THE REPUBLIC OF AZERBAIJAN

MINISTRY OF ECOLOGY AND NATURAL RESOURCES

TECHNOLOGY NEEDS ASSESSMENT REPORT

ADAPTATION

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Supported by

PREFACE

Azerbaijan ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995, thereby becoming a Non-Annex I Party to the UNFCCC. The First and Second National Communications of Azerbaijan have been accomplished and submitted to the UNFCCC Secretariat identifying sources and amount of GHG emission, current and future climate change scenarios, as well as providing assessment of vulnerability of main economic sectors and potential adaptation measures. Existing analysis indicates that necessary adaptive measures should be taken in order to cope with forecasted consequences of future climate change.

Azerbaijan has already identified development priorities as part of national development strategies, poverty reduction strategies and sector policies. These strategies are reflected in long-term State Programmes such as “State Programme on Renewable and Alternative Sources of Energy (2008–2015)”, “State Programme for the Development of Fuel Energy Complex (2005–2015)”, “State Programme on Reliable Provision of Population of Azerbaijan Republic with Food Products (2008-2015)” and so on.

The current TNA report describes Azerbaijan’s need for adaptation technologies in prioritized economic sectors, taking into account main development priorities. The technology needs prioritized under the current adaptation report will be the basis of the environmentally friendly technology transfer to Azerbaijan, leading to sustainable development of the country[1].

[1] This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP-Risoe Centre (URC) in collaboration with the Asian Institute for Technology (AIT), for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein are a product of the National TNA team, led by the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan.

ACKNOWLEDGMENTS

The Global Technology Needs Assessment (TNA) project, deriving from the window of the Strategic Program on Technology Transfer, is designed to support countries to carry out improved Technology Needs Assessments within the framework of the UNFCCC.

This report is the outcome of a stakeholder-driven Technology Needs Assessment to identify and assess environmentally sound technologies that will, within national development objectives, reduce the impact of climate change in Azerbaijan.

The adaptation TNA report was developed under the coordination of the TNA National Coordinator and the TNA Adaptation Team Leader. They both extend their thanks and appreciation to the Ministry of Ecology and Natural Resources of Azerbaijan that supported this assessment. Special thanks should be given to all ministries, governmental agencies, private sector organizations and involved NGOs that provided significant support for report development, as well as to UNFCCC previous focal point Mrs. Umayra Tagiyeva and current focal point Mr. Issa Aliyev, who both provided valuable advice and suggestions for improvement of the report.

LIST OF ABBREVIATIONS

EST	Environmentally Sound Technology
GEF	Global Environmental Facility
GHG	Greenhouse gas
HES	Hydro-electric stations
MENR	Ministry of Ecology and Natural Resources
MCDA	Multi Criteria Decision Analysis
NABUCCO	new gas bridge from Asia to Europe passing Caspian Sea
NATO	North Atlantic Treaty Organization
NGO	Non-governmental Organization
OSCE	Organization of Security and Cooperation of Europe
OSC	Open Stock Company
PRECIS	Providing Regional Climates for Impact Studies
PSC	Project Steering Committee
TFS	Technological Fact Sheets
TNA	Technological Needs Assessment
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nation Industrial Development Organization
WB	World Bank
WMO	World Meteorological Organization
WP	Work Plan
WWF	World Wildlife Fund

ENDORSEMENT

The identification and prioritization of climate change adaptation technologies, as well as assessing the barriers for technology deployment and developing measures for overcoming those barriers, are important steps for Azerbaijan in developing its climate-resilient strategy.

The global "Technology Needs Assessment" project was funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Program (UNEP) and coordinated by Ministry of Ecology and Natural Resources of Azerbaijan Republic in close collaboration with all relevant ministries, agencies, institutions, non-governmental organizations, private sector and independent experts.

The methodology proposed by the UNEP Risoe Center (Denmark) for conducting the prioritization, barriers analysis and preparation of Technological Action Plans has been adjusted to meet Azerbaijan's county-specific circumstances. This involved a preliminary overview of the technological options and resources, institutional arrangements and stakeholder engagement, as well as establishing criteria for selecting adaptation technologies and defining and selecting the priority sectors and technologies. Furthermore, the main barriers to technology deployment were identified, followed by measures to overcome these barriers and the preparation of concrete actions and project ideas.

National experts involved to the project, working closely with local stakeholders, have provided significant assessments during the prioritization of adaptation technologies, taking into account its contribution to the country's development priorities. The selected adaptation technologies applied to two prioritized sectors: agriculture and water. Current programmes and initiatives of relevant state ministries, agencies and institutions related to prioritized technologies have been taken into account during the preparation of the technology action plan (TAP).

The Ministry of Ecology and Natural Resources strongly believes that the TNA assessments on adaptation technologies will contribute to the development of a climate-resilient strategy in the country, and that the identified actions will be followed and implemented by respective institutions.

More broadly, we hope that the TNA/TAP reports on climate change developed under "The Global Technology Needs Assessment" project will serve as a roadmap for Azerbaijan in fulfilling its obligations under the UNFCCC. Further, the TNA process makes an important contribution to the implementation of countries' sustainable development strategies and, in general, for development of a "green economy".

Husein Bagirov
Minister of Ecology and Natural Resources

Date: 14.01.2013

EXECUTIVE SUMMARY

This report is the outcome of a stakeholder-driven Technology Needs Assessment (TNA) to identify and assess environmentally sound technologies that will, within national development objectives, reduce the impact of climate change in Azerbaijan. The TNA for Azerbaijan was based on First and Second National Communications of Azerbaijan to the United Nations Framework Convention on Climate Change (UNFCCC) and ongoing/implemented State and National programs in this field.

In recent years the economy of the Republic of Azerbaijan has been growing quickly. New technologies are used in the development of various sectors of economy, which prevent a rapidly increasing amount of emissions of greenhouse gases into the atmosphere. In addition, the country successfully implements various actions on the abatement of climate change effects. Therefore, research on the use of alternative energy sources has been conducted through the implementation of demonstrative projects; forests and vegetation cover zones contributing to the removals of carbon dioxide from the atmosphere are expanding.

Rapid development of all sectors of economy in recent years has resulted in an increasingly adverse effect of human activities on the environment and overexploitation of natural resources. Recently in Azerbaijan, as in many other countries, great attention is being given to issues of environmental protection and sustainable use of natural resources.

Azerbaijan has already identified development priorities as part of national development strategies, poverty reduction strategies, sector policies, as well as the Second National Communication to the UNFCCC. Based on these official publications, the National TNA Team has generated a list of development priorities that they consider applicable to the country's sustainable development. Their focus is on both the short and longer term, for the purpose of guiding technology needs assessment. The list of development priorities has been discussed with key stakeholders to identify key development priorities under main clusters: economic, social and environmental.

In order to provide the assessment of vulnerability to climate change, the National Team identified an initial list of sectors, in keeping with the country's development priorities, that was agreed upon by the PSC. Initially identified sectors are water, agriculture, human health, forest, natural disasters and animal husbandry. The National Team has provided assessment of vulnerability of these identified sectors to climate change.

Available information on climate change impacts of the selected priority sectors have been assessed and discussed with stakeholder groups. Taking into account economic, social and environmental development priorities and applying a 0-5 scoring rating scheme, water resources and agriculture have higher scores for prioritization. Therefore, the water and agricultural sector have been identified as priority sectors for adaptation.

As a next step of the TNA process, the National Team prepared an overview of technologies for adaptation. Technologies were categorized in terms of their availability in time and scale of application. This was based on assessment of the country's current experience as well as data from the source, ClimateTechWiki. The National Team of experts has prepared Technological Fact Sheets (TFS) for pre-selected technologies for both sectors.

The assessment of pre-selected technologies was based on their contribution to sustainable development goals and to adaptation, in light of climate change impact scenarios for the country. First, the criteria on which the assessments are based were decided, involving a wider group of stakeholders. The following criteria have been identified to be applied for prioritization of adaptive technologies:

- Contribution to economic development priorities;
- Contribution to social development priorities;
- Contribution to environmental development priorities;
- Implementation availability;
- Potential contribution to reduction of vulnerability to climate change.

The technology performance, or criteria measure, was assessed considering the information already collated in technology fact sheets, available country knowledge and relevant input of experts. Next, the technologies were scored on a scale of 0-100 by a stakeholder group of 11 experts. The highest value of 100 was given to the most priority technology and a 0 point was given to the least preferred technology. This was followed by assessing weights for each criterion, to enable the stakeholders to determine the relative importance of each criterion. The weighting is done after the scoring, because weights can only be given to criteria within the decision-making context.

As a result of the assessment, four priority measures for each sector have been identified.

For water sector:

1) Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments

2) Flood warning

3) Water reclamation and reuse

4) Reducing water leakages in water management facilities

For agricultural sector:

1) Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes

2) Enhance the application of windbreaks

3) Application of water saving technologies, such as drop or spray irrigation, at irrigated lands

4) Application of conservative agricultural technologies

Finally, sensitivity analysis on assessment results was conducted to evaluate the robustness of the results relative to the weights and scores applied and other uncertainties. Analysis provided by experts proved that the four priority measures for each selected sector are priority measures obtained by all the experts, unanimously.

Results of the technology prioritization were presented to the TNA committee by the Adaptation Expert. Prioritized sectors and technologies for both sectors during the TNA process were endorsed by the TNA committee at the meeting held on 25 June 2012.

As next step, the National TNA Team will prepare Technological Action Plans, including barrier analysis for each technology and options to address the barriers, along with a common action plan for all prioritized technologies in the same sector, as well as specific action plan for each technology.

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CHAPTER 1. INTRODUCTION

1.1. About TNA project

Under the current economic condition of Azerbaijan, the identification of technology needs is a very important task in terms of prevention of adverse effects of climate change. This is highlighted by the necessity to efficiently use the natural resources of the country.

The technologies used for the mitigation of climate change impacts and adaptation to climate change must be an Environmentally Sound Technology (EST) and support sustainable development. When identifying the technology needs of a certain country, the assessment of specific technology types is as significant as the consideration of the entire system, which includes aspects such as know-how, production procedures, goods and services, organization and management.

This report is the outcome of a stakeholder-driven Technology Needs Assessment (TNA) to identify and assess environmentally sound technologies that will, within national development objectives, reduce the impact of climate change in Azerbaijan. The process of conducting the TNA was initiated by the National Climate Change Center.

Azerbaijan is undertaking a TNA with respect to climate change and will submit the report of this assessment. Once these technologies have been prioritized and the TNA Synthesis Report has been submitted to the UNFCCC secretariat, developed country Parties can support the transfer and diffusion of technologies identified in the Report. Subsequently, it can be used as a means to meet their obligations of technology transfer with respect to climate change mitigation and adaptation in developing countries.

The TNA for Azerbaijan was based on First and Second National Communications of Azerbaijan to the United Nations Framework Convention on Climate Change (UNFCCC) and ongoing/implemented State and National programs in this field. The main purpose of TNA is to identify, assess and determine priorities and bring to attention the existing requirements of modern technology.

Technological needs of Azerbaijan cover a wide range of issues from reducing greenhouse gas emissions to climate change adaptation. The main technologies are assessed in order to minimize the adverse effects of climate change.

The following aspects are taken into account for creating a framework for the assessment of technology needs:

- Determining the most effective internal mechanisms to support sustainable business and the markets that deliver the necessary information on technological cooperation with international donors;
- Facilitating the funding of projects;
- Encouraging dialogue between stakeholders;
- Strengthening and expanding human resources by identifying their needs for national and regional objectives in the field of technology;
- Establishing a base for promoting non-governmental organizations to actively participate in the process;
- Defining the role of the private sector in the mechanism of transfer and acquisition of technology.

1.2. Country background and climate change policy

The Republic of Azerbaijan ratified the UNFCCC in 1995. In order to facilitate the implementation of the Convention, a State Commission on Climate Change was established in 1997 by a resolution of the President of the Azerbaijan Republic. The Commission was composed of representatives of all related institutions and ministries. In 2000, the Kyoto Protocol was ratified. Under financial support of Global Environmental Facility and UN Development Programme, a project on Initial National Communication of the Republic of Azerbaijan to UNFCCC was developed during the years 1998 to 2000. The Initial National Communication covered the period of 1990-1994.

One of the main alarming issues presently is the global climate change, which might be a cause of adverse social-economic and environmental effects for the world community. The continuing increase in atmospheric concentrations of greenhouse gases have had an unsettling effect on the earth's radiation balance, which has resulted in the rise of annual mean temperature around the globe.

Understanding the importance of this issue, the Republic of Azerbaijan ratified the UNFCCC in 1995 and subsequently joined the Kyoto Protocol in 2000 with a goal of supporting initiatives towards the mitigation of climate change effects.

The Second National Communication of the Republic of Azerbaijan has been prepared as part of commitments under the UNFCCC. The report provides information on national circumstances, the amount of greenhouse gas emissions and sources, analysis of the present and future climate, the assessment of vulnerability of the economic sectors and ecosystems to climate change effects, and adaptation measures to these effects. An assessment of climate change impact on the human health has, for the first time, been presented in the Second National Communication (Second National Communication to UNFCCC, 2010).

The Initial National Communication by the Republic of Azerbaijan was prepared in 1998-2000. At that time, the Republic of Azerbaijan was recovering from the economic crises; difficulties in collecting statistical data and the cessation of operations by a number of plants led to the rise of uncertainties in a wide range of data, particularly in the calculation of the amount of greenhouse gas emissions and evaluation of abatement measures. The occupation of 20% of the country's territory by Armenia also produced uncertainties in some of the data in the report.

In recent years the economy of the Republic of Azerbaijan has been growing quickly. New technologies are used in the development of various sectors of economy, which prevent a rapid increase in the amount of emissions of greenhouse gases into the atmosphere. In addition, the country successfully implements various actions on the abatement of climate change effects.

The Republic of Azerbaijan will continue to contribute to the abatement of climate change effects, which has evolved into a global problem.

1.2.1. National Circumstances

The Republic of Azerbaijan was established on 28 May 1918 and re-gained its independence in 1991. Its area covers 86.6 thousand km^2 and the population constituted 9.11 million people at the beginning of 2011 (www.azstat.org). Presently, the population density is 105 people per km^2.

Azerbaijan is located between 38°25'-41°55' North Latitude and 44°50'-50°51' East Longitude. Its neighbors are Russia, Georgia, Armenia, Turkey and Iran. Its border with Russia in the north stretches 289 km, Georgia borders 340 km of the northwest, Armenia borders 766 km of the west, Turkey borders 11 km of the southwest, and Iran borders 618 km of the south. The eastern part of the country borders 825 km of the Caspian Sea (Second National Communication to UNFCCC, 2010).

The economy of Azerbaijan mainly includes such industries as oil and gas production, chemical and petrochemical, metallurgical, mechanical engineering, textile and food industries and by wheat, cotton, wine, fruit, tobacco, tea, vegetable growing and cattle breeding in the agricultural sector. Main industrial and agricultural products of the country such as, oil and oil products, electrical energy, cotton and silk fibers, wine and other products are exported to a number of countries. The GDP increased from 4718.1 million mantas in 2000, to 50069 million mantas in 2011 (www.azstat.org).

Over 62 oil and natural gas fields are available in Azerbaijan, with 16 of them found in the Azerbaijan part of the Caspian Sea. Contracts have been signed with 11 overseas companies for the exploration of potential fields in the country owned sector of the sea. According to estimations, Azerbaijan's oil reserve is about 10 billion tons and its natural gas reserve is about 8 trillion m^3. Contracts have been signed with international oil companies for joint exploration of Gunashli, Azeri and Chirag fields if the Azerbaijan sector of the sea (Annual Report, SOCAR).

At present, more than half of the national revenue of the Azerbaijan economy is made up of income from the oil industry. The launch of Baku-Tbilisi-Ceyhan oil pipeline, which pumps oil extracted from the Azerbaijan sector of the sea to Europe, plays an important role for the country's economy. This pipeline is expected to transport 40-50 million tons of oil annually. To transport the gas to Europe, Baku-Tbilisi-Arzurum pipeline has been laid and presently prospective NABUCCO gas pipeline project is under consideration.

The role of electric energy is significant in the development of the country's economy. This complex is comprised of thermo and hydro-electric stations (HES) and electric power network. Electricity generation has been increasing for years and in 2011, 20294 million kwh of electricity were produced in Azerbaijan. 13.1 % of all the output was produced by hydroelectric power stations, and 85.3 percent by thermal electrical power stations, with the remainder 1.6% from different sources.

Main products by the chemical industry are sulfuric acids, superphosphate fertilizers, sodium hydroxide, chlorine, aluminum chloride, sulfur, synthetic detergents and bromide. Main products by the petrochemical industry comprise ethanol, synthetic resin, technical rubber products, various tires, plastic, glass fibers and polyethylene. As a result of breach of the integrated raw materials market of the former union, chemical plants have significantly reduced their production since 1990 and some of the areas have been closed down.

Along with the industry sectors mentioned above such areas as metallurgy, mechanical engineering, construction materials industry, light and food industries have also been developed. Total value of industrial products accounted for 31.1 billion mantas (24.3 billion USD) in 2011.

The agricultural sector also plays an important role in the development of economy in the Republic of Azerbaijan. The most significant areas of agriculture are cattle breeding and plant growing. The overall land area of the country is 8.6 million hectares of which 55% is considered fit for cultivation. Crops constitute a significant share in plant growing area.

In addition to the above-mentioned, major areas in agriculture are cow and sheep breeding, and poultry farming. Forestry, fishery and hunting are also well developed in the country. Agriculture, forestry, fishery and hunting products, in total, accounted for 1072.6 million mantas (836.6 million USD) in 2000 and 4383.7 million mantas (3419.3 million USD) in 2011 (Second National Communication to UNFCCC, 2010).

In 2009, about 58% of the country's total land area was used for agricultural purposes, proving the significance of the agricultural sector in Azerbaijan. The most important crops in the country include cereals, cotton, potatoes, grapes, vegetables, fruits (including subtropical), melons, sugar beets, sunflowers, rice, tobacco and tea. Additionally, cucumbers, tomatoes, cabbage and eggplants, and various types of jams are canned. In total, 90% of the crops grown are cereals, the most common of which is wheat. The agricultural outputs with the highest value of production in 2009 were cow milk, wheat, cattle meat, and tomatoes.

Cattle breeding, poultry farming, forestry and fishing are considered well developed aspects of the economy. Animal husbandry provides the population with meat, dairy, and poultry, and provides the industrial sector with wool, fur, rawhide, down, and other materials. Over half of the total income from animal husbandry comes from cattle breeding, which mainly occurs in the Kura-Araz Lowland and in foothill regions. Cows, sheep, and goats encompass the majority of animal husbandry, although buffalo breeding is also important in milk production. Sheep breeding for meat and wool is most prominent in mountainous regions, and poultry farming is becoming increasingly profitable due to its production of meat, eggs, and down.

However, agriculture still faces difficulties; in many regions, precipitation is both inadequate and inconsistent. As a result, roughly 33% of agricultural land is irrigated and it is this land that accounts for more than 80% of Azerbaijan's total agricultural output.

Recently in Azerbaijan, as in many other countries, great attention is being given to issues of environmental protection and rational use of natural resources. With this focus forming the basis of the environmental policy, a number of important laws and regulatory legal documents approximated to the European legislation have been adopted since 1997. However, it was not feasible to resolve environmental problems that had piled up throughout years while Azerbaijan's own resources were in transition. Therefore, priority was given to the development of international, regional and intergovernmental bilateral cooperation. The Republic of Azerbaijan has joined more than 20 international conventions related to environmental issues.

Major environmental issues in the Republic of Azerbaijan are pollution of water resources by wastewater, including effects of trans-boundary pollution, climate change, emission of harmful substances and greenhouse gases from industrial plants and vehicles, improper disposal of solid municipal and industrial wastes including hazardous wastes, depletion of biodiversity, decline in forest resources and fauna (Environment of Azerbaijan, 2005-2007).

Drinking water resources of Azerbaijan are mainly derived from rivers. The major part of these watercourses (69-72%) is formed in Georgia, Armenia, Turkey, Iran and Russian Federation. Presently, the release of untreated wastewater from the territories of Georgia and Armenia into the Kura River adversely affects its hydro-chemical condition and quality of water. Monitoring showed that in recent times considerable concentrations of copper, zinc, phenol and oil products were found in the river water. As a result of the occupation of 20% of Azerbaijan's territory, it has become very difficult to derive precise data on the pollution level of the Kura River Basin. Since these areas are beyond the environmental control, the destruction of natural monuments, ruthless exploitation of natural resources and extreme pollution of water resources can be observed there. Copper-molybdenum and copper-ferrous metal plants located in the territory of Armenia are the main hot spots polluting the Araz River (Rustamov S.G, Kashkay R.M., 1989).

Due to decline in industrial activities since 1990, the level of greenhouse gasses released into the atmosphere from stationary and mobile sources has reduced. While the country's emissions were 71.1 million tons of CO_2 in 1990, in 2008 this figure had reduced to 50.6 million tons of CO_2.

Soil cover has also been faced with environmental problems due to impacts of human activities. As a result of erosion, soil salinity, bogging, chemical pollution and other processes impacting these lands, soil degradation has assumed a large magnitude. Approximately 3.7 million ha of the area of the country has been affected by erosion and 1.2 million ha suffers from salinity. In consequence of mining operations, intensive desertification and other impacts of human activities 30 thousand ha of land, made up of 14 thousand ha contaminated by oil, 108 ha contaminated by chemical wastes, 5571 ha contaminated by sedimentations of irrigation channels, 1580 ha affected by exploration of mineral resources fields, 163 ha contaminated by construction and municipal waste management agencies with the remainder contaminated by mining activities, have been degraded (State Statistics Committee of the Republic of Azerbaijan, 2001).

About 4500 species of higher plants exist in Azerbaijan and 18,000 fauna species are found in the country. As a result of an increasing impact of human activities, the trend of declining biodiversity has been observed. This is mainly triggered by animal husbandry, particularly by a rapid development of sheep breeding which results in unregulated grazing that puts constant pressure on natural vegetation cover. Other causes are, a widely practiced gathering of rare and medicinal herbs by local communities and various companies, recent logging of trees in forests -- especially in mountainous areas due to a shortage of other energy sources, as well as by poaching (Eyubov A.D., Ragimov Kh.Sh., Ulkhanov N.D., 1988).

Forests cover approximately 11% of the area of the country. Due to repercussions of the Armenian aggression, irreversible damage has been caused to the occupied area. Consequently, 250.9 thousand ha of forest are now under occupation and 10.2 thousand ha of forest have been destroyed. Forests in the occupied zone are being ruthlessly logged. The logging of valuable tree types in this area has made the issue of biodiversity protection critical.

Special attention is given by MENR to broaden relations with international organizations and donor organizations in order to tackle environmental challenges. Notably, cooperation is now continuing with UN Development and Environment Programmes, UN Industrial Development Organization, NATO, OSCE, Global Environmental Facility, Organization of Europe for Cooperation and Development, World Bank, Asian Bank, World Wildlife Fund and other agencies. In addition, bilateral cooperation is established with developed countries based on relevant agreements.

1.2.2. Policy and actions

After the collapse of the former Soviet Union, the break-up of all economic links caused significant damage to Azerbaijan's economy and socio-economic indicators fell during 1990 to 1991. In 1999, the economy began to revive and the increase in oil and gas exploration brought about high economic development. The growth in oil exports provided the impetus for the development of economy and a number of areas began to expand.

In recent years, some of the main factors that ensured dynamic development in the country were the allocation of oil revenues to non-oil sectors, infrastructure development projects and the development of regions in a balanced way.

Conversely, the development of the oil sector is considered as one of the main factors affecting the climate change process. A number of international and regional programmes were implemented in Azerbaijan in order to raise the awareness of climate change and capacity building for the implementation of projects.

In 2005 the Ministry of Ecology and Natural Resources was appointed by a resolution of the President of the Republic of Azerbaijan as the National Focal Point for enhancing Azerbaijan's participation in the Clean Development Mechanism of the Kyoto Protocol.

1.2.3. Systematic monitoring and research

In Azerbaijan, similar to any country that is a member of the WMO, observations are conducted, forecasts are made, climate, agro-climate and water resources are assessed and their changing trends are monitored.

Meteorological, agro-meteorological, hydrological and oceanological observations are carried out by the National Hydro-meteorological Department of MENR and environmental pollution monitoring (of soil, water and air) is conducted by the National Monitoring Department of MENR. In addition, State Amelioration and Water Management OSC implements hydrological monitoring of large and small lakes within the country area.

After Azerbaijan joined the WMO and acceded to a number of international conventions it gained the opportunity to take part in various international observation systems. In Azerbaijan, 5 stations are linked to the Global Observing System and 18 stations are part of the Global Climate Observing System. One station in Astara (GJOS/GSN) has access to Global Surface Observation Network.

The meteorological surface observation network of Azerbaijan is composed of 78 stations, of which 12 stations are located in the territory occupied by Armenia and are not in use. Data obtained from observations at the presently operating 58 stations help to provide climate information to the public.

All observations conducted at meteorological stations are based on the best available practice of the WMO.

Some forms of surface observations related to climate change, such as monitoring of CO_2 emissions, increase in biomass, forests, have not yet been introduced in Azerbaijan. However, the existing infrastructure makes it possible to establish such a monitoring system in the future. In order to implement this task, financial, technical and methodological support is required.

With the goal of building capacity in this area, National Programme on Development of Hydrometeorology in the Republic of Azerbaijan was approved by a resolution of the President of the country. The programme outlines prospects of hydro-meteorological service, strengthening capacity of climate monitoring system with regard to climate and climate changes, development of a database on global climate change and related issues for decision makers and the public.

Particular attention is given to the development of monitoring systems and purchase of devices and equipment that meet contemporary needs for bringing monitoring network and quality of mentoring into conformity with the standards.

1.2.4. Education and awareness raising

One of the main, and possibly most important, activities implemented in the area of environmental protection and mitigation of climate change effects is public education and awareness raising activities. Certain work has been, and continues to be, done in this area in Azerbaijan. Since the preparation of the Initial National Communication until now, a number of international institutions, by means of various programmes, have closely participated in education and awareness raising for those employed in the environmental protection sector of Azerbaijan--particularly regarding climate change issues. Programmes delivered by the Canadian International Development Agency to the Caspian littoral States, technical assistance projects by TACIS to the Caucasus countries and Moldova for the implementation of commitments arising from the Kyoto Protocol, can be mentioned here as examples. Outcomes of these projects have been published on the MENR website.

Azerbaijan's educational system includes primary, middle, middle technical, and higher schools; environmental subjects are taught in middle and higher schools. Specialty courses on climate change and scientific basics of climate change are taught at Geographic faculty of the Baku State University. Courses on environment protection are also taught in other universities and institutes, particularly in technical schools.

Recent discussions on the subject of climate change at the higher international level raised an interest in this topic in Azerbaijan. Climate change issues are addressed almost by all means of mass media in the country. Specialists of MENR engaged in this area and NGO representatives were put forward in order to obtain the public's feedback, interesting ideas, and proposed resolutions on the subject.

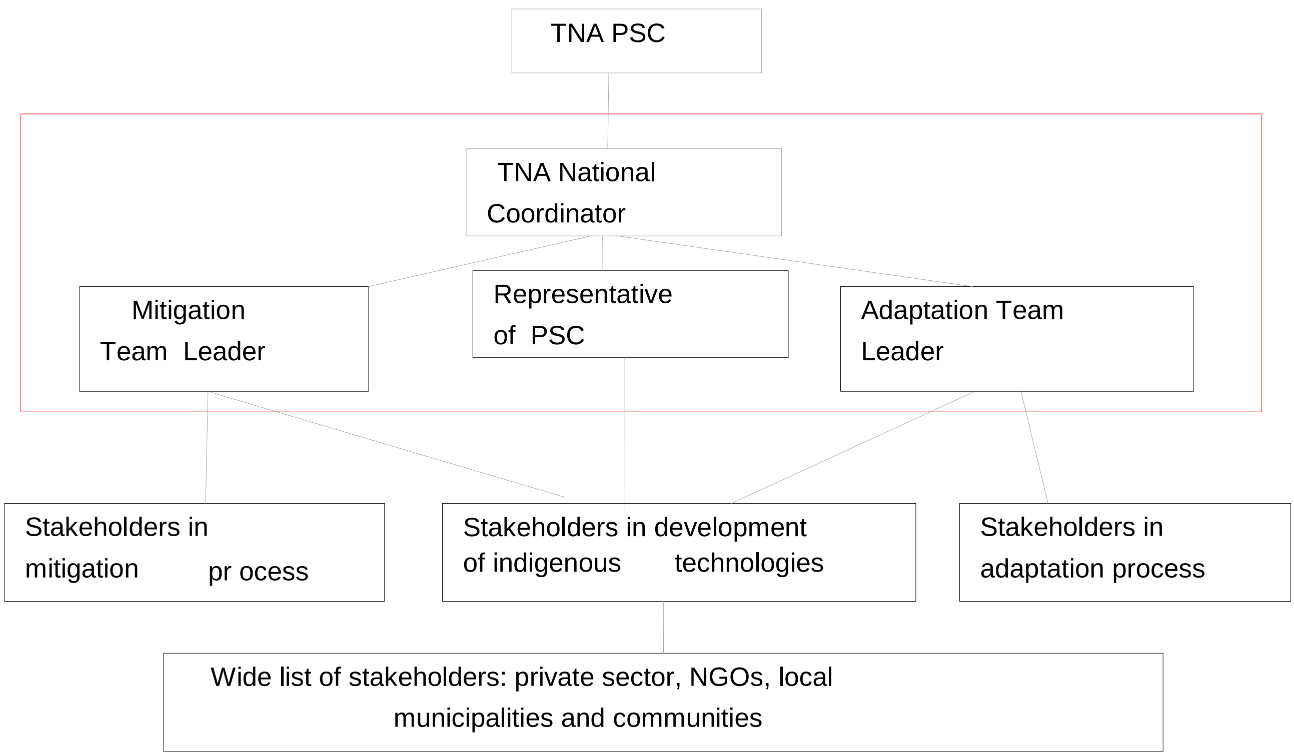
The recent increase of interest in climate change issues in public discussions points to the increasing role that mass media and public institutions role in public education and awareness-raising.

CHAPTER 2. Institutional arrangement for the TNA and the stakeholders involvement

In order to conduct the TNA process the following organizational setup was formed:

- Identification of Ministry responsible for overall process – Ministry of Ecology and Natural Resources (MENR);
- Project Steering Committee formed including members from National Academy of Sciences, Ministry of Agriculture, Ministry of Economic Development, Ministry of Industry and Energy, Ministry of Transport, State Oil Company (SOCAR), Ministry of Health, State Agency on Renewable Energy, State Land and Cartography Committee, Azersu Open Stock Company (OSC), Amelioration and Water Farms (OSC), relevant NGOs and private sector;
- National Team formed involving relevant experts and consultants;
- National stakeholders groups convened regularly for discussion of process and organization of TNA process.

Figure 1: TNA National coordination and participation



A Memorandum of Understanding was signed between the Ministry of Ecology and Natural Resources of Azerbaijan and UNEP Riso Centre in Denmark on 18 July 2011. A TNA National coordinator was appointed in due course.

The Project Steering Committee (PSC) was established. The main responsibilities of the PSC are to monitor the project implementation, to give political and strategic guidance to the team and to make prioritization of sectors for adaptation and mitigation.

Potential stakeholders and experts acting under various climate change related projects have been identified: Ministry of Economic Development, Ministry of Agriculture, Ministry of Energy and Industry, Ministry of Emergency are represented in the PSC and Project Technical Committee.

The first PSC meeting was held in March 2011. Most of the sectors recommended as priority sectors for mitigation and adaptation as well as criteria for prioritization were discussed and agreed upon. The diagram of the TNA National Team structure is attached to this report (Annex 3). The National Team consists of two groups: adaptation and mitigation.

The TNA National Team and PSC are responsible for prioritization of sectors for adaptation and mitigation technologies. The National Team consists of TNA Coordinator, and two Team Leaders for Adaptation and Mitigation. Team Leaders are responsible for leading the experts in prioritization of technologies for each priority sector and preparing TNA reports and Technology Action Plans (TAP). The PSC is responsible for considering the recommendations of the TNA Team and giving approval. The National TNA Team will facilitate active participation of all relevant stakeholders in prioritization of technologies, discussions on barrier analysis and enabling framework development for accelerating technology development, deployment and diffusion, as well as preparing the TAPs. Project stakeholders are continuously consulted by the TNA Team. Team Leaders are in close contact with relevant project stakeholder groups.

All relevant Ministries (MENR, Ministry of Agriculture, Ministry of Economic Development), Agencies, National Academy of Sciences, and some NGO representatives have been identified and included in the PSC. Other relevant NGOs to be involved in the process are identified, and are also communicated with, as well as experts working on technology development. Business sectors interested in getting new technologies will be involved in pilot project preparation process.

Team Leaders for adaptation participated in the regional workshop organized by the project implementing agency (UNEP Riso Centre, Denmark) on 8-11 September 2011 in Bangkok, Thailand.

A national workshop was conducted on 26 December 2011. It was attended by 21 participants from Ministry of Ecology and Natural Resources, Ministry of Industry and Energy, Ministry of Finance, National Academy of Sciences, State Oil Company, NGOs, representatives of private sector and other experts.

Identification of development priorities of countries, sector prioritization and prioritization of pre-selected technologies have been conducted with close involvement of relevant stakeholders. A final prioritization list of adaptive technologies was agreed upon as a result of several discussions conducted with stakeholders, based on developed technological fact sheets using MCDA tools. The final decision was endorsed by PSC.

CHAPTER 3. State of environment and assessment of climate change scenarios

Rapid development of all sectors of economy in recent years has resulted in an increasingly adverse effect of human activities on the environment and overexploitation of natural resources. Recently in Azerbaijan, as in many other countries, great attention is being given to issues of environmental protection and rational use of natural resources

Major environmental challenges facing Azerbaijan could be listed as follows:

- Pollution of water resources by wastewater, including trans-boundary pollution;
- Poor quality level of water supply to human settlements, leakage/loss of drinking water while delivering it to end users, shortage of sewerage lines;
- Air pollution by industrial plants and vehicles;
- Degradation of fertile soil lands (erosion, salinity, etc.);
- Improper disposal of solid industrial and municipal wastes, including hazardous wastes;
- Biodiversity decline, including depletion of forests and fauna;
- Climate change.

3.1. Water resources and their environmental conditions

The river network in Azerbaijan is unevenly distributed over the territory. Along with regions where large and small rivers are densely located there are also areas without permanently running rivers. Kura-Araz Lowland, Gobustan-Absheron region, Ceyranchol, Nakhchivan Lowland are areas where the river network is of the lowest density.

Drinking water in Azerbaijan is mainly sourced from rivers. The greater parts of these rivers (69-72%) form in Georgia, Armenia, Turkey, Iran and Russian Federation.

Azerbaijan is behind other Caucasus countries in terms of the amount of surface water resources per capita and per square km. Of the total amount of water resources in the South Caucasus (310 billion m^3) 62% and 28% belong to Georgia and Armenia, respectively, while Azerbaijan only has the remaining 10%.

Approximately 8.67 billion m^3 of the yearly amount of water resources of Azerbaijan are concentrated in ground water bodies. Ground waters constitute 23% of the total amount of water resources. Presently, only 48.8% of ground waters are used in Azerbaijan.

In 2005, 12.1 billion m^3 of water was drawn from the country’s natural water sources and 8.6 billion m^3 of it was consumed. While there is a shortage of water in Azerbaijan, over one fourth of the drawn water was lost during the delivery. Moreover, 160.5 million m^3 of untreated wastewater were released into water bodies. The shortage of water can also be explained by the failure to sustain water use. Large amounts of water are lost as a result of failure of the water supply network to meet contemporary technical standards (Second National Communication to UNFCCC, 2010).

Unsustainable use of water resources and pollution of water bodies is the consequence of the failure to equip cities, region centers and other human settlements, with adequate sewerage systems and lack of wastewater treatment facilities--taking into consideration that the existing facilities have become obsolete. Untreated industrial and municipal wastewater generated in the large cities significantly contributes to the pollution of water bodies of Azerbaijan.

3.2. State of soil

State of soil varies throughout the country's territory, which is characterized by environmental problems resulting from the impact of human activities. Of the 8.6 million ha of total land, only 49.3% is suitable for agriculture. Soil degradation has assumed a large magnitude of these lands as a result of erosion, salinity, bogging, chemical pollution, etc. One of the factors playing a particular role in this process is erosion (wind, water, gully and irrigation erosion). These factors have affected 3.7 million ha of land area in Azerbaijan, of which 0.7 million ha is intended for agriculture. In addition to natural climate conditions, main causes that contributed to the exposure of soil to this process are, lack of proper land management for a long period of time, low level of cultivation practice, uncontrolled grazing, destruction of forests and vegetation and other human-induced factors.

Approximately 1.2 million ha of the land area is affected by salinity, of which over 600 thousand ha are irrigated lands. Many factors have brought about soil salinity of these lands and led to their withdrawal from the cultivation cycle. Some examples are, poor conditions of drainage network, construction of water impoundments without due consideration of factors such as landscape relief, salinity degree, level of ground waters, inundation of the coastal zone as a result of the rise of the Caspian Sea level, and the rise of ground waters.

Floods affect about 300 km^2 of land area. A particularly dangerous zone encompasses the Great Caucasus chain where floods occurring every other year wash out up to 1 million m^3 of soil and cause great damage to nature.

Until recently, one of the existing environmental challenges in the country was linked to the lack of hazardous waste management. Now a hazardous waste landfill has been constructed and launched to partially resolve the problem.

In consequence of mining operations, intensive desertification and other impacts of human activities, 30 thousand ha of land have been withdrawn from the cultivation cycle. Of this total area, 14 thousand ha are contaminated by oil, 108 ha are contaminated by chemical wastes, 5571 ha are contaminated by sedimentations of irrigation channels, 1580 ha are affected by exploration of mineral resource fields, 163 ha are contaminated by construction and municipal waste management agencies, with the remainder being contaminated by mining activities.

Oil contaminated areas: The use of an outdated technology in oil production for many years has led to the contamination of soil by oil and mineralized water. Presently, the contaminated soil in the Absheron peninsula and surrounding area is 10 thousand ha. These contaminated areas are potential sources of air pollution. Recovery of soil is a costly undertaking in the present economic condition of Azerbaijan.

Currently, a small amount of oil is extracted onshore. According to information provided by SOCAR, a two-phase recovery programme has been prepared for lands affected by oil exploration. In the first phase, the lands (a total area of 2800 ha) that ceased to be used for oil production will be mechanically and biologically remediated and thereafter used for cultivation and grazing. The second phase envisions only technical reclamation of the lands. This type of recovery is used for lands intended for building construction or industries. Mechanical remediation includes the dehydration of artificial lakes and marshes, leveling of the land surface and designation of this area for the disposal of municipal wastes. The World Bank preferentially supports pilot projects envisioning biological remediation.

3.3. Main trends of environmental policy in the area of nature protection

Azerbaijan is a country with rich natural resources and developed branches of industry. However, the country has been greatly polluted as a result of environmental problems that accumulated throughout the years that remained unresolved. Presently, there are a number of environmental challenges that urgently need to be tackled: pollution of water bodies--including the Caspian Sea--by municipal and industrial wastewater, damage caused by the rise of the Caspian Sea level, emission of harmful gases, biodiversity decline, soil erosion and salinity, improper disposal of industrial and municipal wastes, etc.

At the international conference held in Rio de Janeiro in 1992 under the auspices of the United Nations Organization, it was declared that the world's future development would, first and foremost, depend on how environmental issues are resolved. The conference addressed possible solutions to environmental problems currently being faced and adopted important decisions, including the 'sustainable development' concept which has become a programme document for all international environmental institutions. This concept puts harmonizing economic development with environmental balance, giving priority to environmental protection and resolution of environmental issues, at the top of the agenda in order to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. To achieve this, the effectiveness of the economy should be raised and the protection of the environment should be immediately ensured.

As a follow-up to the Rio Conference, the world's development principles were reaffirmed at the World Summit held in Johannesburg in 2002, where the importance of actions required for their implementation was particularly emphasized.

The current environmental condition has forced every country to bring up environmental issues in the global context. Issues of environment protection are now integrated into programme documents of leading international institutions.

At present, Azerbaijan has gained a sufficient amount of success in social and economic development. Ensuring sustainability in social and economic achievements has been adopted by the state as a priority. Environmental strategy of the country is aimed at protecting natural resources at national, regional and international levels. This is done by strengthening coordination of actions in the area of environment protection, applying scientifically grounded development principles, and ensuring a sustainable use of economic and human resources of the country to meet the needs of the present and future generations.

After the Republic of Azerbaijan re-gained its independence and chose a way for further development based on market economy, the national environmental policy assumed a new impetus and started to form. This was done by taking into account environmental issues as a global problem.

Environmental Concept of the Republic of Azerbaijan can be mentioned here as the first document underlying environmental policy of the state based on sustainable development principles. This concept outlined main principles on the resolution of problems that were considered to be significant from the viewpoint of environment protection.

The main goal of the environmental policy implemented in the Republic of Azerbaijan is the protection of the existing ecosystems and the economic potential and sustainable use of natural resources to meet the needs of present and future generations. In order to achieve this goal, elaborate ways to use natural resources and carry out economic development based on sustainability principles are required.

Ensuring environmental sustainability of development requires the elimination and restriction of serious problems arising from industrial activities.

Taking into consideration the present state of the environment and social-economic conditions, three main directions of national policy can be identified:

1. To prioritize environmental safety by applying advanced methods of sustainable development for a maximum reduction of environmental pollutants and regulation of environmental protection;
2. To sustainably use natural resources to meet the needs of present and future generations, using renewable sources of energy, by means of alternative and non-conventional methods, to achieve effectiveness of energy use;

3. To make an assessment of global environmental needs and problems at the national level and meet them by identifying possible solutions and broadening relations with international institutions.

The following principles should be taken as priority to achieve objectives on main directions of the environmental policy:

- Use of contemporary methods of economic and human resources management to improve the quality of the environment;
- Development and introduction of incentive inducing economic models and technologies to meet the needs of present and future generations;
- Implementation of principles of fair distribution of resources among present and future generations;
- Protection of ecosystems and biodiversity that support daily human activities.

Principles:

- Implementation of decision making and consideration of alternatives while taking into account short-term and long-term economic, environmental and social objectives and expected repercussions;
- Wider involvement of representatives of public and non-governmental organizations to decision making process on environmental issues;
- Prevention of any activities which will likely result in irreversible damage to any component of the environment;
- Ensuring the development of a strong multifaceted economy that facilitates the protection of the environment;
- Broadening relations with international institutions and developed countries in the area of environment protection;
- Enhancement of education and public awareness raising.

In 1996 the national environmental policy was presented to the public in a more improved format as part of National Report on a State of the Environment in Azerbaijan. Based on this, National Environmental Action Plan was prepared in 1998 in which priority projects on alarming environmental issues were identified.

The development of a relevant legislative base to European standards, enhancement of the state governance on environment protection, and steady implementation of priority projects by a way of broadening relations with international institutions are all evidence of a successful promotion of the environmental policy.

As social-economic processes are rapidly developing in the country in the transition period, new methodologies and principles emerge in the environmental policy. In this regard, the National Programme on Environmentally Sustainable Social-Economic Development, prepared by MENR and approved by the State President in 2003, has reflected an improved environmental policy and provided opportunities for its application (Climate of Azerbaijan, 1968).

In addition, the enhancement of public awareness raising and increase in curricula hours intended for education in environmental protection in middle schools are also of importance. In recent years, a number of laws on environmental issues adopted by the National Parliament of the Republic of Azerbaijan, including the Law on Public Environmental Education and Awareness Raising, have made it possible to fill gaps in this area.

Further implementation of state programmes and projects aimed at resolving environmental problems and ensuring ecological balance should gradually improve the state of the environment.

3.4. Climate change projections

In the Fourth Assessment Report of Intergovernmental Panel on Climate Change (IPCC), published in 2007, it was stated that observations conducted on all continents and in a number of the oceans showed that many of the natural systems including hydrological cycle and respectively water availability, water quality and water supply, are impacted by human-induced climate change.

Climate change was assessed as the direct or indirect result of human activities. As a result of these activities air composition changes and, in parallel with naturally ongoing climate change, acceleration in this change is also observed.

As is seen from the report, climate change in Europe, Caucasus and Central Asia is likely to bring about high temperatures, droughts and depletion of water resources as well as a decline in the potential of hydro-energy, summer tourism and horticulture.

Countries with economies in transition, as well as the least developed countries, will be impacted by climate change to a larger extent, as they will have a hard time carrying out adaptation measures due to increasing poverty.

One of the important issues is the timely development of a national strategy on adaptation and integration of climate change aspects to joint activities, including relevant national sectors.

One of the main focus areas in climate change is the observation of the change in temperature. Temperature data analyzed by stations of National Hydrometeorology Department of MENR for 1991-2000, as part of climate change assessment, showed that for the period of 10 years the mean temperature rose by 0.41^{0}C. This increase is higher than that of the period 1961-1990 (for the period of 30 years the increase constituted 0.34^{0}C) which means that the increase for the period 1991- 2000 has sped up by three times. This finding is consistent with the results derived from climate modeling (Regional Climate Modeling System, 2002).

Climate Change and Ozone Center of the Department analyzed average annual temperature and precipitation anomaly for the period 1991-2000 in 7 country regions: Kura-Araz, Guba-Khachmaz, Shaki-Zagatala, Ganja-Gazakh, Lankaran-Astara, Nakhchivan and Absheron. Data taken from 28 stations were used for the assessment of average annual temperature and rainfall anomalies.

For the past 10 years the temperature anomaly in **Kura-Araz Lowland** ranged (compared to the level of 1961-90 taken as norm) from -1.12^{0}C (Bilasuvar, 1993) to +1.91^{0}C (Mingachevir, 2000). For the past 10 years temperature anomaly in Kura-Araz Lowland was about +0.49^{0}C.

The temperature anomaly in **Guba-Khachmaz region** ranged from -1.16^{0}C (Guba, 1993) to +1.72^{0}C (Guba, 2000). The average annual temperature anomaly was about +0.48^{0}C.

Shaki-Zagatala region: The temperature anomaly ranged from –1.26^{0}C (Maraza, 1992) to +1.63^{0}C (Oghuz, 1999). For the past 10 years the temperature anomaly in the Shaki-Zagatala region was about +0.48^{0}C.

The temperature anomaly in **Ganja-Gazakh region** ranged from -1.1^{0}C (Gadabay, 1993) to +1.84^{0}C (Ganja, 1998). For the past 10 years the temperature difference from the norm level at stations was about +0.74^{0}C.

According to data taken from stations in **the Southern region** the temperature anomaly ranged from -1.08^{0}C (Astara, 1993) to +1.37^{0}C (Goytapa, 1998). For the past 10 years the temperature anomaly was about +0.43^0 C.

According to data taken from stations in **Nakhchivan,** the temperature anomaly ranged from –2.07°C (Nakhchivan, 1993) to +1.78°C (Ordubad, 2000). For the past 10 years the temperature anomaly was about +0.47^0 C.

For the past 10 years the rise above the norm in the average annual temperature was observed throughout Azerbaijan after 1995 and a drastic increase took place in 1998-2000. The highest level was observed in 1998.

For the past 10 years the average annual **rainfall** level was below the norm by 14.3% in Kura-Araz Lowland, by 2.6% in Guba-Khachmaz region, by 6.4% in Shaki-Zagatala region, by 17.7% in Ganja-Gazakh, by 17.1% in Nakhchivan and by 1.2% in the Southern region.

In summary, for the past 10 years the rainfall level in the country area reduced by 9.9%.

3.5. Climate scenario

The climate scenario was prepared based on «PRECIS 1.4» (**P**roviding **RE**gional **C**limates for **I**mpact **S**tudies) modeling system developed by Great Britain's Meteorology Office Hadley Centre for Climate Change.

Based on the current Global Circulation Models, IPCC recommendations and Hadley Centre developments, and following discussions on boundary conditions on PRECIS modeling system among the countries of the region (Turkey, Georgia, Azerbaijan, Armenia), an option for Azerbaijan with different emissions scenarios was determined. The present ECHAM4 data was selected as boundary conditions for the period 1960-2100 according to A2 scenario of atmospheric and oceanic General Circulation Model developed by Max-Planck-Institute. An assessment was made for 3 periods based on these boundary conditions:

- First period covering years 1960-1990 plays the role of a baseline climate year;
- Second period is a scenario period and covers the years 2020-2050;
- Third scenario period covers years 2070-2100.

For the first time, as a result of the assessment, data widely characterizing past and future climate was obtained. The data was analyzed by means of special visualization systems (XCONV, VCDAT, IDV, GRADS, etc.).

In the IPCC's Special Report on Emissions Scenarios, emissions scenarios were accepted in a declining order as A1FI, A2, B2 and B1. Emissions scenarios were primarily developed with relevance to demography, economy, technology, energy, and agricultural development (Figure 2). According to the emissions scenario, if CO_2 emissions increase at twice the rate, the global temperature will rise from 2^0C to 5^0C. Previous research showed that due to its geographical position the mean temperature increase in Azerbaijan will be almost equal to the global temperature rise (Second National Communication to UNFCCC, 2010).

3.5.1. Climate of the baseline 1961-1990 period and verification of the model

The verification of the model was made based on data for the period 1961-1990. The distribution of temperature in the region during this period is quite authentically calculated by the model. Due to altitude, a decrease in temperature is observed in the Great Caucasus, Lesser Caucasus and Talish Mountains. In higher mountain zones the temperature falls to -2^0C and -5^0C. In lowlands the temperature is 14^0C to 16^0C, which is consistent with observations. However, in some areas even higher temperature levels are observed. This is explicable by model calculations. The verification of the model in the region was made based on CRU (Climatic Research Unit, //www.cru.uea.ac.uk./cru/data) data as recommended by the Hadley Centre.

The difference between CRU data and information about the country and Caucasus, as a whole, varies from -0.5^0C to $+1.5^0$C. This means that the PRECİS model produces slightly higher temperatures than what is observed in reality within the country's boundary conditions. This difference is greater in the eastern coast of the Caspian Sea (–3^0C - +4^0C). In Absheron, which is the eastern part of the country, Central lowland areas and partially in Ganja-Gazakh zone, the temperature difference compared to data produced by modeling constitutes +1.5^0C. The difference in other parts of the country constitutes 0.5^0C. These differences were taken into account while developing climate scenarios.

The distribution of rainfall almost matches the model data. The lowest precipitation level is observed in Absheron-Gobustan and Nakhchivan AR. Rainfall increases in mountainous and foothill regions. The maximum level of rainfall is observed in Lankaran-Astara zone and southern slopes of the Great Caucasus. The quantitative data for precipitation is consistent with climate data. For example, the level of rainfall is 300 mm in Absheron-Gobustan zone. In lowland areas it varies between 300 and 600 mm. In the Great Caucasus the rainfall level is considerably higher than the norm (1500-1800 mm). In Talish zone the rainfall level is very low. Rainfall in Lankaran-Astara zone was not taken into account. In other areas the distribution of rainfall is consistent with what is observed in reality.

In summary, the climate of the baseline period (1961-1990) was quite accurately simulated by the PRECIS model.

3.5.2. Climate scenario for 2021-2050

According to emissions scenario and boundary conditions of the PRECİS model the average annual temperature increase in 2021-2050 constitutes about 1.5^0C-1.6^0C. In the coastal zone and the western part of Nakhchivan AR the increase constitutes 1.7^0C. According to the results, the temperature increase in the first half of the century might be approximately 0.3^0C for every 10 years. The actual temperature rise in Azerbaijan from 1990-2000 was about 0.4^0C. This demonstrates that data provided by the model is consistent with information on climate change in the region.

Rainfall in 2021-2050 will increase by 10-20% compared to the period 1961-1990. During this period, the increase constitutes 0-10% in Nakhchivan AR and rises by 20% in the eastern part of the country. No decrease in rainfall takes place in the Kura-Araz Basin.

According to this scenario, the difference between rainfall and potential evaporation within the scenario period will increase from 0.4 mm to 1.2 mm per day compared to the baseline period. This can be applied to the entire Kura-Araz Basin. During this period no decrease in water supply takes place. On the contrary, it increases. In the event that other scenarios prove the same, it can be accepted as a positive factor. However, this factor changes towards the end of the century, when the difference increases leading up to the year 2050 and starts to decrease afterwards. The rise in evaporation increasingly speeds up.

3.5.3. Climate scenario for 2071-2100

According to simulation results using the PRECİS model, the temperature rise simulated for 2071-2100 will be 3^0C-6^0C, while in most parts of the country's area it rises by 5^0C compared to temperatures in 1961-1990. In Nakhchivan AR the rise is even higher and constitutes 5.4^0C–5.7^0C.

Maximum temperatures rise by 2^0C-7^0C. Therefore, if at present the maximum temperatures equate to 44^0C-46^0C during the period in question it might accordingly be 47^0C-53^0C.

The level of rainfall in the country area increases from west to east by 20% to 80%. Only in Nakhchivan AR the level of rainfall is forecasted to fall by 20%. The authenticity of the rainfall increase model in the Caspian Sea and its surrounding regions, with data on the rainfall raises some doubts. Therefore, other boundary conditions should necessarily be applied to the rainfall scenario.

One of the interesting results produced by the PRECİS model is the difference between rainfall and potential evaporation. The difference between rainfall and potential evaporation during the scenario period significantly decreases in Azerbaijan. Despite the fact that the rainfall level rises by 20-80%, evaporation increases at a higher degree and in the end water supply in the area declines by 0.2 mm-

0.5 mm per day. This, in turn, will result in an increasing need for irrigation (Climate of Azerbaijan, 1968).

Priority needs for capacity development in the systematical climate observations system:

It should be mentioned that in order to provide quick reaction and apply proper technology for adaptive measures in water and agricultural sectors, there must be access to timely and proper long-term forecast on climate (data on air temperatures and precipitation volumes). For this to happen, there need to be systematical climate change monitoring data, which requires contemporary national climate monitoring system. This includes meteorological, agro-meteorological, aerological, as well hydrological monitoring. Priority needs for capacity development in the systematical climate observations system is provided in the table below.

Table 1: Priority needs for capacity development in the systematical climate observations system

Type of observation	Type of activity	Needs
Meteorological observations	- monitoring stations - data collection, processing and management	Technical modernization and provision of stations with standard equipment, introduction of modern telecommunication system for data collection and exchange; automatic control of operative data; improvement of existing and development and introduction of modern database and data management system.
Aerology	- monitoring stations - remote methods - data collection, processing and storage	Technical modernization of radio-sensing stations, introduction of modern system for data collection, automated control, processing and archiving.
Agro-meteorology	- monitoring system - remote methods - data collection and processing	Modern equipment, enhancement of existing monitoring scale with regards to climatic program needs, introduction of remote agro-meteorological observation methods.
Hydrological observations	- monitoring network - data collection and processing	Introduction of modern system for data collection, automated control, processing and archiving.
Aero-spatial observations	- hydro-meteorological and - environmental monitoring	Receipt and processing of digital satellite information; personnel training; technology.
Improvement of scientific and technical capacity	- monitoring network - equipment and technology - data processing and exchange - solution of scientific and applied objectives	Training and re-training of personnel on the basis of scientific and technical progress achieved.

CHAPTER 4. Assessment of vulnerability and sector prioritization

4.1. Country development priorities in light of climate change

The National TNA Team, in close cooperation with core stakeholders, has assessed current development priorities of the country.

Azerbaijan has already identified development priorities as part of national development strategies, poverty reduction strategies, sector policies, as well as the Second National Communication to the UNFCCC. Based on these official publications, the National TNA Team has generated a list of development priorities that they consider applicable to the country's sustainable development. Their focus is on both the short and longer term, for the purpose of guiding technology needs assessment.

The list of development priorities has been discussed with key stakeholders to identify key development priorities under main clusters: economic, social and environmental. Final lists of development priorities have been discussed and agreed upon at the national workshop and are identified as follows:

Economic:

- Sustainable development;
- Energy security;
- Low-carbon development in energy sector;
- Development of infrastructure;
- Tourism development;
- Use of modern agriculture technology to provide food security.

Social:

- Poverty reduction;
- Improvement of water and sanitation system in regions of country;
- Reduction of unemployment;
- Public participation and awareness raising;
- Reduction of child mortality and infectious diseases;
- Food security.

Environmental:

- Conservation and effective use of natural resources;
- Reduction of natural disasters;
- Water pollution prevention;
- Biodiversity protection;
- Atmosphere air protection;
- Prevention of soil degradation, including cleaning of soils polluted by oil and other products;
- Reduction in solid industrial and household wastes;
- Protection of forests;
- Combating desertification.

4.2. Sector prioritization

For sector prioritization, a long list of main sectors most vulnerable to climate change was prepared by the adaptation expert, based on the results of assessments provided in the Second National Communication in keeping with the country's development priorities. The following sectors have been included to the initial list of the sectors most vulnerable to climate change:

- Water Resources
- Agriculture
- Forest
- Human health
- Natural disasters
- Animal husbandry

After approval of the initial list of sectors by the PSC, the adaptation expert provided assessment of vulnerability to climate change in the above-mentioned sectors.

Available information on climate change impacts of selected priority sectors have been assessed and discussed with stakeholder groups. Taking into account economic, social and environmental development priorities, the following rating scheme has been applied for sector prioritization:

0 — no benefit

1 — faintly desirable

2 — fairly desirable

3 — moderately desirable

4 — very desirable

5 — extremely desirable

As a result, the below performance matrix for prioritizing has been identified using MCA method:

Table 2: Sector prioritization

Sectors	Economic priorities	Social priorities	Environment priorities	Total benefit
Water Resources	4	5	4	13
Agriculture	5	5	4	14
Forest	3	3	5	11
Human health	3	5	3	11
Natural disasters	4	4	4	12
Animal husbandry	4	3	2	9

As can be seen in the table, agriculture and water resources have higher scores for prioritization. Most experts have given highest scores to the agricultural sector considering the importance of the sector within the context of vulnerability to climate change and compliance with economic and social development priorities. Taking into account the negative impact of forecasted climate change to agricultural production, applying adaptive technologies is becoming more important in order to achieve food security in the country. The next sector with the highest score, water resources, was considered an important sector in need of adaptive technologies taking into account social and economic, as well as environmental priorities in the country.

Therefore, the following sectors have been identified as priority sectors for adaptation: Water resources and Agricultural sector.

4.3. Vulnerability assessment to climate change of selected sectors

Below, information is provided on vulnerability assessment to climate change of the 2 prioritized sectors: water and agriculture.

4.3.1. Water sector

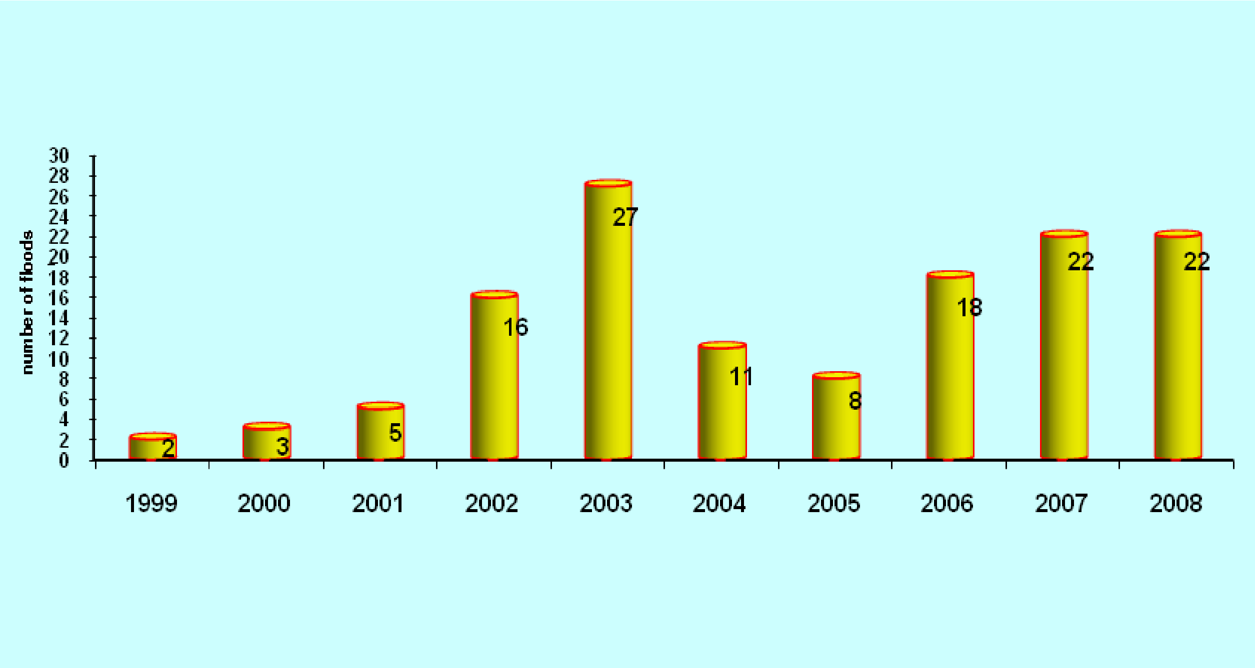
State of water resources

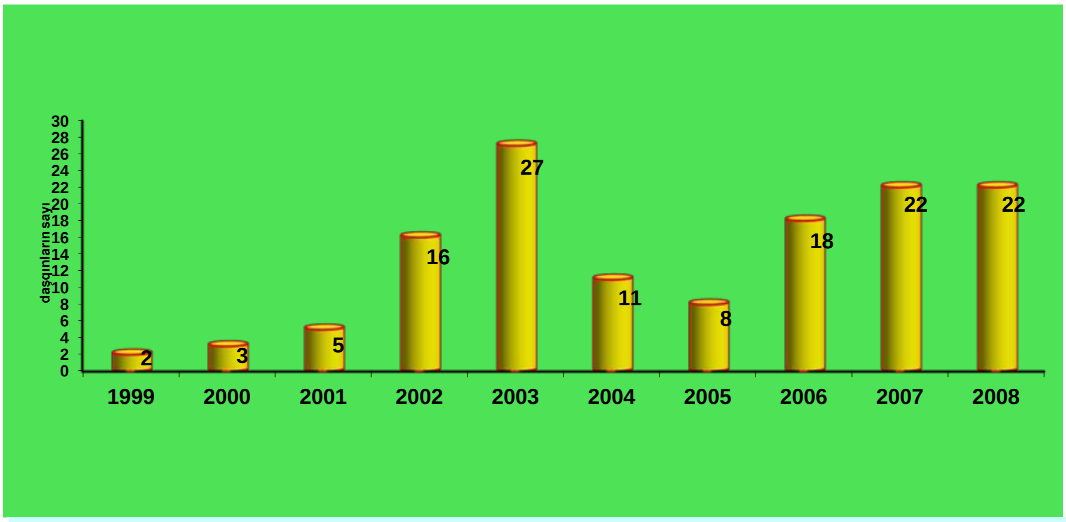
Water resources of the country constitute about 39 km^3. Approximately 29.3 km^3 of that is surface water, 8.8 km^3 is ground water and 0.06-0.08 km^3 is the water contained in glaciers. Although surface waters are now widely used for various purposes, the potential of ground waters is not yet used to a large extent. In addition, various lakes found in the country, water impoundments regulating water between high and low water seasons, and glaciers can all play an important role in the resolution of water supply issues. This is particularly significant in the elimination of water crises, which is likely to occur as a result of an increasing demand for water and climate change effects. These additional factors should become part of adaptation measures.

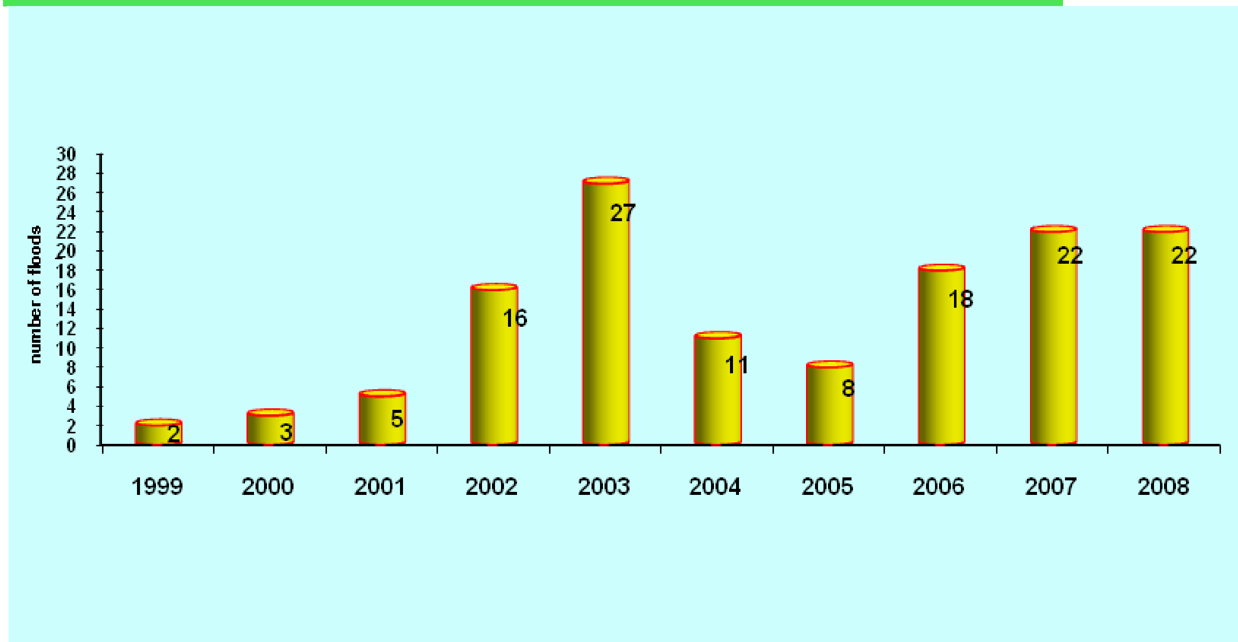
Surface waters: Between 25-30% of the country's surface water resources are formed within the territory of the country. In Azerbaijan the share of water resources per km^2 is about 85-100 thousand m^3 which by making 1000 m^3 per capita per year places Azerbaijan among countries with the lowest levels of water resources.

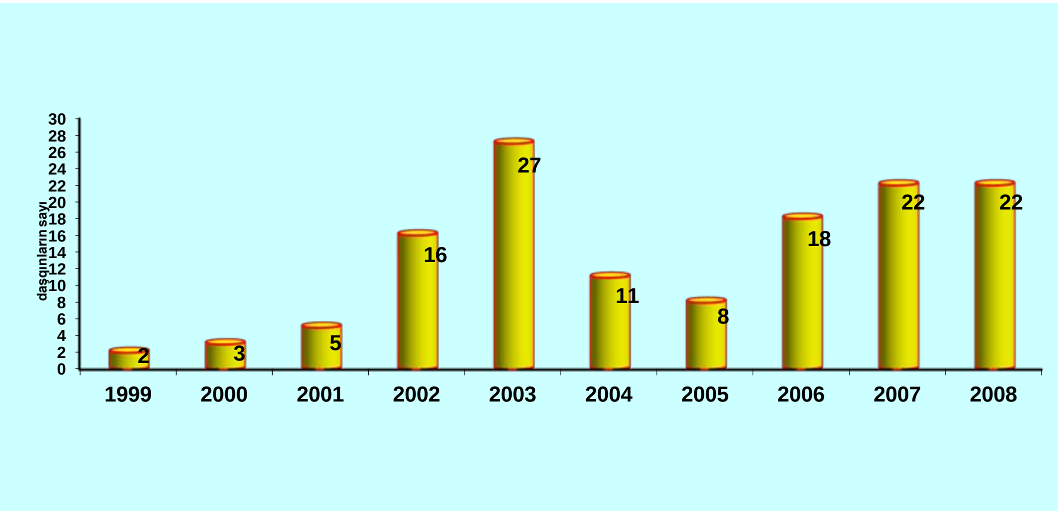
Water resources play an important role in the country's economy. For agriculture, alone, 10-12 km^3 of water is annually drawn from the rivers for irrigation. In most parts of the country, shortage of water resources and its uneven distribution, by seasons and over the country's area, causes problems of water use. During the plants' vegetation period the annual water flow of rivers falls by 5-20% depending on the region. By contrast, while water shortfall is observed during low water seasons, in high water seasons cases of inundations and flash floods take place. In recent years there has been a growing trend in the number of these disasters (Figure 2).

Figure 2: Trend of floods in 1999-2008









After 1993, the rise of ground waters, which are in direct dependence of the fluctuations of the Caspian Sea level, were the cause of the inundation of surrounding areas during the Kura River flood season--encompassing a distance of 200 km from the stream bed. As a result of floods, villages of Salyan, Neftchala, Sabirabad regions located along the river-bank and riparian areas of Shirvan, are subject to regular inundations. Consequently, serious damage is caused to large industries of national importance, farming facilities, gardens and housing.

The territory of Azerbaijan falls under the category of regions where floods take place more frequently. The formations of floods take place more intensively in the Great and Lesser Caucasus mountain systems, which occupy about half of the country's area. Floods mainly occur in the southern slope of the Great Caucasus and high mountainous zone of Nakhchivan AR. Floods cost the country's economy an estimated 18-25 million US dollars in damages, annually. The upcoming climate change is expected to cause serious hardships as a result of the increasing rate of inundations and floods.

Glaciers: Main glacial areas in Azerbaijan are located in the Gusarchay Basin in the Great Caucasus. Studies indicate that in the past 110 years, the area of glaciers decreased from 4.9 km^2 to 2.4 km^2 and their lower boundaries are 3500 m above the sea level on average.

Ground waters are formed in foothill areas of the Great and Lesser Caucasus and lowland areas, Nakhchivan AR and Talish zone and constitute 24 million m^3 per day (8.8 km^3 per year). Presently, only 5 million m^3 per day or 20% of the total resources are used. This points to the possibility of a wide use of ground water potential in the country during low water seasons.

Climate change impact on water resources

Vulnerability of water resources to the upcoming climate change, as shown in the Initial National Communication, was simulated for 2021-2050 and 2071-2100 based on recently updated statistic models. These simulations reflected the dependence of river flows on meteorological factors and the accepted PRECİS 1.4 climate change model. Findings show that natural water resources gradually diminish and water shortage occurs in the country and that this trend will continue in the future. It is obvious that current water shortage occurs mainly as a result of water leakages in water distribution systems. If these leakages are not prevented the situation might be aggravated in the future. According to the simulated data, the volume of natural water resources won't change significantly as the reduction of water resources in the Araz River Basin will be compensated with the increase in the rivers directly flowing into the Caspian Sea, which are located in the eastern part of the country. In 2071-2100 water resources will be reduced by 10% and make up 26.3 km^3. The level of water shortage will make up 4.0 km^3 in the first period and 10.3 km^3 in the second, which is 1.5-3.0 times as high as the level of the baseline period. The reduction of the share of water per capita will significantly worsen water supply for the population, which is expected to grow by 1.5-2.0 times.

It should be noted that the increase of precipitation during 2021-2050 and 2071-2100 by the PRECIS 1.4 model (particularly in the east of the country) seems to be unconvincing. That is why it is necessary to consider this in tandem with the other models indicating 15-20% reduction of water resources. This is also seen from the results of the analysis of the long-term trends of precipitation and run-off, carried out by the specialists in the region (Second National Communication to UNFCCC, 2010).

4.3.2. Agricultural sector

Assessment of agro-climate resources

Of the total 8.6 million ha of land area in Azerbaijan, 4.756 million ha or 55% are suitable for agriculture. Of the latter, 1,796 million ha are under crops, 221 thousand ha are under perennial plants and 2,694 ha are under sown pastures and grasses. About 30% of lands in agricultural use (1,429 ha) are watered. Cereals constitute 90% of crops and 50% of perennial plants are grown in gardens.

Agriculture is the sector of economy most dependent on climate conditions. A slight change in climate conditions makes a considerable impact on agricultural production.

Located in the northern end of a subtropical zone, the majority of Azerbaijan's territory is characterized by high warming resources, mild winter conditions, moisture shortage in the summer, and continuous droughts. Of the total 11 main types of climate, 8 types are found in Azerbaijan - from semi-desert and dry land climate extending into lowlands and foothill areas to mountain tundra climate in high mountainous zones (State Statistics Committee of the Republic of Azerbaijan, 2001).

It is known that the climate makes its impact on agriculture by means of agro-climatic conditions and resources of the areas. Therefore, it is important to make assessments of their upcoming change. Agro-climate data calculated based on scenarios of the baseline year (1961-1990) used GİSS, GFDL-3 and expert scenarios that were thoroughly reviewed in the Initial National Communication. In the present report main agro-climate data simulated by PRECİS 1.4 model and climate change scenarios developed for 2021-2050 and 2071-2100 have been considered. During the assessment of climate change impact on the productivity of agricultural plants, probable future varieties change has not been taken into consideration.

Warming resources: It is forecasted that in 2021-2050 the total of daily mean temperatures above 10^0C will rise by 100-700% in comparison with the baseline period, and the overall duration of such days will extend by 10 to 35 days. Similar to temperature totals the highest rise will be observed in the middle and higher mountainous zones of the Great Caucasus.

In 2071-2100 the total of daily mean temperatures over 10^0C might rise by 1100-1500% in comparison with the baseline period, and the overall duration of such days will extend by 25 to 80 days. The rise might be observed in almost every part of the country during this period.

As a result of these changes warm weather zone might move up by 150-300 m and a further 450-950 m towards mountains in the first and second periods, respectively.

Moisture resources: Azerbaijan is known as a country with significant warming resources. However, insufficient level of precipitation and its uneven distribution during the year cause considerable problems to agriculture. As a result, 85-90% of agricultural products are grown on irrigated lands. Therefore, certain corrections were made to the scenarios in view of the agricultural sector's vulnerability to moisture conditions, taking into account uncertainties arising from the application of scenarios developed based on PRECİS 1.4 model.

Consequently, an expert scenario, which was prepared by Azerbaijan climatologists and presented in the Initial National Communication as an artificial scenario for 2021-2050, best reflects the upcoming evaporation potential.

Based on the above, it can be concluded that the forecasted evaporation in 2021-2050 will rise by 15% from the baseline year level. However, in consequence of a simultaneous rise in rainfalls by 10-20%, a shortage of humidity experienced by plants during the vegetation period (climatic water balance) can be reduced by 85 to 260 mm as compared to the baseline year.

In 2071-2100 the level of precipitation is forecasted to rise by 20-40% in most of the irrigated areas of the country while in Nakhchivan AR the rise will account for 10-20%. During the assessment of climate change impact on agriculture the rise in the level of rainfall in the coastal zone can be taken at a rate not exceeding 40%. During this period, taking into account the rise in air temperature and corresponding rise of evaporation potential, the amount of annual watering norm accepted in the country will increase by 40-180 mm and during the vegetation period it will increase by 20-100 mm compared to the baseline period level.

Assessment of impact on agricultural lands and adaptation measures

Cotton: Cotton is one of the primary agricultural plants of the country. However, in recent years lands under cotton cultivation diminished considerably. For example, the area of cotton plantations diminished by 3 times in 2006 compared to 1985 and constituted 102.8 thousand ha. The productivity fell by twice the level of 1985 and accounted for 13 quintals per ha.

According to emissions scenario and boundary conditions of PRECİS model the average annual temperature increase in 2021-2050 constitutes about 1.5^0C-1.6^0C. An increase in temperature during the growing period may extend agricultural productivity, having a favorable impact on this area. Thus, presently cultivated medium-ripening varieties can be replaced with better quality late-ripening long fiber ones. The decrease in moisture shortage during the vegetation period might contribute to productivity growth.

According to simulation results using the PRECİS model, the temperature rise simulated for 2071-2100 will be 3^0C–6^0C while in most parts of the country's area it will rise by 5^0C, compared to temperatures in 1961-1990. In 2071-2100 there is a probability of increase in the growing season for cotton plantation regions of the country. This increase is 1200-1350% higher than the baseline period. The above increase will provide optimal conditions for the cultivation of heat tolerant, late ripening and more valuable cotton varieties. While planning a location for cotton plantation it should be taken into consideration that a 40% increase in precipitation level is forecasted in the southern part of Kura-Araz Lowland and if part of it coincides with the product's ripening period this will result in its loss. As is mentioned above, moisture shortage will increase during this period and in order to gather a good and high quality yield the plants should be watered at an optimal level. The productivity of cotton plantations is expected to grow by 4-5% compared to the first period (Second National Communication to UNFCCC, 2010).

It should be noted that the current low productivity level is linked more to social-economic factors than natural factors, including climate change. Presently, only a small group of farmers are capable of using, to a sufficient extent, such production facilities as fertilizers, high quality seeds, chemical substances, adequately heavy plant and equipment. In addition, in most of the areas soil conditions and water supply are unsatisfactory. Moreover, low market prices for cotton decreases the interest of farmers in the cultivation of this plant. If these bottlenecks are eliminated the country's climate conditions will contribute to the development of highly productive cotton growing.

In general, climate conditions for cotton cultivation are favorable and allow increasing production by using more valuable late-ripening species. However, the possibility of precipitation during the period of ripening should be considered when laying out cotton fields. Therefore, due to possible harvest loss or its degradation, cotton growing should be limited. It is important to note that the issue of increase or decrease of cotton production depends not only on natural factors but also, to a greater extent, on socio-economic factors.

Winter wheat: In 2021-2050 the duration of a plant's potential vegetation (with air temperature above 5^0C threshold) in conventional areas of cereals growing will extend due to global warming and the actual plants' vegetation will shorten by 10-15 days. Subsequently, this will make it possible to grow cereals in a wider area. Conversely, an early harvest of wheat in conventional areas of cereals growing followed by another sowing (forage, melons and water melons, greens, etc.) will make it possible to gather harvests 2-3 times a year, thereby contributing to raising productivity of crops growing.

In 2071-2100 both warming resources and duration of the potential vegetation of cereals growing will decrease compared to the preceding period. During this period the duration of the actual plants' vegetation might shorten by an additional 20-25 days.

While during the baseline period warming resources met cereals growing needs in mountains at heights of 1600-1800 m, in the future, due to climate change, it will become possible to grow wheat at even higher zones. However, the expansion of wheat lands towards mountains will not be considerable due to limited availability of suitable lands in these areas.

Similar to the first period, in this period a subsequent sowing after wheat harvest might significantly raise effectiveness of horticulture.

In 2021-2050 the borders of vineyards of industrial importance can, dependent on region, move up from the present 800-900 m elevation another 200-450 m toward the mountains. In 2071-2100 favorable conditions for plants can be available in even higher zones (1400-1700 m above the sea).

Grape production: Although in the baseline period the upper boundary of vineyards went through heights of 1100-1300 m, in accordance with thermal conditions of vegetation the mass of industrially significant vineyards were located at heights of 800-900 m. During both future periods, global warming will provide conditions for vineyards to expand towards mountains.

In 2021-2050 the borders of vineyards of industrial importance might, dependent on region, move up an additional 200-450 m towards mountains.

In 2071-2100 favorable conditions for plants can be available in even higher zones (1400-1700 m above the sea). However, due to unavailability of spacious and suitable lands for vine growing at those heights, its spreading in these areas is unlikely.

In both the 2021-2050 and 2071-2100 periods the rise in harvest on fallow vineyards by 4-5 times and by 10%, respectively, is forecasted. It can be assumed that the level of sugar in grape juice would be higher by 2-3% in the first period and increase by 6-7% in the second period. In both of these periods a slight rise of up to 1% in the level of acid in grape juice is expected to take place.

Winter pastures: Despite the fact that the upcoming climate change will be quite favorable for winter pastures their area will not expand, but might even diminish. This will be mainly caused by soil erosion and an increasing use of lands for crops growing. At present, the productivity of winter pastures in the country is dependent on natural moisture level. Therefore, future productivity has also been evaluated from the viewpoint of its change under the effect of the forecasted precipitation level.

In both periods, as a result of increase in rainfall, there might be some rise in the productivity of winter pastures both in winter and spring grazing.

Despite the fact that the level of rainfall in the second period will be higher, due to an increased moisture deficit the growth in productivity will not be higher than that of the first period and will constitute 2-3% in both periods. The increase is also expected in spring grazing. As a result of temperature rise, the number of non-grazing days in 2021-2050 will fall to zero and only in areas with relatively cold winters they will shorten by 5-15 days--compared to the baseline level where their number will vary between 15-35 days. In 2071-2100 the number of non-grazing days will shorten and constitute no more than 5-15 days.

Summer pastures: In both periods, as a result of global warming the area of pastures might expand. However, due to limited availability of suitable lands in these areas this will not assume a large magnitude. The expected rise in rainfall level in these areas with humidity, and in some parts extremely humid conditions, will have little effect on productivity growth. However, if anthropogenic pressure is not reduced, erosion processes observed there would be more intensive as a result of rise in rainfall level.

CHAPTER 5. Technology prioritization for water sector

As a next step of the TNA process, an overview of technologies for adaptation was provided. Technologies were categorized in terms of their availability in time and scale of application. For this, assessment of current country experience was provided, as well as the data source of ClimateTechWiki.

Similar to the present time, in the future hydro-energy and water supply will continue to be the most vulnerable areas:

- As a result of water shortage, taking current watering standards as the basis, water scarcity will be expected in the area of 250-300 thousand ha and might result in the fall of yield;
- Expected decline in river flows might reduce energy production at HESs by 20%;
- Increasing drinking water shortage will be more intensive in the target periods and at that time the share of water per capita will reduce by 1.5 times and constitute 650m^3 accordingly. The pollution of available water resources will aggravate the situation.

Water resources, already under pressure as a result of growing water demand in relation to a finite supply, will be under even greater pressure in the future as a result of climate change. This is a result of three factors: the projected decrease in rainfall, increased evaporation resulting from higher temperatures, and the amplifying effect that the hydrological cycle has on climate change.

Adaptation will principally involve changes in water allocation, from uses that generate less economic or social value per unit of water consumed to uses that generate more. Therefore, all sectors that use water will be under pressure to be more water efficient, especially irrigation in agriculture.

Improvements in irrigation efficiency are particularly important, as the irrigation sector still has the largest use of water. Soil moisture conservation technology, such as use of surface mulches, could be used to compliment traditional irrigation efficiency technologies. This technology is linked to no-till technology that has the advantage of improving soil carbon storage.

In order to mitigate adverse effects of the upcoming climate change, the following long-list of adaptation measures has been proposed by the adaptation expert and approved by PSC.

Table 3: Possible adaptation technologies for water sector

Sector	Technology	Scale of application	Short, medium/long term availability
Water	Construction of water reservoirs of complex destination and increase of efficiency of the existing water reservoirs	Large-scale	Long-term
	Use of water-saving technologies in water consumption system	Large-scale	Long-term
	Improvement of the water resources management system	Large-scale	Medium-term
	Reducing water leakages in water management facilities	Medium-scale	Short-term
	Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments	Medium-scale	Medium-term
	Use of hydrologic cycle water, including ground waters	Large-scale	Long-term
Water	Regulation of flows	Medium-scale	Medium-term
	Taking engineering protective measures in stream beds of lakes and rivers against floods	Medium-scale	Medium-term

Sector	Technology	Scale of application	Short, medium/long term availability
	Water reclamation and reuse	Large-scale	Long-term
	Flood warning technology	Large-scale	Medium-term
	Clean-up of river channels	Large-scale	Medium-term
	Desalinization of sea water to be used for technical purposes	Medium-scale	Medium-term

Below, brief information on the listed adaptation technologies for water sector is provided:

Construction of water reservoirs of complex destination and increase of efficiency of the existing water reservoirs

There are water losses at the existing reservoirs, especially during water delivery. The system is out-dated and leads to water loss. By applying new technologies to the existing reservoirs or by constructing new reservoirs using modern technologies the efficiency could be increased.

Use of water-saving technologies in water consumption system

There are water losses in the water consumption system due to old and decomposed water distribution pipes in buildings constructed 50-60 years ago. All the pipes must be changed with new, durable ones and the system of water measuring must be fully applied in order to avoid water losses in the water consumption system. Raising consumer awareness may also be useful in order to promote efficient use of water.

Improvement of the water resources management system

Modern technologies must be applied in water resources management in order to efficiently use available water resources, regulate water flow and decrease water losses. The issue will become more important due to expected water scarcity as a result of forecasted climate change tendencies.

Reducing water leakages in water management facilities

Management, detection and repair of small leaks in a distribution system are critical functions of system operation and maintenance. Leaks often damage pipes through erosion; therefore, additional benefits of early detection include reduced maintenance costs and lower probability of catastrophic failures. Monitoring systems remotely also enables confirmation that pipes are in good condition, preventing premature replacement. Along with reduction in water losses, such technology reduces health and environmental issues related to water (increase of salty ground water level, mixture of fresh water with waste waters and other polluted waters).

Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments

As there are water poor regions in many areas of Azerbaijan, small-scale collection infrastructure can contribute greatly to the volume of freshwater available for human use. This is especially an issue in arid and semi-arid regions, where the minimal rainfalls are usually very intense and often seasonal. As such, run-off and river flows can be abundant for brief periods and non-existent throughout the rest of the year. Technology can help to store and use water during low water periods and, therefore, increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into rivers or other areas or from evaporating.

Use of hydrologic cycle water, including ground waters

Particularly in areas with the highest water demand, there will be a need for the use of new technologies in application of hydrologic cycle water, including ground waters. For instance, construction of artesian wells or small reservoirs for collection of rain and snow water may lead to provision of demand for water, mainly in the hottest season of the year.

Regulation of flows

Floods are a characteristic disaster for Azerbaijan, especially in the areas on the bank of Kura River. Recent floods have destroyed local infrastructure and damaged agricultural systems leading to significant financial expenses for restoration activities. By regulating flows, accurate management of water resources may be achieved and most cases of floods may be prevented. Construction of small water reservoirs, planting of water regulative forest strips, or other preventive measures may be applied in order to regulate flows.

Taking engineering protective measures in stream beds of lakes and rivers against floods

Recent flows showed that stream beds of rivers must be regularly cleaned in order to maintain regular stream of water. This is especially important for Kura River, which flows into the Caspian Sea. Engineering protective measures must be taken in stream beds of Kura River and cleaning activities must be provided regularly in order to prevent overflow of river that could damage surrounding communities. It also has ecological importance as sturgeons living in the Caspian Sea travel along Kura River with fresh water for nesting, and stirred up stream beds create obstacles for them.

Water reclamation and reuse

This technology focuses on applications of water reuse that directly affect drinking water supplies. It is important to note that agricultural use accounts for the majority of freshwater consumption worldwide.

Water reclamation and reuse approaches utilize the same treatment technologies as conventional wastewater treatment, including secondary clarifiers, filtration basins of various designs, membranes, and disinfection basins.

Technology can help to store and use water during low water periods and, therefore, increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into rivers or other areas or from evaporating.

Flood warning technology

The purpose of a flood warning service is to detect and forecast threatening flood events so that the public can be alerted in advance and can undertake appropriate responses to minimize the impact of the event. It is possible to implement flood warning systems together with other adaptation measures, as part of an integrated flood risk management plan.

Clean-up of river channels

Cleaning-up of river channels is one of the adaptive measures aiming to increase stream flow and decrease water losses. Such measures will be more important particularly in arid zones suffering from forecasted water scarcity.

Desalinization of sea water to be used for technical purposes

Desalinization of sea water in modern technology may be applied for provision of water for technical purposes. First steps in the application of this methodology have already been made in the country and pilot initiatives are in progress. In the event of water scarcity due to forecasted climate change tendencies such initiatives may be enhanced and applied in coastal zones.

If the aforementioned preventive measures are implemented the problem of upcoming water shortage might be eliminated (Table 4).

Table 4: Water balance indicators

Water balance indicators	Water volume, million m3		
	Present	2021-2050	2071-2100
Water shortage	- 2600	- 4600	- 7500
Increase in the use of ground water	3000	3000	3000
Enhancement of water distribution system	3000	3500	3500
Treatment and use of 40% of wastewater	2000	2500	2500
Covering water shortage as a result of provided measures	+5400	+4400	+1500

With regard to complex management of water resources, the variation of water flow by 30% (by about 20 km^3) during high water and low water seasons should be taken into account. Therefore, it is very important to provide long-term hydrology prognosis of water resources.

The National Team of experts has prepared Technological Fact Sheets (TFS) for pre-selected technologies for water sector. These TFSs enabled stakeholder groups to prioritize pre-selected technologies.

The assessment of pre-selected technologies was based on their contribution to sustainable development goals and to adaptation in light of climate change impact scenarios for the country. The criteria on which the assessments were based were decided involving a wider group of stakeholders. The following criteria have been identified to be applied for prioritization of adaptive technologies:

- Contribution to economic development priorities;
- Contribution to social development priorities;
- Contribution to environmental development priorities;
- Implementation availability;
- Potential contribution to reduction of vulnerability to climate change.

Below, a comprehensive explanation for the above-mentioned criteria is provided:

- Contribution to economic development priorities

It is clear that prioritized adaptation technologies should harmonize and fit with current national and sectoral (related to water and agricultural sectors) economic development policies of the country. If identified technologies will fit existing national and sectoral policies related to economic development, it will have more chances to be implemented, and implementation of prioritized technologies will be fully supported by the government. Therefore, this criteria is very important in order to enable relevant experts to compare and evaluate short-listed technologies.

To be more precise, main development directions derived from existing State programs related to economic development of the country such as, ‘State Program on poverty reduction and economic development in Azerbaijan Republic during 2008-2015’ (approved on 15/09/2008), ‘State Program on Social-economical development of regions of Azerbaijan Republic during 2009-2013’ (approved on 14/04/2009), ‘State Program on reliable provision with the food products of the population of Azerbaijan Republic during 2008-2015’ (approved on 25/08/2008) and sectoral programs such as ‘State Program on development of vine growing during 2012-2020’ (approved by Presidential Decree on 15/12/2011), have been taken into account by experts during prioritization of short-listed adaptation technologies.

- Contribution to social development priorities

The same statements could be indicated for criteria of contribution to social development priorities. Prioritized technologies for water and agricultural sectors should harmonize and fit national and sectoral policies related to social development priorities of the country. If identified technologies will fit existing national and sectoral policies related to social development, it will have more chances to be implemented, and implementation of prioritized technologies will be fully supported by the government. Therefore, this criteria is very important in order to enable relevant experts to compare and evaluate short-listed technologies.

Social development is the priority issue for the government of Azerbaijan. Taking into account that forecasted climate change will have negative impact to the social sector, prioritized technologies should minimize those impacts. To be more precise, main development directions derived from existing State programs related to social development of the country such as, 'State Program on poverty reduction and economic development in Azerbaijan Republic during 2008-2015' and 'State Program on Social-economical development of regions of Azerbaijan Republic during 2009-2013', have been taken into account by experts during prioritization of short-listed adaptation technologies.

- Contribution to environmental development priorities

As identified technologies for adaptation to climate change are mostly related to the environmental sector, all technologies should fit with current environmental development priorities of the country and it should be one of the criteria for prioritization.

To be more precise, main development directions derived from existing State programs and action plans related to environmental development and international conventions in the field of environment have been ratified by the country. Regarding the State programs and action plans related to the environment, Azerbaijan has adopted and successfully completed the first National Environmental Action Plan for the period 1998–2003. Currently, the main environmental policy document is the National Programme on Environmentally Sustainable Social and Economic Development for the period 2003–2010, which was endorsed by the 2003 Presidential Decree. The National Programme covers the environmental aspects of the country's overall development strategy and is accompanied by an action plan, covering the years 2003–2010, for its implementation. The National Programme and its action plan were further complemented by the Comprehensive Action Plan on Improvement of the Environmental Situation for the period 2006–2010, which dealt with improving the environmental situation in various areas.

Therefore, the contribution to environmental development priorities of the country was considered an important criteria by the experts during the prioritization of short-listed technologies in both water and agricultural sectors.

- Implementation availability

This criteria embraces different characteristics of adaptation technologies such as access to technology at current market or 'market availability', the level of capacity for application of the technology and comparison of costs for the application of the technology with expected benefits. Some technologies are already applied in the country and final beneficiaries are familiar with those technologies, however, some are not yet applied. It is obvious that the level of capacity for application of new technologies will be lower, as a result. Experts have taken these factors into account during the prioritization process.

Regarding the comparison of costs for the application of the technology with expected benefits, the experts have not conducted specific cost-benefit analysis but rather, made general comparisons between costs for proposed technologies and expected benefits. Technologies with higher costs and lower benefits received lower scores as they were considered to be technologies with less availability for implementation.

- Potential contribution to reduction of vulnerability to climate change

This criteria identifies potential contribution of short-listed technologies to the reduction of vulnerability to climate change. Technologies with more contributions received higher scores by the experts.

The performance of the technology, or measure on the criteria, is assessed considering the information already collated in the technology fact sheets, option page, available country knowledge and relevant experts input. The technologies were then scored on a scale of 0-100 by a stakeholder group, consisting of 11 experts. The average value of scores has been taken into account. The results of scoring for each technology within identified criteria are provided in the table below.

Table 5: Scoring and weighting results for technologies under water sector

Technologies	C1	C2	C3	C4	C5
Construction of water reservoirs of complex destination and increase of efficiency of the existing water reservoirs	17	21	14	32	24
Use of water-saving technologies in water consumption system	35	41	24	52	19
Improvement of the water resources management system	20	16	18	36	22
Reducing water leakages in water management facilities	42	50	34	64	26
Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments	46	74	62	68	64
Use of hydrologic cycle water, including ground waters	27	31	24	38	14
Regulation of flows	16	62	59	42	35
Taking engineering protective measures in stream beds of lakes and rivers against floods	12	34	50	52	21
Water reclamation and reuse	44	48	36	58	62
Flood warning technology	32	62	55	70	52
Clean-up of river channels	11	32	24	40	32
Desalinization of sea water to be used for technical purposes	9	16	20	18	38

Where:

C1 – economic criterion; C2 – social criterion; C3 – environmental criterion; C4 – implementation availability; C5 – contribution to vulnerability

This was followed by assessing weights for the criteria, to enable stakeholders to determine the relative importance of each criterion. The weighting is done after the scoring, as weights can only be given to criteria within the decision context.

In assessing weights, there were different opinions of experts involved in the analysis process. As a result of fruitful debates on the degree of importance of different criteria, weights for each criterion have been provided as following:

- Contribution to economic development priorities – 20%
- Contribution to social development priorities - 15%
- Contribution to environmental development priorities - 15%
- Implementation availability - 20%
- Potential contribution to reduction of vulnerability to climate change – 30%

The overall results are provided in Table 6.

Table 6: Weighting results for technologies under water sector

Technologies	CW1 20%	CW2 15%	CW3 15%	CW4 20%	CW5 30%	Overall Results
Construction of water reservoirs of complex destination and increase of efficiency of the existing water reservoirs	3	3	2	6	7	21
Use of water-saving technologies in water consumption system	7	6	4	10	6	33
Improvement of the water resources management system	4	2	3	7	7	23
Reducing water leakages in water management facilities	8	8	5	13	8	42
Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments	9	11	9	14	19	62
Use of hydrologic cycle water, including ground waters	5	5	4	8	4	26
Regulation of flows	3	9	9	8	11	40

Taking engineering protective measures in stream beds of lakes and rivers against floods	2	5	8	10	6	31
Water reclamation and reuse	9	7	5	12	19	52
Flood warning technology	6	9	8	14	16	53
Clean-up of river channels	2	5	4	8	10	29
Desalinization of sea water to be used for technical purposes	2	2	3	4	11	22

Where: *CW1 – weight for economic criterion; CW2 – weight for social criterion; CW3 – weight for environmental criterion; CW4 – weight for implementation availability; CW5 – weight for contribution to vulnerability*

As a result of assessment, four priority technologies for water sector have been identified:

1) Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments

2) Flood warning

3) Water reclamation and reuse

4) Reducing water leakages in water management facilities

Detailed information on prioritized technologies for water sector is provided in Annex 2.

Lastly, sensitivity analysis was conducted on assessment results to evaluate the robustness of the results relative to the weights and scores applied and other uncertainties. Analysis provided by experts proved that the four priority measures for each selected sector are priority measures according to all the experts. Analysis showed that, for most measures, the experts judgment did not vary significantly.

To sum up, provided analysis enabled the National TNA Team to prioritize adaptation technologies for water sector taking into account the country's development priorities, implementation availability and potential contribution to reduction of vulnerability to climate change. All 4 technologies are topical issues in current national policy and strategy of the government related to water sector. Further assessment of prioritized technologies will clarify implementation availability and barriers, enabling sound measures to be taken to reduce sector vulnerability.

CHAPTER 6. Technology prioritization for agricultural sector

Agriculture is sensitive to the climate and is a vulnerable sector. The climate projections for Azerbaijan are for significantly higher temperatures and possibly less rainfall. On the other hand, rising carbon dioxide levels will help offset some or all of the production losses, and agriculture and forestry are projected to continue being viable (all else being equal) over much of the current cropping, livestock and tree growing regions. Different tree, livestock and crop varieties may have to be used in many areas. The options for growing frost-sensitive crops may even improve in some currently cold parts of the country.

New varieties of crop species and cultivars that are more heat tolerant and, in some cases, more drought tolerant, will be needed. This is an option that requires links with major international agricultural research centers, the application of gene technologies, and possibly some indigenous knowledge.

The development of information, raising of awareness and knowledge sharing are critical components in an adaptation strategy for agriculture.

To improve the resilience of the agricultural sector, economic tools are needed to help farmers adjust quickly to change. One such tool is a dynamic economic optimization model, which integrates scientific knowledge and expert opinion on climatic impact, livestock production systems and economic and financial information. Decision support systems provide a mechanism to quantify the financial risks and vulnerability of different livestock production systems by integrating livestock production with other agricultural enterprises suited, or adapted, to the proposed climatic changes.

Another way of adapting to increased rainfall variability and the possible reduction in precipitation is through diversification. Macro-economic diversification is suitable for commercial farmers as a means of evaluating and testing alternative crops to enhance diversification of production and reduce risk.

For agricultural sector, possible adaptive technology needs are listed in the table below.

Table 7: Possible adaptation measures for agricultural sector

Sector	Technology	Scale of application	Short, medium/long term availability
Agriculture	Improve management and use of cultivated lands	Large-scale	Medium-term
	Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes	Large-scale	Long-term
	Implementation of desalinization measures, continuation and expansion of measures on the prevention of soil erosion and salinity by application of drainage system	Large-scale	Medium-term
	Application of water saving technologies, such as drop or spray irrigation, at irrigated lands	Small-scale/Large-scale	Long-term
	Development of agricultural infrastructure, including irrigation systems for pastures, cultivation system and its effectiveness	Large-scale	Medium-term
	Use/store rain and snow water sources for irrigation	Large-scale	Medium-term
	Enhance the application of windbreaks	Large-scale	Medium-term
	Continuation of work on selection, introduction and farming application of winter wheat varieties characterized by drought resistance and high productivity	Large-scale	Medium-term
	Continuation of work on selection, introduction and farming application of heat tolerant, drought resistant and highly productive cotton varieties	Large-scale	Medium-term
	Restoration of conventional vineyards and expansion of their area by planting new vineyards	Large-scale	Long-term

	on mountain terraces		
	Application of conservative agricultural technologies	Small-scale	Long-term
	Create access for local farmers to timely information on climatic forecast	Small-scale	Short-term

The National Team of experts has prepared Technological Fact Sheets (TFS) for pre-selected technologies for agricultural sector. These TFSs enabled stakeholder groups to prioritize pre-selected technologies. Below, brief information on the listed technologies for agricultural sector is provided.

Improve management and use of cultivated lands

Forecasted climate change tendencies will create the need for efficient use of available land resources. There will be a need for new cultivation methods or cultivation of different types of product. For instance, cultivation of perennial crops will be more advantageous or application of agro-forestry will be important in order to decrease land degradation and erosion. Different good practices must be studied and applied in some pilot areas in order to improve management and use of currently available cultivated lands.

Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes

The introduction of new cultivated species and improved crop varieties is a technology aimed at enhancing plant productivity, quality, health and nutritional value and/or building crop resilience to diseases, pest organisms and environmental stresses. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm, taking into account the different returns from value-added crops with complementary marketing opportunities.

New and improved crop species can be introduced through farmer experimentation with new varieties. Agricultural researchers and extension agents can help farmers identify new varieties that may be better adapted to changing climatic conditions, and facilitate farmers to compare these new varieties with those they already produce.

Implementation of desalinization measures, continuation and expansion of measures on the prevention of soil erosion and salinity by application of drainage system

Salinization is a problematic issue for Azerbaijan, especially in agricultural areas. It is mainly a distinctive feature of the areas situated in Kura-Araz Lowland. Forecasted climate change tendencies will accelerate this process. New technologies for drainage system must be applied in order to decrease vulnerability of salinized areas and efficiently use land resources.

Application of water saving technologies, such as drop or spray irrigation, at irrigated lands

Efficient use of irrigation water will be very important due to expected water scarcity forecasted in light of climate change. Drip irrigation can help use water efficiently. A well-designed drip irrigation system reduces water run-off through deep percolation or evaporation to almost zero. If water consumption is reduced, production costs are lowered. Additionally, conditions may become less favorable for the onset of diseases including fungus. Irrigation scheduling can be managed precisely to meet crop demands, holding the promise of increased yield and quality.

Agricultural chemicals can be applied more efficiently and precisely with drip irrigation. Fertilizer costs and nitrate losses can be reduced. Nutrient applications can be better timed to meet the needs of plants.

Sprinkler systems eliminate water conveyance channels, thereby reducing water loss. Water is also distributed more evenly across crops helping to avoid wastage. Sprinklers provide a more even application of water to agricultural land, promoting steady crop growth. Secondary benefits from improved crop productivity include income generation, employment opportunities and food security.

Development of agricultural infrastructure, including irrigation systems for pastures, cultivation system and its effectiveness

Development of infrastructure is essential for agriculture in order to decrease its vulnerability to climate change. Taking into account forecasted droughts and decrease in rainfalls, new technologies should be applied to improve irrigation systems, aiming to increase efficiency of irrigation water use. Considering the negative impact of droughts on pasture areas, application of new irrigation systems in those areas may be considered in order to maintain grass cover for pasturing.

Use/store rain and snow water sources for irrigation

Taking into account forecasted climate change tendencies (droughts, decrease in rainfall and increase in temperature) water scarcity during hot seasons will be an important problem, especially in arid zones. Applying the technology of use/store rain and snow water sources for irrigation will create an additional source of irrigation water for local farmers, as they will be able to use stored water for irrigation purposes during hot seasons.

Enhance the application of windbreaks

The practice of agro-forestry was applied in Azerbaijan during former Soviet times. Currently, this practice is not applied by most private land-owners due to lack of knowledge. Agro-forestry has a broad application potential and provides a range of advantages, including the maximum use of the land and increased land-use efficiency, increased productivity of the land, protection and improvement of soils and water sources, and so on.

Continuation of work on selection, introduction and farming application of winter wheat varieties characterized by drought resistance and high productivity

Wheat is one of the strategic agricultural products, and in the context of climate change tendencies, work on selection, introduction and farming application of winter wheat varieties characterized by drought resistance and high productivity must be intensively continued. Information on heat tolerant, drought resistant and highly productive winter wheat varieties, applied in relevantly hot countries specialized in wheat growing, must be gathered and their experience studied. This will help Azerbaijan not only learn the experience and applied technology, but also possibly apply the same technology in the country. It is important to note that the possible changes in vegetation period should also be taken into account, as they may lead to change in cultivation and harvesting timing.

Continuation of work on selection, introduction and farming application of heat tolerant, drought resistant and highly productive cotton varieties

With regard to cotton growing activities, and in the context of climate change tendencies, work on selection, introduction and farming application of heat tolerant, drought resistant and highly productive cotton varieties must be intensively continued. Information on heat tolerant, drought resistant and highly productive cotton varieties applied in relevantly hot countries specialized in cotton growing (e.g. Egypt) must be gathered and their experience studied. This will help Azerbaijan not only learn the experience and applied technology, but also possibly apply the same technology in the country.

Restoration of conventional vineyards and expansion of their area by planting new vineyards on mountain terraces

More than 60% of the territory in Azerbaijan is mountainous. At present, vine growing is mostly spread at the mountain slopes with the altitude of up to 700m. Considering the forecasted temperature increase by 2^0C in the near future, vine growing activities may be developed at perpendicular zones and vineyards could be planted at the relatively higher altitudes of 800-900 m.

Application of conservative agricultural technologies

Conservation tillage refers to a number of strategies and techniques for establishing crops in previous crop residues, which are purposely left on the soil surface. Conservation tillage practices typically leave about one-third of crop residue on the soil surface. This slows water movement, which reduces the amount of soil erosion. Conservation tillage is suitable for a range of crops including grains, vegetables, root crops, fruit and wine.

Unpredictability of rainfall and an increase in the mean temperature may affect soil moisture levels leading to damages to and failures in crop yields. Conservation tillage practices reduce risk from drought by reducing soil erosion, enhancing moisture retention and minimizing soil impaction. In combination, these factors improve resilience to climatic effects of drought and floods. Improved soil nutrient recycling may also help combat crop pests and diseases. Conservation tillage benefits farming by minimizing erosion, increasing soil fertility and improving yield.

Create access for local farmers to timely information on long-term climatic forecast

Raising awareness for local population on long-term climatic forecast is very important, especially for the agricultural sector. In this regard, providing information to, and creating access for, local farmers on long-term climatic forecast may help them in planning their agricultural activities. This will enable them to take into consideration the climatic changes for nearly 5-15 years and adjust their strategy, making relevant changes. For instance, if local farmers dealing with wheat production are informed that temperatures will rise by 1.5^{0}C in coming years, they may change the type of agricultural production or use more heat tolerant wheat species. Access to such long-term climatic forecast for local farmers may be provided by special web page, distribution of timely published information materials, regular workshops or meetings conducted by relevant executive bodies.

The assessment of pre-selected technologies was based on their contribution to sustainable development goals and to adaptation in light of climate change impact scenarios for the country. The criteria on which the assessments were based were decided involving a wider group of stakeholders and assessing current national priorities and strategies. The following criteria have been identified to be applied for prioritization of adaptive technologies:

- Contribution to economic development priorities;
- Contribution to social development priorities;
- Contribution to environmental development priorities;
- Implementation availability;
- Potential contribution to reduction of vulnerability to climate change.

The performance of the technology, or measure on the criteria, is assessed considering the information already collated in the technology fact sheets, option page, available country knowledge and relevant experts input. The technologies were then scored for each criterion on a scale of 0-100 by a stakeholder group, consisting of 11 experts. The average value of scores has been taken into account in the table below.

Table 8: Scoring for technologies under agricultural sector

Technologies	C1	C2	C3	C4	C5
Improve management and use of cultivated lands	26	30	34	52	34
Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes	56	52	52	62	70
Implementation of desalinization measures, continuation and expansion of measures on the prevention of soil erosion and salinity by application of drainage system	44	36	78	36	32
Application of water saving technologies, such as drop or spray irrigation, at irrigated lands	66	60	38	62	46
Development of agricultural infrastructure, including irrigation systems for pastures, cultivation system and its effectiveness	42	40	22	70	38
Use/store rain and snow water sources for irrigation	24	22	17	49	16
Enhance the application of windbreaks	48	52	58	80	53
Continuation of work on selection, introduction and farming application of winter wheat varieties characterized by drought resistance and high	32	50	30	54	41

productivity					
Continuation of work on selection, introduction and farming application of heat tolerant, drought resistant and highly productive cotton varieties	40	36	25	56	42
Restoration of conventional vineyards and expansion of their area by planting new vineyards on mountain terraces	52	34	16	74	30
Application of conservative agricultural technologies	41	52	64	40	62
Create access for local farmers to timely information on climatic forecast	12	21	30	42	36

Where:

C1 – economic criterion; C2 – social criterion; C3 – environmental criterion; C4 – implementation availability; C5 – contribution to vulnerability

This was followed by assessing weights for the criteria, to enable stakeholders to determine the relative importance of each criterion. The weighting is done after the scoring, as weights can only be given to criteria within the decision context. Weights for each criterion have been provided as following:

- Contribution to economic development priorities – 20%
- Contribution to social development priorities - 15%
- Contribution to environmental development priorities - 15%
- Implementation availability - 20%
- Potential contribution to reduction of vulnerability to climate change – 30%

The weighting scores and final results are provided in the table below.

Table 9: Weighting scores and final results for technologies under agricultural sector

Technologies	CW1 20%	CW2 15%	CW3 15%	CW4 20%	CW5 30%	Overall Results
Improve management and use of cultivated lands	5	5	5	10	10	35
Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes	11	8	8	12	21	60
Implementation of desalinization measures, continuation and expansion of measures on the prevention of soil erosion and salinity by application of drainage system	9	5	12	7	10	43
Application of water saving technologies, such as drop or spray irrigation, at irrigated lands	13	9	6	12	14	54
Development of agricultural infrastructure, including irrigation systems for pastures, cultivation system and its effectiveness	8	6	3	14	11	42
Use/store rain and snow water sources for irrigation	5	3	3	10	5	26
Enhance the application of windbreaks	10	8	9	16	16	59
Continuation of work on selection, introduction and farming application of winter wheat varieties characterized by drought resistance and high productivity	6	8	5	11	12	42
Continuation of work on selection, introduction and farming application of heat tolerant, drought resistant and highly productive cotton varieties	8	5	4	11	13	41
Restoration of conventional vineyards and expansion of their area by planting new vineyards on mountain terraces	10	5	2	15	9	41
Application of conservative agricultural technologies	8	8	10	8	19	53
Create access for local farmers to timely information on climatic forecast	2	3	5	8	11	29

Where: *CW1 – weight for economic criterion; CW2 – weight for social criterion; CW3 – weight for environmental criterion; CW4 – weight for implementation availability; CW5 – weight for contribution to vulnerability*

As a result of assessment four priority technologies for agricultural sector have been identified:

1) Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes

2) Enhance the application of windbreaks

3) Application of water saving technologies, such as drop or spray irrigation, at irrigated lands

4) Application of conservative agricultural technologies

Lastly, sensitivity analysis was conducted on assessment results to evaluate the robustness of the results relative to the weights and scores applied and other uncertainties. Analysis provided by experts proved that the four priority measures for each selected sector are priority measures according to all the experts. Analysis showed that, for most measures, the experts judgment did not vary significantly.

To sum up, provided analysis enabled the National TNA Team to prioritize adaptation technologies for agricultural sector taking into account the country's development priorities, implementation availability and potential contribution to reduction of vulnerability to climate change. All 4 technologies are topical issues in current national policy and strategy of the government related to agricultural sector, including relevant State Program related to food security. Further assessment of prioritized technologies will clarify implementation availability and barriers, enabling sound measures to be taken to reduce sector vulnerability.

CHAPTER 7. Summary and conclusion

Results of the provided analyses and discussions lead to the identification of 2 main priority sectors, taking into account core development priorities of the country. Vulnerability assessments for both selected sectors (water and agriculture) have described their level of vulnerability to the forecasted climate change and identified the level of need towards adaptive measures.

Prioritizing of technologies for selected sectors was based on TNA methodology and conducted in close cooperation with relevant stakeholders. As a result of assessment, four priority measures for each sector have been identified.

For water sector:

- Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments
- Flood warning
- Water reclamation and reuse
- Reducing water leakages in water management facilities

For agricultural sector:

- Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes
- Enhance the application of windbreaks
- Application of water saving technologies, such as drop or spray irrigation, at irrigated lands
- Application of conservative agricultural technologies

A critical next step would entail a process of translating the TNA results into well-defined implementation plans for the successful transfer of technology to the country. Important components of this implementation of technologies process will include the involvement of appropriate and effective stakeholders within the framework for technology transfer. While elaborating the different steps of the implementation plan for the transfer of a technology, it will be important to identify capacity-building needs and other barriers that will have to be overcome. The eventual outcome may be the preparation of a project document for funding purposes for those technologies requiring heavy investments.

Barrier analysis and Technology Action Plans (TAP) will be prepared in the next stage to accommodate all technologies prioritized, while paying due attention to the specific nature of the various options. Such an action plan will lead to the identification of more precise steps, barriers and capacity-building needs, as well as other activities that may be required, such as awareness raising and information communication.

All above-mentioned activities will be conducted in close cooperation with relevant stakeholder groups involved in development process of prioritized sectors and technologies.

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Annex 1: Azerbaijan, TNA INFORMATION

Priority Sectors and technologies

Adaptation	
Sector	**Technology**
Water sector	Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments
	Flood warning
	Water reclamation and reuse
	Reducing water leakages in water management facilities
Agricultural sector	Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes
	Enhance the application of windbreaks
	Application of water saving technologies, such as drop or spray irrigation, at irrigated lands
	Application of conservative agricultural technologies

Annex 2: Technological Fact Sheets for selected technologies

Technological Fact sheets (1)

Sector	Agriculture
Sub-sector	Crop production
Technology name	Application of water saving technologies, such as drop or spray irrigation
Option name	Drip irrigation
Scale	Small-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

Drip irrigation is based on the constant application of a specific and focused quantity of water to soil crops. The system uses pipes, valves and small drippers or emitters transporting water from the sources (i.e. wells, tanks and/or reservoirs) to the root area and applying it under particular quantity and pressure specifications. The system should maintain adequate levels of soil moisture in the rooting areas, fostering the best use of available nutrients and a suitable environment for healthy plant roots systems. Managing the exact (or almost) moisture requirement for each plant, the system significantly reduces water wastage and promotes efficient use. Compared to surface irrigation, which can provide 60% water-use efficiency and sprinkler systems which can provide 75% efficiency, drip irrigation can provide as much as 90% water-use efficiency.

Drip irrigation technology will support farmers to adapt to climate change by providing efficient use of water supply. Particularly in areas subject to climate change impacts such as seasonal droughts, drip irrigation reduces demand for water and reduces water evaporation losses (as evaporation increases at higher temperatures). Scheduled water application will provide the necessary water resources direct to the plant when required. Furthermore, fertilizer application is more efficient since it can be applied directly through the pipes.

Advantages of the technology:

Drip irrigation can help use water efficiently. A well-designed drip irrigation system reduces water run-off through deep percolation or evaporation to almost zero. If water consumption is reduced, production costs are lowered. Additionally, conditions may become less favorable for the onset of diseases including fungus. Irrigation scheduling can be managed precisely to meet crop demands, holding the promise of increased yield and quality.

Agricultural chemicals can be applied more efficiently and precisely with drip irrigation. Since only the crop root zone is irrigated, nitrogen that is already in the soil is less subject to leaching losses. In the case of insecticides, fewer products might be needed. Fertilizer costs and nitrate losses can be reduced. Nutrient applications can be better timed to meet the needs of plants.

***Disadvantages of the technology**:*

The initial cost of drip irrigation systems can be higher than other systems. Higher costs are generally associated with the costs of pumps, pipes, tubes, emitters and installation. Unexpected rainfall can affect drip systems either by flooding emitters, moving pipes, or affecting the flow of soil salt-content. Drip systems are also exposed to damage by rodents or other animals. It can be difficult to combine drip irrigation with mechanized production as tractors and other farm machinery can damage pipes, tubes or emitters.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	Such technology will be applied at agricultural lands with irrigation water scarcity, as well as areas with potential risks of droughts and high temperatures.
Impact statements (How the options impact countries development priorities)	
Countries social development priorities	• Contributes to food security priority by increasing productivity • Leads to increase in income of rural population

	• Reduces migration to urban areas from rural communities
Countries economic development priorities	• Contributes to diversification of economic activities priority of the country • Leads to improvement of economic condition of rural population • Leads to efficient use of resources such as land, water and fertilizers
Countries environmental development priorities	• Reduces use of irrigation water • Reduces amount of applied fertilizers to agricultural lands • Increases land fertility
Other considerations and priorities such as market potential	• Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets
Costs	
Capital costs over 10 years	The cost of a drip irrigation system ranges from 1000 USD to 3500 USD per hectare depending on the specific type of technology, automatic devices, and materials used as well as the amount of labor required. Financing for equipment may be available from financial institutions via leasing operations or direct credit. Assuming that most parts of cultivated lands are suitable for spring irrigation (as most crops are cereals), there are 180 thousand ha of cultivated lands, in total, in need of drip irrigation. There will be need for investment of around 400 million USD. The process is long-term and should be applied step-by-step. The source of investment could be government budget, financial institutions and international financial organizations.
Operational & maintenance costs over 10 years	Operational cost for technology will be around 50-100 USD per hectare per year.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local farmers.

Technological Fact sheets (2)

Sector	Agriculture
Sub-sector	Crop production
Technology name	Application of water saving technologies, such as drop or sprinkler irrigation
Option name	Sprinkler irrigation
Scale	Large-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

Systems of pressurized irrigation, sprinkler or drip, can improve water efficiency and contribute substantially to improved food production. Sprinkler irrigation is a type of pressurized irrigation that consists of applying water to the soil surface using mechanical and hydraulic devices that simulate natural rainfall. These devices replenish the water consumed by crops or provide water required for softening the soil to make it workable for agricultural activities. The goal of irrigation is to supply each plant with just the right amount of water it needs. Sprinkler irrigation is a method by which water is distributed from overhead by high-pressure sprinklers, sprays or guns mounted on risers or moving platforms.

Advantages of the technology:

One of the main advantages of the sprinkler irrigation technology is more efficient use of water for irrigation in agriculture. Sprinkler systems eliminate water conveyance channels, thereby reducing water loss. Water is also distributed more evenly across crops helping to avoid wastage. The sprinkler irrigation system has also been shown to increase crop yields and is suited for most row, field and tree crops that are grown closely together, such as cereals, pulses, wheat, sugarcane, groundnut, cotton, vegetables, fruits, flowers, spices and condiments and for cultivating paddy crop.

Sprinkler irrigation technology is well adapted to a range of topographies and is suitable for all types of soil, except heavy clay. Sprinkler systems can be installed as either permanent or mobile fixtures. Sprinklers provide a more even application of water to agricultural land, promoting steady crop growth. Likewise, soluble fertilizers can be channeled through the system for easy and even application. The risk of soil erosion can be reduced because the sprinkler system limits soil disturbance, which can occur when using irrigation by gravity. In addition, sprinkler irrigation can provide additional protection for plants against freezing at low temperatures. Secondary benefits from improved crop productivity include income generation, employment opportunities and food security.

***Disadvantages of the technology**:*

The main disadvantages associated with sprinkler systems are related to climatic conditions, water resources and cost. Even moderate winds can seriously reduce the effectiveness of sprinkler systems by altering the distribution pattern of the water droplets. Likewise, when operating under high temperatures, water can evaporate at a fast rate reducing the effectiveness of the irrigation. Although sprinkler irrigation can help farmers use water resources more efficiently, this technology relies on a clean source of water and, therefore, may not be suited to areas where rainfall is becoming less predictable. Implementation costs are higher than that of gravity-fed irrigation systems and large labor force is needed to move pipes and sprinklers in a non-permanent system. In some places such labor may not be available or may be costly. Mechanized sprinkler irrigation systems have a relatively high energy demand.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	Such technology will be applied at agricultural lands with irrigation water scarcity, as well as areas with potential risks of droughts and high temperatures.
Impact statements **(How the options impact countries development priorities)**	
Countries social development priorities	• Contributes to food security priority by increasing productivity

	• Leads to increase in income of rural population • Reduces migration to urban areas from rural communities
Countries economic development priorities	• Contributes to diversification of economic activities priority of the country • Leads to improvement of economic condition of rural population • Leads to efficient use of resources such as land, water and fertilizers
Countries environmental development priorities	• Reduces use of irrigation water • Reduces amount of applied fertilizers to agricultural lands • Increases land fertility
Other considerations and priorities such as market potential	• Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets
Costs	
Capital costs over 10 years	The cost of a drip irrigation system ranges from 1000 USD to 3500 USD per hectare depending on the specific type of technology, automatic devices, and materials used as well as the amount of labor required. As most cultivated lands are suitable for the application of sprinkler irrigation (approximately 1.6 million ha of cultivated lands), huge investment will be needed (up to 4 billion USD). Financing for equipment may be available from financial institutions via leasing operations or direct credit.
Operational & maintenance costs over 10 years	Operational cost for technology will be around 50-100 USD per hectare per year.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local farmers.

Technological Fact sheets (3)

Sector	Agriculture
Sub-sector	Crop production
Technology name	Application of windbreaks
Option name	Windbreaks
Scale	Large-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

Agro-forestry is an integrated approach to the production of trees and of non-tree crops or animals on the same piece of land. The crops can be grown together at the same time, in rotation, or in separate plots when materials from one are used to benefit another. Agro-forestry systems take advantage of trees for many uses: to hold the soil; to increase fertility through nitrogen fixation, or through bringing minerals from deep in the soil and depositing them by leaf-fall; and to provide shade, construction materials, foods and fuel. In agro-forestry systems, every part of the land is considered suitable for the cultivation of plants. Perennial, multiple purpose crops that are planted once but yield benefits over a long period of time are given priority. The design of agro-forestry systems prioritizes the beneficial interactions between crops, for example trees can provide shade and reduce wind erosion.

Advantages of the technology:

Agro-forestry has a broad application potential and provides a range of advantages, including:

- Agro-forestry systems make maximum use of the land and increase land-use efficiency;
- The productivity of the land can be enhanced as the trees provide forage, firewood and other organic materials that are recycled and used as natural fertilizers;
- Increased yields;
- Agro-forestry promotes year-round and long-term production;
- Employment creation – longer production periods require year-round use of labor;
- Protection and improvement of soils (especially when legumes are included) and water sources;
- Livelihood diversification;
- Provides construction materials and cheaper, more accessible fuel wood;
- Agro-forestry practices can reduce needs for purchased inputs such as fertilizers.

Disadvantages of the technology*:*

Agro-forestry systems require substantial management. Incorporating trees and crops into one system can create competition for space, light water and nutrients and can impede the mechanization of agricultural production. Management is necessary to reduce the competition for resources and maximize the ecological and productive benefits. Yields of cultivated crops can also be smaller than in alternative production systems, however, agro-forestry can reduce the risk of harvest failure.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	Such technology will be applied at agricultural cultivated lands with high risk of erosion (land and wind).
Impact statements (How the options impact countries development priorities)	
Countries social development priorities	• Contributes to food security priority by increasing productivity • Leads to increase in income of rural population • Reduces migration to urban areas from rural communities
Countries economic development priorities	• Contributes to diversification of economic activities priority of the country

	• Leads to improvement of economic condition of rural population • Leads to increase in agricultural productivity
Countries environmental development priorities	• Reduces land degradation and erosion • Carbon absorption is increased leading to improvement of air quality • Increases land fertility
Other considerations and priorities such as market potential	• Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets • Fruit production will be increased as well, creating additional income source for local farmers
Costs	
Capital costs over 10 years	The cost of 0.1 ha of windbreak is approximately 400 USD (1 ha of windbreak will therefore cost 4000 USD). Assuming that there is need for windbreak application for approximately 60% of cultivated lands, taking into account relief, climate and erosion factors, a total of 3,240,000 ha of windbreaks will be needed. This will require an investment of around 13 billion USD, which is a huge amount. The process is long-term and should be applied step-by-step. The source of investment could be government budget, financial institutions and international financial organizations.
Operational & maintenance costs over 10 years	Operational cost for technology will be around 100 USD per hectare per year.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local farmers.

Technological Fact sheets (4)

Sector	Agriculture
Sub-sector	Crop production
Technology name	Conservative agriculture
Option name	Conservative tillage
Scale	Small-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

Conservation tillage refers to a number of strategies and techniques for establishing crops in a previous crop's residues, which are purposely left on the soil surface. Conservation tillage practices typically leave about one-third of crop residue on the soil surface. This slows water movement, which reduces the amount of soil erosion. Conservation tillage is suitable for a range of crops including grains, vegetables, root crops, fruits and wines.

Unpredictability of rainfall and an increase in the mean temperature may affect soil moisture levels leading to damages to, and failures in, crop yields. Conservation tillage practices reduce risk from drought by reducing soil erosion, enhancing moisture retention and minimizing soil impaction. In combination, these factors improve resilience to climatic effects of drought and floods. Improved soil nutrient recycling may also help combat crop pests and diseases.

Advantages of the technology:

Conservation tillage benefits farming by minimizing erosion, increasing soil fertility and improving yield. Plowing loosens and aerates the soil, which can facilitate some deeper penetration of roots. Tillage is believed to help in the growth of microorganisms present in the soil and help mix in the residue from the harvest, organic matter and nutrients evenly in the soil. Conservation tillage systems also benefit farmers by reducing fuel consumption and soil compaction. By reducing the number of times the farmer travels over the field, farmers make significant savings in fuel and labor. Labor inputs for land preparation and weeding are also reduced once the system becomes established. In turn, this can increase time available for additional farm work or off-farm activities for livelihood diversification. Additionally, once the system is established, requirement for herbicides and fertilizers can be reduced.

Disadvantages of the technology:

Conservation tillage may require the application of herbicides in the case of heavy weed infestation, particularly in the transition phase, until the new balance of weed population is established (FAO, no date). The practice of conservation may also lead to soil compaction over time; however this can be prevented with chisel plows or subsoilers. Initial investment of time and money, along with purchases of equipment and herbicides, will be necessary for establishing the system. Higher levels of surface residue may result in increased plant diseases and pest infestations, if not managed properly. There is a strong relationship between this technology and appropriate soil characteristics. This is detrimental in high clay content and compact soils.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	Such technology will be applied at agricultural cultivated lands with low fertility.
Impact statements **(How the options impact countries development priorities)**	
Countries social development priorities	• Contributes to food security priority by increasing productivity • Leads to increase in income of rural population

	• Reduces migration to urban areas from rural communities
Countries economic development priorities	• Contributes to diversification of economic activities priority of the country • Leads to improvement of economic condition of rural population • Leads to increase in agricultural productivity
Countries environmental development priorities	• Reduces greenhouse emission • Increases land fertility
Other considerations and priorities such as market potential	• Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets • There will be a need for wide range capacity building activities to increase knowledge of farmers on applied technology • Technology application will create demand for specific agricultural machinery
Costs	
Capital costs over 10 years	It is impossible to immediately shift from traditional cultivation methods to conservative tillage, as this process will take decades. Therefore, the process could be launched by pilot initiatives in all agricultural regions in order to initiate application of technology among local farmers. The most important cost for farmers will be machinery and fuel. There will be a need for specific agricultural machinery. Such machineries may be purchased by the government and provided to Agro-leasing Service Centers that currently provide services in all regions of the country. Farmers may use services of the Center or buy the machinery on leasing terms. Approximate costs for such machineries are about 130,000-150,000 USD. Considering that pilot initiatives should be launched in all agricultural regions (there are about 50 regions in the country), overall capital costs for 10 years will be 7,500,000 USD.
Operational & maintenance costs over 10 years	There will be a need for maintenance costs for purchased machinery. It will add 10% per year to the overall price of the machinery.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local farmers. Consulting services could be provided by the 10 existing Regional Agricultural Advisory Centers. There will be need for an additional 3,500,000 USD to organize necessary capacity building activities, including awareness raising activities, publication of different information materials and training activities.

Technological Fact sheets (5)

Sector	Agriculture
Sub-sector	
Technology name	Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes
Option name	Introduction of plant varieties resistant to climate change
Scale	Large-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

Agriculture is of great importance to Azerbaijan, accounting for a large portion of employment, rural livelihoods, food security, and rural growth. However, the sector is highly climate sensitive and there exist potential adverse changes in temperature, precipitation, and frequency of extreme events (e.g. droughts, heat waves, floods) with climate change. New plant varieties more resistant to high temperatures and droughts will enable farmers to sustain or increase productivity.

The introduction of new cultivated species and improved crop varieties is a technology aimed at enhancing plant productivity, quality, health and nutritional value and/or building crop resilience to diseases, pest organisms and environmental stresses. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm, taking into account the different returns from value-added crops with complementary marketing opportunities.

New and improved crop species can be introduced through farmer experimentation with new varieties. Agricultural researchers and extension agents can help farmers identify new varieties that may be better adapted to changing climatic conditions, and facilitate farmers to compare these new varieties with those they already produce. In some cases farmers may participate in crossing select seeds from plant varieties that demonstrate the qualities they seek to propagate, in order to develop new varieties with the characteristics they desire.

Breeding new and improved crop varieties enhances the resistance of plants to a variety of stresses that could result from climate change. These potential stresses include water and heat stress, water salinity, water stress and the emergence of new pests. Varieties that are developed to resist these conditions will help to ensure that agricultural production can continue and even improve despite uncertainties about future impacts of climate change. Varieties with improved nutritional content can provide benefits for animals and humans alike, reducing vulnerability to illness and improving overall health.

Advantages of the technology:

By introducing new crop species farmers will be able to cover production losses made by climate change impact with increased yield and quality. Crop diversification provides better conditions for food security and enables farmers to grow surplus products for sale at market and thus obtain increased income to meet other needs related to household well-being.

The process of farmer experimentation and the subsequent introduction of adapted and accepted varieties can potentially strengthen the farmers cropping systems by increasing yields, improving drought resilience, boosting resistance to pests and diseases, as well as by capturing new market opportunities.

Disadvantages of the technology:

The costs of new species, as well as costs for cultivation can be higher than others. Farmers may need to be provided with necessary capacity building and awareness raising activities in order to adapt new technology. Farmers may also face risk from poor economic returns if crops are not selected based on a market assessment.

Implementation assumptions	Such technology will be applied mainly in arid and semi-

(How the technology will be implemented and diffused across the subsector)	arid zones of the country. Assessment of vulnerability should be provided in the areas with most risk to negative impacts of climate change. Agricultural research institutions must be involved in the process in order to provide analyses and experiments with new species.
Impact statements (How the options impact countries development priorities)	
Countries social development priorities	• Contributes to food security priority by increasing productivity • Leads to increase in income of rural population
Countries economic development priorities	• Leads to improvement of economic condition of rural population • Contributes to the diversification strategy of countries economy by increasing weight of agricultural sector within economic system
Countries environmental development priorities	• Reduces negative impact of forecasted climate change
Other considerations and priorities such as market potential	• Agricultural production will increase leading to decrease in the dependence of imported agricultural products at local markets
Costs	
Capital costs over 10 years	Financial requirements of diversification revolve around the costs involved in researching the species to be planted and training in the management of diversified systems. These activities could be provided by existing Agricultural Research Institutions in the regions. Approximate costs for researching would be around 20-30 million USD. Preliminary feasibility study and assessment of vulnerability of currently used species in different regions with different ecosystems are also to be considered in the financial requirements. There would be a need for assessment of currently used species in countries with relatively hot climate (e.g. species currently applied in Egypt or southern part of Turkey) as the forecasted temperature increase would be similar. This may be done through a pilot project covering all agricultural regions of the country. The approximate cost of such a project will be around 8-10 million USD. Infrastructure and marketing costs should also be considered. Costs of farmer experimentation are generally low, but results may only have local applicability. Capital investment will relate to the purchase of new seed varieties (if not available 'wild' locally) and labor time. In total, capital costs over 10 years will be around 60-70 million USD.
Operational & maintenance costs over 10 years	There might be a need for operational and maintenance costs for purchased equipment, but it will not be a significant amount and could be provided using local resources.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local farmers. Consulting services could be provided by the 10 existing Regional Agricultural Advisory Centers. There will be need for an additional 2 million USD to organize necessary capacity building activities, including awareness raising activities, publication of different information materials and training activities.

Technological Fact sheets (6)

Sector	Water
Sub-sector	Water supply
Technology name	Rainwater Collection
Option name	Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments
Scale	Medium-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

As there are water poor regions in many areas of Azerbaijan, small-scale collection infrastructure can contribute greatly to the volume of freshwater available for human use. This is especially an issue in arid and semi-arid regions, where the minimal rainfalls are usually very intense and often seasonal. As such, run-off and river flows can be abundant for brief periods and non-existent throughout the rest of the year.

Advantages of the technology:

Technology can help to store and use water during low water periods and, therefore, increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into rivers or other areas or from evaporating.

***Disadvantages of the technology**:*

The initial cost of these systems can be higher than other systems. Higher costs are generally associated with the costs of infrastructure and installation. Unexpected rainfall can affect the system.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	This technology covers collection, storage and use of rainwater that lands on the ground, utilizing “micro-catchments” to divert or slow run-off so that it can be stored before it evaporates or enters watercourses; and • Collecting flows from a river, stream or other natural watercourse (sometimes called floodwater harvesting). This technique often includes an earthen or other structure to dam the watercourse and form “small reservoirs” Collection and storage infrastructure can be natural or constructed and can take many forms. These include: • Below ground tanks (i.e. cisterns) and excavations (either lined for waterproofing or unlined) into which rainwater is directed from the ground surface • Small reservoirs with earthen bunds or embankments to contain run-off or river flow • Groundwater aquifers can be recharged by directing water down an unlined well Collection and storage of rainwater can provide a convenient and reliable water supply during seasonal dry periods and droughts. Additionally, widespread rainwater storage capacity can greatly reduce land erosion and flood inflow to major rivers. Rainwater collection can also contribute greatly to the stabilization of declining groundwater tables.

Impact statements **(How the options impact countries development priorities)**	
Countries social development priorities	• Contributes to water security priority by increasing water availability • Leads to improved living standards of rural population and sanitation • Reduces migration to urban areas from rural

	communities
Countries economic development priorities	Lack of adequate water supply during droughts and seasonal dry periods can halt economic development and hinder human health and well-being. Access to a convenient supply of stored rainwater can decrease travel time to remote water sources, increase agricultural productivity and reduce depletion of groundwater resources. Increasing the availability of irrigation water during the dry season, and even during short dry spells, has been shown to yield large increases in agricultural production.
Countries environmental development priorities	• Reduces use of drinking water from centralized system for other purposes • Reduces health and environmental issues related to lack of sanitation
Other considerations and priorities such as market potential	• Collected water can be used in different areas of economy
Costs	
Capital costs over 10 years	Implementation of large-scale rainwater collection programs should include a survey of current reservoir capacity and location. Satellite-based methods for tracking surface water, including radar and other methods that are not hindered by cloud cover, can reduce the costs of the survey. It is difficult to find specific data on the construction and implementation costs of rainwater collection projects. Many factors, including the scale of the project, location, etc. will strongly affect costs. The program cost for implementation in one community (40 ha or greater) may be around 60,000 USD.
Operational & maintenance costs over 10 years	There might be a need for operational and maintenance costs of about 8,000-10,000 USD per year.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local residents, which will cost approximately 6,000 USD per year per project.

Technological Fact sheets (7)

Sector	Water
Sub-sector	Flood management
Technology name	Rainwater Collection
Option name	Flood early warning
Scale	Large-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

The purpose of a flood warning service is to detect and forecast threatening flood events so that the public can be alerted in advance and can undertake appropriate responses to minimize the impact of the event. This is a particularly important technology in developing countries, where flooding results in massive loss of life and property.

Flood warnings are a highly important adaptive measure where protection through large scale, hard defenses, is not desirable or possible. This may be the case if defenses would cause adverse environmental or social problems, or where the cost of defense construction would be prohibitive.

A flood warning process has two distinct stages: (1) flood warning and (2) response.

The flood warning stage requires constant monitoring of meteorological conditions. This allows detection and assessment of threatening events to take place before it hits a community. Forecasts may also be made to help decision-makers model how an event is likely to develop, how significant it will be upon arrival, and what sections of the population are likely to be at risk. This is necessary because simple detection of an event will not provide enough time to undertake appropriate responses. To achieve monitoring and forecasting, it is likely that a flood warning system will include meteorological and tidal detection systems and river and coastal flood forecasting models.

Once an event exceeds a given threshold, a warning will be issued. This message is likely to be disseminated to the 'at risk' population through a number of channels. The media, services such as the police and fire departments and basic signals such as sirens and flags all play important roles.

After the 'at risk' population have been warned, the second stage of the flood warning service is initiated: the response. Communities in the hazard zone are required to take action to minimize their exposure to the danger and to reduce the consequences of flooding. It is important that appropriate actions are communicated to the public through awareness raising campaigns, prior to an emergency. Doing so will mean actions can be quickly taken, helping to mitigate the consequence of flooding to the greatest degree.

Advantages of the technology:

Flood warning systems provide advance warning of flood events which can potentially allow:

- The risk to life to be minimized;
- Evacuation of vulnerable groups;
- Residents to move assets (e.g. food, livestock, personal effects) to safer locations;
- Timely operation of flood control structures (e.g. storm surge barriers, temporary flood defenses, etc.) to prevent inundation of property and land;
- Installation of flood resilience measures (e.g. sandbags, property flood barriers);
- Pre-event maintenance operations to ensure free channel conveyance.

If warnings can be disseminated to the public, it will also be possible to give communities advice on what to do in the event of a flood, as well as providing further information to limit losses. This may include areas to be evacuated, evacuation routes and the location of refuges for evacuees. It is likely that advice and guidance can be issued through the same channels used to notify communities of the flood risk and be made available prior to flood events.

***Disadvantages of the technology**:*

A flood warning system is not sufficient on its own to reduce risk; people's reaction to warnings – their attitude and the nature of their response – has an important bearing on the effectiveness of a warning system. Flood warnings must be disseminated to local communities and responses must be made to minimize risks. Without these elements, the effectiveness of flood warning systems is compromised. It is, therefore, highly important that warnings be communicated effectively to the public and that emergency responses are implemented. It is essential that the public is educated about appropriate responses to flood warnings, in advance of a flood emergency.

It is also essential that the flood warning system is accurate. System inaccuracies may lead to complacency if previous warnings were unfounded, or fear by causing unnecessary anxiety. In order for a flood warning system to be successful, it is essential that communities heed the warnings issued – this requires the public to trust the agency providing the warning.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	It is possible to implement flood warning systems together with other adaptation measures, as part of an integrated flood risk management plan. Complementary actions could be part of a protection, accommodate or retreat approach. The costs involved in implementation of a flood warning system could be offset through the construction of multi-purpose shelters, which could also serve as schools, health facilities and agricultural extension centers. Technology used for detecting flood risk may also be used for forecasting rainfall when flood risk is low. This could benefit agricultural practices in these regions.
Impact statements (How the options impact countries development priorities)	
Countries social development priorities	• Contributes to flood security priority by warning population • Leads to saving of property and human life • Leads to increase in income of rural population • Reduces migration to urban areas from rural communities
Countries economic development priorities	Lack of flood management system can halt economic development and hinder human health and well-being. Good flood warning system helps to increase efficiency of flood reaction and reduction of economic damages.
Countries environmental development priorities	• Reduces negative consequences of flooding for environment
Other considerations and priorities such as market potential	Some private companies will be interested in paying to get more accurate information on expected floods.
Costs	
Capital costs over 10 years	The costs of implementing flood warning systems are expected to differ widely, depending on the level of sophistication of monitoring and forecasting technologies. Some of the key factors which contribute to variations in the cost of flood warning systems are provided below: • Extent of meteorological monitoring network • Cost of sourcing meteorological data • Set up costs of warning dissemination

	system and its degree of sophistication
	• Training and employment costs of meteorological data analysts
	• Cost of associated measures:
	  o Provision of flood shelters
	  o Creation of evacuation routes
	  o Awareness raising
	  o Training of emergency services
	
	Approximate costs for application of flood early warning system may be around 200,000-250,000 USD.

Operational & maintenance costs over 10 years	There will be a need for operational and maintenance costs of around 10,000 USD.
Other costs over 10 years	Additional costs (around 40,000 USD over 10 years) will be needed to provide necessary capacity building activities for users.

Technological Fact sheets (8)

Sector	Water
Sub-sector	Water supply and sanitation
Technology name	Water treatment
Option name	Water reclamation and reuse
Scale	Large-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

This technology, an integrated approach that is gaining acceptance, is to consider municipal wastewater as a vital resource for appropriate applications, including agricultural and other irrigation, industrial and domestic uses. This practice is called water reclamation and reuse and is an example of an Environmentally Sound Technology because it protects the environment, results in less pollution, utilizes resources in a more sustainable way, allows its waste and products to be recycled, and handles residual wastes in a more acceptable manner than the technologies for which it substitutes.

It focuses on applications of water reuse that directly affect drinking water supplies. It is important to note that agricultural use accounts for the majority of freshwater consumption worldwide.

A number of sustainable and safe approaches include:

- Substituting reclaimed water for applications that do not require potable water;
- Augmenting existing water sources and providing an additional source of water supply to assist in meeting both present and future water needs;
- Protecting aquatic ecosystems by decreasing the diversion of freshwater, as well as reducing the quantity of nutrients and other toxic contaminants entering waterways;
- Postponing and reducing the need for water control structures;
- Complying with environmental regulations by better managing water consumption and wastewater discharges.

Water reclamation and reuse approaches utilize the same treatment technologies as conventional wastewater treatment, including secondary clarifiers, filtration basins of various designs, membranes, and disinfection basins.

Advantages of the technology:

Technology can help to store and use water during low water periods and, therefore, increase water use efficiently as the system collects water from the nearby area and keeps it from flowing into rivers or other areas or from evaporating.

Disadvantages of the technology:

There are a number of socio-political barriers that often limit successful implementation of water reclamation and reuse programs. In many cases, public opposition to the use of reclaimed water for any application to which humans might be exposed (especially for potable reuse) can hinder progress.

Lack of communication and collaboration between stakeholders is also another significant socio-political barrier to water reclamation and reuse programs. The first step in the design and implementation of water reclamation and reuse initiatives should be to identify these institutional gaps and to forge the necessary links among agencies.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	Among a number of other predictions made by the Intergovernmental Panel on Climate Change, it is anticipated that climate change will lead to increased periods of drought, reduced freshwater storage, and sea level rise. Such changes can have drastic impacts on both the quantity and quality of the world's water resources. However, water reclamation and reuse approaches can and have been shown to be effective for adapting water resource management in the face of such stressors. Most importantly, water reclamation and reuse contributes to climate change adaptation by allowing water resources to be diversified and conserved. Using reclaimed water for applications that do not require potable water can result in greatly decreased depletion of protected water sources and prolong their useful lifespan. In addition, reclaimed water can be applied to permeable land surfaces or directly injected into the ground for the purpose of recharging

	groundwater aquifers and preventing saline intrusion in coastal areas.
Impact statements (How the options impact countries development priorities)	
Countries social development priorities	• Contributes to increasing water availability • Leads to improved living standards of population and sanitation
Countries economic development priorities	The water and nutrients that can be recovered from wastewater are simply too valuable to waste in areas where resources are limited. For this reason, it is very common for farmers in developing countries to supplement their crop irrigation supplies with wastewater. In fact, except for a handful of cases where applications such as natural filtration systems for water reclamation259, sewage reclamation for industrial uses, or direct potable reuse have been implemented, almost all water reclamation and reuse in developing countries is dedicated to agricultural irrigation. Not only does this practice increase the volume of water available for crops and utilize the nutrients in wastewater in a beneficial way, it also contributes to greater quality of human life by increasing household water availability.
Countries environmental development priorities	• Reduces use of drinking water from centralized system for other purposes • Reduces health and environmental issues related to lack of sanitation
Other considerations and priorities such as market potential	Treated water can be used in different areas of economy.
Costs	
Capital costs over 10 years	The financial requirements for implementing water reclamation and reuse programs will vary significantly based on the type of application that is planned for the reclaimed water. The approximate costs for application of pilot project will be around 60,000–80,000 USD.
Operational & maintenance costs over 10 years	Operational and maintenance costs will be around 20,000-25,000 USD per year.
Other costs over 10 years	Additional costs (around 50,000 USD over 10 years) will be needed to provide necessary capacity building activities.

Technological Fact sheets (9)

Sector	Water
Sub-sector	Water supply
Technology name	Water saving technology
Option name	Reducing water leakages in water management facilities
Scale	Medium-scale
Availability	Available
Technology to be included in prioritization?	Yes

Background/notes

Water losses in water management systems consist of three categories: unbilled authorized consumption; apparent losses; and real losses. Unbilled authorized consumption (e.g. water donated to a non-profit organization) usually makes up a small fraction. Apparent losses include unauthorized consumption (e.g. illegal connections) and meter inaccuracies; these often account for a considerable percentage of total NRW, especially in developing countries. Real losses consist of any water that is physically lost from the system before it reaches a consumer's water meter. A small fraction of this may include overflow of storage tanks owned by the utility.
However, the vast majority of real losses are due to leakage in distribution systems; this chapter focuses on detecting and addressing this leakage.
Management, detection and repair of small leaks in a distribution system are critical functions of system operation and maintenance, yet they are often neglected.
Acoustic methods are able to recognize leaks based on the characteristic patterns of sound that leaks create; they have been and continue to be the most common leak detection methods. The choice of an appropriate leak detection technology must consider the pipe material and pipe diameter of a system.
Acoustic methods have been successfully used for leak detection in metallic pipes for many years. However, their application in non-metallic piping is more challenging as the sounds created in plastic and concrete pipes tend to be lower-frequency and attenuate more quickly. Despite these challenges, recent technological innovations have enabled the successful application of acoustic methods to these types of piping.

Advantages of the technology:

In contrast to the existing situation, leak management, detection and repair programs generally pay for themselves by enabling early repair of leaks and reducing water waste. Leaks often damage pipes through erosion; therefore, additional benefits of early detection include reduced maintenance costs and lower probability of catastrophic failures. Monitoring systems remotely also enables confirmation that pipes are in good condition, preventing premature replacement.

Disadvantages of the technology:

The initial cost of these systems can be higher than other systems. Higher costs are generally associated with the costs of infrastructure and installation.

Opportunities for leakage management, detection and repair programs should abound when decision makers are made aware that the economic benefits often outweigh the costs. The economic benefits of these programs are particularly favorable when: (1) energy costs for transport, treatment and distribution are expensive; (2) infrastructure is aging and leakage is high; (3) high-profile water main breaks, leading to media attention and political pressure; (4) there is water stress or water scarcity conditions; and (5) water conservation is valued.
By contrast, motivation to prevent leakage may be low when water is inexpensive and abundant, and when water utilities are short-staffed or under-funded.

Implementation assumptions (How the technology will be implemented and diffused across the subsector)	Used methods for leak detection in intermittent systems will involve isolating a small zone of the network, closing the stop taps to customers, providing temporary water pressure to that zone, and then using conventional or modified leak detection methods. The basics of these methods can be found in the references.

Impact statements (How the options impact countries development priorities)	
Countries social development priorities	• Contributes to water security priority by increasing water availability • Leads to improved living standards of population and sanitation
Countries economic development priorities	Increasing access to piped water at home leads to large gains in health and development. However, per capita demand for water increases rapidly during the development transition. As population expands and water resources are stressed, economic development can be hindered. Leakage prevention can slow the onset of water stress and preserve limited water resources. Additionally, these programs often pay for themselves through water conservation, reduced costs for treatment and distribution, and reduced maintenance and pipe replacement costs.
Countries environmental development priorities	• Reduces water losses • Reduces health and environmental issues related to water (increase of salty ground water level, mixture of fresh water with waste waters and other polluted waters)
Other considerations and priorities such as market potential	• Saved water can be used in different areas of economy
Costs	
Capital costs over 10 years	The costs of leak management, detection and repair include staff training, management, labor, and equipment. There is a need for 2-3 million USD for initial assessment of leak detection and implementation of repair works.
Operational & maintenance costs over 10 years	Operational and maintenance costs will be around 45,000-50,000 USD per year.
Other costs over 10 years	Additional costs will be needed to provide necessary capacity building activities for local residents.

Annex 3: TNA process in Azerbaijan

Steering Committee Members

No.	Position	Agency	Names
1.	Head of Steering Committee	Deputy Minister of Ecology and Natural resources	F.Aliyev
2.	Secretary of the Steering Committee	Head of international relations division MENR	E.Garabagly
3.	Steering Committee Member	UNFCCC focal point of Azerbaijan Republic	I.Aliyev
4.	Steering Committee Member	Director of National Hydrometeorology department	R.Mahmudov
5.	Steering Committee Member	Head of Environment department/ State Oil Company (SOCAR)	A.Aliyev
6.	Steering Committee Member	Deputy Director of State Company of Alternative and Renewable Energy Sources of Azerbaijan Republic	C.Melikov
7.	Steering Committee Member	Deputy director of phytosanitary Service of Ministry of Agriculture	Y.Ibrahimov
8.	Steering Committee Member	Head of environment department/ “Azerenergy” agency	Z.Mammadova
9.	Steering Committee Member	Environmental NGO “Ruzgar”	I.Mustafayev
10.	Steering Committee Member	Deputy director of Geography Institute under the National Academy of Sciences	R.Mamedov

Technical Committee Members

No.	Position	Agency
1.	Head of Technical Committee	National Academy of Sciences head of Climatological department
2.	Secretary of Technical Committee	Head of sciences and technical division Ecological department of State Oil Company (SOCAR)
3.	Technical Committee Member	“Ecosos” NGO
4.	Technical Committee Member	Director of Institute for irrigation and erosion under the Ministry of Agriculture
5.	Technical Committee Member	Head hydrologist of the National Hydrometeorology Department
6.	Technical Committee Member	Head of division of State Environmental Expertise Department
7.	Technical Committee Member	Head of climatology service division under the department of National Hydrometeorology
8.	Technical Committee Member	Head of reforestation sub-division of the National Forestry Department
9.	Technical Committee Member	Expert on water issues, Ministry of Emergency Situations
10.	Technical Committee Member	Head of environment division/ Ministry of Economic Development
11.	Technical Committee Member	Water expert, “Azersu” (Azerwater) State agency
12.	Technical Committee Member	Head specialist on biodiversity issue/Ministry of Ecology and Natural Resources
13.	Technical Committee Member	Expert of Climate change and Ozone centre under the Ministry of Ecology and Natural Resources

Annex 4: National workshop minutes

National Inception Workshop was held on 26 December 2011 at Caspian Plaza Hotel, Baku city.

It was attended by 21 participants from Ministry of Ecology and Natural Resources (MENR), Ministry of Agriculture, Ministry of Economic Development, Ministry of Industry and Energy, State Agency on Alternative and Renewable Energy Sources, Ministry of Transport, Ministry of Finance, National Academy of Sciences, State Oil Company (SOCAR), State Land and Cartography Committee, Azersu Open Stock Company (OSC), Amelioration and Water Farms (OSC), relevant NGOs and private sector.

Participants have been informed about TNA coordination structure and TNA work plan. Main discussion topics were the following:

- Sector prioritization;

- Identification of long list of possible adaptive technologies;

- Identification of criteria for technology prioritization.

During the discussion of key development priorities, Mr. Suleymanov widely presented Economic development details (Sustainable social-economic Development: Energy security, Low-carbon development in energy sector, Development of infrastructure, Tourism development, Use of modern agriculture technology to provide food security). Then, other experts presented social and environmental priorities.

Criteria for prioritization of adaptation sectors have been developed and agreed to. Two sectors have been prioritized for adaptation technologies and agreed to by the PSC: agriculture and water resources.

Then, there were discussions on possible adaptation measures and a list of technologies for both sectors were prepared. Experts will develop technological fact sheets for all proposed technologies to enable prioritization.

Annex 5: Institutions involved

Institutions	Representative	Contacts
National Academy of Sciences	X. Ragimov	khayyamr@yahoo.com
Ministry of Ecology and Natural Resources	O. Jafarov	o_jafarov@yahoo.com
Azenerji Open Joint-Stock Company	A. Heydarov	Abdulkhaliq38@mail.ru
State Water Agency under Ministry of Emergency Cases	S. Hasanzade	sahib540@mail.ru
Ministry of Economic Development	A. Cafarov	altay.cafarov@gmail.com
State Oil Company (SOCAR)	M. Mehdiyev	m_mehdiyev@mail.ru
"Azersu" State agency	A. Bayramov	a.memmedov@sukanal.az
State Company of Alternative and Renewable Energy Sources of Azerbaijan Republic	C. Melikov	cmelikov@abemda.az
Ministry of Agriculture	S. Safarly	erosiya_suvarma@mail.ru
Climate change and Ozone centre under the Ministry of Ecology and Natural Resources	A. Mehtiyev	m_anar78@yahoo.com
Amelioration and Water Farms Open Stock Company	T. Osmanov	safsu@mail.ru
State Land and Cartography Committee, Head of Division at the Scientific Research Institute on Soil Science	G. Yagubov	gasham.yagubov@gmail.com
NGOs - "Ecooil" "Ruzgar" Independent expert (on energy and renewable energy sources)	M. Gurbanov I. Mustafayev Sh. Movsumov	m_gurbanov@mail.ru i_mustafayev@mail.ru movzumov@yandex.ru

TNA team contacts

TNA team	Position	e-mail
Issa Aliyev	National TNA coordinator, UNFCCC focal point in Azerbaijan	aliyev@iglim.baku.az
Mr. Bariz Mehdiyev	Adaptation expert	barizali@gmail.com
Mr. Gulmali Suleymanov	Mitigation expert	Gulmali_climate@yahoo.com , gulmali.climate@gmail.com

Annex 6: TNA Committee Endorsement

Minutes of TNA Committee meeting

25 June 2012, Baku city

Chairman: F. Aliyev

Secretary: E. Garabagly

Participants: 11 members

On 25 June 2012, the TNA Committee meeting was held at the Oarhus Center in Baku city. The following issues were on the Agenda:

1) Endorsement of prioritized technologies under adaptation/mitigation reports
2) Finalization of TNA preparation phase and shifting to Barriers Analysis and TAP preparation phase

The Chairman has opened the meeting and provided information on current status of TNA report preparation. He noted that the TNA process was implemented in close cooperation with relevant stakeholders representing different sectors. As a result of comprehensive analysis provided under assessment process of involved adaptation and mitigation experts and intensive discussions with respective stakeholders, final prioritization has been provided applying MCDA approach. Subsequently, the following sectors and technologies have been prioritized for adaptation and for mitigation:

For Mitigation:

Alternative energy sources sector:

- Wind energy sub-sector: air generating technology and mechanical wind energy conservation
- Solar energy sub-sector: the electrical and thermal conservation of solar energy
- Small hydro-powers on mountain rivers

Commercial and residential sector:

- High efficiency lighting systems
- Combined heating systems
- Biogas for cooking and electricity and efficient stoves

For Adaptation:

Water sector:

- Rainwater Collection from Ground Surfaces—Small Reservoirs and Micro-catchments
- Flood warning
- Water reclamation and reuse
- Reducing water leakages in water management facilities

Agricultural sector:

- Optimizing of location and structure of agricultural lands with introduction of crop species resistant to expected climate changes
- Enhance the application of windbreaks
- Application of water saving technologies, such as drop or spray irrigation, at irrigated lands
- Application of conservative agricultural technologies

Then, intensive discussions were held between TNA Committee members on prioritized technologies and adaptation/mitigation experts have clarified all unclear points related to applied approach and methodology. As a result of productive discussions, TNA Committee members have come to the following decision by common consensus:

1) TNA Committee endorses prioritized technologies under adaptation/mitigation reports

2) TNA Committee entrusts adaptation/mitigation experts to finalize TNA preparation phase and launch Barriers Analysis and TAP preparation phase