REPUBLIC OF KAZAKHSTAN

TECHNOLOGY NEEDS ASSESSMENT FOR ADAPTATION TO CLIMATE CHANGE

ADAPTATION

Supported by:

FOREWORD

The global climate change is one of the most important environmental issues facing the world today. Kazakhstan attaches great importance to climate change for implementation of the policy of national environmental security and sustainable development.

In May 2013 the President of Kazakhstan has approved the Concept for the Transition to a "Green Economy" which laid the foundation for systemic changes to be done. Measures for the transition towards the "green economy" will be implemented in such areas as: sustainable use of water resources; development of sustainable and highly productive agriculture; energy saving and energy efficiency; development of power industry; waste management system, reducing air pollution; and ecosystems protection and effective management.

Identification and prioritization of technologies to reduce greenhouse gas emissions and adapting to climate change, based on international methodologies, is an important step for Kazakhstan to develop low-carbon strategies sustainable for climate change. Assessment of technology options and resources, institutional mechanisms, interactions with stakeholders, and defining criteria for selecting priority sectors and technologies, are the key actions towards the implementation of climate -friendly technologies.

The Ministry of Environment and Water Resources believes that the Technology Needs Assessment on mitigation and adaptation to climate change is aimed at forming sustainability of the economy and at developing measures to be adopted and implemented.

We consider that the report on Technology Needs Assessment will assist Kazakhstan in fulfilling its commitments under the UNFCCC and that the process of technology needs assessment is an important contribution to the implementation of country's strategies for sustainable development and to development of a "green economy".

Vice-Minister

Talgat Akhsambiyev

ABBREVIATIONS

ACDP	Agroinustrial Complex Development Program of the Republic of Kazakhstan for 2010-2014
ADB	Asian Development Bank
Ak bulak	"Ak bulak" Program for 2011-2020 and Action Plan for its implementation
CIBMPD	Construction Industry and Building Materials Production Development Program of the Republic of Kazakhstan for 2010-2014
CNG	Compressed Natural Gas
CH_4	Methane
CO_2	Carbon dioxide
COP	Conference of the Parties under the United Nations Framework Convention on Climate Change
DNA	Designated National Authority
ESC	Environmental Security Concept of the Republic of Kazakhstan for 2004-2015.
GHG	Green house gases
GEF	Global Environment Facility
HIMDC	Housing Sector Modernization and Development Concept of the Republic of Kazakhstan
IDTMSP	Innovation Development and Technological Modernization Support Program of the Republic of Kazakhstan for 2010 -2014
IPCC	Intergovernmental Panel on Climate Change
LIDP	Light Industry Development Program of the Republic of Kazakhstan for 2010 – 2014
LULUCF	Land use, Land use change and Forestry
MCDA	Multi Criteria Decision Assessment
MIDP	Mining Industry Development Program of the Republic of Kazakhstan for 2010-2014
MPM	Mechanical Engineering Development Program of the Republic of Kazakhstan for 2010-2014
N_2O	Nitrous oxide
PMU	Project Management Unit
PDP	Power sector Development Program of the Republic of Kazakhstan for 2010 – 2014
PDEPCM	Draft Program for the development of export potential of cattle meat in the Republic of Kazakhstan for 2011-2020

PIDP	Pharmaceutical Industry Development Program of the Republic of Kazakhstan for 2010 – 2014
SPAIID	State program for accelerated industrial and innovative development of Kazakhstan for 2010-2014
PP-2020	Performance 2020" Program
REDD	Reducing Emissions from Deforestation and Forest Degradation
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
URC	UNEP Risoe Center
WDP	Water Industry Development and Modernization Program of the Republic of Kazakhstan by 2020 (Draft)

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Technology Needs Assessments

EXECUTIVE SUMMARY

The current process of Technology Needs Assessment (TNA) is a continuation of completed and current research on climate change in Kazakhstan, including the First and Second National Communications, National Human Development Report (on Climate Change), Principles of Kazakhstan's National Climate Change Adaptation Concept (draft) and the Concept of Low-carbon Development in Kazakhstan. The technological adaptation needs assessment was prepared taking into account the common approach and was presented in this report reflecting adaptation issues only.

The selection of sectors for adaptation technologies was summarized by the team on adaptation, project coordinator in conjunction with the representative of the Ministry of Environment Protection, in close cooperation with representatives of various concerned parties. When selecting sectors and sub-sectors the strategic priorities of the country and the general criteria, such as economic impact, social impact, environmental impact, and vulnerability to climate change, were considered. As a result, two priority sectors and four sub-sectors were identified. The assessment included agricultural and water sectors and the following sub-sectors: grain production and sheep breeding, water management and agricultural irrigation. The last two sub-sectors are a new segment that has not been considered in the previous studies.

The technology assessment criteria included the scope and timing of implementation. Along with the general criteria, the potential to reduce greenhouse gas emissions, the adaptation potential, the cost of innovation and the cost of training were considered.

The current status of technologies in the sectors (agriculture, water management) was estimated based on current information. For agriculture, 8 technologies were considered: no-Till, diversification of crop production, chemicalization, development of drought-resistant varieties, reestablishment of transhumance system, development of the grazing and stabling system on an industrial basis, selective breeding, pasture improvement.

Of technologies listed above were proposed as potential and with a high rating in grain production n**o-till technology and crop diversification.**

For the sheep breeding the following sectors were proposed: **transhumance system and grazing and stabling system on an industrial basis.**

No-Till technology significantly improves the soil fertility owing to better control of wind and water erosion, improves the soil capacity to hold water and increases the content of organic matter. This reduces the dependency of crop on weather conditions.

The technology of crop diversification allows diversifying from monoculture and become more independent in the production of other crops. The introduction of a wider range of species and improved varieties of crops increases the natural biodiversity, enhances the resistance of agro-ecosystems to environmental stresses and reduces the risk of crop failure resulted from drought.

The transhumance system allows linking together a variety of seasonal pastures, reducing exogenous stress on animals, making good use of pasture resources, and as a result more productive livestock.

The grazing and stabling system on an industrial basis allows integrated use of natural pastures, field forage production and grain production, reduces the dependence of animals on external weather conditions.

Thus, the proposed technologies in crop production and livestock breeding are small-and large-scale and achievable in the medium and long term.

In the Water sector 8 technologies were considered and the following of them were proposed as potential: **metering of water for watering and irrigation in agriculture, drip irrigation, technology of extreme events prevention.**

In Kazakhstan, as well as throughout the world, agriculture accounts for an average of 70% of water consumption (watering and irrigation). Despite the fact that most of the water resources in the country are used in agriculture for irrigation, there is no metering system in this sector.

It is not possible to solve the problem of water conservation without introducing water metering and water-saving technologies in agricultural sector such as drip irrigation. Thus, metering of water and drip irrigation are recommended as priority technologies in Agricultural irrigation. The introduction of technologies is possible in the short term (2-5 years), and their application is possible in large areas.

The most pressing challenges in the water sector is forecast floods (a high water, flood) based on the use of advanced forecasting models of hydrological events. The solution to these problems is based on the elimination of barriers to further development of quality management of hydrological events through their predictions. All these technologies listed above are described in detail in Annex I.

CHAPTER 1. INTRODUCTION

Climate change is an evidence of global warming and has significant and even catastrophic consequences for nature and human beings. The number of natural and extreme weather events is increasing; glaciers in mountain areas are shrinking; there is a shortage of water resources. The average temperature is increasing rapidly. The global challenge of global warming affects all countries and regions, and all countries are faced with certain social and economic impacts of climate change.

In accordance with the requirements of the UNFCCC, all Parties cooperate in development, application and diffusion of technology transfer, practices and processes that reduce or prevent greenhouse gas emissions. These tasks have been fulfilled based on an integrated approach on the national and sectoral levels with participation of various stakeholders (the private sector, the government, donors, research institutes, non-governmental organizations, etc.).

1.1 TNA project

In late 2010 the Government of Kazakhstan approved the UNEP Project "Technology Needs Assessment". The Project was started in 2011 and implemented by the Ministry of Environment protection of the Republic of Kazakhstan and Climate Change Coordination Centre. The project partners are the UNEP Risø Centre (URC) and the Asian Institute of Technology (AIT) Bangkok. The Project is funded by the Global Environment Facility.

The main goal of the TNA Project is to assist participant countries in identify and analyze of priority technology needs, which may serve as a basis for a portfolio of projects and programs on mitigation and adaption to climate change and provide access to selected measures.

The specific goals of the Project are:

1. identify priorities and technologies on adaptation and mitigation, and promote the national goals of sustainable development;
2. identify barriers to the acquisition, deployment and diffusion of priority technologies;
3. develop technology action plans (TAPs) to overcome barriers and facilitate the transfer, adoption and diffusion of certain technologies in the participating countries.

1.2. The national policies on climate change adaptation and mitigation and development priorities

Kazakhstan is one of the most vulnerable countries to climate change. The Republic has faced the problem of drying up of the Aral Sea, shoaling of the Lake Balkhash, degradation of glaciers, risks of water scarcity and flooding in the coastal regions of the Caspian Sea, which in its turn leads to the industrial and oil pollution in the Kazakhstan part of the Caspian Sea.

In Kazakhstan there is also a risk of landscape degradation and impoverishment. According to the experts' estimates, more than 60% of the country's territory is subject to severe desertification, which leads to a decrease in soil fertility, and, consequently, reduces the productivity of livestock and crop production. The intensive pollution of air, water and soil, degradation of flora and fauna, depletion of natural resources have led to the destruction of ecosystems, desertification, and significant loss of biological and landscape diversity and increase in morbidity and mortality of the population. The consequences of these changes are the reduction of the quality of life and unsustainable development of the country.

Currently, Kazakhstan is faced with the climate change impacts on the lives of people and natural resources, society, infrastructure and economic development. The climate change is not only an environmental, but it is also a socio-economic issue. The resilience to climate change is essential for the development, both in Kazakhstan and other countries in the region.

The climate change not only adversely affects the socio-economic development of Kazakhstan, but at the same time creates conditions for accelerating the process of the development, transfer and deployment of clean technologies, mitigation its consequences and adaptation to climate change and further transition to a low-carbon economy.

Recognizing the problem of climate change, Kazakhstan ratified the UN Framework Convention on Climate Change in 1995. In accordance with Articles 4.1 (c), (j) and 12 of the Convention, under which the countries periodically submit reports on actions to address climate change to the Conference of the Parties, Kazakhstan has prepared and presented the First National Communication at the Fourth Conference of the Parties. At the same conference the voluntary quantitative commitments to reduce greenhouse gases emissions were announced. The Kyoto Protocol to the UNFCCC was signed by Kazakhstan in 1999 and ratified in March 2009. At the seventh Conference of the Parties in Morocco it was agreed that *Kazakhstan is a non- Annex 1 country under the Convention and in the case of ratification of the Protocol and its entry into force, Kazakhstan becomes Annex 1 country under the Kyoto Protocol.*

Since 2000, Kazakhstan has held an annual inventory of GHG emissions. In May 2009 in Bonn, Kazakhstan had developed and submitted the Second National Communication to the UNFCCC. In the same year in Barcelona, Kazakhstan announced about its quantitative reductions of GHG emissions for the post 2012 period - by 15% by 2020 and by 25% by 2050 against the base 1992 and an inventory in the form of Annex I countries was submitted to the UNFCCC Secretariat.

Since December 2012 Kazakhstan was included in the number of countries of Annex B under the Kyoto Protocol.

A series of laws and regulations directly or indirectly aimed at adapting to climate change were developed and adopted in the Republic. Among them, it should be noted:

1. Environmental Code of the Republic of Kazakhstan, January 9, 2007 № 212-III;
2. Water Code of the Republic of Kazakhstan, July 9, 2003, № 481-II;
3. Forest Code of the Republic of Kazakhstan, 8 July 2003, № 477-II;
4. Land Code of the Republic of Kazakhstan, June 20, 2003, № 442-II;
5. Law on Protection, Reproduction and Use of Animals of the

Republic of Kazakhstan, July 9, 2004, № 593-II;

6. Law on Specially Protected Natural Areas of the Republic of Kazakhstan, July 7, 2006, № 175-III.

State policy, covering the issues of adaptation, is reflected in the following papers:

1. Long-term Development Strategy of Kazakhstan "Kazakhstan-2030", (1997);

2. Strategic Plan for the Development of Kazakhstan till 2020 (February 1, 2010, № 922) is the basis for the development of strategic plans of ministries and agencies, national companies, regions, cities of Astana and Almaty;

It should be noted that the issues on adaptation to climate change are component parts of the Programs, which have been implemented or being implemented in the country:

1. **The "Ak bulak" Program** for 2011 - 2020 (provision of the population with drinking water in required quantity and quality assured), Decision of the Government of the Republic of Kazakhstan, May 24, 2011, № 570;

2. The "Agrobusiness-2020" Program on Agro-industrial Complex Development in the Republic of Kazakhstan for 2013 - 2020, *the Resolution of the Government of the Republic of Kazakhstan dated February 18, 2013 No.151;*

3. **The "Drinking Water" Program** (implementation period 2002-2010)

4. **The "Zhasyl Damu" Program** for 2010 - 2014, *the Resolution of the Government of the Republic of Kazakhstan dated September 10 № 924,* is focused on the application of the principle of "green economy". It defines the activities for the development of international relations, scientific support for environmental protection and environmental management, the system of monitoring of environment and natural resources, issues on environmental education, and public awareness raising.

Consistently continuing the policies to address the climate change issues the **Concept on the Transition of Kazakhstan to the Low-carbon Development by 2050**, which defines the direction, activities and mechanisms of the transition to a low-emission development in Kazakhstan and the National Concept of Kazakhstan on Adaptation to Climate Change was developed by the country with the support of UNDP in 2010.

In December 2011 amendments to the Environmental Code of the Republic of Kazakhstan were adopted for the purpose of state regulation of greenhouse gases emissions. On the basis of the provisions of Chapter 9-1 of the Code, since 2013 the Greenhouse gases emissions trading scheme will be operational in the county. The system involves the use of project-based mechanisms of internal emissions reductions and issuance of certificates on emission reduction that can be used by companies to fulfill their obligations under the quota system.

CHAPTER 2. INSTITUTIONAL ARRANGEMENT FOR TECHNOLOGICAL NEEDS ASSESSMENT AND INVOLVEMENT OF STAKEHOLDER`

The Ministry of Environmental Protection (MEP) is the national Focal Point to implement the UNFCCC and the Kyoto Protocol.

The Department of Low Carbon Development (DLCD) is responsible for: i) leading and coordinating the implementation of the UNFCCC and the Kyoto Protocol, ii) coordinating body with other agencies and the UNFCCC Secretariat contact point and also for *Kazakhstan's National Communications to the UNFCCC.*

2.1 National TNA Team

National Supervising Agency: Ministry of Environment Protection.

National Coordination Institution Body: Department of Low Carbon Development.

The TNA process leds by the National Steering Committee for TNA Project.

National Executing Agency is Climate Change Coordination Centre

In order to attract a wide range of stakeholders to coordinate and support the implementation of the Project the National Project Steering Committee, headed by Vice-Minister of Environment Protection, was established. The Committee included representatives from the Ministries of: Healthcare, Industry and New technologies, Agriculture, Transport and Communications, Emergency situations; as well as Nazarbayev University (Center for Energy Researches). The full list of members of the Committee is given in Annex 2.

Institutional arrangement of the Project is as follows:

Figure 2.1 Project Institutional Arrangement

The TNA process led by the National Steering Committee, which is headed by the Ministry of Environmental Protection, and formed from representatives of the Ministries of Environment Protection, Agriculture, Industry and New Technologies, Health, Emergency Situations and Nazarbayev University.

2.2. Stakeholder Engagement Process

The project has been implemented in collaboration with UNEP Risoe Center and AIT.

An inception workshop under the Project was held in August 3, 2011 in Astana, where the following presentations were presented:

1. Project's goals and objectives;
2. Work Plan;
3. Policy documents: the basis for prioritization of sectors, subsectors of the economy, technologies;
4. Methodological approaches used to implement the Project.

Two sets of criteria have been considered for selection of technologies: general, country level criteria based on country's priorities and sector specific criteria. The country wise general criteria are listed in the chapter 3 of this report, while sector wise specific criteria are considered in the sector related chapters. The general criteria are based on state priorities defined in “Strategy 2020” and “Strategy 2030” and other strategic documents and programmes. The second step in the decision making process was the assessment of sectors and ecosystems most vulnerable to climate change. Assessment of the sectors and their vulnerability to climate change was carried out in the First and Second National Communications of Kazakhstan, where grain production and livestock breeding were identified as the most vulnerable sectors. And the final step in the selection of sectors was the workshop with 32 participants held on 3th August, 2011.

Representatives of the Ministries of: Environment Protection, Industry and New Technologies, Agriculture, Transport and Communications, Emergency Situations, Healthcare, Foreign Affairs; as well as Agency for Statistics, Center for Energy Researches of Nazarbayev University, KAZENERGY Association, KazahCarbon, Kazakhstan Institute for Industry Development, Kazakhstan Business Association for Sustainable Development, Association for Water Supply and Wastewater Disposal "KazahstanSuArnasy", RSE "Kazakh Scientific-Research Institute for Environment and Climate" of the Ministry of Environment Protection and others participated in the workshop.

The National TNA Team had two groups of experts on adaptation: water resources and agriculture. The team included members that familiar with national development objectives and sector policies, overall insights in climate change science, and potential climate change impacts for the country, adaptation needs and mitigation options of climate change. The intermediate results were discussed in two working groups – on impacts mitigation and adaptation to climate change. The working group on adaptation included representatives from Climate Change Coordination Centre, Shortandy Scientific and Research Institute for Grain Farming, State Agrotechnical University named after S.Seyfillin, International Maise and Wheat Improvement Center and Kazakh Scientific-Research Institute for Environment and Climate.

The details for the stakeholders consulted provided in Annex 2.

The tasks of TNA Team included:

- Identifying national development priorities on the basis of national plans, National Communications, energy plans, previous TNAs; identifying and categorizing the country’s sectors, and identifying potential technologies for mitigation and adaptation.
- Leading the process of technology needs assessment, identifying assessment criteria, and identifying and addressing the barriers.
- Preparing the TAP - a roadmap of policies that will be required to removing the barriers;
- Preparing the mid-term reports and final report (TNA and TAP).

CHAPTER 3. SECTOR SELECTION

Agriculture is one of the key sectors of the economy of Kazakhstan. Agriculture as one of the priorities of country’s economic development, has huge potential and large reserves. The agro-industrial complex of Kazakhstan is based on two components: crop production and livestock breeding.

Crop production is the main sector of agricultural production, providing the population with food, livestock - forages, industry - raw materials for processing. Most of the cropland of the country is rendered for cereal crops. Primary production of spring wheat, oats, barley and other cereal crops is in the north of the country, as the climatic conditions of the region are favorable for the cultivation of these types of agricultural products. The southern region of the country is favorable for the cultivation of cotton, sugar beet, rice, yellow tobacco, orchards and vineyards.

Yield level of grain and leguminous crops is primarily dependent on weather conditions; respectively, from year to year it varies in a wide range. For example, the average yield of wheat in the last five years ranged from 700 to 1300 kg / ha.

As a whole, the territory of Kazakhstan is characterized by intensive aridity, its major area - in the global holistic system sector of the Earth's biosphere, are dry steppes, semi-deserts and deserts with sharply continental foot-of-the mountain-climatic conditions.

The soil condition, on which the crop productivity depends, varies throughout the whole territory of the country. It is characterized by an ecological problem related to human activity impact. About 250 thousand ha of lands are removed annually from agricultural turn over. The soils in a number of regions of the republic are polluted by pesticides and toxic substances of industrial nature. The major land areas are exposed to soil degradation as a result of erosion, salinization, swamping, chemical pollution and other processes. One of the greatest factors is erosion (wind, water).

When speaking about ecological condition of the topsoil in the republic, one should not forget about intensively degraded pastures as a result of overgrazing and irrational use of them, which are also considered to be destroyed lands. The area of degraded pastures reaches 60 mln ha including the areas removed from agricultural use - 15 mln ha.

There are vast land areas destroyed and polluted as a result of technogenic and transport load, as well as oil and bitumen wastes and oil and gas emissions in the Pre-Caspian region, such areas occupy 5 mln ha. Besides, in many region of the republic, to say nothing about Semipalatinsk test site, nucleus tests particularly hazardous for the topsoil were conducted. They number over 20 nuclear and over 500 air and underground explosions.

The gross yield of grain and leguminous crops was high in 2007 and 2009, exceeding 20 million tonnes (wheat - about 17 million tons). These volumes meet the domestic needs in the grain and maintain the export potential of the state. However, in drought years of 2008 and 2010 the gross yield decreased significantly. In 2010 the gross yield of grain and leguminous crops was only 12.2 million tonnes, wheat - 9.6 million tonnes because of the drought.

At present, the total cultivated area in Kazakhstan is more than 21.0 million hectares, and more than 75% of this area is planted with the most valuable cereals. The wheat, mostly spring wheat, has the largest share in total sown area and in total grain production. The main cultivated area of spring wheat is in the north. In four regions (Akmola, Kostanai, North Kazakhstan and Pavlodar) on average this culture occupies more than 12.0 million hectares or 89% of the total area of wheat in the country, and in the west (West Kazakhstan and Aktobe) - only 1636 thousand hectares, or 7.4%. Barley ranks second in cultivation area and in total grain production.

Thus, considering all the above indicators it may be concluded that the focal area of crop production, and very dependent on weather conditions is grain production, namely the cultivation of wheat.

Kazakhstan's Livestock Sector has a significant but not fully used potential for development. Livestock production has been the key economic activity in Kazakhstan for centuries and remains as a main source of employment, food and rural incomes. The extensive grazing lands and hayfields of Kazakhstan provide an important industrial base.

Today the leading enterprises on livestock breeding of the country are dealing with sheep and cattle breeding. In the period from 1990 to 1998 the number of cattle decreased from 9.8 million to 3.9 million heads, while sheep and goats - from 35.7 million to 9.5 million heads. By 2010 the number of sheep and goats reached nearly 18.0 million, cattle - 6.2 million.

The main number of sheep and goats (63%) are bred in South Kazakhstan, Almaty, Zhambyl and East Kazakhstan regions, 2-3 million heads in each. Also in Aktobe and Karaganda regions there are 1 million heads in each. The number of cattle is widespread (except for desert areas), but most of all they are in the South Kazakhstan, Almaty, East Kazakhstan and Kostanai regions, 500-800 thousand heads in each.

If we compare the dependence of cattle and sheep breeding on natural conditions, the dependence of sheep breeding on the weather (climate) conditions is obvious.

In Kazakhstan cattle is kept mostly in stabling, and sheep and goats in grazing fields. The climate conditions of the southern half of Kazakhstan determine the transhumance system. Furthermore, the weather and climate conditions affect the animals in two ways: firstly, determine the state of pasture vegetation, the main source of forages; secondly, have a direct impact on the animals' organism.

Thus, considering all the above indicators it may be concluded that sheep breeding is the priority and the most climate-sensitive subsector in the livestock breeding sector of the country.

3.1. An Overview of Expected Climate Change and Impacts on the Sectors Vulnerable to Climate Change

The climate change scenarios for Kazakhstan *Technology Assessment* have been developed for temperature and precipitation; and the influence of surface air temperature as well as precipitation on the degree of soil surface wetting in the plain areas of Kazakhstan.

In order to develop scenarios 4.1 ver. MAGICC/SCENGEN software (Model of the Assessment of Greenhouse-gas Induced Climate Change / Scenario Generator) was used. Three scenarios on increasing greenhouse gas concentrations were used: P-50 scenario - a median scenario, A1F1 and B1 scenarios - extremely high and low (Table 3.1) [6].

Table 3.1 Projected changes in mean annual temperature and precipitation for the three climate scenarios by 2030, 2050 and 2085

	2030			2050			2085		
	median	extremely high	extremely low	median	extremely high	extremely low	median	extremely high	extremely low
Mean annual temperature, C	+1.3÷1.9	1.2÷1.9	1.5÷2.2	+2.3÷2.5	– 2.5÷4.0 ºC	– 1.6÷2.6	+4.2÷6	– 5.7 ÷8.0	– 3.1÷3.4
Annual precipitation, %	-2÷+7	- 2 ÷ 8	0÷8	-3÷12	-4÷15	- 3÷ 9	-6÷20	8 - 28	- 2÷13

Source: Technical Report of the UNDP project Enabling Activities for the Preparation of Kazakhstan's Second National Communication to the UNFCCC*, 2008*

Model calculations, under all climate change scenarios, show an increase in mean annual air temperature in the Republic of Kazakhstan; there is no clear trend in changes in precipitation.

Changes in seasonal air temperature, under different scenarios of increasing of CO_2 increasing concentrations and under different models, are almost in the same ranges as the changes in mean annual temperature.

The worst conditions for wetting are expected under the extremal scenario by 2085, when wet zones shift northward on average by 250-300 km. The Northern regions of Kazakhstan and the extreme Eastern regions would be in the semi-arid zone, and the rest of the territory - in the arid zone. Under the remaining two scenarios - среднему и экстремально низкому, the shift of wetting zones to the North is less significant and on average is about 100 - 120 km[6].

3.1.1. Agriculture: Grain production

Kazakhstan's grain production is largely dependent on the fluctuations and changes in climatic conditions. The territory of the country is situated in the zone of risk farming. The ongoing global climate change will lead to changes in the system of climate - water - agricultural production, which will affect the conditions of growth and yield of spring wheat.

During the study period (1894…2003) the changes in the regimes of air temperature and precipitation occurred. The warming in the region occurred at a rate of 0.09°C/10 years in summer and in autumn, and up to 0.20 ... 0.23°C/10 years in winter and in spring. The increase in the average annual temperature in the region amounted to more than 0.15°C/10 years, i.e. in 110 years period the air temperature in North Kazakhstan has increased by 1.5°C. The trend of seasonal and annual precipitation is negative but statistically insignificant. This combination of temperature and precipitation change indicates the increase of aridity in Kazakhstan in the previous 110 years period.

To assess the vulnerability of grain production in North Kazakhstan the increase in mean surface air temperature, the number of days in the growing season and consumptive use of moisture in the warm period with the air temperature above 5ºC by 2030, 2050, and 2085 were calculated. The FAO recommended Penman-Monteith method was used for the calculations. The climate change scenarios of **A2** and **B2**, which take into account a possible change in the concentration of greenhouse gases and methane, were used. The calculation results showed that the differences between **A2** and **B2** scenarios are small.

In North Kazakhstan there is a lack of regularity of the annual atmospheric moisture because of its arid climate. In order to provide sufficient moisture for crops and create a sustainable yield, under the both scenarios more intense evaporation from farm fields is expected in the long term. This indicates a possible increase in the intensity of atmospheric and soil drought, and therefore there is a need to develop adaptation measures in grain production [6].
In general, the possible change of climate conditions in Northern Kazakhstan can be described as warming, accompanied by increased aridity. Calculations performed under the model of efficiency and climate change scenarios, show a decrease in grain yield. However, the reduction will occur at different rates, depending on the increase in CO_2 concentration. In general, calculations have shown positive effects of increased CO_2 concentration on the yield of spring wheat. At the same time a significant increase in air temperature will adversely affect plant growth and development, which will ultimately lead to a substantial reduction in crop yields.

Thus, further development of Kazakhstan's grain production should take place taking into account the adaptation to possible climate change.

3.1.2. Livestock breeding (sheep breeding)

In the conditions of sharp continental climate in Kazakhstan assessment of the impact of unfavorable weather events on animals is important in all seasons. Due to the low yield of pasture vegetation, lack of moisture and climatic features of Kazakhstan sheep herders are forced to drive the sheep throughout the year for long distances.

The main indicators that affect the productivity of sheep are the number of days impossible for grazing during the cold period (NUD), shearing time, duration of the stable hot summer period (SHP), air temperature, rainfall amount in several periods and pasture productivity.

The climate change, which has led to temperature increase, has not affect the average productivity of sheep breeding. However, in the years with unfavorable weather conditions, the productivity of sheep breeding decreased sharply, in some years up to 50% of mean level. In a long-term period, the average duration of SHP in the south had a steady upward trend. During the 40 years period the duration of the period increased by 12 days (11%). In the last decade the frequency of abnormally hot summers with high level of SHP (more than 120 days) has increased. Both the duration of SHP and its interannual variability have increased - the standard deviation increased from 9.3 to 11.2. However, during the cold period the number of days impossible for grazing days decreased and the average NUD during this period decreased from 11 to 6 days, although there is a tendency of growing interannual variability.

The research over the past 40 years has shown that winter conditions for sheep breeding have become milder, but the frequency of abnormally cold winters increased. The dates of the spring shearing became earlier and their interannual variability has increased. The summer conditions for grazing became more severe due to the increase in the frequency of abnormally hot summers.

The results of the research showed (Table 3.2), that for sheep breeding winter will become warmer by 20–67%, summer will be hotter by 12–55%, so, the sheep should be sheared by 8–28 % earlier and the average yield of flat pastures will decline by 9-32%. Thus, the conditions for sheep keeping in winter will become better and in summer will significantly worsen.

Table 3.2. The changes in the number of days impossible for grazing in winter (ΔNUD), the revised shearing dates (ΔD), the duration of the stable hot period (ΔSHP) and the pastures productivity (ΔP) in the south of Kazakhstan under the expected climate changes for the A2 and B2 scenarios

Year	Number of days impossible for grazing, %		Revised shearing dates, %		Duration of the stable hot period, %				Pastures productivity, %	
					(fine-fleece sheep)		(karakul sheep)			
	A2	B2	A2	B2	A2	B2	A2	B2	A2	B2
2030	-20	-26	-8	-8	12	22	21	39	-9	-11
2050	-36	-38	-15	-13	24	28	43	50	-16	-16
2085	-67	-58	-28	-20	55	45	96	79	-32	-25

Source: Technical Report of the UNDP project Enabling Activities for the Preparation of Kazakhstan's Second National Communication to the UNFCCC*, 2008*

The greatest decrease in sheep productivity is expected in the south of South Kazakhstan region, in Kyzylorda and Mangystau regions, as well as in the Southern Balkhash. The consequence of global warming includes an increase in stability of meteorological regime in winter pasturage and frequency of abnormal hot summers leading to significant productivity fluctuation in sheep breeding from year to year. In future climate conditions, under the relatively cold winter, relatively hot summer and reduced yield of pastures, sheep productivity will decline by 10-14% (Table 3.3). However, in more unfavorable years, the level of productivity will decrease more significantly.

Table 3.3 The sheep productivity change in the south of Kazakhstan in relatively unfavorable years (the deviation from the norm in 2030, 2050 and 2085)

Scenario	Средне-высокий сценарий эмиссии парниковых газов, A2			Средне-низкий сценарий эмиссии парниковых газов, B2		
Years	2030	2050	2085	2030	2050	2085
Продуктивность овец, %	-10	-11	-14	-10	-11	-12

Source: Technical Report of the UNDP project Enabling Activities for the Preparation of Kazakhstan's Second National Communication to the UNFCCC*, 2008*

Thus, the expected climate change impact has negative consequences:

- the increase of the inter-annual and intra-seasonal variability of the meteorological indicators;
- the increasing frequency of anomalous cold winter and hot summer;
- the difficulty in summer sheep pasturage conditions;
- the reduced pastures productivity and the earlier summer sun burning;
- the significant reduction in animal productivity through inadequate technology for maintaining the pastures.

3.1.3. Water resources

The Republic of Kazakhstan is a region with a low level of water supply. Particularly unforable conditions in this relation are in the flat regions of the country. The mountainous regions of Kazakhstan, where flows for large rivers are formed, occupy only the eastern and southern borders of the Republic.

According to scientists' data, the climate in Kazakhstan is becoming warmer. With the exception of some local regions, temperature rises were recorded in all seasons of the year. For each of the 10 years the average annual air temperature increased by 0.31°C. The highest temperature shift was taking place in Winter – on average by 0.50°C/10 years and 0,60-0,65 C/10 years in the West, and in certain Northern and Central parts of the country. The least temperature shift occurred in Summer, on average by 0.21°C/10 years, in the West – only by 0.04°C/10 years.

The results of precipitation ratio estimating showed that there is increasing climate aridity in the areas of deserts and semi-deserts of Kazakhstan, but in the Urals, in the extreme northern parts of Kazakhstan and in the Saryarka zone there is an increase in total rainfall and the climate is becoming generally wetter. The same trend was seen in the mountainous parts of the South and South-East of the country; however this had less impact on rising air temperatures.

The studies evaluating the glaciations of Kazakhstan's mountains showed that since the end of the Little Ice Age (mid-19th century) glaciations have been in a state of degradation, especially since the early 1970s. The rate of degradation of glaciers in Central Asia is among the highest in the world. The freezing of the South-East Mountains during the last half century was reducing with the average trend about 0.8 % per year in the area and 1% per year in the ice store. In the period of 1955–2004 on the Northern side of the Ileisky Alatau (basins of left inflows of the Ili River) the area of glaciers decreased by 117.26 km^2, or 40.8%.

In the last decade, the volume of river flow from bordering states to Kazakhstan reduced by 15.1 km^3 per year, i.e. decreased from 58.8 km^3 per year to 43.7 km^3 per year. Thus, currently the general resources of river flow in Kazakhstan account to 100.7 km^3 per year [6].

Under such climate change conditions the climate in the agricultural regions will become more arid. The demand for water will grow both for population and industry, as well as neighboring countries of Central Asia and China. The water dependency of Kazakhstan on these countries reaches almost 50%.

The analysis of the norms of the annual flows in 30 river basins showed that there are no significant differences in the quantity of the norms. The exceptions are the rivers of the Balkhash Lake basin, where the flows increased by 8%, mostly due to additional flows of melt waters from glacier degradation. Thus, in the second half of the 20th century and in early 21st century no significant changes in natural flow in Kazakhstan under the influence of climate change have occurred.

The assessment of expected vulnerability of water resources of Kazakhstan due to the anthropogenic climate change is carried out on the basis of an improved model of flow formation developed at the Kazakh Research Hydrometeorological Institute (KazNIGMI). Daily amounts of precipitation and average daily air temperature data from the meteorological stations were the input data for modeling the flow hydrograph in accordance with the greenhouse gas concentration change under the A2 and B2 scenarios for the period till 2030 and for the period till 2050. The assessment results are shown in Table 3.4.

Table 3.4 The changes of the river flowing (ΔW, %), the sums of the atmospheric falls (ΔX, %) and air temperature (ΔT oC) under the anthropogenic climate change in the rivers' basins for the outlook to 2030 and 2050

River	ΔW, %		ΔX, %		ΔT °C	
	A2	B2	A2	B2	A2	B2
2030						
Uba +Ulba	16	9.88	1.6	4.67	1.29	1.51
Tobol	-10.3	-6.05	1.22	3.24	1.25	1.61
Ishim	-7.02	-6.76	1.35	4.57	1.24	1.52
Ily	14.2	12.3	2.01	4.01	1.19	1.59
Karatal	16.6	9.26	0.02	0.85	1.29	1.59
Koksu	22.5	9,25	0.02	0.85	1.29	1.59
Arys	0.75	-1.95	2.86	1.85	1.31	1.72
Shayan	4.54	2.50	2.86	1.85	1.31	1.72
2050						
Uba +Ulba	5.72	3.17	3.95	18.8	2.47	2.38
Tobol	-4.38	-8.48	2.99	4.87	2.41	2.51
Ishim	-7.82	-7.96	3.79	6.88	2.41	2.40
Arys	1.29	-7.25	3.14	2.11	2.48	2.64
Shayan	12.7	-19.5	3.14	2.11	2.48	2.64

Source: Technical Report of the UNDP project Enabling Activities for the Preparation of Kazakhstan's Second National Communication to the UNFCCC*, 2008*

So, we may consider that, under the influence of the anthropogenic climate change, an increase of the water resources in the mountain areas and decrease in the flat areas of Kazakhstan will occur.

The analysis shows that the increase in winter snow coverage in mountain areas leads to increases in flows during the spring period. The increase in air temperature is not so much to lead to a significant earlier defrosting of soil, and as a result to the increase of flow losses during the spring flood.

A different situation is experienced in the flat basins. Due to the losses in the catchment area the volume of flow is less influenced by the increased precipitation. In the flat basins the dependence on the air temperature has been more clearly observed. In case of its increase, a decrease of autumn frost depth and as a consequence an increase of flow losses for infiltration has been observed.

By 2030, according to the A2 scenario, the water resources in Kazakhstan's mountain basis will increase on average by 0.8% - 4.5% in the basins of the Arys and Shayan Rivers, by 14% - 22.5% in the basins of the Ily, Uba, Ulba, Karatal and Koksu Rivers. However, in the flat basins of the Ishim and Tobol Rivers they will decrease by 7.0% and 10.3% respectively.

According to the B2 scenario, the river flows in the mountain areas will increase by 2.5% in the basin of the Shayan River and by 12.3%- 9,2% in the basins of the Ily, Uba, Ulba, Karatal and Koksu Rivers. In the basin of the Arys River it will decrease insignificantly, i.e. by 1.9%. It should be noted, that the B2 scenario is more concrete for the mountain areas than for the flat basins. In the basins of the Ishym and Tobol Rivers the water resources will reduce by 6.1% and 6.8% respectively.

If climate change for the A2 scenario in 2050 occurs, then the water resources in Kazakhstan's mountain areas will increase, on average from 1.3%-12.7% in the basins of the Arys and Shayan Rivers to 5.7% in the basins of the Uba, Ulba Rivers. In the basins of the Ishym and Tobol rivers flowing in flat areas it will decrease by 7.8% and 4.4% respectively. According to the more concrete B2 scenario there will not be an increase of flows in the mountain areas, it will decrease in the range of from 7.2% to 19.5% in the basins of the Arys and Shayan Rivers and only in the basins of the Uba, Ulba Rivers the flow will increase by 3.2%. It should be noted, that the B2 scenario for 2050 is also more concrete for the flat basins. So, the water resources in the basins of the Ishim and Tobol Rivers will decrease by 7.9% and 8.5% respectively [6].

3.2. Process and criteria of sector prioritization

Sector prioritization process and criteria for subsequent assessment of adaptation technology needs were carried out in accordance with the Handbook on conducting technology needs assessment for climate change by the UNFCCC and the United Nations Development Programme (UNDP), published in November 2010. Several results in this report are inherited from Kazakhstan's Second National Communication to the UNFCCC (May, 2009). According with the Guidance the analysis of priority sectors set out in the strategic documents and development plans of the Republic was carried out.

- The Water Industry Development and Modernization Program of the Republic of Kazakhstan by 2020 (at a development stage);
- The program of the modernization of housing and communal services of the Republic of Kazakhstan for 2011 - 2020;
- The "Agrobusiness-2020" Program on Agro-industrial Complex Development in the Republic of Kazakhstan for 2013 - 2020;
- The State Program on Forced Industrial-innovative Development of the Republic of Kazakhstan for 2010-2014.

Analysis of strategic plans and programs showed the priority of the following sectors in Kazakhstan: agriculture and water resources. The results of assessment of national reports, prepared in accordance with international requirements of the UNFCCC, confirm these priorities and they are given in Annex 3.

Since the purpose of the work is not only economic development priorities ranking, in the next stage the impact of the previously selected sectors on environmental, safety and social issues was assessed.

The analysis of the impact of priority sectors development on economic, social and environmental priorities, and vulnerability to climate change has been carried out (Table 3.5).

Table 3.5 Scoring matrix of prioritizing sectors for adaptation

	Economic priorities	Social priorities	Environmental priorities	Vulnerability to climate change	Total benefits
Agriculture	5	5	3	5	18
Water resources	5	5	5	5	20
Forestry	3	1	3	3	10
Biodiversity	3	1	4	3	8

In order to assess the sectors and sub-sectors a six point scale has been used:

0 — no benefit
1 — faintly desirable
2 — fairly desirable
3 — moderately desirable
4 — very desirable
5 — extremely desirable

The criteria used are given equal weightage at this stage.

3.2.1. Prioritization of subsectors for agriculture

According to our assessment two subsectors of agriculture (crop production and sheep breeding) have approximately the same estimated scores, 20-21 points to each. It is followed by cattle breeding and horse breeding, as well as the cultivation of oilseeds and legumes (by 18-19 points) (Table 3.6).

Table 3.6 Matrix for prioritizing sub-sectors of agriculture

	Subsectors	Economic priorities	Social priorities	Environmental priorities	GHG reduction potential	Climatic vulnerability	Total benefit	Priority
Crop production	**Crops**	5	5	4	2	5	21	1
	Oilseeds	4	4	4	2	5	19	2
	Legumes	4	4	4	2	5	19	3
	Fodder	3	3	4	2	5	17	4
Livestock breeding	**Cattle**	5	5	4	1	3	18	2
	Sheep breeding	5	5	4	1	5	20	1
	Horse-breeding	4	5	4	1	4	18	3
	Pig-breeding	3	3	3	1	2	12	5
	Aviculture	3	4	3	2	2	14	4

Kazakhstan is not only a producer of grain, but also a major exporter of grain due to the high quality of wheat. Kazakhstan annually exports 6-8 million tons of grain and the export potential is up to 10 million tons. The volume of livestock production is also quite high, but does not competitive in foreign markets because of poor quality. Accordingly, the economic priorities of both sub-sectors can be assessed at 5 points.

The rural population of Kazakhstan is mainly engaged in grain production and cattle breeding. The share of agriculture in total employment is 32%. Accordingly, the social priority of grain production and livestock breeding sectors is assessed as extremely desirable, i.e. 5 points each.

Environmental priorities of the sectors of agriculture were assigned 4 points each, i.e. as very desirable. Both of these sub-sectors are part of the ecological environment, and at the same time, they use natural resources (soil, water, climate). These natural resources are renewable. Using science-based technologies of grain production and livestock breeding allows avoiding undesirable ecological stress. However, in case of excessively high stress, agriculture may led to degradation of ecological environment. For example, pasture degradation, diminishing of fertility and soil erosion. Eventually, all this can lead to desertification of the area. According to the UN, 179.9 million hectares of the territory of Kazakhstan of 272.5 million hectares are affected by desertification, or 66% of the total area. The damage caused by the degradation of pastures equals to $963 million. The loss of income because of the erosion of tillage equals to $779 million, because of the secondary salinization - $ 375 million. The total damage from the loss of humus in Kazakhstan is estimated by international experts at $2.5 billion. Fertile land degradation continues, partly because of the environmental issues, partly because of the primitive technologies of cultivation [2].

The impact of agriculture on greenhouse gas reduction potential is not unique. Whereas soil treatment and fertilization lead to GHG emissions to atmosphere, growing plants absorb it. However, this process can be somewhat balanced through the introduction of soil conservation technologies on cultivation. Animals also contribute to the GHGs emissions to atmosphere, and pastures absorb GHGs. The volume of emissions from agriculture is the third highest in total national emissions of gases with direct greenhouse effect. In 2005 the share of emissions from agriculture amounted to 9.4% of total national GHG emissions. The shares of methane and nitrous oxide in the total flow of GHGs from agriculture are 53% and 47% accordingly. The share of livestock breeding in the structure of methane emission is the highest (96%). The greatest share in the structure of nitrous oxide emissions is agricultural soils treatment (97%) [2]. It may be argued that with the development of grain production and livestock breeding, even in case of introduction of advanced technologies, the GHG emissions to atmosphere will increase. The agriculture of Kazakhstan has a low potential to reduce GHG emissions. Accordingly, this item was rated as 1-2 points.

The climate vulnerability of all subsectors of crop production and subsectors and the sheep-breeding subsector is assessed as extremely desirable (5 points), since they are closely dependent on weather conditions.

3.2.2. Prioritization of sub sectors for water

The climate change has a negative impact on economic growth in general, and to a greater degree on those industries that depend on the availability of water resources, such as drinking water supply, health care, industrial water supply, agriculture, hydropower, water transport, fisheries, forestry and water management, coastal zones, biodiversity and ecosystems. Adaptation of these sectors to the impacts of climate change is only possible through the introduction of new technologies. On the one hand, it would reduce the vulnerability of these sectors to the impacts of climate change, on the other hand, increase the efficiency of use of natural resources use and increase the GDP per capita.

The water resources, mainly surface water, are used in the agriculture sector of Kazakhstan for irrigation, irrigation of pastures, water supply to livestock farms, in public utilities and industry. Also, the water users are hydropower, water transport, fisheries, and water withdrawal is not needed for these water management sub-sectors.

In addition, the largest consumer of water in Kazakhstan (70% of the total water used) is agriculture, where it is used for watering and irrigation. It is the agricultural irrigation, the water management sub-sector, which should be given a priority. It is this subsector that is characterized by poor organization of water metering.

Another equally important subsector is drinking (municipal) water supply. Its priority is determined, firstly, by the physiological need for water of every living thing on the Earth, including people, and secondly, high wear of systems and facilities (fixed assets) of drinking water supply in Kazakhstan, which entails a large loss of water, excessive consumption of electric power and reagents, and as a consequence, high water rates (tariffs). However, wastewater disposal cannot be considered separately from water supply since we should dewater and purify as much waste (polluted) water as much water we use for water supply.

Also, 100% water accounting is not organized in this sub-sector. According to the "Ak bulak " Program, 100% coverage of the population by water meters in urban areas is planned in 2013, and in rural areas - only 55% coverage in 2015 and 80% coverage in 2020.

The evaluation of the matrix of the sectors impact on socio-economic parameters also demonstrates the priority of the previously selected sectors: agriculture and water resources.

In order to identify a short list of sub-sectors the main sub-sectors of water management of Kazakhstan and the characteristics according to the importance of their input and benefits for the sustainable development of the country are presented below in Table 3.7 in the following assessment scheme (in points): 0 — no benefit; 1 — faintly desirable; 2 — fairly desirable; 3 — moderately desirable; 4 — very desirable; 5 — extremely desirable.

Table 3.7 Matrix for prioritizing of water sector sub-sectors of the Republic of Kazakhstan

Main sub-sectors of the water sector	Economic priorities	Social priorities	Environmental Priorities	Climate vulnerability	Total benefit
Water management and drinking water supply	5	5	5	4	19
Agricultural irrigation	5	4	5	4	18
Health care	4	5	4	4	17
Industrial water supply	4	3	5	4	16
Hydropower industry	4	3	4	4	15
Water management (water-supply engineering)	5	3	3	2	13
Ecosystems (river and water basins, wetlands, etc.)	3	2	4	3	12
Loss of biodiversity	3	2	3	3	11
Fish industry	3	2	2	2	9

Thus, two main priority sub-sectors of the water sector of Kazakhstan of paramount importance are water management and agricultural irrigation.

CHAPTER 4. TECHNOLOGIES PRIORITIZATION FOR AGRICULTURE SECTOR

4.1 Current Technologies in Agriculture

4.1.1 Crop production (grain production)

Currently, the total area of crops in Kazakhstan is more than 21.0 million hectares, over 75% of the area is occupied by the most valuable cereals. The wheat, mostly spring wheat, has the largest crop area and gross yield. The main crop areas for spring wheat cultivation are in the north. In four regions (Akmola, Kostanai, North Kazakhstan and Pavlodar) this culture occupies at average more than 12.0 million hectares or 89% of the total area for wheat, and in the West (West Kazakhstan and Aktobe) - only 1636 thousand hectares, or 7.4%. Barley crop fields are the second largest crop areas with the second largest gross yield.

4.1.1.1 Spring wheat

Two types of spring wheat are cultivated in the country: soft and hard. The most common is soft wheat; its varieties are ductility and occupy a large area. The late-season varieties have high possibility to use later precipitations than the mid-season ones. This is very important for the conditions of the North and Central Kazakhstan.

For seeding of spring wheat the best land should be allocated, as well as they should be planted on the best forecrops. Fallow is the best forecrop for spring wheat in the arid zone. Fallow is used for weed control and to accumulate nutrients and moisture. However, fallow has some disadvantages: no harvest is produced within one year; there are costs for the field cultivation and unproductive loss of humus. In this regard, in farms with high farming standards the fallow is being replaced by fallow-crops: peas, oats, etc. Fallow tillage is conducted in strict accordance with the zonal farming systems. The soil is cultivated by spraying infested fields with herbicides to reduce the number of mechanical cultivation of fallow lands and to conserve moisture.

For the steppe zone, short-term fallow rotations based on minimum tillage technology are applied.

Soil preparation under wheat depends on a zone, a forecrop, soil characteristics, a degree of infestation, dominant weed species, and many other conditions.

The period of spring wheat sowing is defined taking into account the zonal features and it is one of the decisive factors that largely determine the level and quality of grain and seeds. The difference in climate conditions of Kazakhstan require a special approach to the selection of optimum sowing period for spring wheat.

The most perfect way of seeding is the method that provides the area of plant nutrition, approaching to a square in shape. Since the spring wheat tillers less than barley and oats, it is responsive to a slight increase in sowing rate. On fertile soils with adequate moisture and on weedy fields the seeding rate is increased and in dry areas it is decreased.

Harrowing, chemical control measures, fertilizing can be used for wheat plantings. Two methods of harvesting can be used: separate and direct harvesting.

4.1.1.2. Spring barley

The barley is the second crop in relation to crop area and the gross yield. The crop area of spring barley in recent years amounted to 1.9 million hectares. The crop yield of barley, in recent years, on an average amounted to 1020 kg / ha, but the potential is at the level of 2000-2500 kg/ha.

This crop is resistant to high temperatures, so it is high-yielding in almost all areas of Kazakhstan. Spring barley is a type of crop with early date of sowing, in rainfed zones it is sown early. Early sowing of barley associated with their biological feature to germinate at low temperatures and withstand spring frosts.

In North Kazakhstan the best sowing date, both grain and animal feed, is the end of May - beginning of June that allows disposing of weeds, including wild oats, and making the best use of summer rainfall.

The optimum sowing period for barley in Central Kazakhstan is May 25-28. In West and East Kazakhstan barley is sown on May 15-25. In the foothill steppe zone of East Kazakhstan the optimal period of sowing barley is the end of April, with the rate of 6.0 million viable seeds/ha. Cultivars of spring barley admitted to use are:

Early-ripe: Arna, Asem, Baysheshek, Saule;

Mid-season: Tselinnyi 91, Donetski 8, Medikum 85, Karaganda 5, Granal, Zhuldyz, Odesski 100, Sever 1, Tselinnyi 5, Tselinnyi 30, Kedr, Karabalyk 150;

Middle-late: Omsk 87.

4.1.2 Livestock breeding (sheep breeding)

In Kazakhstan sheep breeding is the leading livestock breeding industry. The number of sheep and goats decreased from 36.7 (1987) to 9.5 million (1998) but in recent years has increased to 17.9 million heads (2010). Around 87% of the country's agricultural livestock is concentrated in small cattle farms, and the remaining 13% in agricultural enterprises.

There are four main environmental types of sheep by their adaptation to climatic conditions [4]:

1) Mutton and mutton-wool sheep, that are well adapted to the climate of temperate forests characterized by hydrothermal coefficient (HTC) of 1.2 - 1.6.

2) Worsted and Merino sheep are inhabitants of the steppes and areas with moderate dry Mediterranean climate, with HTC = 0.5 - 1.0.

3) Fat tailed sheep, particularly, are well adapted to arid climate of extratropical and tropical deserts with HTC = 0.2.

4) Northern short-tailed sheep, spread across the north of Europe.

Sheep breeding in Kazakhstan is represented by the following main areas of productivity: fine-wool, semifine-wool, mutton and karakul. Mainly new, more productive species, such as Kazakh fine-wooled, Merino of South Kazkhstan, arkhar-merino, Merino of North Kazakhstan, Kazakh wool-mutton type of Tsigal, factory type of Zadarya Karakul sheep, Edilbayev mutton-tallow (fat-tailed) sheep, etc. are bred [5].

According to bio-climatic conditions A.Chekeres divided the territory of Kazakhstan into 4 zones [10]. Division of the territory is held taking into account the historical systems of sheep breeding in major sheep breeding regions of the country:

- Zone A – Zone of predominant continuous stabling system in winter and favorable conditions during the summer grazing.
- Zone B - Zone of grazing and stabling system in winter and difficult conditions for summer grazing of fine-wool sheep.
- Zone C – Zone of grazing and partly stabling system in winter, difficult and unfavorable conditions for summer grazing of rough-haired and fine-wool sheep respectively.
- Zone D – zone of predominant grazing in winter and extremely severe conditions during the summer grazing of all breeds of sheep

The basis of fodder for livestock in the dry and hot climate and limited water resources are natural pasture of 182 million hectares, of which the desert and semi-desert accounts for over 50% of this area.

Till the 1990s, the former transhumance system allowed to link the natural and economic complex, various seasonal pastures. In the south of Kazakhstan there are predominantly the system of vertical zonality, in central and western regions - horizontal zonality (Fig. 4.1). In Almaty region transhumance of animals was practiced from the desert lowlands of the Chu-Ile Mountains and Taukum, Saryesik-Atyrau sands to the highlands of Trans-Ili Alatau and Djungar Alatau.

In Zhambyl region Moinkum Sands are used as winter pastures, in summer most of the cattle were driven to the Susamyr area and valleys of the Chatkal Ridge. The farms of northern regions of Zhambyl and South Kazakhstan regions used to drive their sheep through Betpak-Dala to the summer pastures of Sary-Arka (Central Kazakhstan). Pastures of Betpak Dala were used in spring and autumn. In the South Kazakhstan region, along with a year-round maintenance of livestock in the Kyzylkum desert, a foothill agricultural strip are used as winter pastures, and pastures of Ugam Mountains and Karatau ridge are used in summer. In Kyzylorda region the sheep were driven from the lower reaches of the Syr Darya River and the northern part of the Kyzylkum desert to the Aral Karakum deserts and semidesert basins of the rivers Irgiz and Sarysu. Also, the routes of cattle drive were stretched: in Mangystau region from winter pastures of Mangyshlak to summer pastures of northwestern Ustyurt, in the Atyrau region from Naryn sands to the headwaters of rivers Sagyz and Emba. Forage reserves, water points were created; facilities for livestock were constructed, etc. on the cattle drive routes.

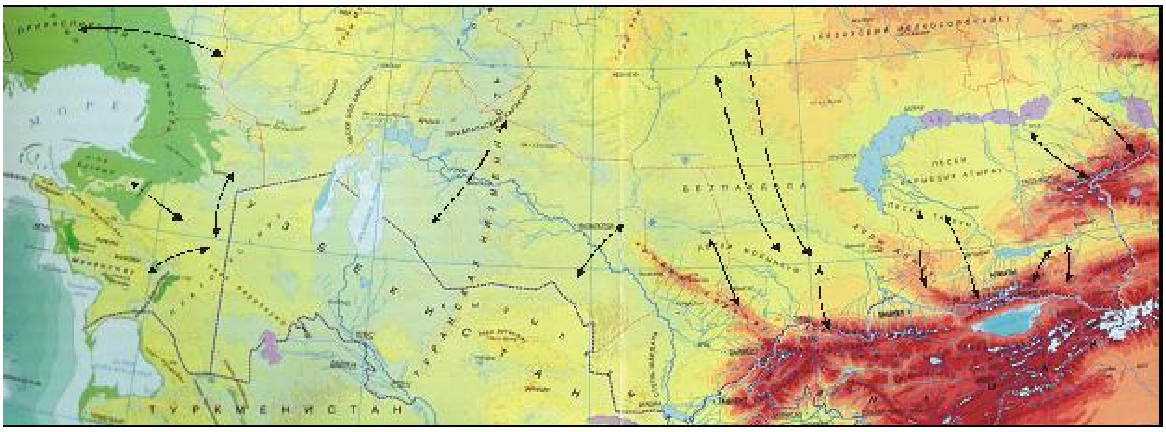

Figure 4.1 Cattle drive routes to winter and summer pastures

Sources: Technical Report of the UNDP project Enabling Activities for the Preparation of Kazakhstan’s Second National Communication to the UNFCCC, 2008

The basis of forage base for livestock in conditions of dry and hot climate and limited water resources is natural pastures on 182 million hectares, more than 50% of which are desert and semi-desert areas.

The most widespread is stabling and grazing system, in which sheep are kept in premises within a certain period, depending on climatic conditions and organization of forage basis, and in summer - on cultivated or natural pastures. This way of sheep breeding is used mainly in the areas of intensive agriculture. Its advantage is that it allows using more efficiently not only the forage (coarse, juicy and concentrated), but also the pastures.

The dates of important activities such as lambing, transhumance, breeding, sheepshearing are also closely related to climatic conditions.

In the area of high-intensity farming, where natural pastures are very few or entirely absent, the sheep breeding is transferred to industrial basis. Some of its elements are introduced in many areas of the country, although this process has not been widely distributed yet.

When sheep production is transferred to industrial basis the stabling and grazing system or the grazing and stabling system is mostly used, and in some areas the system of year-round stabling of sheep is used.

4.2. Potential technologies for crop production and livestock breeding

A detailed description of individual technologies is given in Technology Fact Sheets (See Annex I).

4.2.1. Potential technologies for crop production

The overview of the "Kazakhstan’s Second National Communication to the Conference of the Parties of the UN Framework Convention on Climate Change" and other sources [2, 9, 10, 11, 12, 13, 14, 15, 16] allowed to choose the following technologies for adaptation of grain production to climate change:

1. Implementation of soil and moisture saving technologies (technology No-Till). Zero tillage (No-till) is a direct seeding with use of a complex, i.e. a disk, or a chisel, with minimal disruption of soil. No-Till technology significantly improves the soil fertility through the better control of wind and water erosion, improving the ability of soil to hold water and increasing organic matter content in it. High stubble in the fields holds and accumulates more snow, and granulated and spread out straw improves the structure and quality of soil owing to biological degradation. This reduces the dependency of crops on weather conditions, which is a measure on adaptation to climate change;

2. Crop diversification, with the inclusion of crop adapted to stressful situations. The introduction of new cultivated species and improved varieties of crop is a technology aimed at enhancing plant productivity, quality, and building crop resilience to environmental stresses. In addition, it is necessary to use the potential of selection and gene engineering in order to develop more drought-resistant crop varieties. Breeding new and improved crop varieties enhances the resistance of plants to a variety of stresses that could result from climate change. Crop diversification should also be based on a rational distribution of crops on the basis of agro-ecological and agro-climatic zoning. Diversifying from the monoculture can support a country in becoming more self-reliant in terms of food production. Introducing a greater range of varieties increases natural biodiversity, strengthening the ability of the agro-ecosystem to respond to external stresses reducing the risk of total crop failure.

3. Chemicalization. This technology is focused on rational chemicals use and methods to improve crop productivity, soil characteristics and agricultural products quality to protect crops from pests and diseases. The application of chemical protection means will allow plants resisting to various stresses. All this will lead to improvement of crop productivity.

4. Development of draught resistant varieties. From time to time drought covers vast land cultivation areas of the country. The introduction of new, more draught resistant varieties is of great importance. Along with that the opportunities of selection and gene engineering to nurture more draught resistant grain crops should be used. The selection of new and improved agricultural crop varieties allows strengthening the resistance of plants to various stresses as a result of climate change. The technology allows reducing the risk of yield losses and drought.

4.2.2. Potential technologies for livestock breeding

The overview of the "Kazakhstan's Second National Communication to the Conference of the Parties of the UN Framework Convention on Climate Change ", and other sources [2, 7, 20, 21, 22, 23, 24] allowed to choose the following technologies for adaptation of sheep breeding to climate change:

1. Reestablishment of transhumance system in the southern part of Kazakhstan. In case of the transhumance system the animals are driven from one pasture to another (winter, summer, spring and autumn, as well as year-round). It is necessary to introduce the system of controlled grazing, taking into account the grazing capacity of pastures and climatic conditions, to restore the wells and water points in pastures and legislate rangelands for users. It is also necessary to organize an effective veterinary and sanitary oversight, security and quarantine and other measures. The transhumance system is an adaptation measure to climate change. It allows linking together a variety of seasonal pastures, reducing exogenous stress on animals, using the pasture resources more efficiently, and improving the productivity of livestock;

2. Development of the grazing and stabling system on an industrial basis, especially in the northern half of the country. Here the animals may be kept on

pasture from May to October and during the cold period of the year – in stalls. The transition to the industrial maintenance requires the construction of mechanized farms, introduction of new technologies in order to fully mechanize the production process. Mechanized farms can include parent stock farms, young-stock breeding farms, fattening farms, and farms with a complete production cycle. This reduces the dependence of animal productivity on external weather conditions;

3. Strengthening the genetic potential of the animals through selective breeding. It is necessary to carry out zoo-climatic zoning of sheep breeds in the light of climate change, to determine the degree of adaptability of the sheep and to identify more stress-adapted sheep breeds, separately for each climatic zones of Kazakhstan and their subzones. This measure will allow the animals to adapt quickly to changes in climatic conditions;

4. Pasture improvement. Radical and simplificated improvement of vegetation covers on degraded pastures. Planting saxaul in the desert and semi-desert pastures. Production of coarse fodder by sowing perennial species of grass on fallow lands. Such activities will not only increase food supply for animals, but also mitigate thermal stress for animals.

4.3. Technology Assessment for the Agriculture Sector

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 (Prof. Musynov K.M., Prof. Serekpaev N.A., and Associate Professor Baysholanov S.S.) and on the basis current national priorities and strategies. Certain members of the groups, including Prof. Karabaev, provided their inputs by email.

As a result for agricultural sector have been identified:

Grain production

- No-Till;
- Diversification of crop production;
- Chemicalization;
- Development of drought-resistant varieties;

Livestock breeding

- Reestablishment of the transhumance system;
- Development of the grazing and stabling system on an industrial basis;
- Selective breeding;
- Pasture improvement.

No-Till technology can be applied in the context of the farm, respectively, relets to small-scale technology. It is available in the medium term, as at first it is necessary to achieve high level farming and recover the field from weeds (Table 4.1).

Diversification of crop production should be conducted at the regional level with the same type of soil and climatic conditions, with support of research institutes and experimental farms. Also, a certain time for final determination of species and varieties of crops adapted to climate change of the region is required. Accordingly, this technology is large-scale and long-term.

Restoration of the transhumance system requires the solution of many problems (barriers) at the state level, as well as the procedure of driving and the use of pastures should be regulated by a certain public association or a government entity. Accordingly, this technology is large-scale and long-term.

The grazing and stabling system on an industrial basis is small-scale and medium term system. It can be implemented at the level of a large farm or community. However, the construction of infrastructure and its mechanization will require specific knowledge, financial resources and time.

Table 4.1 Scale and timeline on implementation of the proposed technologies

Sector	Subsector	Technology	Scope of application	Availability
Agriculture	Grain production	No-Till	small-scale	medium term
		Diversification of crop production	large-scale	long-term
		Chemicalization	small-scale	medium term
		Development of drought-resistant varieties	large-scale	long-term
	Sheep breeding	Transhumance system (southern part of the republic)	large-scale	long-term
		Grazing and stabling system on an industrial basis	small-scale	medium term
		Strengthening the genetic potential of the animals through selective breeding	large-scale	long-term
		Pasture improvement	small-scale	medium term

4.4. The criteria of technologies prioritization

A set of the criteria to define the priorities on technologies adaptation in agriculture includes:
- Economic benefits;
- Social benefits;
- Environmental benefits;
- Potential for GHG reduction;
- Adaptation to climate change;
- Innovation costs;
- Training costs.

Based on the criteria specified above the most priority technologies in agriculture have been defined.

4.4.1 Grain Production

Technologies were estimated by all above-mentioned criteria and located as priority. To assess the benefits of the proposed technologies the prioritization matrix has been used. The assessment was conducted on a scale from 0 to 100 points, and the weighting factor (w), from 0 to 0.1, of each criterion was considered. The development of drought-resistant varieties technologies has the highest rate of benefits (Table 4.2).

In assessing the environmental benefits the fact that the No-Till technology is aimed at the least distruction of the soil cover, and crop diversification leads to increase the green cover of the Earth was taken into account.

No-Till technology has higher potential to reduce greenhouse gases, since not disturbed soil releases less carbon dioxide. Crop diversification allows absorbing more CO_2 due to the increase of green matter.

All the proposed technologies are one of the main measures to adapt to climate change. Since the determining factor for the grain production of Kazakhstan is the presence of atmospheric moisture, the highest score was assigned to the cultivation of drought-resistant varieties.

The costs for acquisition of technical and other related equipment were implied under the costs for innovation. Here, higher scores were assigned to technologies requiring less financial resources.

Table 4.2 Matrix for prioritizing technologies of grain production

Technology	Economic benefits	Social benefits	Environmental benefits	Adaptation to climate change	Costs for innovation	Costs for training	Total benefits	Priority
Weighting factor, w	0,1	0,1	0,3	0,2	0,2	0,1	1	
No-Till	90	80	100	90	100	0	85	**1**
Diversification of crop production	100	50	80	70	80	100	79	**2**
Chemicalization	0	100	0	0	70	60	30	**4**
Development of drought-resistant varieties	70	0	60	100	0	80	53	**3**

In assessing the costs for training the technologies requiring less financial resources were assigned higher scores. In our opinion training of farmers in chemicals requires more investment, as well as cultivating drought-resistant varieties developed by breeders. Training of farmers in the correct use of more adapted species or varieties of plants (diversification) was proposed by scientists.

4.4.2 Livestock (Sheep) Breeding

When assessing environmental benefits the fact that the distant-pasture and industrially-based pasture-and-stabling systems allow reducing the load on pastures around the rural populated area and preventing their degradation.

The increase in livestock leads to an increase in greenhouse gases emissions. Therefore, the three technologies were given lower scores. Improvement of pastures allows absorbing more CO_2, due to the increase of green matter.

Table 4.3 Matrix for prioritizing the technologies of sheep breeding

Technology	Economic benefits	Social benefits	Environmental benefits	Adaptation to climate change	Costs for innovation	Costs for training	Total benefits	Priority
Weighting factor	0,1	0,1	0,3	0,2	0,2	0,1		
Transhumance system (southern part of the republic)	50	50	50	70	100	60	65	1
Grazing and stabling system on an industrial basis (all regions)	100	100	40	100	0	0	52	2
Selective stock breeding	40	0	0	50	40	100	32	4
Pasture improvement	0	40	100	0	30	50	45	3

All mentioned technologies have been applied for adaptation. The transition to industrially-based live-stock breeding also allows considerably reducing its dependence on weather conditions. The distant-pasture also leads to the decrease in external load of animals, however, along with that the productivity depends on weather conditions.

When assessing the costs for innovations and training, the higher rates were appropriated to the technologies requiring lower costs. The distant-pasture requires less investments and the transition to industrially-based live-stock breeding leads to greater expenses. The training of farmers in application of selection and breeding technology results in less costs, and the transition to industrially-based sheep breeding requires allocation of greater funds.

So, the proposed technologies of plant growing and live-stock breeding are small-scale and large-scale that may be implemented for mid-term and long-term periods. Of mentioned technologies high benefit rates are defined for grain cultivation - No-Till and diversification, and for live-stock breeding - distant-pasture and industrially-based pasture-and-stabling system.

Weight (W): reflects importance of each **criterion** in decision-making. It considered differences between the upper and lower of the elevation of point and the level of group interest. This is necessary to ensure independence when giving point to one criterion. For example, 100 points for environment is different from 100 point for society.

The experts are asked to give point from 0-100 in TNA Table (0 means least preferable option). The best and least options are identified first and issued in order from 100-0, then come other points of other options.

CHAPTER 5. TECHNOLOGIES PRIORITIATION FOR WATER SECTOR

5.1. Existing practices in the Water Sector

Like in the whole world in Kazakhstan:

- Irrigation systems, hydrotechnical constructions (dams, reservoirs), systems and facilities of municipal water supply and wastewater disposal (sewerages) are used.
- Trainings and upgrading of skills of specialists are conducted. Sanitary and epidemiological control of water quality is provided in order to improve the health of the population.
- An institutional framework for the organizations involved in the adoption and diffusion of new technologies is established and operates. For example, the River Basin Councils created in each water basin, Associations of water users and rural consumer cooperatives of water users for irrigation of irrigated lands, Water services companies (*Vodokanals*), the Association of enterprisers on water supply and wastewater disposal in the country "Kazakhstan Su Arnasy", etc.

Currently, the technologies to provide water supply and wastewater disposal with pipes made of advanced materials (i.e., polyethylene, fiberglass, dci) have been actively introduced. Standard lifetime of such pipes is 50-100 years, in contrast with the previously used steel pipes, standard lifetime of which was 20-25 years. In Kazakhstan several factories for the production of pipes made of fiberglass and polyethylene have been built already.

In recent years, energy-efficient pumps allowing savings of up to 30-40% or more of electricity have been actively introduced as well. Also new effective chemicals for water treatment as well as filtration materials (zeolites) are used.

There are examples of new technologies application in irrigated agriculture, such as sprinkler devices, discrete and drip irrigation instead of the system of watering through irrigating ditches applied in the southern regions of the country, which are increasing the efficiency of water use.

There are many examples of the construction of hydraulic facilities and structures intended to regulate the river flow or to create water reserves for different purposes (domestic and drinking, irrigation, etc.), or, conversely, to prevent flooding. One of them is the construction of flood control dams in the new Kazakh capital - Astana.

To improve the reliability of water supply for Astana the project on the construction of additional water supply source has been started. The reconstruction of Nur-Ishim channel in Akmola is to be completed soon. The main goals of the reconstruction are: to take additional measures to clean up the channel from bottom deposits in order to increase water intake for technical needs of the capital's water supply and use the channel for recreational purposes.

In 2011 the Project "Elimination of Taldy-kol Waste Water Storage" was launched. In the first phase it is planned to provide wastewater discharges into the River Yesil (Ishim) with the application of modern treatment technology. In the second phase the elimination of Taldykol storage will be started. In this phase cleaning of the bottom sediment and decrease of the surface water area of from two thousand hectares to 400 hectares, i.e. to its original size, will be carried out.

All mentioned projects make direct contribution to the improvement of sustainability and adaptation of the country to expected climate change impacts.

In 1997, two desalination plants for water treatment of the French company "Degremon'' of total capacity of 35, 5 thousand m^3/day were put into operation in order to provide Zhanaozen town (Atyrau region) with high-quality drinking water.

In three cities (Almaty, Shymkent and Kyzylorda) to disinfect the drinking water, hypochlorite obtained from the technical salt is used instead of traditional use of chlorine sodium.

In 2010 the construction of Koksarai counterregulator was completed. Koksarai counterregulator is a strategically important hydro facility for the southern regions of the country, designed to rescue people from the annual floods of the Syrdarya River and save the budget from the multimillion costs for the purposes of responding to flood impacts. The Koksarai flood control conterregulator reduces the risk of occurrence of extreme hazard up to 1 time in 200 years and contributes to the restoration of the environment in the lower reaches of the Syrdarya River and the Aral Sea, which creates favorable economic and environmental conditions to improve living standards of the population.

All these projects and implemented technologies allow directly improving the sustainability and adaptation of water management systems and structures in Kazakhstan to expected impacts of climate change.

5.2. Potential technologies for the water sector

Below there is a list of potential water technologies and their expected input to climate change adaptation.

1. <u>Improvement of legislation in drinking (municipal) water supply and wastewater disposal sub-sector</u>

Development of water resources management, creation of a balanced system that is equidistant from water users, compliance with international standards and international obligations, elimination of non-cooperation, promotion of accounting and water conservation. It will allow strengthening the water security of the Republic of Kazakhstan.

2. <u>Renovation of networks and facilities of water supply and wastewater disposal organizations</u>

Reduce water losses and interruptions in water supply, reduce energy consumption and environmental pollution and thus significantly increase the level of adaptation of the sub-sector to expected impacts of climate change.

3. <u>Leakage control, detection and elimination of leakages in pipe networks</u>

Rapid detection and elimination of leakages in pipeline networks using these technologies, significantly reduce the time of operations and the amount of water leakages, do not affect the circulation and, ultimately, increase the level of adaptation to expected impacts of climate change.

4. Catchment of rainwater and melt water, construction of tanks and reservoirs

This activity is an effective tool against drought and water shortages, and the most important contribution to the adaptation expected impacts of climate change.

5. Metering of water for irrigation and watering.

Metering of water in agriculture has not been organized. This technology is designed to improve and to predict the consumption in order to improve the adaptation of this sub-sector to expected impacts of climate change.

6. Reconstruction and renovation of hydrotechnical constructions - HTC (water reservoirs, dams and etc.), irrigation systems and networks

Improvement of such facilities would enable to increase the productivity and therefore to increase the level of adaptation of both water and agricultural sectors to expected impacts of climate change.

7. Technology of drip irrigation

The introduction of this technology would enable to save water reserves and to increase crop yields, as well as to increase the level of adaptation of both water and agricultural sectors to expected impacts of climate change.

8. Extreme events prevention technology

The constant monitoring of weather conditions is required to provide flood warnings. This will identify and assess dangerous hydrological events.

5.3. Technology assessment in the water sector

The main technologies in the water sector of Kazakhstan are presented in Table 5.1.

Table 5.1 Prioritization of technologies in the water sector of Kazakhstan

Sector	Technologies	Scale	Period
Water sector	Improvement of legislation in drinking (municipal) water supply and wastewater disposal sub-sector	Large-scale	Short-term
	Extreme events prevention technology		Long term
	Renovation of networks and facilities of water supply and wastewater disposal organizations		Medium term
	Leakage control, detection and elimination of leakages in pipe networks		Short-term
	Catchment of rainwater and melt water, construction of tanks and reservoirs		Long term
	Metering of water for irrigation and watering	Large-scale	Medium term
	Reconstruction and renovation of hydrotechnical constructions - HTC (water reservoirs, dams and etc.), irrigation systems and networks		Long term
	Drip irrigation technology	Medium scale	Medium term

The most priority type of technologies for adaptation to climate change impacts in Water management sub-sector is technology of extreme events prevention. Application of the technology is possible in the long term (over 5 years).

The most priority types of technologies for adaptation to climate change impacts in the agricultural irrigation subsector are metering of water for irrigation and introduction of drip irrigation technology. Both of these technologies may be implemented in the medium term (up to 5 years).

Most of these types of technologies correspond suite to a number of typologies, since they make impact on some aspects of adaptation to climate change. In addition, they are classified both by scope of application (small-, medium-and large-scale) and by the period of application (short-, medium-and long-term).

To assess the costs and benefits of the proposed technologies the prioritization matrix was used. The assessment was conducted on a scale from 0 to 100 points, and a weighting factor (w) of each criterion from 0 to 1was taken into account (Tables 5.2).

Table 5.2 Matrix of prioritization of the technologies of water management and agricultural irrigation

Technologies	Benefits			Adaptation to climate change	Costs for		Total benefits, including w	Priority
	economical	social	environmental		innovation	training		
Weighting factor, w	0.2	0.2	0.1	0.2	0.2	0.1	1.0	
Extreme events prevention technology	100	100	90	80	0	40	69	1
Drip irrigation technology	70	80	80	100	20	20	64	2
Metering of water for irrigation and watering	80	60	100	90	30	0	62	3
Renovation of networks and facilities of water supply and wastewater disposal organizations	60	70	60	60	50	30	57	4
Leakage control, detection and elimination of leakages in pipe networks	50	50	50	70	60	50	56	5
Catchment of rainwater and melt water, construction of tanks and reservoirs	40	0	70	50	80	100	51	6
Reconstruction and renovation of hydrotechnical constructions - HTC (water reservoirs, dams and etc.), irrigation systems and networks	30	40	40	40	40	60	40	7
Improvement of legislation in drinking (municipal) water supply and wastewater disposal sub-sector	0	30	0	0	100	80	34	8

Despite the fact that most of the water resources in the country withdrawn for consumption are used in agriculture for irrigation, it is the subsector, where the technologies on water resources use are organized worst of all. This is primarily related to the metering technologies of water resources used in agriculture.

To promote economic development of the country and to reduce disaster risks, it is very important to strengthen technical and personnel potential to secure better operative monitoring, forecasting and warning. Moreover, in the conditions of a higher risk level, as well as in view of the new opportunities related to instability and climate changes, the investments into research on climatic modeling, forecasting and analysis should be increased to improve the efficiency of planning in various sectors of social and economic activity.

In spite of water metering, the most acute problem in agricultural irrigation is water-saving, because water for irrigation in the country is used irrationally, without the application of modern water-saving technologies such as drip irrigation.

Thus, in the sub-sector of agricultural irrigation in Kazakhstan the most priority technologies, that require the immediate application, are the technologies of water metering and drip irrigation, which are described in details in ANNEX 1 below.

These technologies have been chosen since, firstly, they can be used to solve the most acute problems facing the agricultural irrigation sub-sector at present, and secondly, the introduction of these technologies is possible in a short term period (within 2-3 years, perhaps - up to 5 years), and thirdly, they are large scale technologies.

Currently the most acute problems in water management is relate to прогноз экстремальных явлений.

Addressing these priorities are based on the fact that it is one of the main obstacles to further development of the water management subsector. This technology is described in details in ANNEX 1 below.

The main technologies in the agricultural irrigation sub-sector are related to:

- Use of the most efficient water-saving irrigation technologies, including drip irrigation, sprinkle irrigation, etc.;
- Introduction of 100% metering of water for irrigation, etc.

CHAPTER 6. CONCLUSION

As a result of consultations two economic sectors have been chosen and approved for technology needs assessment: the water sector (water supply and wastewater disposal; agricultural irrigation) and the agricultural sector (grain production and sheep breeding). Expert groups for each sector held discussions with stakeholders in each segment, as well as nationwide discussion.

The multi-criteria analysis was conducted in accordance with the handbook for conducting technology needs assessment. The details of this assessment are presented in Chapters 3, 4 and 5 presented above. The main conclusion from the technology needs assessment for adaptation of sectors is that the adaptation technologies and adaptation needs are largely determined by local conditions, and cannot be always assessed using the method, which is applied in case of mitigation.

As a result of the technology needs assessment process 7 technologies were presented for the approval by of the Project Steering Committee.

The innovative nature of some of the technologies is taken into account when selecting the project proposal.

The selected technologies with values are presented in Table 6.1.

Table 6.1 List of priority technologies for agriculture and water sector in Kazakhstan

	Technologies	Sector	Comments
1.	Transhumance system (southern part of the republic)	Agriculture	Project proposal
2.	Grazing and stabling system on an industrial basis (all regions)	Agriculture	Project proposal
3.	No-Till	Agriculture	
4.	Diversification of crop production	Agriculture	Project proposal
5.	Technology of extreme events prevention	Water	
6.	Metering of water for irrigation and watering.	Water	Project proposal
7.	Technology of drip irrigation	Water	

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ANNEX 1

1. Factsheet for the technology of No-Till technology

Technology: No-Till technology	
Sector: Agriculture	
Subsector: Grain production	
Technology characteristics	
Introduction	«No-till» technology is the direct seeding with minimal disturbance of the soil, i.e. establishing crops in a previous crop's residues without preliminary tillage. No-Till technology significantly improves soil fertility through the better control of wind and water erosion, improving the ability of soil to hold water and increasing organic matter content in it. High stubble in the fields holds and accumulates more snow, and granulated and spread out straw improves the structure and quality of soil owing to biological degradation. This reduces the negative impact of adverse weather on crops.
Technology characteristics/highlights	In the terminology of the FAO zero tillage (No-till) is a direct seeding with the help of sowing complex, i.e. disk, or chisel, with minimal disruption of soil. In Canada zero technology includes all types of seeding without cultivation. In case of zero technology weed control is carried out with the help of herbicides. In 2000, the International Centre for improvement of wheat and maize (ICIWM) in collaboration with scientists and farmers of Kazakhstan began the work on the introduction of no/minimum tillage and direct planting (leaving stubble, granulating and spreading straw on the fields). Director of Scientific Production Center of Grain Farming (SPCGF) Zh.A.Kaskarbaev in his report [13] notes that mulching the soil surface by granulated straw in order to minimize the tillage contributes to maintaining and increasing moisture reserves in soil, increasing organic matters in soil 1.5 times, and contributes to the erosion resistance of the soil surface. In SPCGF it is established that the basis for developing resource-saving technologies of cultivation of leguminous and oilseed crops in the steppe regions of North Kazakhstan is the reduction of tillage in autumn, spring, until the complete failure, and use of disk based and chisel tools during the sowing of crops [12].
Institutional and organizational Requirements	The following techniques of agriculture should be combined in resource-saving farming systems: crop rotation, permanent ground cover from plants or their residues, minimum or no tillage. Food and Agriculture Organization (FAO UN) notes that sustainable agriculture requires extensive knowledge and cannot be spread so quickly. Experiences in many countries showed that the acceptance and dissemination of sustainable agriculture requires changes in attitudes and behavior of all stakeholders [13].
Operation and maintenance	The introduction of zero tillage technology involves the use of modern high-performance agricultural machinery and equipment.
Endorsement by experts	With the help of no-till technology about 150 million hectares are tilled worldwide. Direct seeding has been effectively used in Canada, USA, and in several countries of South America and Europe for about 30 years [17]. More than 60% of the crop area in Argentina, Brazil and Paraguay is

	tilled by No-Till technology. It is recommended by all the experts and researchers around the world.
Adequacy for current climate	Kazakhstan's climate is arid, and zero tillage technology enables to preserve moisture in the soil and its less evaporation. It meets both current and anticipated climate.
Scale/Size of beneficiaries group	Beneficiaries include all the agricultural producers, regardless of the form of ownership of enterprises. No-Till technology can be applied in the context of the farm, respectively, is related to small-scale technology.
Disadvantages	It should be noted that one of the conditions for the introduction of minimum and zero tillage is high level farming; i.e. when weed infestation is high, the system does not provide benefits. It is necessary to strictly observe the technological discipline of cultivation. Weed control should be conducted using only herbicides. Zero tillage without autumn tillage is accompanied by negative factors: soil compaction, reduction of water permeability and air intensity, deterioration of the phytosanitary status of crops.
Capital costs	
Cost to implement adaptation technology	Use of new tractors, seed drills, modern harvesters and sprayers. Although the modern technology is resource-saving, it is more costly. First of all, due purchase of expensive equipment. The cash costs for the depreciation of machines will increase, although the number of machines is decreased.
Additional cost to implement adaptation technology, compared to "business as usual"	It will require costs for weed control using herbicides. In some cases, the use of fungicides will increase in order to protect plants from disease. As a result, the cost of grain production per hectare of crop may be close, and sometimes can be a little higher or lower, depending on the conditions. Herbicides are used against weeds in large amounts in the early years of the introduction of the technology, and further it can be reduced.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	If the zero tillage technology is not implemented and the traditional farming is continued, the yield of agricultural crops will be reduced due to the increased aridity. Accordingly, agriculture would require additional subsidies.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	The long-term costs of the introduction of the zero technology (with adaptation) include the costs for purchasing new machinery and equipment.
Development impacts, direct and indirect benefits	
Direct benefits	The traditional system of farming leads to soil degradation and low efficiency costs, and the transition to the zero tillage technology significantly increases the stability of the yield, i.e. the dependence on weather conditions is reduced, and, accordingly, the risk is reduced. Minimizing the tillage helps to increase the labor productivity, to reduce labor requirements and demand for technology, reduces the time of field work.
Reduction of vulnerability to climate change, indirect	In the result of introduction of No-till technology, the dependence of crop productivity on weather conditions will be decreased, which is an adaptation measure to climate change.
Economic	The introduction of No-till technology reduces manufacturing processes,

benefits, indirect	and reduces the fuel consumption by more than 3 times, which cover the increasing costs of application of herbicides. Analysis of these two growing technologies (traditional and zero tillage), carried out in the North Kazakhstan showed that zero tillage reduced the costs for fuel by three times, for depreciation and repair by two times, for labor costs almost two times. In consequence of increased productivity and decreased labor requirements and demand for technology, the financial costs will be significantly reduced compared with traditional technology of crop cultivation. If in case of use of traditional technology for growing wheat on 100 hectares the five-course rotation requires 624 hours, no-till technology - 364 hours [15]. In the article [16] it is noted that in the early years of the introduction of No-till the financial costs for 1 ha were 138.9 U.S. dollars, on the contrary intensive technology - 120.8 U.S. dollars, but despite this, in case of use of No-till the financial profit was higher by 31.6% owing to higher yield (wheat).
Employment	The use of No-till technology leads to the decreases in labor costs, and, respectively, to the decline in employment.
Growth & Investment	Investments will be needed to purchase modern equipment.
Social benefits, indirect	Increase in productivity and decrease in financial costs enables to raise the well-being of the rural population.
Income, Education, Health	Implementation of the technology will save the natural and human resources, and, at the same time, improve living and working conditions of people, and, ultimately, have an impact on health improvement.
Environmental benefits, indirect	No-Till technology aimed at the least soil disturbance. In case of no-tillage annually a sufficient amount of crop residues enters into soil; the rate of mineralization of humus reduces, which further increases the fertility of the soil. In addition, a tendency of productivity increase begins to appear when using biologics; also a favorable soil density is formed [12].
Local context	
Opportunities and Barriers	Application of No-till technology on sloping lands for the cultivation of crops on forecrops could cause the runoff of melt water, because the infiltration slows down in the compacted soil. About 33% of arable land in North Kazakhstan is placed on slopes greater than 0.5^{o}, 12-14% on the slopes of 1-3^{o}. The risk of erosion processes of usage of No-till technology is still not completely researched. [14].
Market potential	Technology has a large market potential nationwide.
Status	It is being implemented.
Timeframe	It is available in the medium term, as previously it is necessary to achieve high level farming and recover the field from weeds.
Acceptability to local stakeholders	In Kazakhstan the zero tillage technology is being most widely implemented in the three northern regions (North Kazakhstan, Kostanay, Akmola). According to academician Suleimenov M.K., the share of resource-saving technologies in these three regions is 40-70%, and national average is about 55%.

2. Factsheet for the technology of Crop diversification

Technology: Crop diversification	
Sector: Agriculture	
Subsector: Grain production	
Technology characteristics	
Introduction	Crop production is being diversified with the cultivation of crops adapted to stressful situations. In addition, it is necessary to use the potential of breeding and genetic engineering, to create varieties and hybrids of more drought-resistant grain and leguminous crops with high yield and good grain quality, with increased resistance to pathogens, to high and low temperatures, to high acidity and salinity of the soil. Breeding new and improved crop varieties enhances the resistance of plants to a variety of ecological stresses. Crop diversification should also be based on a rational distribution of crops on the basis of adaptive agriculture and agro-climatic zoning. Diversifying from the monoculture can support a country to becoming more self-reliant in terms of food production. Introducing a greater range of varieties increases natural biodiversity, strengthening the ability of the agro-ecosystem to respond to external stresses, reducing the risk of total crop failure.
Technology characteristics/highlights	The aim of crop diversification is to increase crop portfolio so that farmers are not dependent on a single crop to generate their income. When farmers only cultivate one crop type they are exposed to high risks in the event of unforeseen climate events. For example, emergence of pests and the sudden onset of frost or drought. New and improved crop species can be introduced in different ways. Agricultural research organizations identify new varieties that are better adapted to changing climatic conditions. Also farmers can do experimentations with new varieties. The introduction of new crop species to diversify the crop production systems needs to take into account many issues: availability and quality of natural resources, availability of technologies of cultivation, storage and processing; investment capacity; economic policy of the country, price and market related factors; Institutional and infrastructure related factors and etc. Before introduction of new variety, a rigorous security assessment should be conducted. A decision to introduce new varieties needs to be founded on sufficient evidence that new varieties offer promising opportunities, and, equally, that their introduction will not expose farmers further to increased risk. It is important to monitor and evaluate (with farmer participation) the performance of new varieties, report results and recommend next steps and changes to improve processes. In making decisions about diversification, farmers need to consider the issue on income generated by new varieties. Therefore preliminary feasibility and market studies are needed. Good opportunities to introduce new species and varieties of crops arise when they can be developed for sale on national and international markets.
Institutional and organizational requirements	The successful crop diversification needs a clear national policy on strengthening of farms, crops and selection of equipment, etc. Farmer has to be linked to research programs and should have access to research products through intermediary organizations such as NGOs and

	others. These links have to be made explicit and institutionalised. Institutional recommendations include establishing farmers' committees in order to synchronize diversification on neighboring farms or plots that share common ecosystems. The committee exercises some authority by establishing the most appropriate crop portfolio and can provide a body that supports local farmers to access financing and technical support. Government policy supporting diversification is key to facilitating access to inputs and technical skills and building national markets .
Operation and maintenance	Crop diversification involves the use of modern high-performance agricultural machinery and equipment.
Endorsement by experts	It is recommended by all the experts and researchers around the world.
Adequacy for current climate	Crop diversification increases the resistance of crop production to drought conditions. It meets both current and expected climate change.
Scale/Size of beneficiaries group	Beneficiaries include all the agricultural producers, regardless of the form of ownership of enterprises. Diversification of crop production should be conducted at the regional level with the same type of soil and climatic conditions, with the help of research institutes and experimental farms. Accordingly, this technology is large-scale.
Disadvantages	Farmer experimentation using only native varieties, adapted to local conditions, can limit the range of benefits that can provide import materials. At the same time, problems can with the introduction of exotic species. In terms of commercial farming, access to national and international markets may be limited by a range of factors including government policy including subsidies, the price and supply of inputs, infrastructure for storage and transportation. Farmers also face risk from poor economic returns if crops are not selected based on a market assessment. For example, drought tolerant crop varieties may fetch a low market price if there is not sufficient demand.
Capital costs	
Cost to implement adaptation technology	Capital investment will relate to the purchase of new seed varieties (if not available 'wild' locally), relevant agricultural equipment and technology, and training of technical experts. Market research needs also to be considered in the financial requirements.
Additional cost to implement adaptation technology, compared to "business as usual"	In making decisions about diversification, farmers need to consider the issue on income generated by new varieties. Therefore preliminary feasibility and market studies are needed.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	If crop production is not diversified and the traditional farming is continued, the yield of agricultural crops will be reduced due to the increased aridity. Accordingly, agriculture would require additional subsidies.
Long term cost (i.e. 10, 30, or 50 years) with	Plant breeding requires know-how and investment in terms of human and financial resources as well as time. It may take a number of years to create a new variety with improved features and an additional number of years for it to be introduced into the market.

adaptation	
Development impacts, direct and indirect benefits	
Direct benefits	The introduction of adapted varieties can potentially strengthen farmers' cropping systems by increasing yields, improving drought resilience, boosting resistance to pests and diseases and also by capturing new market opportunities. Calculations of cost-effectiveness showed that the diversification of crop production in Kazakhstan by the introduction of crops such as peas and canola in crop rotation increases profitability that is by 32% and 10% more than in case of traditional structure of arable land [9].
Reduction of vulnerability to climate change, indirect	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 impacts of climate change. With a diversified plot, the farmer increases his/her chances of dealing with the uncertainty and/or the changes created by climate change. This is because different crops will respond to climate scenarios in different ways.
Economic benefits, indirect	Diversifying from the monoculture can support a country to becoming more self-reliant in terms of food production. Crop diversification provides better conditions for food security and enables farmers to obtain increased income. Diversification can enable farmers to gain access to national and international markets of products. Diversification can also manage price risk.
Employment	Cultivation of new crops involves the expansion of cultivation areas and correspondingly the employment will be increased.
Growth & Investment	Investments will be needed for breeding works, and for the purchase of modern equipment.
Social benefits, indirect	Increase in productivity and acquisition of additional income enables to raise the well-being of the rural population.
Income, Education, Health	Varieties with improved nutritional value may be useful for people and animals, reducing their vulnerability to disease, and improving their health.
Environmental benefits, indirect	Introducing a greater range of varieties increases natural biodiversity, strengthening the ability of the agro-ecosystem to respond to external stresses, reducing the risk of total crop failure. Compared to producing monocultures, crop diversification enables to use natural resources more sustainable and more effectively.
Local context	
Opportunities and Barriers	The main barrier to introducing new and improved crop varieties is the misconception that local species have low productivity. Это может привести к утрате местных устойчивых видов. The main barrier to diversification is lack of clear government policy, predominance of small farms, poor technical equipment of farms, and price fluctuations.
Market potential	Technology has a large market potential nationwide.
Status	It is being implemented.
Timeframe	It is necessary a certain time in order to determine the species and

	varieties of crops that are adapted to the region. Accordingly, this technology is long-term.
Acceptability to local stakeholders	In Kazakhstan in recent years the crops of sunflower, canola, flax, soybean and pea have significantly increased. A range of crops provide greater cost-effectiveness to diversify crop production in northern Kazakhstan. They are spring barley, millet, oats and buckwheat from grain, peas, chickpeas and lentils from legumes, sunflower, canola, flax and mustard from oil-producing crop [10].

3. **Factsheets for the technology on chemicalization**

Technology: Chemicalization	
Sector: Agriculture	
Subsector: Grain production	
Technological characteristics	
Introduction	Chemicalization is one of efficient means for improving grain production to increase the gross crop product and improve grain quality. The application is based on the use of fertilizers, chemical land reclamation (gypsuming and liming), plant protection from weeds, pests and diseases, the use of chemical stimulators accelerating plant development and others. Annually, up to 24% of crop is lost in the world because of pests, weeds and diseases, the annual total damage to agriculture reaches 70 bln USD. Kazakhstan mainly imports he preparations to be used in agriculture (herbicides and insecticides). The insufficient amount and assortment of the fertilizers produced by Kazakhstan enterprises is one of the key problems in the sector. A single pesticide (KZ) is produced in the country, and the producers of fertilizers in Kazakhstan are “KazAzot" Ltd, "KazPhosphate" Ltd.
Technological characteristics/key aspects	The main goal of chemicalization is securing production growth, improvement of agricultural products quality and extension the periods for their storage, as well as improvement of husbandry efficiency. An important direction of agricultural chemicalization is the use of biotechnology and gene engineering methods to solve food problems. The chemicalization technology is based on the use of various organic and inorganic compounds toxic for hazardous organisms. It covers a set of measures both on application of various chemical means (mineral fertilizers, plant protection means, stimulators for plant development), and on introduction of chemical methods into technological processes.
Institutional and organizational requirements	To realize the process on chemicalization the following should be taken into account: 1. available raw material resources for the production of fertilizers; 2. operating chemical industry enterprises processing the raw material for fertilizers; 3. a network of research institutions and the personnel to predetermine the success of chemicalization.
Operation and technical maintenance	The chemicalization of agriculture requires technical equipping of farms with machinery and mechanisms to apply fertilizers and plant protection means and to conduct well-timed agricultural works.

Approval by experts	It is recommended by all experts and researchers throughout the world.
Correspondence to current climate	The chemicalization of crop growing allows improving resistance of plants to weeds, diseases and pests.
Scale/size of a group of beneficiaries	a small scale technology
Shortcomings	The use of chemical substances for a long period makes negative impact in a long-term prospect, since a greater amount is required from year to year, and the destruction of the ecosystem as a result of their use is becoming more and more. Pests resistant to pesticides appear. Besides, mass distribution of pests occurs after using the pesticides. Excessive and improper use of fertilizers in agriculture leads to considerable negative effect in the form of excessive content of nitrites and nitrates in agricultural products; the need in growing environmentally safe products; pollution of water bodies, seas and oceans by washed out fertilizers; inclusion of pesticides applied in agriculture in the circulation of substances. The amount of outdated chemical protection means in the republic is increasing from year to year, and decontaminated preparations and containers is decreasing (according to the official data, about 500 tons of unidentified pesticides have been stocked in the country).
Capital costs	
Costs for introduction of adaptation technologies	Funding for acquisition of chemical substances, protection means, related agricultural machinery and technologies and training for technical specialists is required. At present, in Kazakhstan the cost of herbicides of the glyphosphate type is 3 times more than in the USA, Canada or Australia. This is one of the main reasons restraining transition to chemical vapor deposition. No more than 2 kilograms of the substance is applied per 1 hectare of crop lands, at the norm of 60 kilograms. In 2012, over 6 mln USD were allocated by the state to combat pests in Kazakhstan.
Additional costs for introduction of adaptation technologies compared to "business as usual"	Observance and application of technological regulations such as well-timed checkup of crop land areas will allow avoiding additional expenses or costs saving. In 2011, 3.2 bln tenge were allocated from the national budget to eliminate pests.
Long-term costs (that is 10, 30 or 50 years) without adaptation	Unless chemical protection means and fertilizers have not been used, the productivity of agricultural crops will decrease. Organization of reliable checking for the content of hazardous substances will allow turning the production of products of poor quality to be cost-ineffective.
Long-term costs (that is 10, 30 or 50 years) with adaptation	Chemicalization of agriculture will inevitably lead to increase of costs and means per a unit of area, but these additional expenses are paid back through significant crop growth. They allow increasing the crop productivity by 40 - 50 %.
Impact on the development, direct and indirect benefits	
Direct benefits	Chemicalization will lead to reduction of wheat production costs and to its better productivity. Application of chemical protection means will enable the environment for full mechanization of the processes on plant

	cultivation, will allow harvesting process becoming easier and disposing of labor-consuming operations. The benefits also include the opportunity for cultivation of greater areas for a short period.
Reducing vulnerability to climate change, indirect costs	Chemicalization allows improving plant resistance to various stresses. Along with that the use of fertilizers and other chemicalization means is a rather significant impact on natural environment. The presence of various toxic admixtures, their unsatisfactory quality, as well as possible deviation from the technology may lead to serious negative impacts.
Economic benefits, indirect benefits	To get the producers of fertilizers and farmers more interested, the subsiding of Kazakhstan herbicides is considered under a separate program that will enable the production of them in the country.
Employment	Plant chemicalization envisages additional processing of agricultural areas and the demand for specialists in the agrochemical field is increasing accordingly.
Growth and investments	Even though the state subsidizes 50% of fertilizer costs, their cost will remain high. So, application of the technology will require investments [43].
Social benefits, indirect benefits	The improvement of crop productivity and soil fertility through chemicalization will allow improving grain crop productivity and quality as well as the well-being of the rural population.
Income, education, health	The remainders of chemical substances in the crop and water may be released to drinking water and make hazardous impact on human health. The problem on their application in agriculture may be solved through strict dosage and proper use. Such preparations, which can be rather rapidly decomposed, should be created and used and the products of their natural processing should be not poisonous. The solution of these problems is connected with lack of highly skilled specialists in the field of agricultural chemistry.
Environmental benefits, indirect benefits	Chemicalization allows combating weeds, pests and diseases.
Opportunities and barriers	The domestic chemical production of plant protection means should be created in the country. To support local producers of herbicides, the subsiding of their purchase should be continued, 50% of the cost, and included in the list of foreign producers' purchase, probably, in a smaller proportion (40%). The subsidies should be delivered to final consumers of agricultural chemistry products (agricultural producers).
Market potential	The technology has a great national wide market potential.
Status	Introduced in practice.
Period	A mid-term technology.
Acceptability for local stakeholders	The financial support of the sector, in particular, by means of subsidies remains to be an important instrument of governmental regulation of the agricultural and industrial complex. The chemical protection means and fertilizers are mostly inaccessible for Kazakhstan grain production enterprises because of their high costs, so according to an advanced program on subsiding the producers of protection means and fertilizers may be only the domestic plants.

4. Factsheets for the technology of development of drought-resistant varieties

Technology: Nurturing of development resistant varieties	
Sector: Agriculture	
Subsector: Grain production	
Technological characteristics	
Introduction	Drought periodically covers the vast cultivated land areas of the country. According to the data of the Central Forecast Institute, drought in the majority of areas of Kazakhstan occurs at the average every three years. In 2012 the drought in Kazakhstan destroyed 1.1 mln ha of grain crop and the yield was 12.3 mln t. It was two times less compared to 2011. The risk of harvest loss or poor harvest as a result of drought may be reduced through nurturing of more resistant varieties. So, the agro-industrial complex has to improve grain productivity using the achievements of modern agricultural science.
Technological characteristics / key aspects	Two conditions are required for nurturing of draught resistant varieties: 1) knowledge of natural particularities of the area and 2) knowledge of the source material for selection. The primary task for the selection related to draught resistance is the combination of plant draught resistance properties with their improved productivity at hybridization. Fertilizers make impact on draught resistance improvement: potassium and phosphoric, and nitric, particularly in greater doses - reduce resistance. The microelements (zinc, copper and others) improve draught resistance of some agricultural crops. Drought resistance in field condition enables agricultural crops growing, when zonal technologies of their cultivation are observed. The more organic substances are in the soil, the more moisture is retained in it.
Institutional and organizational requirements	The regulatory-legal base in the grain production sector should be updated. Specialists to nurture new varieties should be trained. Both the scientists working in this area and the students preparing to scientific work should be trained.
Operation and technical maintenance	Modern instruments for laboratories to nurture new varieties are required. Modern machinery for sowing, planting, cultivation and harvesting.
Approval by experts	Recommended by researchers all over the world.
Correspondence to current climate	The technology on nurturing new draught resistant varieties is suitable for Kazakhstan territory, since the longest rainless period has decreased, practically, on the whole territory of Kazakhstan.
Scale/size of a group of beneficiaries	A large-scale technology.
Shortcomings	The difficulty in nurturing draught resistant varieties is connected with the fact that high productivity and draught resistant is a very rare combination in one and the same gene type. The selection for draught resistant is also complicated, because in different areas the plant resistance to lack of moisture and overheating is preconditioned by various physiological mechanisms. There is one more problem - many selection centers are not equipped with

	modern equipment for selection and seed-growing works [44]. Insurance of crops has become of demand because of drought. To solve the problem on agroinsurance the legislation should be updated.
Capital costs	
Costs for introduction of adaptation technologies	For more productive use of new varieties potential, seed-growing work, awareness raising activity and government participation in the restoration of семеноводства, as the basis for improvement of gross high-quality grain yield in the republic should be improved. Selection hothouses for scientific tests should be constructed; the research institute should be reequipped with new labware and heavy repair of them should be organized. At present in arid years the gross grain yield reduces by 25-35 %, when draught resistant varieties are cultivated this indicator reduces by 10-15 %. So, there will be an opportunity to increase the average wheat productivity in the country to 15-20 centners.
Incremental costs for introduction of adaptation technologies compared to “business as usual” scenario	Along with nurturing of new draught resistant plant varieties, the role of preparations to improve draught resistance is also great. The assortment of these preparations begins to appear on the market just now. Such notion as an emergency situation is not specified in the Kazakhstan legislation. For this reason, to help the farms damaged by drought in summer 2012, the government of Kazakhstan allocated 12 mln USD.
Long-term costs (that is 10, 30 or 50 years) without adaptation	Unless the technology hasn’t been introduced, the grain productivity may be reduced owing to expected climate warming.
Long-term costs (that is 10, 30 or 50 years) with adaptation	The work on the projects to protect soil from water and wind erosion and reduce evaporation should be conducted.
Impact on the development, direct and indirect benefits	
Direct benefits	Owing to the current process on climate warming, nurturing of more draught resistant grain varieties is becoming more important.
Reducing vulnerability to climate change, indirect costs	The natural-climatic conditions of the major territory of Kazakhstan relate to the zone of risky husbandry. The introduction of new draught resistant varieties will allow reducing the vulnerability of grain production to expected climate change.
Economic benefits, indirect benefits	The proposed technology will allow resisting to drought leading to the reduction of the risk related to large-scale yield productivity losses.
Employment	The demand for specialist in the field of selection will increase.
Growth and investments	Enabling the environment to attract large-scale investments and the interaction of the agrarian sector with financial institutes is of great importance.
Social benefits, indirect benefits	Nurturing of draught resistant varieties will allow improving yield productivity and the well-being of the rural population.
Income, education, health	The introduction of the technologies will lead to increasing income in the field of grain production. To maintain the technology on a qualitative level specialists with higher education are needed.

Environmental benefits, indirect benefits	Along with nurturing of new draught resistant plant varieties, the role of preparations to improve plant draught resistance is also great. The assortment of these preparations begins to appear on the market just now.
Opportunities and barriers	At present the Kazakhstan scientists jointly with Australian scientists are nurturing new draught resistant varieties and, at least, in 2013 they are planning field testing.
Market potential	The technology has a great national wide market potential.
Status	Some developments are used in sown areas.
Period	A period of 10-15 years is required to nurture a new variety, to receive the seeds that meet all requirements and, moreover, not only productivity, but also grain quality is assessed, when nurturing new wheat variety. Accordingly, the technology is long-term in relation to its implementation.
Acceptability for local stakeholders	The technology may be acceptable for all concerned parties, which are going to work on nurturing draught resistant, high-quality varieties that meet the requirements of modern technologies on crop cultivation.

5. Factsheet for the technology of transhumance system

Technology: Transhumance system	
Sector: Agriculture	
Subsector: sheep breeding	
Technology characteristics	
Introduction	Transhumance system allows interconnecting the natural and economic complex, various seasonal grazing, and is the main measure of adaptation established by age-old experience of nomads - animal breeders.
Technology characteristics/highlights	In case of transhumance system the animals are migrated from one pasture to other in certain seasons. They are called for the seasons - winter, summer, spring and autumn, as well as year-round.The climatic conditions of the south allow sheep to be pastured all year round. It is proposed the system of using pastures in eight major pasture complexes [7]. For example, in *Zhungar-Pribalhash pasture complex,* winter grazing (January-March) is proposed to hold in the desert Sary Ishyk-Otrau. In unfavorable days animals are foddered by hay. In spring and early summer (April-June) Sary-Bulak stow is used, where the return and shearing are carried out. In summer and early autumn (July - 15 September) grazing is conducted in mid Zhungar Alatau, on stows Satyly. At the same time cattle are distilled off to the mountain area Matai. In the autumn the sheep are grazed on stows Tchuruk in 20-30 km from the spring grazing. In late December, the cattle are moved to winter pastures to the sands Sary-Ishyk-Otrau. The total length of cattle drive to seasonal pastures amounts to 180-200 km per year. The sheep get over this distance in about 20-25 days, 8-9 km a day.
Institutional and organizational requirements	Currently, there is no legal basis to use pastures, and to define the driving routes and areas for grazing animals. One of the barriers is the concentration of livestock in small farms, which do not have the potential for further development due to the lack of finance, skills, low profitability and low productivity. In private farms there are 77% of sheep and goats, 81% of cattle, in farms - 16% of sheep and 14% of cattle, in agricultural enterprises - 7% and 5% respectively.

Operation and maintenance	The herdsman needs a truck transport to move. The engineering structures, providing cattle with water (mine and tube wells), should be kept in working condition.
Endorsement by experts	It is endorsed by many experts.The transhumance system was widely used in Kazakhstan, Central Asian countries and the Caucasus, in south-east areas of the RSFSR before the collapse of the USSR. Year round livestock pasture system is used in Australia, Mongolia, Afghanistan, Argentina, Brazil, New Zealand and other countries. In Australia, the pastures contain about 170 million sheep and about 18 million head of cattle, in Mongolia - over 22 million head of different animals.
Adequacy for current climate	Transhumance system conforms to the conditions of hot summer and warm winter of the southern part of Kazakhstan.
Scale/Size of beneficiaries group	Renovation of transhumance system requires solving many issues at the state level, as well as the procedure of driving and use of pastures should be governed by a certain public association or government entity. Accordingly, this technology is a large-scale.
Disadvantages	Transhumance system has extensive development character and low potential, where the increase in livestock production is achieved through the increase in livestock number. The intensive technology is stabling or grazing and stabling system, where the increase of livestock production is gained by increasing the productivity of animals (breeding, concentrated forage). The maximum amount of high quality products can be gained with a small number of livestock. Also, the disadvantage of grazing is a large dependence of livestock on weather conditions.
Capital costs	
Cost to implement adaptation technology	It is necessary to resolve lots of issues requiring certain investments. For example, renovation of water points, radical and simplificated improvement of surface vegetation in degraded pastures, etc.
Additional cost to implement adaptation technology, compared to “business as usual”	In order to correctly allocate the sheep breeds, it is necessary to conduct researches to determine the degree of adaptability of sheep and identify the stress-adapted breeds of sheep for each natural-climatic region of Kazakhstan, as well as to calculate the real soil-feeding and grazing capacity of pastures by seasons.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	If the technology is not introduced, the productivity of sheep breeding may decrease due to global warming and degradation of the surrounding pastures. Accordingly, sheep breeding could need subsiding.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	The long-term costs of the introduction of transhumance system include the costs for renovation of water points and pasture improvement.
Development impacts, direct and indirect benefits	
Direct benefits	Sheep drive from spring to summer pastures allows avoiding loss of productivity, caused by the influence of high temperatures on sheep,

	owing to the transition from the parched pastures to greener.
Reduction of vulnerability to climate change, indirect	Transhumance system allows interconnecting the natural and economic complex, various seasonal grazing, and is the main measure of adaptation established by age-old experience of nomads - animal breeders. Transhumance can reduce exogenous stress on animals and prevent adverse impacts of climate conditions.
Economic benefits, indirect	The cost of livestock products is decreased at little cost for feeding and keeping of livestock and for labor for animal care. Labor costs for animal care could be significantly reduced, feeding is not needed, and large amounts of fodder for the winter are not required. This is the cheapest way to keep animals.
Employment	The number of animals, respectively, the rural employment will be increased.
Growth & Investment	Large investments are not required.
Social benefits, indirect	The use of transhumance system will benefit the growth of the number of animals and the welfare of rural people.
Income, Education, Health	Livestock development increases the welfare of the rural population.
Environmental benefits, indirect	Load on environment is excluded, overgrazing and degradation of pastures is prevented.
Local context	
Opportunities and Barriers	One of the deterrents of development of transhumance is the absence of water sources for livestock watering. Engineering structures providing cattle with water (more than 60 thousand well-points) got out of order as a result of prolonged inactivity.
Market potential	Increase in productivity and product quality, and decrease in the cost of production increases the competitiveness of sheep breeding in domestic and foreign markets.
Status	It is being implemented in the south of the country.
Timeframe	Renovation of transhumance system requires solving many issues at the state level, as well as the procedure of driving and use of pastures should be governed by a certain public association or government entity. Accordingly, this technology is long-term.
Acceptability to local stakeholders	Transhumance system is acceptable to the conditions of the southern half of Kazakhstan.

6. Factsheet for the technology of grazing and stabling system on an industrial basis

Technology: Grazing and stabling system on an industrial basis	
Sector: Agriculture	
Subsector: Sheep breeding	
Technology characteristics	
Introduction	In the area of high-intensity agriculture, where natural pastures are few or entirely absent, livestock (sheep and cattle) are transferred to grazing and stabling system on an industrial basis.
Technology characteristics/hi	In conditions of North Kazakhstan, the livestock can be kept on pasture from May to October months, and during the cold half of the year – on

ghlights	stabling. Feeding the livestock is determined by climatic conditions and the characteristics of the arable forage production [20]. The transition to industrial basis involves the construction of mechanized farms, the introduction of new technologies to fully mechanize the production processes. Mechanized farms can be on parent stock, on young-stock breeding, fattening, and with a complete production cycle, which contain different gender and age groups of animals. The optimal sizes of these farms depend on the specialization of the zone and farming, containing systems, level of mechanization and the state of forage reserve [22]. Types and sizes of facilities are defined by climatic conditions, farm pattern and specialization, production technology used. Microclimate parameters (temperature, humidity, air velocity in the facility, etc.) in any area for each group of animals are set by gender, age and physiological state. The stabling system should use the balanced high-quality forage (mainly concentrated forage). One of the reserves to get forage is lands, taken out of circulation 8-12 years ago. They can be used as pastures and hayfields. For example, in the northern regions of the country such lands amount to 10-12 million, and most of them are located near settlements.
Institutional and organizational requirements	One of the barriers is the concentration of livestock in small farms, which do not have the potential for further development due to the lack of finance, skills, low profitability and low productivity. In private farms there are 77% of sheep and goats, 81% of cattle, in farms - 16% of sheep and 14% of cattle, in agricultural enterprises - 7% and 5% respectively.
Operation and maintenance	The transition to the industrial containing involves the construction of mechanized farms. Accordingly, they must be maintained.
Endorsement by experts	It is endorsed by many experts. Livestock breeding on an industrial basis is developed in Denmark, the Netherlands, Switzerland, Germany, USA, Australia, and New Zealand. This new technology of containing of sheep has been widely used in farms Stavropol, Rostov, Yaroslavl, and in several other regions of Russia.
Adequacy for current climate	Conforms to the climate conditions of any part of Kazakhstan.
Scale/Size of beneficiaries group	Grazing and stabling system on an industrial base is a small-scale technology. It can be implemented at the level of large farms or communities.
Disadvantages	It requires certain knowledge and skills, investment funds.
Capital costs	
Cost to implement adaptation technology	It is necessary to invest considerable financial resources at the beginning of introduction of this technology. They are required for construction of facilities and purchase of various equipments for industrial process.
Additional cost to implement adaptation technology, compared to “business as usual”	It requires investments for the procurement of coarse, juicy and concentrated forage.

Long term cost (i.e. 10, 30, or 50 years) without adaptation	If this technology is not introduced, the productivity of sheep may decrease due to global warming and degradation of the surrounding pastures. Accordingly, sheep breeding could need subsiding.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	The long-term costs of the introduction of this system include the construction of buildings and purchase of equipment for the mechanization of the production process.
Development impacts, direct and indirect benefits	
Direct benefits	This technology allows getting the maximum amount of high-quality products with a small number of animals. It allows integrated use of natural pastures, field forage production and grain production.
Reduction of vulnerability to climate change, indirect	The transition of livestock breeding to the industrial base reduces its dependence on weather conditions.
Economic benefits, indirect	Labor costs will be significantly reduced, productivity of livestock will be increased and livestock breeding will become a highly profitable industry. For example, mechanized farms can be used during summer for intensive fattening of livestock for meat. This allows bringing the meat to the conditions in the short term, significantly reducing labor costs of production. For example, the increase in live weight of lambs for weaning by 5-8 kg, provides an opportunity to earn additional income from each sheep by 1500-2400 tenge more [23].
Employment	In rural areas new jobs could be created.
Growth & Investment	It requires investment for the mechanization of the production process.
Social benefits, indirect	Livestock development increases the welfare of the rural population.
Income, Education, Health	It has positive impact on the growth of the number of animals that increases revenue and improves health of the population.
Environmental benefits, indirect	Grazing and stabling system on an industrial base reduces load on pastures and prevents their degradation.
Local context	
Opportunities and Barriers	In Kazakhstan, there is no proper policy on the use of grazing lands and information services on modern production technologies transfer. Forages from grains and oilseeds are used incompletely. Also, the barriers are the low level of genetic potential of animals and proportion of breeding stock, the concentration of livestock in small farms, the imperfection of a network of procurement, storage and transportation of raw materials.
Market potential	The introduction of this technology will increase the competitiveness of livestock breeding in Kazakhstan to the level of the global market.
Status	It is being introduced.
Timeframe	Grazing and stabling system on an industrial base is a medium-term technology. The construction of the infrastructure and its mechanization takes time.
Acceptability to local	It has not widely used in Kazakhstan yet, but some of its elements are being introduced.

stakeholders	This system can be used over the whole territory of Kazakhstan.

7. Factsheets for the technology of selective breeding

Technology: selective breeding	
Sector: Agriculture	
Subsector: Sheep breeding	
Technological characteristics	
Introduction	In the republic there are about 300 breeding facilities for sheep breeding, where semicoarse-wooled, coarse-wooled, fine-wooled and semifine-wooled sheep is bred. The number of live-stock sheep was 1 048.3 thousand animals. The support from the state allowed improving the development of selective breeding [45]. The work on sheep selective breeding is focused on the creation of new high-productivity and fast-growing viable breeds. The sheep selective breeding is based on the techniques and methods generally accepted in zootecnics: 1. The thoroughbred breeding is applied at breeding facilities and breeding farms; 2. Crossbreeding, mating of different breeds to nurture new breeds and different animal groups.
Technological characteristics / key aspects	Selective plans including the following sections are developed at selective breeding farms: 1) the history of the herd and description of the selective breeding work conducted in the herd; 2) description of the results of work, the herd productivity, its main strengths and weaknesses; 3) justification of the selective breeding activity direction; 4) description of the methods applied in the selective breeding activity; the plan on quantitative growth and qualitative development of the herd for a specified period; the plan on expected improvements in herd productivity by the end of the period; 5) a tentative calendar work plan on selective activity during the year. One of the most important organizational issues at sheep breeding farms is well-timed and careful preparation of sheep to a mating season that depends on the availability of sufficient forage amount and warm premises, proper feeding and maintenance of sheep and young animals.
Institutional and organizational requirements	The selective breeding activity will require the solution of a great number of issues on the state level. In 2011 the work on the improvement of the legislative base in the selective breeding and veterinary sector was conducted; the introduction of cost subsiding for the selective breeding activity in the republic was specified [46]. The decision on cancelling the VAT payment for imported pedigree cattle and sheep on leasing was made by the Government of the RK. That allowed reducing the cost of imported animals, reducing the financial load on leasing recipients, who participated in projects implementation [45]. Valuation (selection, evaluation) of animals at farms should be plasticized. Really, the best animals should be selected and one should know the particularities of each of the animals in order to select carefully right female sheep for a ram, with which they will give lambs as best as

	possible. Proper organization of sheep feeding requires, first of all, securing sufficient energy and nutrients for animals. The system of veterinary activities envisages a set of special measures on elimination of contagious sheep diseases, medical-preventive measures to combat non-contagious diseases and infertility, as well as veterinary-sanitary activities on securing of a good quality product in sanitary relation.
Operation and technical maintenance	The laboratories that meet international standards and equipped with modern equipment should be constructed. The quality of training for engineers and specialists in modern computerized equipment should be improved.
Approval by experts	Many foreign scientists consider that the live-stock breeding worths and productivity may be more efficiently improved through the application of the biotechnological method and large-scale use of high-productive animal embryos.
Correspondence to current climate	The technology on selective breeding activity corresponds to the conditions on the whole territory of Kazakhstan and should be used in the areas, where the main income is gained through sheep breeding.
Scale/size of a group of beneficiaries	A large-scale technology.
Shortcomings	To increase the number of sheep, the state support should be provided through soft loan to renew circulating assets and increase the number of sheep, particularly, female sheep. Small farms should unite to create larger farms, since the banks credit larger ones (3% households and individual sellers use bank services and 2% of them use credits). To have access to subsidy in Kazakhstan, one should have 400 cows and 600 sheep (over 2 years). The level of selective breeding activity of the majority breeding facilities should be raised.
Capital costs	
Costs for introduction of adaptation technologies	The selective breeding activity, maintenance of the staff of breeding units and interaction with scientists require considerable costs. According to the Law on the National Budget for 2010-2012, nearly 17 thousand USD were allocated from the budget to support selective breeding activity [45]. In 2012 additional 137.9 mln tenge were allocated within the framework of the program on the support of selective breeding activity that will allow supporting additionally 18400 animals. The production of wool in Kazakhstan should be focused on international standards. This envisages additional target financing of selective breeding facilities and farms for breeding sheep.
Incremental costs for introduction of adaptation technologies compared to "business as	Inaction leads to reduction of live-stock productivity and the number of animals.

usual" scenario	
Long-term costs (that is 10, 30 or 50 years) without adaptation	The selective breeding base is characterized by stable growth of the number of breeding facilities, annually their number increases by 40-50 units. As of 1 January, 2012, the specific weight of sheep bred at breeding farms in the country was 12.7% of the total live-stock number. However, the specific weight of pedigree animals compared to the total live-stock number remains to be low. Unless the technology hasn't been introduced, the sheep breeding productivity may be reduced owing to the processes of climate change.
Long-term costs (that is 10, 30 or 50 years) with adaptation	The state support for the selective breeding activity should be provided not only for large agrarian enterprises, but to private households. Since 2012 agricultural enterprises have been provided with subsidies for selective breeding activities for the first time, as well the costs for rich fodder and roughage was reduced in the amount of 110 USD per female animal. The selective breeding facilities the herds' productivity of which 15-20 % exceed the breed standard place should be subsidized first of all.
Impact on the development, direct and indirect benefits	
Direct benefits	The qualitative selective breeding activity allows improving animals' productivity.
Reducing vulnerability to climate change, indirect costs	Breeding of new sheep breeds more adaptable to climate conditions of the country will lead to the reduction of their vulnerability to the expected climate change.
Economic benefits, indirect benefits	One kilogram of sheep living weight in subsidized in the amount of 125 tenge. To multiply this amount on average weight animal - 50 kilograms is 6250 tenge that is nearly one third of the animal cost [47].
Employment	The number of animals and accordingly employment of the rural population will be improved.
Growth and investments	The environment to attract investments should be enabled.
Social benefits, indirect benefits	The introduction of the technology will allow increasing the number of animals and improving the well-being of the population.
Income, education, health	The stock-breeding development allows improving the well-being of the rural population and, accordingly, the life quality of the population and human health and requires improvement of the personnel's skills.
Environmental benefits, indirect benefits	The selective breeding activity allows improving animals' productivity.
Opportunities and barriers	The main barrier is imperfection of the selective breeding activity system that should be supported by the state.
Market potential	The improvement of productivity and quality of the product, as well as reduction of its prime cost leads to the improvement of sheep breeding competitiveness on domestic and foreign markets.
Status	Introduced in practice.
Period	In 2010 the employees of the research sheep breeding institute developed a sheep breed and it took them 20 years to complete this work. Accordingly, this is a long-term technology in relation to its implementation.
Acceptability for local stakeholders	The support of breed transformation and qualitative improvement of breed composition of agricultural animals should be secured by local executive bodies.

8. Factsheet for the technology on pasture improvement

Technology: Pasture improvement	
Sector: Agriculture	
Subsector: livestock sector	
Technological characteristics	
Introduction	The pasture is a source of cheap and valuable green forage. However, overloading of pastures by live-stock makes negative impact on their environmental condition. Significant overgrazing leads to destruction of sod cover of pasture plants and mechanical soil structure, as well as to reduction of yield productivity. According to the data of the Institute of World Resources the pasture lands in Kazakhstan cover 188 million hectares or 70% of the total area.
Technological characteristics / key aspects	The main ways of pasture improvement are: • clearing from weeds and prickly shrubbery; • application of mineral and organic fertilizers; • irrigation (where applicable) of desert, steppe and meadow-steppe pastures; • sowing of grasses, harrowing and chapping. When doing that natural vegetation remains completely or partly there and the productivity and feed properties become improved. Fundamental improvement also envisages change of natural vegetation for valuable crops to nurture crop pastures. When achieving fundamental improvement the soil is cultivated with ground plows, disc harrows, milling cutters; fertilizers are applied and seeds of meadow grasses are sown. In Kazakhstan overloading of pastures by live-stock makes negative impact on their ecological condition. Significant overgrazing leads to destruction of sod cover of pasture plants and mechanical soil structure, as well as to reduction of yield productivity. To prevent these problems rational system of pasture use management should be introduced. The activities on the improvement of pastures in mountain areas may not be always implemented because of complicated relief, the rational management system for pasture turn over use and regular grazing may be applied, practically, in all pasture areas of the country [48]. An option of pasture restoration, which is becoming more and more popular in Kazakhstan, is an "electronic shepherd" system: a pasture area sufficient for grazing and including a watering object is fenced, and electric current is applied using the wire on the fence. The live-stock, when feeling electromagnetic waves from the fence, does not approach it and stays only within the fenced pasture. In 20 - 30 days the fence is moved to another area, and the live-stock is driven there, a grass cover in the area of previous live-stock location becomes restored.
Institutional and organizational requirements	The Draft Laws "On Pastures" developed by the Committee on Agrarian Issues envisages efficient pasture management. Establishment of a public-coordination body on the issues of pasture use is envisaged. A new public-coordination body "Zhaiylymdar kenesy" (a Pasture Council) will be established for efficient cooperation between pasture users and a local executive body [49].
Operation and technical maintenance	The periods and repetition of grazing in pasture areas should be interchanged combining all that with the activities on maintenance and improvement of them. To improve meadows and pastures use, fertilizer spreader, soil cultivation and special machines: meadow harrows, graders, meadow units and others are applied.

Approval by experts	It is recommended by all experts and researchers all over the world.
Correspondence to current climate	It corresponds to the conditions of the current climate.
Scale/size of a group of beneficiaries	A small-scale technology.
Shortcomings	The main reason of all negative impacts on pastures is an imperfect normative and legal base determining the basis for pasture land management. The loads on the lands of populated areas, according to calculations of specialists, three-four and more times exceed the established norms in the regions. So, the issue on delivery of land plots to private households for haymaking and live-stock grazing on the conditions of long-term lease or purchase for their own property within the norms specified by the same law should be solved on a law level. The restraining factor is the lack of experienced specialists and means to acquire special machinery to prepare soil for sowing, maintaining and harvesting of forage crops. A problem related to lack of grass seeds (only 10-15% is provided) is faced in the process of pasture improvement. Prickly shrubberies in natural forage crop areas make great damage to livestock breeding, particularly, to sheep breeding, reduce pasture area, decrease access of animals to grazing areas, make inaccessible forage plants for live-stock and injure animals. In the winter season the pasture productivity is low, and winter pasturelands are extremely overloaded. The production of winter forage is low. Besides, additional losses may occur because of bad storage. The load on winter pastures may be decreased without reduction of the number of animals through the improvement of winter forage production and storage.
Capital costs	
Costs for introduction of adaptation technologies	The total degraded lands area is over 48 million hectares, or 26% of the total area. The estimated total economic losses as a result of desertification and irrational management in the agricultural sector of Kazakhstan are 700 mln USD per annum.
Incremental costs for introduction of adaptation technologies compared to "business as usual" scenario	Constant supervision over proper pasture use, well-timed planning and implementation of the activities on improvement of them will allow saving additional investments. This may be realized only through proper organization of the monitoring and pastureland evaluation system. Scientific and informational support and awareness raisng on combating pasture degradation should be provided through organization of workshops and delivery of information materials to remote rural areas. At present, the subsidies are 300 tenge per on 1 ha. This constitutes only 2% of total costs. The subsiding should cover a certain, significant part of circulating means for production.
Long-term costs (that is 10, 30 or 50 years) without adaptation	To protect pastures from degradation an optimum pasture load should be maintained, and the system of seasonal pasture areas use should be observed. For the last years live-stock is grazing near villages, and these pastures are degrading. In remote pastures there are no wells for live-stock watering. Currently, the whole infrastructure should be restored.

Long-term costs (that is 10, 30 or 50 years) with adaptation	When introducing the technology wells for live-stock watering should be constructed in remote pastures.
Impact on the development, direct and indirect benefits	
Direct benefits	The improved pastures will allow improving stock-breeding productivity, since at present the pastures do not provide sufficient forage for live-stock.
Reducing vulnerability to climate change, indirect costs	The pastures have been intensively and irrationally used for a long time. The reduction of vulnerability to climate change through decrease of the load on pasturelands, rational use of them and application of mineral fertilizers will allow improving the composition of vegetation in pastures.
Economic benefits, indirect benefits	The introduction of the technology will lead to farmers' income growth and cost recovery.
Employment	The demand for workers in rural areas will increase.
Growth and investments	Kazakhstan is the only country in Central Asia, where pasturelands are not state owned to full extent. Enormous pasture areas have been delivered for long-term lease to natural persons and legal entities, which do not work in agriculture, but simply use the sublease. The lack of guaranteed property rights (exclusive - individual or collective - rights for use or ownership) is a barrier to investments from potential farm owners to a required auxiliary infrastructure.
Social benefits, indirect benefits	The productivity improvement through pasture improvement will allow improving the well-being of the rural population.
Income, education, health	Improvement of living and working conditions, health and education level of the population
Environmental benefits, indirect benefits	Improvement of animal productivity.
Opportunities and barriers	In Kazakhstan, the improved pasture area with average productivity of 36.5 c/ha may be extended to 49.1 mln ha. Along with that the number of live-stock in Kazakhstan will 5 times increase and will be at the average 0.2 of conditional animal per 1 ha of pastureland. Fundamental improvement of pastures will allow enlarging the number of cattle to 25.3 mln animals, and along with that up to 1.1 mln tons of beef in the amount of 3 bln USD, up to 6.8 mln tons of milk in the amount of 2.2 bln USD and leather in the amount of 150 mln USD may be produced. The production of meat and milk products may lead to additional 1.8 bln USD. To 68.8 mln of sheep may be maintained on the same pastures, accordingly to 1.1 mln tons of mutton in the amount of 3.4 bln USD, wool - to 210 thousand tons in the amount to 260 mln USD, hides of sheep and goats - 30 mln pieces in the amount to 110 mln USD may be produced.
Market potential	The technology has a great national wide market potential.
Status	Used in practice.
Period	A mid-term technology.
Acceptability for local stakeholders	The technology should be of interest for farms, since pasturelands provide over 70 percent of forage for stock-breeding in Kazakhstan [50].

9. Factsheets for the technology of national legislation improvement

Technology: water legislation improvement	
Sector: Water sector	
Subsector: Drinking water supply and wastewater disposal	
Technology characteristics	
Introduction	One of the highest priorities in drinking (municipal) water supply and wastewater disposal in Kazakhstan is the improvement of the legislation and introduction of amendments and additions to the accompanying codes and regulations.
Technology characteristics/highlights	Adoption of such measures is long overdue because of the objective factors (climatic conditions, scarce amount of water resources, their uneven distribution throughout the country, etc.) and subjective (fragmentation of water management, inefficient activity of water management organizations of the country, etc.) factors.
Institutional and organizational requirements	It is required to improve the institutional framework and organizational measures along with the development and adoption of new laws and regulations to improve water supply and wastewater disposal.
Operation and maintenance	In this case operation and maintenance is not required.
Endorsement by experts	Improvement of water legislation is being actively implemented in the developed countries of the world and is being promoted in developing countries. It is recommended by all the experts and researchers.
Adequacy for current climate	Improvement of water legislation is aimed at improving the water resources management and adaptation to the expected climate change.
Scale/Size of beneficiaries group	Beneficiaries include all water users in the country using water for different needs regardless of the form of ownership of enterprises.
Disadvantages	Making amendments and adoption of new regulations takes time.
Capital costs	
Cost to implement adaptation technology	No additional financial requirements and costs for the improvement of the legislation are required.
Additional cost to implement adaptation technology, compared to "business as usual"	No additional costs to implement this adaptation technology are required.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	Long-term costs are not required.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	Long-term costs are not required.
Development impacts, direct and indirect benefits	
Direct benefits	The advantage of the new paper is the improved legal regulation in the field of water supply and wastewater disposal.

Reduction of vulnerability to climate change, indirect	The improvement of water legislation will improve the management of water resources of the country in the view of climate change and estimate future expenditures.
Economic benefits, indirect	Cost savings for the future.
Employment	Good planning and cost savings will increase the possibility of creating additional jobs in industrial, livestock breeding, crop breeding and other sectors.
Growth & Investment	Improvement of water legislation is aimed at accelerating the economic growth and production in all areas and regions of the country.
Social benefits, indirect	Water resources saving is aimed at providing access to water supply and wastewater disposal of the significant part of the population, increasing the yield of agricultural products and livestock breeding, as well as employment of people.
Income, Education, Health	The improvement of water legislation will improve the living and working conditions, the health of the population and the level of education
Environmental benefits, indirect	Improvement of drinking and irrigation water, reduction of the use of chemical fertilizers, high-quality treatment of domestic and industrial wastewater, minimization of pollution of soil, groundwater and waste water
Local context	
Opportunities and Barriers	The Program "Ak Bulak" has already noted that in order to improve the legal relations, it is necessary to improve the legislation on water supply and wastewater disposal. The barriers to improve the legislation could be the following risks: • inefficient functioning of water utilities compared with the applicable law; • non-application of real rates, covering the costs of water utilities; • fixed assets of the water utilities are not formalized (absence of BTI passports, land acts, etc.); • the presence of ownerless networks; • no real revaluation of fixed assets of water utilities is carried out; • lack of qualified personnel in water utilities meeting the modern requirements.
Market potential	Technology has a market potential nation-wide.
Status	Currently, in Kazakhstan the water legislation in the field of drinking water supply is being improved.
Timeframe	Short term.
Acceptability to local stakeholders	Improvement of water legislation could be accepted by all stakeholders.

10. Factsheets for the technology of renovation of fixed assets of Water utilities

Technology: renovation of fixed assets of water utilities
Sector: Water sector

Subsector: Drinking water supply and waste water disposal	
Technology characteristics	
Introduction	Currently, one of the major obstacles for the effective operation of water supply and wastewater disposal (W&W) enterprises is high wear of their fixed assets (networks and structures, machines, buildings, etc.). In some cities the growing loss of water accounted to almost 40% of the total water supply per year. It causes both interruptions in water supply and excess demand of electricity and environmental pollution.
Technology characteristics/highlights	As of January 1, 2011, according to the data of the 20 surveyed urban water utilities, the length of water supply networks was 10,458 km, wastewater disposal networks - 6057 km, while the level of deterioration of water supply networks was on average 64%, wastewater networks - 56%, the level of availability of the centralized water supply services - 79%, and sanitation services - 69%. The budgetary funds accounted for 78.8%, own funds - 12.8% and borrowed funds - 8.4% of the total investment amount in these water utilities.
Institutional and organizational requirements	Despite the fact that annually about 25 billion tenge are allocated from the republican budget for the reconstruction and modernization of the only urban water supply and wastewater disposal networks, the overall level of deterioration of urban networks and facilities of water sector of Kazakhstan remains at the high level of 60-80%. On this basis, according to expert assessments, the overall need for funds solely for the reconstruction of water supply and wastewater disposal networks, excluding the costs of water supply and sewer facilities in 86 cities (26 big and 60 small cities), is estimated at 515.6 billion tenge. It is obvious, that such investments cannot be provided only through budget allocations and it is necessary to create conditions for attracting foreign investment, which could be provided by international financial institutions, private investors with the experience in water sector and other development partners. In this regard, one of the main activities within the framework of the Program "Ak bulak" is the creation of investment attractiveness of the water supply and wastewater disposal sector.
Operation and maintenance	Operation and maintenance of water supply and wastewater disposal systems consists in early detection and elimination of problems in systems of scheduled and preventative maintenance and replacement of obsolete equipment and machinery by the new and modern ones. Due to the chronically underfunding, the depreciation of fixed assets of systems and structures of water supply and wastewater disposal (W&W) enterprises has reached the critical level. Currently, the preventative maintenance of networks and facilities of W&W is no longer in question. It is almost replaced by the emergency recovery efforts, one-off costs of which are 2.5-3 times higher than the costs of scheduled maintenance of the same facilities. The number of accidents on the networks of W&W is increasing on average by 4-5% per year.
Endorsement by experts	Timely renovation of fixed assets of water utilities is implemented in all developed countries, and is being promoted in developing countries. It is recommended by all the experts and researchers around the world.
Adequacy for current climate	The relevant requirements are eligible, necessary and good both for the current and, especially, for the expected climate change.

Scale/Size of beneficiaries group	Beneficiaries include all the users of drinking water and consumers using the sewerage services in the country, regardless of the form of ownership of enterprises.
Disadvantages	The technology of renovation of fixed assets of water utilities requires high financial costs and much time to implement.
Capital costs	
Cost to implement adaptation technology	1. The main source of funding the technology of renovation of fixed assets of water utilities could be the Government; 2. Tariff increases.
Additional cost to implement adaptation technology, compared to "business as usual"	Increase in the cost of restoration of damaged systems and facilities will be multiplied and could require substantial material cost, labor and time.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	Renovation of fixed assets of water utilities is necessary up to 10 years, and even regardless of any changes in climatic conditions.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	Renovation of fixed assets of water utilities is necessary up to 10 years, and even regardless of any changes in climatic conditions.
Development impacts, direct and indirect benefits	
Direct benefits	Reduction of water losses, interruptions in water supply, electricity consumption and environmental pollution, improvement of the quality of drinking water.
Reduction of vulnerability to climate change, indirect	Increase of the operating life of drainage systems and structures, reduction of water losses .
Economic benefits, indirect	Enhanced access to the improved systems of water supply and wastewater disposal.
Employment	Renovation of fixed assets of wastewater disposal systems and facilities will require the creation of new jobs.
Growth & Investment	Requires a significant increase in investment in water systems and wastewater disposal facilities. Renovated systems and facilities speed up the economic growth and production in all areas and regions of the country.
Social benefits, indirect	Renovated water systems and wastewater disposal facilities will provide people the necessary amount of safe drinking water and timely waste water disposal.
Income, Education, Health	Water conservation, improved living, work and health conditions, and improved education.
Environmental	Improvement of drinking water quality and purification of municipal and

benefits, indirect	industrial wastewater will improve the ecological situation in the region.
Local context	
Opportunities and Barriers	The main factor in increasing the investment attractiveness of the sector should be investment-attractive tariffs ensuring cost-effective operation of enterprises and guarantees of return on investment of private investors. One of the main barriers is the private ownership of some water utilities, which is a barrier to government funds. The other barriers to implement the technology of renovation of fixed assets of water utilities are the following major and possible risks (threats): - lack of the legal framework for improving water supply and wastewater disposal; - ineffective use of budgetary funds to implement the projects in the field of water supply and wastewater disposal; - lack of specialized operating companies and organizations in rural areas; - lack of implementation of innovation and investment projects; - low level of involvement of private operators to implement the innovative and investment projects; - lack of qualified personnel; - lack of incentive mechanisms for the involvement of young and talented professionals; - unfavorable investment climate and growth in inflation; - current high rate of bank loans; - small number of medium-term and the absence of long-term rates for 5 or more years; - low level of ability of the rural population to pay debts; - low population density and need for construction of water pipelines to transport water over long distances in rural areas; - Social discontent.
Market potential	Technology has a market potential nation-wide.
Status	Currently, the fixed assets of water utilities are worn out and need to be renovated.
Timeframe	Medium-term.
Acceptability to local stakeholders	Renovation of fixed assets of water utilities can be accepted by all stakeholders - consumers of drinking water and wastewater disposal services.

11. Factsheets for the technology on leakage control, detection and elimination of leakages in pipe networks.

Technology: leakage management, detection and elimination in networks	
Sector: Water sector	
Subsector: Drinking water supply and water drainage	
Technological characteristics	
Introduction	One of the priority tasks in the drinking (municipal) water supply and water drainage subsector is reduction of water losses through detection and elimination of leakage in networks.
Technological characteristics / key aspects	At present one of the main barriers to efficient activity of water supply and water drainage enterprises is considerable wear-out of main assets (networks and constructions, machinery, mechanisms, buildings and etc.).

	The growing water losses in some cities reach about 40 % of the total water supply amount per annum. This leads to interruption in water supply and overconsumption of electric power as well as to environmental pollution.
Institutional and organizational requirements	Improvement of water resources management, metering and economy system. When investing the technology qualified personnel potential will be required for operation and technical maintenance of water supply and water drainage systems.
Operation and technical maintenance	Operation and technical maintenance is of great significance at detection and elimination of leakage in networks.
Approval by experts	Leakage management, detection and elimination in networks is applied in all developed countries of the world, being introduced in developing countries and recommended by all experts and researchers.
Correspondence to current climate	Leakage management, detection and elimination in networks will lead to the improvement of water resources management, water resources saving and adaptation to expected climate change.
Scale/size of a group of beneficiaries	The beneficiaries include all water users in the country, using water for various needs regardless of' the form of ownership of enterprises.
Shortcomings	The modern equipment for leakage detection in networks (leakage detectors and other) is not produced in Kazakhstan and rather expensive.
Capital costs	
Costs for introduction of adaptation technologies	1. The main sources of funding the technology on detection and elimination of leakage in networks should be Vodocanals. 2. Growing tariffs are expected.
Additional costs for introduction of adaptation technologies compared to "business as usual"	Inaction leads to reduction of water resources and requires additional costs.
Long-term costs (that is 10, 30 or 50 years) without adaptation	In 10 years the country will experience water deficit and considerable costs will be required to search for additional water sources or to remove water from the areas with excessive water amount.
Long-term costs (that is 10, 30 or 50 years) with adaptation	Lack of water resources at growing pace of country development and population growth will require considerable costs to search for additional water sources or to remove water from the areas with excessive water amount.
Impact on the development, direct and indirect benefits	
Direct benefits	The advantage of the introduction of the technology on leakage management, detection and elimination in networks is water resources saving in the field of water supply and water drainage.
Reducing vulnerability to climate change, indirect costs	The improvement of the technology on leakage management, detection and elimination in networks will allow improving water resources management in the country taking into account the climate change and planning the costs qualitatively in prospect.

Economic benefits, indirect benefits	Saving of costs in prospect.
Employment	Qualitative planning and costs saving will enhance the opportunity for creation of additional jobs in the industry, live-stock breeding, crop and others sectors.
Growth and investments	Water accounting and water resources saving are focused on acceleration of economy and production growth in all areas and regions of the RK.
Social benefits, indirect benefits	Water resources saving will allow securing access to water supply and water drainage for a considerable number of the population, increasing crop productivity and agricultural and live stock breeding products production and improving the employment of the population.
Income, education, health	The improvement of the technology on leakage management, detection and elimination in networks will allow improving living and working conditions and health of the population and will require qualified specialists to maintain the system.
Environmental benefits, indirect benefits	Increased amount and improved quality of drinking water and the water for irrigation, reduction of chemical fertilizers use, qualitative treatment and minimization of soil and ground and waste waters pollution.
Opportunities and barriers	The main barriers to the introduction of the technology may be the following main risks: • inefficient activity of organizations, servicing systems; • lack of real tariffs covering costs of servicing organizations; • lack of inventory, passport issuing and registration of water supply and water drainage networks • real assessment of main assets of servicing organizations; • lack of skilled personnel meeting modern requirements and lack of servicing organizations.
Market potential	The technology has a national wide market potential.
Status	At present only some effectively operating servicing organizations are able to actively use the equipment for leak detection (leak detectors) and actively eliminate the leakage.
Period	Mid-term prospect
Acceptability for local stakeholders	Leakage management, detection and elimination in networks may be adopted by all concerned parties.

12. **Factsheets for the technology on catchment of rainwater and melt water, construction of tanks and reservoirs**

Technology: rainwater, melt water and river water collection through construction of reservoirs and water reservoirs	
Sector: Water sector	
Subsector: Drinking water supply and water drainage	
Technological characteristics	
Introduction	One of the climate change impacts in Kazakhstan may become drinking water deficit. The fresh water defect will make impact not only on the population health and agricultural development, but also will lead to growing risk of political discord and conflicts related to access to water resources. In the condition of climate change the demand for water to meet the population needs and industry of Kazakhstan, as well as neighboring

	countries of Central Asia and China will increase. So, Kazakhstan should create its own reservoirs and water reservoirs to store water resources.
Technological characteristics/key aspects	The major part of Kazakhstan territory is located in the arid zone and experience fresh water deficit. The urgency of the problem on steady water supply is defined by insufficiency of water resources volume, high level of their pollution and unevenness of their distribution throughout the territory of the country. Besides, there are considerable seasonal fluctuations, both for many years and within one year that preconditions uneven water supply in different regions. Owing to climatic particularities of the country up to 90 % of surface water sources occur in the spring season. Along with these "natural" problems in the water sector of the economy, there are also institutional, engineering-technical and financial (or economic) problems.
Institutional and organizational requirements	In the country there is a variety of institutional problems on this sector management related to: 1) improvement of the system management; 2) considerable disunity of the water sector and water resources management; 3) conflict of interests between the agricultural sector and the water sector management body; 4) an outdated legislative base, which is a barrier to introduction of new technologies; 5) deficit of personnel for the water sector activity. The main engineering and technical problems: • considerable wear-out of the networks and hydrotechnical constructions; • insufficient construction of new systems, • incomplete accounting of water amount and improper control of water quality, reduction of the developments and approval of new modern regulatory documents. The financial problems in the water sector are: 1. The tariff policy creating a barrier to attraction of private capital to the sector on a competitive basis; 2. Insufficient privileges and preferences for the water sector and many others. (Are the privileges really insufficient? 70 % is financed from the budget) Along with that there are the issues that should be solved: • Lack of measures on water saving; • Updating of legislation taking into account the climate change impacts; • Creation of additional water stock through construction of new water reservoirs and hydropower stations; • Improvement of the regulation of interstate water relations; • Introduction of integrated water resources management; • Creation of an automated united database on water resources condition.
Operation and technical maintenance	Normative operation and technical maintenance of reservoirs and water reservoirs is of great importance for creation of required water stocks.
Approval by experts	The practice on designing and construction of reservoirs and water reservoirs to create water stocks is used from the very beginning of husbandry development, and recently it is also used at construction of

	greater and small hydropower stations. The construction of small hydropower stations is reasonable both from ecological, and economical point of view. Presently, the potential of small hydropower is used and national programs on its expansion are being developed in many countries of the world. In C.I.S. countries including Kazakhstan the national programs on small hydropower development are being designed. So, in 2005 the concept on the construction of 20 small hydropower stations with annual generation capacity of 4.8 mlrd kWt/hour till 2015 was developed and adopted by the Government of the RK. The incentives for the construction of small hydropower stations are: - constant renewability of water resources; - the least impact on the environment; - low prime cost for electric power in contrast with heat stations; - considerable saving of mineral fuel; - improvement of public utility conditions and labour conditions of people; - short periods for construction of small hydropower stations; - low capital intensity, a short investment cycle. So, the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs is used in all developed and developing countries of the world and recommended by all experts and researchers.
Correspondence to current climate	The collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs will lead to the improvement of water resources management, water resources saving and adaptation to expected climate change
Scale/size of a group of beneficiaries	The beneficiaries include all water users in the country, using water for various needs regardless of' the form of ownership of enterprises.
Shortcomings	The collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs is a rather costly activity.
Capital costs	
Costs for introduction of adaptation technologies	The main source of funding the technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs may be the state budget and the means of international institutes. Growing tariffs for water users are expected.
Additional costs for introduction of adaptation technologies compared to "business as usual"	Inaction leads to reduction of water resources and requires additional costs.
Long-term costs (that is 10, 30 or 50 years) without adaptation	In 10 years the country will experience water deficit and considerable costs will be required to search for additional water sources or to remove water from the areas with excessive water amount.
Long-term costs (that is 10, 30 or 50 years) with	Lack of water resources at growing pace of country development and population growth will require considerable costs to search for additional water sources or to remove water from the areas with excessive water

adaptation	amount.
Impact on the development, direct and indirect benefits	
Direct benefits	The advantage of the introduction of the technology is water resources saving in the field of water supply and water drainage.
Reducing vulnerability to climate change, indirect costs	The improvement of the technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs will allow improving water resources management in the country taking into account the climate change and planning the costs qualitatively in prospect.
Economic benefits, indirect benefits	Saving of costs in prospect.
Employment	Qualitative planning and costs saving will enhance the opportunity for creation of additional jobs in the industry, live-stock breeding, crop and others sectors.
Growth and investments	The technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs is focused on the creation of water resources stocks, their saving and acceleration of economy and production growth in all areas and regions of the RK
Social benefits, indirect benefits	The technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs will allow securing access to water supply and water drainage for a considerable number of the population, increasing crop productivity, agricultural and live stock breeding products production and improving the employment of the population.
Income, education, health	The technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs will allow improving living and working conditions and health of the population and raising the education level.
Environmental benefits, indirect benefits	The technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs will lead to increased amount and improved quality of drinking water and the water for irrigation, reduction of chemical fertilizers use, qualitative treatment and minimization of soil and ground and waste waters pollution.
Opportunities and barriers	In Kazakhstan there are opportunities for the construction of a number of reservoirs and water reservoirs to create the water resources stock including for small hydropower stations. The establishment of joint-ventures for the construction of small hydro generation objects with the total capacity of 300 MWt on the territory of Kazakhstan is envisaged. The Project is the first effort on cooperation between Russian and Kazakhstan in the field of renewable energy sources. On the results of this activity a great number of potential sites for construction of small hydropower stations have been defined on territory of the republic.
Market potential	The technology has a national wide market potential.
Status	At present new reservoirs and water reservoirs are being constructed in Kazakhstan. The Koksaray counter regulator, the construction of which was completed in 2011, may serve as an example. It can provide water stock during a high water period, and use it in a vegetation period, up to 3 km^3/year of irrigation water in the south of the country. However, a number of reservoirs and water reservoirs should be constructed.

Period	A long-term prospect.
Acceptability for local stakeholders	The technology on the collection of rainwater, melt water and river water through construction of reservoirs and water reservoirs may be adopted by all concerned parties.

13. Factsheets for the technology of metering of water for irrigation and watering

Technology: metering of water for irrigation and watering	
Sector: Water sector	
Subsector: Agricultural irrigation	
Technology characteristics	
Introduction	The largest consumer of water in Kazakhstan is agriculture and it accounts for about 70% of all water consumption. Water is used for irrigation and watering. It is in this sub-sector metering of water is adjusted poorly.
Technology characteristics/highlights	Complex system of metering of water resources of the country, including metering of water for irrigation, is based on data from long-term observations of the major river basins, including all bodies of water and waterworks. This system should also include an updated network of monitoring system, consisting of the required number of gauging stations equipped with modern water measuring devices and structures. Metering of water resources and their changes should be carried out in real time on the basis of automated systems.
Institutional and organizational requirements	Improvement of the system of water resources management and assessment
Operation and maintenance	Operation and maintenance of metering system of water for irrigation and watering consists in early detection and elimination of problems in the system, and conducting of scheduled and preventative maintenance and replacement of obsolete equipment and machinery by new and modern ones.
Endorsement by experts	Metering of water for irrigation and watering is established in all the developed countries in the world, and is being promoted in developing countries. It is recommended by all the experts and researchers around the world.
Adequacy for current climate	The relevant requirements are acceptable and comply with the current requirements and the requirements of the expected climate change.
Scale/Size of beneficiaries group	Beneficiaries include all water users in the country who use the water for irrigation and watering irrespective of the form of ownership of enterprises.
Disadvantages	The costs of establishing a system of metering of water resources of the country and metering of water for irrigation are high and are calculated for medium-term.
Capital costs	
Cost to implement adaptation technology	The main source of financing of the system could be the Government of Kazakhstan. Refunds available from the water users' payments for the water for irrigation.
Additional cost to implement	Failure to take measures leads to a reduction of water resources and the project for the transfer of the missing water from regions where there is a

adaptation technology, compared to "business as usual"	surplus of water requires high costs and much time.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	After 10 years, the country will incur a shortage of water and it will require significant costs to search additional sources of water or to transfer the water from regions where there is a surplus of water.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	Lack of water resources, in case of increasing rate of development of the country and increase in population, will require significant investment in searching additional sources of water or to transfer the water from regions where there is a surplus of water.
Development impacts, direct and indirect benefits	
Direct benefits	The introduction of water meters enables to accumulate and distribute the available water resources to all sectors of the economy, and to plan and forecast their future consumption.
Reduction of vulnerability to climate change, indirect	Metering of water for irrigation and watering, as well as its efficient use enables to save available water reserves, which, in turn, will significantly reduce the vulnerability of the region to climate change. These measures will prevent the outflow of population from areas where there is scarcity of water for living and business.
Economic benefits, indirect	Only on the basis of the presence of such a complex system of water resources metering it is possible to plan and execute any forward-looking estimates on the further development of any sector of the economy. The presence of this system enables to integrate it into the Integrated scheme of water resources management of the country for long term.
Employment	The conservation of water resources (or their increase) will greatly enhance the ability to create additional jobs in the sectors of agriculture, industry, livestock breeding and etc.
Growth & Investment	Investments in water metering system enable to increase the availability of water resources, to use water more efficiently, to keep the population in areas where there is scarcity of water. All of this in turn will accelerate the growth of the economy and production in all areas and regions of the country.
Social benefits, indirect	Implementation of the system enables to save water and at the same time to provide water for a significant part of the population, to increase agricultural yields and livestock productivity.
Income, Education, Health	Introduction of the water metering system is aimed at saving and provision of water resources, improving living conditions and health, as well as training in educational institutions.
Environmental benefits, indirect	Metering of water for irrigation and watering determines not only the quantitative characteristics, but also its quality, and the application of fertilizers compared with the rules. Improving the quality of irrigation water and reducing the use of chemical fertilizers are to minimize the pollution of soil, ground water and waste water, which will significantly improve the ecological situation in the regions.
Local context	
Opportunities and Barriers	Under the current imperfect system of water management the introduction of metering of water for irrigation is problematic, since the Water

	Resources Committee (the body of water management) is the part of the Ministry of Agriculture - the main consumer of water resources. The fragmentation of the database by different entities is not conducive to the improvement of water resources management.
Market potential	Technology has a large market potential nationwide.
Status	Currently, the system of metering of water for irrigation and watering in the country is virtually absent.
Timeframe	Medium-term
Acceptability to local stakeholders	Technology of metering of water for irrigation and watering could be accepted by all the stakeholders. However, management of conjunctive water use can be a challenge due to the absence of water user associations and the necessary legal documents.

14. Factsheets for the Drip irrigation technology

Technology: drip irrigation	
Sector: Water sector	
Subsector: Agricultural irrigation	
Technology characteristics	
Introduction	Irrational use of water without the application of modern water-saving technologies requires the introduction of the most advanced technology of irrigation, i.e. drip irrigation, which is widely used throughout the world. Drip irrigation is most appropriate, where there is limited or irregular supply of water for agricultural use. The drip technology uses less water than sprinkler irrigation, since water can applied directly to the crops. Furthermore, the drip system is not affected by wind or rain (as is the sprinkler technology). Kazakhstan has so far only a few cases of application of drip irrigation.
Technology characteristics/highlights	Drip irrigation system is based on the constant application of a specific and focused quantity of water to soil crops. The system maintains 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 moisture requirement for each plant, the system significantly reduces water wastage and promotes efficient use.
Institutional and organizational requirements	Investment will also be required to build workers capacities in order to accurately manage maintenance and water flow control.
Operation and maintenance	Operation and maintenance includes the early detection and elimination of problems in the system, carrying out planned and preventative maintenance and replacement of obsolete equipment and machinery by the new and modern ones. Drip tape or tubing must be carefully maintained in order to avoid leaking or plugging and emitters must be regularly cleaned to avoid blockage from chemical deposits.
Endorsement by experts	Drip irrigation is used in many developed and developing countries. It is recommended by all the experts and researchers around the world.
Adequacy for current climate	The relevant requirements are acceptable for both present and expected climate change.
Scale/Size of beneficiaries group	Beneficiaries include all water users in the country who use the water for irrigation and watering irrespective of the form of ownership of enterprises.
Disadvantages	The initial cost of drip irrigation systems can be higher than other

	systems. Final costs will depend on terrain characteristics, soil structure, crops and water source. Higher costs are generally associated with the costs of pumps, pipes, tubes, emitters and installation. Weather conditions, i.e. rainfall, can affect drip systems either by flooding emitters, moving pipes, or affecting the flow of soil salt-content. It is difficult to combine drip irrigation with mechanized cultural operations that can damage pipes, tubes or emitters.
Capital costs	
Cost to implement adaptation technology	The technology is widely variable, however the cost of a drip irrigation system ranges from US$ 800 to US$ 2,500 per hectare depending on the specific type of technology, automatic devices, and materials used as well as the amount of labor required. Financing for the introduction of the system may be available from financial institutions via leasing operations or direct credit. Farmers usually cover installation, design and training costs that represent about 30 to 40 per cent of final costs depending on the size of the land, characteristics and shape, crops, and particular technology applied.
Additional cost to implement adaptation technology, compared to “business as usual”	The old ways of irrigation reduces water resources, and further it would be necessary additional costs for the transfer of the missing water from areas where there is a surplus of water.
Long term cost (i.e. 10, 30, or 50 years) without adaptation	If drip irrigation is not implemented, then after 10 years Kazakhstan will experience significant water shortages and it would require significant costs to search to search additional sources of water or to transfer of water from areas where there is a surplus of water.
Long term cost (i.e. 10, 30, or 50 years) with adaptation	Introduction of drip irrigation reduces water consumption and in perspective results in increase in population in case of the growing rate of development of the country.
Development impacts, direct and indirect benefits	
Direct benefits	1. Introduction of drip irrigation enable to accumulate and distribute the available water resources to all sectors of the economy of Kazakhstan, as well as to forecast and plan future consumption of water, including the water for watering. 2. Efficient use of water resources and reduction of water run-off through deep percolation or evaporation, reduction of production costs, and the conditions would less favorable for the onset of fungus diseases of plants. 3. Use of insecticides could be reduced. 4. The drip system technology is adaptable to terrains where other systems cannot work well due to climatic or soil conditions and to lands with different topographies and crops.
Reduction of vulnerability to climate change,	Introduction of drip irrigation will keep the existing stock of water resources and reduce the vulnerability of the region to climate change.

indirect	
Economic benefits, indirect	This technology will prevent the outflow of population from the areas, where there is a scarcity of water for living and business.
Employment	This technology reduces the threat of relocation of residents in water-rich regions and creates jobs in the sectors of industry, livestock breeding, crop breeding and in the areas of water scarcity.
Growth & Investment	Increased investment in drip irrigation system enables to use the water more efficiently, to keep the population in areas of water scarcity, which will accelerate the growth of the economy and production in all areas and regions of the country.
Social benefits, indirect	Introduction of drip irrigation enables to save water and to provide an access to water for a large part of the population, and to increase the agricultural productivity.
Income, Education, Health	Introduction of drip irrigation will save water and, at the same time, improve living conditions, conditions for work and health, and aimed at increasing the level of education.
Environmental benefits, indirect	Reduction of costs for irrigation, water quality improvement, reduction of fertilizer consumption and environmental conditions improvement in the regions.
Local context	
Opportunities and Barriers	Drip irrigation is particularly suitable for use with ground water from wells. It requires institutional arrangements and capacity building of water users to avoid an overuse of aquifer resources and potential conflicts. Drip irrigation is a versatile technology and can be implemented at small or large scales and with low-cost or more sophisticated components. It is suitable in areas with permanent or seasonal water scarcity, and for crop varieties with different periods of ripening. However, this system also has barriers, including lack of access to finance for the purchase of equipment, a higher amount of initial investment involved than other systems, and limited market for repurchased equipment. Even though several suppliers with wide experience may exist, these firms are usually focused on large land extension projects and do not cater for small and medium-sized farmer markets. One of the barriers to use the drip irrigation technology in Kazakhstan is a partial state subsidy for irrigation water for agricultural producers. Cheap irrigation water does not encourage these agricultural producers to use the water effectively.
Market potential	The technology has an average market potential nationwide.
Status	Currently, the scale of application of drip irrigation in Kazakhstan is small.
Timeframe	Medium-term.
Acceptability to local stakeholders	Drip irrigation technology could be accepted by all stakeholders, and especially by farmers.

15. **Factsheets for the technology on reconstruction and renovation of hydrotechnical constructions - HTC (water reservoirs, dams and etc.), irrigation systems and networks**

Technology: reconstruction and renovation of hydrotechnical constructions - HTC

(water reservoirs, dams and etc.), irrigation systems and networks	
Sector: Water sector	
Subsector: Agricultural irrigation	
Technological characteristics	
Introduction	The largest water consumer in Kazakhstan is agriculture consuming about 70 % of the total water amount used for watering and irrigation. It is the sector, where hydrotechnical constructions (water reservoirs, dams and etc.), irrigation systems and networks are very worn out.
Technological characteristics/key aspects	Kazakhstan relates to a number of countries, where irrigated husbandry plays a leading role in agricultural production and consumes about 70 % of irrigation water amount. In the previous years, over 30 % of the whole crop product in cost expression (at present - 5 %) was produced in irrigated areas covering 5 % of land areas. Due to some reasons, practically, a half of irrigated land areas has been removed from agricultural use. According to the experts' assessment the loss of over 1 mln ha of irrigated lands annually leads to the loss of agricultural product in the amount of over 700 bln tenge. One of the reasons of the reduction of land areas and crop productivity of irrigated lands is deterioration of technical condition of hydrotechnical constructions and channels, aggravation of irrigated land drainage because of vertical drainage wells destruction and aggravation of technical condition (silting, overgrowing and deformation) of horizontal drainage, water resources deficit and acceleration of degradation processes on irrigated lands. For the period of nearly two last decades no works on reconstruction of the irrigation network, improvement of land areas' reclamation condition and increasing their water supply have been conducted in the country. The systems are not sufficiently equipped with water metering, communication and transport means. Serious reconstruction works are required for a number of large channels. The coefficient of efficiency of irrigation systems is within 0.53 and lower. The water losses are about 2.5-3 km^3. The actual wear-out of the water sector systems and constructions is over 60 %. The reliability and safety of strategically important constructions has become lower.
Institutional and organizational requirements	Updating of the structures to improve the stability of hydrotechnical constructions, irrigation systems and networks to strengthen adaptation to climate change.
Operation and technical maintenance	The operation and technical maintenance of hydrotechnical constructions, irrigation systems and networks envisages well-timed detection and elimination of faults in constructions, systems and networks, organization of planned and preventive repair and replacement of outdated equipment and mechanisms for new and modern ones.
Approval by experts	Reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks is duly applied in all developed countries of the world, being introduced in developing countries and recommended by all experts and researchers throughout the world.
Correspondence to current climate	The related requirements are acceptable both for the current climate and the expected climate change.
Scale/size of a group of beneficiaries	The beneficiaries include all water users in the country, using water for various needs regardless of' the form of ownership of enterprises.

Shortcomings	The cost of the reconstruction and renovation of hydrotechnical constructions - HTC (water reservoirs, dams and etc.), irrigation systems and networks is rather high and envisaged for a long-term prospect.
Capital costs	
Costs for introduction of adaptation technologies	The source of funding may become: the government of Kazakhstan and international financial organizations, private capital. Partial cost return may be received from water users' payment for watering.
Additional costs for introduction of adaptation technologies compared to "business as usual"	Inaction leads to reduction of water resources and requires great costs and long periods for implementation of projects to remove the required water amount from the areas with excessive water resources. Besides, when dams and other constructions are too worn out, they may be broken or destroyed that will require additional means for their restoration.
Long-term costs (that is 10, 30 or 50 years) without adaptation	In 10 years the country will experience water deficit and considerable costs will be required to search for additional water sources or to remove water from the areas with excessive water amount.
Long-term costs (that is 10, 30 or 50 years) with adaptation	Lack of water resources at growing pace of country development and population growth will require considerable costs to search for additional water sources or to remove water from the areas with excessive water amount.
Impact on the development, direct and indirect benefits	
Direct benefits	The well-timed reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks will allow reducing the costs for response to emergency situations in case they are broken or destroyed.
Reducing vulnerability to climate change, indirect costs	The well-timed reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks will allow maintaining the existing water resources that in turn will lead to considerable reduction of the vulnerability of the region to climate change.
Economic benefits, indirect benefits	The activities will allow preventing the movement of the population from the areas with lack of water resources for living and economic activity.
Employment	The well-timed reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks will allow considerably enhancing the opportunity for creation of additional jobs in the industry, live-stock breeding, crop and others sectors.
Growth and investments	The investments in the reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks will allow increasing the water resources, water saving and preventing migration of people from water-deficit areas. All that, in turn, will lead to acceleration of the economy and production growth in all areas and regions of the country.
Social benefits, indirect benefits	The well-timed reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks will allow water resources saving and along with that securing access to water supply and water drainage for a considerable number of the population and will lead to improvement of crop and live-stock breeding productivity.
Income, education,	The reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks will allow water saving and securing water

health	resources, improving living conditions and health, studying at educational institutions and enlarging the income for the population.
Environmental benefits, indirect benefits	The reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks envisages increasing and conservation of water resources for watering and irrigation that will lead to considerable improvement of environmental conditions in the regions.
Opportunities and barriers	The imperfection of the water resources management system does not allow reconstructing and renovating hydrotechnical constructions and irrigation systems. The lack of the united information database on various structures is a barrier to the improvement of the water resources management system.
Market potential	The technology has a great national wide market potential.
Status	At present a number of activities on the technology have been defined under the draft Program on the development and modernization of the water sector of the RK till 2020.
Period	A long-term prospect.
Acceptability for local stakeholders	The technology on reconstruction and renovation of hydrotechnical constructions, irrigation systems and networks may be adopted by all concerned parties.

16. Factsheets for Extreme events prevention technology

Technology: Extreme events prevention using satellite data	
Sector: Water sector	
Subsector: Water resources management	
Technological characteristics	
Introduction	According to the estimates of the experts of the World Meteorological Organization and the World Bank, the production of 20-30 percent of the world gross domestic product depends on weather conditions. Annually, on an average, the total economic losses for 1991-2011 as a result of natural disasters constituted 2.2% of the world GDP. In Kazakhstan the greatest damage is made by floods on large transboundary rivers – the Ural (Zhayyl), the Tobyl, the Ishim, the Nura, the Zhem, the Torgay, the Sarysu, the Buktarma and their numerous tributaries. For the last 15 years over 300 floods of various origin, of which 70% occur in spring high water period, 20% were caused by rain and 10% by other reasons, have been registered in the republic. 850 potential flood-prone sites, where 732 populated areas are located and more than 900 thousand people living there have been identified on the territory. Of 653 hydroconstructions 268 (including 28 larger ones) should be urgently repaired. In the country there should be the data on weather events occurring in real time beyond its boundaries. The data on the extreme hydrometeorological events is collected through a great number of land, air and space observation networks, which make great input in the increase of the information volume and knowledge to reduce disaster risks. The available data and access to it in real time is the main factor for efficient early warning systems and measures to respond to natural disasters. The key elements of the functional system on warning about meteorological threats are provided below:

	• Data collection; • Continuous monitoring; • Identification of threats; • Forecasting of threats; • Formulation of reports and notifications; • Dissemination of information; • Response of communities and feedback
Technological characteristics / key aspects	The activity of the organizations involved in the management of various aspects related to extreme meteorological events is focused, first of all, on the efficiency of the systems on early warning about these threats. The early warning means providing timely and efficient information, which allows the persons exposed to threats to undertake actions to avoid or to reduce a risk and to be prepared for efficient response. The key elements of the functional system on warning about meteorological threats are provided below: • Data collection; • Continuous monitoring; • Identification of threats; • Forecasting of threats; • Formulation of reports and notifications; • Dissemination of information; • Response of communities and feedback
Institutional and organizational requirements	Improvement of the system on extreme weather events forecasting
Operation and technical maintenance	The main modules of the system are: a system for information reception and processing, a database on observations and data on extreme temperatures, expenses and high water levels, the maximum daily precipitations, etc. which are constantly updated, methods on information processing and forecast of extreme hydrological events allowing modeling changes in extreme natural events parameters for modeling and forecasting.
Approval by experts	The forecast on extreme weather events is prepared and disseminated in all developed countries of the world. It is recommended by all experts and researchers worldwide.
Correspondence to current climate	The related requirements are acceptable and correspond to the present requirements and expected climate change.
Scale/size of a group of beneficiaries	The beneficiaries include governmental bodies (MEP, the Ministry on Emergency Situations, MA), research institutes, concerned organizations, as well as all population of the country.
Shortcomings	The cost of the creation of extreme weather events forecast system is quite high for all countries and intended for a long-term prospect.
Capital costs	
Costs for introduction of adaptation technologies	The Government of Kazakhstan and international organizations may become the main sources of funding for the system.

Incremental costs for introduction of adaptation technologies compared to "business as usual" scenario	Insufficient warning on storms and disasters, as well as the lack of reliable long-term weather forecasts in the country lead to the reduction of the efficiency of response to these emergency situations. In many cases the reason for that is insufficient network of stations and posts, a small number of hydrological stations and insufficient technical and methodical provision.
Long-term costs (that is 10, 30 or 50 years) without adaptation	The country may bear enormous losses as a result of adverse hydrological events, both from the economical and social and environmental point of view.
Long-term costs (that is 10, 30 or 50 years) with adaptation	At more frequent adverse hydrological events in long-term prospect the country may bear enormous losses, both in economical and social and environmental relation.
Impact on the development, direct and indirect benefits	
Direct benefits	Observation and forecasting of disastrous hydrometeorological events (DME) long before they occur, warning of public authorities, the economy sectors and the population of the country about these events are the main tasks to prevent people's death and reduce economic damage.
Reducing vulnerability to climate change, indirect costs	According to the data of the World Meteorological Organization (WMO) 90% of natural disasters are of meteorological or hydrological origin. Forecasting and warning about extreme events will considerably reduce vulnerability of the region to climate change. These actions will allow preventing population's movement from the areas exposed to disastrous hydrological events.
Economic benefits, indirect benefits	The social and economic significance of the information on weather and climate is defined by the impact of this information on the decisions made by users in sectors vulnerable to weather and climatic conditions; this significance tends to increase, when the quality, accuracy and timeliness of local specifics is improved, and it is focused on the users of such information. The forecast calculations and warning about extreme events may be planned and implemented only on the basis of an integrated forecast system. The modernized service will allow promoting qualitative solution of primary tasks (reception, processing, database creation, forecasting of threats, decrease in vulnerability level, risk analysis, etc.). The experience of the developed countries on conducting hydrometeorological monitoring shows that the warning about the disasters prior to their occurrence allows saving people's lives and considerably reducing the impacts of disasters on the national economy.
Employment	Modernization of the system on warning and forecasting of extreme events and increase of the number of hydrometeorological posts will considerably enable the environment for creation of additional jobs and

	improvement of educational level.
Growth and investments	In the conditions of risk level increase, as well as in view of new opportunities related to instability and climate changes, the investments into research on climatic modeling, forecasting and analysis should be increased to improve the efficiency of planning in various social and economic sectors. The initiative on risk management is focused on the reduction of the vulnerability of the country concerning natural disaster risks and covers three main areas with the opportunity for inclusion of additional activity areas: • coordination of the activity on mitigation of impacts, securing preparedness and response; • financing of expenses on compensation of damage caused by extreme events, reconstruction and restoration, and development of instruments on the sharing natural disaster risks – such as insurance from natural disasters and weather derivatives; and • hydrometeorological forecasting, data exchange and early warning about natural disasters. The initiative is the basis for defining investment priorities in such spheres as early warning, disaster risk reduction and financing of related activities and should supplement and strengthen the activity of relevant structures to promote the efficiency of measures on mitigation and securing preparedness and response.
Social benefits, indirect benefits	**Social and economic efficiency** of the proposed technology is determined by the following factors: –the reduction of threat for the life of the population and reduction of damage to national economy (for marine activity areas) from hazardous hydrometeorological conditions; –the reduction of the risk of accidents making damage to the environment; –adaptation of new experimental developments related to designing, construction and operation of engineering objects exposed to environmental impacts.
Income, education, health	Introduction and modernization of extreme weather events forecast system is focused on the improvement of living conditions and human health, training in innovative technologies at educational institutions and securing population safety
Environmental benefits, indirect benefits	Improvement of the equipment of the National Hydrometeorological Service and qualification of specialists for timely warning about disaster risks and undertaking protective measures to mitigate impacts on the population and the economy is more cost-effective than financing the destroyed economy and eliminating emergency situations after their termination.
Opportunities and barriers	The hydrometeorological service of Kazakhstan conducts systematic monitoring and prepares forecasts concerning floods, high waters, mudflows and avalanches and warns about them. However, the operating warning system should be modernized. The technical base requires modernization. The cooperation between the research centers should be developed.
Market potential	The technology has great market potential on the national level.

Status	Currently, there is a system on extreme weather forecast in the country; however, the system should be modernized.
Period	A long-term prospect
Acceptability for local stakeholders	The technology on extreme weather forecast may be adopted by all concerned parties. However, the existing barriers: high cost of research, the lack of qualified personnel and limited access to new technologies, restrain the adoption of the technology.

ANNEX 2

List of stakeholders
Project Steering Commission

	Name/Surname	Field of expertise / position	Contact information
1.			
2.	**Tolebay Adilov**	Director of Department of Kyoto Protocol, Ministry of Environment protection RK	+7 7172 740258
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12.	**Gulden Okatayeva**	Expert of management of technogenic character Emergency Prevention of Emergency Prevention Department, Ministry of emergency situations of RK	

List of stakeholders
involved in interview in selection of technologies, including their names, organization, approach of consultation (like interview, meeting discussion, questionnaire etc), time, and topics.

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5.	Nurlan Serekpayev, Professor	Dean of the Agronomy Faculty of S.Seifullin Kazakh Agro Technical University (Astana)	тел.раб 8 (7172) 39-78-07 моб. 8 (701) 439 25 51
6.	Murat Karabayev, Professor	CIMMYT. International center of improvement of wheat and corn.	701-2167721. 7172-343713.
7.	Lubov Lebed, c.g.s.	"The Kazakh Research Institute of Ecology and Climate"	7272-255-84-14
8.	Aigul Kusainova	Climate Change Coordination	8 7172 519802

		Centre, Specialist	

List of water experts

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5.	Valeriy Syundyukov	manager-coordinator of the Association "Kazakhstan Su Arnasy"	87015445945
6.	Valeriy Torubara	Expert	87014267133
7.	Badashev	Ministry of Agriculture	
8.	Damezhan Kartpayeva	Climate Change Coordination Centre, Specialist	8 7172 280177

ANNEX 3

Results of MCDA application

Figure 6.1 Applying MCDA: Detailed steps
1. Establish the decision context. 1.1 Establish aims of the MCDA, and identify decision makers and other key players. 1.2 Design the socio-technical system for conducting the MCDA. 1.3 Consider the context of the appraisal. 2. Identify the options to be appraised. 3. Identify objectives and criteria. 3.1 Identify criteria for assessing the consequences of each option. 3.2 Organise the criteria by clustering them under high-level and lower-level objectives in a hierarchy. 4. 'Scoring'. Assess the expected performance of each option against the criteria. Then assess the value associated with the consequences of each option for each criterion. 4.1 Describe the consequences of the options. 4.2 Score the options on the criteria. 4.3 Check the consistency of the scores on each criterion. 5. 'Weighting'. Assign weights for each of the criterion to reflect their relative importance to the decision. 6. Combine the weights and scores for each option to derive an overall value. 6.1 Calculate overall weighted scores at each level in the hierarchy. 6.2 Calculate overall weighted scores. 7. Examine the results. 8. Sensitivity analysis. 8.1 Conduct a sensitivity analysis: do other preferences or weights affect the overall ordering of the options? 8.2 Look at the advantage and disadvantages of selected options, and compare pairs of options. 8.3 Create possible new options that might be better than those iriginally considered. 8.4 Repeat the above steps until a 'requisite' model is obtained.

Source: Chapter 6, Multi Criteria Handbook