IEA, UNEP and others. The main partners of the Azerbaijan Renewable Energy Agency include EBRD, IFC, IRENA, ADB, German Energy Agency (GEA). A number of bilateral and multilateral agreements have been signed for development of renewable energy.[141]

3.3.1 Disaster risk knowledge

The energy sector needs disaster risk information to identify relevant meteorological and climate phenomena for energy infrastructure and energy systems, as well as to come up with feasible adaptation and mitigation options for Azerbaijan.

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[133] IEA, 2021. Azerbaijan 2021. Energy Policy Review. Available at: https://iea.blob.core.windows.net/assets/49662c46-575f-4561-a541-5541f5342b07/Azerbaijan2021EnergyPolicyReview.pdf

[134] IEA, 2021. Azerbaijan 2021. Energy Policy Review. Available at: https://iea.blob.core.windows.net/assets/49662c46-575f-4561-a541-5541f5342b07/Azerbaijan2021EnergyPolicyReview.pdf

[135] IRENA, 2019. Renewables readiness assessment. Republic of Azerbaijan. Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RRA_Azerbaijan_2019.PDF

[136] Arent, D.J. et al.,2018. AR5 Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. pp. 659-708. Available at: www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap10_FINAL.pdf.

[137] Arent, D.J. et al.,2018. AR5 Climate Change 2014: Impacts, Adaptation and Vulnerability https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap10_FINAL.pdf

[138] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan. Available at: https://www.adb.org/sites/default/files/publication/707466/climate-risk-country-profile-azerbaijan.pdf

[139] The Ministry of Energy of the Republic of Azerbaijan. Agencies under the Ministry. Available at: https://minenergy.gov.az/en/ministry/nazirliyin-tabeliyinde-olan-qurumlar

[140] IEA, 2023. Azerbaijan energy profile. Available at: https://www.iea.org/reports/azerbaijan-energy-profile

[141] Azerbaijan Renewable Energy Agency under the Ministry of Energy of the Republic of Azerbaijan. International cooperation. Available at: https://area.gov.az/en/page/beynelxalq-emekdasliq

Identified opportunities in Azerbaijan include:

- Improve knowledge about potential impacts of various climate-related hazards (including extreme heat, drought, floods, storms) on energy generation and transmission infrastructure;

- Strengthen collaboration between the authorities, academia, private sector and population to get better information on the impact of disasters on the energy sector (e.g. how higher temperatures lead to increase in cooling demand and reduction of generation efficiency).[142]

3.3.2   Observations and forecasting

Better weather and climate modelling and prediction capabilities are required to advise on early action and timely measures to mitigate climate risks for thermal power plants, hydropower plants and power grids in Azerbaijan.

Identified needs and opportunities in Azerbaijan include:

- Provide better observational data with high spatial resolution to match ancillary datasets (electric grid, distance to coast, elevations, populated centres, geomorphology, social acceptance surveys, etc.) and inform resource and risk assessment in energy sector;[143]

- Improve hydrological forecasting tools for development and application of appropriate measures to deal with extreme hydrological events, specifically with a view towards estimating power energy modelling, which might help better predict energy output for hydropower in the context of changing precipitation patterns;[144]

- Conduct climate stress tests and flood frequency analyses supported by numerical modelling to predict performance of hydropower plants under various climate scenarios;[145]

- Conduct seasonal climate forecasting for maintenance of infrastructure and risk management purposes (e.g. to ensure sufficient water reserves are available for hydropower production);

- Use weather data to provide tailored climate services for renewable energies;[146]

- Develop wind and solar atlases for assessment of renewable energy potential.[147]

3.3.3   Dissemination and communication

The energy sector needs improved communication methodologies to effectively convey warnings to the energy sector at various lead times and predict energy demand at various timescales.

Identified opportunities in Azerbaijan include:

- Issue advance notice of dry periods for planning hydropower operations planning,[148] informing potential threats for biofuel production and preparing for low water availability for cooling;

- Strengthen EWS to warn of short-term risks of meteorological disasters (hail, storms, strong winds) that could affect energy generation and transmission infrastructure;[149]

- Produce advance warnings on extreme heat to better predict higher demand for cooling;

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[142] Early Warning for All Initiative. Executive Action Plan 2023-27. Available at:
https://www.preventionweb.net/publication/early-warnings-all-executive-action-plan-2023-2027
[143] WMO 2014. Energy exemplar to the User Interface Platform of the Global Framework for Climate Services.
[144] International hydropower association, 2019. Hydropower sector Climate resilience guide. Available at: https://assets-global.website-
files.com/5f749e4b9399c80b5e421384/5fa7e38ce92a9c6b44e63414_hydropower_sector_climate_resilience_guide.pdf
[145] International hydropower association, 2019. Hydropower sector Climate resilience guide. Available at: https https://assets-global.website-
files.com/5f749e4b9399c80b5e421384/5fa7e38ce92a9c6b44e63414_hydropower_sector_climate_resilience_guide.pdf
[146] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at:
https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf
[147] WMO, 2022. 2022 State of Climate Services. Energy. Available at:
https://library.wmo.int/doc_num.php?explnum_id=11340
[148] WMO, 2022. 2022 State of Climate Services. Energy.
[149] WMO, 2022. 2022 State of Climate Services. Energy.

- Improve communication methodologies to effectively disseminate warnings to different energy market participants.

3.3.4 Preparedness and response capabilities

Capacity development of the energy sector is needed to improve preparedness and response capabilities to climate-related hazards. In turn, enhanced capabilities would support the energy sector to tackle possible impacts from impending severe climatic events.

Identified opportunities in Azerbaijan include:

- Use weather and climate data for renewable energy suitability mapping (including wind, solar, small hydro and bioenergy) to ensure optimal energy mix and mitigate climate risks;

- Provide detailed site-specific weather and climate information, support and advice for energy private sector to manage climate-related risks and opportunities;

- Use high-quality meteorological data combined with other data sources to predict energy production and demand, as well as energy efficiency and insurance pricing[150];

- Plan for operation and maintenance of energy infrastructure under future climate trends and projections[151].

3.4 Disaster risk reduction

Azerbaijan faces high levels of disaster risk and ranks 66th out of 191 countries in the 2022 Inform Risk Index "Natural Hazard Exposure" dimension.[152] Floods are considered to be the largest climate-related risk in Azerbaijan (annual average losses (AAL) is estimated at $300 million), followed by drought (AAL estimate - $6 million) and landslides (AAL estimate - $0.3 million).[153] Temperatures in Azerbaijan are projected to rise at a faster rate than the global average, with potential warming of 4.7 °C by the 2090s over the 1986–2005 baseline, under a highest-level emissions scenario,[154] which is likely to lead to higher disaster risks. For example, droughts of a severe magnitude are 5-10 times more likely to occur in Azerbaijan, causing a transition to a chronically drought-affected environment and desertification in many regions,[155] and melting glaciers are expected to increase the risk of downstream flooding, landslides and mudslides. Increased strong winds, heavy rain, icy roads, fog and low air temperature can hamper marine transportation.[156] At the same time, the country has relatively low institutional strength to combat increased risks and climate-related hazard exposure.[157]

MoES is the central executive body of the government responsible for emergency management throughout the territory of the country.[158] The main tasks of MoES include protecting the population and territory from fires and disasters, preventing emergencies and eliminating their consequences, organizing a rapid response to emergencies, organizing awareness-raising activities among the population, and organising and implementing rescue and first-aid operations, as well as life-saving measures in aviation and other means of transport in the event of emergencies. The MoES also coordinates the implementation of the goals of the Sendai Framework for Disaster Risk Reduction at the national level and preparation of the national strategy for disaster risk reduction.[159] In addition, MoES is planning the publication of an Atlas of Emergency Situations,[160] which will help strengthen disaster risk knowledge, study past and potential future hazards and their impact, determine danger zones and controlling them,

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[150] WMO 2014. Energy exemplar to the User Interface Platform of the Global Framework for Climate Services.

[151] WMO 2014. Energy exemplar to the User Interface Platform of the Global Framework for Climate Services.

[152] Joint Research Centre, 2022. INFORM Risk. Available at: https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Risk-Facts-Figures

[153] Further information on AAL is provided in the Pre-Feasibility Study (Annex 2)

[154] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan. 8

[155] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan.

[156] World Bank, 2008. Weather and Climate Services in Europe and Central Asia. A Regional Review.

[157] World Bank and ADB, 2021. Climate Risk Country Profile: Azerbaijan.

[158] Asian Disaster Reduction Center, 2019. Available at:
https://www.adrc.asia/nationinformation.php?NationCode=31&Lang=en&NationNum=34

[159] Ministry of Emergency Situations of the Republic of Azerbaijan. A meeting of the Coordinating Group on the creation of the National Strategy was held. Available at: https://www.fhn.gov.az/?aze/menu/99/458

[160] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

improve natural resource management as well as better protect people and property from climate-related hazards. The main executing entities for the Atlas are the Institute of Geography and the Institute of Geology and Geophysics,[161] however, it is unclear how is their work coordinated with the MoES. Publication was expected to be completed by 2018-19, however, its state is currently unclear.[162] There also seems to be a lack of coordination between MoES and NHMS on the execution of the Atlas.

3.4.1 Disaster risk knowledge

To be able to take effective response measures, there is a need to strengthen disaster risk knowledge at the level of relevant authorities, as well as vulnerable communities. Local communities have been involved in data collection and early warnings only within pilot projects, if at all, which should be changed to ensure adequate disaster risk knowledge at all levels.

Identified opportunities in Azerbaijan include:

- Identify the nature, location, intensity and likelihood of major hazards;
- Identify populations at risk and delineate disaster prone areas;[163]
- Finalise the development of the Atlas of Emergency Situations;
- Consolidate databases in order to produce expert hydrological data (e.g., flood return period)[164]
- Create a loss database with systematic collection of relevant data for historical analysis of disasters and for future potential disasters based on past evidence.[165]

3.4.2 Observations and forecasting

The disaster risk reduction sector needs historical and real-time databases to make predictions about future climate-related hazards and associated consequence, which requires strengthening data collection, analysis and modelling capacities. There is also a need to fill in observational data gaps through engagement of local communities in data collection, where possible.

Identified opportunities in Azerbaijan include:

- Increase the number of operative stations for daily meteorological and hydrological data, as well as meteorological and hydrological AWS with online transfer of data;
- Improve rainfall data (especially from radars) to improve the hydrological assessment of flood situations;[166]
- Rehabilitate existing radars and install new ones;
- Improve capacity to maintain observational equipment, especially in remote areas;
- Establish Internet of Things (IoT) and wireless communications infrastructure integrated with IoT networks to enable local data collection;
- Engage local communities in hydrometeorological data collection;
- Include opportunities for mobile data collection (for example, use smart sensors in mobile phones or vehicles as emerging sources of meteorological data);[167]

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[161] Institute of Geography named after academician H.A.Aliyev, 2023. ARFH atlas of ES. Available at: https://igaz.az/en/news/315
[162] Azernews, 2023. Azerbaijan drafts atlas of emergencies. Available at: https://www.azernews.az/nation/97723.html
[163] WMO 2014. Energy exemplar to the User Interface Platform of the Global Framework for Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-Areas/Disaster%20risk%20reduction/GFCS-DISASTER-RISK-REDUCTION-EXEMPLAR-FINAL-14467_en.pdf
[164] Further details are provided in Annex 2 - Feasibility Study
[165] WMO 2014. Disaster risk reduction exemplar to the User Interface Platform of the Global Framework for Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-Areas/Disaster%20risk%20reduction/GFCS-DISASTER-RISK-REDUCTION-EXEMPLAR-FINAL-14467_en.pdf
[166] Further details are provided in Annex 2 - Feasibility Study
[167] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

- Digitise historical observational climate data;

- Enhance technical and human capacity to undertake data processing, database management, GIS mapping, and utilization of other relevant software;

- Upgrade flood forecasting centre equipment with a hydrometeorological data visualisation platform and a hydrological modelling platform;[168]

- Automate data processing and forecast systems to improve forecasts;

- Produce impact-based forecasts[169] and multi-hazard warnings;

- Apply the newest technologies and best practices in forecasting and provide training on World Meteorological Organization (WMO) standards, methodologies and requirements.[170]

3.4.3 Dissemination and communication

Although individual warnings for some climate-related hazards (such as floods, heatwaves) are issued via conventional channels such as newspapers and television, there is no comprehensive, systematic, nationwide multi-hazard early warning system. Warnings and forecasts tend to be generic and not impact-based, while more accurate, timely and location-specific climate information is needed for planning, decision-making, and response actions.

Identified needs and opportunities in Azerbaijan include:

- Establish a nationwide multi-hazard early warning system;

- Use Flash Flood Guidance System for issuing flash flood warnings;[171]

- 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)[172]

- Develop an automatic warning system based on hydrological criteria / water-level threshold exceeded;[173]

- Identify and strengthen several of the most efficient, preferred and trusted communication channels to reach communities at risk; use multichannel warning dissemination;

- Engage with more mobile operators to increase coverage of EWS;

- Establish community-based early warning systems;

- Leverage Artificial Intelligence to support the development of 'client' profiles and scale dissemination of actionable information.[174]

3.4.4 Preparedness and response capabilities

To further strengthen disaster preparedness and response capabilities there is a need for additional training and capacity building at institutional and local level, as well as international collaboration, especially regarding transboundary risks.

Identified needs and opportunities in Azerbaijan include:

- Strengthen the preparedness capacities, systems and procedures of local governments and communities through training and equipping them to respond based on integrated community and national early warning systems;

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[168] Further details are provided in Annex 2 - Feasibility Study

[169] WMO Community members. Azerbaijan, 6.4. Available at: https://community.wmo.int/members/aze

[170] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf

[171] WMO Community members. Azerbaijan, 6.8. Available at: https://community.wmo.int/members/aze

[172] Further details are provided in Annex 2 - Feasibility Study

[173] Further details are provided in Annex 2 - Feasibility Study

[174] Early Warning for All Initiative. Executive Action Plan 2023-27. Available at: https://www.preventionweb.net/publication/early-warnings-all-executive-action-plan-2023-2027

- Strengthen internal cooperation between NHMS and MoES, e.g. through joint data portals, to enable more efficient and timely response actions;

- Develop and implement a National Hydromet Early Warning Service training programme to both enhance capability and to develop a sustainable knowledge base;[175]

- Identify and implement cost effective risk reduction options;[176]

- Participate in regional initiatives to exchange information on DRR and combine efforts regarding monitoring, forecasting, and responding to climate-related disasters.[177]

3.5 Water resource management

Water resources of Azerbaijan consist of surface and groundwater. According to 2014 data, surface water resources are 32 billion m^3, in dry years their volume is reduced to 23 billion m^3. Surface water resources are rivers, lakes, reservoirs, glaciers and sea water. 70% of the total water resources is formed on the territory of neighbouring states. While surface water is actively used, the potential of groundwater is not widely exploited.[178] Major water-related challenges in Azerbaijan include pollution of water resources with wastewater, including transboundary pollution, as well as inadequate supply of quality water to human settlements, wastage in delivery, and shortage of sewer lines. Azerbaijan's three main ground water sources – the Kura, Araz and Samur rivers – originate outside the country and are heavily exposed to overuse and pollution from industries and municipalities in neighbouring countries and within Azerbaijan. Since not all wastewater treatment facilities are properly functioning, untreated municipal wastewater is the largest source of pollution of the water basins,[179] which also has negative impacts on public health. Another challenge is drastic reduction of water levels and water stress because of drought, which poses threats to agriculture and food security. The Government of Azerbaijan has identified its lakes and glaciers as having potential to play an important role in the resolution of water crises likely to occur as a result of increasing demand for water and climate change effects.[180]

Management of water resources is conducted by multiple national authorities. MENR is responsible for developing state policy in the field of water resources, management of groundwaters and state control over the quality of water in rivers and reservoirs. The Water Resources State Agency under MoES prepares and implements drought emergency plans, ensures reliable protection of water reservoirs of national importance, oversees technical maintenance of water reservoirs in the country, conducts monitoring of water bodies, hydrotechnical structures, water supply systems, and undertakes measures to improve water resources management.[181] The Land Reclamation and Water Management OJSC is responsible for management and distribution of surface water for irrigation, and operation of public facilities. Azersu OJSC provides the population with drinking water, other users with industrial water, as well as management of sewerage and wastewater systems. The Ministry of Health conducts state supervision (control) of water quality.[182] The coordination between the state and non-state bodies

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[175] Early Warning for All Initiative. Executive Action Plan 2023-27. Available at:
https://www.preventionweb.net/publication/early-warnings-all-executive-action-plan-2023-2027
[176] WMO 2014. Disaster risk reduction exemplar to the User Interface Platform of the Global Framework for Climate Services. Available at: https://gfcs.wmo.int/sites/default/files/Priority-Areas/Disaster%20risk%20reduction/GFCS-DISASTER-RISK-REDUCTION-EXEMPLAR-FINAL-14467_en.pdf
[177] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan. Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[178] The State Statistical Committee of the Republic of Azerbaijan, 2014. Water statistics in the Republic of Azerbaijan. Available at:
https://unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.57/2014/Session_2_Azerbaijan_Water_statistics_EN.pdf
[179] Yu, W, 2022. Azerbaijan's water services: Shifting focus from building infrastructure to building institutions. Available at: https://blogs.worldbank.org/europeandcentralasia/azerbaijans-water-services-shifting-focus-building-infrastructure-building
[180] Ministry of Ecology and Natural Resources Republic of Azerbaijan, 2010. Second National Communication to the UNFCCC. Available at: https://unfccc.int/resource/docs/natc/azenc2.pdf
[181] UNCCD. National drought plan in Azerbaijan. Available at:
https://www.unccd.int/sites/default/files/country_profile_documents/1%20FINAL_NDP_Azerbaijan.pdf
[182] The State Statistical Committee of the Republic of Azerbaijan, 2014. Water statistics in the Republic of Azerbaijan. Available at:
https://unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.57/2014/Session_2_Azerbaijan_Water_statistics_EN.pdf

function in the water sector of Azerbaijan and the leadership over the whole sector is exercised by the Cabinet of Ministers and its relevant departments.[183]

3.5.1 Disaster risk knowledge

The water sector needs comprehensive information on climate-related risks to water resources development, surface water resources and groundwater – including hazards (namely extreme rainfall or drought), exposure, vulnerability and capacity. Research and development on climate and water applications are essential for the support and creation of new products that suit the needs of the water community.

Identified opportunities in Azerbaijan include:

- Identify and map extreme weather and climate hazards that pose water-related risks;
- Identify populations vulnerable to water-related hazards.

3.5.2 Observations and forecasting

Water availability is expected to become one of the main challenges for most sectors of economy in Azerbaijan, including agriculture and energy. However, Azerbaijan's current hydrometeorological network has gaps in its coverage, partially lacks automation, and lacks the timely generation of hydrometeorological-related warnings. Azerbaijan does not possess a national numerical weather prediction model, an operational impact-based flood forecasting model, surface water modelling software packages, which will become especially important as water resources become more strained.[184]

Identified needs and opportunities in Azerbaijan include:

- Increase the number of operative stations for hydrological data and hydrological AWS with online transfer of data (including high-altitude stations);
- Ensure regular monitoring and assessments for climate-related risks in flood-prone communities;
- Identify measurement sites to meet the need for both measurement of water resources and for flood alerts;[185]
- Unify 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;[186]
- Develop national flood forecasting models and surface water modelling software packages;[187]
- Establish a Quality Management System (QMS) for hydrology;[188]
- Develop / purchase software for rainfall-runoff modelling for better predictions of water resource availability;[189]
- Evaluate the impact of water withdrawals on flow regimes and the impact of wastewater discharges on water quality during drought;[190]
- Invest in efficient monitoring programs of water quantity and quality for reliable data;

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[183] UNCCD. National drought plan in Azerbaijan. Available at:
https://www.unccd.int/sites/default/files/country_profile_documents/1%20FINAL_NDP_Azerbaijan.pdf
[184] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[185] Further details are provided in Annex 2 - Feasibility Study
[186] Further details are provided in Annex 2 - Feasibility Study
[187] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
Available at: https://azerbaijan.un.org/sites/default/files/2022-07/cb8486en.pdf
[188] WMO Community members. Azerbaijan, 8.24. Available at: https://community.wmo.int/members/aze
[189] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
[190] UNCCD. National drought plan in Azerbaijan. f

- Strengthen cooperation with neighbouring countries through development of joint forecasting models on the transboundary rivers.[191]

3.5.3   Dissemination and communication

The water resource management sector needs monitoring systems to estimate the impact of water-related hazards on the local community. It also needs forecasting and warning services to project potential water-related climate hazard events.

Identified needs and opportunities in Azerbaijan include:

- Strengthen flash flood warnings with the help of automated hydrological stations;[192]

- Update actual drought status in real time to enable decision-makers and local stakeholders to take adequate measures (e.g. activate irrigation system);

- Establish a drought communications system between the state and local governments and water systems.[193]

3.5.4   Preparedness and response capabilities

There is a need to promote integrated water resource management to guarantee access to clean and safe water in the context of climate change.

Identified needs and opportunities in Azerbaijan include:

- Strengthen capacity for climate risk management within water institutions;

- Strengthen response capacity of communities, including through better risk knowledge;

- Develop and implement water and flood management policies and strategies;[194]

- Shift towards performance-based financing (for example, government subsidies may be linked to specific service performance indicators by the Azersu Water Utility,[195] such as improvement of high-quality water availability in regions vulnerable to climate change);[196]

- Strengthen internal cooperation on water issuers between NHMS and relevant stakeholders, e.g. through joint water data portals;

- Develop water sector and public awareness to value and uses of climate and weather information for water;[197]

- Strengthen international collaboration in transboundary water climate data exchange for better risk management and response capabilities.

4   BARRIERS TO PRIVATE SECTOR ENGAGEMENT IN CLIMATE SERVICES

Multiple barriers exist that impede private sector engagement in climate services in Azerbaijan. These include an underdeveloped private sector, lack of an enabling environment and relevant regulation, low quality of services provided by NHMS, as well as limited awareness about the value of climate services at all levels. These barriers largely overlap with those identified by the GCF[198] as factors preventing

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[191] Skoien, J. et al. Assessment of the capacity for flood monitoring and early warning in Enlargement and Eastern/ Southern Neighbourhood countries of the European Union. Publications Office of the European Union.
[192] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
[193] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan.
[194] WMO 2014. Water exemplar to the User Interface Platform of the Global Framework for Climate Services.
[195] Yu, W, 2022. Azerbaijan's water services: Shifting focus from building infrastructure to building institutions. Available at: https://blogs.worldbank.org/europeandcentralasia/azerbaijans-water-services-shifting-focus-building-infrastructure-building
[196] EU4Environment, 2021. New green public investment programme in water sector in Azerbaijan. Available at: https://www.eu4environment.org/news/new-green-public-investment-programme-in-water-sector-in-azerbaijan/
[197] WMO 2014. Water exemplar to the User Interface Platform of the Global Framework for Climate Services.
[198] GCF, 2022. Sectoral guide: Climate information and early warning systems

achievement of a paradigm shift in climate information and early warning systems (CIEWS). The identified barriers are discussed in further detail below:

(1) Limited quality of climate data and forecasts: Lack of high-quality localised observational data as well as low capacity for analysis and modelling, resulting in limited availability and quality of tailored services and low willingness to pay amongst private sector actors.

(2) Technical complexities of hydromet operations: There are major gaps in more advanced data processing capabilities, including capacity for big data analysis and geospatial modelling, which reduces the ability to develop high-quality tailored services. There is also a lack of training and capacity development for operating automated weather stations.

(3) Lack of coverage and scale for effective service delivery: IT hardware and software is not sufficient to ensure efficient delivery and uptake of information. For example, there is no integrated ICT system covering data collection, database management, weather forecasting, multi-hazard early warning system, and communication and dissemination. Data storage capacity is limited, and all data transfer is done manually. These factors reduce the ability of NHMS to provide high-quality tailored services in accordance with the best available international practices.

(4) Lack of enabling environment for institutional effectiveness: There is a lack of institutional arrangements and technical capacity for information and data exchange between NHMS and different ministries as well as non-governmental entities. This has resulted in insufficient data availability for high- and industry-specific tailored services which sometimes require combining weather and climate data with other information (e.g. health-related data, agricultural data, environmental information, etc.). Lack of arrangements and capacity for data exchange with international partners reduces the ability to prepare timely forecasts on cross-border threats.

(5) Market barriers to monetising value creation: There is a lack of enabling environment, appropriate policies and incentives for private sector engagement in climate services. For example, there is no legislation describing how exactly the NHMS could engage with private sector. Although the NHMS reportedly cooperates with some companies on hydrometeorological and environmental conditions monitoring for the purpose of environmental impact assessment, there are no formal agreements signed. Lack of non-restrictive institutional environment for private sector engagement, lack of clear and updated policies for data sharing with private sector, absence of public-private partnership legislation explicitly covering hydrometeorological services, as well as absence of defined roles and responsibilities of public and private sector limits private sector capacity and motivation to cooperate in the field of climate services.

(6) Achieving sustainable 'last mile' effectiveness: Community engagement in climate services is prevented by the low level of last-mile communication. Up to the present there have been just infrequent project-based activities that disseminated data and warnings directly to communities at risk. The level of disaster risk knowledge among the communities at risk, as well as the private sector, is also low, which, for instance, prevents willingness to pay for insurance.

5 RECOMMENDATIONS AND OPPORTUNITIES FOR CREATING AN ENABLING ENVIRONMENT FOR PRIVATE SECTOR ENGAGEMENT

5.1 Disaster risk knowledge

- There is a need for training and capacity building at all levels, in both the public and private sectors as well as amongst communities, to strengthen disaster risk knowledge. Market opportunities could include providing paid training courses and educational materials for various industries, which could be developed and carried out by NHMS, private sector or academia. Delivery of these services could be included in the national financial strategy for sustainable climate services. There is also the need to create an educational programme within NHMS to provide training for staff.[199]

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[199] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf

- Improved risk knowledge could motivate the private sector and communities to take actions to reduce climate vulnerability and increase resilience. This, coupled with raising awareness on the benefits of MHEWS, could lead to their increased willingness to pay for climate services.

5.2 Observations and forecasting

- There is a need to improve the observational network through upgrades and installation of new sensors and equipment. Private sector could help overcome the lack of observational capacity and support improvement in the observational network through public-private partnership agreements. The company could pre-finance the observational infrastructure, NMHS could run the instrumentation, receive knowledge transfer and pay back the private company over a certain period.[200] In order to enable this model, there is a need to develop a national financial strategy for sustainable climate services that would contain separate provisions for public-private partnerships in the climate services sector. Establishment of a Quality Management System (QMS) within NHMS would also be important.

- There is a need to improve data policies and data sharing arrangements to incentivize private sector engagement, which could be a part of a National Climate Data and Information Management Strategy. For example, NHMS could start a move towards a semi-open data policy with more observational data being provided by NHMS for free to relevant stakeholders (private sector, academia). In the long run, open data policy could be introduced, as recommended by the World Bank and in the WMO Unified Data Policy. In the future, this could support creation of a competitive market of climate services and, in the long run, lead to provision of better climate services tailored to specific needs of end users.[201]

- While observational data and basic services (including public weather forecasts and extreme weather warnings) should be provided for free, NHMS could provide targeted services and industry-specific services for a fee. These services could include forecasts for specific user groups (e.g. mariners, farmers), information provided to shipping companies, etc.,[202] information for health sector. Development of targeted services for urban health would also require development of a comprehensive strategy for service delivery in relation to urban weather, climate, hydrological and air quality services, e.g. as a part of an Integrated Urban Services Framework. A list of services that can be provided by NHMS (free of charge and on a fee basis) should be included within a national financial strategy for sustainable climate services. The quality of the services would need to be improved to ensure the users' willingness to pay. To deliver high-quality services, NHMS would need to: (1) expand and optimize the hydrometeorological observation network (including with the help of private investments) and develop SOPs for Automated Weather Stations;[203] (2) build capacity for data modelling and analytic; (3) establish an integrated data visualization and analytics system; (4) build capacity for multi-hazard risk profiling and vulnerability assessments; (5) strengthen the QMS; (6) enhance Numerical Weather Prediction (NWP) and modelling processes, including air quality forecasting; and (7) establish multi-hazard impact-based forecasting tools and capabilities.

- There is also a need to partner with various other stakeholders, from relevant ministries (MoA, MoH) to private sector and academia. Such partnerships could be supported by clearer framework on how NHMS can collaborate with different governmental and non-governmental stakeholders (e.g., National Framework for Climate Services), better inter-institutional dialogue (e.g. through National Climate Outlook Forum), data sharing policy (as a part of National Climate Data and Information Management Strategy) and appropriate infrastructure for interaction between the providers and users of climate information (e.g. User Interface Platform which should be an integral part of the National Framework for Climate Services).

- In the future, private sector could provide value-added services for various industries by integrating business data with the information purchased from NHMS. These services could include areas that go beyond NHMS mandate, such as recommendations on supply chain

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[200] World Bank & GFDRR, 2019. Public Private Engagement in Hydromet Services
[201] World Bank, 2021. Public and Private Engagement in Hydromet Services
[202] World Bank & GFDRR, 2019. Public Private Engagement in Hydromet Services
[203] Based on consultations with NHMS

optimisation; advice on fertilisers, irrigation and pesticides for farmers; medical advice; powerplant management advice, etc. These services could also be co-produced by the public and private sectors. Digitisation of these services could help improve reach to target audiences, as well as contribute to the strategic goals of Azerbaijan – for example, development of e-agriculture and agritech start-ups is one of the national priorities in terms of digital development.[204]

- To improve data storage and management, it is recommended to modernise IT infrastructure, which could help to fully deploy the benefits from automated observations as well as create additional opportunities for employment of IT specialists. IT infrastructure for data storage, which is currently missing,[205] could be developed with participation of the private sector, given that Azerbaijan already has similar experience of public and private collaboration: Azerbaijan Service and Assessment Network (ASAN) platform, a one-stop-shop for public services, is implemented in partnership with the private sector, which develops the software and earns revenue from transaction fees.[206]

5.3   Dissemination and communication

- To ensure timely issuance and dissemination of early warnings, there is a need to establish a nationwide multi-hazard alert system, strengthen interaction between NHMS, MoES and end users of climate information (e.g. through the User Interface Platform), as well as build capacity for community MHEWS.

- There is also a need for an integrated ICT system which would cover data collection, database management, weather forecasting, multi-hazard early warning system, and communication and dissemination.[207] Such a system could be further developed in the long run with the support of the private sector (see ASAN model)[208].

- There is a need to improve linkages between NHMS and MoES to ensure consistency of information delivered in line with their respective mandates, and avoid eroding public trust in the information disseminated.

- There is an opportunity to engage more private mobile operators in warning dissemination (in addition to "Bakcell") to increase the coverage of EWS.[209]

- Private sector and civil society organisations could also more actively engage in disseminating warnings through other channels, including mobile applications and other Internet-based services,[210] as well as engage in last-mile communication.

- To issue more timely warnings on cross-border disasters, e.g. floods on transboundary rivers, there is a need to strengthen collaboration with neighbouring countries through data and climate information exchange.

5.4   Preparedness and response capabilities

- To strengthen preparedness and response capabilities there is a need for Early Action Protocols with well-designed triggers based on impact-based forecasts and detailed analysis of relevant hazards, exposure and vulnerability indicators. Triggers could be improved based on better and more localised underpinning data.

- There is also a need to improve inter-institutional collaboration through regulations, data sharing policies and joint portals, as well as strengthen capacity for disaster response at all levels.

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[204] ADB, 2019. Azerbaijan: Country Digital Development Overview
[205] Based on consultations with NHMS
[206] https://www.adb.org/sites/default/files/institutional-document/484586/aze-digital-development-overview.pdf
[207] Strengthening hydrometeorological and climate services in Azerbaijan. ANNEX C1: Twinning Fiche. Available at: https://www.esteri.it/wp-content/uploads/2022/02/ANNEX-C1-Twinning-Fiche_Hydrometeorological-forecasting-EN-clean.pdf
[208] ADB, 2019. Azerbaijan: Country Digital Development Overview
[209] FAO, 2022. Comprehensive analysis of the disaster risk reduction system for the agricultural sector in Azerbaijan
[210] World Bank & GFDRR, 2019. Public Private Engagement in Hydromet Services

- Private sector could participate in building preparedness and response capabilities through development of insurance products, e.g. weather-based micro-insurance for small farmers, based on better underpinning data. It could also engage in raising awareness, as well as providing training and educational products for communities at risk.[211]

6   CONCLUSION

The main institution responsible for providing hydrometeorological information and climate services in Azerbaijan is the National Hydrometeorology Service (NHMS) under the Ministry of Ecology and Natural Resources (MENR) of the Republic of Azerbaijan. The mandate and duties of NHMS include organization of hydrometeorological observations; and providing factual information, forecasts and warnings about dangerous hydrometeorological events to relevant state bodies, general public, mass media and individuals sectors. Although NHMS executes its mandate to an extent, lack of observational data due to low coverage by weather stations, as well as low capacity for data analysis and local modelling prevent the delivery of high-quality services required by end users.

Multiple needs of climate-sensitive sectors for climate services have been identified across all four pillars of EWS. Addressing those needs requires strengthening the observational network, building capacity for data modeling, analytics and mapping, improving warning dissemination and communication through various channels and strengthening capacity for preparedness and response through better collaboration between stakeholders, training and capacity building, as well as better usage of weather and climate data for disaster risk management and planning.

Participation of the private sector in hydrometeorological services in Azerbaijan is limited due to three main reasons: (1) low quality of services provided by NHMS as a result of multiple factors (lack of observational data; lack of capacity for data analysis, management and exchange with other stakeholders, etc.); (2) lack of enabling environment for private sector engagement (underdeveloped private sector, public-private partnership regulation, data sharing policies, etc.); (3) low awareness among private sector and communities about the benefits of climate services and early warning systems.

Key recommendations and opportunities for creating enabling environment for private sector engagement in climate services that could be implemented as part of the proposed project include: (1) strengthening observational network and improving its resolution; (2) strengthening forecasting and modeling capacity, Quality Management System (QMS) and IT infrastructure; (3) development of a clear framework for private sector engagement and financial strategy for NHMS; (4) strengthening inter-institutional collaboration on data and information exchange; (5) improvement of warning disseminations and communication through engagement of multiple stakeholders; (6) raising overall awareness about the benefits of climate information and early warning systems.

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[211] World Bank & GFDRR, 2019. Public Private Engagement in Hydromet Services