NATIONAL HUMAN DEVELOPMENT REPORT 2008

Climate change and its impact on Kazakhstan's human development

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FOREWORD BY MR. KAIRAT KELIMBETOV, HEAD OF THE PRESIDENT'S ADMINISTRATION OF THE REPUBLIC OF KAZAKHSTAN

This National Human Development Report is devoted to one of the most important problems of the century, in which humanity encounters global climate change. The territory of Kazakhstan is located in climatic zones which are very sensitive to physical fluctuations in conditions, and which, crucially, may threaten livelihoods and lead to a deterioration in the overall quality of human life.

Climate change may disturb the natural balance and lead to irreversible environmental processes. The world's ecological equilibrium which has existed for many centuries, and the energy and water balance in Eurasia, now faces a significant anthropogenic impact.

In the seventeen years since independence, Kazakhstan has achieved a great deal in forming an independent state, which is recognized and respected worldwide. This is not only because Kazakhstan is acknowledged as rich in natural resources, and has become one of the key players in global energy, metallurgy and agricultural markets, but also because over this period an important point has been reached: the consolidation of the nation and its people, tolerance and respect for people of different religions, racial and ethnic backgrounds. Kazakhstan has succeeded in a short time in overcoming difficult years and in establishing essential improvements in people's lives, with a solid basis of new nationhood, achieving large scale progress in social development, reviving the economy of the country and infusing powerful dynamics.

At each stage of development the challenges facing the country have been resolved. Today, the time is ripe for consideration of the environment, climate protection and the conditions for human life, which ultimately provide the cornerstone of Kazakhstan's development. Considering the scale of the problem, today's concerns of scientists, the population and public groups are being discussed in various high level political forums. Kazakhstan, as a responsible member of the world community, is making intensive efforts to protect the environment and observe ecological standards.

Energy, water and climate are three interrelated concepts which impact on life, people's living conditions and human development. In many respects a globalized world has no borders, and no country can isolate itself from those problems which affect the whole planet. We support the endeavors of those countries, which have decided to pursue low carbon development in order to reduce the impact of climate change. The points of energy saving, utilization of renewable resources, technological development and the 'greening' of all aspects of life are given high priority in Kazakhstan at its new stage of development. This is a subject for dialogue between the state, public and private sectors. Human welfare and development, a favorable environment and climate protection are key long-term goals for Kazakhstan.

Opening remarks of Mr. Haoliang Xu, UN Resident Coordinator/UNDP Resident Representative

The subject of the 2008 National Human Development Report in Kazakhstan is an especially topical one both for Kazakhstan and the world community. The importance of this subject is emphasized by the global political processes targeting the struggle against poverty and progress towards sustainable development. In the Millennium Declaration, adopted by Heads of all States at the World Sustainable Development Summit, the leaders of governments unambiguously stated the importance and high priority attached to the resolution of climate change problems, the impact on the world economy and people's welfare. Sustainable human development in the modern world is impossible without the study and alleviation of the impact of climate change on the economy, communities and the environment.

This report is a first endeavor to analyze the impact of climate change on the Kazakhstan economy, and the influence of Kazakhstan on the global problem of climate change. I hope that this report, in modern Kazakhstan, will be useful for all levels of government, public institutions and international organizations, both to promote discussion on climate change as one of the barriers to successful development of the country, and to highlight the need to study the issue and propose practical measures to resolve climate change problems.

Climate change has an acute impact on the poorest and non-represented population, primarily the rural disadvantaged population, which is sidetracked, compared to the urban population, as climate change is more closely connected to agricultural problems, access to water resources and changing weather conditions. Climate change has its human face, economic measurement and tangible consequences, which are impossible to ignore, particularly as a country ranked amongst the highest in terms of greenhouse gas emissions. I sincerely believe that this report will help all parties and organizations concerned with the development and implementation of long-term environmental changes and their influence on the economic development of the country.

International experience shows that the climate change risks can be mitigated. The main focus of this report is on possible ways to ameliorate climate change problems through more efficient and rational use of energy resources, diversification of energy sources, changing the consumption and production model, targeting more vulnerable sectors of the population, and other related measures.

The transition to an economy adapted to climate change will take a long time and will require investment. This will help prevent huge financial losses in the future, preserve habitats for future generations, and provide for economic growth, given the effects of external factors connected to climate change. In other words, each tenge invested today in adaptation measures will save millions of tenge in 20-30 years. This is especially important for a country such as Kazakhstan, where 9% of GDP is derived from agriculture, and is thus more exposed to climate change effects than many other countries. The second vulnerable sector is the water sector, which is already facing difficult economic conditions. The problem of water deficit and access to water in Kazakhstan is most acute in the southern regions, where the situation is predicted to continue to deteriorate in future if adaptation measures are not undertaken urgently.

I hope that this report will provide a basis for the development and implementation of development strategies oriented towards balanced growth, given all the current requirements and contributory factors, for the benefit of Kazakhstan's human development.

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SUMMARY

"Climate change and its impact on human development" is a specialized report on human development in the Republic of Kazakhstan placing emphasis on the global environmental problem of climate change and its influence on the economy, human development and the importance of inclusion of this problem in national programs and strategies.

The first chapter "Climate change and human development" is devoted to the emergence of climate change problems, specifying the main trends of temperature regimes and showing global temperature forecasts and the main threats concealed in this problem for manpower resources. The chapter cites measures undertaken at global level to decrease the anthropogenic influence on climate change. Brief overview of Kazakhstan legislative and institutional machinery of counteracting climate change is provided. However, the character of interdependency of climate change and human development effects is determined by local effects of climate change influence, varying capacities to overcome social and economic challenges and government policy choices. Human development baseline conditions are deemed to be initial conditions for consideration of how climate change scenarios are elaborated.

The main conclusion of the chapter is that there is high level of awareness of the climate change problem on a global scale, although in Kazakhstan this problem is not really considered as a factor which may influence the country's development.

Chapter Two, "Climate change, risks and mitigation", is dedicated to the mitigation of climate change effects in Kazakhstan. This chapter shows the possible effects on the environment of Kazakhstan, the economy and its separate sectors and indicates the main risks and problem sectors which may suffer most due to climate change. The chapter reveals barriers leading to negative social phenomena such as famine, poverty and worsening public health, which may inhibit realization of mitigation measures. The chapter identifies problem sectors in need of urgent attention and the introduction of adaptation and mitigation measures: food security, cereal crop production, livestock breeding and land (crop and pasture) productivity, poverty and migration, impacts on territorial development, regional tensions, access to water resources, preservation of ecosystems, public health and emergency situations (natural disasters).

The following barriers to the mitigation of climate change impacts are revealed: institutional and legislative, financial-economic and social, educational, informative and transborder barriers.

The third chapter "Kazakhstan: actions for the solution of climate change problems" focuses on adaptation to climate change in Kazakhstan – what kind of measures are necessary and how detrimental inaction would be. The review shows that insufficient attention is being paid to the solution of climate change problems in Kazakhstan. There is no program for the mitigation of climate change and its negative impact, any relevant institutional structure, and mitigation and adaptation measures are not integrated into sectoral programs.

The authors of the report believe that in order to develop the adaptive capacity of the country a national program (strategy or action plan) for mitigation of climate change and its negative effects should be developed. The country should develop cooperation mechanisms for increasing the country's potential to identify sustainable solutions for mitigation of climate change impacts, integrate the goals and objectives of climate change adaptation and sustainable development strategy, encourage innovative activities, increase energy efficiency, protect the environment, improve policy, legal and financial frameworks for providing accelerated introduction of environmentally clean technologies leading to decreases in greenhouse gases emissions. The country should build upon current partnerships with developed countries to strengthen capacity, develop programs to transfer technologies in

renewable energy in order to attract private investment. Technology transfer should be in line with current demand for energy and the relevant priorities of the country. The country has to strengthen and implement market mechanisms (including mechanisms of the UNFCCC Kyoto protocol) in order to mitigate climate change impacts.

It is noted that in Kazakhstan there is no or not enough support and financing for research aimed at gaining a better understanding to climate change risks and its potential impact on sectors of the economy and socio-economic living conditions or standards and public health. It is necessary to increase the level of awareness of climate change and associated risks, as well as risk resilience measures and the supply of relevant information to business circles and energy consumers to ensure greater energy efficiency and decreases in greenhouse gases emissions.

This report addresses several questions including which development path Kazakhstan should take, which priorities to set to move towards more sustainable development, how climate change influences the economy during such a transition period, what mistakes were made and how to avoid them in future. Are we moving in the right direction, and how should our strategies be corrected? These are questions of primary importance and the answers to them are analyzed in this report.

CONTENTS

ABBREVIATIONS

ADB	Asian Development Bank
AOGCM	Atmosphere-Ocean General Circulation Model
BGU	Biogas unit
CA	Central Asia
CC	Climate change
CCCC	Climate Change Coordination Center
CDM	Clean Development Mechanism (Kyoto Protocol Mechanism)
CIS	Commonwealth of Independent States
CSD	Sustainable Development Council
EEA	European Environmental Agency
EIA	Environmental impact assessment
EP	Environmental protection
Et	Environment
GDI	Gender-related human development index
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEM	Gender empowerment measure
GES	Hydropower station
GHG	Greenhouse gas
GNP	Gross National Product
GOST	State standards
GRP	Gross Regional Product
HDI	Human Development Index
HE	Higher education
HPC	Heat and power center
HPI-1	Human Poverty Index for developing countries
HPI-2	Human Poverty Index for OECD countries, Central & Eastern Europe and the CIS
IDC	Interdepartmental commission
IFAS	International Fund for Aral sea
IPCC	Intergovernmental panel on climate change
IPD PP	Institute of Professional Development of Pedagogical Personnel
ISDC	Interstate Commission on Sustainable Development
JI	Joint implementation (Kyoto Protocol Mechanism)

KAPUR/SD	Kazakh Association of Natural Resources Users for Sustainable Development
KazNIGMI	Kazakhstan Scientific Research Institute of Hydrometeorology
KazNIIEC	Kazakhstan Scientific Research Institute of Environment and Climate
KazNIIMOCK	Kazakhstan Scientific Institute of Environment and Climate Monitoring (currently KazNIIEC)
KP	Kyoto Protocol
LE	Life expectancy
LTD	Limited liability partnership
MARKAL	Software product line for macroeconomic forecasting
MDG	Millennium Development Goal(s)
MFA	Ministry of Foreign Affairs
MOA	Ministry of Agriculture
MOEP	Ministry of Environmental protection
MOES	Ministry of Education and Science
NEAP	National Environmental Action Plan
NEC/SD	National Environmental Center for Sustainable Development
NGO	Non-governmental organization
NHDR	National Human Development Report
NSOE	National state-owned enterprise
OECD	Organization for Economic Cooperation and Development
PPP	Purchasing power parity
PRC	People's Republic of China
R&D	Research and development
RES	Renewable energy sources
RIPDES	Republican Institute of Professional Development of Managerial and Scientific-Pedagogical Personnel of Education System
RK	Republic of Kazakhstan
SD	Sustainable development
SNC	Second National Communication
SPA	Specially protected areas
SPP	Solar power plant
SRES	Special Report on Emissions Scenarios
Strategy - 2030	Kazakhstan's Development Strategy 2030
TAR	The Third appraisal report IPCC

UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VAT	Value added tax
WB CF	World Bank Carbon Fund
WMO	World Meteorological Organization
WPS	Wind power station

Chemical formulas and agents

CH_4	Methane (greenhouse gas)
CO_2	Carbon dioxide (Greenhouse gas)
O_3	Ozone
N_2O	Nitrogen dioxide (Greenhouse gas)

Units of measurement

OC	Degrees Celsius
ha	Hectare
Gcal	Giga-calorie
kWh	Kilowatt-hour
$км^3$	Cubic kilometer
MW	Megawatt
bln	Billion
cm	Centimeter
t/ha	Ton per hectare (output parameter)
thous.yrs.	Thousand years
ppm	Parts per million

«A Human being is a guest in this life»

Kazakh saying

«The land is not inherited from our ancestors, We just borrow it from our children»

American Indian saying

INTRODUCTION

If the next decade will be similar to the previous one, "two disasters", which we are able to avoid, will overtake the world – the human development regression in the near future and the ecological disaster risk for future generations

from Global Human Development Report 2007/2008

The human potential of people living on the great steppe terrains in severe climate conditions formed over many centuries, is a result of the interaction of man with the environment. Unique natural conditions and climate have formed the Kazakhs' nomadic civilization, and preserved it for many centuries. The most important quality of people inhabiting the steppe was the ability to settle in and adapt to find optimal places for habitation and routes for movements. Then the relation between the climate and people's lives was so obvious and important that even a retrospective flashback shows the organization of life on the steppe from a social relations viewpoint. As well as was effective use of natural resources and energy: nomadism, summer pastures and winter encampments, yurts and food storage; i.e. many things have been developed from nomads' secular experience. Nomads endured 'civilization' and industrial development as a fight for survival. In particular, the Communist government period significantly affected social development, and appeared to be a test of its sustainability and viability. Tolerance, openness and eagerness to learn from other nations' experience and knowledge have allowed survival and the development of relations with people who have come to this land by force of historical circumstances. For the past 50-60 years industry has had a strong impact on global climate, but in this particular period, catastrophic social and political apocalypses descended upon Kazakhstan: collectivization, industrialization, nuclear weapons development, space exploration, and the conquest of its 'virgin lands'. This has resulted in a titanic "historical pollution" of human and wildlife habitats in Kazakhstan, including nuclear test sites, and the Aral Sea disaster - an infamous example of destructive climate change.

Photo by Pavel Kosenko

These disasters are well known. Speakers appeal for solutions to these problems as they are always deemed priorities, because they are measurable, and can even be demonstrated from space. But intangible global warming and climate changes taking place within countries have never been taken into consideration in any strategic document; despite the fact that the dates 2030, 2020 and even 2015 are deemed to be relevant timescales during which climate change will become an obvious phenomenon impacting on the country's economy, and on people's lifestyles. Therefore, it will impact on human potential and development - this is why this study is so timely and appropriate.

Since 1990 UNDP has supported the preparation of the National Human Development Reports, which consider actual problems at global and national levels. With the development of the first NHDR for Kazakhstan in 1995, the human development concept propagates people-oriented development and the satisfaction of human needs. Nine reports have been issued since 1995.

Similar reports promote an intensive extension and discussion of sustainable human development statements and their achievement. NHDRs are valuable information sources and references, and are used when elaborating different

Changes in the life style and utilization models, which emphazise the necessity of saving of natural resources, can facilitate the low-carbon economy that is fair and sustainable.

(Climate Change 2007: Mitigation of Climate Change. Working Group III Contribution to the Fourth Assessment Report of IPCC)

programs and projects. They are used by politicians and the public at large, and are referred to by NGOs, the mass media and academic institutes.

According to the UNDP report "Human Development Concepts and Measurement" 1990, human development is a process enhancing human potential. The definition of a «human development» term is indicated in the summary measure of the human development index, which is a basic criterion in estimating the level of development of countries, and comprises three aspects of human welfare:

1. Health and longevity as measured by life expectancy at birth;

2. Knowledge, as measured by a combination of two indices - adult literacy rate and gross enrollment ratio in three levels of education (elementary, secondary and post-secondary);

3. Decent standard of living, as measured by GDP per capita at purchasing power parity in US dollars.

Performance in each dimension is expressed as a percentage value of the following: this should be checked in Global HDR

1. Life expectancy equal to 85 years;
2. Literacy and education of people for all three levels at 100%;
3. Real GDP per capita equal to USD 40,000.

A simple average of these three indices reflects the general level of human development.

One can argue that these indices do not fully reflect human development potential, but indeed, based on current world priorities determined for the last twenty years, the human development index allows us to make a qualitative comparison of all countries in three dimensions. The first dimension describes the physical condition of human potential, and the other two describe its growth and development perspectives, since namely intellect, knowledge, and education, together with economic development, will allow for the identification and solving of health and environmental problems in general.

CLIMATE CHANGE IS A GLOBAL CHALLENGE TO HUMAN SOCIETY.

The level of economic development of civilization reached its critical point at the turn of XX-XXI centuries, which affected global environmental conditions. It is difficult to predict which weather conditions and surprises await us, and how nature will rid itself of the anthropogenic problems created by people striving to "survive" or more precisely to "squeeze out" more and more resources.

By learning from experience and escalating crisis processes in any business, we should radically rethink mankind's role away from being "the lord" of nature to being part of nature. A human is one of the kinds occupying the Earth, not in the right to cross objectively laws in force and the restrictions imposed by biosphere on all its components. As a result of mankind exceeding its niche, a number of negative trends are currently observed in economic, social and demographic sectors and originate in the conflict of man and the environment. The stern reminder given by the World Sustainable Development Summit (2002) was that the capacity of the global eco-system is actually finite; economic development should take into account issues of environmental management and technological progress is not always aligned with social progress. At the turn of the 21st century, these issues gained far greater public awareness.

In the late 1970s scientists initiated discussions on global environmental problems, which exceeded the scope of national and regional government. At the beginning this was primarily the threat of ozone layer depletion and the danger of human exposure to excessive ultraviolet radiation. The next global problem is climate change and related issues. Human activity is the cause of both these hazards.

Now there is no doubt as to the availability of scientific evidence of the issues raised, and these questions have been moved from scientific discussions into concrete actions, international legal documents and rules. Global climate change has become a subject of political and economic forums, meetings at all levels: national and regional, and discussions in the UN at the highest level.

CLIMATE CHANGE INFLUENCE ON HUMAN DEVELOPMENT, COMPETITIVENESS, AND THE DEVELOPMENT OF COUNTRIES: THE ROLE OF KAZAKHSTAN

The present environmental situation is different from anything that mankind has ever faced. Hazardous environmental changes have become global. These changes have affected all environmental subsystems and components, the entire Earth's surface right up to the poles. This is supported by results of various scientific observations. All symptoms of a global environmental crisis, i.e. concentration of CO_2, climate change, eutrophication of coastal and fresh waters, desertification, etc., reflect faults in the functioning of nature's mechanisms under anthropogenic pressure. The concentration of CO_2 increased from 338 ppm in 1980 to 368 ppm in 2000. CO_2 concentration had been relatively constant: up until 1750 it had stood at 280 ppm for thousands of years. The current concentration is higher than it has ever been for the past 420,000 years according to analysis of air samples obtained from ice. As the Intergovernmental Panel on Climate Change (IPCC) reports, such high concentrations of CO_2 have not been observed for the last twenty million years. Also, a number of factors demonstrate the size of unprecedented biosphere disturbance: the area of destroyed land ecosystems expanded to 63% at the end of the 20th century, from 20% in the early century; human consumption or utilization of clean primary photosynthetic materials increased from 1% in the early 20th century to 40% at the end; the ratio of human biomass and cultivated vegetation and animals to all natural lands currently equals 20% versus 1-2% a hundred years ago.

Photo by Pavel Kosenko

The Earth has come through different stages of climatic system development: warming and cooling that significantly exceeded present values. However, the current situational risk is that changes are fast, and creatures and organisms are physically incapable of adapting to what is happening. Only the human being and his conscious lifestyle can take action to achieve equilibrium on the planet. The human mission is to save life, perhaps namely by mitigation of an on-rushing disaster. Creation of a stable equilibrium between the planet's capacities and civilization's development is a challenge to be overcome by the efforts of all people and all countries. How does global warming jeopardize human development?

Climate change will affect the basic elements of life – access to water, food, health and environment. Due to global warming hundreds of millions of people may suffer from hunger, water deficiency and floods.

(The Stern review "The Economics of Climate Change")

Global greenhouse gas (GHG) emissions increased since preindustrial times, while growth from 1970 to 2004 was 70%, i.e. from 28.7 to 49 Gt CO_2-equivalent.

(Climate Change 2007: Mitigation of Climate Change. Working Group III Contribution to the Fourth Assessment Report of IPCC)

- Firstly, further average temperature increases directly affect human health and life, as there is no chance to adapt and re-adjust to fast changes in such a short time. Maybe only the simplest forms of life in the animal kingdom (protozoa) or very rich people are capable of doing this.
- Secondly, global environmental and climate change and its subsequent human impact is induced by environmental and climatic conditions: inundation of island states, desertification and loss of farmland and other habitable lands. Extreme climatic phenomena (hurricanes, floods, heatwaves and so forth) put people's lives under jeopardy.
- Thirdly, the exhaustion of reserves of fresh potable and industrial water may lead to regional conflicts and disputes that considerably affect relations between states and population groups. Mankind has historical experience of conflicts based on water distribution and responsibility for water supply. As stated in the 2007 Global Human Development Report, such a threat exists in the Central Asia region.
- Fourthly, animal and human food chains will start to collapse. The stability of the agricultural sector will be under significant threat. The threat to food security will be most evident, especially for the world's poor.
- Fifth, the global economic system will be affected in general. This includes direct expenditure to mitigate global warming impacts such as extreme weather phenomena: hurricanes, floods, heatwaves, mudflows in mountain areas. Economic losses caused by climatic system variability include unsustainable agriculture, poor harvests, particularly in zones highly sensitive to weather changes and risky farming, the reliability of marine and air transportation corridors, changes in construction standards and rules necessary for the protection of human habitats, necessary changes in the insurance business, which is as an important segment of the global economy.
- Sixth, humankind will radically reconsider its attitude to the power sector, as the most important component of the sustainable existence of civilization. The role and impact of the massive global oil and gas sector affecting the livelihoods and existence of vulnerable regions and the planet in general are to be revised. We should learn from the positive experience of the past, for example the energy crisis of the 1970s, when developed regions and countries, especially in Europe and Japan and some other countries moved ahead in the development of alternative energy sources, especially in energy efficiency.
- Seventh, all this will entail movement and migration of population around the Earth in search of a better life, leading to escalation of tensions in areas considered less exposed to climate change risks, or areas with high mitigation capacity and standards of living.

The list of problems incurred by the changes taking place in the Earth's climatic system is much longer than this and is subject to more detailed and specific consideration in the following chapters. The problems are well described and analyzed in a number of recent publications, among them the Fourth Assessment Report of the IPCC and Albert Gore's Nobel Prize winning work. Besides this, Nicholas Stern's review "The Economics of Climate Change" has had positive repercussions.

This report is devoted to human development and climate change impact in Kazakhstan. The authors describe the specific characteristics of the country in the context of the above-mentioned papers as well as the previously published 2007/2008 UNDP Human Development Report.

Kazakhstan is a relatively young state, which just launched its integration into the world community. It should be noted that since the first day of independence, the approach to environmental problems strongly affected the country's foreign policy at the national and global level. Kazakhstan took part in the World Summit held in Rio de Janeiro, and this gave a strong impetus for Kazakhstan's participation in all global international environmental treaties: the UN Framework Convention on Climate Change, the UN Convention on Biodiversity, and the UN Convention to Combat Desertification.

Of course, accession to international conventions and agreements does not yet mean integration into international trends on the global environmental, economy or energy security fields. It is an unusual demonstration of intentions. There are many steps to take before real integration will be realized in foreign policy and national action at the decision-making level and among civil society, such as harmonization of legislation, development of regulatory and legal frameworks, and institution-building. It should be stated that Kazakhstan is at the beginning of the second step of integration into the global community.

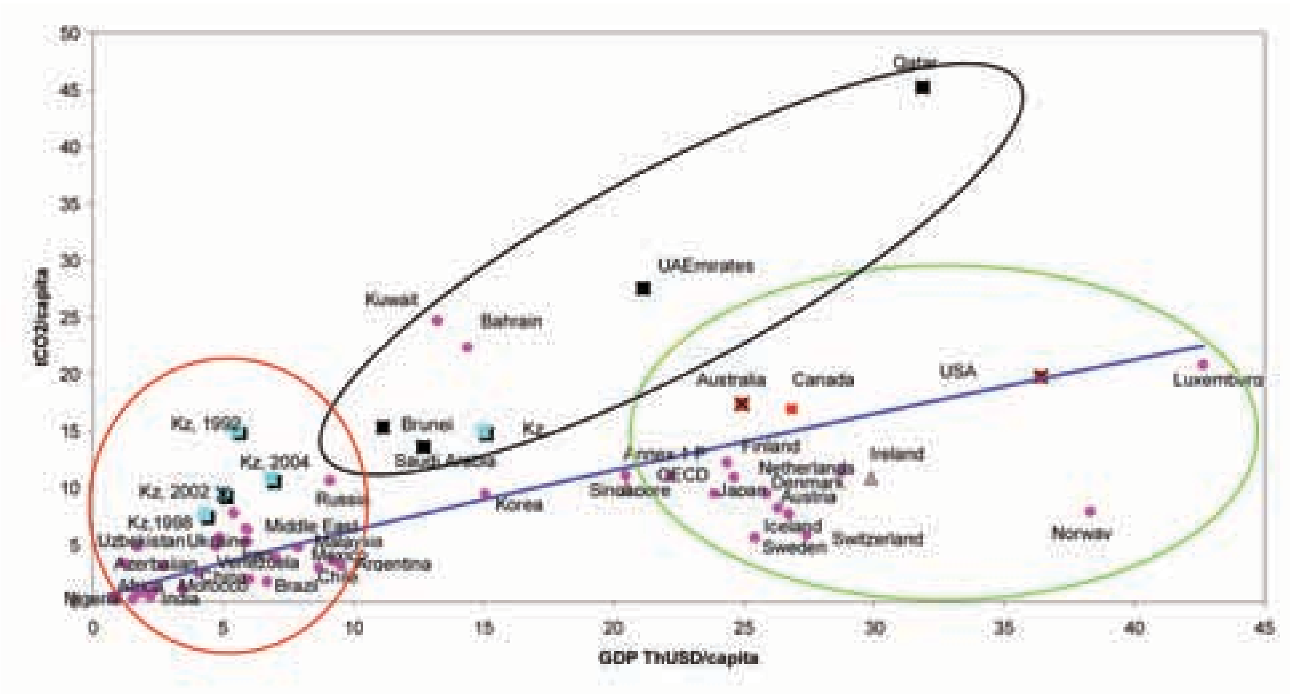
Climate change is a global problem. It is one of the greatest concerns of the leaders of many countries, scientists, politicians and society.

Is this problem apparent in Kazakhstan and its regions?

Is climate change a real threat for Kazakhstan?

We would like to draw attention to the diagram below, which in our view gives a quality assessment of the distribution of the economic welfare of the population in different countries and the value of economic welfare from the point of view of the global environment and climate impact on the population of these countries. The horizontal axis plots GDP per capita growth while the vertical axis shows anthropogenic pressure on the environment as expressed by greenhouse gas emissions per capita.

Figure 1. The Ratio of GHG emissions by burning fuel and GDP per capita



Three groups of countries can be clearly identified:

The first group are leaders (green elliptic segment), i.e. developed countries with a high GDP per capita and relatively high level of CO2 emissions per capita;

The second group (red circle)is in the majority, i.e. the states lagging behind in economic development. Former socialist states are in this group;

The last group (black elliptic segment) consists of countries with high living standards and high greenhouse gas emissions. Raw material producing countries and oil exporters are found in this group.

The heterogeneity of the leaders' group is explained by different levels of emissions. Countries making big investments in the development of renewable resources over recent decades and pursuing energy efficiency policies (European countries and Japan) differ greatly from countries which are at the same time proceeding to solve economic issues as part of an old energy policy (USA, Australia, Canada). The red circle is a tangle of problems mainly connected to adverse historical development. Here are countries with transition economies that shoot ahead to 'trespass' beyond the red line and also distanced outsiders that continue their eternal combat against poverty. In the red circle are the present and future giants of the global economy: China, Russia, Brazil, India and so forth.

Tackling climate change is the pro-growth strategy for the longer term, and it can be done in a way that does not cap the aspirations for growth of rich or poor countries.

(The Stern review "The Economics of Climate Change")

Kazakhstan is marked with blue squares at various development milestones on this diagram. If one compares Kazakhstan in 1992 and 2004, it is clear that since 2000 the economy has settled into sustainable growth by overcoming a minimal recession. Nevertheless, it is clear that the rise of greenhouse gas emissions caused by fuel burning is growing proportionally. The last square that drops into the black circle is a forecast relevant to target factors of an industrial and innovative development strategy.

Let us assume that blue line describes the outline of sustainable development of industrial countries, and Kazakhstan's development trend can be traced; even by 2015 Kazakhstan will fall into the black oval segment, i.e. those states depleting their own resources. Taking into consideration the topic of the report we deliberately focus on the analysis of the situation. This leads us to address decision makers on the need to consider international development trends in long-term policies that global economy leaders adhere to. It should be noted that countries exporting energy resources over the past period mainly implement projects aimed at the diversification of their economies. This is why major investments are made into tourist business development, transport and infrastructure, high technology, information and communication services.

The complexity of the preparation of such a report is that climate change cannot be identified as a prominent factor in Kazakhstan's fifteen yeas of independence, but it is characterized by trends of thousands and millions of years, or at least by the past century of industrial development. Therefore we are compelled to consider it mentioning surrounding world space and time. Kazakhstan is integrated into the international community in many aspects, without any doubt in political, economic and education dimensions. Yet the global warming impact on the daily life of the country has yet to receive proper attention. First of all, there is no full understanding of the importance of this problem for the future of the country and for coming generations. The urgency of this problem is not yet recognized at the highest political levels. In spite of the fact that the issue is not recognized as relevant at this stage of development, it is important to assess potential threats that may occur in future. This report analyzes the reasons that the EU and other developed countries, as well as Russia and China, attach to this issue not only environmental and economic importance but also deem it to be as an essential policy element within the country and internationally.

Returning to the circles and elliptic segments of the diagram, we note that these reflect a drama that has been playing out in human development for hundreds of years. The diagram depicts the full development given to a human being by nature - something which is playing out all over the planet: prudence and greed, hope and helplessness, the present and the past.

CHAPTER 1

CLIMATE CHANGE AND HUMAN DEVELOPMENT

Fossil fuel exporting countries (enlisted and not listed in Annex I) may expect a decline in demand and price, and a decline in GDP growth due to the mitigation policy. A level of this floating very much depends on assumptions related to political decisions and oil market trends.

(from the report of the Working Group III Mitigation of climate change)

1.1. Global environmental problems and climate change aspects

Human economic activity reached a scale in the 20th century, whose distinctive feature was massive environmental impact due to the irrational use of natural resources and sustained pollution of natural ecosystems. But such human impact on the environment is accompanied with an increase in regional and global environmental problems that in many cases handicapped the social and economic development of countries. Among these problems the following stand out: climate change, depletion of the ozone layer, desertification, soil acidification, biodiversity loss, fresh water depletion and pollution, forest and soil degradation, coastal zone problems and growth in industrial wastes. Among the regional environmental problems occurring in Central Asia and Kazakhstan the natural and anthropogenic disaster of the Aral Sea, radioactive pollution of the Semipalatinsk nuclear site, and Caspian Sea problem are well known.

Climate change is a serious potential threat to the environment. The so-called "greenhouse effect" is the basis of this phenomenon. The main point is that a part of the infrared heat radiation from the earth's surface is trapped by greenhouse gases (carbon dioxide CO_2, methane CH_4, nitrogen oxide N_2O, halogenous gases, and ozone O_3) and vapor. Similar to greenhouse glass, the above gases facilitate a temperature rise at the surface layer. The greenhouse contribution to global warming is estimated as follows: carbon dioxide CO_2 – 65 %, methane CH_4 – 20 %, halogenous gases – 10 %, nitrogen oxide N_2O – 5 % (Source: IPCC, 1996 and EEA, 1998). The increase in greenhouse gas composition aggravates the warming effect.

The main anthropogenic sources of carbon dioxide - the basic greenhouse gas - are the energy sector, industry, and transport running on fossil fuel.

In the explanation of anthropogenic reasons of global climate change conclusions of the fourth report of the Intergovernmental group of climate change experts on estimations are important. A basic point of the conclusion is:

"Present atmospheric concentration of CO_2 and CH_4, and their respective positive radiation impact over exceed concentrations and impact determined from ice cores covering the last 650 thousand years. Annual CO_2 emissions occurred because of burning fossil fuels, cement production and burning associated gas grew from the average value 6.4 ± 0.4 Gt C/year in 1990 to 7.2 ± 0.3 Gt C/year for 2000-2005."

Fig. 1.1 **Changes in physiographic and biological systems from 1974 to 2004.**

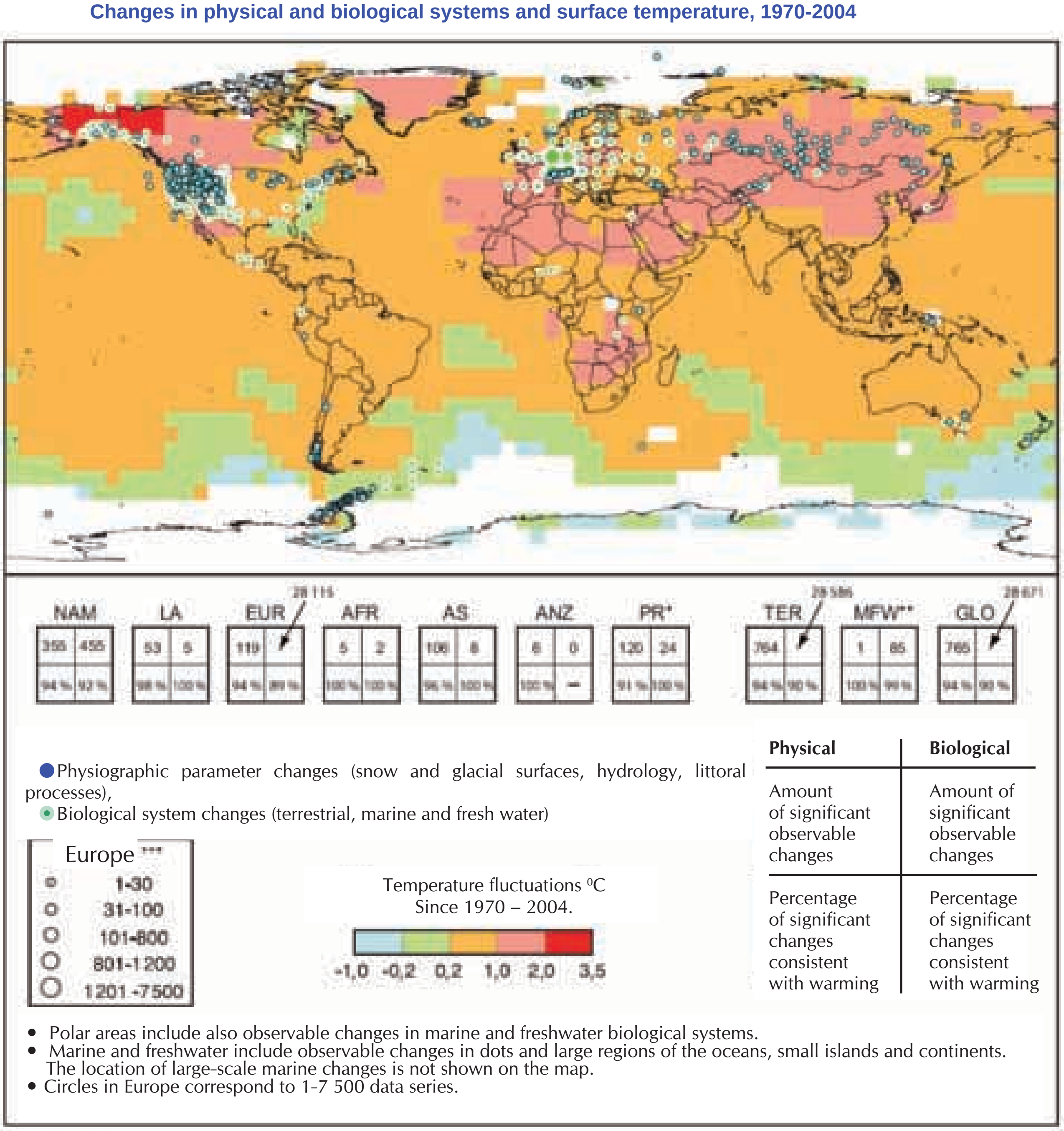


Fig. RP2. Location of significant changes in observation data series of physical systems (snow, ice and frozen soil, hydrology; and coastal processes) and biological systems (land, sea and fresh water biological systems) are shown together with surface temperature changes for the period from 1970 to 2004. A subset comprising nearly 29,000 data series was selected among approximately 80,000 data series collected by 577 pieces of research. They comply with the following criteria: (1) they are completed in 1990 or later; (2) they cover a period of minimum 20 years; and (3) they demonstrate a significant change in this or that direction according to estimations of different research. These data series are received from approximately 75 pieces of research (70 of them were carried out after issue of the Third report) and contain about 29,000 data series, 28 of them are published in European research. White spots do not contain sufficient quantity of climate observation data to assess the temperature trend. In squares 2 x 2 the general quantity of data series reflecting significant changes (upper row) and percentage of those changes which agree with warming (low row) for: (i) continental regions: North America (NAM), Latin America (LA), Europe (EUR), Africa (AFR), Asia (AS), Australia and New Zealand (ANZ) and polar regions (PR); and (ii) global scale: land (TER), marital and freshwater (MFW) and global (GLO). The figures with relation to seven regional areas (NAM, LA, EUR, AFR, AS, ANZ, PR) do not provide the global total (GLO), as regional research, except for the polar ones, do not include figures related to maritime and fresh water (MFW) systems. The location of maritime changes of large scale is not shown in the map. (Fig. 1.2)

As is clear from figures 1.1 and 1.2, Kazakhstan appears in the strong climate change zone, and faces problems with fresh and glacial waters. Central Asia, North Africa and North American areas anticipate similar problems.

The predicted temperatures demonstrate that Kazakhstan will be in a "hazard zone" with a temperature rise from 4.5 to 5.5 degrees Celsius.

The IPCC experts predict that by 2050 there could be a serious decrease in water resources, especially in large fluvial systems and rivers nourished by glacial streams.

1.1.1. Climate change and its global consequences

The announcing of 1957 as International Geophysical Year allowed the international community to create the basis for an understanding of planetary atmospheric processes and the impact of human activity. Data from a wide range of stations created for environmental observation demonstrated a continuous increase of carbon dioxide concentration in the ground atmosphere. Research by different scientific institutes and groups, the IPCC, WMO and UNEP (2007) also found data proving the existence of climate change. The main consequences of climate change are as follows:

Geographical distribution of surface warming

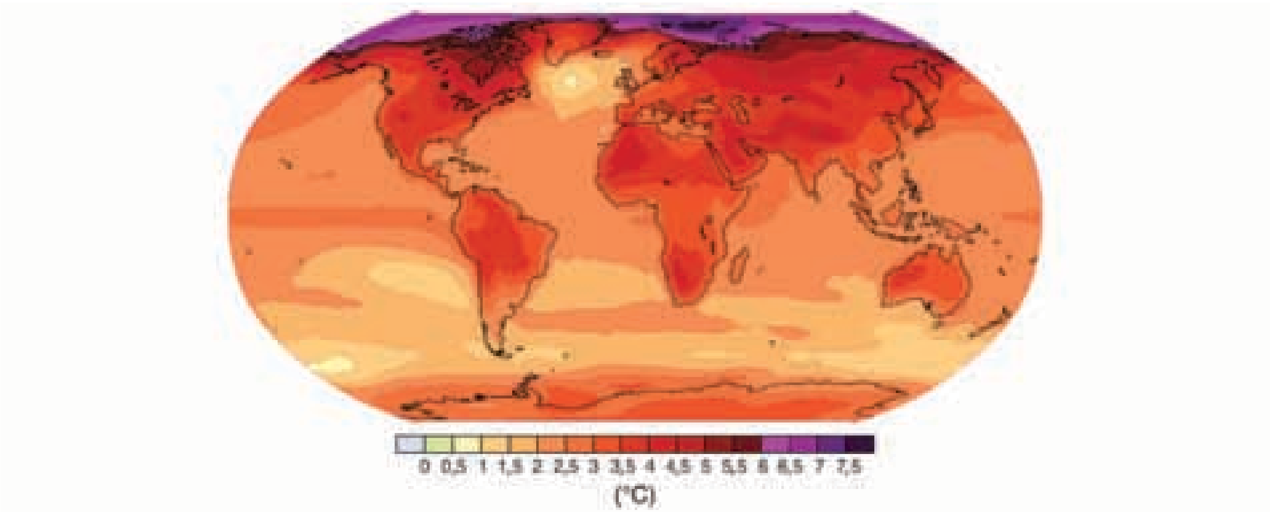


Fig. RP.6. *Simulation of surface temperature changes for the end of the 21st century (2090-2099). The map illustrates an averaged simulation of some AOGCM models for the A1B CDCB scenario. All temperatures are presented in relation to the period 1980-1999 (Fig. 3.2)*

Fig 1.2 **Simulation of temperature changes for the end of the 21st century (2090-2099)**
Source: "Summary for Policy Makers" in Climate change 2007, IPCC report.

- A rise in average global temperature near the surface. According to the data of the "Summary for Policy Makers" in Climate Change 2007 of the IPCC (1906-2005), 0.74 (0.56 – 0.92) °C appeared to be even higher than was stated in the third IPCC report (0.6 °C (0.4 – 0.8)).

•	Ocean level rise. Global warming increases the melt rate of glaciers and sea ice, resulting in the expansion of ocean boundaries. The global average sea level has increased since 1961 at an average speed of 1.8 (1.3 – 2.3) mm per year, and since 1993 by 3.1 (2.4 – 3.8) mm per year. This increase of ocean level rise leads to flooding, shifting of the borders of marshes and low-lying lands, as well as increases in water salinity in estuaries, deterioration of fresh water soil profiles, and potential loss of habitats.
•	Precipitation changes.
•	Changes in the hydrological regime and water resource quantity and quality. Hilly areas may lose crucial parts of their glaciers, resulting in higher snowlines. This will influence land run-off and river discharge, which in turn results in more frequent and more severe floods, poor water quality due to salt water penetration of coastal soil profiles, and reduced river flows.
•	Impact on ecosystems, agriculture and forestry. The rise in temperature will lead to displacement of climatic zones northwards. The process may run much faster than the migration speed of species associated with certain zones (namely wild fauna species). In agro and forestry business climate change influences the length of growing seasons and land productivity. Global warming can also lead to agricultural production growth. However, there may also be proportionate increases in pests and diseases.

All factors mentioned above may have a strong impact on people's health, economy and society as a whole. The acceleration of droughts and the consequent agricultural crisis may threaten security and social stability in some regions.

The warming of the climate is also occurring in Kazakhstan, as potable water in the south-east comes mainly from the Zaili Ala Tau glaciers. Also because of the shifting of climate zones, medical service problems occur and due to climatic warming tropical insects and plants will invade warmer zones. In addition to water problems, Central Asian states may encounter diseases previously not found in the region. This threat is a challenge to the regional security of Kazakhstan and Central Asia.

1.1.2 International endeavors in combating climate change

The problem of global climate change is the subject of many high level international meetings. It has been declared a phenomenon at the first World Climate Conference held in 1979. In the 1980s the UN Environment Program and WMO held a number of international scientific seminars where researchers worked out a preliminary scientific vision of the problem. Increasing public awareness of environmental issues also played its role, resulting, in 1988, in the creation of the Intergovernmental Panel on Climate Change under UNEP and WMO auspices.

The first IPCC report, issued in 1990, concluded that the increase of carbon dioxide and other greenhouse gas concentration in the atmosphere was due to human activity, and may result in a global rise in temperature and climate change. The IPCC proposed the following assessment: should greenhouse gas emissions increase according to predictions, then the average atmospheric temperature would start increasing by 0.3°C ± 0.15° per decade.

A second working group studied the impact of climate change, and was unable to find common ground on this point. According to this group, climate warming could primarily result in sea level rise (because of oceans heating) and an increase in precipitation.

A third working group analyzed possible actions for climate change mitigation. The work was summarized in a report prescribing a specific recommendation: launch negotiations on the elaboration of an international treaty on climate change. At the second World Climate Conference held in November 1990, ministers appealed to the UN to start negotiations on preparation of an international agreement on climate change.

The IPCC third working group also studied the social and economic consequences of climate change, actions on their mitigation and adaptation, and came to the conclusion that most countries could significantly curtail their greenhouse gas emissions without additional costs. Such measures to reduce GHG emissions could include the relaxation of market limitations and economic distortions, for instance, statutory regulation and curtailment of subsidies for fossil fuels.

The Fourth IPCC Assessment Report was prepared by the IPCC in 2007 and comprised five studies: 1) Current Climate Changes and their Effects, 2) Reasons for Climate Change, 3) Simulation of Climate Change and its Consequences 4) Adaptation and Mitigation Measures and 5) Long Run Perspectives of the Stabilization and Reduction of Emissions.

Under UN auspices negotiations on enacting the UNFCCC commenced in February 1991, which was executed at the World Conference on Environment and Development in Rio de Janeiro in June 1992.

The basic objective of the UNFCCC is achievement of «greenhouse gas concentration stabilization in the atmosphere at a level not allowing a dangerous anthropogenic effect on the climate system. This level should be reached soon enough for a natural adaptation of ecosystems to climate change, avoiding jeopardizing food production and providing future economic development on a stable basis». It is stated, «that owing to human activity the atmospheric greenhouse gas concentration has increased significantly; such an increase aggravates the natural greenhouse effect and results in additional warming of the ground and atmosphere, and may have negative effects on natural ecosystems and mankind ».

By December 1990 the UNFCCC had been ratified by 50 states, and three months later it took effect. By negotiations at Kyoto there were already 167 Parties to the UNFCCC, excluding the EU, and now 192 Parties have signed it.

At the first Conference of the UNFCCC Parties held in Berlin in 1995, a decision was made, entitled "the Berlin Mandate", to draft a new legally-binding document complementing the FCCC on certain commitments of the Parties to the Convention on a quantitative reduction or limitation of greenhouse gas emissions. The Kyoto protocol was adopted in 1997 at the Third Conference of UNFCCC parties in Kyoto (Japan) where the following was specified: plans and actions, the limitation and reduction of greenhouse gas emissions; and also problems of developing countries and their participation in this document regime. The adoption of the Kyoto protocol represented a recognition that previous agreements on the reconciliation of climate change problems appeared inadequate.

The Kyoto protocol: content and principal commitments of the Parties.

First of all, the Kyoto protocol prescribes an allowable quantity of greenhouse gas emissions for each industrially developed country. This amount is called the "fixed amount" for the "commitments validity period 2008-2012". Commitments are referred to industrially developed countries listed in Annex 1 to UNFCCC, and commitments quantification is given in Annex 2 to the Protocol. These commitments represent a 5.2% reduction in emissions compared to 1990 levels.

Obligations under the Kyoto protocol include the emissions of six greenhouse gases from clearly defined sources; this covers almost all anthropogenic greenhouse gas emissions in industrially developed countries. Gases are considered as a total ("basket") that is compared on the basis of "global warming potentials". Appendix "A" to the Kyoto protocol lists specific gases and sources of their emission. To minimize problems connected with uncertainty, all states are to provide national reports on an emissions inventory to be studied by experts.

The Kyoto protocol offers three flexible market mechanisms with which greenhouse gas emissions may be reduced and developing countries gain access to new technologies allowing

them sustainable development and prevention of further emissions: the Clean Development Mechanism (article 6, Kyoto Protocol), Joint Implementation (article 12 KP) and International Emissions Trading (article 17, Kyoto Protocol).

The most important aspects of the Protocol, and its international importance

The Kyoto protocol is a complicated and innovative document. Its important achievement is in the determination of legally binding quantitative limitations of greenhouse emissions in all industrially developed countries. The creation of an international emissions trade mechanism that compels countries to achieve their obligations under the Protocol in a more efficient manner and on a wider scale is clearly one of the key points.

IInternational trade mechanisms are the newest and most complicated aspects of the Protocol. Many issues related to its functioning, introduction and consequences have been adopted only after difficult negotiations just before the beginning of the valid Protocol period (2008 – 2012).

In spite of the many difficulties connected with national interests, hard and slow negotiations, non-ratification of the treaty by the USA, the Kyoto protocol is a great achievement of mankind, where the interests of all parties concerned are respected.

To-date a reversal point is envisaged in global negotiations: Australia has returned to the fold, many historically inactive African states have ratified the treaty; and the USA has stated that it will be party to the post-Kyoto agreement (after 2012). About 1,000 projects on clean development mechanism are being realized worldwide, and large scale registration of projects on the joint implementation mechanism is anticipated. Of course, 1,000 projects are a mere drop in the ocean compared with global emissions, but this number represents a willingness of developing countries to develop responsibly, and the potential of developed states to support such an objective.

1.1.3. Role of Kazakhstan in combating climate change

The Republic of Kazakhstan has taken an active position in the resolution of global environmental problems since its independence, including the international process of climate change prevention. Since 1995 Kazakhstan has been a party to the UNFCCC, and exercised the Kyoto protocol on 12 April 1999, and is now preparing its ratification.

Since 1994 actions on the performance of the UNFCCC obligations with the support of international donors have been ongoing in Kazakhstan. The first National Communication was prepared in 1998, and presented at the Fourth UNFCCC Conference of Parties in Buenos Aires (Argentina). Now, with UNDP/GEF financial support, the Second National communication is under preparation.

In 1998 at the Fourth UNFCCC Conference of Parties, Kazakhstan declared its willingness to participate actively in the solution of climate change processes, and in 2000 the MFA filed a note to the UN Secretary General, noting that it was Kazakhstan's intention to undertake voluntary obligations on greenhouse gas emissions reduction.

After difficult negotiations on Kazakhstan's status in 2001 at the Seventh UNFCCC Conference of Parties, a resolution was adopted that after ratification of the Kyoto protocol by Kazakhstan and its implementation, Kazakhstan would become a Party included in Annex 1 for Protocol purposes under Article 1, paragraph 7 of the Protocol.

Beginning in 2000, on request of the Ministry of Environment, a greenhouse gas emissions inventory is carried out in Kazakhstan every year. Kazakhstan is the only country in Central Asia where a greenhouse gas emissions inventory is done on a regular basis. In 2006 at the Twelfth UNFCCC Conference of Parties, deemed to be the 2nd meeting of the Kyoto protocol parties in Nairobi, 1992 was defined as Kazakhstan's base year.

An assessment of the potential and effect of Kyoto protocol participation was carried out in Kazakhstan. In April 2005 this issue was reviewed at the meeting of the Commission for environment quality stabilization, chaired by the Vice-Prime Minister of the Republic of Kazakhstan. According to the decision of this commission the Ministry of Economy and Budget Planning was assigned to continue research on exploring possibilities of performance by the RK of its quantitative obligations on greenhouse gas emissions reduction, and to submit the results of its studies to the Ministry of Environment.

In February 2006 parliamentary hearings "Ecological, economic and political aspects of Kyoto protocol ratification by the Republic of Kazakhstan to the United Nations Framework Convention on Climate Change" were held. Recommendations of the hearings described the effect of protocol ratification positively, and recommended ratification.

A number of projects are already being implemented under the Kyoto mechanism in Kazakhstan. These are projects on the utilization of associated gas, improvement of energy efficiency, construction and reconstruction of hydropower stations, use of wind energy and others, which make their own contribution to global reductions of greenhouse gas emissions and prevention of climate warming.

The preliminary registration of greenhouse emission reduction projects was launched in Kazakhstan by the decision of the Ministry of Environment, in other words a national authorized agency was created.

1.1.4. Legislative and institutional mechanisms to combat climate change

The Ecological Code was enacted on 9th January 2007 in Kazakhstan, where rates of greenhouse gas emissions accounting, restriction and valuation were introduced for the first time. Then government resolutions were enacted and the required bylaws on realization of such rates were approved. To observe procedures and requirements relevant to greenhouse gas emission reduction projects, an Instruction Manual for the preparation, coordination and approval of projects on the reduction of greenhouse gas emissions in the Republic of Kazakhstan was approved by Order of the Ministry of Natural Resources and Environment Protection No. 70-p dated 14/03/2002, but as Kazakhstan had not ratified the Kyoto protocol, the Ministry of Justice of RK refused to register this Order. For the implementation of the Ecological Code the Rules of state records of greenhouse gas emissions sources and ozone depleting consumption were approved by Resolution of the Government #124 of 28/02/2008. Also, the Rules for development and approval of maximum allowable limits of greenhouse gas emissions and consumption of ozone depleter were approved by Order of the Ministry of the Environment RK (MOEP RK) № 350 of 13/12/2007.

The drafting of the law "On government support for use of renewable energy resources" and the law "Strategy on the efficient use of energy and renewable resources of the RK" on the instructions of the Head of the Government, which are currently pending approval, significantly facilitates the implementation of the UNFCCC obligations.

In addition, the draft law on energy saving is expected in 2009. The introduction of ecological taxes, including a power tax, in the Republic of Kazakhstan is currently under discussion.

These measures allow for a reduction in greenhouse emissions for the period 2010-2024 of about 75 million tons of CO2 equivalent when substituting electricity generated by coal-fired power stations.

The main objective of the UNFCCC institutional structures is support for the implementation of convention provisions, creation of a legal basis, acknowledging decision-makers and the community on requirements and potentials provided to Parties to the agreement and associated documents. Also, institutional enhancement implies the creation of groups of experts, which provide scientific, expert and project support, and set up the reporting system needed for national and international agencies.

For the realization of UNFCCC provisions there are a number of institutions. The Ministry of Environmental Protection of the RK provides general coordination of works at governmental level, while institutions such as the "Kazakh Scientific and Research Institute of Environment and Climate" RSE and Kazhydromet, provide expert and technical assistance. In addition, a non-governmental organization, the Climate Change Coordination Center makes expert assessments.

1.2. Human development in terms of climate change

It is stated in the 2007/2008 UNDP Human Development Report "Fighting climate change: Human Solidarity in a Divided World" that "the character of interaction between climate change and human development is determined, among other things, by local differences of climate effect, varying abilities to overcome social and economic challenges and government policy choice". Human development baseline conditions are deemed to be the initial conditions for consideration of how climate change scenarios are elaborated.

Since the publication of the First UNDP Human Development Report in 1990 there have been lopsided achievements in human development.

The proportion of people in developing countries living on less than $1 per day declined from 29% in 1990 to 18% in 2004. The child mortality rate for the same period declined from 106 deaths per thousand live born children to 83, and life expectancy increased by three years. Also progress in education has been gathering pace. Globally, the proportion of children who completed primary school increased from 83% in 1999 to 88% in 2005 [2].

Economic growth – a condition for stable progress in poverty reduction – has been accelerating in many countries. On the basis of this impressive growth, the number of people living in extreme poverty decreased by 135 million from 1999 to 2004. Recent high levels of growth of the Indian economy, where income per capita has risen by 4-5% since the mid 1990s, have created huge opportunities for expediting human development [2].

It is stated in the Report that "The negative aspect of the existing situation is in the fact that climate change will be imposed on the universe described by deep and commonly perceptible human underdevelopment and inequality between propertied and poor people".

Globalization provides unprecedented opportunities for some people, while others are left out. In some countries, for instance in India, rapid economic growth has resulted in very modest progress in curtailing poverty and malnutrition. In other countries, including most parts of sub-Saharan Africa, economic growth is too slow and erratic to substantially reduce poverty. Despite high growth in many Asian countries, most countries, according to current trends, are failing to maintain progress in reaching the MDGs on curtailing extreme poverty and hardships in other areas by 2015. Statements on human development are studied in more detail in other parts of this report but it is an important fact that in the context of climate change risks are borne disproportionately more in countries with high poverty and vulnerability.

- **Income poverty.** There are about 1 billion people still living on or below $1 per day, and 2.6 billion, or 40% of the world's population, live on less than $2 per day.

It is clear from the Table 1.1. that the level of the of marginal population in Kazakhstan has significantly declined since 2001; however, climate change will strongly affect more marginal people residing in rural areas. In 2006 the increasing numbers of those with substandard income is explained by revision of the composition of the food basket of subsistence minimum from 20 to 43 goods, as well as by an increase in the non-food part of the subsistence minimum from 31.6 to 40% in the structure of the subsistence minimum.

- **Food.** According to estimates, about 28% of children in developing countries are of substandard weight or lagging in height. Half of rural children weigh less than standard for their age, the same proportion as in 1992.

- **Child mortality.** Progress in the child mortality rate remains weaker than in other areas. About 10 million children die every year before their fifth birthday, mainly from poverty and malnutrition.

- **Healthcare.** Infectious diseases continue to affect poor people's lives worldwide. Every year 350-500 million people contract malaria, of whom one million die: 90% of malaria deaths are in Africa, and African children make up more than 80% of those dying worldwide from malaria.

Table 1.1. **Main Poverty Indices in the Republic of Kazakhstan**

	2001	2002	2003	2004	2005	2006
Monthly average subsistence minimum in Kazakhstan (in KZT, 1$ = 132,88 KZT)*	4596	4761	5128	5427	7618	8410
People with substandard income	28,4	24,2	19,8	16,1	31,6	18,2
Poverty depth	7,8	6,1	4,6	3,3	7,5	3,9
Poverty acuteness	3,1	2,2	1,6	1,0	2,5	1,3
People with income below the cost of the food basket	11,7	8,9	6,3	4,3	5,2	2,7
Income ratio of richest 10% and poorest 10% of population.	8,8	8,1	7,4	6,8	6,8	7,4
10% population Gini ratio	0,339	0,338	0,315	0,305	0,304	0,312

Source: Statistical yearbook, 2006.
** National Bank of the RK data*

Income distribution influences the degree that economic growth is converted into reductions in poverty levels. Over 80% of the world's population lives in states where income differentials are growing. As a result, in order to get equivalent results in poverty reduction, high economic growth should be achieved.

Climate change is a global phenomenon. But climate change impacts on human development cannot be automatically excluded from global scenarios or from predictable dynamics of average global temperatures. People (and states) differ in their environmental resilience and ability to overcome gradually increasing climate change risks. They differ on their capability to adapt.

The distinct ability to cope with these risks accentuates inequality of opportunities. While additional risks will escalate owing to climatic changes, they will also interface with existing structures, generating contradictions and shortcomings.

CONCLUSIONS AND RECOMMENDATIONS TO CHAPTER 1.

1. The data given above show that there are general trends in global climate change, and that Kazakhstan is in a climatically vulnerable zone, due primarily to the threat of a lack of fresh water and access to water resources.
2. So far, the international community's endeavors are important but are insufficient. There should be significant endeavors to overcome the climate crisis, including the active participation of both developing and the poorest countries and developed states.
3. Much attention is being given to climate change, with all branches of political and economic life participating in the process, as well as decision-makers (G8, governments), business structures (transnational companies) and civil society (including NGOs).
4. A set of pilot projects have been carried out in Kazakhstan under Kyoto protocol rules, but for a country with such potential, these are quite insufficient. Besides, Kazakhstan's ratification of the Kyoto protocol itself has been delayed unreasonably.

Recommendations:

1. Kazakhstan should ratify the Kyoto protocol and actively engage in the post-Kyoto discussion
2. Crucially change and adjust strategic planning with climate change, biodiversity, desertification issues at regional and local levels for more efficient and effective development of Kazakhstan and creation of adaptation and mitigation measures.
3. The RK Government should promptly create all conditions and the impetus for wide implementation of a large number of projects aimed at climate change mitigation.
4. Current national financial institutions should prioritize the prevention of negative climate change effects, and form necessary mechanisms for funding and actual implementation of respective projects and measures as soon as possible.

CHAPTER 2

CLIMATE CHANGE: RISKS AND MITIGATION

We should create conditions which will actively stimulate all businessmen to “ecologization” of business. Here it is necessary to use modern levers, including economic character.

(From N.A. Nazarbayev’s speech at 18th plenary session of the Council of foreign investors under the President of the Republic of Kazakhstan 8 Dec 2007)

2.1. Climate change in Kazakhstan

An introduction to the climate change problem and its impact on the appraisal of sensitivity, adaptation potential and vulnerability of natural and anthropogenic systems with regard to climate change, as stated in the "Third assessment report" of the IPCC working group II (2001) for Asian countries with dry climate, is given below:

- Adaptation potential of anthropogenic systems is low, and vulnerability high in developing Asian states;
- Reduction of agricultural production volumes because of thermal duty and lack of water resources and droughts will curtail food security in many Asian countries;
- Water flow and availability may diminish;
- Human health will be threatened due to susceptibility to infectious diseases and thermal stress;
- Climate change will increase demand for power, and reduce the attractiveness of tourism;
- Climate change will aggravate risks to biodiversity owing to changes in land use and soil cover.

Table 2.1 demonstrates that according to the IPCC appraisal, even a rise in precipitation of 20%, a rise in the ground air temperature of 3 ^{0}C will increase the vulnerability of water resources due to flow changes. The flow change will involve an intensification of winter floods and decline of summer flows, which will have a negative impact on summer water resources. The experts of RGP Kazakh scientific research institute of ecology and climate (KazNIIEC) preparing "the First National Communication of the Republic of Kazakhstan on the Framework UN Convention on Climate Change" came to the same conclusion [1].

According to the IPCC Group II assessment for arid and semi-arid zones of Asia, which includes Kazakhstan, the provision of food for people may become a serious problem if current global and regional climatic trends remain the same (Table 2.2).

Under climate change scenarios a significant rise in ground air temperatures can be expected in future, a negative effect of which may overlap with the effect of increased annual precipitation predicted in many models.

Given that most of Kazakhstan's territory is desert and semi-desert, their

Photo by Pavel Kosenko

Table 2.1. **Impact of Climate Change on Selected Asian Regions**

Change of climate elements and sea level rise	Vulnerable area	Paramount change	Impact	
			Primary	Secondary
0,5–2°C (sea level rise of 10—45 cm)	Bangladesh Sundarban	– Flood almost 15 %(~750 km2) – Salinity increase	– Death of vegetation species – Death of fauna species	– Economic losses – Extending lack of safety and decline in employment
4 °C(+10 % precipitation)	Permafrost areas in Siberia	– Shortage of perpetual permafrost – Shift of northern outline of the Siberian permafrost by ~ 100—200 km to the North	– Change of rock strength – Change of bearing capacity – Change of compressibility of frozen rock – Thermal erosion	– Consequences for construction industry – Consequences for the mining industry – Consequences for agriculture
> 3 °C(> +20 % precipitation)	Water resources in Kazakhstan	– Flow change	– Intensification of winter floods – Decrease of summer flows	– Risk to life and property – Stress on water resources in summer time
~2 °C(-5—10% precipitations;Rise of sea level of 45 cm)	Lowlands in Bangladesh	– Extension of flood range of 23—29 %	– Change of flood depth category – Change of monsoon model of rice harvesting	– Risk to life and property – Aggravation of health problems – Decrease of rice yields

ecosystems and many economic sectors in Kazakhstan, particularly agricultural and water economies, are vulnerable to observed climate anomalies and their changes.

The research proves that human health and ecological systems and social and economic sectors, each of which is highly important for sustainable development, are sensitive to climatic changes, including the scale and pace of change. Climate change is a crucial additional burden for those systems that already suffer the negative effects of irrational economy, and as a consequence require the attraction of additional resources. These consequences may be equal to, or even exceed the negative climate change impact. These loads interact in different areas in various ways. However, it is possible to assume that they decrease the capacity of some environmental systems to provide key goods and services needed for stable social and economic development, including: due food, fresh air and water, energy, safe habitation, low morbidity rate and opportunities for the employment of people.

In addition, the results of studies by the KazNIIEC research demonstrate that [1]:

- Humid zone borders may shift to the North and, therefore, worse conditions of humidity are to be anticipated in that region;
- Winter wheat yield capacity may decrease by more than 25%;

Table 2.2. **Assessment of key sectors' vulnerability to climate change effects in arid and semi arid zones of Asia**

Food	Biodiversity	Water resources	Human health	Settlements
High vulnerability	Moderate vulnerability	High vulnerability	Moderate vulnerability	Moderate vulnerability

- The rise in temperature will negatively affect the harvesting capacity of natural forage lands, which may decline by 30-90%;
- Anticipated climate change will negatively affect sheep productivity due to deterioration of the forage base (decline in harvesting capacity of pastoral vegetation) and have a direct influence on animals because of the extension of periods with constant hot weather.

Studies of possible climate change in Kazakhstan have revealed a high level of vulnerability within climate-dependent economic sectors to expected anthropogenic climate change. The negative effect of these changes may be much stronger for Kazakhstan.

2.1.1. Regional aspects of climate change

According to Kazakhstani scientists' assessment, during the past century a rise in ground air temperature has been observed in Kazakhstan. For the period from 1991 to the present have been several abnormally hot years, and an increase in average annual air temperatures in Kazakhstan of 1.5°C over 50 years (1954-2003). The air temperature rise is irregularly distributed throughout Kazakhstan.

Climate changes from one area to another. This change is determined by the erratic distribution of solar heat, specific atmospheric reaction, water and soil surface, the interaction between them, and physical characteristics of regions. In order to assess regional distinctions in climate change in Kazakhstan, the ground air temperature and precipitation for the period 1936-2005 have been estimated.

2.1.1.1. Trends in atmospheric precipitation change

The analysis of summarized annual precipitation in Kazakhstan indicates that precipitation is tending to decline. This is evidenced by a steady decrease of positive anomalies, namely after 1970 (figure 2.1). From 1970 to 2005 positive trends were infrequent. But the period of 2001 2005 is characterized as a period with anomalies exceeding standards up to 20 %.

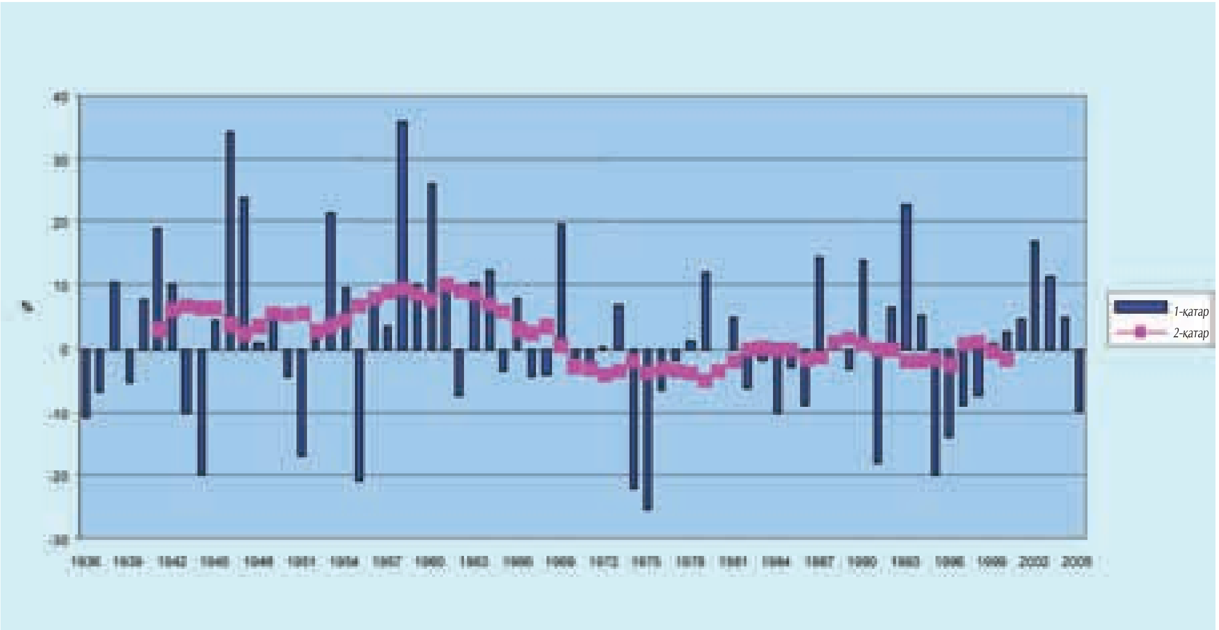


Figure 2.1. **Anomalies of average annual precipitations**

Analysis of cold season precipitation demonstrates that from 1936 to 1941 total precipitation in Kazakhstan increased, positive anomalies reached 35 % in 1941, and significantly declined during 1943-1947 – maximum of 28 % (figure 2.2). Precipitation increased again until 1961, and during 1962-1979 decreased by a maximum of 32 %. From 1980 to 2005 there was a slight trend towards growth in precipitation, though this period is described by alternate anomalies of around 25-27 % above and below standard, respectively.

In warm periods there was a trend towards reduced precipitation from 1962 to 1979. In subsequent years there were variations of 25-27 % below and above norms (Figure 2.3).

A comparison of climate standards – average perennial values, estimated for two different thirty year periods, indicates the existence of climate change, according to data from over 70 Kazakhstani stations showing precipitation ratios for the period 1971-2000 to precipitation for 1931-1960.

There were also areas where average perennial precipitation increased or decreased from time to time.

The area of the region was divided into two zones in January. In the bigger area (in the north) of the country a significant 20% increase in rainfall was observed. The southern part of Kazakhstan (except for piedmont areas) experienced less precipitation. But a decline of 20% or more was observed only in the Caspian region and a small part of Kzylorda, South Kazakhstan and Zhambyl oblasts.

In April, compared to January, the precipitation enhancement zone was significantly reduced and the rainfall increment of 20 % or over was observed only in Aktobe and Akmola oblasts. A small increase in precipitation was observed also in the south of Kazakhstan in Kzylorda and South Kazakhstan oblasts. Precipitation in other areas during 1971-2000 has been a little less than for the previous period. As in January, a decrease of precipitation of over 20 % was observed only at some stations of the East Kazakhstan oblast.

In July, zones of slightly increased precipitation are located in northern districts of Western Kazakhstan, Kostanai and North Kazakhstan oblasts, but here changes did not exceed 20 %. The precipitation enhancement zone in southern areas of over 20 % also remained

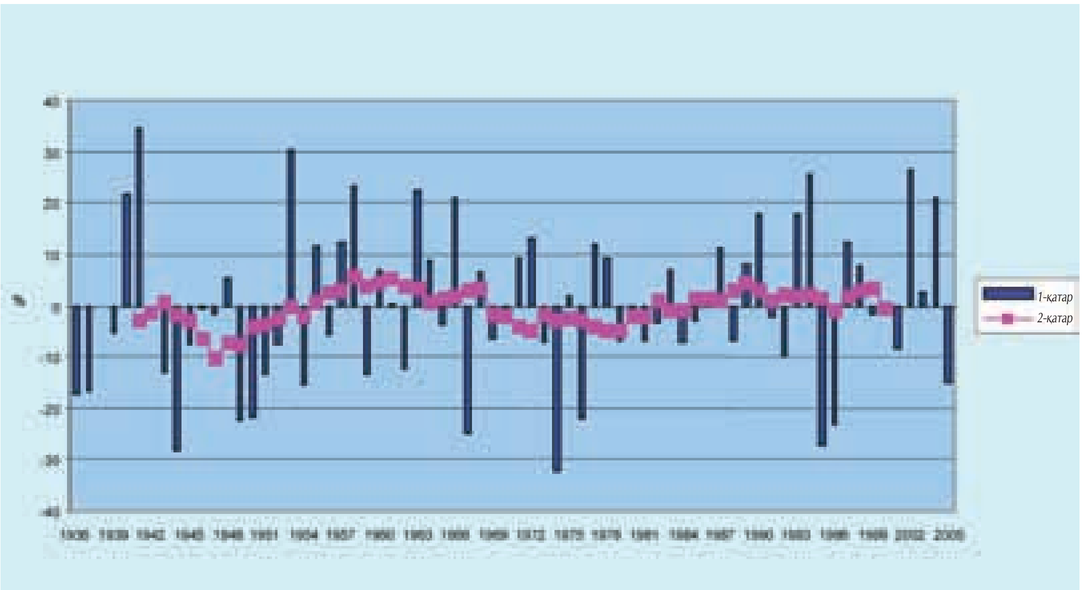


Figure 2.2. **Anomalies of total precipitation for the coldest 6 months, averaged for Kazakhstan**

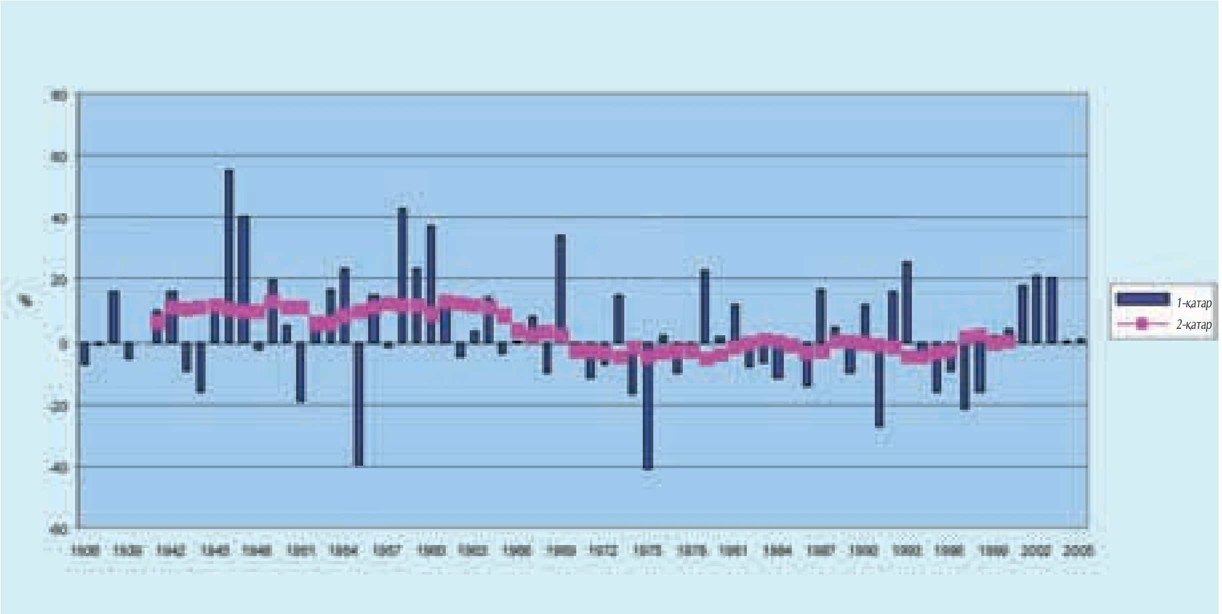
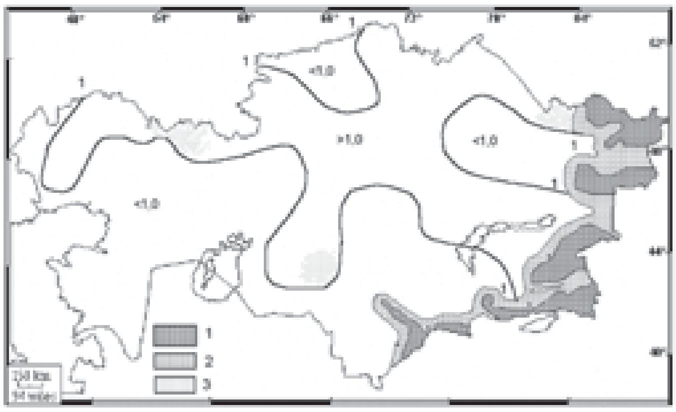


Figure 2.3. **Anomalies of total precipitation for the warmest 6 months averaged for Kazakhstan**

in July. Besides, precipitation increased by over 20% in parts of Pavlodar and East Kazakhstan oblasts. In other areas precipitation reduced slightly and only at some stations was the decline over 20 %, for example, in the area to the north-east of the Aral Sea.

In October, the majority of the country's precipitation during 1971-2000 was 80 - 100 % of that in 1931-1960. A slight rise in precipitation was observed at several stations of Aktobe, Karaganda and East-Kazakhstan oblasts, and also a large area of North Kazakhstan, Akmola, Pavlodar, Zhambyl and Almaty oblasts. In West Kazakhstan and Kzylorda oblasts there were zones of crucial precipitation decrease of over 20%.

The change in annual precipitation (Figure 2.4) may be described as follows: only at some stations was there a change either below or above 20%. In northern, north-western and some southern districts precipitation increased slightly, while in others there was a slight decrease. Therefore, annual precipitation in the regions actually did not change.



1 – mountain areas; 2 – piedmont areas ; 3 – areas where changes statistically significant.

Figure 2.4. **Average perennial annual precipitation for the period of 1971-2000 compared to average perennial annual precipitations for the period of 1931-1960 ratio.**

The years 2005 and 1998 were the warmest among data of global surface air temperature since 1850. Eleven years of the past twelve (1995-2006) – except for 1996 – are in the 12 of the warmest years registered since 1850.

Report of Working Group I. Physical scientific basis to the fourth IPCC assessment report

2.1.1.2. Kazakhstan thermal regime changes

In Kazakhstan there is a trend towards a rise in average annual and seasonal air temperatures. Winters in Kazakhstan are mostly warmer, with an average rise of 0.5 °C/10 years, while in summer temperatures have increased by 0.2 °C per 10 years, and for whole years temperatures have increased by 0.3 °C every 10 years (Table 2.3).

The temperature regime seasonal change has been inconsistent in Kazakhstan. Thus, the winter air temperature rise on the eastern coast of the Caspian Sea was highest, at 0.7 °C/10 years, while in the south the tendency was weaker (up to 0.2 °C/10 years). However, in summer in southern districts the temperature increased much more versus south-western and western districts.

Climate-dependant economic sectors and ecosystems are affected by the average air temperature and frequency of extreme temperature occurrence. For instance, the recurrence of hot and chilly days affects remote pasture livestock breeding conditions, human health, power and heat consumption (for heating premises in winter, and cooling in summer).

The number of cold days (≤ 0 °C) is tending to decrease throughout Kazakhstan. The decrease is observed most of all in the Caspian region, western part of the Caspian valley, Caspian lowlands, the Mangyshlak peninsula, in the North, the Turgai plateau area, the Ishim-Barabinsk flatland, in central Kazakhstan, the flatlands of the Kazakh bald mountains and the Tien Shan highlands.

The number of hot days (temperature ≥ 25 °C) has significantly increased in deserts of Balkhash lake and adjacent districts, to the south of the hilly elevations of the Kazakh bald mountains, the Aral sea, the Moiynkum desert, southern hilly areas of the Altai. There is a weak positive tendency in other areas, and also in the Mangyshlak, Kyzylkum desert a slight decline in hot days is observed.

Table 2.3. **Change rate of average seasonal and annual air temperatures (°C/10 years), number of days with air temperature ≥25 °C days/10 years and number of days with the temperature ≤ 0 °C, days/10 years over the whole territory and in the regions**

Region	Air temperature					Days	
	winter	spring	summer	autumn	year	≥25 °C days/10 years	≤ 0 °C, days/10 years
Kazakhstan	0,5	0,3	0,2	0,3	0,3	1,3	-3,2
Northern area	0,5	0,3	0,2	0,2	0,3	1,1	-2,3
Western Kazakhstan	0,5	0,3	0,1	0,2	0,3	1,2	-4,6
South-western area	0,7	0,1	0,0	0,5	0,3	-2,0	-7,7
Eastern area	0,5	0,3	0,1	0,2	0,3	1,4	-1,6
Central Kazakhstan	0,4	0,3	0,2	0,3	0,3	2,4	-2,3
Southern Kazakhstan	0,3	0,2	0,2	0,2	0,2	1,2	-2,3
Mountains in the East	0,5	0,3	0,2	0,3	0,3	2,3	-2,1
Mountains in the South	0,2	0,1	0,1	0,2	0,1	-0,1	-1,6

The number of cases of extremely high daily temperatures is increasing throughout Kazakhstan, but more often such temperatures are observed in the Aral area, in the south of the Turan lowlands, Kyzylkum desert, and at the central part of the Kazakh bald mountains. The Tien Shan and Altai mountains and piedmont are much warmer. Extremely low daily temperatures occur much more rarely, and are observed in the Aral sea area, northern part of the Turgai lowlands, in the North of the Ishimsk-Barabinsk flatland, at the easternmost northern part of the Kazakh bald mountains, the north of the Mugodzhar-Turgai plateau, in areas adjacent to the north-western Kazakhstan border.

Nighttime temperatures have increased much more than daily temperatures, except for hilly elevations of the Kazakh bald mountains, hilly Altai and districts adjacent to the Dzungarian Gates, where there is a slight negative tendency in the occurrence of extremely cold nights. This means those cold nights (as winters in general) for more parts of Kazakhstan become warmer, accordingly the daily and annual amplitude of temperature of air decreases. This, in turn, is leading to a decrease of Kazakhstan's continental climate.

The analysis of extremely high daily and low night temperatures shows that the Kazakhstan flatlands will warm up due to night temperature rises, and the mountain areas due to the rise in daily temperatures.

According to the IPCC report's conclusions, all observed climatic changes have a multilateral effect when impacting on ecosystems and society. For example, a minimal temperature rise may lead to a decrease of hazards for one cultivated crop and increased hazards for other crops, to extension of the abundance and intensifying the activity of some pests and transmitters of disease. The combination of global warming with other ecological stresses and human activity may result in rapid destruction of ecosystems, namely in arid zones, which make up the majority of Kazakhstan's territory.

Analysis of territorial distribution of air temperature changes (gaps) for the period 1971-2000 with regard to norms for the period 1931-1960 showed that temperatures in January from 1971 to 2000 are higher than from 1931 to 1960 throughout the whole region except for a small area in the South, although the negative gaps do not exceed 0,5 ⁰C. A rise in air temperature of over 2,0 ⁰C is observed at West Kazakhstan and Akmola oblasts, and also in northern parts of Kostanai, North Kazakhstan, Pavlodar, and East Kazakhstan oblasts. Maximum values of positive gaps (up to 3,2 ⁰C) are observed in the north of East Kazakhstan region.

The temperature difference in April is positive throughout the region, with values fluctuating less than 0,3 ⁰C in the East to 2,0 ⁰C in West Kazakhstan and Akmola regions.

In July, in most of the region the normal temperature of the second period was higher than the normal temperature of the previous thirty years by 0,5-1,0 ⁰C. The exceptions are some regions in East Kazakhstan oblast, where negative margins have been within limits up to minus 0,3 ⁰C. Regions where positive values of normal temperature differences exceed 1,0 ⁰C, cover northern areas of Kostanai, North Kazakhstan, Mangistau, Kzylorda and South Kazakhstan oblasts, and also central parts of Karaganda and Zhambyl oblasts. The maximum positive values of difference (1,7 ⁰C) were observed to the north-east of the Aral Sea.

In October, the decline in normal air temperature for the period 1971-2000 relative to the normal temperature for the period of 1931-1960 (not exceeding 0,5 ⁰C) were observed in East Kazakhstan region, but also in the Caspian, Balkhash, to the north of the Aral sea, and in some piedmont areas of southern Kazakhstan. Positive margins reached 1,0 ⁰C only at several stations. The October temperature differences, both negative and positive, are statistically insignificant everywhere.

The difference in normal average annual temperatures was positive in all regions (Figure 2.5.). The minimal margins (less than 0,5 ⁰C) are observed in South Kazakhstan region, and maximal margins (from 1,0 ⁰C to 1,5 ⁰C at several

Photo by Pavel Kosenko

meteostations) – in western, central and northern areas, and also partly in Almaty oblast.

It should be noted that the temperature rise for the period 1971-2000 compared with the previous period is statistically important for the whole of Kazakhstan except for the southern part of South Kazakhstan region.

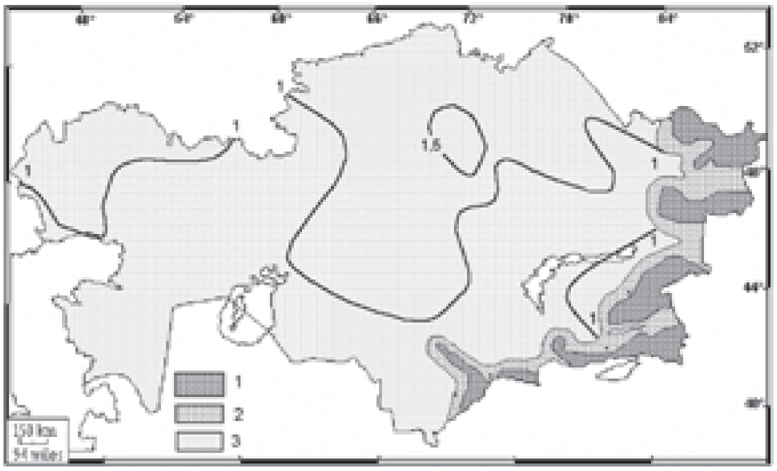
Given the annual fluctuation of margins of average perennial temperatures (normal) at every station, the more positive margins appear as a rule in November-December (up to 3,0-4,0 ^{0}C in the north of the country). The most negative margins are observed in February – up to minus 1,0-2,0 ^{0}C in southern areas.

It can be concluded that the territorial distribution of temperature changes and precipitation has its own characteristics in different seasons, but for most months and for the whole year on average there was significant rise in ground air temperature against a background of slight precipitation change.

2.1.2 Kazakhstan climate change scenarios till 2100

Assessment of climate change for the next decade and even the next hundred years in different regions of the world may crucially adjust policies and economies of many countries aiming to adapt to new climate conditions. For estimation of the vulnerability of economic sectors and ecosystems to climate change in the framework of the UNDP GEF project "Assistance in preparation of the Second National Communication" the climate change scenarios in Kazakhstan have been worked out.

A predicted CO2 concentration in 2100 of about 540-970 mln–1 versus 280 mln–1 in pre-industrial times is mentioned in the ad-hoc report on emissions scenarios (SRES) of the intergovernmental group of experts



1 – mountain areas; 2 – piedmont areas; 3 – areas with statistically important changes.

Figure 2.5. **The difference between average perennial annual ground air temperatures (^{0}C) for the periods 1971-2000 and 1931-1960.**

2

CLIMATE CHANGE: RISKS AND MITIGATION

(IPCC) [3]. Various social and economic assumptions (demographic, social, economic and technological changes) on which the SRES are based, stipulate different amounts of future greenhouse gas emissions and aerosols. Those emissions in turn result in changes in concentration of those gases, and therefore, in a change of the external radiation impact on the climatic system. A detailed description of social and economic assumptions of six illustrated SRES emissions scenarios is presented in the Special Report on Emissions Scenarios. [3]. The SRES scenarios are made without consideration of any additional initiatives to reduce impact on climate.

To date, the best opportunity for estimation of future climate is provided by general atmospheric and ocean circulation models (AOGCM), which give us the opportunity to obtain the likely range of climate change due to anthropogenic greenhouse gas concentration increases in the atmosphere, given the sulfate aerosol effect (reducing global temperature). In this case it is not a climate change prediction. It is a sort of presumption of what happens if greenhouse gas concentration increases, for a range of various values.

An average scenario of regional climate change was obtained using the average scenario of CO_2 increase in the atmosphere and average air temperature and precipitation changes of five models (the model of the European Center for Research and Advanced Training of Scientific Valuations; the model elaborated at the Australian Research and Industrial Organization; the Max Plank Institute model, Germany; the model of the National Center for Atmospheric Research, USA; the Hadley Center model, Great Britain). Version 4.1 of the program complex "Climate change appraisal model greenhouse gas induced/ A Generator of scenarios" [4] elaborated by IPCC task was used to make the scenario, also to perform works on vulnerability assessment. Conforming to the obtained scenario, the following climate change can be predicted for Kazakhstan (Table 2.4.):

Tables 2.4 and 2.5 show (in parentheses) a range of possible changes in compliance with the results obtained by several AOGCM. It describes the uncertainty of climate change scenarios with CO_2 increase in the atmosphere under the average scenario provided.

As the annual distribution of precipitation is important from a practical viewpoint, expected seasonal

Table 2.4. **Possible climate change in general in Kazakhstan conforming to AOGCM results**

Change	Period		
	by 2030 (2016-2045)	by 2050 (2036-2065)	by 2085 (2071-2100)
Of average annual temperature	+1,4 °C (+1,3 ÷ +1,9 °C)	+2,7 °C (+2,3 ÷ +3,5 °C)	+4,6 °C (+3,8 ÷ +5,9 °C)
Annual precipitation	+ 2% (-2% ÷ +7%)	+ 4% (-3% ÷ +13%)	+ 5% (-5% ÷ +20%)

Table 2.5. **Likely changes in seasonal precipitation (%) on average throughout Kazakhstan according to AOGCM results**

Season	Period		
	By 2030 (2016-2045)	by 2050 (2036-2065)	by 2085 (2071-2100)
winter	+ 8% (+5%÷ +11%)	+ 13% (+8%÷ +18%)	+ 24% (+11%÷ +33%)
summer	+ 5% (+1% ÷ +14%);	+ 0% (-11%÷ +18%)	– 11% (-28% ÷ +18%)

precipitation changes have been calculated (Table 2.5). For example, in winter time up to the end of this century an increase in precipitation is expected according to all reviewed models. For summer time, from the middle of the century only two models predict increased precipitation and by the late century a decline in precipitation is anticipated.

It should be noted that as most of Kazakhstan's regions are arid because of comparatively low precipitation, a rise of even 20-25 %, given concurrent ground air temperature rises, may not have a positive effect on ecosystems, agriculture and water resources.

2.2. Risks and vulnerability to consequences of climate change and their impact on human development

2.2.1. Social and economic development and risks

Pursuant to the Environmental Safety Concepts of the Republic of Kazakhstan for 2004-2015, the Ecological Code and Concepts on transition to Kazakhstan's sustainable development for the period to 2024, the country's most acute environmental challenges are: climate change, ozone layer depletion, air pollution, contamination of water and soil, lack of water resources, loss of forests, desertification, land degradation, biodiversity shortage, accumulation of wastes, the Aral Sea crisis and others.

Achieving environmental security is possible only by implementing major social and economic reforms covering all aspects of the society's life and providing its transition to sustainable development, continuous improvement of living standards, health, education and potential of all Kazakhstani people to improve the environment.

Kazakhstan's natural environment, including mainly steppe, semi-deserts and deserts, and also unique inland seas and lakes, such as Caspian Sea, Aral, Balkhash, Zaisan and Alakol, are highly vulnerable to anthropogenic impact. As a result of such burdens, the natural capacity of the environment to provide future economic and social development is deteriorating in all Kazakhstani areas. The intensive and irrational development of irrigated farming, and controlled flow in arid climate conditions has caused water deficit in basins of small and large rivers in the south, such as the Ili, Syr Darya, and others. The area covered by the Aral Sea has shrunk by almost two times in a generation. A similar picture could occur with Balkhash lake, if no real measures are undertaken for its protection and preservation for future generations.

Intensive air pollution, contamination of water and soil, degradation of flora and fauna, and depletion of natural resources has led to deterioration of ecosystems, desertification and crucial losses of bio- and landscape diversity, as well as increased disease and human mortality. The inevitable effect of these changes is a worsening quality of life.

Transition to environmentally safe and sustainable development is currently one of the priorities in Kazakhstan's development policy.

Overcoming these challenges may be possible by:

Central Asian countries, northern China and the northern part of Southern Asia appear to be more vulnerable because of the fast melting of glaciers in the Himalayas at a rate of 10-15 meters per year.

Global Human Development Report 2007/2008, Fighting climate change: human solidarity in a divided world

•	The introduction of modern, scientifically substantiated approaches to nature management, including ecological methods of using land, water, forest, mineral and other resources;
•	Increase energy efficiency of the domestic economy by the implementation of special state programs, single policy regarding overcoming energy waste and encouraging the changeover of economic business entities to best available technologies;
•	Curtailing of the share in the national economy of those enterprises which exploit natural resources and the development of science-intensive, low impact and high tech productions;
•	The abolition of historical contamination and regeneration and use of valuable materials accumulated at waste sites;
•	The introduction of farmland vegetation and farming systems adapted to natural landscapes, development of ecologically clean agricultural technologies, preservation and rehabilitation of natural fertility on farm lands;
•	Support of environmentally efficient energy production including use of renewable sources and recoverable resources;
•	The curtailment of energy losses and raw materials from transportation, also due to ecologically justified decentralization of power production, optimization of energy supply systems to small consumers, prohibition of irrational management of resources, including the flaring off of fossil fuel energy resources;
•	Upgrading and development of environmentally safe transport, transport communications and fuel, including non-carbon methods; shifting over to environmentally safe public transport and making this the main mode of transport in big cities;
•	Development of environmentally safe technologies for the reconstruction of housing and public utilities facilities, and construction of new buildings;
•	Development of legal mechanisms to stimulate the introduction of environmental technologies: environmental management standards, rules, statutes, subsidies for emissions reduction, tax incentives.

2.2.1.1. Food security

Food security in the global warming context is becoming an important and prioritized issue in many countries' policies. Kazakhstan also has concerns here, where physical availability of food is provided at minimal levels of consumption. GDP in agriculture per one rural resident in the republic was 73,000 tenge in 2005, 84,000 tenge in 2006, 99,000 tenge in 2007.

The climate in Kazakhstan's main farming areas provides the preconditions for possible droughts, hot winds, late spring and early autumn frosts and other weather conditions unfavorable for agriculture. According to observation results, a slight rise in average annual ground air temperature in Kazakhstan has been observed in winter and early spring. At the same time, there was a decline in precipitation in warm seasons and an increase in cold seasons. Such a situation may lead to early depletion of spring stocks of soil moisture and declining summer precipitation, on which the harvesting of crops is highly dependent on irrigated farmlands. Changing hydrothermal conditions during the growing season influence the occurrence of different diseases of cereal crops due to which the grain quality and harvest may worsen.

There are sufficient land and climate resources for growing the main crops in Kazakhstan. However, harvest losses due to poor weather conditions in some years may reach 50 to 70% in the region.

Global climatic changes may lead to a change of the existing balance of climate - water resources - agricultural production system that directly impacts on crop planting conditions and harvesting. According to estimations, even a precipitation increase of 20%, a rise in ground air temperature of 3 °C makes water resources vulnerable due to flow changes. The latter circumstance will have a negative impact on water resources in summer. The KazNIIMOCK experts came to the same conclusion when drafting the First National Communication of Kazakhstan on the UN Framework Convention on Climate Change [1].

As a result of the IPCC's assessment of arid and semi-arid Asian countries, where Kazakhstan is included, continuing to supply the whole population with

food may become a serious problem if current trends in global and regional climate change continue.

According to expert estimates, about 70 percent of potential damage from poor weather and climate conditions falls on agricultural production [5,6].

High temperatures may result in the reduction of soil moisture, spread of weeds and pests, proliferation of infectious diseases and declining biodiversity. In general, a negative effect will prevail, which means a decline in production in the range of 15% – 50%. There are similar scenarios for livestock breeding. Some countries hope for higher concentrations of CO_2 and longer pasture management. On the other hand, scenarios forecast a reduction of livestock production because of a shortage of pasture, the size of pastures or productivity of existing pastures, which could be curtailed by 30%.

Let us consider an example of climate change impact on agriculture within a major agricultural sector – grain production and range sheep production, as these sectors are deemed to be most climate dependant in arid climate conditions in Kazakhstan.

Grain is the main component of food security in Kazakhstan. An important factor of subsistence support is self-sufficiency of grain as the raw material for the production of bakers and a forage source for livestock.

The production of grain is the priority target of the national economy in Kazakhstan, as the basic subsistence of people appears to be more problematic and acute year after year. An increase in gross harvesting of high quality crops is a good basis for economic stabilization in Kazakhstan, and people are better off. Kazakhstan is one of the world's six biggest grain exporters, mainly spring wheat, exported to 40 countries worldwide. The biggest buyers are Russia, Azerbaijan, Turkey, and Saudi Arabia. Kazakhstan is gradually increasing wheat exports to other foreign countries – Iran, Jordan, Tunisia, Italy, France, and Afghanistan. Volumes of exports have totaled from 2 to 6 million tons per year. Making use of a favorable world environment Kazakhstan has increased grain exports significantly against previous years. According to statistical data of the Ministry of Agriculture of the RK, 6.9 million tons of grain was exported in 2007.

The grain production situation depends on current soil and climate conditions of the country, which play an important role in land management, formation of the rich soil layer, and, therefore, the quality of land. Soil types, air temperature, and quantity and distribution of precipitation are factors determining business sectors of agricultural entities and the efficiency of sector performance. The most preferable farming areas are northern lands of

Kazakhstan with black earth, black chestnut and chestnut soil.

The soil and weather conditions facilitating yield growth reduce the quality of wheat as a rule. This pattern is observed in geographic and time-domain measurements. The tacky gluten content of grain declines by 4 to 7% when the yield increases by 3 to 8 centner/ha. The quality of wheat is always higher in Kazakhstan with its continental climate, than in other countries [7]. Wheat cultures produced in North Kazakhstan, Akmola and Kostanai regions are distinctive, with a high protein content of over 17%. According to international standards the protein content in wheat should be at least 12,5%. Kazakhstan has an advantage over other countries exporting wheat, as it produces wheat with high protein and gluten content.

Northern Kazakhstan, where the majority of spring wheat is planted is, is classified as a high-risk farming zone. Here, up to 60-70% of risk in farming is connected with weather and climate dynamics [8]. Climate change in this region for the past 30 years had great importance in spring wheat yield fluctuations for the period 1984-2003. In 1984 the yield was 5.1 centner/ha, in 1985 9.6 centner/ha, in 1995 5.5 centner/ha, and in 2003 9.7 centner/ha. The annual spring wheat harvests change by 4-6 times in this region because of the droughts. A severe drought was observed in this region in 1995 and 1998. In these years the average yield of spring wheat in the region equaled 5.5 centner/ha and 4.3 centner/ha respectively.

The reason for yield decline is the recurrence of droughts due to climate change. Also, single crop planting has reduced the water and physical properties of arable soil, resulting in destruction of their macrostructure and an increase of the bulk weight of plough-pan soils (up to 1,4...1,5 g/cm3). Deflation, erosion and salinization of soil are intensified on ploughed land.

The humus content of soils in Northern Kazakhstan was reduced by 12 to 19,6% [9] over forty years. Fertilizer systems used are not balanced with the main nutrient elements. Organic fertilizers' ratios are negligent and do not compensate for organic carbon losses. According to Ministry of Agriculture data, ploughed lands lose 2.5 million tons of nutrient elements every year. To replenish them, 1.8 mln tons of phosphorus, 1.1 mln tons of nitrogen and 0.4 mln tons of potassium pomace fertilizers of active material should nourish the soil per annum. In fact, according to data provided by the Agency of the RK on statistics 127,000 tons of organic and 41,500 tons of mineral fertilizers enriched the soil in 2006, 77.9 and 59.0 thousand tons of fertilizers respectively in 2007.

An average harvest over the past 40 years in North Kazakhstan region is 68%, in Kostanai – 54%, in Akmola – 51%, in Pavlodar – 60%, against 72% for the period 1881 to 1940. On this basis it could be concluded that the number of years with abnormally low and high yields has increased.

Analysis of agro-meteorological conditions of spring wheat harvesting for the period 1965 to 2005 demonstrates [8], that there was vast diversity in this region. Severe droughts alternated with prosperous wet seasons. After the severe drought of 1965, when for a forty year period in North Kazakhstan the lowest spring wheat yield occurred (about 2.6 centner/ha, which is about 30% of average perennial value), 1966 was noted as one of the most productive years. Average yield in the region was 11 centner/ha, which is 140 % of the average perennial value. A similar picture was observed in 1984, 1985 and 1986. In dry 1984, the yield was about 5,1 centner/ha (about 60% of average perennial value), and in prolific 1985 and 1986 – 9,6 and 11,5 centner/ha respectively, which is about 120 and 160% of the average perennial value.

Droughts increase risk in grain production. Spring and summer droughts covering many major grain districts inflict the greatest damage on the grain business. Spring wheat harvests affected by droughts change by many times in northern Kazakhstan (Table 2.6).

Table 2.6. **Spring wheat yields in northern Kazakhstan regions during severe droughts (centner/ha)**

Year/Region	Akmola	Kostanai	North Kazakhstan	Pavlodar
1965	2,0	4,1	4,6	1,3
1975	6,2	3,0	7,9	4,2
1984	5,0	3,0	8,8	6,8
1989	9,1	6,1	7,3	5,3
1991	5,6	4,2	5,3	4,3
1995	5,3	4,5	6,8	4,6
1998	3,6	4,1	7,1	3,9
Average yield 1965 to 2005	8,7	9,7	11,9	6,5

Cereal crop production in this region is the main business for the majority of the rural population, whose welfare is mainly connected with crops' harvest. Possible climate warming and related droughts pose a serious threat to progress in grain production. Wheat production has been steadily growing in recent years. So, in 2004 the total wheat yield equaled 9.9 mln tons, in 2005 – 11.2 mln tons, in 2006 – 13.5 mln tons, in 2007 – 20.1 mln tons. The increase in cereal crop production is not restricted in the modern period, as on world markets a rise of cereal crop prices has been observed, including prices for bread grain. This allows an increase in cereal crop cultivation areas, adhering to agrotechnical norms, making use of crop rotation, improving seed stock and reducing grain losses by using modern imported combine-harvesters. At the same time, the possibility of climate change impacting on agriculture and, in particular, on grain husbandry is often not perceived by farmers as a possible threat to their business. Chiefly, an opinion prevails that a warmer climate and accordingly fine weather will only improve yields. Adaptive arrangements necessary for grain husbandry must be developed on experimental farms and at the level of scientific laboratories to breed hardy varieties which will be ready for sudden moisture reduction or even longer periods of drought.

The problem of rural population poverty in the region consists also in the lack of land and credit resources, social-alienated inhabitants of the remote areas, the lack of qualified medical aid and good education, bad quality of potable water and so forth.

Sheep husbandry is the leading livestock sector in Kazakhstan. In 1983 the number of sheep and goats across the republic peaked at 36.6 million animal units, then during economic recession this declined to 9.5 million units by 1998. Since 2001 sheep breeding is developing again because of general economic growth. The annual amount of sheep stock growth increased from 268,000 units to 656,000 units in 2007 and now (2008) stands at 13.5 mln units. About 75.4% of all farm livestock are bred on private farms, 18.6% are concentrated in peasant farms and 6% in farming units [10]. The main products of sheep husbandry are wool, meat, astrakhan krimmers and lambskin.

Sheep husbandry is well developed in the South, South-East and East of Kazakhstan. Three southern regions – South Kazakhstan (21.3%), Almaty (17.4%), Zhambyl (13.9%) and in East Kazakhstan (12.5%) – account for 65% of the country's total sheep and goat stock.

The natural and weather conditions of these regions, namely the first three regions, allow breeding of sheep in pastures throughout the year. However, for grazing there are no comfortable conditions for all seasons. There are many cases when weather conditions severely damage grazing in Kazakhstan. [11]

Climate changes over the past 40 years have had a definite impact on sheep management conditions during the year. The number of non-pastoral days during the cold period has a descending trend in the south of Kazakhstan. But against this background, an increase in the recurrence of years with long lasting winter pastoral lack of fodder has been noticed.

The duration of the period with settled hot weather for sheep on flatlands in the southern part of Kazakhstan has been growing steadily. Meanwhile the recurrence of abnormally hot years has increased. In contrast, in summer time temperature conditions are almost comfortable in the summer pastures of the Sary-Arka and mountain pastures.

However, since late last century, because of the shortage of sheep units and transition to private ownership, this practice of sheep breeding (drift-pasture system) has almost been lost.

At present, in contrast with traditional distant grazing, most sheep are maintained near settlements without differentiation of pastures into seasons. Such grazing has resulted in a severe reduction in productivity of those pastures, reduced its biodiversity and the quality of fodder. Such a situation restricts private farmers' potential to increase livestock numbers and improve product quality. Pastures degrade around settlements because of overgrazing. In summer sheep do not fatten, but lose weight because of the heat. Only large entities are able to observe the generally acknowledged (historical) and economic scheme of sheep breeding in Kazakhstan – the drift-pasture system.

The problem of climate change will also aggravate the problem of water shortage, lack of pools and watering holes for stock. Previously, this problem was solved by underground waters pumped up by facilities. These facilities used over 60,000 shaft and tube wells but these fell into disrepair. The tube wells for the most part cannot be repaired. The reduction in precipitation leads to a situation in which access to water will be limited, and the infrastructure almost completely destroyed in the 1990s does not meet modern requirements.

The problem of the climate change effect on Kazakhstani agriculture is extremely complicated and poorly explored. In connection with the obvious climate change occurrence, a further elaboration of prospects, and preparation of special measures are to adapt the agrarian sector to the new natural conditions, with a possible shift of agricultural crop planting zones to the north. This problem is not being given sufficient attention, which may be explained by such positive factors for agricultural crops (including cereals) like extension of the growing season, increase of CO2 concentration, and improvement of grain quality. Meanwhile, the ultimate negative environmental and social consequences in the villages are not being considered, which, because of climate change, may worsen the general agricultural situation in future decades.

Many countries already review how climate change will impact on agricultural crops and plants (wheat, corn, rice, cereals, cotton, vegetables, grapes, and fodder grass), and assess the potential effects – positive and negative. As for the positive effect, crop production growth could occur due to a longer growing season and higher concentration of carbon dioxide in the atmosphere; as for the negative effect an increase in droughts, expansion of dryness and decline in agricultural crop yields are all possible.

The results of Kazakh research [8,11,12-14] show that climate change may have the following impact on the agriculture of Kazakhstan:

Extent of humid zones will change. Under minimal warming scenario the humid zone outlines will shift to the north by 50 to 100 km. The area of insufficient humid zone, where under current climate conditions in Kazakhstan grain crops are planted, will reduce by 6 - 23 %. Under the Great Britain Meteorological Office scenario, which predicts maximum warming, the insufficient humid zone will disappear altogether in Kazakhstan, an arid zone will appear that will cover 38% of the total area. The dry steppe zone will be greatly increased, with a shortage of the steppe zone area. These effects may lead to a revision of crop harvesting areas, moving people from the arid zone to more auspicious regions, which will increase the share of non-productive territories.

Agro-climatic conditions will change. Due to global warming the interphase vegetation period, soil heat and humidity endowment will change at springtime that makes provisions for revision of dates of crops seeding.

Yield of spring wheat crops may decline. The increase of CO2 concentration will have a positive effect on spring wheat yield in northern Kazakhstan. At the same time a crucial rise of air temperature will have a negative impact on vegetation growth and development, resulting in consistent harvest reduction after 2050. The spring wheat will sprout 1-3 weeks earlier than average perennial dates and therefore the vegetation will cease 1-3 weeks earlier as well. Given that grain crop production is a lifestyle of most rural people in northern Kazakhstan and their welfare depends on the harvesting of those crops, a fall in yield may significantly increase poverty rates.

Pasture land productivity in flatlands may decrease. About 30% of pastures are under insufficient use to date, some of them are neglected, and there are about 49 million ha of degraded pastures. Because of the dominance of animal grazing on pastures adjacent to settlements, uncontrolled grazing and low permanent vegetation resources, which is dramatically evident in extremely dry years, pasture productivity and biodiversity decline, and soil erosion process is enhanced. For pastures in aeolian flatlands with an air temperature rise, some tendency for a possible increase in seasonal yield dynamics and forage reserves is possible for springtime. In summer-autumn and winter seasons, depending on species composition of vegetation, yield and food reserve may decline in most cases, particularly for plots exposed to pasture degradation. The above effect in general may result in a reduction in livestock productivity.

Stable hot weather for sheep will increase on flatlands. A current rise in air temperature in Kazakhstan has brought about an extension of the duration of a stable hot period (when sheep do not gain weight) unfavorable for sheep grazing, and its annual variability has increased. A further air temperature rise may lead to the future extension of the stable hot weather period. The thermal burden on animals will increase in summer, and a decline in productivity and increased sheep production costs are possible.

Enhancement of animal diseases is possible. With the rise in air temperature, animal infection episodes can be expected to increase. An increase in such diseases as aftosa, brucellosis, hoofed sheep necrosis brucellosis, soil infections (anthrax, blackleg, and so on) and parasitic diseases (itch, bald ringworm, warble fly, etc.) can be predicted.

Dates of agronomical and zoo-technical actions will change. Due to climate change, activities such a crop seeding, crop development, harvesting and sheep husbandry (spring driftway, shear, clump and so on) may be performed earlier.

According to specialist opinion, global warming's impact on agriculture, in general, will be controversial, as negative effects will be combined with positive ones. Positive effects could include:

- extension of growing seasons;
- increase of crops heat supply;
- improvement of horticultural and field crops wintering and livestock husbandry conditions in winter;
- enhancement of biological vegetation activity due to increase of CO_2 in the atmosphere.

However, it should be emphasized that in most climate scenarios and predictions climate change will be connected with an increase in the frequency of phenomena adverse for agriculture. The increased likelihood of reduced harvests due to increased frequency and reiteration of droughts and aridity may become dangerous in some regions. The predominance of these negative effects of climate change may crucially reduce agricultural production, increase the primary cost of agricultural products, decrease the number of farm producers, and as a result, impact on human welfare.

2.2.1.2. Impact on territorial development

The possible losses predicted may make private producers in rural areas vulnerable. Falls in productivity decrease foodstuff volumes of private households produced for self-consumption, cut short the supply of food to local markets and constrict employment potential. This is another area where past failures may imply threats in the future. Reduced productivity because of climate change will increase imparity between producers of non-irrigated and commercial crops, undermine the means of living and exacerbate factors forcing migration. Induced migration because of climate's negative impact may be caused by the shifting of humid zones to the north, the increase of drought phenomena, and decline in productivity of cultivated crops, soil degradation and desertification in Kazakhstan. If climate conditions appear to be more severe, there could be more migration of the rural population to the north, piedmont and hilly areas, where the negative impact of global warming is likely to be less severe.

The extensive development of agricultural production in the RK is affected by land depletion and landscape impoverishment. Over 60% of the territory is exposed to severe desertification that results in falling soil yields and, as a consequence, in reduced livestock and crop husbandry productivity. During forty years of utilization of virgin and derelict lands 1.2 billion tons of humus has been lost because of wind and water erosion. The intensive and irrational development of irrigated farming and detention volume in arid climate conditions have resulted in a water deficit in small and big river basins in the south, such as the Ili, Syr Darya rivers and so on. The Aral Sea area has been depleted almost two-fold within one generation. The Balkhash lake faces a similar possibility.

Over 200 million m^3 of pollutant effluents are discharged into open reservoirs every year. Over 3,000 pollution bubbles of underground waters are found, whose areas range from several to hundreds of square kilometers.

Most of the processing and power facilities have outdated technology, a morally and physically worn out stock of capital goods, all of which facilitates an increase in hazardous emissions. Due to the business activity of mining and metallurgy complexes in Kazakhstan, over 20 billion tons of industrial waste has accumulated with an annual injection of about 1 billion tons. Some 95% of the total volume of extracted ore runs to waste, being often very toxic and stored at sites unfit for its storage. The annual volume of toxic

waste in the country is 84.4 million tons; of these 63% are non-ferrous metallurgy wastes. They are concentrated mainly in the Karaganda region– 29,4%, East Kazakhstan– 25,7%, Kostanay – 17% and Pavlodar – 14,6% regions.

As for investment, the petroleum and gas industry is in first place among the industrial sectors. Despite this fact, Atyrau and Mangistau, the main oil and gas producing and processing regions, inherited historical contamination. As a result, the total oil polluted area in Western Kazakhstan is 65,000 ha, and the volume of spilled oil is over 5 million tons. The practice of gas flaring also crucially harms the environment and the economy. A higher thermal background and acidification of environmental components around fields of gas combustion have a negative effect on soil, vegetation and animals adjacent to oil facilities, contributing to the greenhouse effect. Irretrievable losses of gas are over 740 million m3 per annum. The positive correlation between higher morbidity of people in the Tengiz oil field (over 6 times higher than oblast indices) and atmospheric air pollution by carbon and nitrogen dioxides has been noted.

Due to the rising level of the Caspian Sea, over 200 wells and oilfields, including the Kalamkas and Karazhanbas, have been flooded, which threatens biodiversity (90% of world reserves of sturgeon, a great number of avifauna and endemics – Caspian seals are located only in the Caspian sea), and the whole Caspian ecosystem. Over the past ten years the commercial fish yield has fallen 10 times.

Vast territories in Kazakhstan suffered from military activities and operation of space launching facilities. During the period between 1949 and 1991 at the Semipalatinsk nuclear testing ground there were 470 nuclear explosions. It is impossible to accurately evaluate the death toll; about half a million people were exposed to radiation. At the Semipalatinsk ex-nuclear site about 2 million ha of cultivated lands were exposed to radioactive contamination.

Another special concern is the condition of forest lands. Although occupying only about 4% of the area of the country, these are a habitat area for the most valuable and rare animals and 90% of the larger vegetations well known in the country. Fires inflict serious damage on forest resources.

To avoid further worsening of the ecological situation and reduction of climate impacts in Kazakhstan, an innovation policy on sustainable regional development in compliance with the ecosystem principle has been developed. As specified in the Kazakhstan's Strategy to access 50 most competitive countries, "...today we need a new and contemporary strategy of regional development, targeted on activation of economic activity in the developed regional centers, able to become "locomotives" of economic improvement of the country in general, and also the formation of efficient economic specialization of regions".

Meanwhile, the ecosystem principle is the most appropriate approach to the development of a similar strategy.

Sustainable development at regional level cannot be carried out in the framework of political division entities, as nature, its resources and ecosystems in Kazakhstan have a well-defined trans-regional character.

In this regard, the creation of 8 sustainable ecosystem development zones based on the basin principle, each with its own action plan, will be developed for the provision of sustainable development and reduction of environmental impact.

These sustainable development zones are:

1. Aral – Syr Darya;
2. Balkhash – Alakol;
3. Ertis;
4. Essil;
5. Zhajyk – Caspian ;
6. Nura – Sarysu;
7. Tobol – Torgai;
8. Chu – Talas.

Social-entrepreneurship corporations should be created in these zones. Their activities should have trans-regional character.

This allows us to:

– provide the efficient use of nature and preservation of natural resources based on a single approach to the management of territories related to integral ecological systems;

– overcome the inefficiencies of existing management of natural resources, departmental segregation and duplication of functions by creating Boards for each sustainable development zone;

– create regional centers for sustainable ecological development as "locomotives" of sustainable domestic economic development;

– consolidate the territorial integrity of the Republic of Kazakhstan, and reduce the stratification of the social and economic status of the regions;

– create conditions for elaboration of the ecosystem approach in international relations, enhancing cooperation with neighboring states within the framework of joint activity on preservation of transnational environmental systems.

2.2.2. Water resources

Climate change may impact significantly on water resources globally and in Kazakhstan. Fresh water is becoming a more scarce and valuable resource for our planet, where the population size and economy are growing fast. With climate change in farming zones, climate is becoming more arid, which significantly reduces the water supply. Demand for water will increase in order to satisfy people's needs and growing industry in Kazakhstan, and also growing population and the economies of neighboring Central Asian states and China. At the same time Kazakhstan depends on these countries for almost 50% of its water supply.

Kazakhstan's orientation towards production of water-retaining farm crops (cotton and rice) has created a rural production profile of high water demand. The great majority of water is used for irrigated farming in southern regions. The dry climate, water deficit and shortcomings of irrigation infrastructure all lead to massive uptake of water resources, as happened in the Aral basin when only 4-8 km^3 of water flowed into the Aral sea in recent years, while in some years the waters of the Syr Darya and Amu Darya rivers did not reach the sea at all.

There are 8 hydro-economic basins in Kazakhstan (Fig. 2.6).

Kazakhstan is a region with poor water supply. In this regard the flat lands are very unfavorable. Mountain areas, the main place of formation of big river flows occupy only the eastern and

Fig. 2.6. **Layout of hydro-economic basins of the Republic of Kazakhstan**

1. Aral – Syr Darya;
2. Balkhash – Alakol;
3. Ertis;
4. Essil;
5. Zhajyk – Caspian ;
6. Nura – Sarysu;
7. Tobol – Torgai;
8. Chu – Talas.

1 – outlines of hydro-economic basins:
2 – administrative district borders

southern margins and are related to the Altai, Sauro-Tarbagatai, Dzungaria, Tien Shan orographic systems. Surface waters comprise the main part of the country's water resources. In some of Kazakhstan's regions huge reserves of underground waters have been explored, but their quality cannot always satisfy all users.

Average perennial river flows in Kazakhstan (general surface water resources in natural conditions) is 115,8 km^3 per annum, including that formed in the country - 57 km^3 per annum and the remaining part – 58,8 km^3 per annum flowing from neighboring states: China, Uzbekistan, Kyrgyzstan, and Russia (Table 2.7).

For the past decade river inflow to Kazakhstan from adjoining states was cut by 15.1 km^3 per annum, i.e. from 58,8 km^3 per annum to 43,7 km^3 per annum. Therefore, total resources of Kazakhstani river flow currently total 100,7 km^3 per year.

Water resources, mainly open water resources, are utilized in agriculture for land irrigation, stockwater development, livestock farms water supply, public utilities and industry. The hydropower industry, fisheries, and water transport sectors are water users. River run-off is mostly used for irrigation and water supply of populated areas. Volumes of river flows used during hydro-economic activity fluctuate widely. Sometimes the water is fully utilized from some water sources. Hydro-economic activity branches out on to big rivers, piedmont and valley areas, but mountain areas gradually fall under development.

"Glacierization" has a strong impact on open water resources and mountain rivers' hydro regime. Because of degradation of glaciers the flow and hydrological regime will change significantly. These changes may make agricultural business difficult on irrigated farmlands. Due to mountain glacier degradation, the river flows of the northern slopes of the Zaili Ala Tau will fall by about 16 percent, according to experts. There will be no control impact of river basins glacierization on the annual total flow change generated by asynchronous glacier run-off and flow from the non-glacier watershed surface. Annual river flow distribution will change: the flow volume will decline in summer (July-August) and increase in spring and early summer (May-June). This will negatively impact on agricultural production on irrigated farmlands. All three negative effects of glacier degradation on water resources and the hydrological regime of mountain rivers are subject to detailed study and measurement. The study of this issue is the main objective of proposed performance.

River flow fluctuations at 30 different hydro-economic river basins have been studied in the 20th and early 21st centuries in order to assess climate change impacts. It was found from the analysis of annual flow standards determined during the first and second halves of the reviewed period that there is no significant difference in rates, except for rivers of the Balkhash lake, where flow increased by 8 %, mainly owing to additional snowmelt inflow following mountain glacier degradation. Therefore, in the second half of 20th and early 21st centuries there was no crucial change in the natural flow influenced by climate.

To study the potential vulnerability of Kazakhstan's water resources due to anthropogenic climate change, an updated conceptual mathematic model of flow formation, developed by the Kazakh Scientific and Research Hydrometeorological Institute (KazNIGMI) led by V.V. Golubtsov [16, 17 and so forth] for mountain rivers was used. Daily total precipitation and average daily air temperatures were measured at meteorological stations located near or within the basin. These data have been received on the basis of global climate models under A2 and B2 greenhouse gas concentration change scenarios [3] for different periods of the 21st century: for the period to 2030 and for the period to 2050.

According to estimates of global climate models snow cover increases owing to greater winter precipitation in mountain areas, which results in flow rise in spring. Air temperature will rise a little, resulting in earlier soil melting and

It is known that over 20% of utilized water is lost at transportation. Up to 30% of electric power is used inefficiently. That's why for the sustainable development of our country we have to be friendly to natural resources. Saving of water, raw materials, and energy should become a part of our mentality, industrial and living culture.

(N.A. Nazarbayev's speech at 18th plenary session of the Foreign Investors Council at President office of the Republic of Kazakhstan (08.12.2007)

Table 2.7. **River flow resources of Kazakhstan in normal water year**

Hydro-economic basin	River flow, km³/year		
	Flowing from neighboring states	Formed within the country	Total resources
Aral – Syr Darya	22,6/14,9	3,5	26,1/18,4
Balkhash – Alakol	12,2/8,5	16,4	28,6/24,9
Irtysh	9,5/8,0	26,1	35,6/34,1
Ishim		2,6	2,6
Nura – Sarysu		1,3	1,3
Tobol – Turgai	0,8/0,6	1,5	2,3/2,1
Chu – Talas	3,3/3,1	1,0	4,3/4,1
Ural – Caspian	10,4/8,6	4,5	14,9/13,1
Total in Kazakhstan	58,8/43,7	57,0	115,8/100,7

Note: *the numerator is river flow values flowing from neighboring states in natural conditions; the denominator is inflowing to Kazakhstan under current water utilization within the borders of foreign states.*

in increased flow losses during spring flooding.

In lowland basins the picture is different. Increased precipitation has a smaller effect on the scale of flow, due to losses from watersheds. Dependence on air temperature is clear in lowland basins. When air temperature increases, the autumn frost line declines, and as a consequence infiltration flow losses increase.

Under the A2 scenario by 2030 water resources in mountain districts of Kazakhstan will increase on average from 0,8 % – 4,5 % in the Arys and Shayan basins to 14 % – 22,5 % in the Ili, Uba, Ulba, Karatal and Koksu basins. In the lowland Ishim and Tobol basins they decrease by 7,0 % and 10,3 %, respectively.

The B2 scenario is more severe from a water resources point of view. According to this scenario the increase in flow in mountain areas will be less and within 2,5 % in the Shayan basin to 9,2 % – 12,3 % in the Ili, Uba, Ulba, Karatal and Koksu basins. Flow will also decline in the Arys basin, but insignificantly, by 1,9 %. It is worth noting that the B2 scenario is more "rigid" for mountain areas, and "easier" for lowland basins. For instance, in the Ishim and Tobol basins resources will decrease by 6,0 % and 6,8 %, respectively.

If future, climatic changes up to 2050 occur according to the A2 scenario with water resources in mountain basins increasing on average from 1,3 % to 12,7 % in the Arys and Shayan river basins, to 5,7 % in the Uba and Ulba basins. In the valley Ishim and Tobol basins they decrease by 7,8 % and 4,4 %, respectively. According to the more "rigid" scenario B2 there will be no increase in flow in mountain districts: it will decrease by between 7,2 % and 19,5 % in the Arys and Shayan basins, and only in the Uba and Ulba basins will flow insignificantly increase, by 3,2 %. One should keep in mind that the B2 scenario for the period up to 2050 is also more "rigid" for valley basins, for instance in the Ishim and Tobol basins the decline in resources will be 8,0 % and 8,5 % respectively.

Predicted simulations of annual flow of different rivers in Kazakhstan with air temperature and precipitation fluctuations under A2 and B2 scenarios of CO_2 concentrations are given in Table 2.8.

Special attention is given to the point of mountain glacier degradation effect

on Balkhash lake basin river flow as it is one of the biggest and most populated. The results of the reconstruction of the Tuiyk Su glacier regime and balance located at the Malaya Almatinka river basin on the northern slope of the Zaili Ala Tau demonstrates that from the late 19th century to the mid-20th century its area shrank slowly but continuously. From the mid-late 20th century the reduction of glaciation area has increased significantly (Figure 2.7) [18, 19].

In total, the volume of glaciers in the Balkhash basin during the period under review fell by about 110 km^3 (42,2 %), or on average by 2,19 km^3 (0,84 %) per year. According to the estimations made, it is clear that due to the reductions in perennial glacier reserves and water storage in glacier rivers, there is over 10% of additional water inflow [20-22].

According to glaciologists' views, based on the results of determination of glacier degradation in the mid-to-late 20th century under current global air temperature rise, glaciers will actually disappear by the late 21st century. The studies provide evidence that owing to glacier degradation, mountain river flow will decline significantly. On the northern slope of Zaili Ala Tau, the flow will reduce by 163 mln. m^3 per year, or about 12 % in relation to flow from the mountains. For the upper reaches of the Ili basin (in China) the mountain river flow owing to the glacier degradation will decrease by 13000-14000 mln. m^3 per year, and for mid-part of the basin by 400-500 mln. m^3 per year. The total flow shortfall for the Ili basin will be 1800-2000 mln. m^3 per year. For agricultural production, particularly for irrigated farming, any flow change during the growing season (August – September) has special importance.

Due to degradation of the mountain glacier system it no longer exerts a

Water stress and lack of water security. Change in river flood nature and melting of glaciers significantly exaggerate occurrence of ecological stress that results in a shortage of intake volumes for irrigation and settlements. As a result, by 2080 the population living in water deficit will increaseby about 1.8 million people. Central Asia, northern China and the northern part of Southern Asia appear to be more vulnerable because of rapid glacier melting in the Himalayas at a rate of 10–15 meters per year. First water level in the seven largest river systems of Asia will rise, and then become a water resource deficit with further melting of glaciers.

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Table 2.8. **Likely change of annual river flow with anthropogenic climate change for the periods to 2030 and 2050.**

River	ΔW, %		ΔX, %		ΔT oC	
	A2	B2	A2	B2	A2	B2
30 years						
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
Ili	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
50 years						
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

Note: ΔW – deviations of simulated annual flow from its measured values (%), ΔX – simulated rainfall change (%) and ΔT – simulated air temperature fluctuation (°C), at CO_2 concentration change under A2 and B2 scenarios.

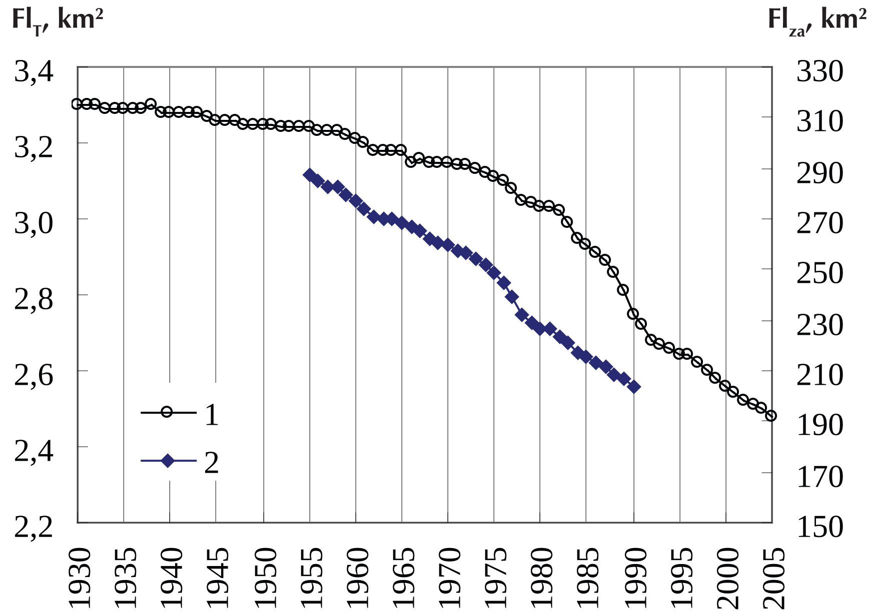

Figure 2.7 **Change in glaciation area of the Zaili Ala Tau. 1 – area of the Tuiyk Su glacier (FlT, km²); 2 – the Zaili Ala Tau glaciation area (Fl_{za}, km²).**

controlling influence on inter-seasonal fluctuation of river flow. The research has proved that this results in significant rise in flow change during the growing season and annual flow increase.

The annual distribution of river flows will change significantly. In normal years

the third quarter flow will increase by 20%, while first and fourth quarter flow will also increase. With the reduction in dryness of the year, 3rd quarter flow will decline more, and 4th quarter flow will increase. The annual river flow change makes the implementation and development of irrigated farming difficult in the south eastern part of the country in the Balkhash basin. For the reconciliation and compensation of mountain glacier degradation in river basins, whose flow is used for irrigated farming, water pools and waterworks facilities are to be constructed for river flow seasonal monitoring. Such measures will allow supply of water to irrigated lands suitable for cultivated vegetation.

In current conditions there is a real risk to mountain river flow resources. After an extended period of high annual and summer air temperatures and high moistening the beginning of a contrasting period is very likely.

The likely risks to river flow due to the degradation of mountain glaciers and the consequences under conditions of increasing water consumption in the Ili river basin may lead to deterioration of the Balkhash lake environment. The rise of global air temperatures and continuing degradation of mountain glaciers exacerbate social and trans-border tensions regarding flows in the Balkhash basin. The design and construction of seasonally controlled water pools at mountain river sites, and flood and mud-flow waterworks, are required for the relief of such tension.

2.2.3. Ecosystems and biodiversity

Climate change is a supplementary factor influencing eco-systems and species that are already affected by other factors, such as habitat change due to land use changes; over-intensive agriculture; contamination of environment and occurrence of invasive species. Let us assume that climate change will bring about reduced biodiversity. Species extinction is quite possible, given that some species have been made marginal because of the effects of many factors. Migratory species are at particular risk as they require separate habitat sites for reproduction, wintering, and migration. In the framework of existing climate change scenarios the frequency of migration may increase ten times more than during the last glacial retreat because of adaptations to climate change, and for some species this may be beyond their migratory capability [23].

Differences in species' ability to adapt and migrate give little hope that biomes will keep their integrity.

The emergence of new types of communities and formation of new ecosystems are possible. Climate change may cause the advent of hazard invasive and alien species.

Climate change may directly influence biological species due to changes in phenology (for instance, earlier blooming of trees and birds' egg-laying), the extension of the growing season and changes in dispersal of species due to their migration (e.g. changes in the range of insects towards the poles and by altitude).

Some ecosystems may be particularly vulnerable. For instance, climate change is very dangerous for 'ecotones' (transition zones located between different ecosystems with a wide diversity of species and genes), which play very important roles in climate change adaptation. Examples of these are semi arid lands subject to desertification, and forest and steppe zones of Kazakhstan.

Climate change impacts on biodiversity will be nonlinear. Impacts could be very intensive when some critical 'tipping' points are reached. It is stated in climate change studies carried out in many countries that due to the climate warming many animals may disappear, as climate change will happen too fast, and migration and adaptation to changes will be restricted by biological potentials and developed infrastructure.

Most global climate models forecast a redistribution of climate zones adverse for one area and good for others. A bias of climate zones to the north will bring about the expansion of desert and semi-desert zones, and the curtailment of steppe and forest-steppe zones. Because of climate change Kazakhstani mountain areas will fall into the risk group. Alpine and glacier ecosystems will experience serious river regime, and therefore natural ecosystem, disturbance.

Currently observed changes in fresh water basins and rivers' biosystems are in all likelihood related to global warming [23]. These changes happen because of rises in water temperature, and changes in ice sheet regimes.

The Kazakhstan landscape is poorly forested. The Kazakhstan forestry area, including bushes and saxauls, is 4.5% and pure forest only 1.2% [2]. Forests play an important role in ecosystems and human life. Forests protect soil, control climate, protect and moderate water supply and have recreational functions. Kazakhstan's forests constitute a major source of biodiversity. However, uncontrolled logging, forest fires, the human factor, lack of reforestation works and inadequate protection from pests have all contributed to the reduction of forest resources in Kazakhstan. When assessing the climate change impact on forestry it should be kept in mind that forest communities are sustainable

and gradually react to changes in living conditions. But in most regions of the RK many timber species grow alongside area frontiers and even very little climate change may lead to substitution of valued forest ranges to less valuable. Some districts may be transformed into areas inappropriate for vegetation due to climate zone shift to the north. The climate zones' shift to the north may result in the spread of fires, pests and diseases, and in deterioration of forest ecosystems. In general, the forest areas of Kazakhstan may be deemed very vulnerable to climate change.

There is feedback. Climate stability is assured by biotic management of the environment, which is assured by land and ocean biota. When the biota is disturbed climate biotic stability is reduced. Wide scale deterioration of natural ecosystems influences the continental hydrological cycle 70% regulated by vegetal biota, as well as disturbance and unpredictability of hydrological regimes and river flow, and desertification. For climate stabilization it is important to reduce greenhouse gases and preserve undisturbed land and ocean biota and primary forests.

The conclusion to the above is that ecosystems, while being highly important for human development and welfare, are very vulnerable to climate change. Climate change may result in the decline of bio-diversity and goods and services that a community gains from eco-systems, e.g. food, fibers, medications, recreation and tourism. The scope of environmental services provided will decline, the number of detrimental characteristics (e.g. quantity of insect pests, new diseases and invasive species) will increase and spread.

2.2.4. Poverty and migration

Many poor people in Kazakhstan live in rural areas. Besides, many rural settlements are isolated communities without access to relevant medical, educational or cultural services or public transport to connect them with other settlements. Statistical data demonstrates that rural living conditions worsened during 1996 and 1999. In 1999 about 29% of rural inhabitants did not have access to public transport. A lack of good roads limits access to medical and educational services. Despite this, the proportion of such "lost" settlements decreased from 44% in 1996 to 28% in 1999.

Lack of employment, raising children and hard living conditions in general have made many rural people move to cities. In most cases they then also face problems of unemployment, expensive accommodation, food and so on, just simply carrying over their problems from village to town. This has resulted in urban and peri-urban slums expanding in Kazakhstan. Climate change and problems of falling crop yields or deterioration of livestock farming conditions may lead to major urbanization as occurred in the 1990s. In its turn, the migration of population will lead to abrupt decline in the supply of agricultural products that could cause food crisis aggravation both on global and national scales.

Rural development was identified as the principal challenge of national development for 2002-2005. Rural development programs, and agro-industrial policy stated in the Strategy 2010 are targeted on improvement of rural people's welfare.

About 45% of people living in rural areas are highly vulnerable and poor. Climate change processes accompanied by reduction of land productivity, shortage of water supply and expanding desertification may result in that crucial part of the population being without a source of income, as they inherit a lack of non-farm employment and other sources of income in rural areas from the Soviet economy.

Over the past decade birth rates in rural areas declined much faster than in cities. The migration of young people to cities exacerbates the problems of rural areas. As a result of these two trends village populations are aging. Today the share of aged people (above 45) in villages is over 24.2% as of early 2007, versus 10% and 18% in 1939 and 1970 respectively. However, in total, from 2006 with the introduction of government support for families, birth rates have begun to increase in Kazakhstan.

Therefore, an aging, rather apathetic and unskilled rural population has emerged as a demographic background. The ability of such people to adapt to dramatic climate change and create new agricultural economic systems is very restricted. In new climatic conditions the rural population will be a very vulnerable group unable to adapt without special assistance from the government. Rural people will have to either migrate from these regions, or change their activity into non-agricultural business.

Changes in climate and environment are associated with serious social consequences. First of all, it is related to a general decline in health in the Aral Sea region. Also the pollution of potable water with chemicals and salt, contaminated food, and air pollution during chemical treatment bring about a decline in health. As a result, the child mortality rate is 80 per 1000 infants, which is 5-7 times higher than in Russia, Ukraine, and Belarus. Over 70% of adults and 80% of children suffer from one or several diseases. Up to 90% of women in labor are sick with anemia and poor blood. All these factors have resulted in a continuous decline in average life expectancy in the Aral Sea region. It is natural that for the description of the ecological and social situation in the Aral Sea area the word "ecocide", i.e. genocide of nature and human beings, is often used.

2.2.5. Public health

Even at present, climate affects public health in Kazakhstan. In the future the influence will be more intensive due to the forecasted warming of the climate. The prospect of having a long and healthy life and having access to resources needed for decent living standards could be threatened. Human health is deemed to be one of most integral indicators of changes in the environment. Severe climatic and geographical conditions in Kazakhstan, together with anthropogenic factors speak of the timelines of special monitoring of human health owing to climate change. Climate change is considered by the World Health Organization along with such well-known risk factors as smoking, alcohol, obesity and poor physical activity.

Predicted climatic warming in Kazakhstan will influence people's health directly and indirectly. In terms of direct influence people die as a result of extreme weather, e.g. extremely high temperatures (heat waves), floods, mudflows, and landslides. Indirect effects include increases in the number of infection – carrying insects (mosquitoes, mites and others), extension of the potential risk period of infections, water – and – sanitation failures, quality and lack of potable water, due to which digestive tract infection morbidity risk increases, and so on.

People's morbidity and mortality rates, because of cardiopulmonary diseases, are more weather dependent characteristics of health conditions. The veracious growth of such diseases with increases in air temperature is found in virtually all Kazakhstan oblasts and all age groups.

Climate warming will result in increases in mortality rates from cardiopulmonary diseases, primarily, cerebro-vascular diseases, where people suffering from chronic diseases, children and the elderly are most vulnerable. This process is worsening due to the aging of the population structure of the RK.

High air temperatures increase heat apoplexy, sunburn and water casualties. Primarily children, the elderly, and socially underprivileged people having no capability to mitigate high temperature impact (e.g. to buy air conditioners, drink enough potable water, promptly get qualified medical aid, leave the town, etc.) may suffer.

Climate warming will result in the occurrence of disasters including mudflows, soil flows, and floods. For example, according to Kazakhstan specialists' research, with a temperature increase of 2-3°C mudflow occurrences will increase by ten times [14, 20]. As a result, towns and life support facilities located in lowland zones, and economically and socially developed

areas of the country may become zones of environmental disaster. Considerable numbers of victims may be expected, primarily in certain districts of Almaty, Zhambyl and West Kazakhstan oblasts.

The rise in air temperature will aggravate the negative influence on people's health. That is why in cities with highly polluted air (Almaty, Ust-Kamenogorsk, Balkhash, and so forth) the risk of people's health being dependent on the environment will increase, first among children, the elderly, and people with respiratory and cardiovascular problems.

The indirect impact may stem from the worsening of social and economic conditions and nutrition due to the deactivation of farmlands because of the escalation of drought, degradation, and desertification. The desertification risk will grow in different regions, but mainly in the south, and will affect people's health. The most vulnerable group is rural inhabitants, namely children, as poor nutrition is the most important negative factor in their normal growth and development. The predicted spread of desert and semi-desert areas, soil degradation, and reduced soil humidity will result in higher risk of dust storms and accumulation of their impact on the health of people living there. This is of primary importance for Atyrau oblast.

The frequency of forest and steppe fires will increase with climate warming, and is a cause of great concern. Fires may significantly damage agriculture and have a negative effect on public health because of intensive air smog.

According to a large body of studies, with rising air temperature the risk of infections and parasitic diseases, primarily acute intestinal infections [20], will increase. Climate change will result in growth of infectious diseases and modification of their structure, as conditions of contagious diseases and their carriers will change.

A major increase in environment migrants from adjacent states is to be expected. Also the migration of Kazakhstani people from southern to northern regions will increase. All these things will aggravate social problems and affect disease occurrence in regions.

Thereby, forecasted climate change in Kazakhstan will significantly affect public health. The most negative effect on public health is possible in southern regions, and industrial centers, where the environment is highly contaminated with industrial and transport emissions.

Kyzylorda oblast, whose main area is located in the zone of environmental disaster because of the shrinkage of the water bed and diminishing of the Aral Sea, deserves special attention. People there live in unfavorable weather, environmental, social and economic conditions, resulting in poor public health. For instance, in Kyzylorda oblast the infant mortality rate is very high. According to reports [24] the child mortality rate in Kyzylorda oblast is 20.7 per 1000 live births.

The potable water supply of a quality and volume complying with hygienic standards is one of the most important factors in determining living standards. It should be noted that despite the implementation of a program on centralized water supply, some settlements still need good quality potable water, which needs to be increased because warming up of the climate.

It was in Kyzylorda oblast that the maximum number of proven correlations between climate and public health were observed. One could assume that under expressed environmental degradation and low social and economic development rates, when people are stressed by adaptation systems, the additional impact of negative climate factors will lead to a failure of adaptation and development of pathologies occurring in disease and mortality growth. Direct and indirect climate warming impacts on public health will be clearly seen in these conditions.

The influence of climate change on health indicates the necessity to initiate actions on mitigation and adaptation.

Among these actions the following main groups can be highlighted: legal base improvement; architectural, urban development, engineering and design solutions; control, treatment and prevention of infectious and non-infectious diseases caused by climate change.

Little emphasis is currently given to issues of climate change influence on public health. If no action is taken to mitigate and adapt, the impact on growth, and even a decline of the human development index in several regions can be expected, due to declines in health, and a lowering of life expectancy. It should be noted that measures to adapt people to climate change will be efficient only if they are applied extensively, given specific peculiarities of several regions of Kazakhstan.

Measures aimed at reducing greenhouse gas emissions applied in the energy and industry sectors also lead to reduction of other kinds of pollution since greenhouse gases will "drag along" other hazardous emissions, while exclusion of these emissions will be positive for the health of the population.

Human health. In rich countries the preparation of public healthcare systems for future climate stresses like the 2003 heat in Europe, and even for more extreme summer and winter conditions is initiated. However, climate stresses are most dangerous for people from developing countries because of high poverty and public health services' limited ability to resist. A vigorous growth of epidemic diseases is to be anticipated in the future. For example, 220-240 million people may incur danger of malaria, which already takes about 1 million lives every year. Recently tropical fever outbreaks became more frequent, especially in Latin America and in some Eastern Asia regions. Climate change may geographically expand the manifestation of this disease.

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2.2.6. Emergencies and disasters

The increasing occurrence of natural disasters should be reviewed relative in the light of climate change. As many scientists think, the Earth is in the high disequilibrium zone, and occurring natural disasters indirectly prove that view.

Indeed natural disasters, together with technogenic failures, gradually become regular occurrences in our daily life, and sometimes it is not easy to draw a line between these two phenomena.

Warming process will result in the expansion of hydrological cycle intensity, and therefore to heavier rainfall and floods [20].

With Caspian Sea level rise, offshore areas may suffer from storms and floods. Old and abeyant wells, oil spills and oil-storage pits pose a serious threat to the Caspian ecosystem, biodiversity and the whole oil and gas business due to inundation and floods.

Conversely, some areas in Kazakhstan will be stricken with drought more frequently. Forest fires may occur more often and extensively. The majority of the land area is in arid zones, represented by steppe, semi desert and desert landscapes, less favorable for forest vegetation, except for mountainous south-eastern and northern regions, where the forest ranges are mainly located. Forests in Kazakhstan serve riparian, soil protecting and climate control functions, and are also sources of wood, food and medicinal products. The forest vegetation completely depends on climate conditions to determine species composition of the stand, productivity and growth conditions.

Despite the seemingly positive general trend of Kazakhstan forestry, several worrying climate phenomena have been observed in recent years. The number of fires and the burnt area is increasing. For instance, for the five-year period 1998-2003 the area of forest lost to fire was 64,100 ha. It should be taken into account that part of this burnt area was not recorded in official forestry data, because as a result of regeneration it was reclassified as forest area or was promptly cut and classified as timber. Well-known pinewoods of the Ob-Irtysh interfluves were fully burnt out. Very often fires are observed in lowland forests. For example, in spring 2007 the relict high-density riparian woodland burnt out in the Nurinsk forest farm of the Chilik State Institution.

According to the scenario of the US Laboratory of Geophysical Flow Dynamics, the area covered by fires annually will increase from 30% to 41% due to the extension of the fire season. According to the climate change scenario based on M.I. Budyko's paleoanalog model, with a rise of average global temperature of one degree the period of forest fire hazard in mid latitudes will increase by 17-21 days per year. An increase in the number and area of wild fires due to the extension of the fire hazard season will, in this case, be limited by 12.6 –16.1% and 12.0 –15.6%, correspondingly. If average global temperature increases by two degrees the estimated results are doubled.

The activation of thunderstorms in the boreal zone may result in increased numbers of wild fires by 3.6 – 4.8 % and expansion of covered area of 12 – 16 %. The fire area of thunderstorms equals 52 – 56% of total wild fires area in protected areas. In general, the extension of duration and asperity (stress) of fire hazard seasons, activation

of thunderstorms in frames of reviewed climate change scenarios may result in growth of wild fire numbers and area by 1.5-2.0 times.

Due to warming of climate in mountain regions, the risk of mudflows and avalanches jeopardizing people, infrastructure and the economy of these areas is increased.

It is easy to calculate fluctuations of mud-flow activity in time over 2000–2050 if we assume that by 2050 air temperature will increase by 2,8 ^{0}C [20], and will change over time in linear fashion. Considering that a mud-flow generating catchment area was located in the 20th century in the range of altitudes 3200–3500 m, the mud-flow generating flood discharges, and mud-flow discharge and volumes will increase, conforming to an extension of Alpine zone areas integrated in mud-flow generation because of warming. Let us assume the value of mudflow activity in the basin of the Malaya Almatinka River in 2000 as unit of measurement, then with a 2050 climate (air temperature increased by 2.8 ^{0}C) mudflow activity increases 48 times.

Data given in Figure 2.8 allows estimation of the average number of mud-flows comparable with the 1921 mud-flow which occurred at the Malaya Almatinka river basin, which may result in this basin due to precipitation. It is easy to see (Table 2.9.), that the debris basin in the Medeu gorges mudflows will be fully filled with mudflow deposits by 2030–2040 only due to rain-induced mudflows.

Mudflows similar to the one in 1921 will therefore happen once in two years. It should be noted that this is most likely a minimal estimation. An estimation of mud-flow activity with a run-off rate increase due to the increase of rock and ice watershed percentage, and annual precipitation layer due to air temperature increase, and most importantly, abnormal dampening of unconsolidated detrital rocks of permafrost zone degradation were not taken into account. The latter circumstances create conditions for the evolution of a chain mudflow process where mudflow discharge and size may increase tenfold [26].

Glacial and rain mudflows starting in the high-altitude zones are dangerous for settlements and businesses located

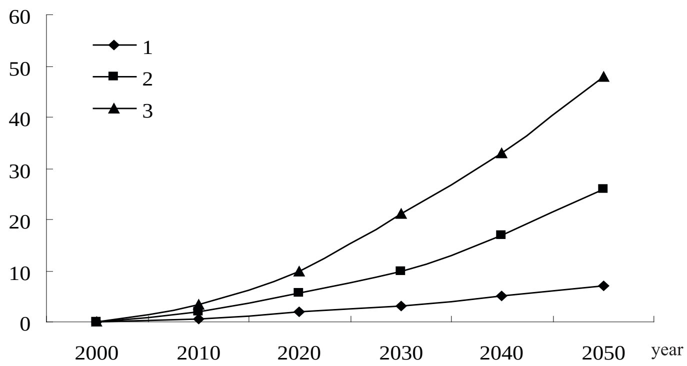


Fig.2.8. **Change of relative rain induced mudflow activity with different warming scenarios: 1 – 1 єC; 2 – 2 єC; 3 – 2,8 єC.**

Table 2.9. **Number of rain induced mudflows on years interval with different global warming scenarios**

T, єC \ years	2000-2010	2000-2020	2000-2030	2000-2040	2000-2050
1	0,05	0,25	0,55	1,0	1,7
2	0,1	0,45	1,25	2,6	4,8
2,8	0,2	0,8	2,3	4,9	9,0

in mudflow evacuation cones. Also, mudflows that can be formed in bottom-hill areas (so-called stands) are dangerous for piedmont rural inhabitants and businesses located within 10 km of the Ili valley adjacent to the bottoms of the Zaili Alatau Mountains. Mudflows in the stands are formed due to rainfall and cause significant damage and casualties even under present-day climate conditions.

2.3. Analysis of current policy

The Kazakhstan government addresses environmental problems and climate change impact mitigation within its main priority – the provision of sustainable national economic growth, and increasing the prosperity of its citizens. The Kazakhstan government, ministries and departments are ruled in their actions by fundamental documents prescribing the country strategic development, such as:

- Kazakhstan Strategic Development Plan 2030 (“Strategy 2030”);
- Kazakhstan Strategic Development Plan 2010;
- The Address by the President of the Republic of Kazakhstan “Kazakhstan in the course of expedited economic, social and political modernization”;
- Program implementation Action Plan “Action Plan for implementation of the program “Environment protection in the RK for 2008-2010”;
- National Environment Protection Action Plan;
- Ecological Code RK (enacted in 2007);
- Program to combat desertification in the RK for 2005-2015;
- “Zhassyl El 2008-2010” Program;
- The draft Strategy “Efficient use of energy and renewable resources of the Republic of Kazakhstan for sustainable development up to 2024»;
- “Concept on Kazakhstan’s transition to Sustainable Development for 2006 – 2024”;
- “The Kazakhstan accession strategy to the top 50 competitive countries” and other programs.

On the basis of these fundamental documents the “Kazakhstan Mid-Term Development Plan” has been developed. This regulates governmental structures’ activity for provision of harmonious economic development and fulfillment of strategic development plans today and for future given climate and environmental impact abatement.

Within the framework of the action plan on the implementation of “Kazakhstan Environmental Protection 2008-2010” program the following studies have been carried out:

A set of measures are under development on the introduction of the “Green oil” system (introduction of international standards using the principle of “Green Oil”, improvement of regulatory legal basis) for the prevention of contamination of the Caspian sea shelf, with an assessment of the negative impacts of petroleum production on the piscifauna and benthic invertebrates population and migration in the North Caspian Sea region.

When implementing articles of the UN Convention to Combat Desertification, in particularly in Africa, of June 17 1994, the UN Convention on Biological Diversity of June 5 1992, the

UN Framework Convention on Climate Change of May 9 1992, the potential of technical and scientific and research studies on combating desertification and mitigation of consequences of drought carried out by research institutes in cooperation with regional and international organizations has been built up.

The sustainable development target criteria for major industrial and energy facilities, specifying dates and transition mechanisms to best available technologies have been developed as economic instruments in view of environmental protection and reduction of the overall effect on climate.

Now research on the assessment of the environmental situation in Kazakhstan, the level of natural resource management, business environment impact and measures undertaken to reduce negative effects on the environment is being carried out with the support of the Ministry of Environmental protection of RK. Also motor vehicles' environmental safety is being studied in order to estimate the possibility of Kazakhstan adopting international standards.

A comprehensive assessment is being made of current ecological soil constitution of irrigable zones in chemical industrial fluorine containing emissions, and recommendations on fluoride effect

mitigation are being worked out.

As for the mitigation of human impact on climate and the ozone layer, a qualitative assessment of greenhouse gas emissions is being carried out; the Kazakhstan national strategy on the reduction of greenhouse gas emissions and conditions for the formation of a national system for greenhouse emissions rates permits are being created. For this purpose the greenhouse gas emissions/drainage monitoring and reporting system is under alignment. During the estimation of current development of sectors using ozone depleting substances and their effect on ozone layer and climate change, possibilities of adaptation of various economic sectors to actions undertaken to fulfill commitments under the Montreal Protocol of 16 September 1987 are being studied. Ecological and economic assessment of the efficiency of measures on curtailing ozone depleters is underway.

As for the preservation and sustainable management of biodiversity as part of the performance of basic provisions of the UN Convention on Biological Diversity of 5 June 1992 in the Republic of Kazakhstan 1999-2009, a National program on preservation and rational use of bioresources has been elaborated. Works on forest conservation and forestry expansion throughout the country are continuing.

To prevent depletion, contamination of land and water resources, and air pollution, detailed surveys of qualitative and quantitative composition of emissions from business entities help to forecast their effect on air technogenic pollution in Kazakhstan. Given perspective fuel and energy complex development plans studies of hazards and greenhouse gas emissions from the energy sector of the Republic of Kazakhstan for the next 10-20 years are underway. A comprehensive assessment is being conducted of the ecological situation of highly contaminated industrial centers of the RK in order to elaborate improvement measures. Main indicators of environmental contamination and its influence on people's health in environmentally unfavorable areas in Western Kazakhstan have been determined.

Realization of strategic documents has created favorable conditions for Kazakhstan's economic development. According to the State development program of the Kazakhstan sector of the Caspian Sea after the start of commercial production at the Kashagan field, a crucial increase in oil and gas condensate production is expected. Production growth rate will increase 2-3 fold, helping to stabilize the economic climate in general.

"The Industrial and innovative development strategy of the Republic of Kazakhstan" is being implemented to help ensure that other economic sectors become competitive. Under this program pilot clusters in priority economic sectors are being created. The realization of seven projects has been launched: tourism, construction materials, textiles, food industry, metallurgy, oil and gas, production equipment industry, and transport.

Three regional technical parks have been created in Almaty, Uralsk and Karaganda, with the aim of promoting technological development by creating effective mechanisms of introduction of new domestic and foreign technologies.

The main strategic challenge for the near future is the realization of the Address by the President of Republic of Kazakhstan "Kazakhstan in the course of expedited economic, social and political modernization". According to this document an average annual economic growth of 8.5% is presumed. The development of high living standards and accession of Kazakhstan to the group of most efficiently developing world economies are the main political and social objectives of the country.

The prevention of economic "over-heating", evidence of which is already observed, is one of the most significant points of macroeconomic policy. A set of measures has been developed to prevent overheating, including the lowering of oil production (and sale) growth rate.

The main economic growth factor for the near future is maintenance of high oil prices on the world market.

Therefore, measures to mitigation of climate change in the Republic of Kazakhstan are carried out under severe conditions of reorganization and modernization of many economic sectors, given steady growth of production of oil and gas condensate, and other raw material resources (non-ferrous metals, coal), sales revenues of which provide for industry upgrading. The rehabilitation of the use of modern energy-saving technologies is essential to the reduction of greenhouse gas emissions per unit.

2.4. Barriers to introducing adaptation mechanisms in Kazakhstan

The main obstacles to Kazakhstan gaining potential to mitigate the impact of and adapt to climate change are described below. Many of these are common when observing environmental convention articles [27].

2.4.1. Institutional and legal issues

Climate change problems issues are of high interest to many ministries of Kazakhstan, but the coordination of ministries and departments interested in reducing greenhouse gas emissions and adapting to climate change cannot be called efficient. Despite the creation of an interdepartmental commission on ratification of the Kyoto Protocol by the Republic of Kazakhstan, and on execution of commitments of the Republic of Kazakhstan on the UNFCCC, its mandate is limited to consultation procedures. In addition, the interdepartmental commission focused only on Kyoto protocol procedures. Other commitments under the UNFCCC and other climate change problems have been discussed less. For example, potential improvements regarding climate change information awareness of state agencies, the industrial sector and the general population, or the necessity of assessing the potential climate change adaptation and so forth have not been discussed at all. In the framework of the process of activation of Kazakhstan's accession to the Kyoto protocol an interim interdepartmental working group has been created to take forward the ratification of the Kyoto Protocol to UNFCCC, and it has focused on discussion of opportunities and outcomes of Kyoto Protocol ratification.

Climate change is not included in the government work plan. For instance, about 50 various development programs are being realized in Kazakhstan, but there is no clear agreement of programs at the development and implementation stages. The environment agency has insufficient authority for compulsory integration of climate change into state programs and strategies.

Also, the lengthy procedures for reconciling, passing and approving various national programs, including on climate change, should be noted.

Basic country development strategies have been elaborated in Kazakhstan, where the necessity and intention to find solutions to the climate change problem (namely by improving energy efficiency and promoting the development of alternative energy sources) and to reduce greenhouse gas emissions have been defined. However, the realization of such intentions at the level of a single legal and other regulatory document has failed. The declarative character of these actions is retained.

A document was passed and a number of documents ("Ecological Code", "On Energy Saving", "On electric power" and others) are planned to be passed that could provide the basics for future legal monitoring of greenhouse gas emissions. Currently, Kazakhstan has no quantitative obligations on greenhouse gas emissions within the framework of the Kyoto protocol regime. Quantities of greenhouse gases emitted are not specially regulated as part of national legislation, and correspondingly, there is no special system of sanctions or penalties for any violations.

In the Forestry Code of 8 July 2003, the nationwide importance of forests due to their climate regulating, environmental component, field and soil protection, water protection and sanitary and hygienic functions is recognized as one of the basic principles of forestry legislation. There are a number of articles on reforestation of forest reserve lands and on forestation. However, private timber cutters are not interested in reforestation works carried out mainly at budget cost.

With the enactment of a new land law in Kazakhstan (Land code of June 20, 2003) there were no crucial changes to the basic requirements on rational use and protection of farmland. The key condition of farmland's rational use legally prescribed is their targeted use as before, i.e. for agricultural production. A significant innovation in land protection is Item 3 Article 140 of the Land law, which provides for economic motivation of land protection and rational use for purposes of increasing interest of land owners and land users. But it seems to be a reference point to budget and tax laws.

Pursuant to the existing form of environment protection regulation, prevention of environmental contamination and introduction of new technologies with minor GHG emissions or allowing accumulation of carbon in soils and forests seem unsound for natural resource users. This barrier is caused by:

- a lack of legally prescribed mechanisms allowing the government to influence greenhouse gas emissions or volumes of their basins and absorbers;
- a lack of motivation from the government to stimulate energy saving, energy efficiency and the involvement of renewable energy resources and clean technologies into the energy mix;
- the declarative nature of some legal and regulatory acts.

The system of permits for pollutants (hazards) and air emissions has no relevance in terms of greenhouse gasses and does not contribute to international commitments on reduction of emissions. This system does not cover greenhouse gases, which are not highlighted in

Greenhouse gas emissions reduction policies have to include three main components: carbon emission cost management, technological policy and clearing of obstacles to increase efficiency of energy resources use by change in behavior.

(The Stern Review "The Economics of Climate Change")

official reports. The system itself is not transparent; to some extent it does not take into account the natural and climate specific character of regions. With regard to the commitments under the UNFCCC and possible accession to the Kyoto protocol mechanism, the creation of licensing and quota arrangements, certification and a greenhouse gas emissions verification system will be required. This is especially relevant since extractive industries distinguished by high impact on the environment dominate Kazakhstan's economy.

2.4.2. Financial, economic and social issues

Despite steps undertaken to extend the environmental protection policy, to date there is disinterest among the economic sectors in setting high environmental standards. There is a lack or insufficient influence of parties concerned (governmental agencies and NGOs) on those economic sectors which impact on the real environmental situation in the country.

Still there is a shortage of private and state funding of environmental measures. State control mechanisms should guarantee investors good stability, and reduce tax and legislative risks connected with long term investments. Also the government is prudent with regard to introduction of mechanisms for the management of environmental impacts of economic activity because of limitations of the state budget.

Under the electric power industry development program up to 2030 approved by resolution N 384 of the Government of the RK of April 9, 1999, great attention is given to increasing the renewable energy sources, though the legislative imposition of a number of measures, promoting their development also by granting exemptions from customs duties on the supply of equipment; companies owning those energy sources receive exemptions from VAT on electric power as payment for clean air. At the same time many similar measures of economic incentives are not being performed.

We are faced to create conditions that will vigorously inspire all entrepreneurs to the ecologization of business. Here we have to use modern leverages including economic ones.

(Speech of Mr. N.A. Nazarbayev at the 18th plenary session of Foreign Investors Council under the President of the Republic of Kazakhstan 08.12.2007)

Kazakhstan, as a country with a command management method in the past, is distinguished by a specific barrier at individual level – a certain public mentality influencing the accumulation of national potential to resolve problems. This mentality manifests itself as follows:

- taking official documents as pieces of paper regardless of the content;
- an established opinion that global environmental problems have an insignificant effect on human health;
- existing opinion that the population is unable to participate in environmental management;
- public distrust to ecological statistics;
- lack of efficient feedback between power structures and the local population.

2.4.3. Education and information

Environmental education is part of the general education system and one of the main directions of education system activity: in compliance with the State obligatory education standard (order of the Ministry of Education of RK of 13/08/2002), environmental education including climate and its changes on the territory of Kazakhstan are integrated into the natural science subjects and work to get schoolchildren involved in scientific activity in the area of ecology is being carried out. Contests of scientific projects and ecological Olympiads are held annually, competitions of business projects on environmental education and the upbringing of schoolchildren have been held two years running. The challenges of climate change in Kazakhstan and its regions are among the most vital issues for the abovementioned activities. Besides, children's ecological clubs in East-Kazakhstan oblast ("Ecobiocenter"), Kostanay city ("Young generation for ecological security and stable development"), West-Kazakhstan oblast ("Landscape"), Central Kazakhstan ("Edelweiss") are functioning. The purpose of these organizations is formation of basic environmental skills and abilities of schoolchildren, implementation of developed methods and programs into the academic process, and coordination of the activity of teachers in the system of continuous environmental education.

The Republican Institute of Professional Development of Managerial and Scientific-Pedagogical Personnel of the Education System (RIPDES) and regional institutes of professional development of pedagogical personnel (IPD PP) are working to improve the ecological knowledge of managers and pedagogical personnel of the education system; the Ministry of Education and Science cooperates with republican and foreign non-governmental organizations on issues of environmental education and upbringing of schoolchildren. In particular, with methodological help of the personnel of the department of secondary education of the Ministry of Education and Science, the Centre of Coordination and Information on ecological education "Eco-obraz" (2006-2008) developed a module for the project "Development and Implementation of Educational Materials on Climate Change". For realization of the project, training seminars were organized for teachers of the republic on the basis of regional IPD PP. Also, an international school project on resources and energy use "SPARE-Kazakhstan" has been implemented in the country. Participation in the project develops the skills of an environmentally sustainable way of life and involves useful activity on energy and resource preservation. In 22-governemnt-run and in 11 non-government higher educational institutions personnel training in the profession of "Ecology" is being implemented:

- in the 2007-2008 academic year in Kazakhstan 6,239 people studied Ecology at Bachelor's level and 166 at Masters level;

- training is taking place on programs of high professional education with specializations in "Ecology and Environmental Management", "Applied Ecology", "Agroecology".

- since September 2008 the discipline "Ecology and sustainable development" worth 90 hours or 2 study credits is envisaged in the State obligatory education standard of the Republic of Kazakhstan in the cycle of all specializations of higher education.

However, the accepted environmental education concept does not perform as a mechanism of education, public information and awareness-raising on climate change problems. The necessity of raising awareness of global challenges like climate change is stated in the environmental education concepts. However, there are problems with the realization of this concept, as there is not enough capacity to carry it out. At the same time, the Ministry of Environmental Protection of RK is incompetent in environmental education, and is unable to provide its robust implementation in the context of awareness-raising of global environmental problems. Therefore, joint actions of Ministry of Environmental Protection and Ministry of Education and Science are necessary.

The current training of environment specialists is random and methodless, with no system of continuous personnel development, though lately there are some signs of improvement with the establishment of development priorities of Kazakhstan and ecological activity.

Awareness of climate change among the general population is still low; people are skeptical of the negative effect of climate change on people and business. Climate change problems are highlighted without any system in curricula and mass media. The lack of accurate and open information about climate change and its features in Kazakhstan, and the existing public mentality adversely affect people's awareness of the issue. The community as yet does not perceive climate change as vitally important or requiring an adequate and prompt solution.

Assessment of current regional climate change due to carbon dioxide concentration increase in the atmosphere, assessment of the ecological system and climate-dependant economic sectors'

Combating climate change demands that we place ecological imperatives at the heart of economics.

Global Human Development Report 2007/2008

vulnerability and possible adaptation to climate change are being carried out in Kazakhstan. In particular, this research has been included in the national budget program of the Ministry of Environmental Protection "Environmental scientific research" for 2004-2007. However, briefings to demonstrate the results of this research have been highly limited at different levels – from other ministries to the population at large.

2.4.4. Transboundary issues

The Central Asian states – Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan – depend on two rivers, the Amu Darya and Syr Darya. The population of Central Asia is increasing fast; water resources are in short supply for needs of the developing agriculture, populated areas and industry. It is clear that climate change combined with continuation of existing economic and social tendencies will bring water deficit and increased potential for conflict. Yet the five states still failed to come to an agreement on reasonable joint utilization of the Amu Darya and Syr Darya waters. The five decided to survive one by one: Tajikistan and Kyrgyzstan will expand the construction of big hydropower stations; Turkmenistan, Uzbekistan and Kazakhstan dyke their waters without conducting environmental impact assessments or reconciliation of transborder issues. General regional strategies remain on paper only. If the countries solve the water shortage problems in the region without consideration of their neighbors' interests, then conflicts may arise over access to scarce water resources. The Aral Sea is a complicated set of social and economic problems which has become an international issue due to the nature and scale of its effects. The Aral crisis is one of the biggest environmental and humanitarian disasters in the history of the mankind. It has affected about 35 million people living in the sea basin. The severely increased drought observed and forecasted for this century in the region may further expedite this environmental catastrophe and negative processes in Central Asia and may make it one of the most unstable regions.

Kazhydromet studies have shown that substantial reduction of the River Ili's flow from China started in the 1970s. During past decade it stood at 3.5-4.0 km3 per year. The total decline of the Ili's flow in Kazakhstan from 1970s to the present was 80 km3. Because of high economic growth Chinese water consumption from the Ili river basin is expected to increase by approximately 1.5 km3 per annum in the future. So far, due to mountain glacier degradation and slight increase of mountain ridges macro-slopes sludging, a large part of water consumption is temporarily compensated in China and Kazakhstan. But glacial water storage is exhaustible, and reduction of glacier run-off to rivers may result in lowering of the Balkhash lake level. The politicians and scientific community of the two countries should understand clearly that in this situation the Balkhash Lake is expected to suffer a similar fate to the Aral Sea, with possible full decimation of the Eastern Balkhash. In the near future a comprehensive system of Balkhash water management and protection are to be developed and introduced jointly with China, based on international practice for transborder river basins.

The UNFCCC market mechanisms may be used as a basis for enhancing regional coordination mechanisms of neighboring states' actions on similar issues.

Considering these realities, the priorities in overcoming the above environmental and climate change challenges in Kazakhstan may be identified. These are:

- Development of plans on climate change mitigation and adaptation to already existing regional climate change,
- Development and improvement of institutional structures – clear assignment of mandates and commitments between the government agencies,
- Improvement of legal, regulatory and economic mechanisms in relation to climate change,
- Increase of climate change awareness among the general population, government officials and decision-makers and people responsible for educational issues and personnel training,
- Creation of conditions for involving business sectors in action to prevent and adapt to climate change,
- Climate change information system development,
- Acceleration of bilateral and multilateral agreements on resolution of environmental problems.

CONCLUSIONS AND RECOMMENDATIONS TO CHAPTER 2.

Food security

The impact of global warming on agriculture will be ambiguous; negative and positive effects may occur. The dominance of negative climate change impact may lead to a substantial decline in agricultural production, increases in the cost of agro-products, reduction in the number of manufacturers, and an overall adverse effect on people's welfare.

Grain production is the main component of the food security policy in Kazakhstan. The observed and expected climate change may result in increased risk in grain production owing to changes of agro-climatic conditions. A rise in temperature and reduction of precipitation in summer will lead to a decrease in soil moisture, an expansion of weeds, pests and diseases and decrease in biodiversity.

Sheep husbandry is the core sector of livestock breeding in Kazakhstan. Sheep husbandry is better developed in the south, south-east, and east of Kazakhstan, where natural and climate conditions allow sheep to be kept in pastures throughout the year. One negative effect is loss of driving-pasture system experience on sheep breeding, because of privatization of sheep breeding. Climate change has and will have a negative effect on sheep breeding conditions during the year because of increasing lack of winter fodder and the longer periods of stable hot weather for sheep in the southern flatlands; expansion of animal diseases is also possible.

Pastoral land productivity on flatlands may decline. With a rising air temperature the yield and fodder stock of aeolian flatland may increase in spring, but in summer, autumn and winter depending on vegetation species composition, both yield and fodder stock may decline in most cases, in particular for lands subject to pastoral degradation.

Social and economic development

Rural poverty problems may worsen. Possible climate warming and related droughts have potential to seriously jeopardize grain production, as opportunities for income growth in grain production are limited because of poor technology. Potential consequences of this are low labor productivity, unavailability of land and diminishing credit resources.

Impact on territorial development

The area of the humid zone, where cereal crops are currently harvested in Kazakhstan will decrease because shifting humid zone outlines to the north and desert and semi-desert areas will expand, respectively. These effects may lead to the revision of cropping areas, moving people from arid zones to more fertile regions, which will mean an increase in the proportion of unproductive land.

A reduction of agricultural productivity caused by climate change will increase the disparity between unirrigated and commercial crop producers, impoverish maintenance of life and enhance factors leading to induced migration of rural people to the north and piedmont and mountain areas of Kazakhstan, where negative global warming effects will be less perceptible.

Regional problems will intensify. For example, climate change will bring further worsening of living conditions in the Aral region. Increasing water resource deficit may provoke and aggravate regional conflicts.

Safe water supply

It is anticipated that in the first half of this century water resources in Kazakhstan mountain river basins may be higher than current levels, from 1 – 5 % to 14 % – 22 %, because of melting of glaciers. In flatland river basins water resources will decline by 6 % - 10 %.

The annual distribution of river flow will change: its value will fall in summer (July-August) and increase in spring and early summer (May-June). This will negatively affect agricultural production in irrigated areas.

In changed climate conditions water supply issues will be aggravated: in farming areas with irrigated cropping; in industrial areas because of attempts to satisfy the water needs of people and emerging industry; because of increasing dependence of the RK on water resources as a result of growing population and economies of neighbouring Central Asian countries and China, which Kazakhstan depends on for almost 50% of water supply.

Ecosystems and biodiversity

Climatic changes will increase pressure on natural ecosystems, most of which are already under anthropogenic burden. Rapid climate change and shifting of humid zones to the north will bring this about. For most types of flora and fauna the possibility of migration and adaptation to these changes will be restricted by biological potential and manmade infrastructure.

Mountain ecosystems' glacier degradation may become the most serious obstacles for the welfare and food security of all CA states.

Even slight climate change may cause degradation and loss of value of forest ranges; many areas may become useless for forest range vegetation.

Public health

The global warming predicted in Kazakhstan will have a direct and indirect effect on public health. The mortality rate caused by cardio- and respiratory diseases and the risk of heat stroke way all increase, as may the risk of infections and parasitic diseases; primarily acute intestinal infections. Those who may suffer more then others are children and elderly people, and socially underprivileged people with fewer opportunities to mitigate the high temperature impact (e.g. to buy air conditioners access sufficient potable water, obtain timely qualified medical aid, leave town, etc.) as well as residents of zones of environmental disaster. An example of this is the Aral region where negative climatic factors induce growth of diseases and mortality of people.

The migration of people from neighboring states and southern regions of Kazakhstan to the north will increase. All these factors will aggravate social problems and affect occurrence of diseases in regions.

Emergencies and disasters

It is difficult to foresee all possible climate change effects. Studies carried out in Kazakhstan provide evidence of the possibility of increasing frequency of:

– *Heat waves (extremely high temperatures)*
– *Wild fires*
– *Mudflows and, therefore, landslides.*

Obstacles to the introduction of adaptation mechanisms in Kazakhstan

The following can be identified among the main obstacles to enhancing Kazakhstan's potential to mitigate the effects and adapt to climate change:

Institutional and legislative issues

There is a lack of coordination among those bodies addressing climate change, from ministries and departments at the implementation stage and at the stage of development of programs.

The environmental agency has insufficient power to enforce integration of the climate change question into state programs and strategies.

The private sector is currently not economically concerned about solving climate change challenges.

Pursuant to existing procedures of environmental protection control, it is not useful or profitable for natural resource users to prevent environmental pollution or introduce new technologies with low greenhouse gas emissions or those which allow carbon capture in soils and forest ranges.

Financial, economic and social issues

Economic sectors are still not interested in setting high environmental standards, due to:

A lack or insufficient influence of parties concerned (government agencies and NGOs) on economic sectors which have an impact on the real environmental conditions in the country;

A practical lack of economic incentives to take environmentally friendly measures;

A lack of private and state funding of environmental actions;

A lack of experience in raising funds and international donors' grants has an adverse effect at the governmental and NGO levels;

The existing view that environmental problems have an insignificant influence on human health; that the population can not participate in environmental management;

Public distrust of ecological statistics;

A lack of efficient feedback between authorities and local population.

Education and information

Accepted environmental education concepts do not realize the educational mechanism, of inform the community and enlighten them in the context of the climate change question.

Capacity building (of environmental specialists) is currently carried out unsystematically, without continuous personnel training on these issues.

The level of people's awareness about climate change is still poor, while skepticism dominates on the notion that climate change has a negative effect on people and business.

Transboundary issues

In connection with rapid economic growth, water consumption in China from the Ili river basin will further increase by about 1,5 km3 per annum. Meanwhile, much water consumption in China and Kazakhstan is currently compensated by the melting of mountain glaciers and some increase in humidity of several mountain ranges' macro-slopes. However, water storage in the glaciers is exhaustible, and a shortage of glacier run-off to rivers may lead to lowering of the level of Lake Balkhash. Politicians and the scientific community of the two countries are coming to understand clearly that in this situation Lake Balkhash faces a similar fate to the Aral Sea, with possible full decimation of Eastern Balkhash. In the near future comprehensive plans for Balkhash water management and protection are to be developed and introduced jointly with China, based on international practice for transboundary river basins.

CHAPTER 3

KAZAKHSTAN – ACTIONS FOR MITIGATION OF CLIMATE CHANGE IMPACT

Unlike mitigation, adaptation will in most cases provide local benefits, realized without long lead times. Therefore some adaptation will occur autonomously, as individuals respond to market or environmental changes.

(The Stern review
“The Economics of Climate Change”)

3.1. Adaptation to climate change consequences and human development. International practice, mechanisms and barriers

All countries are to adapt to climate change, as adaptation is the only possible course of action in the face of such a phenomenon. Climate will change in the coming decades before measures to reduce greenhouse emissions will have any effect [1].

The scale of climate change risk requires addressing a number of quantitative and qualitative challenges, including:

- social and economic policy making, giving opportunities for countries and people to adapt to climate risks;
- investments in infrastructure development, to protect against emergencies;
- creation of institutions for watershed management.

The human development level, technological and institutional potential and financial resources all play an important role in determining the possibilities for adaptation.

Climate risks and adaptation capabilities vary depending on the country or region. In rich countries a system of state investments and large-scale strategies for the protection of citizens are under development. Many of these countries have conducted detailed climate change effect studies. Some of them are already starting to implement climate change adaptation strategies. European states like France, Germany and Great Britain have established national institutional structures for planning adaptation measures. State investments are seen as a method of insurance against future expenditure. On the whole, politicians of developed countries do not think that uncertainty about climate change is a reason to defer the implementation of adaptation measures.

But adaptation implies not only protective actions. In the short term, climate change will most likely lead to the emergence of winners and losers and most of the winners look set to be in rich countries. This can be demonstrated by the example of agriculture. While small business owners in developing countries are more likely to lose out in combating climate changes, the medium term climate change impact may create new opportunities for many developed countries. National predictions on climate change in the USA show that in the near future the volume of agricultural production will grow, though in southern states the growth rate appears not so high, and the Great Plains will encounter more severe droughts upon moving production centers to the north [1].

Northern Europe may also gain from longer and warmer growing seasons due to enhanced conditions for competitiveness in the production of some types of fruits and vegetables [1]. Thus, the import substitution from developing countries may jeopardize human potential development in some industrial regions.

Planning of climate change adaptation measures is a fast developing field of activity in developed countries but the owners of small farms will most likely lose out.

Some vulnerable groups living at risk of drought, floods and tropical storms must fight the forces of nature by using highly limited resources. Inequality in climate change adaptive techniques is a potential driver of greater inequality in terms of human welfare, safety and potential development opportunities.

Global assessment of climate change impacts on agriculture hides big differences between and even within countries. In general, climate change

increases the risks to agriculture in developing countries and in particular reductions in its productivity. In contrast, agrarian production may expand in developed countries, possibly resulting in changes in the allocation of global food production. Developing countries will depend more on imports from rich states, and their farmers will lose market share in agricultural products [1].

There are obstacles to climate change adaptation throughout the world. The following are obstacles common for all countries:

1. Inadequate understanding of ecosystems' reaction to climate change, including shortage of historical climate data;

2. The importance of the problem has raised awareness of climate change risks, but at the same time hope and consumption are encouraged.

Developing countries face more obstacles to adaptation:

1. Deficiency of political will, skepticism, and incredulity;

2. Lack of a statutory and legislative basis;

3. Economic and social factors such as high cost of adaptive process support, including the support of socially unprotected people, and the introduction of new technologies;

4. Lack of infrastructure;

5. Low level of public awareness and education.

3.2. Kazakhstan's capacity to adapt to climate change in key development sectors

How does a rise in temperature of 2.70C by 2050 have an economic effect? Estimations made in the first and second National Communications of the Republic of Kazakhstan to the UNFCCC demonstrate the movement of humid zones to the north by as much as 100 120 km to 250-300 km on average [3,4]. In this case, the northern and remote eastern areas of Kazakhstan appear to be in a semi-arid zone, while the rest of the territory will be in an arid zone. The climate change tendencies observed and forecast in Kazakhstan allow us to make conclusions regarding future risks for Kazakhstan's nature and human development. Most research, including Nordhous [16, 30] think that this will affect more tangibly on agriculture and less on industry. The higher the level of industrialization, the lower the expected losses due to climate change in percentage terms [see for example 18, 19, 30]. According to recent and more substantiated studies, there may be a reduction of income by 2-10 times in agriculture in low-profit regions and by up to 2.0% in high profit regions, i.e. in industrially developed areas with an average loss of 1,8 % [18, 19, 30].

Climate change is associated with the following negative effects:

- Enhancement of cropland erosion;
- Decline in cereal crops' quantity and quality;
- Decline in livestock breeding productivity;

•	Degradation of pastoral land;
•	Increased frequency of natural disasters related to extreme weather;
•	Shift of climate zones and change of flora and fauna habitats;
•	Change of the hydrographic regime of open water;
•	Increased melting of glaciers

Kazakhstan is relatively rich in hydropower resources. There are many big hydropower stations, generating up to 12 % of the country's electricity. The volume of water-generated energy fluctuates a little from year to year depending on water reserves. This indicates the sensitivity of this industry to climate change, especially to any reduction in precipitation. A depletion of water resources by 5% may be partly compensated by optimization of their management, but will result in a 3% reduction in power generation and in some cases to full shutdown of stations.

The extent of under-production of hydroelectric power may be compensated either by its energy efficiency measures or a corresponding increase in power from heat power stations.

At the same time, climate change will affect the industry of the country less. In winter, when the temperature rise will be visibly apparent, the energy consumption for domestic needs will decline a little, but in warm seasons consumption will increase for cooling purposes ee333tc. Changes in ore processing technology and a crucial reduction of pollutant emissions will most likely be accompanied by increased energy consumption, also because of enhancing the processing of old ores. In other industrial sectors no significant falls in energy consumption are anticipated.

According to estimates of statistical agencies, with a GDP decline of 3% in 2006 the income index (GDP) will fall by 0,005, and HDI - by 0.002.

3.3. Kazakhstan's perspectives on climate change adaptation in short-term, mid-term and long-term timespans

Climate change as a result of manmade greenhouse gas emissions will lead to large-scale negative consequences in virtually all fields of human activity. According to estimations of the first and second national Communications of the Republic of Kazakhstan within UNFCCC, management of agricultural, forest and water resources are extremely vulnerable to climate change. This is mainly associated with redistribution of precipitation and increasing severity and frequency of drought. Climate change may have a negative impact on the health of the population both because of intensification of thermal stress in southern regions and the spread of disease. The international experience of countries in addressing and adapting to climate change could be useful for Kazakhstan and indicates a need to elaborate a National Strategy (Program) on climate change adaptation, an action plan, and the creation of an institutional structure for the coordination of this process nationally. There is also a need and opportunity to integrate climate change adaptive measures into sectoral programs. Such a program should ensure fulfilment of commitments of the Republic of Kazakhstan within UNFCCC, as well as realization of measures on the prevention of negative consequences of climate change in Kazakhstan. The main objective of the Program is prevention of negative consequences for the economy and health of the population of Kazakhstan, taking into account any possible positive consequences of climate change.

will facilitate climatic forecasting and provide interested bodies with information on impending climatic changes and calculations of possible impacts on the economy of Kazakhstan.

The challenges of the Program:

1. Climate data monitoring improvement and network development. This will increase information reliability on climate system status and provide the user with information on climate change.

Countries lacking opportunities or resources for the realization of meteorological observations, forecasts, detection of changes, consequences and risk assessment, cannot provide reliable information to citizens and are not able to adequately allocate state investments or develop policies to decrease vulnerability. The absence of broad access to information of government and population deprives the country of the opportunity to develop efficient climate change adaptation strategies. Creation of opportunities for complete meteorological monitoring requires international cooperation.

2. Implementation of modern regional climate models and climate change impact assessment models on various sectors of the economy and ecosystems

3. Vulnerability assessment of natural ecosystems, the economy and public health of the country.

Countries encounter different risk levels, are at different stages of human development and vary in terms of technological and financial capabilities. Good Human development policies are the most reliable foundation for adaptation to climate change. These risks will increase expenditures incurred due to past failures and will require revision of existing human development practice. This will attach primary importance to the issue of implementation of climate change scenarios to broader national programs.

4. Development of preventive adaptation measures to decrease vulnerability of climatically dependant branches of the economy and public health of the country.

5. Elaboration of policies to adapt to and mitigate consequences of climate change; determination of proper costings and efficiency measures; development and assessment of a

portfolio of long-term, strategically important political measures in order to mitigate consequences and adapt to climate change.

6. Improvement of the insurance system which is to become an integral part of the climate change adaptation strategy.

The development of effective adaptation measures is concerned with many issues. Strategies are developed in terms of:

- uncertainty of timeframes;

- various geographical locations and threats of climate change consequences.

The scale of climate change consequences will depend on the mitigation measures taken now, since delay will increase future expenditure on climate change adaptation. Such uncertainty should be taken into consideration in the development of climate change adaptation strategies and financial plans. However, this may serve as an excuse for inaction.

3.3.1. Introduction of adaptation mechanisms

The integral part of the Strategy on climate change adaptation is sectoral measures. The general sectoral measures are:

1. Integration of climate change adaptation measures in short-, medium- and long-term sectoral programs.

2. Improvement of the normative-legal base. Completion of state and land reforms.

3. Management improvement of economic sectors and support for adaptation measures.

4. Improvement of the monitoring system.

5. Assessment and reduction of social costs.

6. Increase of information and the training of experts.

3.3.1.1. Agriculture

Kazakhstan is classified as a country where agriculture substantially depends on climate fluctuations and changes. The system of measures related to adaptation of Kazakhstan's agriculture should contain [4]:

•	strengthening and implementation of measures to combat drought;
•	completion of state and land reforms;
•	changing hydrophilic crops on irrigated lands to less hydrophilic ones.

a) Cereal Production

• Introduction of cereal crop varieties with a longer growing season.

b) Driving-Pasture System

•	Implementation of a system of regular livestock pasturing taking into account the livestock capacity of pastures and climatic conditions.
•	Rehabilitation of the sheep driving-pasture system, the wide use of summer mountain pastures, development of pastures located a little higher than summer ones.
•	Prohibition of overgrazing of pastures.
•	Optimization of Kazakhstan's arable and livestock farming locations, given the current and future climate in Kazakhstan.
•	Conservation of more degraded farmlands.

c) Agrotechnical activities

•	Introduction of modern soil treatment methods. Evidence-based organic and mineral fertilizing.
•	Development and introduction of water-conservation technologies.
•	Optimization of the duration of agrotechnical measures because of climate change;

- Elaboration of new, and modification of existing, methods of weed, pest and disease control.

Considering that Kazakhstan's climate has already changed and its further change is anticipated, such proposed adaptive measures should not be deferred. Any delay may have a negative effect on agricultural development in Kazakhstan.

The successful planning of adaptive measures will require a certain transformation of public administration practices. Spontaneous measures are inefficient, and rushed measures to address transboundary climate change impact in the framework of interregional cooperation are inefficient.

3.3.1.2. Water resources

Water resources are of strategic importance for the country, requiring special attention.

The priority is as in [4]:

- strategic economic development oriented towards arid and low-water technologies;
- an increase in the proportion of water obtained from underground sources;
- transfer of the part of river flows inside regions and outside;
- prospective development, taking into account climate change; adaptation of schemes of complex use of water resources in design of necessary hydrotechnical structures.

To mitigate the negative effects of water resource vulnerability impact on economic sectors the following is required:

- reconstruction of irrigation and water supply systems for minimization of water losses;
- introduction of advanced technologies in irrigated farming;
- introduction of low-water technologies and water recycling systems at existing industrial enterprises and utilities;
- effluent water utilization;
- revision of hydropower stations' operation regimes;
- conducting dredging operations, reconstruction of wharfs and quays in navigable rivers;
- change of existing river service ships and fishing fleets to include shallow draft vessels.

Possible measures to optimize water ecosystems' condition and environmental protection:

- vigorous restriction of business activity in most low-water areas and transfer of activity to other locations;
- strict observance of measures to create sanitary protective zones near open water sources and near underground water withdrawal points, as well as compulsory environmental impact assessment of new water resource use projects;
- universal application of chemical and biological effluent water treatment;
- development and performance of supplementary ameliorative, agro-forestal and agrotechnical measures in order to ensure the environmental safety of water resources;
- arrangement of favorable water and heat regimes for habitats and reproduction of fish and other living organisms, together with their quality control.

3.3.1.3. Forestry

Climate change adaptive measures in the forestry industry are to focus on the expansion of water conservation,

soil protection, balneological and raw materials sectors of the forestry industry. Research activity based on the breeding-by-sampling method and selection of wood species able to adapt to climate change and provide primary needs of people, play the main role in this process.

For Kazakhstan, with its severe and arid climate, forest fighting measures are very important. Not only administrative and technical measures should be taken in this regard, but also initiatives to improve the education of local people and to foster a feeling of responsibility for the survival of forest ranges.

Forestry's climate and weather adaptive measures need to focus on overcoming their negative effects and gaining the maximum from those changes, as well as the development of national parks and specially protected areas.

3.3.1.4. Power industry

It is necessary to decide today what energy support and measures are required for climate change adaptation. Currently, Kazakhstan's power generation depends largely on seasonal river flows. It is therefore important to consider alternative energy sources in the republic and embed them on a wider scale [4].

Renewable energy sources are inexhaustible and ecologically clean. Their utilization does not change the energy balance of the earth. This causes intensification of power industry development on the basis of renewable energy sources, and allows more optimistic forecasts on RES utilization for the next 10-15 years.

Use of wind energy appears feasible when using small wind energy facilities (up to 100 KWt) generating power for individual households, mainly agricultural consumers in remote locations not connected to the national grid. Projects are expected to be profitable, and in the regions' energy balance an increase of 30-40 MBt power could be expected. The existing distribution networks with applied voltage of 110, 35 and 10 KV may be used to increase power. The construction of such a suitable WPS offers the following prospects:

- trends of wind power and potential trends, and taking a strong stand for WPF on the Kazakhstani energy market;
- Construction and standardization of wind energy equipment for their large-scale acquisition following establishment of domestic production of wind energy facilities, mainly by joint ventures.

Kazakhstan has substantial solar energy potential. The solar radiation level in Kazakhstan is 1300-1800 KWt. h/m2 per annum. There are 2200-3000

As for solar energy Kazakhstan is one the most "well off' states of the world. We have great potential for wind energy utilisation. It is possible to construct hydropower stations. But unlike many countries of the world we almost do not deal with alternative sources. That is why the Government together with investors is to work more intensively on the development of alternative energy sources using renewable resources .

(Speech of Mr. N.A. Nazarbayev at the 18th plenary session of the Foreign Investors Council under President of the Republic of Kazakhstan, 08.12.2007)

solar hours over the year. This makes it possible to utilize solar energy to supply heat. According to Kazakh specialists' estimates, solar energy's utilization potential to provide heating is 13 mln Gcal per annum, which would equate to a saving of over 1,4 mln. tons heat per unit.

Kazakhstan has high levels of biomass resources such as plant waste (straw, wood waste, etc.), livestock waste and solid domestic waste. According to preliminary evaluation, plant waste is about 18 million tonnes per annum, livestock waste about 22,1 mln tonnes and solid domestic waste about 5 mln tonnes per year. Utilization of agricultural waste is equivalent to a saving of 14-15 million tons of u.t. fuel per annum. For large-scale biomass utilization (primarily city dumps) as fuel in Kazakhstani cities, a special study and development of a special action plan for collection and waste classification, its disposal and utilization would be needed.

The construction of nuclear power stations would be most efficient and seemingly logical. It would provide a safe energy source, which is stable, powerful, and long-term.

3.3.1.5. Transport

Current conditions of the transport system in Kazakhstan cannot be deemed to be optimal or sufficiently developed.

Kazakhstan is located at the center of the Eurasian continent, which predetermines its geopolitical role as a transit bridge between Europe and Asia, and also between Russia and China. Four international transport corridors pass through Kazakhstan, formed on the basis of the existing transport infrastructure of the country.

"Transport Strategy of the Republic of Kazakhstan till 2015" has been accepted in the country. The implementation of the Strategy will be related to meeting the following challenges:

•	Urban freeways are to be constructed in the direction of international transit corridors, observing parameters of several parts up to the technical category I, which is already under performance in Akmola and Almaty regions;
•	The conversion of buses and trucks to European environmental standards;
•	Transition of the transport system to a new qualitative functioning level. Formation of an optimal transport network, meeting necessary requirements, and achievement of maximal satisfaction of economic and social needs in reliable and safe transport services;
•	Decline of transport's proportion of environmental pollution by 2,5 times;
•	A rise in trucking speed of 15-20 %, and on main international transport corridors by 20-30 %.

The realization of the Strategy will provide more efficient use of transport potential to the benefit of the social and economic development of the Republic of Kazakhstan.

At the same time, there is a notable lack of climate change impact studies on transport and adaptation of transport to climate change.

3.3.2. Public health

In the "Kazakhstan 2030" program, public health is defined as one of the main long-term priorities of the development of the country. Public health and economic development are positively correlated: the sustainable development of the country is impossible without healthy people, and improving public health is impossible without stable economic growth. The condition of public health is an important element of social community cohesion and social benefit, describing the level of responsibility of the government to its citizens.

Stabilization and improvement of the main medical and demographic indicators have been observed in Kazakhstan in recent years – birth rate, mortality rate, and life expectancy. There is a trend towards reduction of infant and maternal mortality rates. The "State program on health care reform and development for 2005-2010» and the program «Healthy lifestyle for 2008-2016» have been adopted in the country, while a strategic development plan for 2009-2011 has been developed by the Ministry of Health. At the same time, analysis of the existing healthcare system and special institutions provides evidence of the need to pay more attention to mitigating negative climate change effects on public health in Kazakhstan [4]. Government programs do not include measures to mitigate negative climate change effects on health and on the adaptation to changes. There have been no detailed practical studies on climate change impact mechanisms on people's health of different ages and sexes residing in various regions. Preventive actions with the population are also insufficient. The main legislative documents regarding people's health care and provision of sanitary and epidemiological welfare do not cover measures on the mitigation of the negative impact of climate change. Therefore, currently Kazakhstan has no adequate legal base to facilitate adequate estimation of climate change risk factors on health and to take preventative measures.

The following should be emphasized among adaptive measures:

-architectural, city planning, engineering solutions on the adaptation of housing and public structures and facilities as well as settlements as a whole;

- measures to prevent, control and treat infectious and non-infectious diseases that climate change has caused;

- use of new technologies when designing and constructing buildings, providing optimal comfort for labor and leisure;

- creation of zones with a cooling microclimate – parks, green zones, fountains in populated areas;

- landscaping and development of ponds for people's summer leisure and provision of rescue services, etc.;

- robust activity with the population regarding their lifestyle, given climate change, as well as training on individual precautionary measures;

- improvement of social and economic living conditions, allowing people to organize their lives more adequately (in particular, to purchase air conditioners, buy good quality food and potable water, etc.);

- improving the sanitary and hygienic culture of the population;

- provision of professional training of medical staff regarding prevention and diagnosis of meteo-dependant conditions;

- better monitoring of people's health, especially those who may be more sensitive to climate change (e.g. the elderly, people with chronic illness, etc.);

- early warning of possible climate change, and carrying out preventative measures in order to lessen the severity of taxes;

- to provide people with good quality potable water and food;

- monitoring and control over sanitary and hygienic condition of water intake facilities, water collectors, distribution networks, and prompt disinfecting;

- stricter control of the spread of infectious diseases, including those transmitted through inoculations or through air;

- conducting immunological prophylaxis with the population, given the forecast rise in numbers of infectious diseases subject to climate change effects;

- reduction of air pollution in populated areas (reduction of industrial and vehicle emissions).

Scientific research devoted to climate change impact studies on different population groups depending on location, and compilation of a database could be highlighted as a separate

The climate change policy related to energy efficiency and renewable energy is often economically sound, improving energetic safety and reduce local emissions of pollutants. Other mitigation opportunities connected with energy supply may be arrange such way to gain benefits for the sustainable development, for instance, to prevent moving local people, create jobs, and improve health condition.

Contribution of Working group III Mitigation of climate change effect

important element of the climate change adaptation system.

It should be emphasized that climate change adaptation measures will be efficient only if they are afforded comprehensive management, given the specific character of several regions of the Republic of Kazakhstan.

The intensive and comprehensive introduction of climate change adaptive measures will help to preserve the health of present and future generations, which will guarantee the country's sustainable development.

CONCLUSION AND RECOMMENDATIONS TO CHAPTER 3.

«Speed is not important if one moves in the wrong direction »

Mahatma Gandi

Conclusion:

The above review provides evidence that insufficient attention is being given to the solution of climate change challenges in Kazakhstan. There is no program on mitigation of detrimental impact of climate change; there is no institutional framework, while measures on mitigation or climate change adaptation are not integrated into sectoral programs.

Recommendations:

1. To develop a national program (strategy or action plan) on mitigating the detrimental impact of climate change. To develop cooperation in order to enhance the country's potential and stability for mitigation of climate change effects. Integration of goals and objectives on climate change adaptation in the sustainable development strategy.

2. To encourage innovative activity, improving energy efficiency, environmental protection, improving policy, legal and financial conditions to expedite introduction of environmentally friendly technologies facilitating reduction in greenhouse gas emissions.

3. To collaborate with developed countries to enhance the development and implementation of programs and technologies in renewable energy resources, including bioenergy; in the interests of attracting private investment and technology transfer to consider the needs of energy and relevant sector priorities of the country.

4. To improve and introduce market instruments (including the Kyoto protocol mechanism) for climate change mitigation.

5. To support and finance studies directed at getting a better picture of climate change risks and effects for economic sectors, society, living standards and health of the population.

6. To support and expand the national system of climate observations, increasing potential for the analysis and interpretation of data, and the development of systems and instruments given local needs, to substantiate the decisions made.

7. To improve people's awareness of climate change and associated risks, as well as measures against those risks. To provide information required for the business community and consumers to adopt more efficient energy utilization and reduction in greenhouse gas emissions.

EPILOGUE

> «In order to survive mankind should crucially change its mode of thought»
>
> **Albert Einstein**

The conclusion of the report is included in order to highlight perspectives needed for the sustainable development of Kazakhstan in the long run. For that purpose we would like to say what is omitted to date, but, certainly, a starting point and an important basis for the development of future human potential in the country. Kazakhstan and its people have come through the worst of the transition period. It was a period of pragmatic decisions for cardinal reconstruction of economic relations in the country and the creation of a basis of the future state. This required many sacrifices, but now the next breakthrough is required, and its mission is humanitarian to a great extent. In this regard we would like to make two points:

- For the development and progress of its people now and in the future Kazakhstan has not, as yet, used world experience, which includes the framework of a comprehensive program on fighting global climate change. This is very good experience, which demonstrates the striving of the world's society to find a joint and reciprocally acceptable solution of the problem with the participation of all states and nations. The varying levels of responsibility of countries for manmade impact on global climate is not admitted at national level as a mechanism of mutual liability of different groups for existing environmental problems.
- The national practice of integrating existing achievements of human development is not used yet. For example, the well-known practice of inter-ethnic and inter-faith harmony achieved in Kazakhstan, is not used during discussions and elaboration of public opinion on environmental problems at national and international levels, or on the global climate change problem.

As it seems to many experts, a gap between various social levels regarding understanding and evaluation of general human values has appeared in Kazakhstan. This difference has appeared due to the level of economic development of different groups and also a difference in education received by young generation today, and education given to the older generation. Without any dramatization of the situation, as a supplement to the above recommendations to each chapter, it makes sense to say that Kazakhstan needs to create a development strategy for the next decade: 2010-2020. The focus of this strategy should be human development. This corresponds to a historical moment and was referred to by Nursultan Nazarbayev, President of the RK in his address to the youth of the country.

One would like to see in this strategy a realization of the accumulated human potential of Kazakhstani people for the benefit of national and global values. The efficiency and competitiveness of the nation, which is specified as a goal of the country's development over the next decade, should increase significantly due to the improving education and health of the nation, and economic growth should follow. The natural resources and land of the Kazakhs have launched the growth of the state owing to its great hidden wealth. But further excessive exploitation of those resources may prevent development, not only of the state, but also people. This is why it is time for the fundamental refocusing of human values in Kazakhstan in favor of thrift, efficiency and modesty. Understanding of global problems as individual or local will help in this reassessment of values.

In particular, the subject of the environment, climate change and global processes and their role in the determination of rhythm and balance of human life may help to outline a new paradigm of national consciousness for the next development period. A nation coming out of a nomadic lifestyle and people living with the nature should take a stand alongside the citizens of the world, and realize their responsibility to our common home – the Earth.

HUMAN DEVELOPMENT QUOTIENT STATISTICAL REVIEW

1. Total human development dynamics in Kazakhstan and CIS countries 1990-2006.

The dynamics of human development indices (HDI) in countries selected from various world human development reports of the UN Development Program are to be carefully compared, as HDI estimation methods have been improving from one report to another, and also data of better quality have been used. This can be inferred from the comparison of data published in different HDI reports for 1990 and 1995, and also re-estimated data for the same period given in the last 2007/2008 report (please, see Table 1).

As is clear from the table, the last revaluation of indices using comparable methodology and higher quality data led to a reduction of the 1990 HDI figures published earlier for CIS countries (except for Tajikistan and Uzbekistan), and (except for Belarus) to their increase for 1995.

To analyze the CIS countries' human development dynamics, it is better to use their HDI rank, which they had for several years among 173-177 countries,

Table 1. **HDI of CIS countries for 1990 and 1995, given in different world human development reports of the UN development program.**

Country	Earlier published		Last issue [3]		Deviation from earlier report [4]	
	1990[1]	1995[2]	1990	1995	1990	1995
Azerbaijan	0,770	0,623	...	...	...	...
Armenia	0,831	0,674	0,737	0,701	-0,094	+0,027
Belarus	0,861	0,783	0,790	0,755	-0,071	-0,028
Georgia	0,829	0,633	...	...	...	...
Kazakhstan	0,802	0,695	0,771	0,724	-0,031	+0,029
Kyrgyzstan	0,689	0,633	...	...	...	...
Moldova	0,758	0,610	0,740	0,684	-0,018	+0,074
Russia	0,862	0,769	0,815	0,771	-0,047	+0,002
Tajikistan	0,657	0,575	0,703	0,638	+0,046	+0,063
Turkmenistan	0,746	0,660	...	...	...	...
Uzbekistan	0,695	0,659	0,704	0,683	+0,009	+0,022
Ukraine	0,844	0,665	0,809	0,756	-0,035	+0,091

Sources:
1) 1993 World Human Development Report
2) 1998 World Human Development Report
3) 2007/2008 World Human Development Report
4) Estimation by author

rather than the HDI. For example, the CIS countries ranked 38th-88th (out of 173 countries) in the HDI table in 1990, but by 1995 had dropped to 68th-118th (out of 174 countries), while by 2000 they had risen to 56th-112th among 175 countries and now stand at 64th-122nd out of 177 countries. The HDI scale-down of the country in 1995 and 2005 against 1990 is shown in Figure 1.

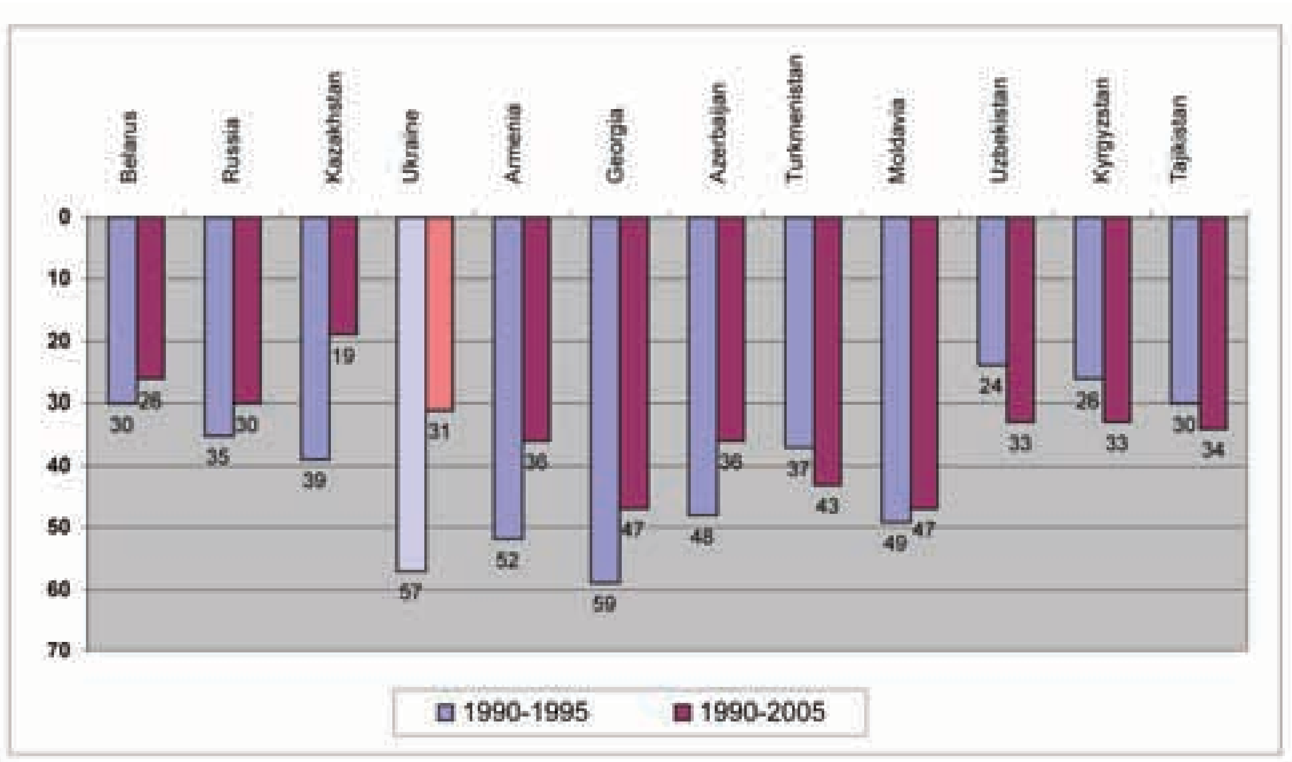
During the period 1991-1995 Georgia fell most in terms of human development, by 59 places, Ukraine by 57, Armenia 52, Moldavia 49 and Azerbaijan 48. The countries which declined least were Uzbekistan (24 places), Kyrgyzstan (26) and Tajikistan (30). Kazakhstan dropped 39 places.

In terms of human development in 2005, Georgia and Moldova fell most (47 places) compared with their 1990 rankings, with Turkmenistan dropping 43 places. The smallest falls in CIS were experienced by Kazakhstan (19 places), Belarus (26) and Russia (30).

According to the 2007/2008 UNDP World Human Development Report, Kazakhstan's HDI rating puts it in 73rd place (0,794) amongst 177 countries, while its GDP per capita was rated in 74th place ($7,857 USD at PPP) in 2005. Already 70 countries currently have an HDI of at least 0,800, the minimum required for classification as a country with a high level of human development. Belarus and Russia are also on that list.

Among CIS countries, only Belarus (64th) and Russia (67th) have a higher HDI rating than Kazakhstan. Aprt from this, the situation varies on several

Figure 1. **Change in HDI rating of CIS countries in 1990-2005 using UNDP data**



Source: plotted on the basis of UNDP World Human Development Report data for 1993, 1998 and 2007/2008.

Note: countries are given in descending order of HDI values according to the latest 2007/2008 UNDP World Human Development Report. The numbers represent descending rank of countries versus 1990, in 1995 and 2005, respectively.

Table 2. **Basic human development indices and ratios in Kazakhstan, 1990-2006.**

	1990	1995	2006	1995-1990	2006-1995
Life expectancy (LE) at birth, years [1]	68,1	63,5	66,2	-4,6	+2,7
Literacy rate, % [1]	97,7	98,7	99,5	+1,0	+0,8
Aggregate education cover, % [1]	80,0	73,0	94,0	+7,0	+21,0
GDP per capita, USD by PPP [2]	6283	4508	9057	-1776	+4549
LE index [2]	0,718	0,642	0,687	-0,077	+0,045
Education index [2]	0,918	0,901	0,977	-0,017	+0,076
Income index [2]	0,691	0,636	0,752	-0,055	+0,116
HDI [2]	0,776	0,726	0,805	-0,050	+0,079

Sources:
[1] data from the Statistical Agency RK
[2] estimation by author

human development factors. For instance, in terms of GDP per capita Kazakhstan again ranks third in the CIS after Russia and Belarus ($10845, $7918 and $7857 USD at PPP, respectively); for life expectancy at birth Kazakhstan is also third in CIS, after Turkmenistan and Russia (62,6, 65,0 and 65,9 respectively). In terms of the education element of HDI, Kazakhstan ranks first in the CIS, with 93,8% enrolment of people aged 5-24, followed by Russia (88,9%), Belarus (88,7%) and Ukraine (86,5%).

2. Human development dynamics in Kazakhstan during the transition period

In UNDP World Human Development Report data for Kazakhstan and other CIS countries two periods can be observed in terms of human development dynamics. The first period (1990-1995) is characterized by the deterioration of all the main human development factors and resulted in Kazakhstan's HDI ranking falling from 54th to 93rd place in the world. During the second period (1996-2005) Kazakhstan's HDI slowly rises, to 73rd place in world HDI ranking. So, Kazakhstan's HDI (equal to 0,794) already exceeds its value readjusted in the 2007/2008 Report for 1990 (0,771).

Kazakhstan's HDIs for 1990, 1995 and 2006 (using the method prescribed in the last World Human Development Reports) are given in Table 2.

These estimates show that over the period 1990 to 1995 Kazakhstan's HDI dropped by 0.050 points. The main reason (causing HDI to decline by 52%) was a 4.6 year decline in life expectancy at birth. A second reason was economic recession, which brought about an HDI decline of 37%, and a third reason was a reduction in aggregate education coverage by 11 per cent.

In 1996-2006 Kazakhstan's HDI grew by 0.079 points. Economic growth accounted for 49% of this positive change as GDP increased two-fold against the 1995 level, and exceeded by 25,7% the 1990 level.

Kazakhstan's GDP per capita in USD at PPP also doubled over the same period. The growth of aggregate education coverage rate of 21 percent (up to 94%) and of life expectancy at birth of 2.7 years (up to 66.2 years) had less effect (32% and 19%, respectively) on the HDI increase within the period.

It is clear from these figures that the demographic factor – life expectancy at birth – has played the main role in reducing Kazakhstan's HDI during the first transition stage, and remained a significant drag on the country's HDI growth during the second stage also. Moreover, Kazakhstan's latest reported life expectancy of 65.9 years (2007/2008 Human Development Report) remains very low compared to OECD countries (78,3 years) and even to most countries in transition (68,6 years).

3. Human development dynamics in Kazakhstan's regions

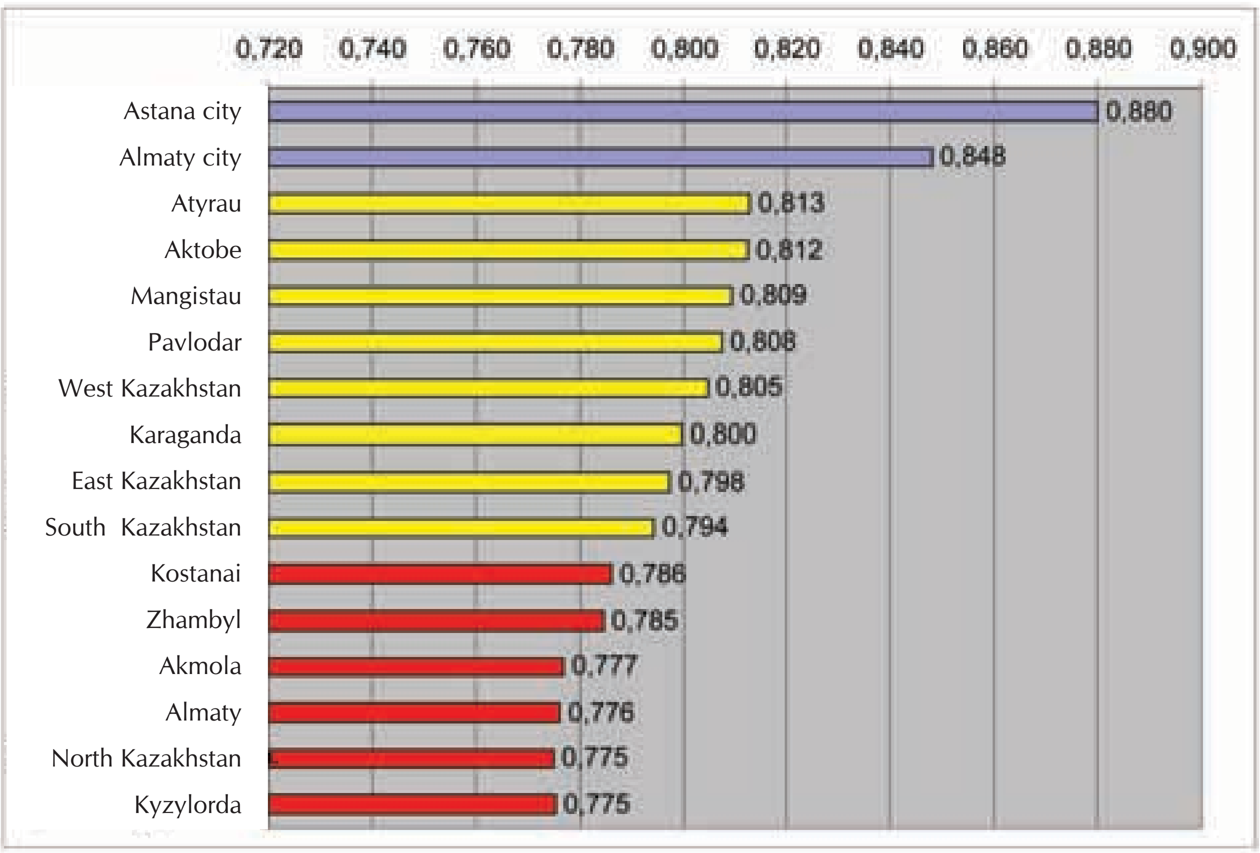
Estimate's show that there was insignificant regional HDI differentiation in Kazakhstan in 1990 – the gap between maximum and minimum indices was only 7 per cent. However, by 1997 this had increased to 20%, and, with slight fluctuations, stood at the same level up until 2006 (see Table 1.1 in Appendix 1). This is primarily connected with persistent differences among the regions' GDP per capita, which in 2006 was 12,7 fold (see Table 1.2 in Appendix 1). The relevant GRP per capita differs by 0.425 points (see Table 1.3 in Appendix 1).

Income per capita used for consumption by the regions differs less – in 2006 by 2,9 times (see Table 1.4 in Appendix 1). As a result, income indices of the regions differ by only 0.191 value (see Table 1.5 in Appendix 1). Respectively less differentiation is observed also for the HDI, evaluated on the basis of income used for consumption (by 13,5%) (see Table 1.6 in Appendix 1 & Figure 2). Countries with corresponding indices stood 34th-84th in 2005 in the human development rankings (see Table 1.7 in Appendix 1).

Analysis of HDI in the regions shows that the human development factor in Kazakhstan's regions reached a minimum in 1995-1996. In recent years Kazakhstan's regions have divided into three groups in terms of their human development (HDI):

1) With comparatively high human development factor (Astana and

Figure 2. **HDI of regions, evaluated by people's earnings used for consumption**



Almaty): HDIs over the past five years have exceeded the threshold value (0,800) of countries with high human development; the countries ranked 34th and 47th in world HDI (Malta and Croatia) had similar indices to the two Kazakhstani cities, according to the 2007/2008 World Human Development Report;

2) With approximately the national average HDI (Atyrau, Aktobe, Mangistau, Pavlodar, West Kazakhstan, Karaganda, East Kazakhstan and South Kazakhstan regions): these oblasts had HDIs in 2006 within the range 0,794-0,813; such indices are similar to countries ranked 60th-73rd in the world, including Romania, Saudi Arabia, Panama, Malaysia, Belarus and Brazil, according to the last World Human Development Report;

3) Oblasts with HDIs somewhat less than the national average (Kostanai, Zhambyl, Almaty, Akmola, North Kazakhstan and Kyzylorda): in 2006 these regions had HDIs in the range of 0,775-0,788, similar to countries such as Ukraine, China, Grenada, Armenia and Turkey, HDI ranked 76th-84th globally.

Basic human development rates, their indices and HDI for Kazakhstan's regions for 2006 are presented in Table 1.8 of Appendix 1. The most significant differences among the regions is observed in terms of income used for consumption (by 2,9 times), and income per capita, which differs by 28 per cent. Inequality in terms of life expectancy and education availability are also apparent, respectively equal to 19,2 and 9,8%.

4. Gender-related development index (GDI)

During 1999-2006 in Kazakhstan, the gender difference in life expectancy increased significantly: female life expectancy increased by 1 year, for males by only 0.25 year (see Table1.9 in Appendix 1).

During the same period, the ratio of women in the workforce did not change, but inequality in the salaries of women and men increased by 5.3 per cent. As a result, despite overall GDP per capita growth of some $4,764 USD, the corresponding figure for women was only $3,428 USD at PPP.

Analysis of several human development components, as well as overall and gender-adjusted HDI (GDI) demonstrates an increase in all human development indices for both women and men. Thereafter however, gender inequality on all human development components has increased (see Table1.10 in Appendix 1).

For example, gender inequality in education availability increased from 10 to 27 points in women's favor, but on allocated income increased by 3 points in men's favor, which was 96 points in 2006. For overall HDI in Kazakhstan, gender inequality increased by 8 points (from 0,032 to 0,040). Meanwhile gender inequality for income over all years has been largely "compensated" by men's lower life expectancy and education availability, which has resulted in a higher female HDI overall.

The differences in female and male HDIs means that HDI is evaluated for both sexes with a special formula taking into account this difference (GDI) which appears to give a lower HDI value evaluated for both sexes without gender inequality (see Table1.11 in Appendix 1).

Gender differences in the availability of education are not, in practice, reflected in the indices: there was a 1 point difference 1999-2000, but no difference 2001-2006. However, the increasing gender differences in life expectancy have led to a gap in the respective indices, evaluated with and without the gender factor, of 0.002 points, leading to an increase in the gap between HDI and GDI by one more point.

Therefore, gender inequality in two human development components is observed in Kazakhstan – life expectancy at birth and income available, reflected in falling respective indices.

5. Human poverty index (HPI)

Estimations of the human poverty index, despite an almost two-fold decrease in the income poverty scale in 1999-2006, provides evidence of a slight HPI decline. This is connected with the fact that the dynamics of other basic rates are responsible for the income poverty decline.

For example, in 2006 as before, over 30% of the population of the country did not survive to 60 years (see Table1.12 in the Appendix 1). This was connected with low life expectancy at birth – only 66,2 years in 2006. Thereafter, there was no decline in the proportion of people not surviving to 60 years during 2000-2006: a figure of 30,5% in 2000, and still at 30,3% in 2006.

The range of values of this factor in the regional context was about 10 percent. Citizens of Karaganda region, where 33.3% of the population did not survive to 60 years in 1999, and in 2006 36.1% of people, was least encouraging for this factor. Even in the more prosperous cities of Almaty and Astana about a quarter of people do not survive to 60 years.

The proportion of 16 year olds not in education, as of early in the 2006/2007 school year, after a reduction to 1.1% in 2004/2005, again increased to 6.7% (see Table 1.13 in Appendix 1), i.e. the situation with receiving general secondary education started worsening again. The regional variations in this factor in the 2006/2007 school year were also significant: 0-17% compared with 4,0 to 14,0% in 1999/2000.

Comparatively high rates of school dropout among 16 year olds in Akmola and Almaty regions are probably connected with their proximity to the national cities – Astana and Almaty, where the number of educated children far exceeds their numbers based on data of current population registration. It is notable that relatively high values of this factor among other regions are also connected with registration problems nationwide.

According to the Statistical Agency of the RK, 34.5% of Kazakhstani people had a consumption level below the subsistence minimum in 1999, falling to 18,2% in 2006 [1] (see Table 1.14 in Appendix 1). The differences in this factor among the regions are high. All southern regions and also Atyrau and Mangistau regions, where this factor exceeded 35% in 1999, and then 25%, appeared to suffer most in terms of this factor for the period to 2004. In 2004 poverty crucially decreased in all regions. Only in four regions – Atyrau, Kyzylorda, South Kazakhstan and Mangistau – did it exceed 20%. In 2006 the poverty index increased, which is connected with the acceptance of a higher poverty line.

By 2006 Kazakhstan's unemployment rate of 7,8% had declined to a level observed in many established market economies, while even in 1999 it was only 13,5%[2] (see Table 1.15 in Appendix 1). Among the regions this factor varied in the range of 7.8-16,1% in 1999, and in 2006 by 6,9-9,3%.

Estimation of the human poverty index (HPI)[3] in Kazakhstan on the basis of the above data proves that in 2006, 20,5% of the population were poor from a human development perspective (in 1999 - 26,2%) (see Table1.16 in Appendix 1). Thereafter, Atyrau region was five times among the three regions with the worst HPI within the considered period. Four times the Akmola region was in the trio of "leaders" on this factor, three times – Zhambyl, Karaganda, Kyzylorda and Mangistau regions, two times – the South Kazakhstan region.

The most favorable situation remains in Astana and Almaty cities, where HPI declined in 2003 to 14,4 (Astana) and 16,9% (Almaty). But in 2006 it again rose, to 15,1 and 18,5%, respectively. In other regions the HPI varied from 17,3% (South Kazakhstan) to 26,3% (Kyzylorda region) in 2006.

6. What results may Kazakhstan achieve in human development by 2015?

1 Data on poverty line in regions for 2006 are not comparable with data for previous years, because a new methodology for evaluation of subsistence line was accepted in 2006.

2 The unemployment rate was estimated by the Statistics Agency RK prior to 2001 on the basis of balance of labor resources, and since 2001 it is determined from the results of analysis of 21,000 households on employment and unemployment issues.

3 According to the UNDP method the HPI is estimated as the cube root of arithmetic mean value of cubic rates, which base it is estimated on.

Table 3. **Possible HDI dynamics of Kazakhstan and its components up to 2015**

Year	LE, years	Aggregate education cover, %	GDP per capita, USD by PPP	HDI	Country with similar HDI in 2005	HDI rating of the country in 2005
2007	65,0	95	10000	0,805	Belarus (0,804)	64th place
2010	67,0	100	13000	0,836	Cuba (0,838)	51st place
2015	69,5	100	19000	0,871	Poland (0,870)	37th place

Source: estimation by author.

In the second part of Table 1 of the Appendix to the World Human Development Report for 2007/2008 it is clear that the OECD countries have a life expectancy at birth of some 78,3 years, while for Kazakhstan it is estimated at 65,9 years[4] . The LE indices corresponding to these values are 0,888 and 0,682; the low life expectancy in Kazakhstan, given its weight in the HDI, causes the HDI to decline by 0,069[5]. If the LE at birth in Kazakhstan were at a level of countries with high human development, then its HDI could be as high as 0,864. Such an index would rank it 42nd in the HDI table, similar to Slovakia.

In Central and Eastern Europe and CIS countries the average LE at birth is higher by 2.7 years (68.6 years) than in Kazakhstan, which allows us to group this region, given other rates – education level (99,0%), aggregate education coverage (83,3%) and GDP per capita ($9,527 USD at PPP) – with a set of countries with high human development level (HDI equal to 0,808).

In Kazakhstan the adult literacy level and aggregate education coverage is even a little higher than average for this group (99.5% and 93.8% respectively) while in terms of GDP per capita it is already approaching them ($7,857 USD). Therefore, Kazakhstan's main HDI problem and area with greatest potential for improvement in human development is the low life expectancy of its people.

According to our estimates, Kazakhstan may join the list of countries with a high human development level if data for 2007 shows life expectancy at birth has reached 65 years[6].

Thereby, Kazakhstan may realistically be able to join the top 50 developed countries by 2010 from a human development perspective. Meanwhile however, all other countries will be striving to improve their own human development as they pursue commitments under the Millennium Declaration, and therefore we estimate that Kazakhstan will rise from its current 73rd place on the HDI to 65th in 2010.

4 According to our estimation they are at the level of 65 years.

5 Each of three components in HDI is with a different weight. Therefore, the HDI reduction rate is one third of the falling of the index of any component. In our case: (0,888-0,682)/3=0,206/3=0,069.

6 This will be shown in the 2009 World Human Development Report, as data for 2007 will be used in that report.

Statistical Appendix 1

Table 1.1 **HDI dynamics of Kazakhstan and its regions estimated by GDP per capita for 1990-2006**

Regions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	0,762	0,765	0,748	0,755	0,733	0,706	0,701	0,704	0,715	0,737	0,740	0,747	0,762	0,780	0,799	0,816	0,825
Akmola	...	...	...	...	...	...	...	0,696	0,692	0,715	0,708	0,715	0,725	0,725	0,737	0,739	0,743
Aktobe	0,793	0,784	0,772	0,766	0,750	0,734	0,729	0,738	0,746	0,747	0,742	0,751	0,763	0,776	0,798	0,814	0,815
Almaty	0,764	0,751	0,741	0,718	0,706	0,693	0,712	0,713	0,707	0,700	0,696	0,710	0,715	0,718	0,726	0,727	0,731
Atyrau	0,773	0,762	0,765	0,733	0,760	0,766	0,776	0,781	0,777	0,785	0,813	0,825	0,837	0,857	0,867	0,875	0,880
East Kazakhstan	0,773	0,764	0,760	0,739	**0,731**	**0,723**	0,716	0,720	0,730	0,737	0,729	0,738	0,742	0,748	0,759	0,759	0,765
Zhambyl	0,763	0,742	0,748	0,707	*0,686*	*0,664*	*0,695*	*0,685*	*0,684*	*0,684*	*0,676*	*0,687*	*0,699*	*0,711*	*0,728*	*0,735*	*0,732*
West Kazakhstan	0,786	0,775	0,751	0,745	0,721	0,703	0,699	0,726	0,728	0,739	0,754	0,764	0,775	0,784	0,817	0,817	0,820
Karaganda	0,774	0,770	0,781	0,758	0,752	0,744	0,723	0,729	0,729	0,745	0,748	0,754	0,760	0,768	0,787	0,793	0,800
Kostanai	0,803	0,788	**0,805**	0,793	0,768	0,729	0,728	0,746	0,736	0,734	0,731	0,739	0,743	0,751	0,762	0,766	0,765
Kyzylorda	*0,749*	*0,731*	*0,737*	0,712	0,707	0,695	0,711	0,710	0,699	0,699	0,710	0,721	0,742	0,755	0,774	0,779	0,792
Mangistau	0,771	0,777	0,785	*0,702*	0,758	0,777	0,785	0,769	0,768	0,780	0,793	0,795	0,811	0,827	0,838	0,848	0,857
Pavlodar	0,777	0,777	0,787	0,774	0,764	0,755	0,754	0,737	0,755	0,745	0,751	0,763	0,771	0,783	0,798	0,798	0,794
North Kazakhstan	**0,793**	**0,800**	0,780	0,746	0,748	0,744	0,750	0,734	0,710	0,719	0,706	0,725	0,723	0,726	0,738	0,740	0,745
South Kazakhstan	0,765	0,758	0,746	0,719	0,700	0,676	0,699	0,703	0,699	0,706	0,713	0,724	0,728	0,733	0,742	0,741	0,741
Astana City	...	...	...	...	...	...	...	0,724	0,757	0,773	0,782	0,786	0,807	0,834	0,858	0,883	0,891
Almaty City	0,802	0,791	0,770	**0,782**	0,769	0,767	**0,802**	**0,821**	**0,823**	**0,828**	**0,821**	**0,839**	**0,850**	**0,852**	**0,856**	**0,862**	**0,885**
KAZAKHSTAN	**0,776**	**0,769**	**0,766**	**0,748**	**0,738**	**0,726**	**0,732**	**0,735**	**0,736**	**0,742**	**0,743**	**0,754**	**0,765**	**0,775**	**0,789**	**0,797**	**0,805**

Source: estimate by author based on Statistical Agency RK data using GRP per capita at regional level. The 2003-2005 indices are revised.
Note: the maximum values for regions are in bold, and minimum values are highlighted in italic

Table 1.2 **Dynamics of GDP (GRP) per capita in Kazakhstan and its regions for 1990-2006**

Regions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	4849	5388	4022	5885	4577	3419	3061	3026	3372	4541	4590	5480	6477	7584	9175	11320	12475
Akmola	...	...	...	...	...	...	...	2698	2331	3134	2732	3324	3482	3660	4062	4158	4541
Aktobe	7750	6903	5593	6475	5652	5077	4204	4995	5108	4391	4505	5207	6161	7073	8208	9848	10253
Almaty	5238	4355	3680	3091	2560	2263	2919	2767	2381	2073	2036	2488	2681	2829	3013	3238	3417
Atyrau	7224	6139	6536	4732	**8558**	9987	11096	**11431**	9120	**10207**	**15348**	**17398**	**21449**	**26451**	**26568**	**28607**	**32104**
East Kazakhstan	6480	5680	5380	4734	4656	5063	4394	4539	4755	4437	4050	4416	4507	4698	4990	5188	5797
Zhambyl	5825	4188	4681	2890	2010	*1557*	2501	*2049*	*1784*	*1551*	*1473*	*1610*	*1850*	*2273*	*2535*	2688	2553
West Kazakhstan	7095	6045	4001	4596	3611	2962	2693	3856	3712	4103	5190	6338	7206	7835	11160	10789	11559
Karaganda	6368	6153	7659	6542	6710	7444	5257	5489	5178	5347	5447	5766	6038	6699	7121	8253	9433
Kostanai	**9121**	7248	**9943**	10309	7086	4320	4019	5380	4621	4349	4247	4461	4631	5167	5569	5751	5826
Kyzylorda	*4270*	*3137*	3544	2900	2727	2662	3155	3016	2486	2084	2489	2923	3911	4608	5491	6364	8020
Mangistau	6337	7415	8753	*2481*	7373	**11894**	**13571**	9838	7388	8813	11077	11793	14703	14253	15885	19450	21718
Pavlodar	6618	7004	8490	**8623**	8457	8489	7377	5115	6500	4831	5530	6429	6552	7526	8430	8372	8470
North Kazakhstan	8185	**9672**	6864	4759	5116	5790	6404	4689	3268	3234	2597	3539	3488	3612	4141	4393	4768
South Kazakhstan	4620	4266	*3447*	2722	*2002*	1574	*2304*	2194	1916	1942	2211	2619	2632	2735	2646	*2590*	*2520*
Astana City	...	...	...	...	...	...	...	4041	6207	7777	8155	9017	11002	13387	16533	21230	23021
Almaty City	6601	5644	3929	6182	5185	5188	9369	10327	**10448**	10024	9115	11771	13843	15144	16931	19409	23829
KAZAKHSTAN	**6283**	**5756**	**5561**	**5204**	**4711**	**4508**	**4682**	**4628**	**4379**	**4293**	**4487**	**5219**	**5862**	**6532**	**7273**	**8090**	**9057**

Source: estimation by author based on Statistical Agency RK data using GRP per capita at regional level.
Note: the index maximum values for regions are in bold, and minimum values are highlighted in italic.

Table 1.3 **Dynamics of income indices in Kazakhstan and its regions estimated by GRP per capita 1990-2006**

Regions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	0,648	0,665	0,617	0,680	0,638	0,589	0,571	0,569	0,587	0,637	0,639	0,668	0,696	0,722	0,754	0,789	0,806
Akmola	...	...	...	...	...	...	...	0,550	0,526	0,575	0,552	0,585	0,593	0,601	0,618	0,622	0,637
Aktobe	0,726	0,707	0,672	0,696	0,673	0,655	0,624	0,653	0,657	0,631	0,636	0,660	0,688	0,711	0,736	0,766	0,773
Almaty	0,661	0,630	0,602	0,573	0,541	0,521	0,563	0,554	0,529	0,506	0,503	0,536	0,549	0,558	0,568	0,580	0,589
Atyrau	0,714	0,687	0,698	0,644	**0,743**	0,768	0,786	**0,791**	0,753	**0,772**	**0,840**	**0,861**	**0,896**	**0,931**	**0,932**	**0,944**	**0,963**
East Kazakhstan	0,696	0,674	0,665	0,644	0,641	0,655	0,631	0,637	0,645	0,633	0,618	0,632	0,636	0,643	0,653	0,659	0,678
Zhambyl	0,678	0,623	0,642	0,561	0,501	*0,458*	0,537	*0,504*	*0,481*	*0,458*	*0,449*	*0,464*	*0,487*	*0,521*	*0,540*	0,549	0,541
West Kazakhstan	0,711	0,685	0,616	0,639	0,599	0,566	0,550	0,610	0,603	0,620	0,659	0,693	0,714	0,728	0,787	0,781	0,793
Karaganda	0,693	0,688	0,724	0,698	0,702	0,719	0,661	0,668	0,659	0,664	0,667	0,677	0,684	0,702	0,712	0,737	0,759
Kostanai	**0,753**	0,715	**0,768**	0,774	0,711	0,629	0,616	0,665	0,640	0,630	0,626	0,634	0,640	0,658	0,671	0,676	0,678
Kyzylorda	*0,627*	*0,575*	0,595	0,562	0,552	0,548	0,576	0,569	0,536	0,507	0,537	0,563	0,612	0,639	0,669	0,693	0,732
Mangistau	0,692	0,719	0,746	*0,536*	0,718	**0,798**	**0,820**	0,766	0,718	0,748	0,786	0,796	0,833	0,828	0,846	0,880	**0,898**
Pavlodar	0,700	0,709	0,741	**0,744**	0,741	0,741	0,718	0,657	0,697	0,647	0,670	0,695	0,698	0,721	0,740	0,739	0,741
North Kazakhstan	0,735	**0,763**	0,706	0,645	0,657	0,677	0,694	0,642	0,582	0,580	0,544	0,595	0,593	0,599	0,621	0,631	0,645
South Kazakhstan	0,640	0,626	*0,591*	0,551	*0,500*	0,460	*0,524*	0,515	0,493	0,495	0,517	0,545	0,546	0,552	0,547	*0,543*	**0,539**
Astana City	...	...	...	...	...	...	...	0,617	0,689	0,727	0,735	0,751	0,785	0,817	0,853	0,894	**0,908**
Almaty City	0,699	0,673	0,613	0,688	0,659	0,659	0,758	0,774	0,776	0,769	0,753	**0,796**	**0,823**	**0,838**	**0,857**	**0,879**	**0,914**
KAZAKHSTAN	**0,691**	**0,676**	**0,671**	**0,660**	**0,643**	**0,636**	**0,642**	**0,640**	**0,631**	**0,627**	**0,635**	**0,660**	**0,679**	**0,698**	**0,715**	**0,733**	**0,752**

Source: estimation by author based on Statistical Agency RK data using GRP per capita at regional level.
Note: the index maximum values for regions are in bold, and minimum values are highlighted in italic.

Table 1.4 **Dynamics of income per capita used for consumption in Kazakhstan and its regions for 1993-2006**

Regions	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	6313	4412	4105	4121	5085	5319	4096	5200	7511	8587	9631	10266	11492	12828
Akmola	...	...	...	...	...	...	2791	4608	5729	6196	7003	7442	8278	8390
Aktobe	4329	4070	4157	4272	3681	3473	3469	4803	5753	7044	8122	8516	9472	9732
Almaty	3586	3074	2544	2723	*2646*	*2458*	*2473*	3360	4029	4608	5483	6705	7458	7782
Atyrau	3985	4400	4183	4303	4520	4573	4753	4472	5148	6215	6363	7165	7970	9639
East Kazakhstan	5699	4829	4524	4692	5270	5399	5084	5117	5910	6562	7038	7970	8865	10449
Zhambyl	3640	3496	3658	3725	3046	3211	3299	2965	*3117*	*3950*	4341	5545	6168	6589
West Kazakhstan	4785	3950	3682	3513	3560	3647	3750	4233	4790	5622	6919	7506	8349	8838
Karaganda	8257	7591	6925	6856	6821	5985	5903	5163	5945	6881	7412	8192	9112	9365
Kostanai	6139	4237	4429	4187	5176	4548	4341	4852	5274	5787	6016	6561	7298	8523
Kyzylorda	4492	3694	3239	5027	5565	5294	4642	3309	3530	3960	4900	5138	5715	*5958*
Mangistau	5953	5284	6461	6057	6408	6276	5198	4389	5632	6648	7422	8589	9553	9243
Pavlodar	5868	5379	5278	5085	5016	4653	4691	5194	6053	5674	6821	7672	8534	10861
North Kazakhstan	5142	3975	3741	4661	4201	3397	3450	5211	6568	6106	6846	7124	7924	8192
South Kazakhstan	*2927*	*2394*	*2320*	*2699*	2714	2547	2698	*3164*	3427	3960	*4268*	*4943*	*5498*	6554
Astana City	...	...	...	...	...	7557	7096	6336	**10434**	**12199**	**13516**	**14329**	**15938**	**18728**
Almaty City	9528	8830	8226	8163	8723	8203	7628	**6585**	8403	9501	10080	10572	11760	12134
KAZAKHSTAN	**5204**	**4711**	**4508**	**4682**	**4628**	**4379**	**4293**	**4487**	**5219**	**5862**	**6532**	**7273**	**8090**	**9057**

Source: estimation by author based on Statistical Agency RK data using per capita consumption income at regional level.
Note: the index maximum values for regions are in bold, and minimum values are highlighted in italic.

Table 1.5 **Dynamics of income indices of Kazakhstan and its regions estimated by income per capita used for consumption for 1993-2006**

Regions	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	0,692	0,632	0,620	0,621	0,656	0,663	0,620	0,659	0,721	0,743	0,762	0,773	0,792	0,810
Akmola	…	…	…	…	…	…	0,556	0,639	0,676	0,689	0,709	0,719	0,737	0,739
Aktobe	0,629	0,619	0,622	0,627	0,602	0,592	0,592	0,646	0,676	0,710	0,734	0,742	0,760	0,764
Almaty	0,597	0,572	0,540	0,552	*0,547*	*0,534*	*0,535*	0,587	0,617	0,639	0,668	0,702	0,720	0,727
Atyrau	0,615	0,632	0,623	0,628	0,636	0,638	0,644	0,634	0,658	0,689	0,693	0,713	0,731	0,762
East Kazakhstan	0,675	0,647	0,636	0,642	0,662	0,666	0,656	0,657	0,681	0,698	0,710	0,731	0,749	0,776
Zhambyl	0,600	0,593	0,601	0,604	0,570	0,579	0,584	0,566	0,574	0,614	0,629	0,670	0,688	0,699
West Kazakhstan	0,646	0,614	0,602	0,594	0,596	0,600	0,605	0,625	0,646	0,672	0,707	0,721	0,738	0,748
Karaganda	0,737	0,723	0,707	0,706	0,705	0,683	0,681	0,658	0,682	0,706	0,719	0,735	0,753	0,758
Kostanai	0,687	0,625	0,633	0,623	0,659	0,637	0,629	0,648	0,662	0,677	0,684	0,698	0,716	0,742
Kyzylorda	0,635	0,602	0,580	0,654	0,671	0,662	0,641	0,584	0,595	0,614	0,650	0,657	0,675	*0,682*
Mangistau	0,682	0,662	0,696	0,685	0,694	0,691	0,659	0,631	0,673	0,700	0,719	0,743	0,761	0,755
Pavlodar	0,680	0,665	0,662	0,656	0,653	0,641	0,642	0,659	0,685	0,674	0,705	0,724	0,742	0,782
North Kazakhstan	0,658	0,615	0,605	0,641	0,624	0,588	0,591	0,660	0,698	0,686	0,705	0,712	0,730	0,735
South Kazakhstan	*0,564*	*0,530*	*0,525*	*0,550*	0,551	0,540	0,550	0,577	0,590	0,614	*0,627*	*0,651*	*0,669*	0,698
Astana City	…	…	…	…	…	0,722	0,711	0,692	**0,776**	**0,802**	**0,819**	**0,829**	**0,846**	**0,873**
Almaty City	**0,761**	**0,748**	**0,736**	**0,735**	**0,746**	**0,736**	**0,723**	**0,699**	0,740	0,760	0,770	0,778	0,796	0,801
KAZAKHSTAN	**0,660**	**0,643**	**0,636**	**0,642**	**0,640**	**0,631**	**0,627**	**0,635**	**0,660**	**0,679**	**0,698**	**0,715**	**0,733**	**0,752**

Source: estimation by author based on Statistical Agency RK data using per capita consumption income at regional level.
Note: the index maximum values for regions are in bold, and minimum values are highlighted in italic.

Table 1.6 **Dynamics of HDI of Kazakhstan and its Regions, estimated by income per capita used for consumption for 1993-2006**

Regions	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	0,759	0,731	0,717	0,718	0,733	0,740	0,731	0,747	0,765	0,778	0,794	0,805	0,817	0,827
Akmola	...	...	...	...	...	...	*0,708*	0,737	0,745	0,758	0,761	0,770	0,778	0,777
Aktobe	0,744	0,732	0,723	0,729	0,721	0,724	0,734	0,746	0,757	0,771	0,784	0,800	0,812	0,812
Almaty	0,726	0,716	0,700	0,708	0,710	*0,709*	0,710	0,724	0,737	0,746	0,755	0,770	0,774	0,776
Atyrau	0,724	0,723	0,717	0,723	0,730	0,739	0,743	0,744	0,757	0,768	0,778	0,794	0,804	0,813
East Kazakhstan	0,749	0,733	0,717	0,720	0,728	0,737	0,745	0,742	0,754	0,763	0,771	0,785	0,789	0,798
Zhambyl	*0,720*	0,717	0,711	0,718	*0,707*	0,716	0,726	*0,715*	*0,723*	*0,742*	*0,747*	0,772	0,781	0,785
West Kazakhstan	0,747	0,726	0,715	0,714	0,721	0,725	0,734	0,742	0,748	0,761	0,777	0,795	0,803	0,805
Karaganda	0,771	0,759	0,740	0,738	0,741	0,736	0,750	0,745	0,755	0,767	0,774	0,795	0,799	0,800
Kostanai	0,764	0,740	0,731	0,730	0,743	0,735	0,734	0,738	0,749	0,755	0,759	0,771	0,779	0,786
Kyzylorda	0,736	0,724	0,706	0,737	0,744	0,740	0,744	0,726	0,731	0,742	0,758	0,771	*0,773*	0,775
Mangistau	0,750	0,739	0,743	0,740	0,745	0,763	0,750	0,741	0,754	0,767	0,790	0,804	0,808	0,809
Pavlodar	0,753	0,738	0,728	0,734	0,736	0,737	0,744	0,748	0,760	0,763	0,778	0,793	0,799	0,808
North Kazakhstan	0,750	0,734	0,719	0,732	0,728	0,710	0,723	0,745	0,760	0,754	0,762	*0,769*	0,773	*0,775*
South Kazakhstan	0,723	*0,710*	*0,697*	*0,708*	0,715	0,715	0,724	0,733	0,739	0,751	0,758	0,777	0,782	0,794
Astana City	...	...	...	...	...	0,779	0,768	0,768	0,794	0,812	**0,834**	**0,850**	**0,867**	**0,880**
Almaty City	**0,806**	**0,799**	**0,792**	**0,794**	**0,812**	**0,813**	**0,813**	**0,803**	**0,821**	**0,829**	0,829	0,830	0,834	0,848
KAZAKHSTAN	**0,748**	**0,738**	**0,726**	**0,732**	**0,735**	**0,736**	**0,742**	**0,743**	**0,754**	**0,765**	**0,775**	**0,789**	**0,797**	**0,805**

Source: estimation by author based on Statistical Agency RK data using GRP per capita at regional level. The 2003-2005 indices are revised.
Note: the index maximum values for regions are in bold, and minimum values are highlighted in italic

Table 1.7 **Human development rating of Kazakhstan's regions in 2006**

Rank	Region[1]	Region HDI by income[1]	reference: states with similar HDI [2]	HDI country rating in the world[2]	Country HDI[2]
2006	2006	2006	2005	2005	2005
1	Astana City	0,880	Malta	34	0,878
2	Almaty City	0,848	Croatia	47	0,850
3	Atyrau	0,813	Romania	60	0,813
4	Aktobe	0,812	Saudi Arabia	61	0,812
5	Mangistau	0,809	Panama	62	0,812
6	Pavlodar	0,808	Malaysia	63	0,811
7	West Kazakhstan	0,805	Belarus	64	0,804
8	Karaganda	0,800	Brazil	70	0,800
9	East Kazakhstan	0,798	Dominican Republic	71	0,798
10	South Kazakhstan	0,794	Kazakhstan	73	0,794
11	Kostanai	0,786	Ukraine	76	0,788
12	Zhambyl	0,785	Samoa	77	0,785
13	Akmola	0,777	China	81	0,777
14	Almaty	0,776	Grenada	82	0,777
15	North Kazakhstan	0,775	Armenia	83	0,775
16	Kyzylorda	0,775	Turkey	84	0,775

Sources:
[1] estimation by author based on Statistical Agency RK data.
[2] the 2007/2008 UNDP Human Development Report.

Table 1.8 **Basic human development indices by Kazakhstan regions in 2006**

Region	Life expectancy at birth, years	Literacy rate	Education coverage	PPP income per capita	LE index	Education index	Income index	HDI
Akmola	*63,67*	99,4	85,4	8390	*0,645*	0,947	0,739	0,777
Aktobe	65,96	99,7	97,8	9732	0,683	0,991	0,764	0,812
Almaty	66,57	99,4	*74,1*	7782	0,693	*0,910*	0,727	0,776
Atyrau	66,50	99,7	95,9	9639	0,692	0,984	0,762	0,813
East Kazakhstan	64,89	99,2	87,1	10449	0,665	0,952	0,776	0,798
Zhambyl	67,05	99,7	87,0	6589	0,701	0,955	0,699	0,785
West Kazakhstan	66,60	99,4	93,2	8838	0,693	0,973	0,748	0,805
Karaganda	64,89	99,5	93,9	9365	0,665	0,976	0,758	0,800
Kostanai	65,13	99,4	85,5	8523	0,669	0,948	0,742	0,786
Kyzylorda	66,19	99,6	88,1	*5958*	0,687	0,958	*0,682*	0,775
Mangistau	65,58	99,5	100,0	9243	0,676	0,997	0,755	0,809
Pavlodar	65,09	99,4	92,9	10861	0,668	0,972	0,782	0,808
North Kazakhstan	65,02	99,2	78,6	8192	0,667	0,923	0,735	*0,775*
South Kazakhstan	67,67	99,9	92,4	6554	0,711	0,974	0,698	0,794
Astana City	**71,10**	99,7	**100,0**	**18728**	**0,768**	**0,998**	**0,873**	**0,880**
Almaty City	69,63	99,8	**100,0**	12134	**0,744**	**0,999**	0,801	0,848
Kazakhstan	**66,19**	**99,5**	**94,0**	**9057**	**0,687**	**0,977**	**0,752**	**0,805**
Maximum/minimum	**1,117**	**1,007**	**1,350**	**3,1**	**1,192**	**1,098**	**1,280**	**1,135**

Source: estimation by author based on Statistical Agency RK data using per capita consumption income at regional level.

Note: the index maximum values for regions are in bold, and minimum values are highlighted in italic.

Table 1.9 **Dynamics of selected human development indices, with gendered perspective in Kazakhstan for 1999-2006**

Index	1999	2000	2001	2002	2003	2004	2005	2006	change
Life expectancy at birth, years [1]	65,5	65,5	65,8	66,0	65,8	66,18	65,91	66,19	0,69
Including: women [1]	71,0	71,1	71,3	71,5	71,5	72,00	71,77	72,03	1,03
men [1]	60,3	60,2	60,5	60,7	60,5	60,62	60,30	60,55	0,25
Gender difference, years[1]	10,7	10,9	10,8	10,8	11,0	11,4	11,5	11,5	-0,8
Rate of employed women among employees, % [1]	47,6	47,5	45,2	45,0	45,9	46,7	46,5	47,6	0,0
Women's and men's salaries ratio, % [1]	67,6	61,5	58,7	61,7	60,8	61,7	61,1	62,3	-5,3
GDP per capita, USD [2]	**4293**	**4487**	**5219**	**5862**	**6532**	**7273**	**8090**	**9057**	**4764**
Including: women [2]	3152	2683	3637	**4212**	**4652**	**5220**	**5761**	**6579**	**3428**
men [2]	5521	6428	6923	**7640**	**8556**	**9484**	**10599**	**11732**	**6211**
Gender difference, USD [2]	2369	3745	3286	**3428**	**3903**	**4264**	**4839**	**5153**	2783

Sources: [1] Statistical Agency RK data . [2] Estimation by author.

Table 1.10 **Dynamics of human development components and HDI indices in gender context for Kazakhstan, 1999-2006**

Index	1999	2000	2001	2002	2003	2004	2005	2006	Change
Index	0,767 0,588	0,768 0,587	0,772 0,592	0,775 0,595	0,775 0,592	0,783 0,594	0,780 0,588	0,784 0,593	0,017 0,005
Life expectancy index	0,925 0,915	0,925 0,915	0,929 0,919	0,940 0,927	0,955 0,939	0,979 0,955	0,989 0,962	0,989 0,962	0,063 0,047
Education availability index	0,576 0,669	0,549 0,695	0,600 0,707	0,624 0,624	0,641 0,743	0,660 0,759	0,677 0,778	0,699 0,795	0,123 0,126
Income index	0,756 0,724	0,748 0,732	0,767 0,739	0,780 0,749	0,790 0,758	0,807 0,770	0,8815 0,776	0,824 0,783	0,068 0,059

Note: numerator – females, denominator – males.
The education availability and human development indices for 2003-2005 are revised.

Table 1.11 **Dynamics of human development components and HDI indices with & without gender factor, using UNDP method for Kazakhstan, 1999-2006**

Index	1999	2000	2001	2002	2003	2004	2005	2006	Change
Life expectancy index	0,675 0,669	0,675 0,669	0,680 0,673	0,683 0,676	0,680 0,674	0,686 0,679	0,682 0,674	0,687 0,678	0,012 0,009
Education availability index	0,921 0,920	0,921 0,920	0,924 0,924	0,934 0,934	0,947 0,947	0,967 0,967	0,976 0,976	0,976 0,976	0,055 0,055
Income index	0,627 0,617	0,635 0,611	0,660 0,647	0,679 0,668	0,698 0,686	0,715 0,704	0,733 0,722	0,752 0,742	0,125 0,125
HDI	0,741 0,736	0,743 0,733	0,755 0,748	0,766 0,760	0,775 0,769	0,790 0,784	0,777 0,791	0,055 0,799	0,064 0,063

Note: nominator – without gender factor, denominator – given gender factor.
The education availability and human development indices for 2003-2005 are revised.

Table 1.12 **Proportion of people not surviving to age 60 by region, for Kazakhstan, 1999-2006, %**

Regions	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	30,6	30,3	31,6	30,3	30,3	30,4	30,6	30,4
Akmola	32,0	33,1	**35,4**	33,7	**35,7**	35,1	35,7	35,1
Aktobe	30,8	**34,3**	34,8	**34,6**	33,6	32,2	31,2	32,2
Almaty	28,0	28,2	27,5	27,0	28,0	28,2	29,5	28,2
Atyrau	**33,6**	33,2	32,2	33,6	30,9	30,0	28,5	30,0
East Kazakhstan	31,6	33,4	31,9	32,1	31,8	32,0	33,1	32,0
Zhambyl	27,4	30,3	28,9	27,9	29,3	28,2	27,9	28,2
West Kazakhstan	30,9	32,0	32,2	33,0	32,8	30,0	29,5	30,0
Karaganda	33,3	33,2	33,8	33,9	35,3	**36,1**	**35,9**	**36,1**
Kostanai	31,0	31,6	30,7	30,2	31,7	31,8	32,3	31,8
Kyzylorda	28,6	27,5	27,5	28,2	26,7	26,0	28,1	26,0
Mangistau	31,0	31,1	33,8	32,6	30,2	29,7	30,1	29,7
Pavlodar	30,2	31,2	31,6	30,6	30,4	30,7	31,2	30,7
North Kazakhstan	31,6	32,3	32,4	33,0	33,3	33,2	33,0	33,2
South Kazakhstan	26,1	26,2	26,1	26,7	26,5	25,9	26,9	25,9
Astana City	27,4	*24,9*	*25,3*	*25,1*	*22,4*	*23,6*	*23,6*	*23,6*
Almaty City	*27,0*	27,1	26,0	25,2	26,5	28,5	29,6	28,5
KAZAKHSTAN	**29,9**	**30,5**	**30,3**	**30,1**	**30,3**	**30,3**	**30,7**	**30,3**

Source: estimation by author based on Statistical Agency RK data.
Note: the index maximum values for regions are in bold, and minimum values are highlighted with italic.

Table 1.13 **Proportion of 16 year-olds not in education, by region, for Kazakhstan, 1999-2006, %**

Regions	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	12,2	13,7	15,8	7,2	5,5	7,1	6,9	6,9
Akmola	13,6	4,1	7,7	6,2	9,2	**12,0**	**12,0**	**12,0**
Aktobe	6,1	7,2	5,2	*0,0*	*0,0*	2,7	2,7	2,7
Almaty	10,0	14,8	**15,5**	10,8	7,4	7,5	7,5	7,5
Atyrau	7,0	6,2	5,4	*0,0*	*0,0*	0,2	0,2	0,2
East Kazakhstan	5,0	8,1	9,0	7,3	3,0	4,2	4,2	4,2
Zhambyl	**14,0**	**17,5**	14,7	8,7	4,7	7,0	7,0	7,0
West Kazakhstan	4,0	*0,0*	5,4	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
Karaganda	5,5	10,7	10,8	3,6	0,1	3,2	3,2	3,2
Kostanai	7,0	14,2	12,0	**11,0**	**10,1**	7,4	7,4	7,4
Kyzylorda	8,0	12,4	14,0	*0,0*	4,5	1,5	1,5	1,5
Mangistau	6,0	0,2	5,0	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
Pavlodar	7,0	11,3	14,0	2,4	1,6	1,7	1,7	1,7
North Kazakhstan	4,0	7,0	6,1	3,5	2,7	5,3	5,3	5,3
South Kazakhstan	9,0	8,9	11,7	1,8	0,8	0,0	0,0	0,0
Astana City	9,0	32,1	29,0	8,7	*0,0*	*0,0*	*0,0*	*0,0*
Almaty City	4,0	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
KAZAKHSTAN	**11,6**	**9,8**	**10,6**	**4,5**	**3,0**	**1,1**	**1,1**	**1,1**

Source: estimation by author based on Statistical Agency RK data.

Note: the index maximum values for regions are in bold, and minimal values are highlighted with italic

Table 1.14 **Proportion of people with income (consumption) below the minimum subsistence level, by region, for Kazakhstan, 1999-2006, %**

Regions	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	29,8	23,0	13,9	12,1	10,6	8,8	6,3	16,9
Akmola	35,4	28,9	21,0	18,6	16,4	14,0	10,1	25,4
Aktobe	24,3	18,3	29,8	22,6	19,0	14,3	12,3	17,2
Almaty	44,2	46,2	39,3	36,3	25,3	15,2	8,5	21,3
Atyrau	50,1	49,6	40,7	34,1	**32,7**	**29,1**	**25,0**	**23,8**
East Kazakhstan	17,3	15,4	21,1	20,0	16,9	14,9	8,2	12,5
Zhambyl	45,7	47,7	48,2	35,8	30,0	18,3	10,8	23,6
West Kazakhstan	28,9	12,0	27,3	28,0	17,1	14,4	8,5	13,2
Karaganda	18,4	18,6	22,8	19,3	15,1	13,5	6,4	20,2
Kostanai	21,7	22,3	25,5	22,3	21,0	19,0	13,4	14,0
Kyzylorda	55,0	51,6	39,5	32,3	27,1	26,5	16,3	37,5
Mangistau	37,9	**59,7**	**45,9**	**39,8**	26,0	21,0	13,6	28,5
Pavlodar	48,0	14,9	16,6	21,6	17,1	14,5	4,7	12,0
North Kazakhstan	27,2	11,9	10,0	14,3	11,9	12,0	8,2	22,3
South Kazakhstan	**55,5**	52,8	39,2	27,5	26,1	23,0	13,3	14,1
Astana City	15,1	11,6	*2,2*	*2,2*	*2,1*	*1,1*	*1,1*	*5,5*
Almaty City	*13,7*	*4,8*	4,9	4,1	3,9	2,8	0,3	12,1
KAZAKHSTAN	**34,5**	**31,8**	**28,4**	**24,2**	**19,8**	**16,1**	**9,8**	**18,2**

Source: estimation by author based on Statistical Agency RK data.

Notes:

1. The index maximum values for regions are in bold, and minimum values are highlighted with italic.
2. The 2006 poverty data are given in comparison with population income with the new increased minimum subsistence level.

Table 1.15 **Unemployment rate, by region for Kazakhstan, at year-end 1999-2006, %**

Regions	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	14,2	12,6	10,2	9,0	8,9	8,8	8,6	8,3
Akmola	14,7	12,6	10,8	9,2	9,2	9,2	8,9	8,6
Aktobe	13,7	13,3	11,4	10,2	9,7	9,4	9,1	8,5
Almaty	14,2	14,1	10,2	9,2	8,6	7,8	7,3	7,1
Atyrau	15,1	15,5	13,5	10,7	9,5	9,3	9,0	8,4
East Kazakhstan	8,5	8,2	*7,3*	*7,3*	*7,3*	*7,2*	*7,4*	*6,9*
Zhambyl	14,6	14,4	12,7	12,3	11,1	**10,2**	**9,7**	9,2
West Kazakhstan	*7,8*	*7,8*	12,5	10,0	9,3	9,2	8,9	8,6
Karaganda	14,3	13,5	9,2	8,3	7,5	7,4	7,0	*6,9*
Kostanai	15,8	13,1	10,3	9,3	8,7	8,5	8,2	7,8
Kyzylorda	**16,1**	14,5	**13,9**	**12,5**	**11,4**	**10,2**	**9,7**	**9,3**
Mangistau	13,2	13,7	10,5	9,8	9,7	9,8	9,6	**9,3**
Pavlodar	13,4	13,8	9,2	8,7	8,2	7,7	8,1	7,4
North Kazakhstan	14,6	12,8	8,9	8,0	8,0	8,1	8,4	7,2
South Kazakhstan	14,1	14,3	11,5	9,4	8,6	7,8	7,4	7,2
Astana City	13,0	12,5	9,3	8,7	8,4	8,3	8,1	8,0
Almaty City	14,0	12,1	10,8	9,6	8,9	8,8	8,4	8,2
KAZAKHSTAN	**13,5**	**12,8**	**10,4**	**9,3**	**8,8**	**8,4**	**8,1**	**7,8**

Source: estimation by author based on Statistical Agency RK data.

Note: the index maximum values for regions are in bold, and minimum values are highlighted with italic.

Table 1.16 **People poverty index dynamics for 1999-2006**

Regions	1999	2000	2001	2002	2003	2004	2005	2006
Akmola region with Astana city	24,6	22,3	21,4	19,7	19,6	19,6	19,6	20,2
Akmola	27,5	25,0	24,0	22,5	23,4	23,0	**23,0**	**25,4**
Aktobe	22,6	23,1	26,0	23,8	22,5	21,0	20,2	21,4
Almaty	30,4	31,7	27,8	25,9	21,4	18,9	18,9	20,8
Atyrau	34,7	34,4	29,6	27,0	**25,4**	**23,6**	21,5	21,8
East Kazakhstan	21,1	21,9	22,1	21,9	21,1	20,9	21,0	21,0
Zhambyl	31,2	33,1	**32,8**	26,0	23,8	19,6	18,2	21,5
West Kazakhstan	23,8	20,6	24,1	24,5	21,7	19,7	18,9	19,7
Karaganda	22,6	22,7	23,6	22,7	22,9	23,2	22,7	24,2
Kostanai	22,3	22,9	23,0	21,7	22,0	21,6	21,0	21,7
Kyzylorda	**36,5**	34,4	28,0	24,4	21,6	21,0	19,0	26,3
Mangistau	27,9	**39,4**	32,4	**29,1**	22,6	20,9	19,7	23,2
Pavlodar	32,8	21,1	21,5	21,4	20,3	20,1	19,8	19,9
North Kazakhstan	23,9	21,1	20,8	21,4	21,4	21,4	21,0	23,4
South Kazakhstan	36,4	34,8	27,3	21,7	21,0	19,6	17,7	17,3
Astana City	18,9	23,5	21,8	16,2	*14,4*	*15,1*	*15,1*	*15,1*
Almaty City	*18,4*	*17,6*	*16,8*	*16,2*	16,9	18,1	18,8	18,5
KAZAKHSTAN	**26,2**	**25,1**	**23,7**	**22,0**	**20,9**	**20,1**	**19,7**	**20,5**

Source: estimation by author based on Statistical Agency RK data .

Note: the index maximum values for regions are in bold, and minimum values are highlighted with italic.

Technical notes

1. Human development integral factors

In 1987 the UN Committee for development planning made a decision to review in its 1988 report the human costs of structural adjustment. Results of studies conducted in the preparation of this report under Mr. M. Ul-Haq's supervision have been prepared by Mr. K.Griffin as a draft report published entitled "Human potential development: forgotten measurement of the development of strategy". Later K.Griffin together with J. Knight (Griffin K. and Knight J.) published the results of their work in 1989 in the special edition of "Development Planning" magazine and republished in 1990 as a book . These works were used as the basis for a conceptual human development approach.

Hypothetical works of Mr. Amartya Sen, the Nobel prize winner in economics, who published his work in 1989 "Development and capability expansion", had a principal influence on the modern understanding of human potential. Sen considered the development process not as an improvement of financial or economic welfare, but as a process of human "capabilities" expansion, i.e. the possibility to have access to knowledge, the chance to perform more and so forth. Meanwhile the expansion of capability is connected with the expansion of human liberty and choice. Thereby, the human development concept targeted not GNP growth as economic development, but capability of human development itself, the expansion of free choice.

The conceptual human development approach (this is a note for Russian readers, should be removed from English version), elaborated by a group of UNDP experts, was published for the first time in the first World Human Development Report, 1990 . In this report, human development was defined as "the process of human choice expansion, and the achieved level of people's welfare". Income is only one of such choices, but health, education, habitat, freedom of discretion and speech are also important. A new instrument was provided in the report for measuring social and economic progress: the human development index (HDI), which incorporates life expectancy, adult educational level and income.

Such a definition of human development ordains a wide and ramified system of statistical indices allowing us to evaluate and analyze human development. The general classification of statistical indices reflecting human development may be presented by three groups of indices:

1. Integral indices providing a general evaluation of human development.
2. Basic indices describing the main components of integral human development evaluation.
3. Other indices describing other aspects of human development.

2. Basic and integral human development rates

The basic human development indices correspond to three basic main human development components – longevity, education and living standards. Each of these components in general covers several important human capabilities. For instance, longevity means the possibility to live a long and healthy life; education – to acquire knowledge, to communicate, participate in community life; living standard – to have access to the resources required to lead a worthwhile, healthy life, have conditions for physical and social mobility, participate in community life, etc.

For these three human development components a system of rates, regularly evaluated and comparable for practically all countries, are proposed. Thereby, the growth of basic indices' values illustrates increasing options in terms of certain human development aspects.

Longevity rates. Longevity is defined as life expectancy at birth. It is often referred to as life expectancy for short. This index is one of the most commonly used international statistics and is determined by evaluations within the framework of so-called "mortality tables".

Life expectancy at birth is the number of years which a person from a generation coming into the world can expect to live on average, provided the mortality rate of each age will be the same for generations, as it was at the date of birth.

This index is calculated for the population as a whole and separately for both sexes.

The index of the people / ratio not surviving to certain age that is used to evaluate poverty indices, describes the extent of loss of opportunity to live a long and healthy life, and is supplemental to life expectancy at birth.

For countries with a medium level of development the life expectancy index may be supplemented by mortality rate up to 5 years of age – child mortality – and for developed countries by the maternal mortality rate.

Rates describing education

Education is estimated by measuring the literacy rate at the age of 15 years old and older, and also by the education coverage (enrolment) index.

Literacy – is the ability to read, understand and write short text regarding daily human life.

For developing countries literacy is the most important education measure, which is why in HDI calculation it is given a weighting twice that of enrolment.

In world human development reports prior to 1995 the rate of average duration of education, calculated for people of 25 years and older, was used instead of enrolment rates. But since the 1995 Human Development Report the enrolment rate has been used.

Education coverage is the relation of the total number of students attending at all educational levels (primary, secondary, secondary technical, post-secondary, postgraduate) regardless of their age, to the total number of population at the age of 5-24 years.

It is worth bearing in mind that different levels of education promote human choice expansion to varying extents. Besides, Anand and Sen proposed supplementing conventional education indices with indicators specific for several development levels: for countries of medium development literacy rate would be supplemented with secondary education coverage index, while for highly developed states a college and university education coverage index would be used.

Rates describing life standards

Unlike the two previous measures this human development aspect only gives opportunities that a human being has, but does not define its utilization, i.e. it is only a means of expanding options, but not the choice itself.

An ideal characteristic of the living standard is to consider multiple factors, determining opportunities to develop and realize human capabilities: personal income, income distribution between social classes, formerly accumulated belongings, access to land resources and credit, developed infrastructure and access to public services (healthcare, education, transport, utilities and so forth); individual lifestyle; family size and structure; household produced amenities; natural, climatic and ecological conditions and so on.

Due to difficulties in choosing any direct rate for the evaluation of financial lifestyle an indirect basic rate – gross domestic product (GDP) per capita – is used. Therefore the GDP per capita should be converted to real GDP per capita in USD at purchasing power parity (PPP) of the national currency against the USD for comparison at the international level.

Purchasing Power Parity (PPP) means the quantity of the national currency units needed to buy a certain basket of goods and services acquirable for 1USD in the United States of America.

Countries in different groups of states depending on their level of economic development may be compared by using supplemental rates, allowing more objective differentiation of countries within the group depending on financial living standards. For example, for less developed countries real GDP per capita relatively adequately reflects the situation regarding access to resources required for a decent life. For countries with a medium level of development it is expedient to supplement this indicator with the ratio of people living below the poverty line. For developed countries these two rates can be supplemented with an index measuring the income inequality level1:

$$Y = (1 - G) * Y^r,$$

where G - Gini coefficient;
Y^r - real GDP per capita.

With equal real income per capita the Gini coefficient allows for the differentiation of countries by living standard.

3. Human development index (HDI)

The human development index is the arithmetic mean of three other indices: life expectancy at birth, education and income levels per capita. The education index is estimated based on the literacy index (weighted two-thirds) and availability of education (weighted one-third).

Four factors are at the heart of calculation of the indices, whose acceptable range is within the following limits:

Indices	Minimum	maximum
Life expectancy at birth, years	25	85
Adult literacy rate, %	0	100
Education coverage (combined gross enrolment ratio) %	0	100
GDP per capita (PPP $US)	100	40000

Indices are calculated on the basis of these rates (except for income index) with the following common formula:

$$I = \frac{\text{Real value xi} - \text{minimum value xi}}{\text{Maximum value xi} - \text{minimum value xi}}$$

To calculate the income index, a modified formula is used, where logarithms of GDP per capita are used in the nominator and denominator:

$$I = \frac{\ln\text{ (real value xi) - ln (minimum value xi)}}{\ln\text{ (maximum value xi) - ln0 (minimum value xi)}}$$

1 Anand S., Sen A. Human Development Index: Methodology and Measurement // Background Paper for Human Development Report 1993. - New York: UNDP, 1992.

The following demonstrates the calculation of human development potential index using Kazakhstan as the example, which had following values of the main factors in 2004:

Indices	Value
Life expectancy at birth, years	66,2
Adult literacy rate, %	99,5
Education coverage (combined gross enrolment ratio) %	94
GDP per capita (PPP $US)	9057

From here according to the above formula the life expectancy at birth index equals 0,682:

(66,2 - 25) / (85 - 25) = 41,2 / 60 = 0,687.

The adult literacy index is 0,995:

(99,5 - 0) / (100 - 0) = 0,995.

Given that education coverage equaled 94%, the total education level index will be 0,977:

(0,995 * 2 + 0,940) / 3 = 0,977.

Income per capita using the above formula is:

(ln(7260)-ln(100)) / (ln(40000) – ln(100)) = = (9,111-4,605) / (10,597-4,605) = 4,506/5,991 = 0,752

Kazakhstan's HDI in 2004, calculated on the basis of these three indices, is 0,795:

(0,687 + 0,977 + 0,752) / 3 = 0,795.

4. Gender-related development index (GDI)

The same factors as in HDI are used in the gender-related development index (GDI). The difference between them is that life expectancy, education and income per capita indices are adjusted to reflect inequalities between men and women for each of the three dimensions. To make such an adjustment a weighting formula based on average exponential function properties to take the lower value taking the average exponent is used (average majority rule).

To calculate GDI indices Anand and Sen proposed the formula given below2:

$$I = [d_w \times I_w^{1-\varepsilon} + d_m \times I_m^{1-\varepsilon}]^{1/(1-\varepsilon)},$$

2 Anand S., Sen A. Human Development Index: Methodology and Measurement // Background Paper for Human Development Report 1993. - New York: UNDP, 1992.

Where d_w and d_m - women and men ratio in total number of people, respectively;

I_w and I_m - corresponding indices for women and men;

(1-ε) - average exponent.

With different values of ε (average exponent 1- ε) we get various types of average value:

ε = 0 – arithmetic mean;

ε = 1 – geometric mean;

ε = 2 – harmonic mean, etc.

The more distinctive accepted average exponent from the arithmetic mean exponent value, the more substantial the effect on reducing the average index. The weighting parameter ε in World Human Development Reports is assumed to equal 2 ("moderate odium to inequality"). The result is a harmonic mean of men's and women's "achievement" rates.

The GDI is also correlated regarding maximum and minimum life expectancy values given the fact that women live longer than men. Therefore the female maximum life expectancy is accepted as 87,5 years, and minimum as 27,5 years, and male are 82,5 and 22,5, respectively.

The equi-distributed average life expectancy index (using weighting parameter ε = 2) is determined from the formula:

$$I = \left(\frac{d_w}{I_{lew}} + \frac{d_m}{I_{lem}} \right)^{-1}$$

where d_w и d_m - women's and men's ratios in the total number of people, correspondingly;

I_{lew} и I_{lem} - female and male life expectancy indices, correspondingly.

The equi-distributed education and income indices are calculated in the same way. The resulting GDI index is determined as the arithmetic mean of three equi-distributed indices.

The evaluation of the gender-related income index is more complicated. It is presumed that income gained in the country is allocated between men and women pro rata to their salaries. Two types of data are used in the calculation of women's and men's earnings ratio: the ratio of women's average wages to the average wages of men and the percentage female and male ratios in the economically active population aged 15 or more. If there is a lack of data about the ratio between the average female wage and average male wage, a ratio of 75 percent is used, which is the average weighted ratio of wage rates for all countries with information on wages.

Salary per woman ($S_ж$) is determined from the formula:

$$S_w = d_{eaw} \times I_{sw} / (d_{eaw} \times I_{sw} + d_{eam}).$$

where d_{eaw} и d_{eam} - the women's and men's ratios in the total number of economically active people, respectively;

I_{sw} - average woman's salary index with relation to the average men's salary.

Taking into account the population sex-age structure, we get income volumes (GDP) per woman and man:

$$GDP_w = GDP \times S_w / d_w ,$$
$$GDP_m = GDP \times (1\text{-}S_w) / d_m,$$

Where GDP, GDP_w, GDP_m - is respectively GDP per capita, GDP per one woman and GDP per one man.

5. Gender Empowerment Measure (GEM)

The Gender Empowerment Measure focuses on women's opportunities rather than their capabilities. Political participation and decision-making power, economic participation and decision-making power and power over economic resources are the three elements included in GEM.

The first two factors are selected to consider women's participation in economic activity and opportunities for making economic decisions: the percentage ratio of women and men holding administrative and managerial positions, and percentage ratio of women and men working in specialist and technical staff positions. As the relative ratio of people filling positions in each category is different from the total number of people, then first several indices for each category are calculated and then summarized.

The third index – ratio of women and men holding parliamentary positions – is selected to reflect participation in political life and opportunities to make political decisions.

By using the proposed averaging-out formula as applied to each of the three indices, where respective population ratios are used as balance, we get an equally distributed equivalent percentage (EDEP) for both sexes:

$$EDEP = \left(\frac{d_w}{d_{iw}} + \frac{d_m}{d_{im}}\right)^{-1}$$

where d_w и d_m - ratio of women and men in total amount of people, respectively;

d_{iw} и d_{im} - corresponding ratio of women and men for each index.

Then every index is readjusted by dividing EDEP by 50 %.

A measure of income is used as a factor reflecting the capability to manage economic resources. Making use of the method applied to GDI the mentioned index is calculated. Therefore the maximum value of income measures is 40,000 USD on PPP, and minimum is 100 USD based on PPP.

Equal weighted indices for each group of factors selected are simply summarized as the last step, i.e. participation in economic activity and opportunities to make economic decisions, participation in political life and opportunities to make political decisions and power over economic resources, as a result we get an aggregate GEM.

6. Human Poverty Index (HPI)

Depending on the social and economic conditions of some countries, there could be various assortments of indices in the human poverty index. In the 1997 World Human Development Report an HPI proposed for developing countries (HPI-1) described all three aspects of human life, which are already reflected in the HDI – longevity, knowledge and decent living standards:

$$HPI\text{-}1 = [1/3(P_1^3 + P_2^3 + P_3^3)]^{1/3}$$

Where

P_1 - ratio of people not surviving to 40 years,

P_2 - percentage of illiterate adults,

P_3 - arithmetic mean of people having no access to safe water and medical services, and also the ratio of children under 5 years, suffering from malnutrition.

Given the different socio-economic conditions in developed industrial countries (OECD countries plus Central & Eastern Europe and the CIS), the UNDP proposed another formula for measuring human poverty (HPI-2) for these countries in the 1999 World Human Development Report:

$$HPI\text{-}2 = [1/4(P_1^3 + P_2^3 + P_3^3 + P_4^3)]^{1/3},$$

Where P_1 - survival ratio of people not surviving to 60 years,

P_2 - percentage of functionally illiterate adults,

P_3 - percentage of population having income less than 50% of the median income in the country (i.e. people income amid income distribution series),

P_4 - percentage of economically active people unemployed for over 12 months.

Since 1999 for Kazakhstan the following formula for HPI-2 has been used in the National Human Development Report:

$$HPI\text{-}2 = [1/4(P_1^3 + P_2^3 + P_3^3 + P_4^3)]^{1/3},$$

where P_1 - survival ratio of people not surviving to 60 years,

P_2 - percent ratio of adults lacking functional literacy skills

P_3 - percentage of people living below the poverty line

P_4 - (long-term) unemployment rate.

The HPI calculation for Kazakhstan for 2006 is as follows: data have the following values: P_1 = 30,3%, P_2 = 6,7%, P_3 = 18,2%, P_4 = 7,8%.

Calculations based on the above formula show that Kazakhstan's HPI in 2006 was 20,5%, i.e. indicating a level of absolute poverty (poverty in the human development context) of over one in five people on the four selected indices.

7. Kazakhstan HDI by region

HDI use may be improved by its disaggregation. The country's general index may hide the fact that various groups of people in the country may have very different human development levels. Such differences may be according to location, sex or type of region (urban or rural).

For HDI calculation by region, the main problem is the selection of a factor to describe the availability of resources for people in an unbiased manner. According to UNDP methodology, GDP per capita is used as a factor at the national level. At the regional level the equivalent measure is gross regional product (GRP) evaluated by the operational method.

The weakness of the HDI evaluation method by region is the use of this factor for HDI estimation. The high weight in GRP production of the export sector gives the impression of imaginary economic welfare of people living in that region.

Considering this criticism of using GRP per capita as a factor describing access to resources, providing a decent living standard, along with the regional HDI, a population income index has been used when acquiring data and regional HDI estimates for national human development reports.

There was a 2.9 – 3.5 fold difference between the GDP per capita and population income at the national level in 1993-2006. There are three reasons for this. First, according to household studies cash income has a systemic error connected with their underestimation. The underestimation at macro level was from one quarter to one third of the declared cash income in 1999-2006. Second, GRP comprises population income in kind, which is up to one quarter of the cash income of people, and the cost estimate of several amenities that households manage as their owners. For example, they include a notional value of people's own accommodation. Third, the GRP from the viewpoint of its end use includes income used not only for consumption, but also for accrual. In addition, it should be noted that total PPP by oblast (GRP) does not give a GDP value at PPP, not allocated by region.

For these reasons the conversion of cash income per capita into USD at PPP will underestimate the assessment of access to resources. This is why in order to tally with results at the national level, cash income per capita converted at PPP into USD are multiplied by a ratio equal to that of GDP per capita to cash income per capita. The same ratio is used to adjust cash income per capita and by region. As a result, correlations of regional incomes with average national rates remain unchanged.

8. Kazakhstan HDI by region type (urban/rural)

To calculate HDI by location type there should be basic factors provided in the context of city/village. Despite some difficulties in calculating indices by location type, in recent years this has become possible, except for GDP per capita.

For the separation of GDP between the city and country, an idea usable at GDP valuation in gender aspects has been used in national human development reports. In the valuation of gender GDP the gained income is allocated between males and females pro rata to the share of their salaries, then when valuing GDP per city/village income per capita gained by urban and rural people is used.

GLOSSARY – DEFINITIONS OF TERMS

Adaptation to climate change – any activity making a contribution to adaptation to the impact of climate change on water and surface ecosystems, hydrology and water resources management, agriculture and forestry, human health (for instance, introduction of stable crops for compensation of local climate change, and so on).

Anthropogenic – a result or product of human activity (manmade)

Atmosphere – circumterraneous gas envelope rotating with the Earth as an organic whole. These gases support life of all living organisms.

Greenhouse gas emissions – manmade gas emissions (carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbon (PFC), sulfur hexafluoride (SF_6)) into the atmosphere above a specific area and over a certain period of time.

Literacy – ability to read, understand and write short text regarding human daily life.

Carbon dioxide, CO_2 – the main greenhouse gas, emitted by fossil fuel burning, disafforestation/changes in land use and cement production. It is also often referred to simply as “carbon”.

Nitrogen oxide, N_2O – the third in order of GG importance of the Kyoto protocol. Released by the production and utilization of mineral fertilizers, in the chemical industry, agriculture and so forth. GGP N_2O equals 310, i.e. in terms of the greenhouse effect 1 ton of N_2O equals to 310 tons of CO_2.

Climate change – change of climate condition, which may be manifest itself as changes in the average value and/or changeability of its properties, is long-lasting, usually several decades or more. Climate change may be caused by natural internal processes and/or external effects, and also by anthropogenic changes in the atmosphere or in land use.

Emission inventory (cadastre) – record of anthropogenic greenhouse gas emissions, made in pursuance of the UNFCCC method adopted by the IPCC

Human Poverty Index – an integral index, which characterizes poverty from the point of view of hardship in the human development context. Under the UN Development Program variations of the index for developing and developed countries (respectively HPI-1 and HPI-2) are suggested. In national human development reports, a modified indicator of the HPI has been used in Kazakhstan since 1999.

Human Poverty Index (HPI) – is calculated for Kazakhstan in national reports starting from 1999 on the basis of the following four indices:

where:
P_1 - survival ratio of people not surviving to 60 years,
P_2 - percent ratio of adults lacking functional literacy skills
P_3 - percentage of people living below the poverty line
P_4 - (long-term) unemployment rate.

Human Poverty Index for developing countries (HPI-1) – is calculated on the basis of the following four indices:
where:
P_1 - survival ratio of people not surviving to 40 years,
P_2 - percentage of illiterate adults,
P_3 - arithmetic mean of people having no access to safe water and medical services, and also the ratio of children under 5 years suffering from malnutrition.

Human Poverty Index for selected developed countries (HPI-2) – is calculated on the basis of the following four indices:
where:
P_1 - survival ratio of people not surviving to 60 years,
P_2 - percentage of functionally illiterate adults,
P_3 - percentage of population having income less than 50% of the median income in the country (i.e. people income amid income distribution series),
P_4 - percentage of economically active people unemployed for over 12 months.

Human development index (HDI) – is calculated as the arithmetic mean of three other indices: life expectancy at birth, education ratio and income per capita. The education ratio is calculated on the basis of the literacy index (weighted two-thirds) and education accessibility (weighted one-third).

Kyoto protocol – The Kyoto protocol to the UN Framework Convention on Climate Change (Protocol) was adopted at the third session of the UNFCCC Conference of parties in December 1997 in Kyoto (Japan). It contains binding legal commitments in addition to those specified in the UNFCCC. Parties included in Annex B to the Protocol (most are members of Organization of Economic Cooperation and Development, and countries with transition economies) agreed to curtail their greenhouse gas emissions of anthropogenic origin (carbon dioxide, methane, nitrogen oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) to at least 5% below 1990 levels over the validity of commitments from 2008 to 2012. The Kyoto protocol came into force on February 16, 2005.

Climate – perennial weather regime in any area determined by the geographical conditions of that area. The ideas of climate are formed on the basis of statistical processing of long-term meteorological observations.

Conference of Parties to UNFCCC – is a supreme body of the UN Framework Convention on Climate Change. It unifies over 170 countries ratifying the Convention. The CoP role is in assistance and facilitation of the performance of UNFCCC articles and control over their observance. The UNFCCC Conference of parties convenes on an annual basis for the solution of current issues.

Intergovernmental Panel on Climate Change (IPCC) – established in 1988 as the joint expert body of the World Meteorological Organization (WMO) and UN Environmental Program (UNEP) for the purpose of getting maximally authentic and reputable answers to climate change related questions. IPCC involves hundreds of researchers and scientists throughout the world, in their work and published reports, with recommendations agreed at intergovernmental level with all details. The first IPCC report was published in 1990, the second in 1995, and third in 2001.

Methane CH_4 – the second GHG (greenhouse gas) in order of importance of the Kyoto protocol. It is released through leakages from pipelines, from agriculture (especially livestock), disposal sites, melting of permafrost, wetlands and so on. GGP of methane is 21, i.e. under the greenhouse effect 1 ton of methane is equal to 21 tons of CO_2.

Education – literacy rate of people at 15 years old and older, and education coverage index.

Life expectancy at birth – the number of years a newborn infant would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life.

Education coverage (enrolment) – the ratio of the total amount of pupils (accepted) at all educational levels (primary, secondary, secondary technical, university, postgraduate education) regardless of the age to total population, at the age of 5-24 years.

Purchasing power parity (PPP) of national currency – the amount of national currency required to purchase a similar market basket which is possible to buy for 1 USD in the USA. Allows international comparisons of real output and incomes.

Greenhouse gas – the atmospheric gas components of a natural and anthropogenic nature that absorb and radiate specific length waves in the range of heat infrared rays emitted by the surface of the Earth, the atmosphere and clouds are related to greenhouse gases (GHG). This property makes the greenhouse effect. The main greenhouse gases in the Earth's atmosphere are vapor (H_2O), carbon dioxide (CO_2), nitrogen oxide (N_2O), methane (CH_4) and ozone (O_3). Besides, there are a number of other greenhouse gases in the atmosphere of fully anthropogenic origin, like halocarbons and other chlorine and bromine containing substances subject to the Montreal protocol. In addition to CO_2, N_2O, and CH_4, such greenhouse gases as sulfur hexafluoride (SF_6), hydrofluorocarbons (HFC) and perfluorocarbons (PFC) are regulated by the Kyoto protocol.

Global warming potential – is a ratio, describing the radiating effect of a greenhouse gas, which corresponds to the warming effect of one unit of carbon dioxide for a given period of time

United Nations Framework Convention on Climate Change (UNFCCC) – was accepted on May 9 1992 in New York and presented during the Earth Summit in Rio de Janeiro, and in 1992 by over 150 states and the EU. It was enacted in March 1994. In compliance with the Convention, the Parties listed in Annex I (all OECD countries and countries with transition economies) strive to revert to greenhouse emissions level by 2000, not subject to Montreal protocol.

Sustainable development – is a comprehensive controllable process of integrated development of nature and society, with the goal of providing current and future generations with a high quality productive life in harmony with nature based on the protection and enhancement of cultural and natural heritage.

Human development – is a process of providing people with a wider range of choices to live long and healthy lives, to gain knowledge and have access to the resources needed for a decent and fulfilling life.

Eutrophication of water – the accumulation of biogenic elements in water under the impact of anthropogenic or natural factors. The eutrophication initially results in enhancing bioproductivity of water basins, and then, with increasing lack of oxygen, to suffocation.

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