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CLIMATE PROFILE OF THE KYRGYZ REPUBLIC

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The State Agency for Environmental Protection and Forestry
under the Government of the Kyrgyz Republic

The United Nations Development Programme

Climate profile of the Kyrgyz Republic

Bishkek 2013

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This profile was prepared as part of the UNDP Project "Climate Risk Management in Kyrgyzstan". The profile aims to analyze the first phase of measures for adaptation to climate change, namely, the extent of the observed and expected climate changes and their impact on the Kyrgyz Republic for further effective implementation of appropriate adaptation measures. This phase aims at vulnerability assessment, which in many ways can be viewed as a model for all sectors. This publication is intended to enhance capacity of professionals and the public in developing sectoral action plans for adaptation to climate change in the Kyrgyz Republic.

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1. LIST OF ABBREVIATIONS AND ACRONYMS

VHA	Viral Hepatitis A
WMO	World Meteorological Organization
GRP	Gross Regional Product
SAEPF	State Agency for Environmental Protection and Forestry under the Government of the Kyrgyz Republic
Kyrgyzhydromet	Agency for Hydrometeorology under the Ministry of Emergency Situations of the Kyrgyz Republic
IPCC	Intergovernmental Panel on Climate Change
MOE	Ministry of Emergency Situations of the Kyrgyz Republic
NSC	National Statistical Committee of the Kyrgyz Republic
NGO	Non-governmental organization
AII	Acute intestinal infections
GHG	Greenhouse gases
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
FAP	Feldsher midwifery points (primary healthcare facility)
ES	Emergency situations
SPEI	The Standardized Precipitation-Evapotranspiration Index
SPI	The Standardized Precipitation Index

2. SUMMARY

Although humanity now perceives climate change as a serious global problem – the UN Framework Convention on Climate Change was adopted at the "Earth Summit" in Rio de Janeiro in 1992 and entered into force on 21 March 1994 – only now this problem has shifted from the research and discussion stage to the stage of concrete actions. A step in this direction is actual work on climate risk management.

This report aims to analyze the extent of observed and expected climate change and the impact on the Kyrgyz Republic for effective implementation of appropriate actions to adapt to climate change.

Even at this current level, numerous consequences of the climate change already seriously affect the environment, public health and various spheres of economic activity.

A detailed analysis of climate change on the territory of the Kyrgyz Republic has demonstrated significance of the observed climate change.

Over the period from 1885 to 2010, temperature in the Kyrgyz Republic has really increased significantly. Moreover, the change rate is not linear, and has also increased significantly in recent decades. The growth rate of the mean annual temperature in the republic was 0.0104oC /year during the entire observation period; however, over the past 50 years (from 1960 to 2010), it has increased more than two-fold and was 0.0248oC/ year, and in the last 20 years (1990 - 2010) was already 0.0701oC / year. The total annual precipitation in the republic over the entire period of observation was slightly increasing (0.847 mm/year); however, in the last 50 years, it has decreased significantly (0.363 mm/year), while in the last 20 years, there is even a slight tendency to decrease (-1.868 mm/year). The duration of the heating period in 1991 - 2010 compared to the baseline period (1961 - 1999) at altitudes up to 1,000 m decreased by 9 days, from 152.7 to 143.5 days.

Analysis of the expected changes shows that in a scenario with the current trends, temperature may increase by more than 4oC by 2100. Virtually in all regions of the republic, the temperature increase will be approximately the same (the difference will be not more than 0.2°C). It is interesting to note that according to the global climate models, the expected temperature change will presumably be the same for all months, in contrast to the observed trends. The duration of the heating period will also significantly reduce – by 16% by 2050 and by more than 30% by 2080.

It is expected that the annual precipitation will decrease in the future, but at a low rate (-0.0677 mm/year), which will fall by approximately 6 mm compared to the current level in 2100. In addition, some volatility in precipitation over time is expected, in contrast to the monotonically changing temperature. Uncertainty in the assessment is relatively insignificant (hereinafter, the term is used in line with the definition in the guidelines [9, 40]). The expected seasonal distribution of precipitation is generally the same as was observed in recent decades.

Previously conducted activities allowed to identify the following most vulnerable sectors to climate change:

- Water resources;
- Hydropower;
- Emergencies;

- Agriculture;
- Public health;
- Forests and biodiversity.

Given the resource constraints and the fact that for some sectors, for example, public health sector, vulnerability analysis has already largely been completed, this report discusses the following as the main two sectors:

- Emergency situations (ES); and
- Agriculture.

The correlation between the following major emergencies and observed climate change was analyzed for the emergency situations sector:

- Mudflows, floods;
- Landslides;
- Avalanches;
- Flooding;
- Heavy rains;
- Hurricane winds;
- Hail; and
- Snowfall

Baseline data on the number of emergencies since 1990 were used for trends analysis. The analyzed ES do not include data on highland lakes breakthroughs, as despite the increase in their number (probably as a direct climate change impact), this ES is not satisfactory monitored.

The results show that Osh and Jalal-Abad regions are the most vulnerable to landslides, with the least vulnerable Talas region. Jalal-Abad region is also the most vulnerable to avalanches, with the least vulnerable Batken region. The most vulnerable to mudflows and floods is the Jalal-Abad region, and the least vulnerable is the Naryn region. Variability in the number of flooding with breakdown by regions has not been analyzed for lack of the baseline data. The Jalal-Abad region is also the most vulnerable to rainstorms, while the least vulnerable is Talas. The Issyk-Kul region is the most vulnerable to hurricane winds, while the least vulnerable are the Naryn and Batken regions. Vulnerability to hails and snowfalls has not been analyzed due to lack of the baseline data.

Despite different trends in certain types of ES, in general, there is a tendency of their total increase in all regions, except for rainstorms, the reduction of which is observed in all regions excluding Talas. Trends in hurricane winds are less clear, they have reduced in the Jalal-Abad and Naryn regions. Significant decrease in the number of landslides in the Chui region should also be noted.

Based on the assumption that during the analyzed period there were no any further changes in the conditions of ES formation, except for obvious climate change, it is assumed that the main factor that leads to the volatile number of ES is climate change, i.e., change in the climate system as a whole. Changes in the climate system are mentioned quite often in the past decade, nonetheless there is no any generally accepted uniform quantitative indicator for assessing these changes; therefore, the relatively monotonous and statistically significantly changing mean annual temperature was used in this report as the indicator, because rainfall did not significantly changed during the period concerned. The increase rates of certain types ES were determined in each region and can be a source of baseline information for determining the expected amounts of damage as a result of projected climate change in the future based on extrapolation. Use of extrapolation naturally imposes certain restrictions. Therefore, the above results can be used as a prognostic assessment only for a limited time period (no more than 5 - 15 years), as statistically unforeseen situations may arise in case of significant changes of the climate system.

In order to avoid the effects of inflation, the economic loss for the period from 1990 to 2010 was determined in constant USD of 2005. The expert assessment of the direct damage attributable to a specific type of ES in 2010 according to the Ministry of Emergency Situations was used (excluding estimates of damage to agriculture by the National Statistical Committee, which is assessed separately).

According to expert assessments of the International Bank for Reconstruction and Development, the total damage from the ES exceeds direct damage several times ("Cost-effectiveness of the Program 'Technical and Technological Development of the National Hydrometeorological Service of the Kyrgyz Republic', pilot research report, 2008).

For the crop sector, the impact of climate change on the yields of crop with available detailed data was assessed, i.e. crops with small gaps in data and less dependent on irrigation. Based on these conditions, wheat, barley, sugar beet and maize were selected as the most vulnerable ones.

Analysis of baseline data on damage from climate impact in agriculture monitored by the National Statistical Committee ("drought, lack of water", "rainstorm, hail", "frost and snowfall") demonstrated no statistically significant correlation with the climate monitoring data. In general, increasing losses were observed neither for these crops, nor across the crop sector from the three types of climate impacts for 1991 - 2011.

The reasons, why there is no any adverse effect of ES, such as "drought, lack of water," "rainstorm, hail", "frost and snowfall" on the yield may include the following:

- Weakness of the monitoring system;
- Actually reduced frequency and severity of the above climatic ES in the current climatic trends;
- Increased focus on irrigated agriculture in crops sector.

Therefore, only yield and its correlation with sufficiently reliable climatic parameters were considered as the main indicator. The possibility to use standardized precipitation index SPI for yield assessment was analyzed and showed that changes in the yield of the following four kinds of agricultural crops can be statistically and reasonably estimated:

- Cereals (weight after processing);
- Wheat (weight after additional processing);
- Sugar beet;
- Barley (weight after additional processing).

As for other analyzed crops, there is no any statistically significant correlation between the index and yield. There may be some correlation for other crops, for which there is no any official data on yield, for example, oats and buckwheat.

The best time for assessing SPI index is October. The highest correlation is observed when using index calculation depth of 9 - 10 months.

Assessment of the projected index allows to estimate variability in yield of selected crops due to climate change in future periods. SPI index can serve as a benchmark in implementing crop insurance scheme.

Geographical analysis was conducted to map key components of vulnerability to climate risks. Geographical aspects of sensitivity and adaptive capacity were considered. The following socio-economic indicators were selected to assess vulnerability:

- the proportion of the rural population
- the proportion of the population engaged in agriculture and forestry;
- the proportion of agriculture in the gross regional product (GRP);
- the arable land area to the land area of the region ratio;
- the non-irrigated arable land area to arable land area of the region ratio;
- the area of crops to the total arable land area of the region ratio;
- the number of livestock per pasture area (load).

In addition, characteristics of the main ES on the territory of the republic - landslides, avalanches, mudflows and floods, flooding, rainstorms, hurricane winds, hail and snowfall were used as indicators of vulnerability.

The following socio-economic indicators were selected to determine capacity:

- the proportion of the working-age population in the territory;
- life expectancy at birth;
- interregional migration in the territory;
- the proportion of the unemployed;
- the number of students in higher, secondary and primary vocational education institutions;
- income by territory;
- income from private farming;
- availability of doctors of all specialties;
- gross regional product;
- equipping housing fund.

The highest vulnerability of agriculture was found in the Talas region and the lowest – in the Naryn region. Direct damage from ES to GRP ratio was the highest in the Batken region and the lowest – in the Chui region. The Chui region has the highest adaptive capacity, while the lowest is in the Naryn region.

Gender analysis of climate risk management related issues was conducted. Key risks reduction methods were formulated from a gender perspective.

Progress and prospects of the institutional sphere development were discussed. Key ministries and agencies involved in tackling climate change and their mandates in accordance with the Regulations were identified, as well as areas for expansion and improving the mandates of the current key ministries and agencies. The main focus of this project is improving the status of the intergovernmental body, this objectives is now practically achieved in full compliance with the proposed recommendations. Policy framework for climate risk management and progress with integrating climate risk management when developing policies and strategies were analyzed. In addition, approaches to climate risk management system development, as well as major barrier to development were identified.

3. INTRODUCTION

This climate risk profile was prepared as part of the UNDP Project "Climate Risk Management in Kyrgyzstan."

In accordance with the KR's commitments as a party to the UN Framework Convention on Climate Change, the country shall formulate, implement, publish and regularly update national and, where appropriate, regional programs that include measures aimed to facilitate adequate adaptation to climate change. A detailed analysis of climate change on the territory of the Kyrgyz Republic has shown the observed climate change is significant. At the same time, the country has not yet actually started systematic implementation of the adaptation measures.

This profile aims to analyze the extent of observed and expected climate change, its impact on economic activity, public health and the environment of the Kyrgyz Republic for the effective implementation of appropriate actions to adapt to climate change.

Based on previous studies, the following sectors were identified as the most vulnerable to climate change:

- Water resources;
- Hydropower;
- Emergencies;
- Agriculture;
- Public health;
- Forests and biodiversity.

Due to:

- certain resources constrains during this study;
- the fact that vulnerability analysis in some sectors had largely been covered by previous reports;
- and planned activities in the hydropower sector were more of mitigation nature (i.e., focused on reducing greenhouse gas emissions) rather than adaptation,

the main two sectors in this report are:

- Emergencies; and
- Agriculture.

Various climatic phenomena representing certain risks for the population occur every year. These risks are the result of the "common" – regional or seasonal climate variability, but there is scientific certainty that the global climate is changing. The main undoubted factors are the following [6]:

- The current global climate is much warmer than at the beginning of the 20th century. Over the 20th century, the global temperature has increased by approximately 0.6˚C;
- It is likely that the period from 1990 to 1999 was the warmest decade in the last 1,000 years;
- The observed warming over the last decades is largely due to human activity, namely, the result of increasing major GHG emissions;
- Due to long period of major GHG removal from the atmosphere and its accumulation in the ocean-

atmosphere system, climate change will continue in the coming decades or even centuries, even despite immediate actions aimed to reduce global GHG emissions, if the decision on global commitments will be adopted in the nearest future.

Climate change related consequences:

Increase in mean temperature:

- Increase of evaporation and dislocation of the water balance;
- Increase in the number of the communicable diseases;
- Increased intensity of droughts;
- Reduced snow cover;
- Degradation of the glaciers;
- Seasons shift;
- Reduction of the heating season;
- Increase in costs for cooling;
- Degradation of agricultural lands;
- Reduced range of alpine ecosystems and species.

Increase in maximum temperatures, more hot days and heat waves:

- Increased incidence of deaths and serious illness, especially in older age groups;
- Increased heat stress for livestock and wildlife;
- Reduced productivity of some crops;
- Increased frequency and intensity of forest fires and spread of pests;
- Increased demand for cooling electrical equipment and reduced energy supply reliability;
- Minimum temperature decrease, reduction in the number of cold and frosty days:
- Reduction in morbidity and mortality from diseases related to cold;
- Reduced risk of decrease in the yield of certain agricultural crops and increased risk to others;
- Increased variety and activity of some pests and disease vectors;
- Reduced demand for energy for heating purposes.

Decrease in precipitation:

- Reduction of the mean runoff;
- Changes in seasonal distribution of surface runoff;
- Deterioration of the water resources quality;
- Reduced productivity of some agricultural crops;
- Reduction of the hydropower capacity;
- Negative impact on river and wetland ecosystems;
- Increase in the number and intensity of droughts:
- Lower productivity of certain agricultural crops and some pastures;
- Increased damage to soils and the respective deterioration of soil fertility;

- Negative impacts on biodiversity and forest resources;
- Increased risk of forest fires;
- Decrease in relative humidity;
- Increasing comfort of living in high and low temperatures.

Not all the above mentioned effects of climate change are largely typical for the Kyrgyz Republic; however, most of them are quite realistic for our conditions. The report of the United Nations University provides ranking of all countries in terms of extent of exposure to climate risks with breakdown by emergency situations and adaptive capacities. [52] The Kyrgyz Republic is ranked as the 50th. In fact, this ranking is not as high, as we expected, because small island states are the first in the ranking. Rise of the global sea level for these states means, at best, loss of the main source of food, and at worst - disappearance of the state as a whole, followed by forced migration.

State agencies and local communities of the republic already have some experience and appropriate structures for climate risk management. However, in future risk management one cannot simply rely on the assumption that the prevailing climatic risks will be the same as those observed over the last 50 or even 100 years.

The experience of resisting to natural climate variability in the existing systems can be valuable when developing strategies for combating climate change, but important differences shall be kept in mind. In case of significant climatic changes, their impact can have extensive consequences and adverse impacts will not or may not disappear by themselves in the foreseeable future without appropriate action.

We will, of course, have to adapt to climate change. However, effective adaptation requires knowledge about the expected risks related to climate change and understanding of the relative importance of these risks.

4. METHODOLOGY

4.1. APPROACH AND METHODS

Methodology was defined based on the literature review [3, 4, 8, 12, 22, 26, 29, 30, 36-39, 43-51]. The following sequence of actions was adopted on the basis of the review:

1. Climate change analysis. The analysis involves reviewing variability of climatic parameters (surface temperature and precipitation) in the past and expected variability of these parameters in the future. The analysis should be conducted so that to ensure further preparation of the climate risks profile.

   Assessing the impact of climate change, which in turn is split into the following areas:

   - Sectoral risk analysis (trends and priorities should be identified for each key sector and observed and expected impacts of climate change, including assessment of damages shall be presented). On the basis of the existing country experience in vulnerability assessment, sectoral analysis helps to define a model of climate change correlation with the reaction of the sector concerned in order to obtain quantitative estimates. The model shall be as follows:

     $$y = f(x)$$

     where

     y is the vulnerability indicator;

     x is the vector of climatic parameters.

     The approach to establishing correlation may be based on known physical correlations or using statistical methods.

   - Geographical analysis (it is necessary to identify "hot spots" in the country in terms of vulnerability to climate change and the existing adaptive capacity);
   - Gender analysis;
   - Climate risks for development priorities (it is necessary to identify the main effects of the climate risks that have the greatest impact on the development of the country, based on Millennium Development Goals);

Analysis of the national capacity is split into the following areas:

- Institutional capacity for risk management (it is necessary to analyze, what ministries and agencies are responsible for the climate risk management and their effectiveness, as well as the ability of national organizations, including universities and scientific institutions, non-governmental organizations and others to influence on the decision-making at the national and local levels and how. It is important to analyze situation with the climate change monitoring system and scientific research);
- The extent of climate change integration into policy (analyze progress with integration of climate risk management in various national and sectoral development strategies);
- The current risk management activities;
- Areas for enhancing risk management capacity (identify priority needs of the national capacity so that to enhance country›s capacity for addressing current and future risks to the development related to climate variability and climate change).

Selecting risk management actions. The whole range of actions shall be considered and presented, including:

- Territorial planning;
- Improving resources management;
- Financing and insurance;
- Capacity-building;
- Education;
- Scientific research;
- Systematic observation;
- Providing information about the climate and risks;
- Priority measures (by sectors) should be clarified in the course of consultations with stakeholders.

The main methodological, and to some extent, scientific challenge is sectoral risk analysis. No any scientific researches aimed to assess the impact of climatic parameters on various even important sectors, such as emergencies and agriculture, were conducted in the country.

Naturally, there are no any appropriate data bases that would be available to the public. Unfortunately, it is almost impossible to retrieve appropriate specifically organized data from the existing standard statistics and production systems.

Ideally, a proper report shall summarize and systematize the conducted surveys and researches of the climate change impact in various sectors of the country. However, given the current situation and the resource constraints, this report can be viewed not as complete guidelines for climate risks reduction, but a stimulant for future work on adaptation to climate change.

4.2. KEY CONCEPTS

This section is based on the ideas presented in the review [34]. Risk is a term, which is often used in everyday life, but it is difficult to define it in practice due to its complexity and complicated links between its separate components. Risk is a combination of the probability of occurrence of an event and adverse effects of this event (e.g., climate threats).

There are two major approaches to assessing climate risks. These approaches differ by their main focus – either on biophysical or socio-economic aspects related to the climate risk, i.e. hazard as a result of climate change or socio-economic problems arising as a result of climate change are considered first. These two approaches complement each other and can be used separately or together. For the first approach, the risk can be defined as:

For the second approach, the risk can be defined as follows:

$$Risk = probability\ of\ a\ climatic\ event * Vulnerability\ to\ this\ type\ of\ event$$

In this case the event is any dangerous *event* that can potentially cause damage. Examples of hazardous weather events are droughts, mudflows, floods, flooding or conditions that lead to unfavorable conditions for the environment or humans.

Probability may relate to frequency and magnitude of the hazard or as frequency of exceeding certain socio-economic criteria. The probability may vary and be assessed using qualitative (such as “probable” or “very likely”) and quantitative assessments.

Vulnerability is broadly defined as the result of hazardous climatic events, preferably in value terms.

5. CLIMATE ANALYSIS

Climatic characteristics were analyzed with the account of administrative division of the country, as well as the adopted climatic zoning.

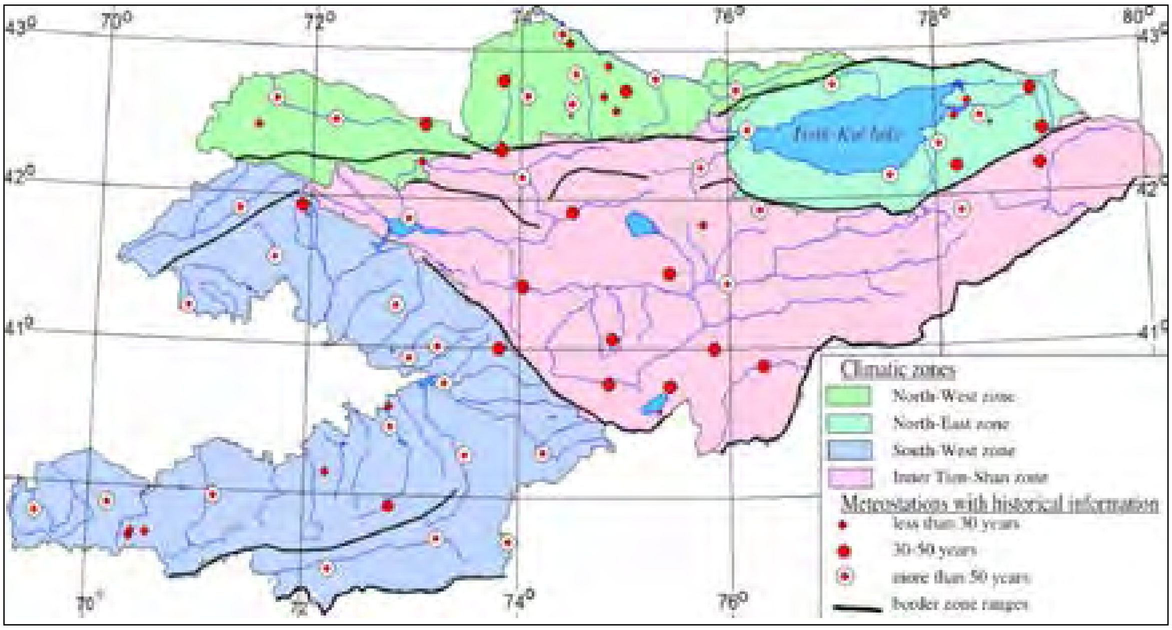


Figure 5.1. Adopted climatic zoning of the republic (source Kyrgyzhydromet)

In general, extremely continental and arid climate in the Kyrgyz Republic, to some extent smoothened by increased cloudiness and precipitation due to mountainous terrain, is caused by its location in the Northern Hemisphere in the center of the Eurasian continent, as well as remoteness from large water bodies and proximity of the desert.

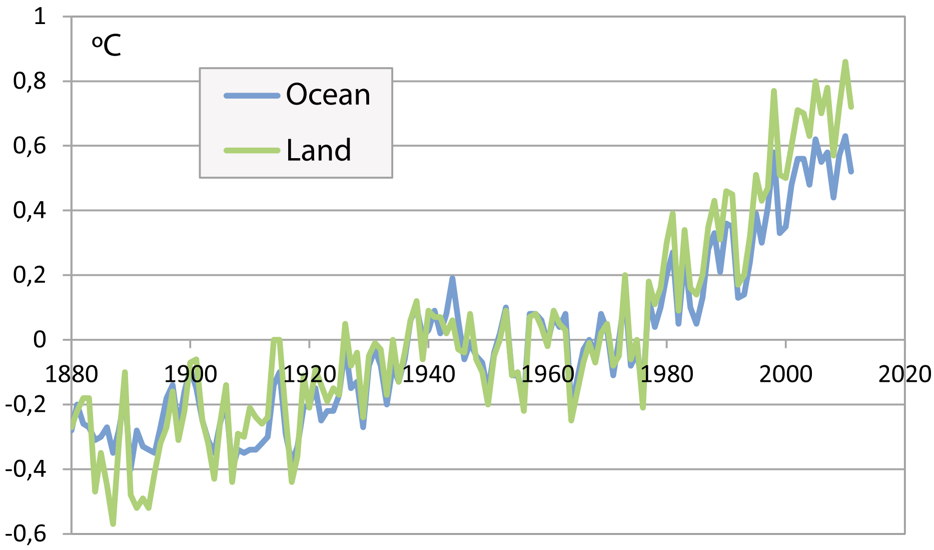


Figure 5.2. Observed global trends of the varying mean annual temperature over land and ocean (Source - IPCC)

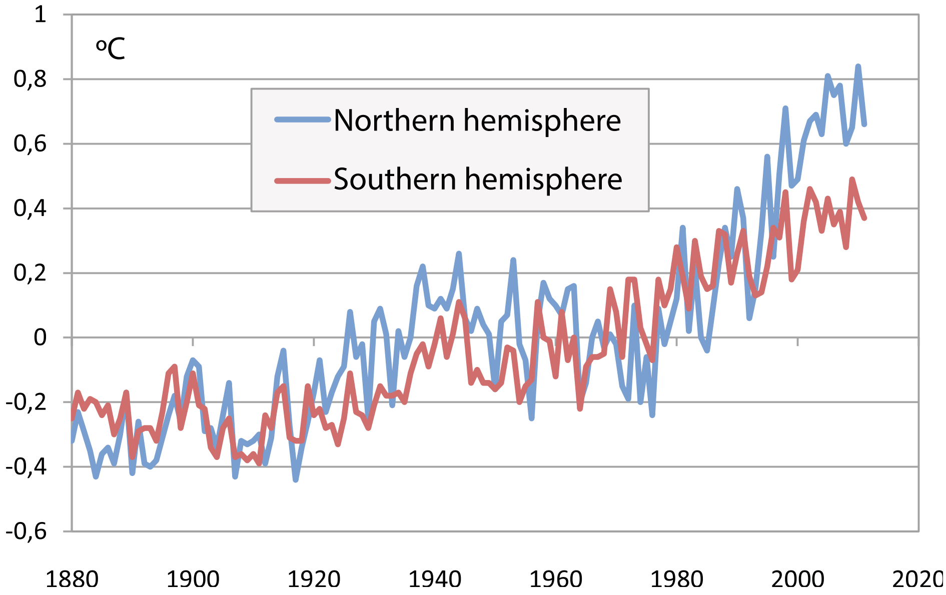


Figure 5.3. Observed global trends of the varying mean annual temperature in the northern and southern hemispheres (Source - IPCC)

As shown in Figures 5.2 and 5.3, the temperature increase over the land in the northern hemisphere is slightly higher than over the water surface and in the southern hemisphere. This causes to some extent greater rate of the temperature increase in the Kyrgyz Republic compared to the global increase. Hence it is clear that the impact of climate change on our country is much higher than on countries with access to the sea and located in the southern hemisphere.

5.1. DESCRIPTION OF THE MONITORING SYSTEM

The first meteorological station on the territory of Kyrgyzstan was opened in 1856 in Ak-Suu village on the coast of the Issyk-Kul lake. It monitored precipitation, air temperature and atmospheric phenomena. Systematic instrumental climate observations actually started in 1883, when meteorological station was opened in Karakol. Changes in the number of meteorological stations by years, their distribution on the territory of the country and their altitude please see in Figure 5.4, which shows their number as a whole and with breakdown by separate climate regions in accordance with the adopted division of the country. Figure 5.4 uses the following symbols for the climatic regions:

- SW – southwestern region;
- NW – northwestern region;
- NE – northeastern region;
- ITS - Inner Tien-Shan

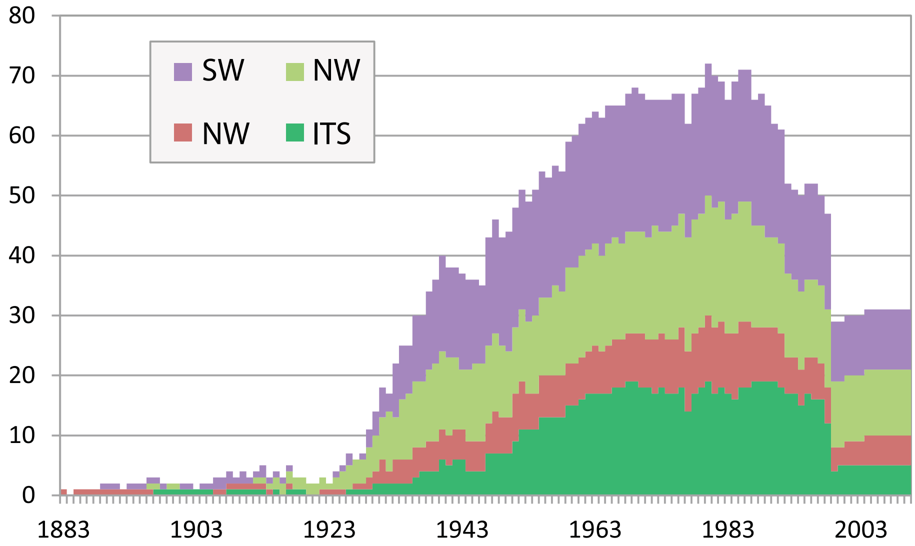


Figure 5.4. Changes in the number of active meteorological stations over the whole period of instrumental observations (source: Kyrgyzhydromet)

The period of the increasing number of meteorological stations since the beginning of observations until mid 80s was replaced in 1990 by consistent decrease in the number of observations, which in 1996 ended up in their sharp decrease to the level of the 30-ies of the last century due to the reduced budgetary funding. Further, the number of observations did not change significantly (see Figure 5.5). Now the meteorological observations network has sharply reduced and a bit more than 30 meteorological stations currently operate, which is significantly below the number recommended by WMO, even for plain countries. It is clear that for the Kyrgyz Republic, as a mountainous country with the rapid change of the climate, density of meteorological stations should be significantly higher for accurate monitoring of the current situation.

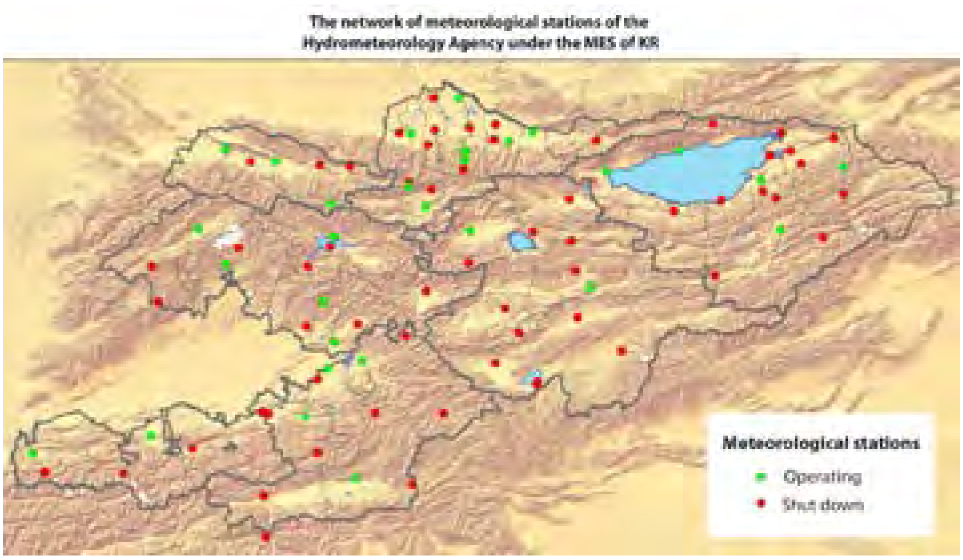


Figure 5.5. The map of meteorological stations location (source: Kyrgyzhydromet)

As can be seen from Figure 5.6, distribution of meteorological stations with breakdown by altitude does not correctly reflect distribution of the country' area. It can be concluded that analysis of trends in the country's climatic parameters is distorted and reflects more the situation at low altitudes. For example, figures reflecting temperature in the country as a whole at the existing meteorological stations will be to some extent overstated.

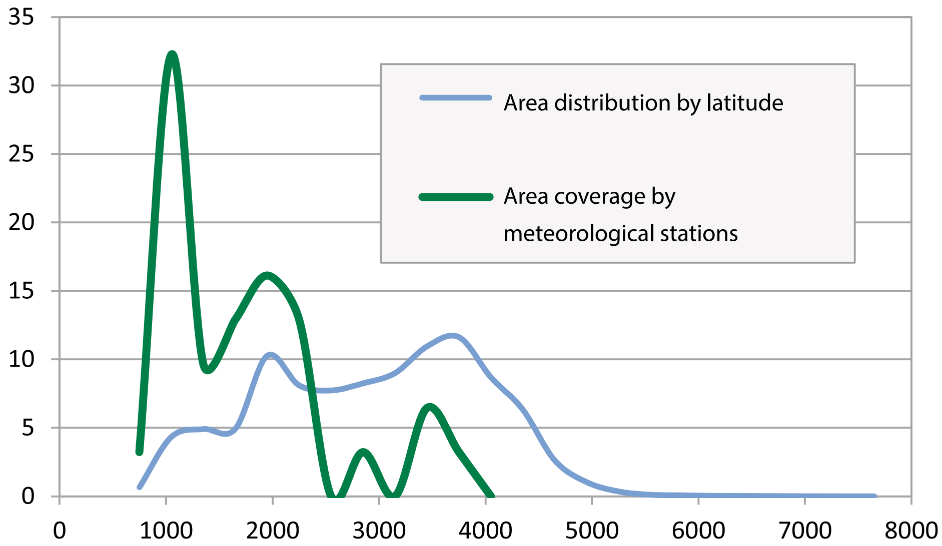


Figure 5.6. Distribution of meteorological stations and distribution of the country's area in percentage with breakdown by altitude

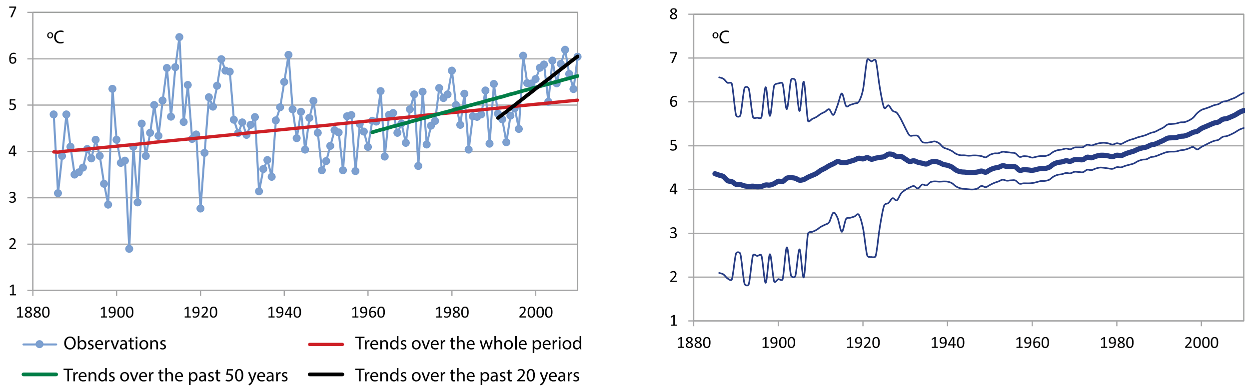
5.2. OBSERVED CLIMATE

Since recommended daily baseline information is not available, climate was observed based on annual and monthly figures.

5.2.1. TEMPERATURE

Due to unsatisfactory system of meteorological monitoring, i.e. generally insufficient number of observations at a small number of long-row meteorological stations and gaps in observations, we applied the approach, which was first used in preparing the Second National Communication of the Kyrgyz Republic on Climate Change [5]. Climate change analysis is based on transformation of the initial series of observations. Certain series of observations were consistently differentiated, followed by averaging differentiated series and then integrating into the summary series. It is clear that the use of discrete data depends on the application of numerical differentiation and integration.

The described approach enabled us to assess mean annual temperature trends for the period 1885 - 2010 in the Kyrgyz Republic, whereas the longest series of observations are less than 100 years, as well as to significantly increase the length of the tendency analysis for certain areas.



Trends at certain intervals

Uncertainty of the assessment

Figure 5.7. Mean annual temperature variability trends across the country

Uncertainty was calculated depending on the number of meteorological stations with the assumption that the temperature was distributed normally. Uncertainty was built on relatively smoothed tendency using the method of unweighted moving mean value over the interval including 31 observations.

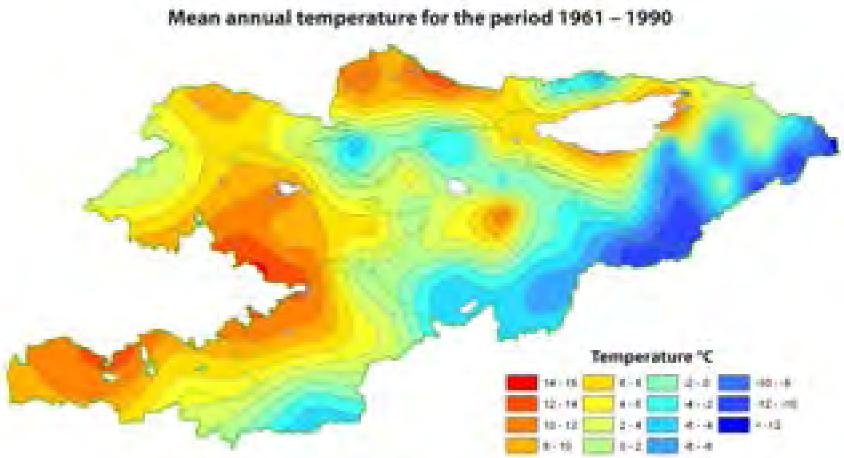


Figure 5.8. Distribution of the mean annual temperature (° C) on the territory of the country

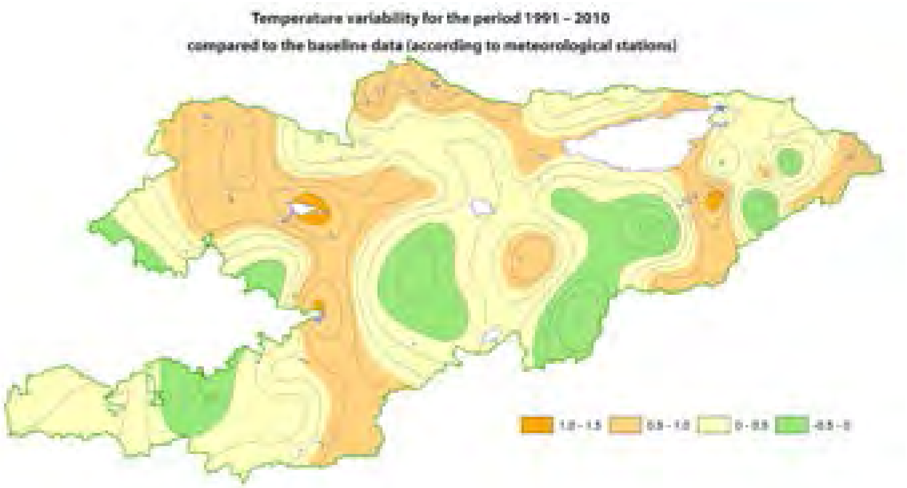


Figure 5.9. Distribution of zones with different increase rate of the mean annual temperature (°C) over the past 20 years compared to the baseline period (1961 - 1990)

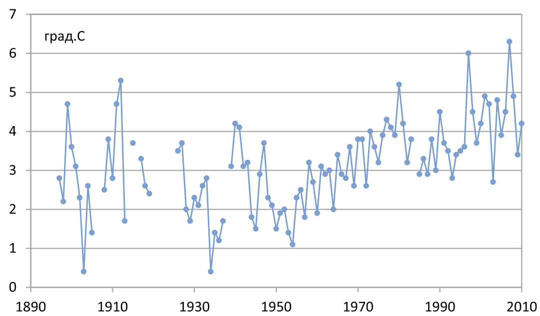
The results of calculation of the mean annual temperature trends in the country as a whole in Figure 5.7 show that the temperature during the period from 1885 to 2010 has really changed significantly. Moreover, the variability rate has substantially increased in recent decades - during the entire observations period, the increase rate was 0.010377oC/ year, over the past 50 years (1960 - 2010) it has increased more than two-fold and was 0.024773oC /year, and over the last 20 years (1990 - 2010), it already reached 0.070082oC / year.

Moreover, the observed increase in the mean annual temperature is almost the same in all climatic zones and regions of the country, with the exception of the Issyk-Kul region (see Table 5.1). It should be noted that in all cases changes are statistically significant. Figure 5.8 shows the distribution of temperature over the baseline period and Figure 5.9 shows changes compared to the baseline period.

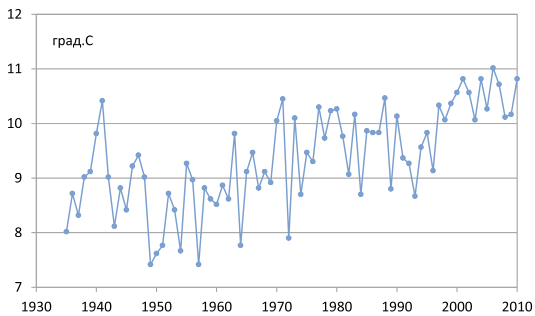
Table 5.1. Changes in temperature (°C) with breakdown by regions compared to the baseline period

Region Indicator	Batken	Jalal-Abad	Issyk-Kul	Naryn	Osh	Talas	Chui
Mean 1961-1990 (baseline)	9,45	8,11	3,04	-0,34	6,32	6,13	5,11
Mean 1991-2010	10,13	9,00	3,36	0,11	7,16	6,66	5,65
The difference between the mean values	0,67	0,89	0,32	0,46	0,84	0,53	0,54
Increase from 1991 to 2010	1,61	1,42	0,88	1,57	1,36	1,39	1,22

Для обеспечения последующих действий по оценке климатических рисков расчеты тенденций среднегодовой температуры проведены по всем климатическим зонам и всем областям, а также построены температурные тенденции по всем действующим в настоящее время метеостанциям. Результаты расчетов сведены в электронный архив. Примеры расчетов приведены на рис. 5.10.



The north-western region



The Batken region

Figure 5.10. Examples of calculating the mean annual temperature trends for certain territories and meteorological stations

Figure 5.11 reflects temperature gradient for all climatic regions. This information can be used to assess displacement of various ecosystems or agricultural lands in the altitude that leads to changes in temperature. The temperature gradient reflects changes in temperature depending on altitude. It should be noted that changes in all the regions are almost the same, if not to take account of the parallel displacement along the ordinate axis due to area latitude. Slightly larger changes are typical for the Issyk-Kul basin (NE), which is due to the influence of the lake and natural lack of meteorological stations located below the surface of the lake.

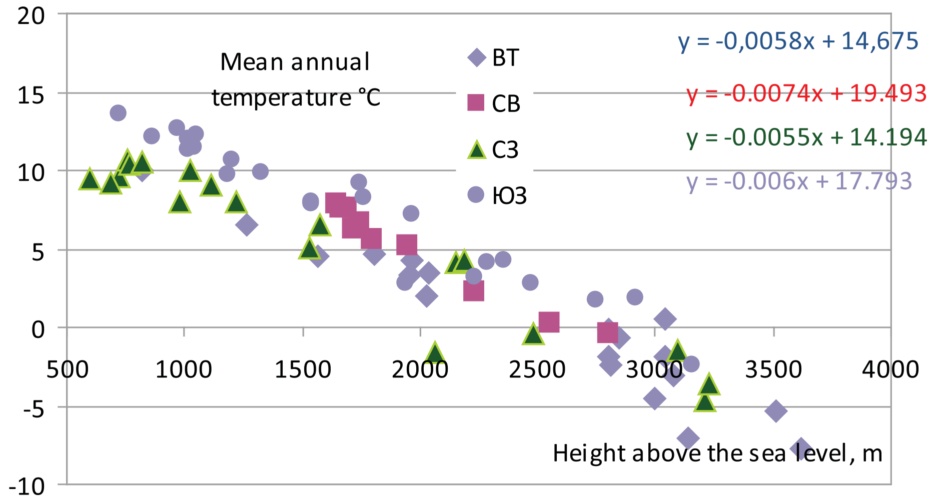


Figure 5.11. The temperature gradient in different climatic regions

Temperature trends in meteorological stations at all altitudes (4 groups - up to 1,000 m; from 1,000 to 2,000 m; from 2,000 to 3,000 m; and above 3,000 m) are almost similar, except for the Inner Tien Shan region, where some distortion is due to sharp reduction in high-altitude meteorological stations in the mid-90s. As an example, Figure 6.12 reflects high-altitude trends in the south-western and north-western regions.

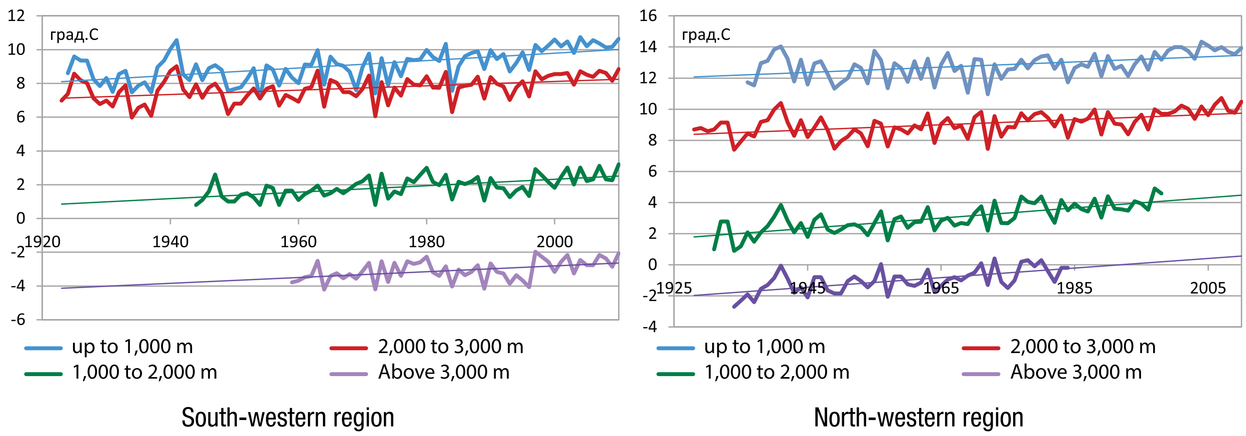


Figure 5.12. Examples of high-altitude trends in climatic regions

Due to natural reasons, high-altitude trends do not cover the whole time interval. However, the provided information clearly shows that there are no significant differences in the temperature change at different altitudes. Inter-annual standard deviations were estimated in order to assess changes in temperature variability. Contrary to expectations that variability would increase, the absolute result showed that inter-annual variability was decreasing, which does not exclude variability increase at other time or factor levels (see Figure 5.13).

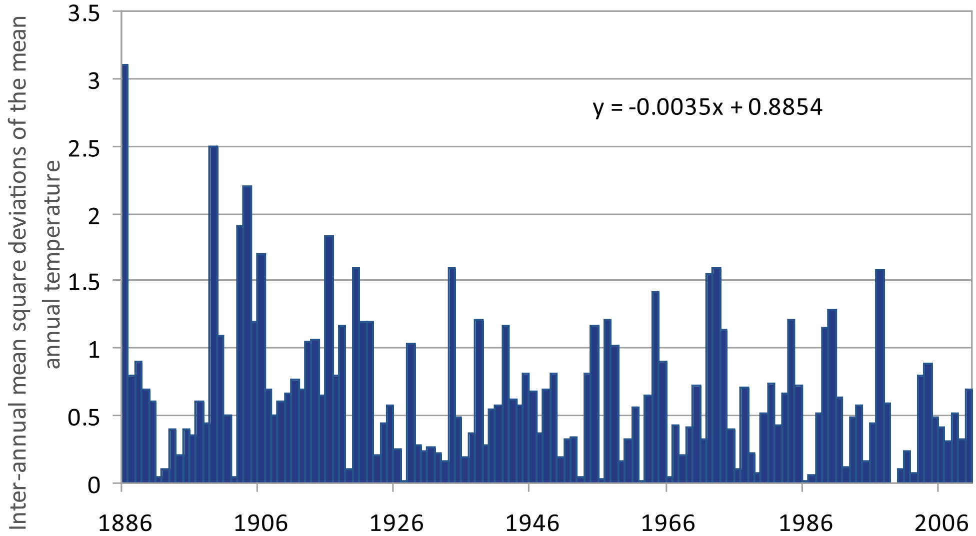
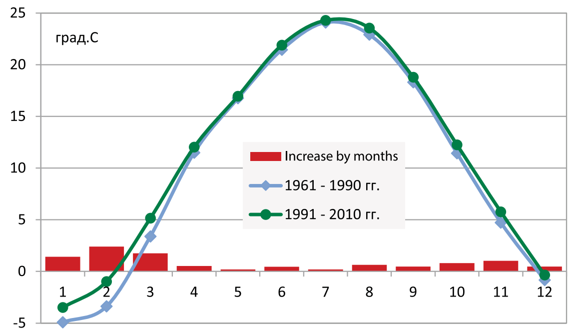
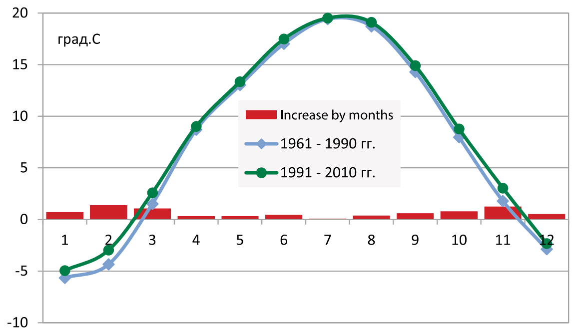


Figure 5.13. The results of inter-annual variability assessment

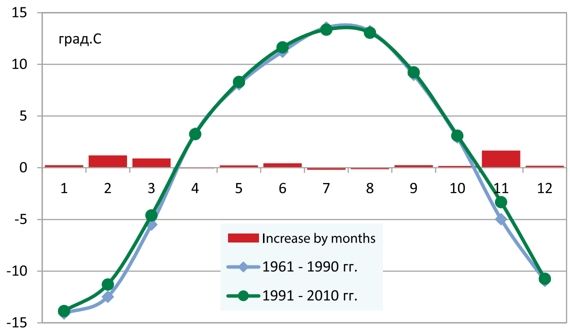
Seasonal changes were compared with the baseline period at different altitude range (up to 1,000 m; from 1,000 to 2,000 m; from 2,000 to 3,000 m; and above 3000 m) and in general for the republic. The mean duration of the heating period for the 1961 - 1990 and 1991 - 2010 and its changes were estimated.



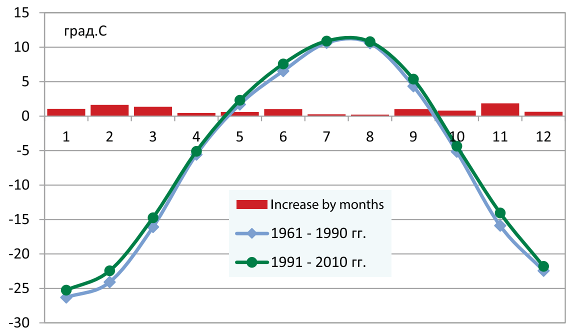
Altitude up to 1,000 m. Duration of the heating period reduced from 152.7 to 143.5 days (by 9 days)



Altitude from 1,000 to 2,000 m. Duration of the heating period reduced from 178.6 to 172.5 days (by 6 days)



Altitude from 2,000 to 3,000 m. Duration of the heating period reduced from 236.9 to 234.5 days (by 2.5 days)



Altitude above 3,000 m. Duration of the heating period reduced from 310.7 to 291.6 days (by 10 days)

Figure 5.14. Comparative seasonal changes in the mean monthly temperature at different altitudes and changes in the duration of the heating period

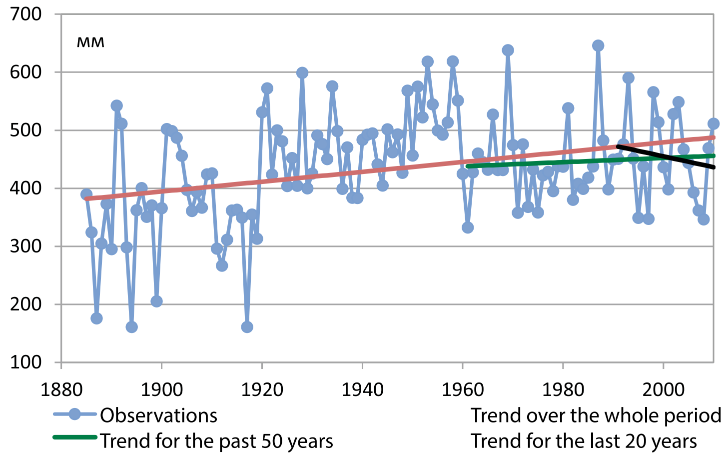
It should be noted that when comparing the mean monthly temperatures for the periods 1961 - 1990 and 1991 – 2010, the greatest increase in temperature (at all altitudes) was observed during the cold months - February, March, October and November, while in summer the temperature increase was the lowest. Perhaps, this is the reason for a significant reduction in the mean duration of the heating period.

5.2.2. PRECIPITATION

The observed trends in precipitation were processed using the same methodology as the temperature trends, as all the above problems with the system of monitoring are definitely the same for all meteorological observations.

The precipitation trends show that the overall mean (for meteorological stations) annual precipitation slightly increased (by 0.847 mm/year), but during the last 50 years this increase significantly reduced (to 0.363 mm/year), and over the last 20 years there is a significant tendency to its decrease (-1.868 mm/year), i.e. we can say that there is a definite aridization of the country's climate. Uncertainty practically coincides with the previously shown temperature related uncertainty.

Figure 5.15. General trends in the mean annual precipitation for the entire period of instrumental observations (1885 - 2010)



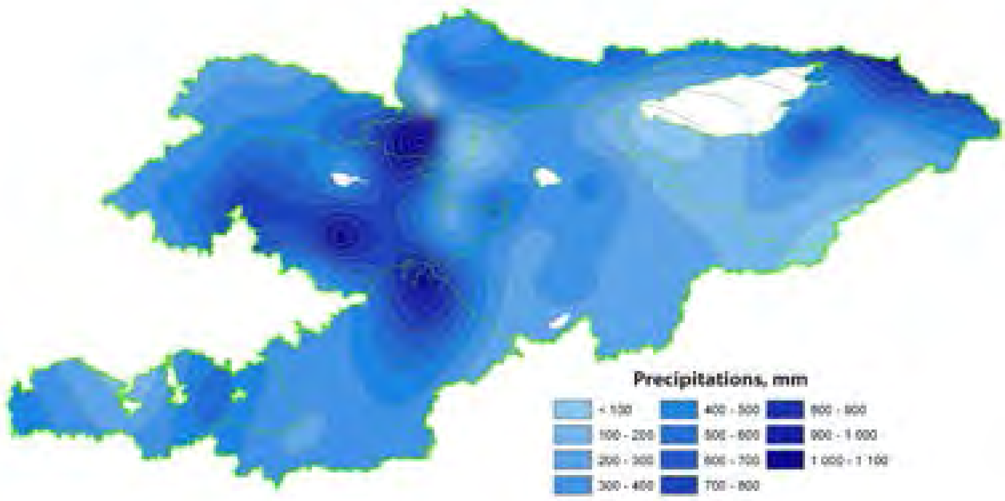


Figure 5.16. Distribution of the annual precipitation in the republic over the baseline period (1961-1990)

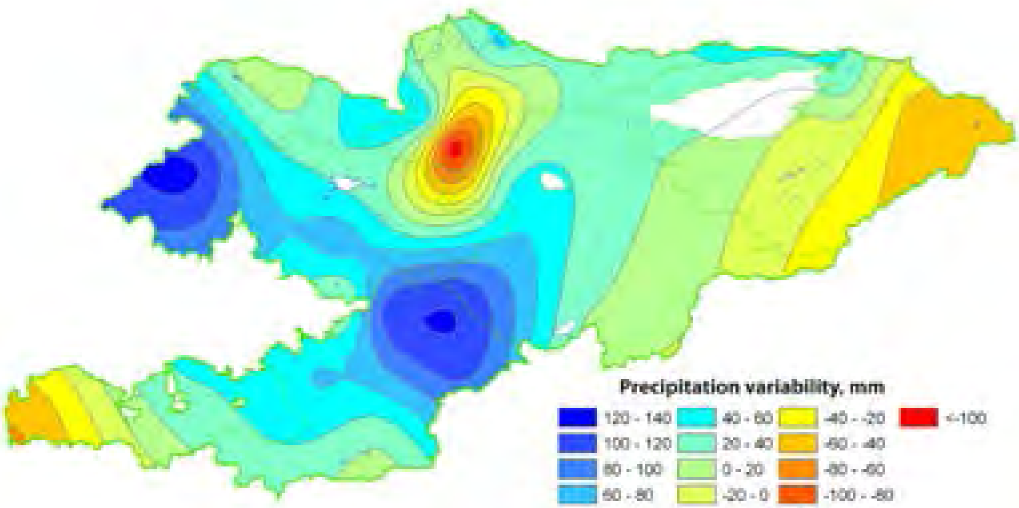


Figure 5.17. Distribution of zones with various variability rate of the annual precipitation for the last 20 years compared to the baseline period (1961 - 1990)

Table 5.2. Results of comparing mean annual precipitations during the baseline period (1961 - 1990) and the last 20 years (1991 - 2010), mm

Region Indicator	Batken	Jalal-Abad	Issyk-Kul	Naryn	Osh	Talas	Chui
Mean 1961-1990 (baseline)	367,7	535,4	457,8	297,2	371,2	366,9	522,3
Mean 1991-2010	386,8	574,1	461,5	295,1	387,2	309,4	502,9
The difference between the mean values	19,1	38,6	3,73	-2,10	16,03	-57,5	-19,4
Increase from 1991 to 2010	-297,1	-0,18	0,13	-0,49	-0,20	-0,38	0,12

Based on the calculations results (see Figure 5.16, 5.17 and Table 5.2), we can conclude that precipitations changed slightly, but for the last 20 years there were quite dramatic changes in certain regions both upward and downward. Moreover, the general tendency in recent years is a downward tendency. Sharper decrease in annual precipitation for the Batken region is probably due not real change, but to deficiencies in the meteorological monitoring system and baseline data shall be checked once again. It should be noted that relative changes in the annual precipitations are not statistically significant.

The altitude gradient for precipitation is not provided, as the results of calculations do not show any clear correlation. High-altitude trends in precipitation are multidirectional and probably more likely to reflect spatial, rather than altitude distribution. The results of the inter-annual variability calculation (see Figure 5.18), similarly to precipitation, do not show any increase trends, but rather a slight decrease in variability.

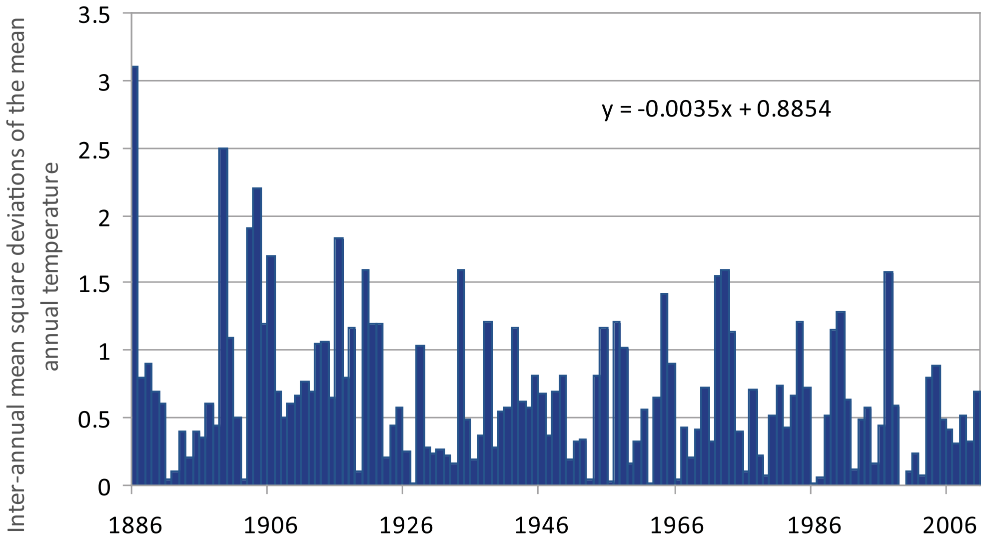


Figure 5.18. The results of inter-annual variability calculation

With the increasing in altitude, seasonal distribution of precipitation evolves from bimodal distribution at low altitudes to unimodal. Moreover, if changes at low altitudes over the last 20 years compared to the baseline period are blurred and one can see only a very slight tendency in displacement of the bimodal rainfall distribution peaks, at high altitudes the tendency of decreasing precipitation in summer time is clearly visible.

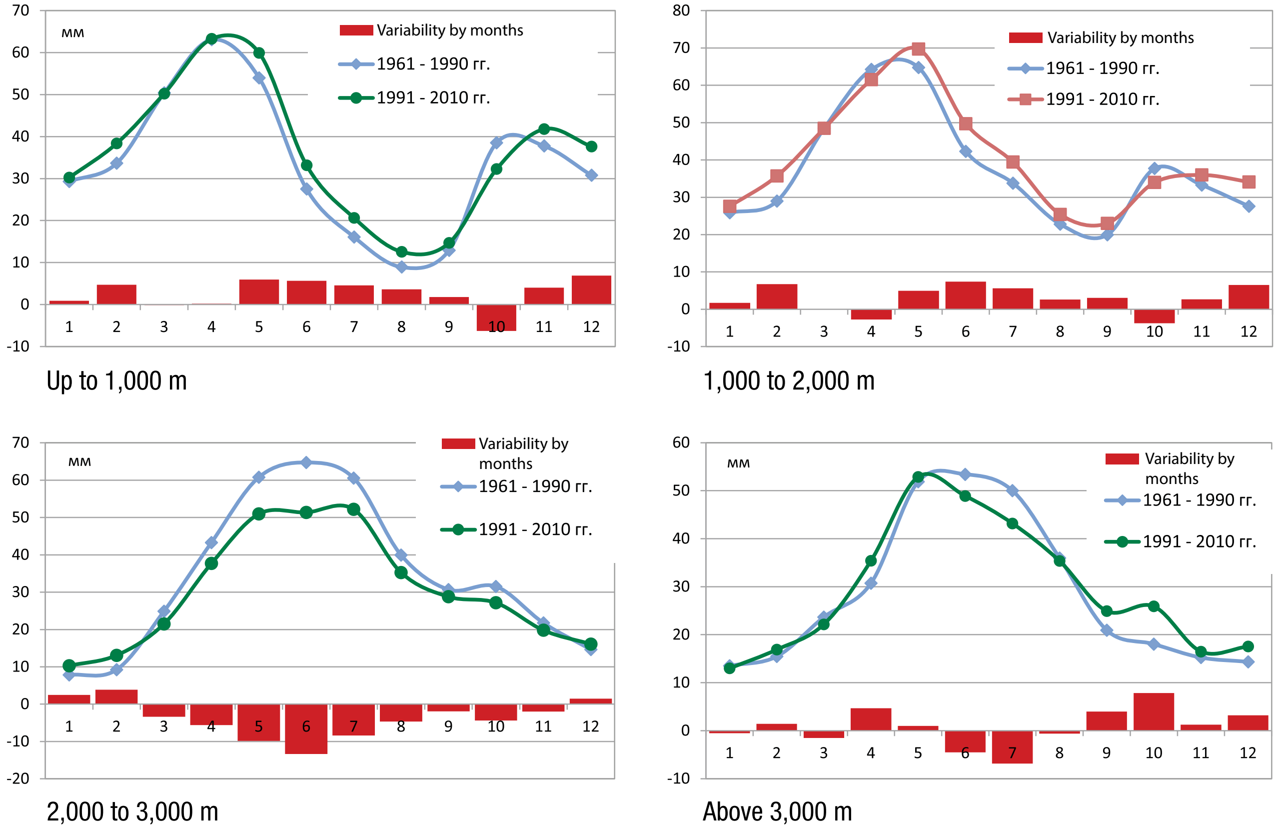


Figure 5.19. Seasonal changes in the mean (at one altitude range) monthly precipitation at various altitudes

5.3. ANALYSIS OF THE EXPECTED CLIMATE TRENDS

The following actions were performed for the analysis of the key climatic parameters (temperature and precipitation) expected in the period from 2011 to 2100:

- Selecting scenarios of greenhouse gas emissions based on recommendations of the Intergovernmental Panel on Climate Change;
- Selecting global climate models and methodologies for their use in order to generate the expected climatic parameters;
- Identifying the source of estimated expected climatic parameters;
- Selecting forms for presenting expected climatic parameters taking into account the purposes of the subsequent climate risks assessment;
- Selecting algorithms for processing baseline information.

5.3.1. SELECTING SCENARIOS OF GREENHOUSE GAS EMISSIONS BASED ON IPCC RECOMMENDATIONS

Emission scenarios represent alternative forecasts of the potential options of using various values of global greenhouse gas emissions.

Figure 5.20. Family of emission scenarios:

"HS" - scenarios with "agreed" assumptions related to global population, world of production growth and final energy;

"OS" - scenarios that consider uncertainty of determining factors in addition to those contained in the agreed scenarios.

Future emissions of greenhouse gases are the product of very complex dynamic systems consisting of determinant factors, such as demographic development, socio-economic development and technological changes. Therefore, emission scenarios are only potential options, the probability of which can only be determined approximately on the basis of current trends and anticipated measures, including political.

Scenario A1

The scenario A1 family is divided into three groups that describe alternative options of technological change in the energy system.

Three A1 groups are distinguished by their key technological component:

- significant use of fossil fuels (A1FI),
- the use of mostly renewable energy sources (A1T)
- the balance across all sources (A1B).

Scenarios A2

The birth rates across the regions converge very slowly, which results in continuous growth of the population. Economic development has primarily regional orientation, while economic growth per capita and technological changes are more fragmented and slower compared to others. This scenario provides for the highest greenhouse gas emissions and, consequently, the greatest warming.

Scenario B1

The storyline and scenario family B1 describes the world moving in one direction with the same global population that reaches its maximum in mid-century, and then decreases, as in the storyline A1, but with rapid changes in economic structures towards a service and information economy with reduced material intensity and introduction of clean and resource efficient technologies. The emphasis is on global solutions for economic, social and environmental sustainability, including improved equity, but without additional initiatives related to climate.

Scenario B2

The storyline and scenario family B2 generally coincides with the preconditions in the B1 scenario, but differ by additional initiatives related to reducing the impact on the climate. Figure 5.21 shows estimates of global temperature change for different scenarios.

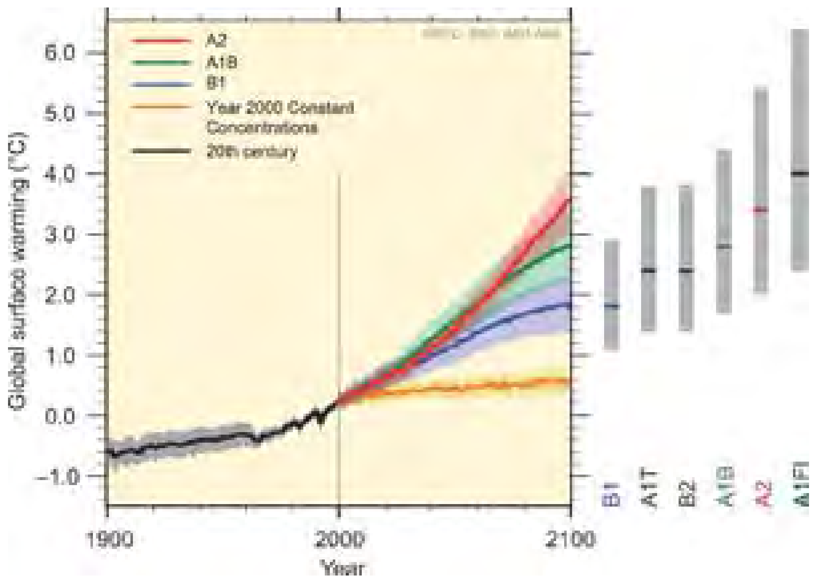


Figure 5.21. Emissions for different scenarios. Source: IPCC

The current available rough estimates indicate that the 2°C target is achievable with a 10% probability, if the concentration of greenhouse gases will stop at 550 ppm. Translated into CO2 equivalent, the total concentration of 550 parts is about 450 parts of CO2. Now, the concentration of CO2 has increased from 285 to 393 ppm, which indicates of the low probability that it will stop at 2°C.

In order to ensure target indicator of 2°C with approximately 50% probability and 1.5oC with 10% probability, CO2 concentration shall be below the current level - 350 ppm.

Thus, if we talk about global climate stabilization levels, there are no any chances to achieve 2°C, and a very small chance to achieve 3°C; in fact, it will end up in 4oC. The observed trends in carbon dioxide emissions do not show any transition to more a ecological development, but on the contrary, show accelerating increase in the consumption of fossil fuels (see Figure 5.22).

Therefore, A2 scenario was selected for further calculations.

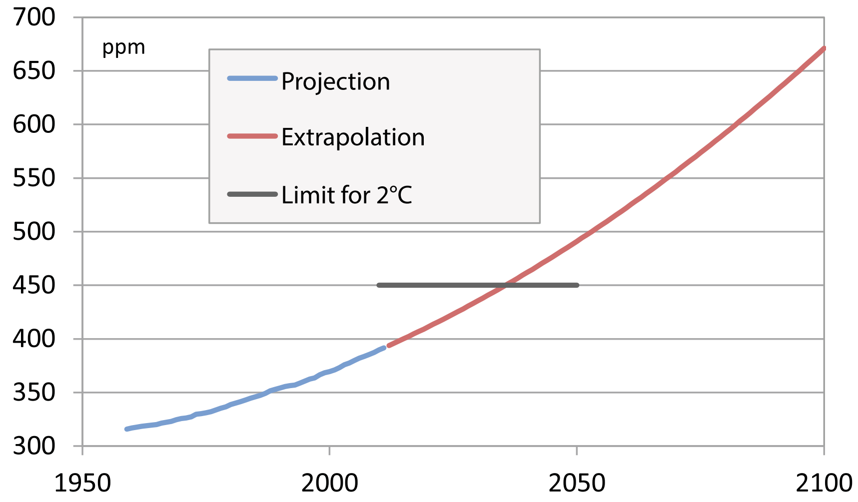


Figure 5.22. Extrapolation of GHG concentration. Blue line shows the examined part of the sample (known data) and the red line is extrapolation. A step reflects the allowable limit of 2°C. In the known data part, the correlation is exactly described by a 2nd degree polynomial (ftp://ftp.cmdl.noaa.gov).

5.3.2. SELECTING CLIMATE MODELS

Climate model is a numerical description of the climate system based on the physical, chemical and biological properties of its components, their interactions and inverse processes that are fully or partly attributable to its known properties.

The climate system can be described using the models of different complexity, i.e. for each component or combination of components one can find a proper "hierarchy" of models that differ from each other in aspects, such as the number of spatial parameters, the degree of accuracy of the physical, chemical and biological processes description or the level of the empirical determination of the parameters.

A comprehensive description of the climate system provides with a general circulation model in the system "atmosphere-ocean-sea ice", the so-called AOCIM model. Currently there is a tendency towards application of more complex models using active chemical and biological correlations.

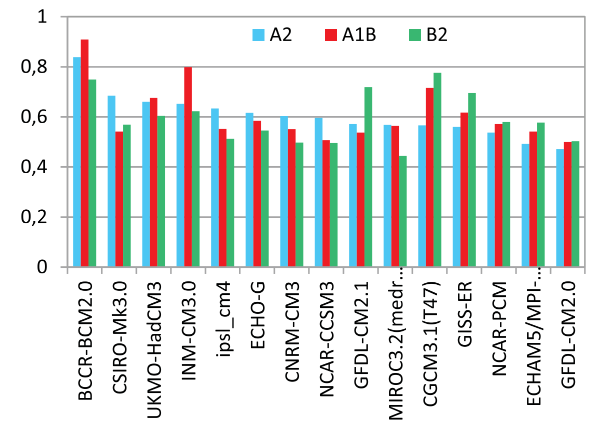
The existing models (approved by IPCC at the time of preparation of this report):

- China - BCC-CM1, FGOALS-g1.0
- Australia – CSIRO-Mk3.0, CSIRO-Mk3.5
- Norway– BCCR-BCM2.0
- USA – CCSM3, GFDL-CM2.0, GFDL-CM2.1, GISS-AOM, GISS-EH, GISS-ER, PCM
- France – CNRM-CM3
- Germany – ECHAM5/MPI-OM, ECHO-G
- Japan – MIROC3.2(hires), MIROC3.2(medres), MRI-CGCM2.3.2
- Canada - CGCM3.1(T47), CGCM3.1(T63)
- Italy – INGV-SXG
- Russia - INM-CM3.0
- England - UKMO-HadGEM1, UKMO-HadCM3

The method of preliminary verification is sometimes used to select models. This method is verification of the results based on the known observations of the climate parameters, i.e. selecting a particular model or a particular subset that would ensure the least uncertainty of the forecast estimates.

However, it should be noted that this problem does not have a uniform solution; therefore, there are no any clear methodical recommendations [41]. The following problems were identified during the analysis:

- Initial multicriteriality (models can be selected based on the least error for the temperature, and for precipitation. Unfortunately, the models ensemble in each case will be different). The best models for each of the separate criteria may be different;
- Errors ambiguity for different scenarios. Verification of the calculations allowed to determine that each emissions scenario has its own optimal ensemble of climate models (see Figure 5.23). If the calculations are made for multiple scenarios, it is necessary to make selection repeatedly;
- Ambiguity of the solution for different metrics. The calculations showed that for the mean square and absolute metrics, the optimal set of models will be different, since their ranking by quality is significantly different;
- In addition, small number of the examined samples leads to the loss of the statistical rationale behind the choice. Errors of different models are not statistically distinguishable between each other. In some cases, even the best and the worst models are statistically indistinguishable;
- In addition, it should be kept in mind that, unfortunately, verification based on the known data for selecting the best models of retrospective data does not guarantee the best results for the future.



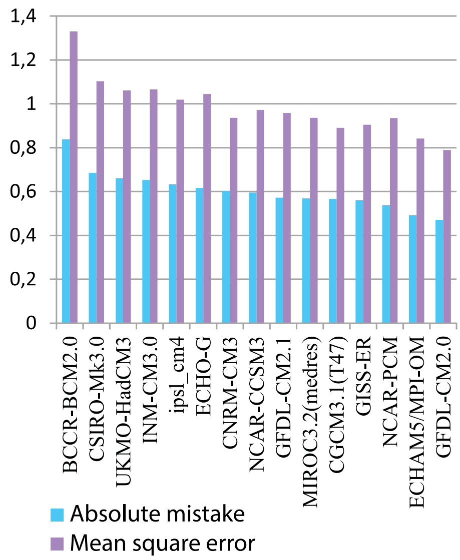


Figure 5.23. Ranking the models depending on the climate scenario. The y-axis shows the mean square or absolute error for the examined sample

In such cases, it is recommended to use the whole available ensemble of climate models in order to assess the expected climate:

- BCCR-BCM2.0 Norway Bjerknes Centre for Climate Research
- CGCM3.1(T47) Canada Canadian Centre for Climate Modeling & Analysis

- CNRM-CM3 France Météo-France / Centre National de RecherchesMétéorologiques
- CSIRO-Mk3.0 Australia
- GFDL-CM2.0 USA US Dept. of Commerce / NOAA / Geophysical Fluid Dynamics Laboratory
- GFDL-CM2.1USA US Dept. of Commerce / NOAA / Geophysical Fluid Dynamics Laboratory
- GISS-ERUSA NASA Goddard Institute for Space Studies
- NM-CM3.0 Russia Institute for Numerical Mathematics
- IPSL-CM4 France Institute Pierre Simon Laplace
- MIROC3.2 (medres) Japan Center for Climate System Research (The University of Tokyo), National Institute for Environmental Studies, and Frontier Research Center for Global Change (JAMSTEC)
- ECHO-G Germany / Korea Meteorological Institute of the University of Bonn, Meteorological Research Institute of KMA, and Model and Data group.
- ECHAM5/MPI-OM Germany Max Planck Institute for Meteorology
- MRI-CGCM2.3.2 Japan Meteorological Research Institute
- CCSM3USA National Center for Atmospheric Research
- PCMUSA National Center for Atmospheric Research
- UKMO-HadCM3 UK Hadley Centre for Climate Prediction and Research / Met Office

5.3.3. TEMPERATURE

The calculations were made using the A2 emissions scenario and the entire ensemble of climate models. The results of the expected temperature assessment over a certain period of time are shown in Figure 5.24, and the spatial distribution of temperature - in Figure 5.25. Uncertainty was assessed based on the climate models, as it is difficult to estimate uncertainty based on climate scenarios, although it is obvious that the uncertainty of the scenarios will be significantly higher.

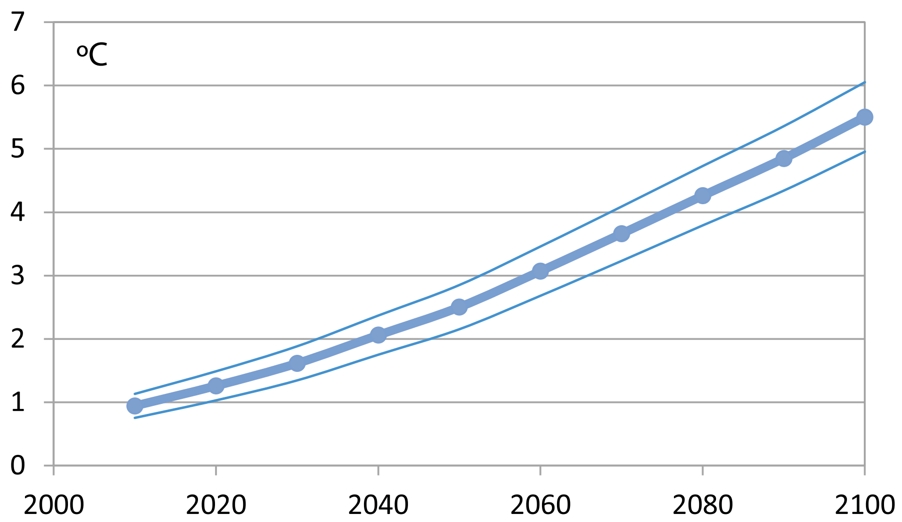


Figure 5.24. Estimate of the expected mean temperature in the country, oC (thin lines outline the area of uncertainty estimated on the basis of models).

As the results show, significant increase in temperature is expected, besides the rate of the rise in temperature will increase, if no actions for the reduction of global emissions will be taken on time at the international level covering all countries, without division into developed and developing countries, which currently makes no sense.

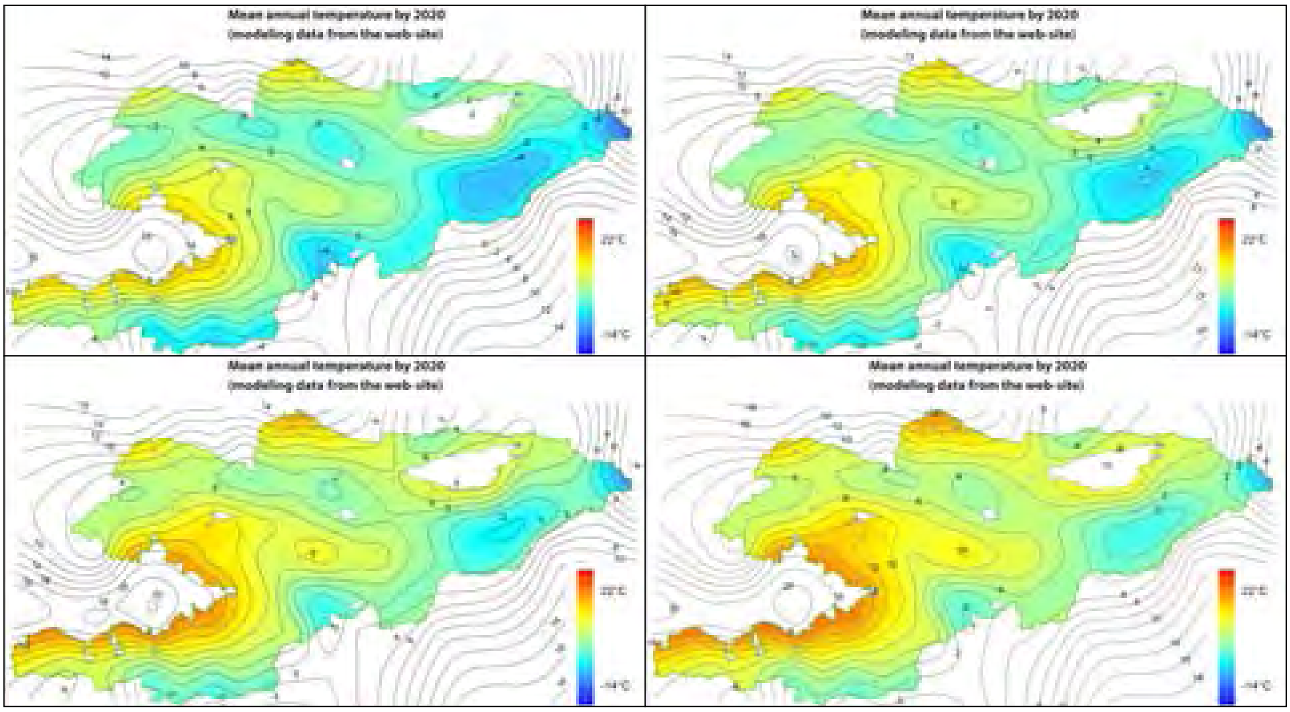


Figure 5.25. Maps of spatial distribution of temperature for different years

As clear from the calculations results, there will be practically no regions with negative mean annual temperature in the republic by 2100.

No significant regional difference in the temperature increase is expected (see Figure 5.26) and the temperature increase in almost all regions will be the same (the difference will be not more than 0.2°C). It is interesting to note that the expected temperature variability will be approximately the same for all months (see Figure 5.27), in contrast to the observed trends. The duration of the heating period will also significantly reduce - by 16% by 2050 and by more than 30% by 2080.

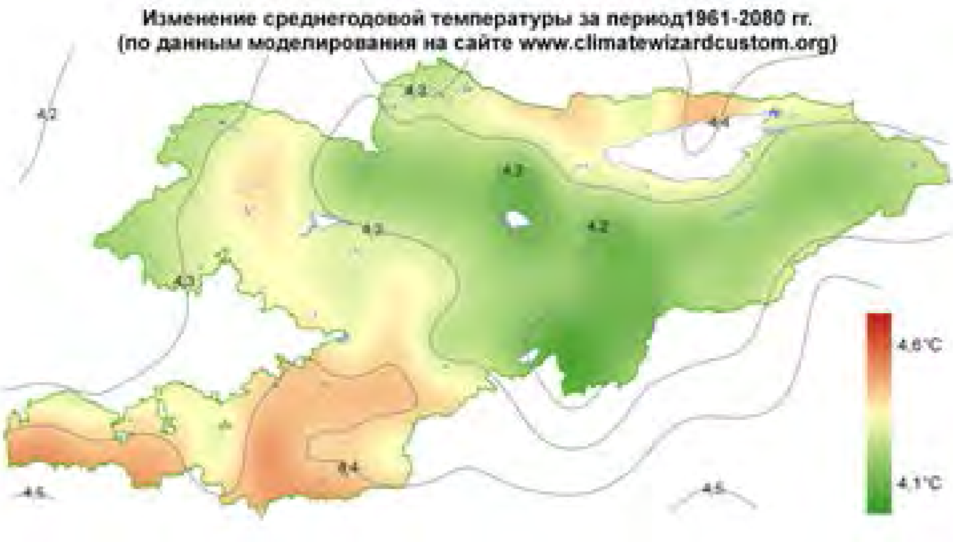
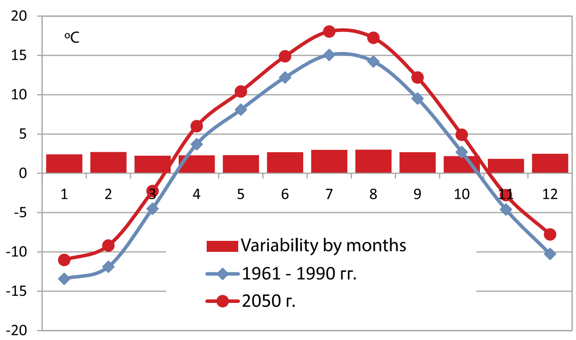
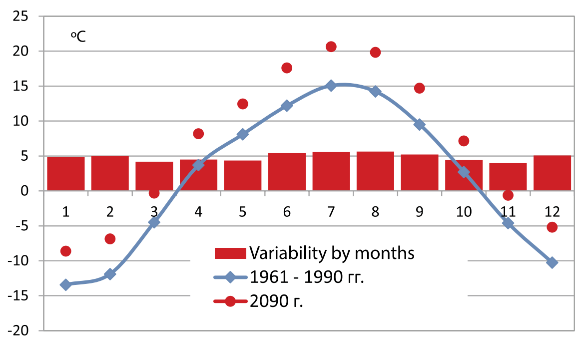


Figure 5.26. Increase of the mean annual temperature in the republic in 2080 compared to the baseline period (1961 – 1990)



Рост температуры в 2050 г. относительно базового периода (1961 – 1990 гг.)



Рост температуры в 2090 г. относительно базового периода (1961 – 1990 гг.)

Figure 5.27. Seasonal variability of the mean annual temperature in the country, °C

5.3.4. PRECIPITATION

The expected annual precipitation was also estimated for the A2 scenario and the ensemble of climate models. The results of estimation of the expected annual precipitation over a certain period of time please see in Figure 5.28, and spatial distribution of precipitation - in Figure 5.29. Like the expected temperature, the uncertainty was estimated based on the dispersion of climate models.

As can be seen from these results, the annual precipitation decreases, but at a lower rate (-0.0677 mm/year). It is expected that the amount of precipitation will vary over time, in contrast to the monotonically changing temperature. The uncertainty is relatively small, i.e., all models predict approximately the same tendency. The expected seasonal distribution of precipitation is generally equal to those observed in recent decades.

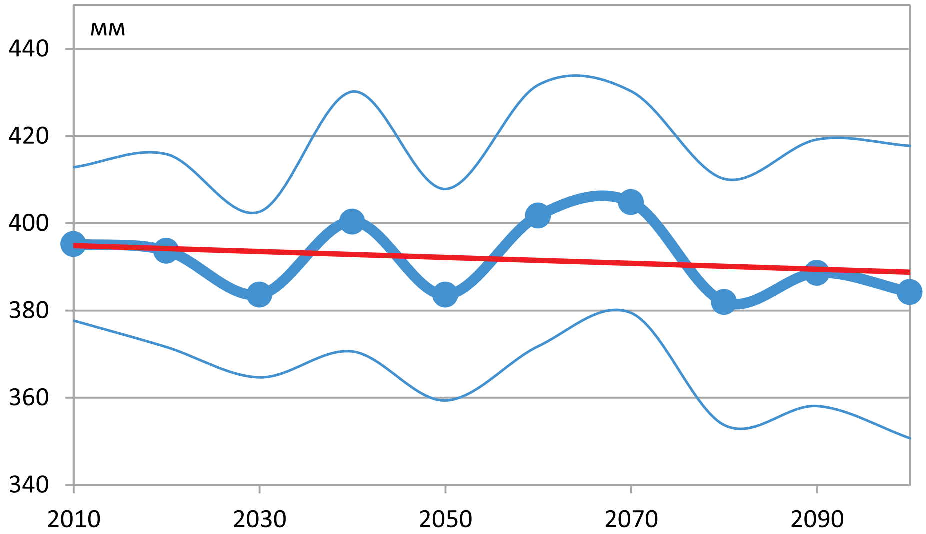


Figure 5.28. Estimation of the expected mean annual precipitation (the red line is a linear tendency, while thin lines are the uncertainty estimate for scattered models).

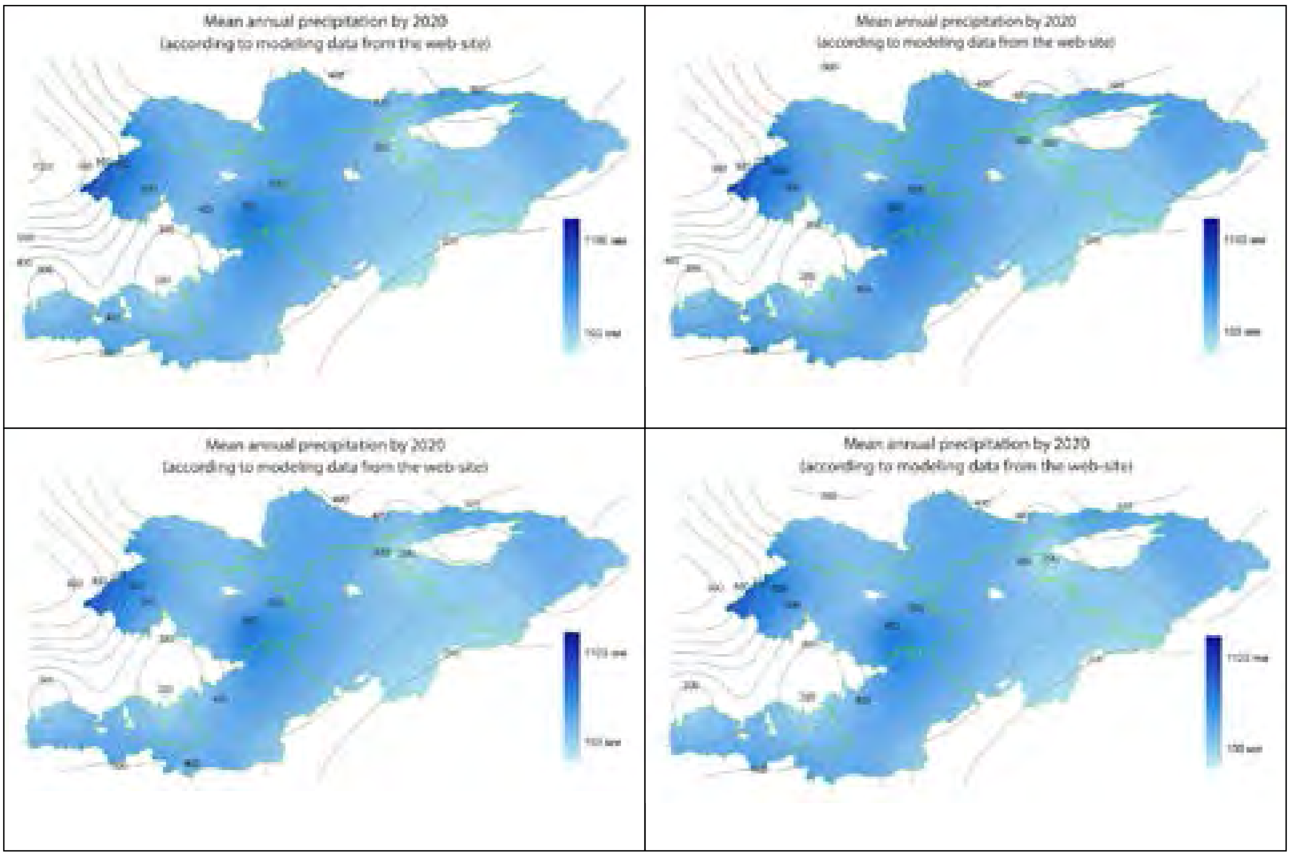
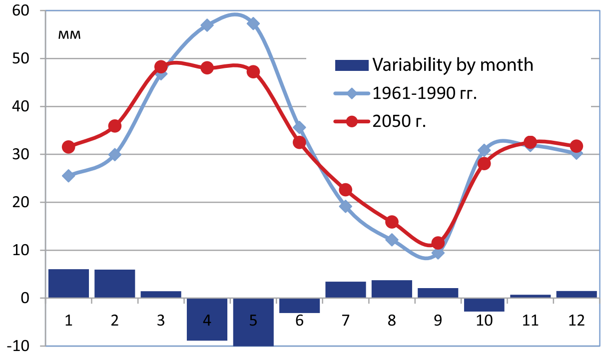


Figure 5.29. Distribution of the annual precipitation across the country, mm



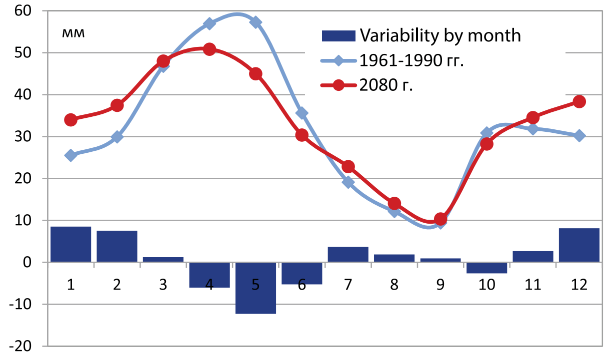


Figure 5.30. Distribution of the monthly precipitation

6. MAJOR IMPACT OF THE CLIMATE CHANGE

6.1. SECTOR ANALYSIS

As was already mentioned above, this section will discuss only two main sectors that are significantly vulnerable to climate change.

6.1.1. EMERGENCIES SECTOR

6.1.1.1. ASSESSMENT OF EMERGENCIES TRENDS

This section will discuss only those ES that presumably depend on climate change. Although major emergencies are monitored in the Kyrgyz Republic since 1951, in fact, data since 1990 only can be used for the analysis, as methodology of data recording has changed in 1990. Therefore, data for different time periods are not comparable. A clear illustration of the above is Figure 6.1, which shows a sharp increase in the number of observed emergencies since 1990.

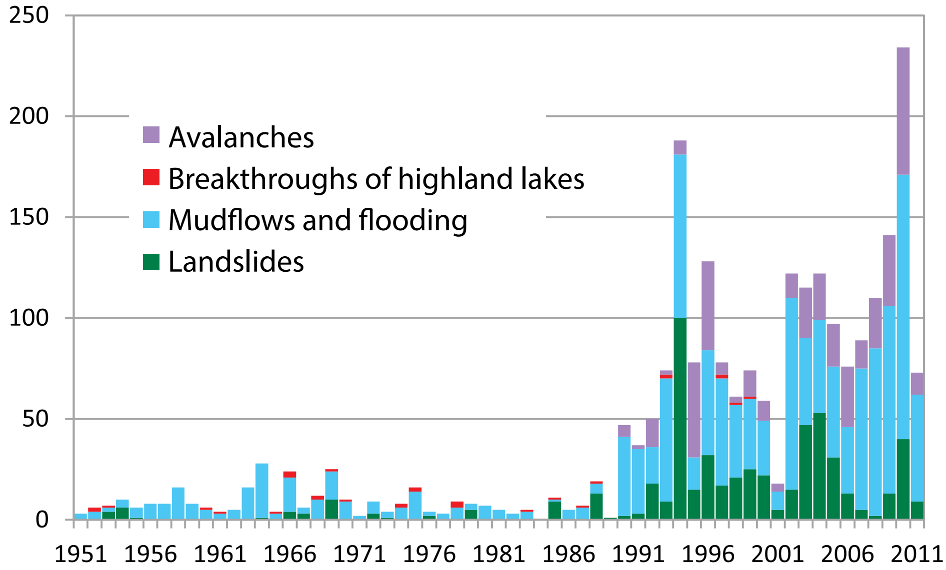


Figure 6.1. The number of major emergencies recorded on the territory of the country

Therefore, baseline data on the number of emergencies since 1990 were further used for the analysis of trends. The Ministry of Emergency Situations maintains the most comprehensive records for the following types of emergencies throughout the country:

- mudflows, floods;
- landslides;
- avalanches;
- flooding;
- rainstorms;
- hurricane winds;
- hail; and
- snowfall

Data on emergencies monitoring, as well as information about the number of the dead and caused economic loss (in thousands KGS) are listed in Annex 2.

The ES related climate risks were analyzed using the approach for assessing general trends, so the review of known methods showed that there are no any models that would link climate characteristics with the ES occurrence (similar to climate-harvest models), and the attempts of statistical modeling of ES occurrence with climatic characteristics made jointly with MOE experts during the preparation of the Second National Communication on Climate Change in the Kyrgyz Republic failed to provide the expected results.

The main purpose of this section is to assess variability of ES characteristics of (e.g., frequency) in case of the expected changes in the climate system. Unfortunately, the survey showed the lack of specific indicators that would help to define status of the climate system as a whole. The available indicators (e.g., [33, 35]), are firstly empirical, i.e. are not based on physical character of the natural processes, and secondly reflect only individual characteristics of the climate system, either explicitly or implicitly defined by the authors. In order to assess possible changes in the ES, ES focused climate indicators can be developed. But this task was not covered by our work plan; therefore, changes in the mean annual temperature in the country were used as an indicator at the first stage. At the next stages, it is preferable to prepare ES oriented indicators and use shorter time periods. For tendency in the mean annual temperature variability over the past 20 years please see Figure 6.2.

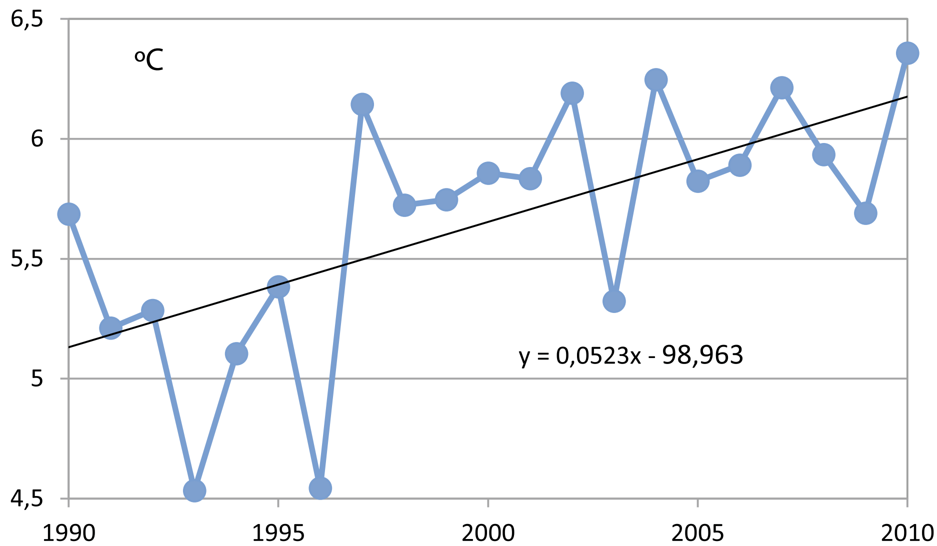


Figure 6.2. Trends in the mean annual temperature variability in the country for 1990 - 2010

Changes in the observed mean annual temperature in 1991 – 2010 compared to the baseline period are statistically significant and analysis of the expected changes shows a significant temperature variability. Precipitation variability for the same period is not statistically significant and analysis of the expected variability shows further minor changes. Therefore, correlation of ES only with temperature variability adopted at the first stage as a conditional indicator of changes in the entire climate system will further be discussed. Figures 6.3 - 6.10 show correlation between the number of emergencies for the period 1990 - 2010 for all above listed ES types, and variability of their number was defined for each of them. Based on variability in the ES number and given temperature variability for the period 1990 - 2010 we can calculate changes in the number of ES attributable to the temperature increase by 1°C, which in accordance with the observed tendency corresponds to a time interval of about 25 years. The results are summarized in Table 6.1. Of course, given the used approach, the calculation results are applicable only for short-term assessments, which is common to all approaches based on statistical extrapolation.

The actual change in the ES number is determined based on selected time of assessment and the adopted scenario of greenhouse gas emissions.

On the basis of the discussed correlations, general conclusions are as follows:

- During 1990 – 2010, the increase in the number of all the above ES throughout country was observed;
- The increase rate is different, but the highest is for mudflows and floods;
- The change in the number of ES when the temperature changes by 1°C was determined as well, which can be used to predict changes in the number of ES in the future.

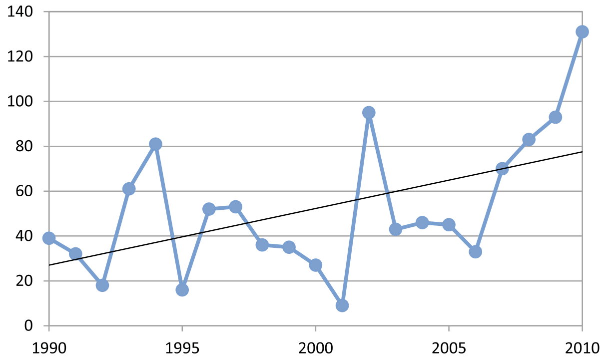


Figure 6.3. The tendency of variability in the number of mudflows and flood

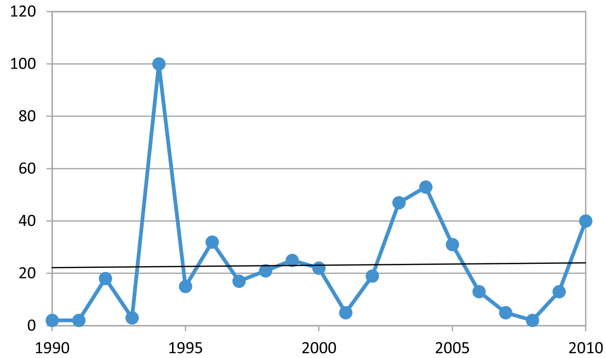


Figure 6.4. The tendency of variability in the number of landslides

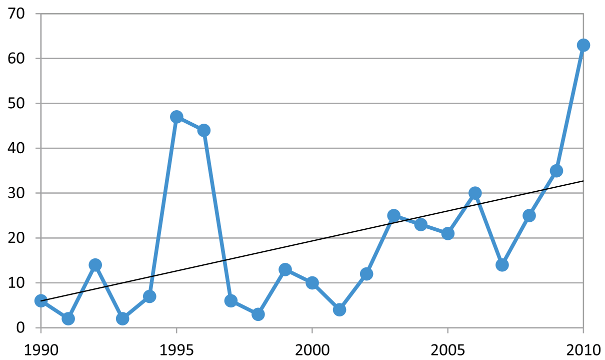


Figure 6.5. The tendency of variability in the number of avalanches

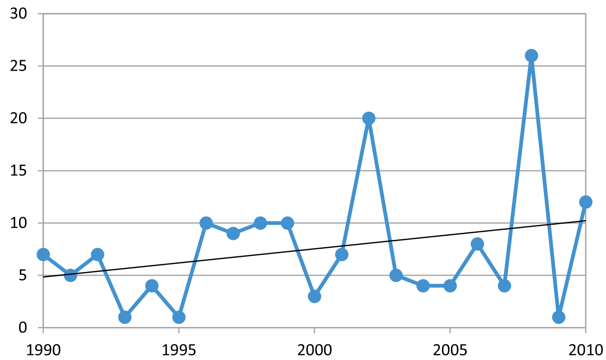


Figure 6.6. The tendency of variability in the number of flooding

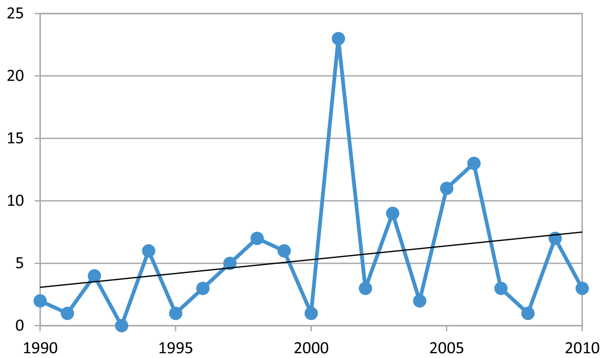


Figure 6.7. The tendency of variability in the number of rainstorms

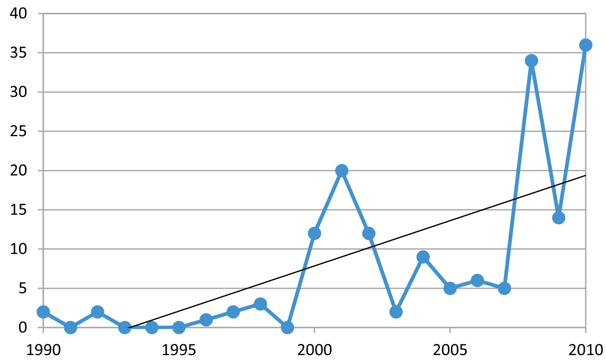


Figure 6.8. The tendency of variability in the number of hurricane winds

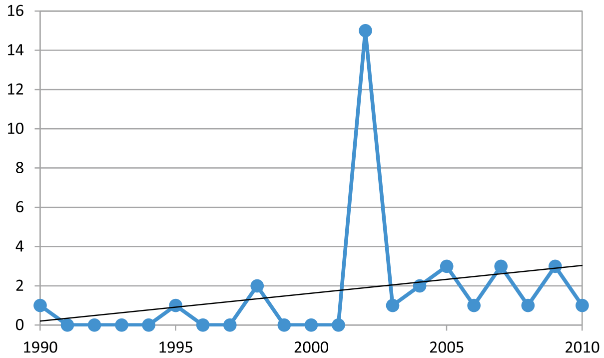


Figure 6.9. The tendency of variability in the number of hail

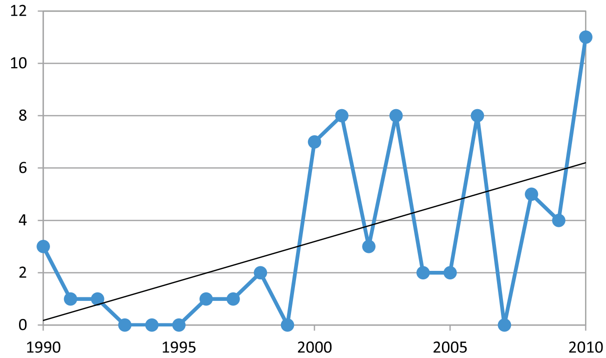


Figure 6.10. The tendency of variability in the number of snowfall

Table 6.1. The increase in ES number due to temperature change

ES type	The increasing ES number for 1990 – 2010	The increase in ES number due to temperature increase by 1oC
Mudflows and floods	50,57	34,4
Landslides	1,896	1,23
Avalanches	26,728	18,2
Flooding	5,376	3,65
Rainstorms	4,416	3,00
Hurricane winds	23,062	15,7
Hail	2,832	1,92
Snowfalls	6,026	4,09

It is not difficult to assess economic losses resulting from changes in the ES number in the next years. However, these estimates will be understated due to the current approaches to defining direct damage only.

6.1.1.2. GRADATION BY REGIONS

The overall prevalence of emergencies on the territory of the country is shown in Figure 6.11.

Baseline data on ES monitoring with breakdown by districts are available only for 2000, data for all other years are with breakdown by regions (see Annex). Furthermore, the number of recorded ES with breakdown by districts is very small, which prevented us for making gradation by districts. Therefore, breakdown by regions only is used similarly to other indicators of vulnerability to climate change. The analyzed ES do not include data on breakthroughs of highland lakes, as the number of reported cases was not enough.

The indicator of vulnerability is the number of ES in each region. A 0 to 5 scoring system is used for comparative assessment of vulnerability of each region. The assessment was made using the following formula:

$$Б = 5\frac{(X - X_{\min})}{(X_{\max} - X_{\min})}$$

where

X – is the current estimate of the indicator in physical units (in our case - the number of ES in a certain region);

Xmin – is the minimal indicator among all regions;

Xmax – is the maximum indicator among all regions.

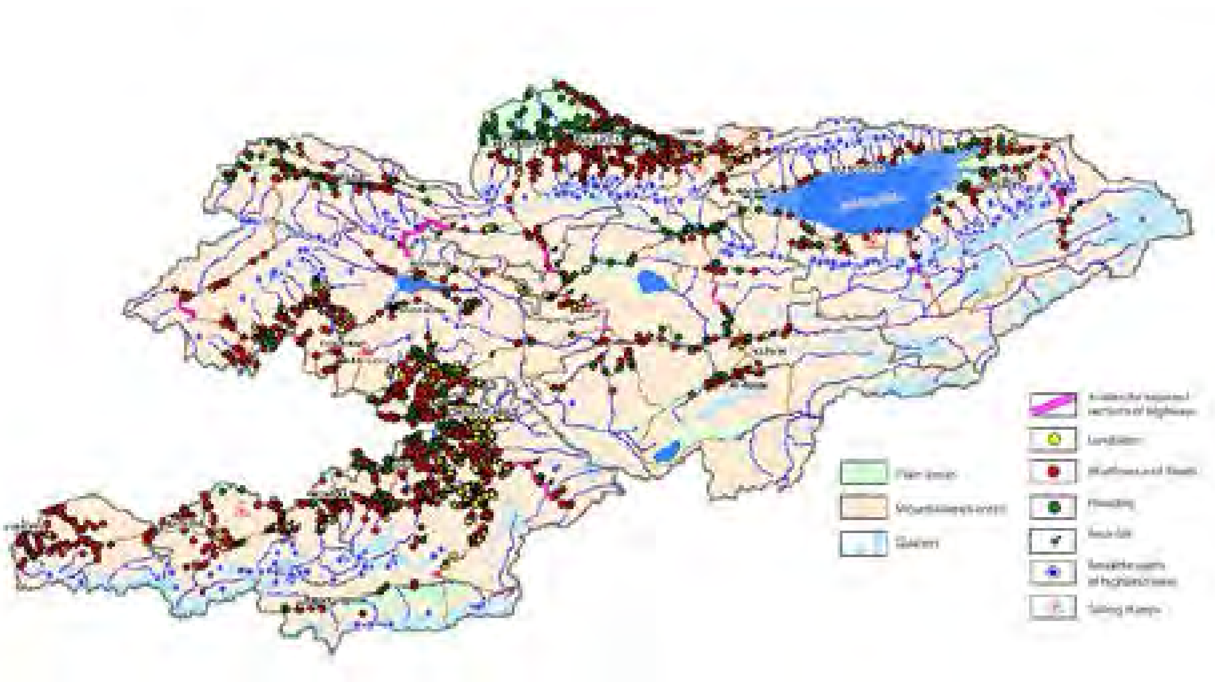


Figure 6.11. Schematic map of the emergencies prevalence (Source: the Ministry of Emergency Situations)

The baseline information is the total number of ES and damages for the period of 2000 - 2010, excluding 2005, information for which is unavailable. To ensure comparability of data by eliminating the inflation factor, the economic damage was recalculated in constant USD for 2005 based on the World Bank›s information on the currencies exchanges rates and their fluctuation over time.

Based on the approach to trends (linear least squares method), the obtained estimates of ES trends due to the small amount of baseline data can be used for the projection only for a very limited time period (no more than 5 - 15 years). For a longer period of time, models based on physical correlations, which at the moment are not yet developed for the Kyrgyz Republic, shall be used.

Assessing economic damage

There are only a few estimates of the economic damage from climatic ES for the Kyrgyz Republic:

1) Basic principles of natural disasters management, Bishkek, 2008 (using data on ES for the period 2002 - 2003)

- mudflows and floods – USD 109,067 dollars (KGS 4.91 million);
- landslides - USD 57,021 (KGS 2.57 million);
- avalanches - USD 97,522 (KGS 4.39 million).

No any published information about other ES is available.

2) Economic assessment of ES impact on the Kyrgyz economy (data are presented in 2006 prices in the report of the World Bank technical mission "Improving hydrometeorological service in the Kyrgyz Republic", Bishkek, 2009

ES type	Annual frequency for the period 1990-2007, the number of events per year	Maximum registered economic losses per 1 event, million KGS	The mean annual economic losses for the period 2001-2007 per 1 event, million KGS	The mean annual economic losses, million KGS
Mudflows	32.1	113.8	11.9	383.9
Floods	10.9	18.1	4.8	52.3
Avalanches	15.1	1.1	0.8	12.1
Rainstorms	5.6	8.2	2.9	16.2

3) According to the MOE, for 2007-11, the mean damage per 1 event by type of emergency is as follows (in thousand KGS)

Year	Landslides	Mudflows, floods	Avalanches
2007		2708,0	32,0
2008	325,0	7349,0	
2009	169,0	2757,0	
2010	138,0	3029,0	27,0
2011	318,0	9439,0	31,3
Mean	237,5	5056,4	30,1

4) Preliminary MOE's data for 2011

Emergencies	2011		
	ES number	Damage (thousand KGS)	Damage per 1 ES (thousand KGS)
Avalanche	11	344,16	31,287
Flooding, rise of GWL	4	215	53,750
Hurricane, strong winds	17	3433,44	201,967
Landslide	9	2861	317,889
Rainstorm	1	221000	221000,000
Snowfall	3	350	116,667
Mudslide, flooding	53	500299	9439,604

Based on the comparison of the damage estimates below, one can see that various estimates differ significantly.

ES type	Damage from one ES for different options							
	1) 0.027455808		2) 0.022289838		3) 0.016071327		4) 0.013745351	
	In current (2003) thousand KGS	US$ 000 (2005)	In current (2006) thousand KGS	US$ 000 (2005)	In current (2007-2011) thousand KGS	US$ 000 (2005)	In current (2011) thousand KGS	US$ 000 (2005)
Mudflows and floods	4910	134,81			5056,4	81,263	9440	129,76
Mudflows			11900	265,25				
Floods			4800	106,99				
Landslides	2570	70,561			237,5	3,817	318	4,371
Avalanches	4390	120,53	800	17,832	30,1	0,484	31	0,426
Rainstorms			2900	64,641			221000	3037,7
Flooding							54	0,742
Snowfalls							117	1,608
Hurricanes							202	2,777

Only the most complete recent data on damage for 2011 will be temporarily used.

ES	In current KGS	Thousand USD in 2005
Avalanche	27,27	0,374834
Hurricane, strong winds	396,167	5,44545
Landslides	137,925	1,895828
Hail, lightning	197	2,707834
Snowfall	7405,545	101,7918
Mudflow, flood	3028,855	41,63267

Landslides

Variability in the number of landslides with breakdown by regions please see in Figure 6.12. Distribution of the number of landslides with breakdown by regions please see in Figure 6.13 below.

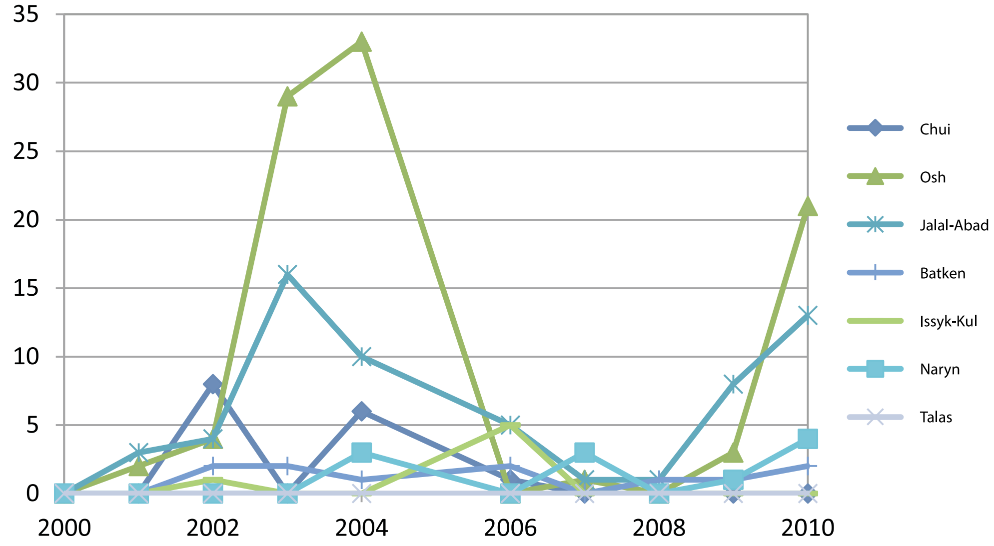


Figure 6.12. Variability in the number of landslides with breakdown by regions (CH - Chui, O - Osh, JA - Jalal-Abad, B - Batken, IK - Issyk-Kul, N - Naryn and T – Talas regions) for the period 2000 – 2010.

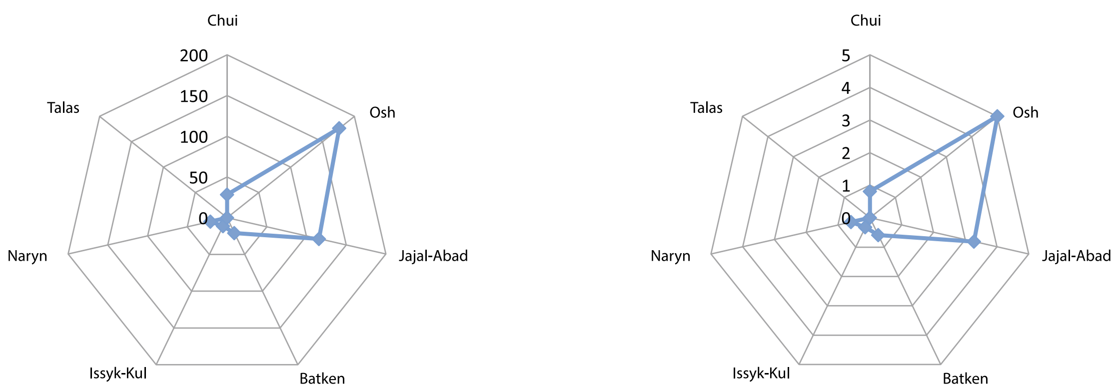


Figure 6.13. Spidergrams on landslides (in thousand USD and points)

As clear from the results, the most vulnerable to landslides are the Osh and Jalal-Abad regions, and the least vulnerable is the Talas region, where no landslides were recorded during this period.

Table 6.2. Vulnerability of the regions to landslides

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
ES number	15	93	61	11	6	11	0
Damage, thousand USD in 2005	28,4	176,3	115,6	20,9	11,4	20,9	0,0
Increase in ES number per year	-0,2634	0,0727	0,3727	0,0727	0,0182	0,2455	нд

NA – data are not available or not enough for the assessment

Avalanches

Variability in the number of avalanches with breakdown by regions please see in Figure 6.14. Distribution of the number of avalanches with breakdown by regions please see in Figure 6.15

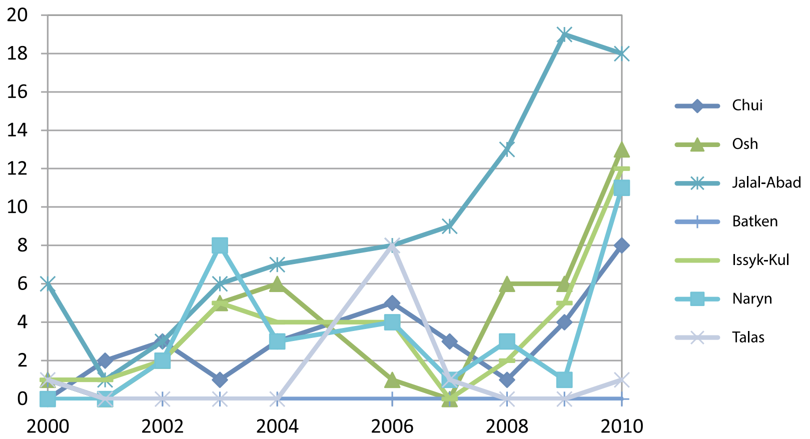


Figure 6.14. Variability in the number of avalanches with breakdown by regions (CH - Chui, O - Osh, JA - Jalal-Abad, B - Batken, IK - Issyk-Kul, N - Naryn and T – Talas regions) for the period 2000 – 2010.

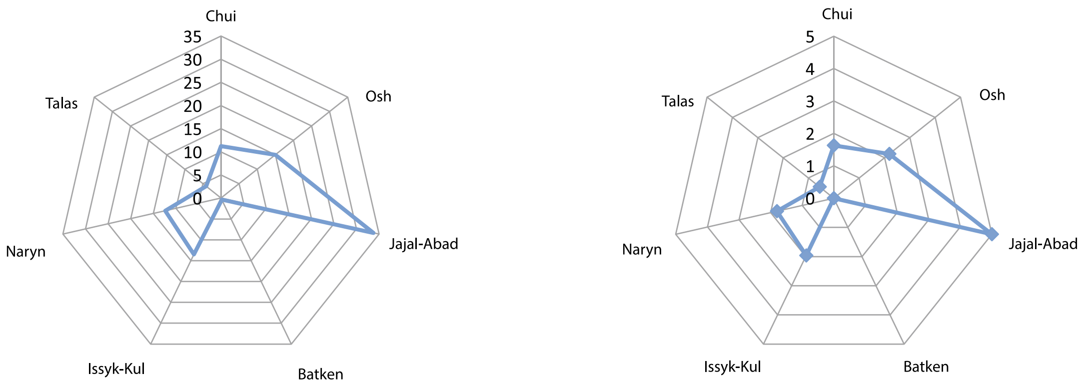


Figure 6.15. Spidergrams on avalanches (in thousand USD and points)

As clear from the results, the most vulnerable to avalanches is the Jalal-Abad region, and the least vulnerable is the Batken region.

Table 6.3. Vulnerability of the regions to avalanches

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
ES number	30	40	90	1	36	33	11
Damage, thousand USD in 2005	11,24502	14,99336	33,73506	0,374834	13,49402	12,36952	4,123174
Increase in ES number per year	0,4364	0,7364	1,5364	нд	0,5545	0,4455	нд

NA – data are not available or not enough for the assessment

Mudflows and floods

Variability in the number of mudflows and floods with breakdown by regions please see in Figure 6.16. Distribution of the number of mudflows and floods with breakdown by regions please see in Figure 6. 17.

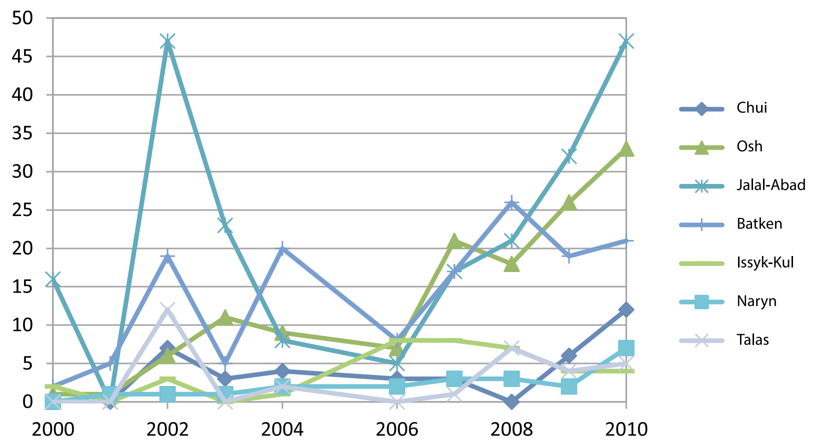


Figure 6.16. Variability in the number of mudflows and floods with breakdown by regions (CH - Chui, O - Osh, JA - Jalal-Abad, B - Batken, IK - Issyk-Kul, N - Naryn and T – Talas regions) for the period 2000 – 2010.

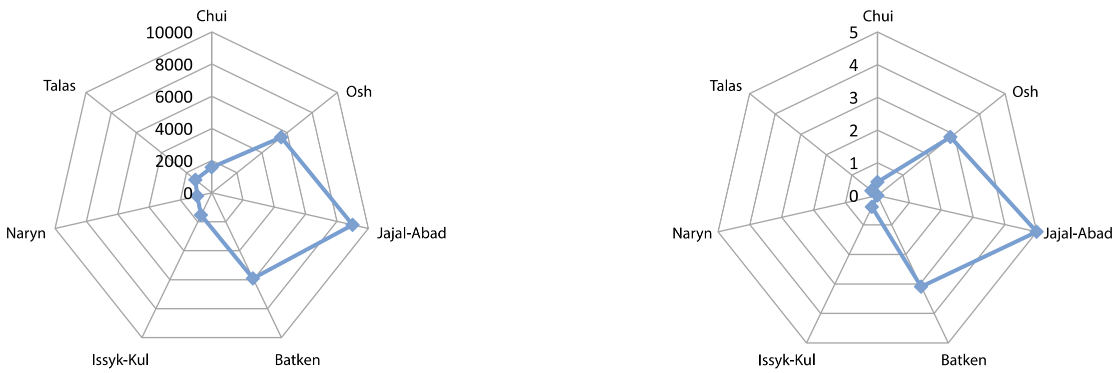


Figure 6.17. Spidergrams on mudflows and floods (in thousand USD and points)

As clear from the results, the most vulnerable to mudflows and floods is the Jalal-Abad region, and the least vulnerable is the Naryn region.

Table 6.4. Relative vulnerability of the regions to mudflows and floods

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
ES number	38	133	216	142	37	22	31
Damage, thousand USD in 2005	1582,042	5537,145	8992,657	5911,839	1540,409	915,9187	1290,613
Increase in ES number per year	0,5636	2,8545	1,7273	1,6727	0,5545	0,4455	0,2364

NA – data are not available or not enough for the assessment

Flooding

Variability in the number of flooding with breakdown by regions was not assessed due to the lack of baseline data.

Rainstorms

Variability in the number of rainstorms with breakdown by regions please see in Figure 6.18. Distribution of the number of rainstorms with breakdown by regions please see in Figure 6.19.

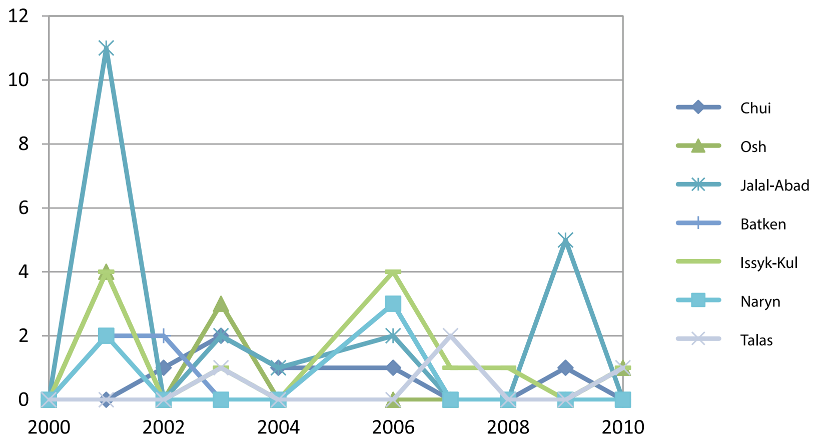
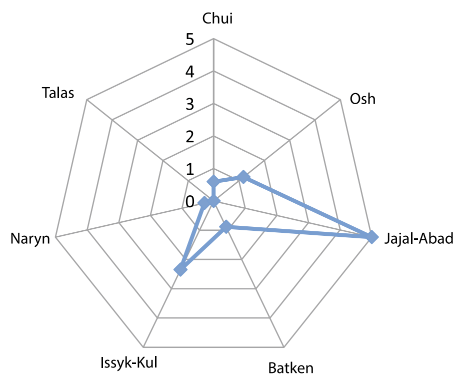


Figure 6.18. Variability in the number of rainstorms with breakdown by regions (CH - Chui, O - Osh, JA - Jalal-Abad, B - Batken, IK - Issyk-Kul, N - Naryn and T – Talas regions) for the period 2000 – 2010.

Figure 6.19. Spidergram on rainstorms (in points)



As clear from the results, the most vulnerable to rainstorms and floods is the Jalal-Abad region, and the least vulnerable is the Talas region.

Table 6.5. Relative vulnerability of the regions to rainstorms

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
ES number	6	8	21	7	12	5	4
Damage, thousand USD in 2005	нд	нд	нд	нд	нд	нд	нд
Increase in ES number per year	-0,0273	-0,1545	-0,2455	-0,1	-0,0364	-0,0455	0,0636

NA – data are not available or not enough for the assessment

Hurricane winds

Variability in the number of hurricane winds with breakdown by regions please see in Figure 6.20.

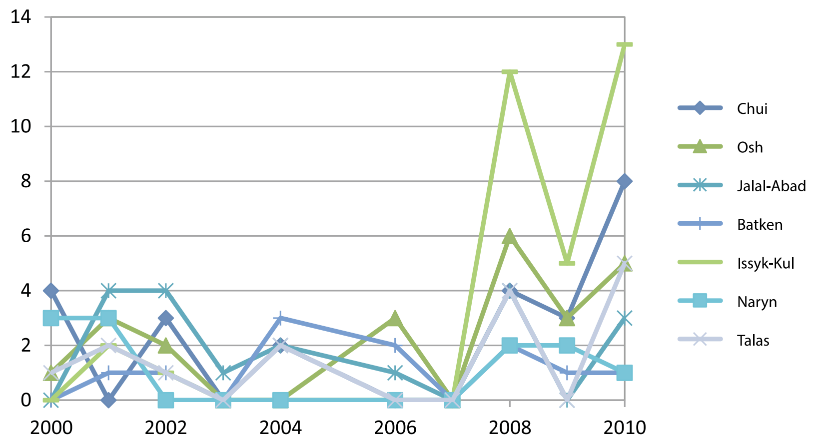


Figure 6.20. Variability in the number of hurricane winds with breakdown by regions (CH - Chui, O - Osh, JA - Jalal-Abad, B - Batken, IK - Issyk-Kul, N - Naryn and T – Talas regions) for the period 2000 – 2010.

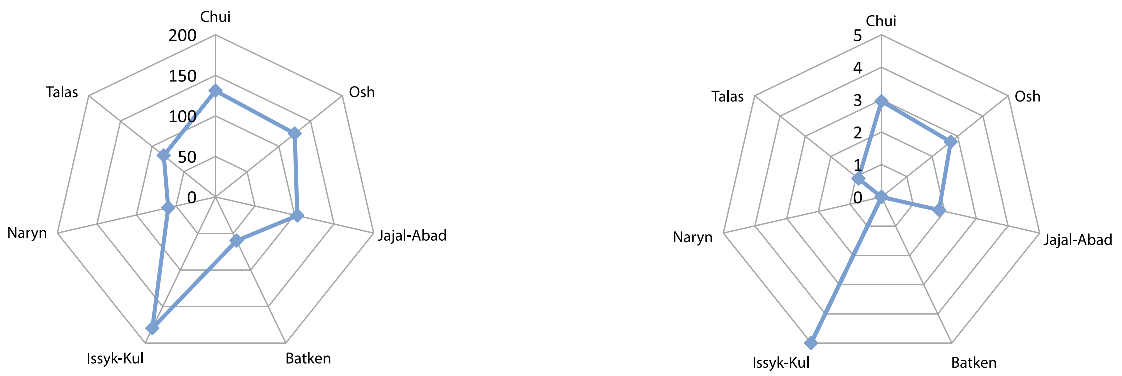


Figure 6.21. Spidergrams on hurricane winds (in thousand USD and points)

As clear from the results, the most vulnerable to hurricane winds is the Issyk-Kul region, and the least vulnerable are the Naryn и Batken regions.

Table 6.6. Relative vulnerability of the regions to hurricane winds

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
ES number	24	23	19	11	33	11	15
Damage, thousand USD in 2005	130,69	125,24	103,46	59,9	179,7	59,9	81,68
Increase in ES number per year	0,3	0,3182	-0,036	0,0636	1	0,0727	0,173

Hail and snowfalls

Variability in the number of hails and snowfalls with breakdown by regions was not assessed due to the lack of baseline data.

Summarized results

The results for certain types of ES are summarized in Table 6.7, which in addition to certain ES also reflects the sum of all ES. As noted above, the results can be used as a projected assessment only for a limited time period (a period not exceeding 5 years).

Table 6.7. Summary results on variability in the number of ES per year as a percentage of the mean annual number of ES/year.

ES	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
Landslides	-17,6	0,8	6,1	6,6	3	22,3	нд
Avalanches	14,5	18,4	17,1	нд	15,4	13,5	нд
Mudflows and floods	14,8	21,5	8	11,8	15	20,3	7,6
Flooding	нд	нд	нд	нд	нд	нд	нд
Heavy rains	-4,6	-19,3	-11,7	-14,3	-3	-9,1	15,9
Hurricane winds	12,5	13,8	-1,9	5,8	30,3	-6,6	11,5
Hails	нд	нд	нд	нд	нд	нд	нд
Snowfalls	нд	нд	нд	нд	нд	нд	нд
Total	4,7	12,3	7,5	9,7	15,2	11,9	8,5

NA – data are not available or not enough for correct assessment

As shown in the last table, despite mixed trends in certain types of ES, in general there is a tendency of increase in the total amount of ES in all regions during the period concerned, except for heavy rains, the number of which is reducing in all regions excluding the Talas region. A less clear tendency is for hurricane winds, the number of which is reducing in the Jalal-Abad and Naryn regions. A significant decrease in the number of landslides in the Chui region shall also be noted. Figure 6.22 shows the tendency in the total number of ES, including flooding, hail and snowfall, variability of which can not be assessed due to the lack of baseline data. However, it was quite possible to assess variability across the country.

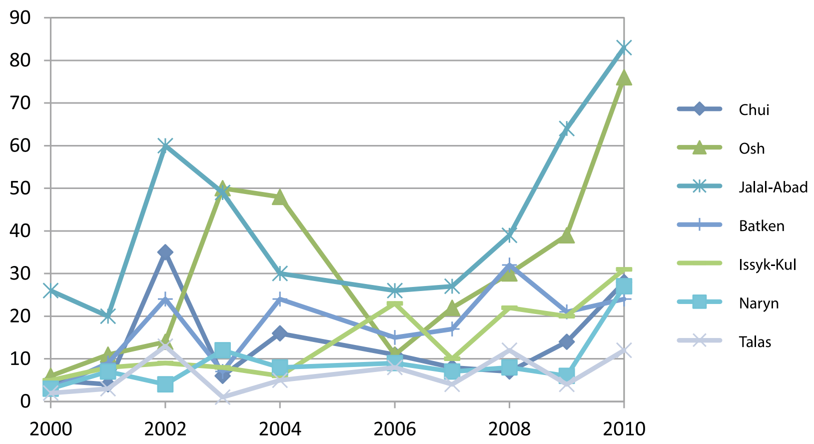


Figure 6.22. Variability in the total number of ES with breakdown by regions (CH - Chui, O - Osh, JA - Jalal-Abad, B - Batken, IK - Issyk-Kul, N - Naryn and T – Talas regions) for the period 2000 – 2010.

Figures 6.23 – 6.25 are spiders assessing the total number in the country (absolute damage in constant dollars in 2005, the damage as a percentage of the GRP, and the absolute damage in scores).

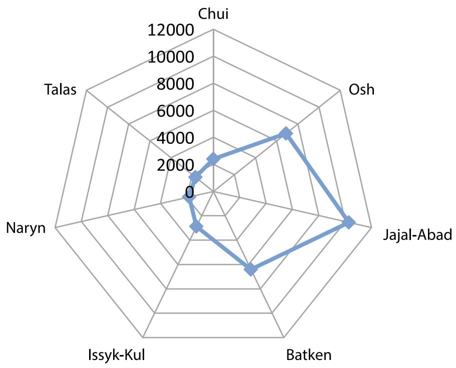


Figure 6.23. Absolute damage as a result of ES for the period 2000 - 2010 in constant dollars in 2005

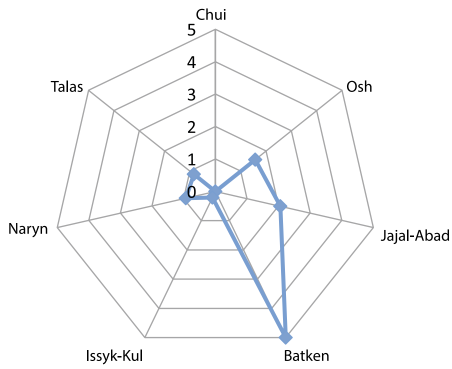


Figure 6.24. Damage as a result of ES for the period 2000 – 2010 as a percentage to GRP in scores

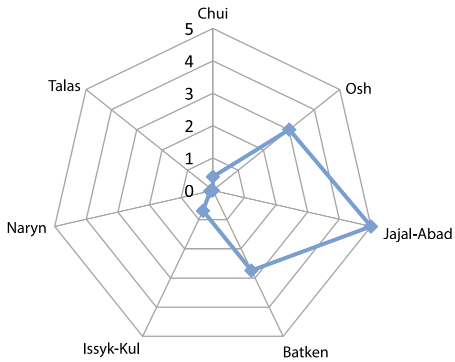


Figure 6.25. Absolute damage as a result of ES for the period 2000 - 2010 in scores

As clear from the results, the Jalal-Abad region is the most vulnerable to ES, and the least vulnerable is the Talas region.

Table 6.8. Relative vulnerability of the regions to the total ES in scores

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
ES number	134	307	424	176	142	91	64
Damage, thousand USD in 2005	2403,783	6871,614	10282,37	6400,135	2883,642	1826,085	1681,793
Increase in ES number per year	0,6364	3,7909	3,1818	1,7091	2,1636	1,0818	0,5455

A more informed total vulnerability to ES can be obtained not by summing the number of certain ES, but using the average of certain types of ES.

Table 7.9. The mean vulnerability to ES

Indicator	Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
Mean	1,779755	2,713197	3,975761	0,843386	2,305635	0,814575	0,212856

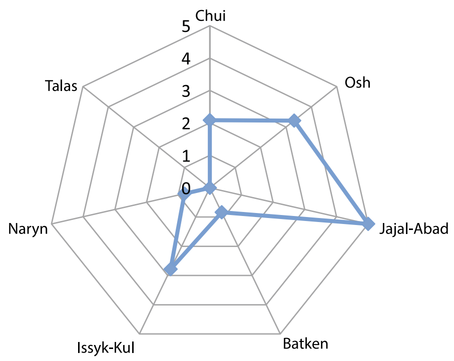


Figure 6.26. Spidergram with mean scores of all ES

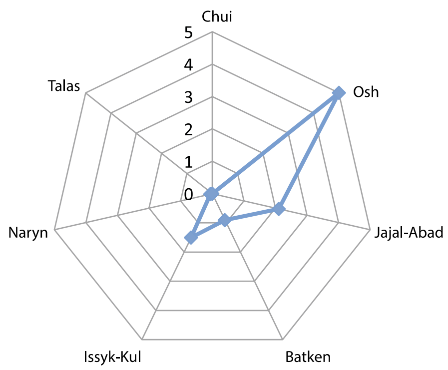


Figure 6.27. Spidergram with the number of victims as result of all ES

Table 6.10. Relative vulnerability of the regions based on the number of victims as a result of ES

Chui	Osh	Jalal-Abad	Batken	Issyk-Kul	Naryn	Talas
2	85	37	17	27	3	2

In order to assess the expected variability in the number of ES, the results can be presented in the form of a quantitative assessment of variability per 1C (see Table 6.11). Depending on the selected climate scenario, this table can be used to estimate the number of ES for any particular time period. Of course, like any other assessment that uses statistical estimates, this assessment can not be extended to long periods in the future, as it does not take account of changes in physical conditions for the ES formation with significant changes in the external conditions, including temperature.

6.1.2. AGRICULTURE

Five different options for climate risk assessment can be used for agriculture:

1. Assessing changes in characteristics of the agriculture using the "climate – yield" models, such as the GLAM model (http://www.see.leeds.ac.uk/see-research/icas/climate_change/glam/glam.html). A significant weakness of this approach is the lack of practical application of such models by specialists of the Kyrgyz Republic, as most of the above models shall be appropriately adapted to specific local conditions. In addition, it will take time to master these models and to collect relevant baseline information.
2. The approach using the correlation between climatic parameters and yield of major crops, i.e. assessing productivity of the main crops on the basis of changes in climatic characteristics that leads to the following statistical models "climate-yield".

$$Yield = f\ (climatic\ parameters)$$

This approach was studied in details during the preparation of the Second National Communication on Climate Change in the Kyrgyz Republic, and it was clear that it would be extremely difficult to obtain correct estimates, as a large number of parameters shall be taken into account (for example, monthly precipitation and temperature over long periods). As a result, the number of parameters to be estimated statistically is close to the length of the sample, taking into account availability of official data for a relatively short time period. Naturally, it is impossible to obtain statistically accurate models in these cases. Review of the available sources also shows rare use and insufficient statistical justification of the method providing for direct correlation between yield and climatic factors;

3. Assessment based on approach that uses a summary (e.g., drought and moisture indices) rather than climatic parameters, i.e. yield assessment based on variability of indices comprehensively characterizing climatic conditions and providing for the following models:

$$Yield = f\ (climatic\ parameters)$$

This methodology has not been used in the country before and Kyrgyzhydromet does not regularly define moisture and drought indices, in contrast to the neighboring countries. Therefore, it will take some time to master the software for the calculation of indexes and selecting the most effective one in terms of the impact on yield of major crops. Available data on the economic damage and yield allow for risk analysis using this approach to both yield variability and economic damage caused by changes in climatic characteristics.

This approach allows to sharply reduce the number of parameters included in the statistical model so that to improve statistical validity of the results in case of small samples. In addition, regular calculation of drought and moisture indices in practice is necessary for the yield insurance system.

Its weakness (which is also typical to previous approach) is that it is difficult to take into account the effect of other factors (other than climatic) on the yield. It is almost impossible to take account of these factors and the results will be significantly distorted, especially given that the concerned period, with statistical data collected using relatively comparable methods (1990-2010) is the period of significant structural changes in the country's agricultural sector.

4. Assessing the impact of climate change using methodology similar to the methodology for calculating correlation, which was used for emergencies - this approach can be called as the approach for analyzing trends of sector indicators and climate trends.

   In assessing climate risks, variability in surface runoff of rivers, which are the main source for irrigation, shall also be taken into account.

   Based on the analysis of various approaches, we can conclude that the models based approach is the most promising for the Kyrgyz Republic as a whole. However, given the resource constraints for this work, and the need to calculate indices for agricultural insurance, the possibility to assess risks using the third and fourth approaches shall be analyzed.

   Changes in surface runoff were analyzed in details in preparing the Second National Communication on Climate Change and strategies for adapting to climate change. Depending on the demographic and emission scenarios, the amount of surface water used by the Kyrgyz Republic in line with the current water allocation may be insufficient for irrigation in the second half of this century; therefore, preventive measures shall be adopted.

6.1.2.1. APPROACH TO GENERALIZED TRENDS

6.1.2.1.1. CROPS BREEDING

Calculations are based on the initial data that reflect the situation in agriculture and are monitored by the National Statistical Committee (Annex 3).

The analysis primarily covers crops with sufficiently detailed data, i.e. with little gaps and which are largely sowed on rain-fed land. Therefore, wheat, barley and maize were selected as the most vulnerable crops.

The calculations aim to look at correlation between the observed climate change, which are particularly observed over the last 20 years and a reduction in crop yields as a result of adverse effects in the form of “drought, lack of water”, “rain, hail”, “frost and snowfall”. The calculation results please see in Figures 6.26 - 6.29.

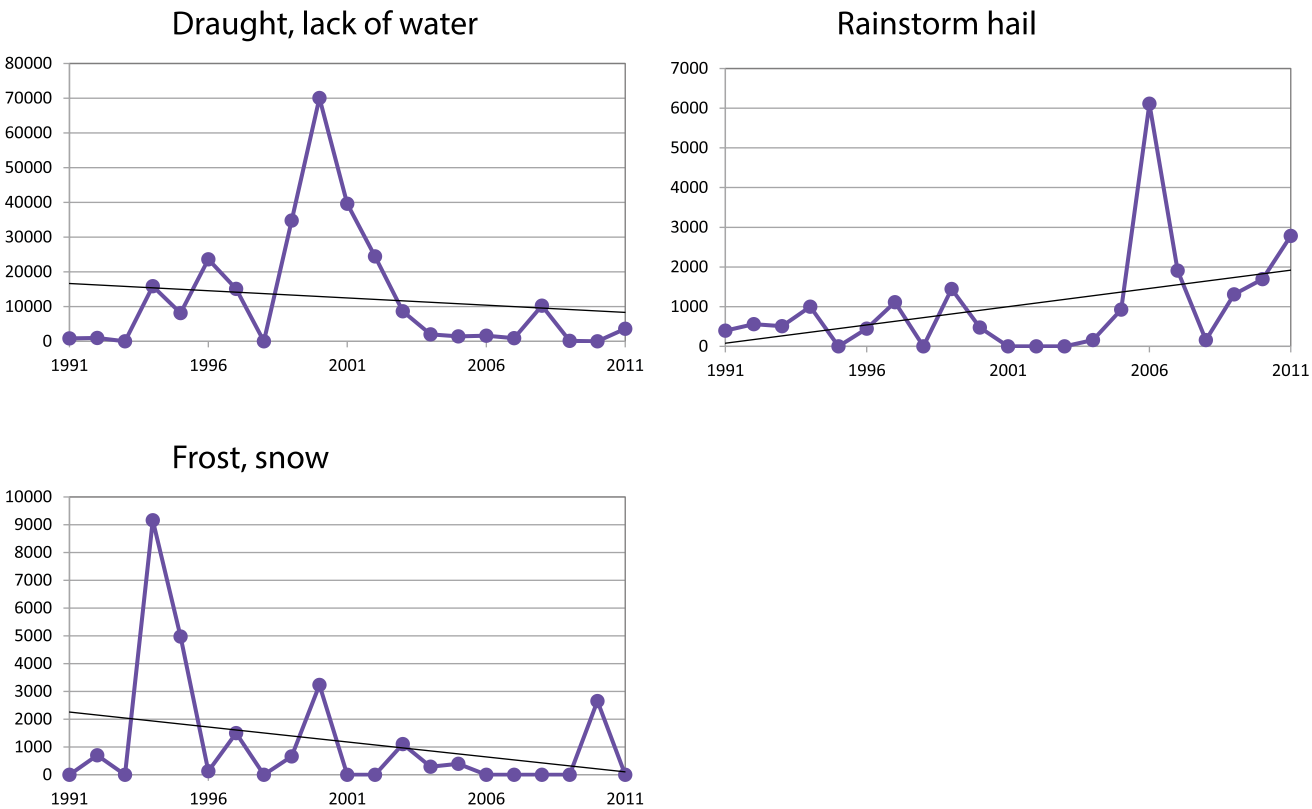


Figure 6.28. The correlation between wheat, barley and maize yield losses (lost hectares) as a result of various types of climatic events

As clear from the calculations results, the events such as “drought, lack of water” and “frost, snow” have no increasing impact of climatic conditions, i.e., no increased adverse effects despite the observed climate change trends. The observed trends will presumably be the same in the future; therefore, we may expect that the impact of the above events will reduce.

The events “rain, hail” show a slight positive tendency, but it is likely that for such a small amount of data (the sampling of 21), it is caused by abnormally strong exposure for one year - 2010.

In general, there is no tendency of losses increase (see Figure 6.29) neither for the concerned crops, nor across the crops sector from the above three types of climate impacts in 1991 – 2011.

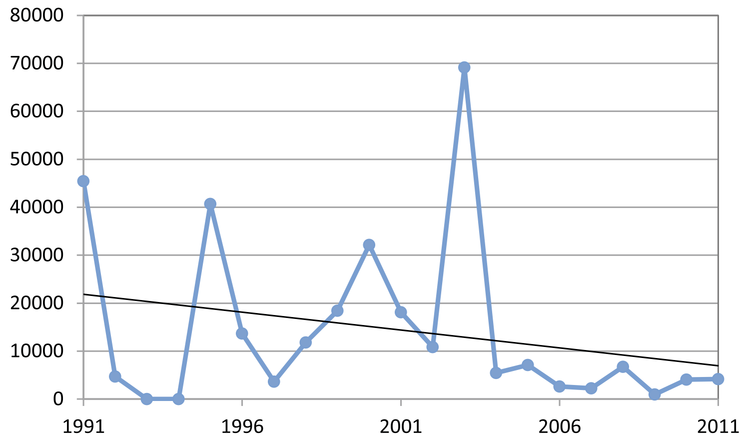


Figure 6.29. Losses from the three types of climate impacts in constant dollars of 2005

The reasons, why no adverse effects on the yield were detected as a result of “drought, lack of water”, “rain, hail”, “frost and snowfall” may be the following:

- Weakness of the monitoring system;
- The actual reduction in frequency and severity of climate impacts under the current climate trends;
- Focus mainly on crop irrigation farming.

Nevertheless, based on the above results that were obtained using this approach, there is no any reasonable need to adopt measures preventing negative impact of the above climate events on crop production sector until further research.

6.1.2.1.2. ANIMAL HUSBANDRY

The livestock sector was considered from the perspective of fodder supply. The impact of the observed climate change on variability of fescue yield (baseline data were provided by the State Enterprise the “State Design Institute of Land Management”) in pastures was analyzed. The results of the analysis are used to discuss future actions using the data on the expected climate.

The impact of basic meteorological parameters - temperature and precipitation - on yields was preliminary assessed. The only conclusion for all climatic zones with a variety of conditions is positive correlation between the fescue yield and the increasing temperature and increased amount of annual precipitation. This also applies to both the Inner Tien Shan area with mean annual temperatures of about 0°C and southern regions with a mean annual temperature of about 10°C. Positive impact on fescue yield in all climatic zones with a variety of conditions is observed with:

- the temperature increase - 0.28 (c/ha) / 1°C
- and the amount of annual precipitation - 0.00096 (c/ha) / mm

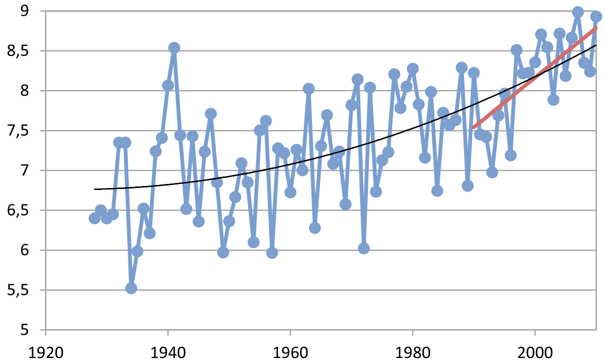
Despite uniform requirements to climatic conditions, the observed changes in yield are more diverse (see Figure 6.30), in contrast to the unidirectional climate trends in all regions (except for the Inner Tien Shan).

In general, a long-term yields decrease tendency was observed in the three climate regions (the Southwest, Inner Tien Shan and the Northeast) (from 1926 to 2011). This tendency has totally changed in recent decades, i.e. there is a yield increase tendency. In the Northwest region (Chui without Susamyr and Talas) it is vice versa - a long-term positive yield increase tendency has negatively changed over the past 20 years.

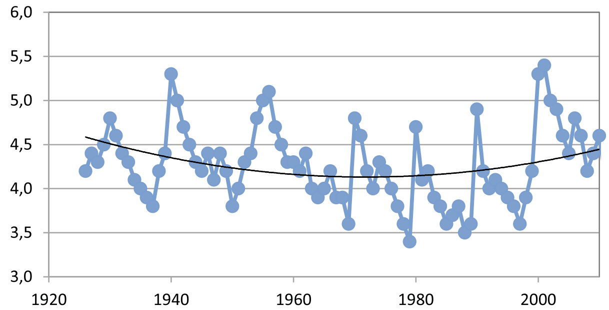
Of course, the above can not be explained only by the influence of natural factors (e.g., climate) and for clarity it is necessary to analyze economic activity depending on season, especially in the densely populated northern region of the country.

Given the above results, it is clear that the observed and expected climate changes within their ranges have currently a positive impact on the yield increase and the main negative factor affecting the yield is imperfect management affecting the yield through pressure on pastures.

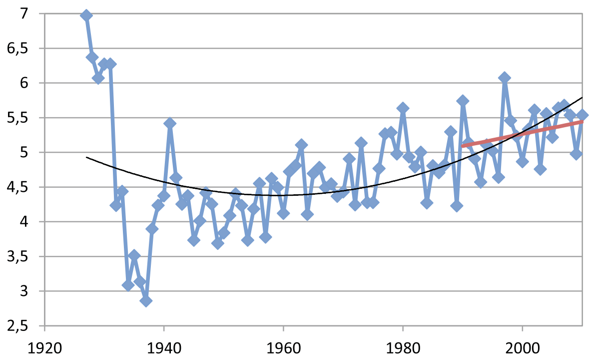
A more detailed study to identify other factors that affect pastures productivity, as well as changes in the yields of other species of edible (except for fescue) and non-edible vegetation shall be conducted for a more specific vulnerability assessments.



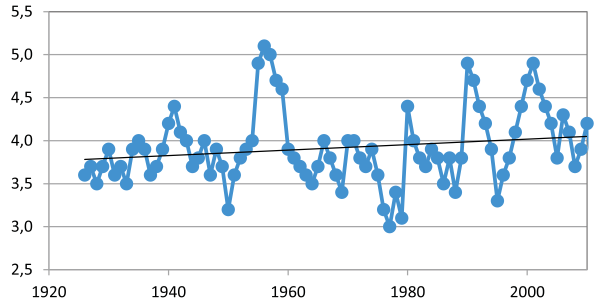
Temperature variability (Southwest region), °C



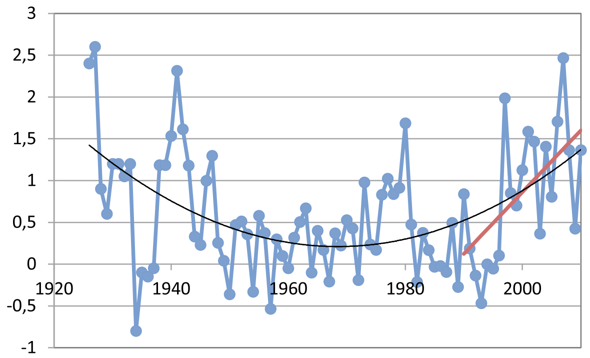
Yields variability (Southwest region), c/ha



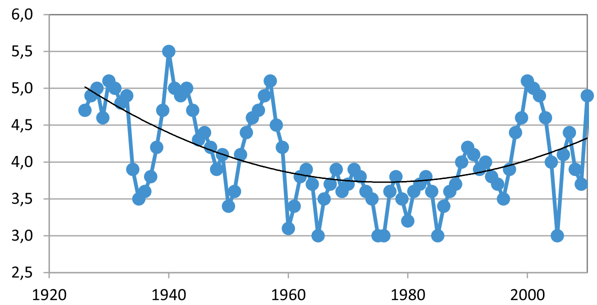
Temperature variability (Northwest region), °C



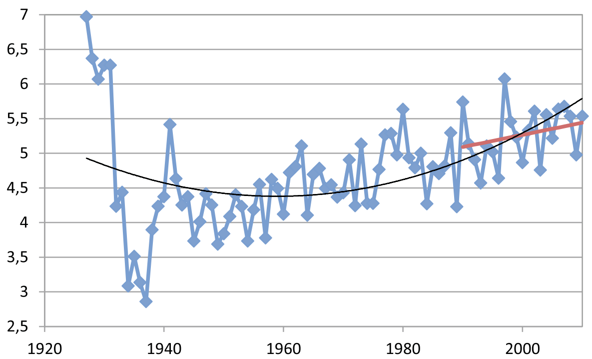
Yields variability (Northwest region), c/ha



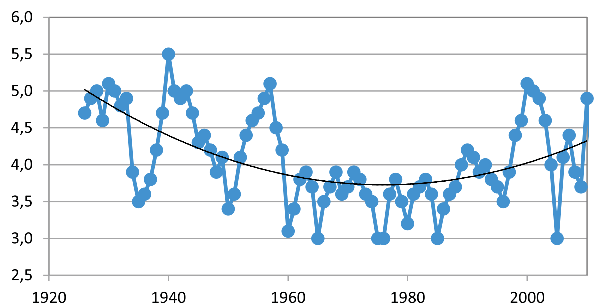
Temperature variability (Inner Tien Shan), °C



Yields variability (Inner Tien Shan), c/ha



Temperature variability (Northeast Region), °C



Yields variability (Northeast Region), c/ha

Figure 6.30. Trends in yield and temperature increase for different climatic regions of the Kyrgyz Republic

6.1.2.2. INDEX-BASED APPROACH

Indices-based approach is based on analysis of the yield correlation with the index characterizing the conditions of agricultural crops cultivation. These indices normally reflect drought. Drought is a complex event that can be viewed from several perspectives. The lack of moisture is the core to definitions of drought. Difficulties with drought definition are due to the need to consider different components of the hydrological cycle, as well as time periods and conditions, respectively, as to when and where there is moisture deficit. The complexity with the definition and identification of drought is also due to the fact that long-term lack of moisture in the soil at a depth occurs simultaneously with short-term moisture excess in the upper layer. There are different approaches to the drought classification.

Meteorological drought. The main feature of the meteorological drought is the deficiency of precipitation accompanied by a decrease in surface runoff, infiltration and groundwater recharge, as well as other events, such as high temperature, low relative humidity, decrease in cloudiness, increased solar radiation, a combination of which leads to increased evaporation and transpiration of moisture by the plants. Meteorological drought can develop very quickly and end abruptly.

Agricultural drought. Agricultural drought is characterized by a deficit of soil moisture, which leads to a stress for the plants, and decrease in bio-productivity and yield. The plants' needs for water depend on meteorological conditions, biological characteristics of the plant species, stage of their growth and development, as well as physical and biological properties of soils. Moisture deficit in the upper layer of soil at planting may hinder seeds germination and lead to a decrease in germination and reduced yield. However, if moisture in the upper soil layer is sufficient to meet the needs of plants at an early stage of growth, the deficit of subsoil moisture at this stage will not affect the yield, if there will not be any deficit later during the growing season. Agro-meteorological indicators used to monitor agricultural drought in Russia take into account the associated changes in physical characteristics of the surface layer of air and root zone of soil horizons, as well as changes in the biomass growth indicators. In terms of timing, the beginning of the agricultural drought can differ significantly from the beginning of the meteorological drought depending on the available moisture. Additional factors preventing accumulation of moisture in soil also contribute to the drought: in winter - the lack of snow; in early spring - unfavorable melt water absorption conditions (rapid snow melting, frozen or non-structured soil and presence of ice crusts).

Hydrological drought. Hydrological drought is characterized by a reduction of water flow into rivers and streams, as well as decrease in their levels and groundwater supplies, which leads to difficulties in meeting the demand for water. The degree of severity of the hydrological drought is defined as a rule for watersheds or river basins. Hydrological drought usually starts with a delay compared to meteorological and agricultural droughts. As the regions concerned are interconnected by hydrological systems, the area covered by hydrological drought may be greater than the area covered by meteorological drought.

The need to quantify the drought is due to the fact that droughts cause significant economic damage to agriculture. Statistical data of the Kyrgyz Republic for the period of 1991 - 2011 show that droughts largely contribute to the total economic damage from all types of weather emergencies (see Table 6.11).

Table 6.11. The mean annual damage caused by all types of weather emergencies, including by drought, to main agricultural crops in thousands constant dollars 2005 for the period 1991 - 2011 (source: the National Statistics Committee)

No	Crop	Damage caused by all ES	Damage caused by drought	Proportion, %
1	Wheat	6560,26	5826,35	88,81
2	Barley	934,68	728,46	77,94
3	Rice	237,82	182,96	76,93
4	Maize	996,04	820,10	82,34
5	Pulses	28,16	26,68	94,74
6	Oats	2,68	2,07	77,24
7	Tobacco	251,66	202,54	80,48
8	Sugar beet	2216,86	2066,22	93,20
9	Oil-bearing crops	202,36	165,50	81,78
11	Potatoes	249,57	143,40	57,46
12	Vegetables	2358,09	1817,60	77,08

The damage amount in the Table 6.11 was determined with the account of different costs per unit of products and different agricultural crop yields. Therefore, despite similar physical volumes of crop losses (written-off cultivated areas), the damage will be higher for those crops, the unit cost of which is higher.

Given that droughts cause significant economic damage, it is necessary to implement effective measures aimed to reduce this damage. Measures aimed to reduce damage can be broadly divided into two main categories:

1. ***Preventive measures.*** These measures are being taken prior to the beginning of the drought in order to reduce potential economic damage. Most of these measures are based on complex systems for early drought forecasting. Quite reliable and, of course, quantitative prediction of drought occurrence allows for timely launch of the mechanisms for reducing damage through a variety of measures, such as changing land use practice, accumulating and redistributing water resources, appropriate changes in the animal husbandry practice, and etc. Other group of preventive measures can also include mechanisms for insuring against agricultural damage, as the insurance mechanism should be defined in advance. The amount of insurance payments must also be determined quantitatively depending on the scale of the drought, i.e. its quantitative assessment. The most effective approach is when these mechanisms aimed to reduce damage are in the form of sections integrated in the general government development programs or formalization of these mechanisms in the form of the targeted state programs.
2. ***Measures undertaken after the drought.*** Unfortunately, this group of measures is the most popular in many developing and developed countries. These measures are in the form of the state (or non-state) intervention after the drought. These measures are typically various activities in the form of aid programs designed to provide monetary or other specific types of assistance (e.g., fodder for livestock, water, food) to the affected persons (or those who were most severely affected by the drought). This category of response measures has serious weaknesses in terms of reducing vulnerability, because it does not require the recipients of this aid to change their practice of economic activity. For example, livestock breeders, who do not have adequate supplies of fodder for livestock in their farm as part of the drought combating strategy will be the ones, who will first experience consequences of the prolonged draught. They will first

turn to the government or other organizations for help in order to get enough fodder for their livestock until the end of the drought and get the adequate amount of fodder. This principle – relying on help from outside - is opposite to the best practice that encourages self-reliance by investing in enhancing capacity so that to resist hazards. This category of measures has additional disadvantages in terms of timing of assistance provision. Given inevitable bureaucratic procedures, provision of assistance may take considerable time, which may exceed the period, when help would be most valuable in terms of eliminating drought consequences. However, this category of measures needs is a clear quantitative assessment of the drought scale for correct assessment of the magnitude and recipients of the provided aid

Analysis of possible measures aimed to reduce economic damage from drought shows that in either case, there is the need for a regular system for drought monitoring allowing to quantitatively assess drought scale; this monitoring system shall further be developed into a warning, i.e. forecasting system.

Further, we will discuss meteorological drought, for which baseline data are not a problem at all.

6.1.2.2.1. STANDARDIZED PRECIPITATION INDEX, SPI

Currently, one of the most common indices of aridity based only on precipitation data is the standardized precipitation index [47].

Understanding that the lack of precipitation significantly affects groundwater, water reservoirs, soil moisture, snow cover and river discharge led to the development of the standardized precipitation index (SPI), which is currently the most common drought monitoring index in the world. Calculation of the index includes preliminary analysis of the precipitation distribution function over a selected baseline period and its approximation, which enables to define probability of not exceeding the value of any observed precipitation. SPI index value is an anomaly of the standardized normal distribution corresponding to the probability of non-exceedance of any observed amount of precipitation.

The index is based on approximation of the precipitation amount through gamma distribution:

$G(x) = x^{\alpha-1}e^{-x/\beta}/(\beta^{\alpha}\,\Gamma(\alpha))$, для x больше 0.

where α and β are distribution parameters.

Parameters of the gamma distribution are estimated using the least squares method based on frequency of precipitation distribution in the meteorological station. Parameters of the gamma distribution are determined for each station and time period (1 month, 2 months, ...). Parameters are determined using the maximum likelihood method:

$\alpha = 1/(4A)(1+(1+4A/3)^{-1})$

$A = \ln(E(x)) - \sum\ln(x)/n$

$\beta = E(x)/\alpha$

The estimated parameters are then used to determine the probability density for a particular set of precipitation, which is observed at a certain time interval (e.g., a month).

Gamma function is not defined at x = 0, but because there can be time periods without any precipitation; it must be modified by considering shorter time intervals:

H(x) = q + (1 – q) G(x)

q - is the probability of the event “without precipitation” at a given time interval.

The probability density H (x) is then converted to a standard normal distribution Z with a mean and standard deviation of 1.

Z = SPI = - (t – (c0 + c1t + c2t2)/(1 + d1t + d2t2 + d3t3)), для 0 ≥ H(x) ≤ 0,5

Z = SPI = + (t – (c0 + c1t + c2t2)/(1 + d1t + d2t2 + d3t3)), для 0,5 < H(x) ≤ 1,0

where

t = (ln(1/H(x)2))-1, для 0 ≥ H(x) ≤ 0,5

t = (ln(1/(1 - H(x)2)))-1, для 0,5 < H(x) ≤ 1,0

c0 = 2,515517

c1 = 0,802853

c2 = 0,010328

d1 = 1,432788

d2 = 0,189269

d3 = 0,001308

SPI is the deviation to the left (drought) or right (humidity) from 0. Below is the table of probabilities for various deviations from 0.

Table 6.12. The probability of various deviations

Deviation	Probability
-3.0	0.0014
-2.5	0.0062
-2.0	0.0228
-1.5	0.0668
-1.0	0.1587
-0.5	0.3085
0.0	0.5000
0.5	0.6915
1.0	0.8413
1.5	0.9332
2.0	0.9772
2.5	0.9938
3.0	0.9986

Table 6.13. Classification of humidity conditions for different values of the Standardized Precipitation Index (SPI)

SPI value	Characteristic of the period
2.0 and above	Extremely humid
From 1.5 to 1.99	Very humid
From 1.0 to 1.49	Moderately humid
From -0.99 to 0.99	Approximately normal
From -1.0 to -1.49	Moderately dry (moderate draught)
From -1.5 to -1.99	Very dry (strong draught)
From -2.0 and below	Extremely dry (severe draught)

SPI index can be used to determine the conditions of aridity at any time intervals (ranging from one month or more). Using this index, variation of averaging scale enables to track both agricultural and hydrological impacts of drought related to items with different sensitivity to precipitation deficiency. The only limitation in using this index is the need to consider the fact that the index shows anomalies for a specific meteorological station. It is quite possible that the actual conditions of extreme drought at one meteorological station correspond to the conditions of extreme humidity at the other one, as extremity is determined for specific conditions.

To assess the possibility of using the SPI drought index, its correlation with the yield was calculated in the Chui region as an example.

Yield of the following crops was analyzed:

1. Cereals (weight after processing);
2. Wheat (weight after processing);
3. Barley (weight after processing);
4. Maize;
5. Rice (weight after processing);
6. Sugar beet (factory weight);
7. Tobacco (in registered weight);
8. Oil-bearing crops;
9. Potatoes;
10. Vegetables;
11. Melons;
12. Fruit and berries;
13. Grapes

SPI index was also calculated for the same period. The final time of index calculation (in months) and the depth of humidity conditions (in months) varied. These parameters were changed to clarify methodology of calculation.

Table 6.14 shows the results of calculating determination coefficient between the yield and SPI index for different crops and different parameters of the SPI index calculation. The table shows only those crops, for which determination coefficient had the highest values.

The critical value of the coefficient of determination for engineering significance level is 0.196958.

Table 6.14. Defining parameters for the SPI index calculation and agricultural crops selection. Significant values are in bold.

Month for calculations	Depth of humidity conditions, months									
	3	4	5	6	7	8	9	10	11	12
Cereals (weight after processing)										
6	0.106	0.166	0.18	0.193	0.165	0.150	**0.261**			
7	0.122	0.140	**0.208**	**0.219**	**0.225**	**0.196**	0.179			
8	0.178	0.137	0.157	**0.221**	**0.234**	**0.239**	**0.209**			
9	0.167	0.194	0.176	0.173	**0.242**	**0.254**	**0.259**			
10	0.075	0.128	**0.212**	**0.263**	**0.260**	**0.332**	**0.341**	**0.343**	**0.290**	**0.274**
Wheat (weight after processing)										
6	0.180	**0.264**	**0.215**	**0.224**	**0.206**	0.155	0.257			
7	**0.203**	**0.222**	**0.261**	**0.254**	**0.255**	**0.236**	0.180			
8	**0.283**	**0.242**	**0.263**	**0.295**	**0.289**	**0.288**	**0.266**			
9	**0.244**	**0.324**	**0.300**	**0.287**	**0.323**	**0.316**	**0.314**			
10	0.050	0.082	**0.219**	**0.290**	**0.312**	**0.348**	**0.337**	**0.336**	**0.300**	**0.242**
Barley (weight after processing)										
6	**0.285**	**0.317**	**0.402**	**0.410**	**0.377**	**0.348**	**0.408**			
7	**0.222**	**0.284**	**0.380**	**0.414**	**0.413**	**0.378**	**0.345**			
8	0.172	**0.224**	**0.299**	**0.390**	**0.423**	**0.424**	**0.388**			
9	0.074	0.181	**0.274**	**0.316**	**0.412**	**0.444**	**0.446**			
10	0.012	0.022	0.122	**0.269**	**0.360**	**0.460**	**0.488**	**0.496**	**0.428**	**0.392**
Maize										
6	0	0.017	0.027	0.033	0.018	0.027	0.065			
7	0	0	0.020	0.032	0.038	0.023	0.032			
8	0.015	0	0	0.017	0.028	0.034	0.020			
9	0.005	0.005	0	0	0.015	0.025	0.030			
Oil-bearing crops										
7	0	0.002	0.020	0.021	0.026	0.017	0.022			
Potato										
7	0.001	0.005	0	0.003	0.003	0	0.003			
Vegetables										
7	0.005	0.004	0.036	0.045	0.051	0.035	0.045			

The results of test calculations enabled to determine time of the index calculation and depth of humidity conditions. Despite recommendations and preliminary assumptions, the obtained optimal parameters do not coincide with the growing season. The selected crops in general coincided with the preliminary assumptions and proved to be a very small sampling. As was expected, the correlation coefficient between yield and SPI index is a bit lower than for grains in Kazakhstan, which is understandable given different cultivation technologies.

Conclusions based on the calculation results:

1. SPI index allows to statistically reasonably estimate variability in the yield of the following four kinds of agricultural crops:

   - Cereals (weight after processing);
   - Wheat (weight after processing);
   - Sugar beet;
   - Barley (weight after processing.

For other analyzed crops, there is no any statistically significant correlation between the index and yield. There may be some correlation for other crops, for which there are no any official data on yield, for example, oats and buckwheat.

2. The best time for index assessment is October.
3. The strongest correlation can be observed when using the depths of index calculation over 9 - 10 months.
4. Using the projected index, one can assess variability in the yield of the selected crops as a result of climate change for future periods.
5. SPI index can serve as a basic indicator in implementing the crops insurance system.
6. In order to verify preliminary obtained results, a full analysis (in all regions) shall be conducted so that to clarify the scope and validity of the SPI index use.

Based on the findings, the coefficient of determination of major crops yield and SPI index for all

regions of the country was calculated.

Table 6.15. The coefficient for determining correlation between the yield and SPI index. Bold values are the most significant ones. A dash means lack of the relevant data

Parameter	Regions						
	Jalal-Abad	Issyk-Kul	Naryn	Osh	Talas	Chui	**0,3953**
Cereals	0.1133	0.0006	0.047	0.0927	0.0636	0.1373	**0.3953**
Wheat	0.0001	0.0026	0.0437	0.0709	**0.0656**	0.194	**0.4052**
Barley	0.0007	0.133	0.054	0.102	0.328	0.0431	0.558
Maize	**0.066**	0.0121	0.0146	0.0017	0.0854	0.0099	0.1056
Rice	**0.2112**	0.0001	-	-	0.0006	-	0.0649
Raw cotton	0.2366	0.0154	-	-	0.0002	-	**-**
Sugar beet	-	-	0.0528	-	-	0.1021	0.3027
Tobacco	**0.0005**	0.028	0.006	-	0.016	0.0333	0.059
Oil-bearing crops	**0.2548**	0.0018	0.1209	0.0114	0.0456	0.0213	0.0611
Potatoes	0.1983	0.001	0.0918	0.0475	0.0314	0.1924	0.0467
Vegetables	0.0593	0.0012	0.1048	0.0446	0.0261	0.0345	0.1226
Melons	**0.1726**	0.004	-	-	0.0202	0.014	0.053
Fruit and berries	**0.5597**	0.0397	0.048	0.0031	0.0001	0.0205	0.0095
Grapes	**0.354**	0.1372	0.0258	-	0.0919	0.1087	0.0591

The calculation results certify previously made findings about the importance of certain crops correlations using Chui region as an example. It is difficult to explain significant values of the coefficient of determination for some crops (e.g., rice). This is likely the result of a random sampling due to small amounts of baseline data or weakness of the accounting and monitoring system.

6.1.2.2.2. STANDARDIZED PRECIPITATION-EVAPOTRANSPORATION INDEX, SPEI

The SPEI index [51] can be underlined among new approaches to the detection of climatic drought. From a methodological point of view, this index is similar to the standardized precipitation index (SPI). However, it is based on the two-dimensional distribution and the amount of precipitation; it takes into account the evapotranspiration value. This feature of the index can be useful in analyzing aridity variability in global warming.

The index is based on the calculation of the monthly series of precipitation and mean temperature, taking account of the geographical coordinates. The procedure for determining the index value fully repeats the procedure for calculating SPI index, but in addition to the amount of precipitation and also takes account of the surface temperature.

Classification of humidity conditions based on the SPEI index values coincides with classification of the Standardized Precipitation Index (SPI) (see Tables 6.15 and 6.16). Practical examination showed almost complete coincidence of the SPEI and SPI indices values in all regions of the republic. Please see below the example in Figure 6.31. However, at the same time, the SPI index ensures a greater correlation of the index value with the yield; therefore, the SPI index was selected.

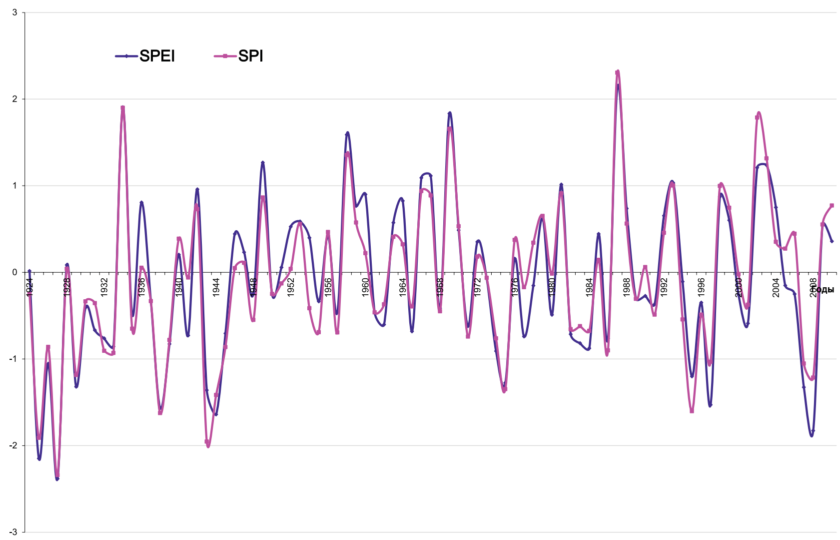


Figure 6.31. Comparative analysis of the SPEI and SPI indices calculation

Table 6.16. The coefficient of determining correlation between the yield and SPEI index. Bold values are the most significant ones. A dash means the relevant data are unavailable

Parameter	Regions						
	Jalal-Abad	Issyk-Kul	Naryn	Osh	Talas	Chui	**0,2708**
Cereals	0.1553	0.0282	0.1563	0.0774	0.0006	**0.1173**	**0.2708**
Wheat	0.0163	0.0051	0.149	0.0668	0.0006	0.279	**0.4014**
Barley	0.0216	0.13	0.184	0.113	0.187	0.1451	0.38
Maize	**0.0754**	0.0002	0.0118	0.0022	0.0174	0.0762	0.0439
Rice	**0.3395**	0.017	-	-	0.0288	-	0.0109
Raw cotton	0.2338	0.0029	-	-	0.0459		**-**
Sugar beet	-	-	0.0911	-	-	0.0354	0.4399
Tobacco	**0.0132**	0.127	0.017	-	0.002	0.0049	0.005
Oil-bearing crops	0.1992	0.0367	0.0761	0.0028	0.0001	0.0027	0.0297
Potatoes	0.1449	0.01	0.0138	0.0034	0.0046	0.0298	0.0014
Vegetables	0.0188	0.0111	0.0356	0.0097	0.0004	0.0003	0.032
Melons	**0.1816**	0.05	-	-	0.0013	0.129	0.00009
Fruit and berries	**0.4464**	0.1221	0.0014	0.0097	0.0184	0.0014	0.0005
Grapes	**0.3728**	0.0455	0.0453	-	0.0929	0.0099	0.0274

6.1.2.2.2. IVANOV'S INDICATOR

Other factors, such as Ivanov's humidity indicator, which is very popular in the CIS countries, can also be used as an index that comprehensively reflects climatic conditions. The Ivanov's humidity indicator shows the annual precipitation to annual potential evaporation ratio.

$$K = \frac{\sum P}{E}$$

where

ΣP –is the amount of precipitation for the year, mm;

E – is evaporation rate for the year, mm;

The Turk's formula with the Vilesov's correction factor can be used for calculating evaporation.

where

T – is the mean annual air temperature for 1 year, °C.

According to N.N. Ivanov, the correlation between the area humidity and landscapes is the following:

- Arid desert area – humidification 0 - 0.13.
- Semi-arid area of semi-desert - 0.13 - 0.30.
- Steppes and dry savanna (the area of insufficient humidity) - 0.30 - 0.60.
- Area of moderate humidity (steppe, savanna) - 0.60 - 1.0.
- Area of sufficient humidity (forest) - 1.0 - 1.50

Thus, possible changes in the ranges of deserts and semi-deserts with the predicted climate change can be modeled on the basis of analysis of the annual precipitation to potential evaporation ratio projected for the future. For this purpose, sufficiently reliable and detailed data on temperature and precipitation in the analyzed area shall be made available, as well as some other data for a fixed initial period.

Changes in humidity conditions for future periods under different scenarios of climate change (see Annex 5) were analyzed using the Ivanov's index.

6.2. GEOGRAPHICAL ANALYSIS

Geographical analysis is usually perceived as a graphical representation of the main components of vulnerability to climate risks. Various studies cover more components and others have lesser components, as there are no any strict rules as to combining or splitting certain indicators. In addition, this report deliberately includes no indicators that require expert review, as it significantly reduces objectivity of the results. Let's consider the three main indicators:

- Exposure that determines the degree of climate stress.
- Sensitivity that determines the degree, to which the country is positively or negatively sensitive to direct or indirect effects of climate change.
- Adaptive capacity that reflects the ability of the system to adapt to actual or expected climatic stresses or cope with their consequences.

Exposure of the system to climate change impacts is usually perceived as an external dimension of vulnerability, while sensitivity and adaptability are internal dimensions. An extremely vulnerable system is a system that is very sensitive to moderate changes in the climate, and its ability to resist its significant negative impact is limited.

As it has previously been found that climate changes are practically the same in all regions, it is natural that the exposure of all regions will be approximately similar. Therefore, we will discuss only sensitivity and adaptive capacity.

The following socio-economic indicators were selected to determine vulnerability:

- The proportion of the rural population;
- The proportion of the population engaged in agriculture and forestry;
- The share of agriculture in GRP;
- The ratio of the arable lands area to the total area of the region;
- The ratio of the dry land area to the arable land area of the region;
- The ratio of the area under crops to the total arable land area of the region;
- The number of livestock per pasture area (load).

In addition, characteristics of the main ES on the territory of the republic - landslides, avalanches, mudflows and floods, flooding, rainstorms, hurricane winds, hail and snowfall were used as indicators of vulnerability.

The following socio-economic indicators were selected to determine capacity:

- the proportion of the working-age population in the territory;
- life expectancy at birth;
- interregional migration within the territory;
- the proportion of the unemployed;
- the number of students in higher, secondary and primary vocational education institutions;
- income by territory;
- income from private farming;
- availability of doctors of all specialties;
- gross regional product;
- equipping of the housing fund.

Selection was based on the recommendations related to indicators selection provided in the available reports, the impact of certain indicators and availability of baseline data from official sources. The results of the graphical mapping of the main indicators please see in Annex 4.

Conclusions:

1. the highest vulnerability of agriculture is in the Talas region, the lowest vulnerability is in the Naryn region.
2. the highest direct damage from ES in proportion to GRP was in the Batken and the lowest – in the Chui region.
3. the highest adaptive capacity is in the Chui region and the lowest is in the Naryn region.

7. GENDER ANALYSIS

Gender, like poverty, is an essential aspect of the climate change problem and this fact should be acknowledged at the policy level. In fact, gender and poverty are interrelated and create mutually reinforcing barriers to social change. Climate change is not gender neutral. The importance of integrating gender-based approach in developing policies aimed to adapt to climate change is due to the fact that women and men contribute to climate change causes, they are affected by consequences of climate change, respond to various impulses and react to climate change and perceive effects of climate change in a different way and prefer different solutions.

The differences are due to different gender roles and responsibilities, different access to resources and decision-making by men and women. This is shown by gender disaggregated statistics. At the same time, the existing statistics and studies do not fully outline gender aspects in all areas, or classify women as a vulnerable group exposed to the effects of climate change. In developing policies, women shall be taken account of not only as objects of policy, but also as important agents in the course of development and implementation.

Integrating gender dimension in climate change related issues is critical for preventing inequality in the development and implementation of climate policy. The key elements of the analysis are: gender dimension of labor, access to various resources, participation in planning and decision-making.

7.1. GENDER COMPONENT IN THE EMISSION OF GREENHOUSE GASES

The main sources of emissions in the Kyrgyz Republic are the energy sector (74%), agriculture (16.1%), wastes (5.5%), industrial processes (4.2%), as well as land use, land use change and forestry (0.2%) [25].

According to gender-disaggregated statistics, employment in the energy and agricultural sectors is gender asymmetric - predominance of men (83% of men in the energy sector [15] and 61% of women in agriculture).

At the household level, reproductive labor[1] распределена также неравномерно. Наиболее значимыми с точки зрения выбросов парниковых газов типами деятельности являются отопление жилища, приготовление пищи и транспорт.

related load is also distributed unevenly. In terms of greenhouse gas emissions, the most significant types of activities are heating of the house, cooking and transport.

Gender-disaggregated statistics also reflect asymmetry in the distribution of the daily time for household works. So, men spend more time on heating the houses than women (44.9% of men and 4% of women [15]), women spend more time on cooking compared to men (31.2% of women and 5.8% of men).

Houses are heated by solid, liquid and gaseous fuels. Solid fuels include firewood, charcoal, coal, peat, liquid fuels are kerosene, fuel oil, crude oil, and etc., and gasoline fuel mainly include natural gas. However,

1 Reproductive labor means working in the household or performing other work aimed to provide care (often performed by women), which is not paid for, and with no reward for this work, it is not included as a component of the total gross domestic product. This includes support to vital activity of social and family structures, which the productive labor depends on.

the most environmentally friendly source of energy is electricity. According to the survey in pilot villages [20], residents do not practically use liquid and gaseous fuels for heating their houses. They use coal (74.7%), wood (68.4%), electricity (47.5%) and dung fuel (46.8%). As a rule, dung fuel and small wood are collected predominantly by women and children. Collection and use of dung fuel involves health risks, it is harmful to health due to emission of toxic gases when it is burned, in addition, it is a source of a variety of infections. Women and children are first of all affected by indoor air pollution due to prolonged exposure to smoke from the burning biomass. This leads to an increased risk of acute viral respiratory diseases among children by 100-400% [27]. Women and children spend more time at home; therefore, they are more sensitive to temperature and microclimate in the house and are more exposed to the risk caused by inefficient heating appliances and furnaces.

Gender asymmetry in types of activities, sectors and functions at the household level suggests that adaptation and mitigation[2] strategies shall be developed and implemented with the account of gender characteristics of men and women.

7.2. AREAS OF CLIMATE RISKS FOR THE POPULATION AND GENDER ASPECT

7.2.1. ACCESS TO NATURAL RESOURCES

Integrating gender perspectives in the water resources management was recognized as essential in many bilateral and multilateral documents at different levels, including at the International Conference on Population and Development (1994, Cairo), at the Fourth World Conference on Women (1996, Beijing), at the UN Millennium Summit (2000, New York) and at the World Summit on Sustainable Development (Rio 92, Johannesburg 2002). Principle 20 of the Rio Declaration states: "Women play a vital role in environmental management and development. Consequently, their active participation is essential in achieving sustainable development".

To date, vertical occupational segregation by gender is observed in the decision-making on water distribution in the country. Thus, out of 4,175 people working in the water users ‹associations (WUAs), only 18% are women; in 436 water users› associations throughout the country, women are represented as follows: in the position of Directors - 6, accountants - 160, Chairpersons of the WUA Councils - 2 and Vice-Chairpersons of the WUA - 9 [17]. This way, women have a very limited impact on the decision-making process regarding water distribution. Given the projected lack of water due to the growing climate change, the current imbalance can lead to rooting inequality in access to water and increased poverty of the most vulnerable groups.

Low women›s access to irrigation water is also confirmed by the results of the study "Gender aspects of access to natural resources" [6].

Women have lesser access to natural resources compared to men, except for non-timber forest products, which are collected mainly by women. However, men have greater access to wood forest resources. These differences are important in developing sustainable forest management programs. Almost the same gap is in access to irrigation water and land for men and women.

2 Mitigating – Engl. mitigation – mitigation, reduction, alleviation

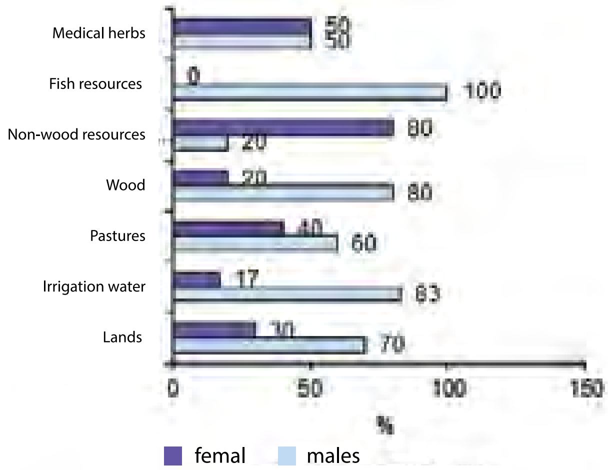


Figure 7.1. Mean assessment of access to various types of natural resources for men and women by focus group participants

Sociological studies showed [32] that when discussing priority water use related problems, women primarily focused on water quality and protection of water sources (men ignored these problems), indicating that sustainable management of water resources is indeed impossible without women involvement in decision-making processes. Men more often than women tend to illegally use natural resources. This is largely due to gender stereotypes when a man, as family breadwinner, is expected to increase family income at whatever cost. At the same time, women, who use any resources illegally are condemned by the society much more than men for the same illegal act [24].

Table 7.1 The number of managers of the active (peasant) farms[3] with breakdown by region (as of 01.01.2011)

Region	Total, people		Specific weight, %	
	Females	Males	Females	Males
Batken region	1,291	24,536	5.0	95.0
Jalal-Abad region	9,941	60,994	14.0	86.0
Issyk-Kul region	3,199	16,754	16.0	84.0
Naryn region	4,431	24,444	15.3	84.7
Osh region	8,962	47,100	16.0	84.0
Talas region	1,873	12848	12.7	87.3
Chui region	11,096	34,000	24.6	75.4
Bishkek city	1	3	25.0	75.0
Osh city	574	1,668	25.6	74.4
Total in Kyrgyzstan	**41,368**	**222,347**	**15.7**	**84.3**

Gender asymmetry is also observed in access to lands, property and vehicles. In 84.3% of cases, legal owners of farms are men; this pattern is typical throughout the country. Only in families with no husband and older son, a woman is recognized as the owner of the farm. [24]

3 Registered in the USRSU

Gender asymmetry is also observed in access to lands, property and vehicles. In 84.3% of cases, legal owners of farms are men; this pattern is typical throughout the country. Only in families with no husband and older son, a woman is recognized as the owner of the farm. [24]

In the context of climate change and abrupt transformation of temperature amplitudes, there will be increase in the number of conflicts over natural resources (e.g. between pasture users, between local communities and mining companies). It is important to enhance participation of local communities, including women and young people in the natural resources planning and control.

In projected conditions, the following problems can be outlined: problems related to agricultural development, which will enhance poverty and reinforce the existing gender inequalities - the use of monocultures in sowing (e.g., beans in the Talas region), burning of crop residues, ignorance of the agritechnical methods of agricultural crops cultivation, and the lack of agrarian strategy and policy at the country and local levels.

In agricultural sector, statistics are collected based on indicators related to productivity, yield, agricultural areas, and etc. and do not include human dimension.

However, as shown by the researches [7], women in rural areas have less time for marketing activities, less access to agricultural knowledge and lesser skills for running their own business. Agricultural reforms, privatization of agricultural enterprises and establishment of farms take place without adequate participation of women due to their low representation in local government, women›s lack of sufficient resources and skills for agricultural business.

Therefore, given the current trends, reduction in the number of vital resources (such as water, food, productive land and pastures), will lead to further exclusion of women from the decision-making system, increase in vulnerability of the poorest population groups and increase in the number of conflicts among the population.

7.2.2. POVERTY, GENDER AND ADAPTATION TO CLIMATE CHANGE

To date, there is no doubt that in case of adverse change in environmental parameters, including climatic, the poor are the most vulnerable, because they can not use the whole range of adaptation practices.

From the point of view of human poverty, poverty is understood as denial of opportunities and the right to choose (or "capacity") to live elementary or "tolerable" life. This approach affects not only the symptoms of poverty, but also its causes. Poverty has impact on families and communities as a whole, men and women bear the burden of poverty, but women›s poverty is more severe compared to poverty of men. Moreover, given gender based distribution of roles in the household, and therefore females' responsibility for reproductive work, women›s poverty entails additional social costs, because it affects children and the elderly: the more hardship is experienced by a woman, the more children and elderly are at risk. This has long-term implications for social sustainability and division of the society into various classes. Similarly, if women are poor, the poverty rate of the elderly people becomes higher.

Gender based differentiation of wages in observed in Kyrgyzstan. The women›s wages to men›s wages ratio is 63.6%.

Statistics show that every born child leads to a decrease in woman's earnings [11]. The fertility rate of women increased from 2.7 children in 2006 to 3.1 children in 2010. In 2010, the highest birth rates were observed in the Naryn and Talas regions (on average 3.9 children per one woman of childbearing age) [33]. At the same time, Kyrgyzstan has a growing number of non-registered marriages and children born out of wedlock, which increases material risks for women. The number of births out of wedlock in 2010 was nearly one-third in the total number of births. In 2010, 24.9 thousand out of (45.2 thousand) children born by officially unmarried women were registered based on application of both parents and 20.3 thousand at the request of only mothers. [11]. Only 42% of all single mothers eligible to benefits, receive financial assistance from the state in the Kyrgyz Republic [1]. 82% of women did not apply to local self-governments (LSGs) for help due to the lack of information.

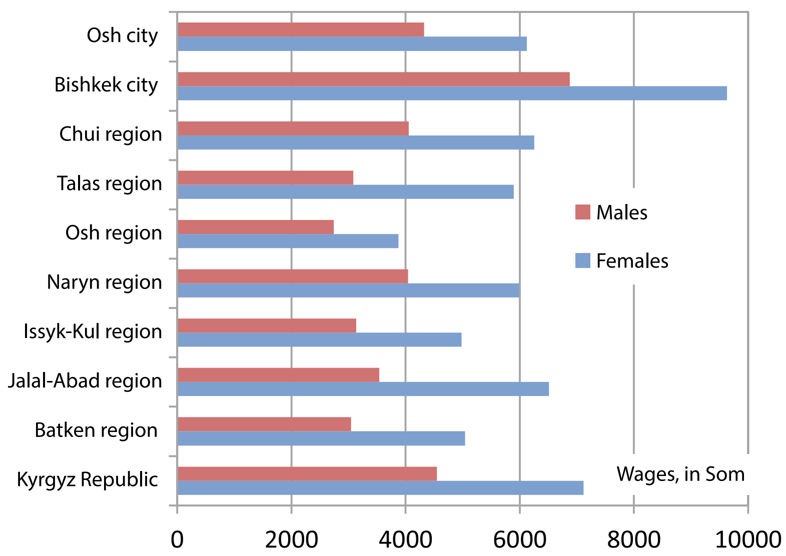


Figure 7.2. The mean wages of men and women

Women›s poverty is closely linked to child poverty. The biggest concern in Kyrgyzstan is the indicator of children poverty related to education and upbringing. In 2006 - 2010 years, this indicator has decreased by 10.4 percentage points to 27.5 percent [31]. The most vulnerable were pre-school education and the quality of education in primary school. Decrease in sub-index of education and upbringing is typical to all regions of the republic.

Women›s poverty is increasing and rooted due to the fact that today women are underrepresented in the decision-making bodies. As a result, interests of women, children and elderly people are not properly taken into account.

According to gender-disaggregated statistics for 2011, the number of female civil servants in public office was 39.9% [24]. The lowest percentage was in the Batken region - 26.5%. The number of women holding political office is even less - 25.2% throughout the country with the lowest rate in the Osh city - 16.7%. The number of women in decision-making positions in local self-governments was 35.8%, and in political office - only 4.9%. The lowest number is in the Osh region, where there are no any women in political office in the local self-governments.

Poor access to the decision-making system, resources, education and low mobility indicate of greater vulnerability of women and children to changes in environmental parameters. Mainstreaming gender aspects in the development of programs and policies aimed at adaptation to climate change is imperative. In addition, there is a need for special measures aimed to take account of the interests of vulnerable groups when developing programs focused on reduction of climate change risks.

7.2.3. HEALTH

The most sensitive to changes are the diseases transmitted through water and food; transmissible diseases; diseases as a result of natural disasters (that lead to mortality, injury and disability); conditions and diseases related to malnutrition.

In the Kyrgyz Republic, despite a series of measures implemented by the government to reform the health care system in recent years, the incidences of various diseases among the population tends to increase [21], which, obviously, among other things, is caused by the impact of the climate. The researches by the NGO "Preventive medicine" [21] compare the correlation between the incidence of diseases of all origin and climatic factors.

The Second National Communication of the Kyrgyz Republic on the UN Framework Convention on Climate Change reflects the expected levels of mean incidence per 100 thousand people over the period until 2100 for the northern and southern regions of the country. The results show that with one exception there will be a significant increase in morbidity due to cardiovascular diseases compared to 2005. Approximately similar increase in the incidence is expected in the northern and southern regions of the country. A less significant growth and even a slight decrease in the diseases incidence in the Issyk-Kul region is the result of significant difference in the climatic conditions of the region due to the smoothing effects of the Issyk-Kul Lake on extreme temperatures.

Respiratory diseases take an important place in the overall morbidity. Gender-disaggregated statistics reflects only mortality, but not morbidity; therefore, it is difficult to develop any informed adaptation strategies.

According to statistics, men are more likely than women to die from respiratory diseases, which is obviously due to risk factors, such as smoking and work in industries with hazardous working conditions.

Figure 7.3. Mortality of women and men from respiratory diseases [37]

Cardiovascular diseases are a leading cause of mortality in Kyrgyzstan, among which more than 90% of deaths are caused by acute myocardial infarction and primary hypertension.

In the past two years, male mortality caused by the diseases of the circulatory system exceeds female mortality, which is probably due not only to climatic impact, but also behavioral characteristics that increase risk factors.

Climate change scenarios predict the increasing incidence of respiratory and blood circulation related diseases among the population due to changes in the air temperature; however, no research were conducted to analyze different impact of these changes on men and women.

Infectious diseases. Overall warming and increased precipitation will lead to expansion of the mosquito habitat on the territory of the country. Without rigid quarantine measures, this may lead to an intense increase in the incidence of malaria. Due to active cross-border relations, warming will increase the risk of mosquito hemorrhagic fevers carrying into Kyrgyzstan.

Geohelminthiasis will become of increased epidemiological significance: ascariasis and whipworm, which prior to infective stage should mature in the soil. In hot and humid climate, the risk of mass infection will increase in direct proportion to the increasing duration of the warm period [18]. Parasitosis in the structure of infectious pathology account for 34% [10] of all registered infectious diseases (except for influenza and ARVI) and remains one of the most pressing problems for public health. Diseases transmitted with water are the priority diseases characterized by strong epidemic potential:

- bacterial diseases: cholera, typhoid, salmonella, bacillary dysentery;
- viral diseases: viral hepatitis A, poliomyelitis, enterovirus infections, noroviruses;
- parasitic diseases: giardiasis, amoebiasis, ascariasis, enterobiasis;
- new expected diseases: campylobacteriosis, cryptosporidiosis.

Climate warming may lead to an increase in intestinal infections, their rise is characteristic of the warm period of the year. It was found that organic pollution and temperature of water bodies influence on survival of vibrio [2].

Shortage of water resources and, consequently, low access to clean water, especially in rural areas, directly correlates with an increase in the incidence of diarrhea. According to statistics, [28] households' expenses for the purchase of fuel have increased (from 14.7 percent in 2006 to 15.2 percent in 2010), while their expenses for the purchase of clothing (from 57.7% to 42.8%) and personal hygiene items (from 12.9 percent to 10.2 percent) decreased.

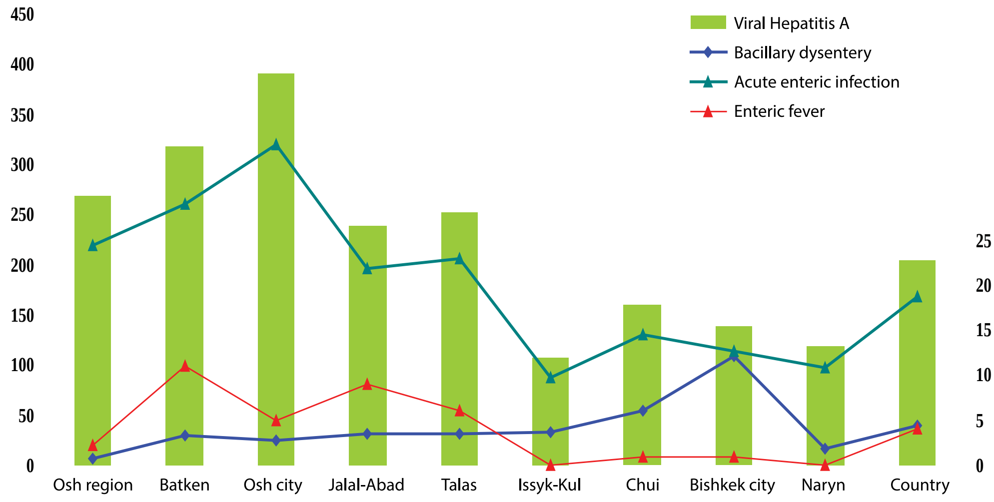


Figure 7.4. Water related diseases in the Kyrgyz Republic with breakdown by regions (mid- and long-term values from 2000 – 2010 per 100 thousand people) [13]

With shortage of water, families often neglect hygiene due to more "important" needs, such as drinking and cooking. The negative impact of the poor quality drinking water and decrease in sanitary conditions will experience children and women.

Frequent diseases of family members, especially children (intestinal due to the lack of water in schools for hand washing), catarrhal diseases due to toilets remoteness from school buildings, and etc. will make women to spend more time on child care.

Mortality as a result of certain parasitic and infectious diseases is traditionally high among both females and males. Moreover, male mortality is clearly predominant. This once again demonstrates the need for an adaptation strategy based on gender-sensitive indicators. Gender-disaggregated statistical data [24] show that women compared to men spend most of their time on care for sick and elderly family members. Decline in the quality of drinking water and an increased incidence of diseases related to water will increase the burden on women and reduce their opportunities in the labor market and will, consequently, lead to loss of revenue, thus contributing to women›s poverty. About 6.5% of the households throughout the country need more than 30 minutes for the delivery of water to their houses, including 1.2% in urban and 10.6% in rural areas. In addition, in 49.3% of households, water is delivered by females, including girls under the age of 15 years old (10.2% of total) [23].

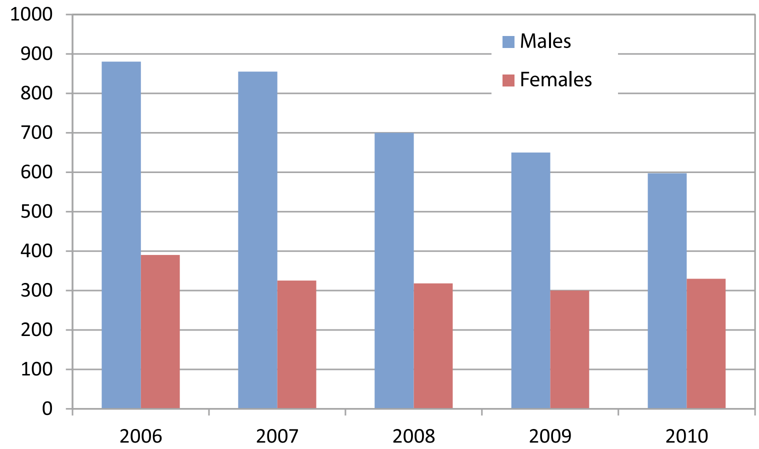


Figure 7.5. Mortality of males and females as a result of certain infectious and parasitic diseases [37]

No gender-disaggregated statistics on population›s access to clean drinking water and adequate sanitation are available in the Kyrgyz Republic.

Climate change and the related social changes can lead to increased abnormalities of mother and child. So, it is noted that pathology of the embryo is to the same extent caused by a decrease and increase in ambient temperature. The researches in Bishkek showed that high temperature, even short-term, can adversely affect the embryo if it coincides with critical periods of pregnancy. According to the researches, the highest rates of perinatal mortality are among full-term and preterm children conceived during the period from July to August [18].

The number of diseases related to pregnancy complications, childbirth and postpartum period, as well as birth defects (malformations) remains high. The latter is directly related to reproductive health of women. Mortality from diseases related to pregnancy, childbirth and the postpartum period are quite different in urban and rural areas. In rural areas, complications occur 3-4 times more often than in urban settings [24]. Moreover, almost 80 percent of maternal deaths are recorded in rural area.

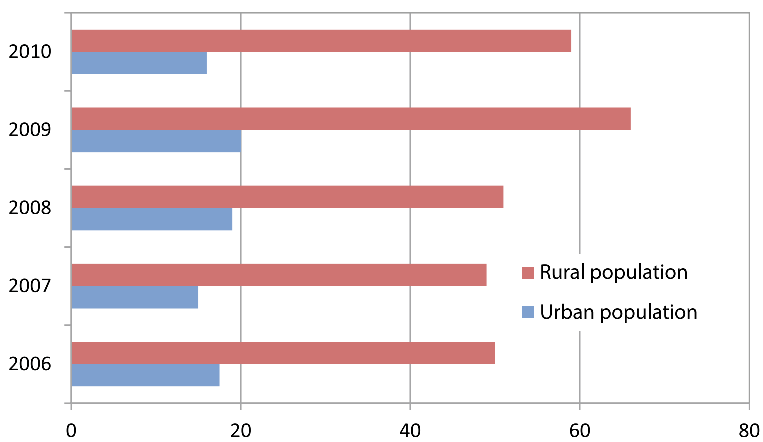


Figure 7.6. Mortality of urban and rural population (women) related to pregnancy, childbirth and the postpartum period [24]

A number of cluster researches showed that most rural people use services of the local hospitals or clinics (93.1%); they rarely go to district healthcare institutions (3.1%) [3], and only in extreme cases they go to regional or Bishkek healthcare institutions. Males twice more often go to urban and national healthcare institutions than females, where they can get better quality services. This is due to higher males' mobility and low mobility of females, especially pregnant women and young mothers, who are most in need of good quality medical services.

Crucial role in addressing health related problems play healthcare and education systems. At the institutional level, most employees of these systems are women, despite low wages; they also have lots of unpaid additional functions (e.g. cleaning FAPs, classrooms, buying washing materials, napkins, and etc.). FAPs and territorial health organizations must be prepared to face new challenges related to health and climate change, while at present the government does not provide them with adequate resources.

Food and nutritional security. The projected lack of precipitation and irrigation water after 2025 may lead to a reduction of cultivated lands, which will reduce crop yields. This will have inevitable impact on food security, especially in the most vulnerable areas. Reduced production of food products can lead to malnutrition and hunger that will have a lengthy impact on health of the population, especially children. According to WHO, by the middle of the 21st century, crop yields in Central Asia may decrease up to 30%, which may pose a threat to food security.

Reduction of personal consumption of food plays a very important role in the families' coping strategies. This will have two consequences: increased proportion of either underweighted people or people who suffer from obesity as a result of unbalanced diet. For example, the caloric value of food in poor households is 36% lower than in other families, 4% of men and 5% of women have chronic caloric deficiency, and 31.8% of men and 37% of women suffer from overweight to varying degrees [16]. Even today, children and pregnant women, especially in rural areas of the Kyrgyz Republic have poor access to nutritious food resulting in a lack of vitamins and minerals (including iron and iodine) and causing a number of diseases (anemia of pregnant women, retarded growth and development of children). In 2009, there were 4.6% of underweighted children aged 1-6 years. 4.5% of boys and 4.6% of girls aged 1-6 years old are malnourished [44].

Due to the need to restrict food consumption, people now reanimate traditional stereotypes stating the ideal of femininity is limited food consumption.

Percentage of pregnant women with anemia
Disease rate of pregnant women (number of people)

	2000	2005	2007	2008	2009	2010
Number of women whose pregnancy completed with						
Anemia						
Circulatory system diseases						
late toxicosis						
Diseases of the genitourinary system						
Venous complications in pregnancy						

From among those under management at the beginning of the year and received under for management in the reporting year

Of the total number of women who completed pregnancy, had: late toxicosis - 3.1% (against 4.2% in 2005). Anemia - 53.5 (47.4%). Diseases of the circulatory system - 1.1% (0.8%) and diseases of the genitourinary system - 22% (14.9%)

Так наблюдается устойчивый рост заболеваемости женщин анемией при беременности, что говорит о неполноценном рационе питания до и после беременности.

7.2.4. EMERGENCIES

The poor are exposed to extensive risks as a result of emergencies. If their houses are damaged, they can not move out or buy a new one in safer locations using compensation from the state often being insufficient to restore previous standard of living. When the standards of living go down, people forget about complex social and cultural needs, and see only economic needs [16] aimed at survival here and now, thus make them to ignore the need to care for the environment and natural ecosystems that repress climate change.

Women as one of the vulnerable groups is particularly exposed to the effects of natural disasters. According to climate change scenarios, frequency of extreme weather events related to water will increase. Therefore, it is important to develop gender-sensitive approaches to research and other activities aimed to prevent and prepare for emergencies.

Particularly vulnerable are women with special needs (pregnant women, women with infants, and those, who take care of sick and elderly members of the family), they are more dependent on environmental conditions, as they have specific needs and are more sensitive to the inability to meet the needs. At the same time, critically low representation of women is observed at the decision-making level in the Ministry of Emergency Situations and local self-governments. Thus, there are no women in top positions in the MOE, with 12% and 42% of women in senior and higher positions, respectively [14].

As a result, interests of women and children in developing ES related plans and performing activities are not taken into account. With the increase in the number of ES, vulnerable people (women, children and elderly people) will be exposed to the maximum risk to their health and life.

7.3. CONCLUSIONS AND MAIN AREAS OF GENDER RELATED ACTIVITIES

Undoubtful correlation was found between the effect of climate change and ES manifestation. Both observed and expected climatic trends contribute to an increase in potential ES that would cause considerable damage to the country›s economy.

Climate change affects agriculture in many different ways. However, already identified problems, such as the impact of climate change on surface water resources and further aridization of farmland, also require adoption of appropriate preventive measures to reduce climate risks.

Geographical analysis shows that the poorer regions of our country do not only have insufficient capacity to reduce climate risks, but most often, they are more exposed to adverse climatic impact.

No proper attention was paid to gender issues until recent times. However, it is clear that sustainable development should take account of all aspects, including provision of equal access to decision-making and coverage of all population groups by the adopted decisions.

Areas of activity are as follows:

- Special attention shall be paid to assessing gender impact and preparing budget for adaptation projects that mainstream gender aspects in the main areas of activity.
- Reviewed materials showed the lack of researches on gender issues in the field of climate change. In order to address this problem, it is important to identify gaps in the existing researches and develop strategies for integrating results of the gender related researches in the decision-making process. In order to ensure maximum use of the collected data, specific objectives and quantitative target indicators of women›s participation in decision-making shall be integrated in the strategy of actions on climate change.
- There should be increased awareness of the importance of gender issues in the field of climate change, so that to change the situation, where gender issues are of low priority, being often perceived as climate neutral.
- Gender mainstreaming is a prerequisite for eliminating consequences of climate change and awareness of the need for fundamental changes in lifestyle that require enormous efforts by the government, private sector and civil society.
- It is necessary to create mechanisms for assessing the impact of the climate change related policy on women.
- There is a need to develop ES response plans at the local, regional and national levels, taking into account specific needs of different target groups. First of all, there should be effective warning systems to inform the population through various channels available for different groups. A separate briefing shall be organized for young mothers and families with persons with disabilities, and etc. Another important thing is active involvement of different target groups in developing ES response plans.

8. INSTITUTIONAL ASPECTS

8.1. KEY INSTITUTIONS AND THEIR MANDATES

10 ministries and agencies were selected as key institutions for assessing the existing capacity for climate risk management and the following documents were analyzed:

1. The Regulations on the State Agency on Environmental Protection and Forestry (Resolution No 123 of the Government of KR dated 20.02.2012);

2. The Regulations on the Ministry of Energy and Industry (Resolution No 127 of the Government of KR dated 20.02.2012);

3. The Regulations on the Ministry of Agriculture and Land Reclamation (Resolution No 127 of the Government of KR dated 20.02.2012);

4. The Regulations on the Ministry of Health (Resolution No 142 of the Government of KR dated 20.02.2012);

5. The Regulations on the Ministry of Emergency Situations (Resolution No 115 of the Government of KR dated 20.02.2012);

6. The Regulations on the Ministry of Transport and Communications (Resolution No 746 Government of the KR dated 08.12.2009);

7. The Regulations on the State Agency for Construction and Regional Development (Resolution No 136 of the Government of KR dated 20.02.2012);

8. The Regulations on the State Inspectorate for Environmental and Technical Safety (Resolution No 136 of the Government of KR dated 20.02.2012);

9. The Regulations on the Hydrometeorology Agency (Kyrgyzhydromet) under the Ministry of Emergency Situations (Resolution No 130 of the Government of KR dated 05.03.2010);

10. The Regulations on the National Committee on Climate Change Effects (Presidential Decree No 281 dated 18.07.2005).

The analysis showed the need to enhance institutional capacity in the two main directions:

- Expanding and improving the existing mandates of the key ministries and agencies; and
- Improving efficiency of the intergovernmental body (the National Committee on Climate Change Effects).

8.2. AREAS FOR EXPANDING AND IMPROVING THE EXISTING MANDATES OF KEY MINISTRIES AND AGENCIES

The analysis showed that no major changes shall be made to the above Regulations. To enhance capacity (excluding human and technical capacity due to financial constraints), the Regulations on each of the key ministries and agencies shall additionally include a provision on their responsibility for regular preparation of the action plan (for a proposed period of 5 years) on adaptation and climate risk management at a more detailed sectoral level to be deemed as an integral part of the overall national strategy on adaptation to climate change. The plans shall regularly be updated because of emergence of new information on the climate change and improvement of methods of future climate assessment, as well as emergence of new techniques and methods of climate risks management.

It should be noted that as part of this project, this work is already being performed and certain proposals for ministries and agencies are already prepared.

8.3. RAISING THE STATUS OF THE INTERGOVERNMENTAL BODY

Analysis of the current structure showed that it properly reflects all national interests and basic requirements of the UN Framework Convention on Climate Change to participating countries, i.e. the Regulations on the intergovernmental body take account of all main areas of the appropriate work:

- Coordinating cooperation in adopting preparatory measures for adaptation to the climate change impacts; designing and developing appropriate comprehensive plans;
- Mainstreaming climate change related factors in implementing national, social, economic and environmental policies; the use of appropriate methods in order to minimize the negative impacts of climate change on the economy, public health and environmental quality;
- Assisting in scientific, technological, technical, socio-economic and other researches, systematic observations, as well as in creating data banks related to the climate system and intended to improve knowledge and to reduce or eliminate the remaining uncertainties about the causes, effects, magnitude and timing of climate change;
- Coordination of the comprehensive, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related to the climate system and climate change, as well as about economic and social consequences of various response strategies;
- Organization of activities in the field of education, professional training and public awareness related to climate change and support for broad participation in this process of the wider public, including non-governmental organizations.

Involvement of other national institutions, including universities and research centers, NGO and others is ensured through inclusion of their representatives in the intergovernmental body.

However, given the increased activity in the field of climate change, both at the international and national levels, the status of the intergovernmental body looks underrepresented, as it is composed of only Vice

Ministers of the key ministries and agencies. In addition, it was headed by the SAEPF Director, which is not a sufficient guarantee of unconditional implementation of the decisions adopted by the intergovernmental body.

At the initiative of this project, the need to raise the status of the intergovernmental body for a more effective involvement of ministries and organizations at the national level in adaptation and climate risk management activities was discussed at the broad meeting of the intergovernmental body and further in the office of the Government of the Kyrgyz Republic. The most difficult problem is filling the gaps in observations and scientific researches on climate change, as neither state nor public bodies have enough funds. Even with the new status, the intergovernmental body on climate change can only coordinate respective efforts.

An important factor for successful reorganization is setting up a standing and effectively working body (Secretariat) under the intergovernmental body.

8.4. POLICY FRAMEWORK FOR CLIMATE RISK MANAGEMENT. SITUATION WITH INTEGRATING CLIMATE RISK MANAGEMENT IN DEVELOPING POLICIES AND STRATEGIES

Analysis of the strategic documents on the development of the Kyrgyz Republic has shown that climate change related issues are reflected in the following most important national strategy documents on development:

The 2009-2011 Country Development Strategy (Presidential Decree No 183 of March 31, 2009);

The environmental safety concept of the Kyrgyz Republic (Resolution No 469 of the Government of KR dated October 16, 2007);

A set of measures to ensure environmental safety of the Kyrgyz Republic for 2011-2015 (Resolution No 599 of the Government of the Kyrgyz Republic dated September 23, 2011). The set of measures have the following three main objectives:

- development of the national strategic documents with the account of the emerging environmental problems based on international practices and commitments;
- formulation of the national policy on climate change;
- implementation of measures for conservation of biodiversity through expansion of the protected areas up to 7% and increase of the area covered by forest, in order to achieve MDG 7.

Medium-term program of the Kyrgyz Republic development for 2012-2014 (Resolution No 540 of the Government of KR dated 8 September 2011). The program, in particular, section “Ensuring environmental safety” integrated the following activities related to climate change:

- Development of the Kyrgyz Republic’s policy on adaptation to climate change;
- Development of the national climate profile;
- Development of the National Strategy and promotion of a set of measures on adaptation to climate change;

- Development and implementation of measures aimed to prevent climate change and promote the principles of low-carbon development;

- Development of practical recommendations on energy efficiency in buildings;

- Promoting international cooperation for addressing environmental problems of the country;

- Development of the Third National Communication of the Kyrgyz Republic on the UN Framework Convention on Climate Change.

In "Energy" section:

- Amending the normative legal acts so that to enhance economic attractiveness of small hydropower development and use of renewable energy sources;

- Developing programs to reduce losses of electricity and heat in their production, distribution and consumption;

- Establishing standards and introduction of mandatory requirements for energy efficiency in various sectors of economy and in the non-production sector.

In healthcare sector:

- Developing mechanisms for organization and interaction of the health care system in emergency situations; ensuring emergency care and first aid;
- Developing a Program on adaptation of the health care system of the Kyrgyz Republic to climate change.

The Program "Stability and Decent Life" (Resolution No 55 of the Government of the Kyrgyz Republic dated 25 January 2012 (Paragraph 102 "Take inventory and make changes and additions to the NLAs for adaptation to climate change with the account of "green development"). Given legal support to actions on adaptation to climate change and risk reduction, amendments were prepared to the following legislation:

- The Forest Code of the Kyrgyz Republic;
- The Water Code of the Kyrgyz Republic;
- The Laws of the KR "On Environmental Protection", "On Air Protection", "On Transport", "On Protection of Citizens' Health in the Kyrgyz Republic" and "On Public Health" that are currently being agreed with the ministries and agencies.

8.5. BASIC AREAS OF THE CURRENT CLIMATE RISK MANAGEMENT ACTIVITY

Officially no such activity is implemented in the country. Despite their names, GEF SGP projects (see Annex 1), unfortunately, are not projects on adaptation or risk reduction. Almost all of them aim to address relevant environmental and social problems, and sometimes mention emissions reduction tasks. Despite the attempts to somehow link the climate change related problem in some projects with the requirements of the funding organization, in fact, the projects fail to cover this problem. At the same time, many of the currently implemented activities can be nominally perceived as climate risks reduction measures. First of all, these are enhancing the system of hydrometeorological monitoring and actions aimed to reduce the impact of climate related emergencies implemented by the Ministry of Emergency Situations.

8.6. WAYS TO DEVELOP A CLIMATE RISK MANAGEMENT SYSTEM. BARRIERS

Mechanisms for further development of the climate risks management system:

Improvement of the regulatory framework. Amendments and changes to:

- The Environmental, Land, Forestry and Water Codes;
- Rules for the development, implementation, monitoring, evaluation and control of the strategic development plans;
- Projected schemes of territorial and spatial development of the country, government programs, territorial development programs, strategic plans of the government authorities to ensure integration of policies on reduction of the climate change related risks in the strategic planning system of the country.

Improving the institutional framework:

- Creating a structural unit in the Ministry of Agriculture to oversee sustainable use of rangelands;
- Creating sustainable mechanisms for self-government by the rural population aimed at joint and effective use of agricultural lands that are in private and public property;
- Setting up a unit on adaptation of forestry to climate change related risks under the SAEPF and enhancing control over the state of the forests, wildlife, their conservation and use;
- Increasing functional responsibility of the government authorities by specifying the duties of officials, the quality of which affects on timely identification of the emerging climate risks and enhancing adaptive capacity of the country, regions and localities;
- Changing the institutional framework of the water supply and water use system at the national and basin levels.

Improvement of technical standards and regulations:

- Improving the systems for accounting and measurement of water use in agriculture and other sectors of the economy;
- Setting limits for consumption of natural resources and penalties for their violation based on predicted climate change.

Improvement of the financial and economic mechanisms:

- Creating national and regional funds for adaptation to climate change and risk reduction;
- Developing the system of insurance, practical introduction of services on index insurance;
- Creating a micro-loans system for the implementation of adaptation projects;
- Creating a system of state control of budgetary spending on adaptation locally involving the public through the "hot lines";
- Introduction of benefits for vulnerable sectors and population groups, combined with quotas.

Improving information tools:

- Creation of the information-analytical center on climate change under the coordinating body on climate change;
- Creating an information database for modeling, predicting the impact of climate change on the population, sectors of economy and ecosystems that would enable to adopt scientifically feasible decisions on adaptation;
- Inclusion of specialized disciplines on effective use of natural resources, vulnerability to climate change impacts, assessment and prediction of natural hazards and increase of adaptive capacity in the curricula of the existing institutions;
- Awareness raising campaigns in the mass media (especially in central state mass media) on climate change in the Kyrgyz Republic, and enhancing adaptation capacity of the economy, population and ecosystems;
- Raising awareness of decision-makers and the population of the country about the climate change related risks through the creation of television programs, newsletters, and recommendations on adaptation.

Improving human resource capacity. Improving the education and scientific research systems:

- Increased monitoring of the natural processes of climate change in the Kyrgyz Republic and strengthening cooperation on this matter with the Central Asian countries;
- Monitoring of anthropogenic factors contributing to increased natural hazards, and researches aimed at their reduction;
- Improving methodology for assessing climate change related risk reduction of the regions and sectors of the national economy, development of a system of indicators to determine the level of the regions' exposure to climate risks and effectiveness of measures on risks mitigation;
- Researches aimed to assess mudflow hazards, droughts, and other hazards related to the risk of natural disasters as a result of climate change;
- Researching the impact of climate change on human health;
- Researches in the field of improving efficiency and competitiveness of the agri-industrial complex in a changing climate;
- Monitoring and evaluation of bioecological state of agricultural lands and their productivity on the basis of the ground-based and space-based information;
- Assessing the impact of climate change on agricultural and natural ecosystems and their adaptation;

- Development of recommendations on the use of agro-climatic information in relation to phytomelioration with the account of climate change;
- Developing a system for monitoring rangeland in order to assess their biological and ecological status, productivity and energy consumption, taking into account anthropogenic and climate change impact using GIS technology.
- Studying the effects of anthropogenic impacts on the soil (desertification, degradation, pollution, erosion, and etc.) and methods of its conservation, rational use and reproduction of soil fertility;
- Research and development of methods for stabilization of soil humus status as one of the priority adaptation approaches;
- Researches to assess the impact of climate change on the yield of the major crops and livestock productivity, assessment of agro-ecosystems and rural population vulnerability.
- The main constraint is the lack of funds for implementing development related activities.

9. CONCLUSIONS

Significant climate changes are currently observed on the territory of the Kyrgyz Republic. For the period from 1885 to 2010, the temperature has in fact increased significantly. Moreover, the growth rate in recent decades has substantially increased. During the entire period of observations, the variability rate was 0.010377oC / year, over the past 50 years (1960 - 2010) it has increased more than twice and was 0.024773oC / year, and over the last 20 years (1990 - 2010), it has already reached 0.070082oC / year. The total precipitation over the entire period of observation was slightly increasing (0.847 mm/year); however, in the past 50 years, it has decreased significantly (0.363 mm/year), while in the last 20 years, there is even a slight tendency to decrease (-1.868 mm/year). The duration of the heating period in 1991 - 2010 compared to the baseline period (1961 - 1999) at altitudes up to 1,000 m decreased by 9 days, from 152.7 to 143.5 days.

Assessment of the expected changes shows that in scenario with the current trends, the temperature may increase by more than 4.5oC by 2100. Virtually in all regions of the republic the temperature increase will be approximately the same (the difference will be not more than 0.2°C). It is interesting to note that the expected temperature change will presumably be the same for all months, in contrast to the observed trends. The duration of the heating period will also significantly reduce – by 16% by 2050 and by more than 30% by 2080.

It is expected that the annual precipitation will decrease in the future, but at a lower rate (-0.0677 mm/year), which will fall by approximately 6 mm in 2100 compared to the current level. In addition, some volatility in precipitation is expected over time, in contrast to the monotonically changing temperature. Uncertainty in the assessment is relatively insignificant. The expected seasonal distribution of precipitation is generally the same as was observed in recent decades.

The correlation between the following major emergencies and observed climate change was analyzed:

- Mudflows, floods;
- Landslides;
- Avalanches;
- Flooding;
- Heavy rains;
- Hurricane winds;
- Hail; and
- Snowfall

Baseline data on the number of emergencies since 1990 were used for trends analysis.

As clear from above results, Osh and Jalal-Abad regions are the most vulnerable to landslides, with the least vulnerable Talas region. The Jalal-Abad region is also the most vulnerable to avalanches, with the least vulnerable Batken region. The most vulnerable to mudflows and floods is the Jalal-Abad region, and the least vulnerable is the Naryn region. Changes the number of flooding with breakdown by regions has not been analyzed due to the lack of baseline data. The Jalal-Abad region is also the most vulnerable to rainstorms, while the least vulnerable is Talas. The Issyk-Kul region is the most vulnerable to hurricane winds, while the least vulnerable are the Naryn and Batken regions. Vulnerability to hails and snowfalls has not been analyzed due to the lack of baseline data.

Despite different trends in certain types of ES, in general there is a tendency of their total growth in all regions, except for rainstorms, the reduction of which is observed in all regions excluding Talas. Trends in hurricane winds are less clear, they have reduced in the Jalal-Abad and Naryn regions. Significant decrease in the number of landslides in the Chui region shall also be noted.

The growth rates of certain types of ES were determined in each region and can be a source of baseline information for determining the expected amounts of damage in case of the projected climate change in the future. In order to avoid the effects of inflation, the economic loss for the period from 1990 to 2010 was defined in constant USD in 2005. The expert assessment of the direct damage according to the Ministry of Emergency Situations attributable to a specific type of ES in 2010 was used (excluding estimates of damage to agriculture by the National Statistical Committee, which is assessed separately).

According to assessments by the expert of the International Bank for Reconstruction and Development, the total damage from the ES exceeds direct damage several times [4].

In the crop sector, the impact of climate change on yields of the crops with available detailed data was assessed, i.e. data with small gaps and less dependent on irrigation. Based on these conditions, wheat, barley, sugar beet and maize were selected as the most vulnerable ones. The calculations used baseline data on the climate impact in agriculture monitored by the National Statistical Committee ("drought, lack of water", "rainstorm, hail", "frost and snowfall").

As clear from the calculations results, the events such as "drought, lack of water" and "frost, snow" have no increasing impact of climatic conditions, i.e., there is no any increased adverse effects despite observed climate change trends. The observed trends will presumably be the same in the future; therefore, we may expect that the impact of the above events will reduce. The events "rain, hail" show a slight positive tendency, but it is likely that for such a small amount of data (the sampling of 21), it is caused by abnormally strong exposure for one year - 2010.

In general, there is no tendency of losses increase neither for the concerned crops, nor across the crops sector from the above three types of climate impacts for 1991 – 2011.

The reasons, why there is no any adverse effect of ES, such as "drought, lack of water," "rainstorm, hail", "frost and snowfall" on the yield may include the following:

- Weakness of the monitoring system;
- Actual reduced frequency and severity of the above climate ES in the current climatic trends;
- Increased focus on irrigated agriculture in crops sector.

Nevertheless, based on the above results, there is no any reasonable need to adopt measures preventing negative impact of the above ES on the crop production sector until further research.

The possibility to use standardized precipitation index SPI for yield assessment was analyzed and showed that changes in the yield of the following four kinds of agricultural crops can be statistically and reasonably estimated:

4 Cost-effectiveness of the Program "Technical and Technological Development of the National Hydrometeorological Service of the Kyrgyz Republic", the report on the pilot study, 2008

- Cereals (weight after processing);
- Wheat (weight after additional processing);
- Sugar beet;
- Barley (weight after additional processing).

As for other analyzed crops, there is no any statistically significant correlation between the index and yield. There may be some correlation for other crops, for which there is no any official data on yield, for example, oats and buckwheat.

The best time for assessing SPI index is October. The highest level of correlation is observed in using index calculation depth of 9 - 10 months. Using the projected index assessment, changes in yields of selected crops due to climate change can be assessed for future periods. SPI index can serve as a benchmark in implementing crop insurance scheme.

In order to verify preliminary obtained results, a full analysis (in all regions) shall be conducted so that to clarify the scope and validity of the SPI index use, as well as SPEI index and Ivanov's indicator.

Geographical analysis was conducted to map key components of vulnerability to climate risks. Sensitivity and adaptive capacity were analyzed. The following socio-economic indicators were selected to assess vulnerability:

- the proportion of the rural population
- the proportion of the population engaged in agriculture and forestry;
- the proportion of agriculture in the gross regional product (GRP);
- the ratio of the arable land area to the land area of the region;
- the ratio of the non-irrigated arable land area to arable land area of the region;
- the ratio of the area of crops to the total arable land area of the region;
- the number of livestock per pasture area (load)

In addition, characteristics of the main ES on the territory of the republic - landslides, avalanches, mudflows and floods, flooding, rainstorms, hurricane winds, hail and snowfall were used as indicators of vulnerability.

The following socio-economic indicators were selected to assess the capacity:

- the proportion of the working-age population in the territory;
- life expectancy at birth;
- interregional migration in the territory;
- the proportion of the unemployed;
- the number of students in higher, secondary and primary vocational education institutions;
- income by territory;
- income from private farming;
- availability of doctors of all specialties;
- gross regional product;
- equipping housing fund

The greatest vulnerability of agriculture was found in the Talas region and the lowest – in the Naryn region. The largest direct damage from the ES in relation to GRP was in the Batken region and the smallest – in the Chui region. The Chui region has the highest adaptive capacity, while the lowest is in the Naryn region.

Gender analysis of climate risk management related issues was conducted. Key risks reduction methods were formulated from a gender perspective.

The state and prospects of the institutional sphere development were discussed. Key ministries and agencies involved in tackling climate change and their mandates in accordance with the Regulations were identified, as well as areas for expansion and improving the mandates of current key ministries and agencies. The main focus was on improving efficiency of the intergovernmental body, which was sought over the implementation of this project and is now practically completed in full compliance with the proposed recommendations. Policy framework for climate risk management and the situation with integration of climate risk management in developing policies and strategies were analyzed. In addition, approaches to development of the climate risk management system, as well as major barrier to development were identified.

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ANNEX 1: BASELINE DATA ON EMERGENCIES WITH BREAKDOWN BY REGIONS. SOURCE: THE MINISTRY OF EMERGENCY SITUATIONS (NO DATA ARE AVAILABLE FOR 2005)

Emergency	Chui		Osh region		Jalal-Abad region		Batken region		Issyk-Kul region		Naryn region		Talas region	
	ES	V	ES	V	ES	V	ES	V	ES	V	ES	V	ES	V
2000														
Landslides	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avalanches	0	0	1	0	6	0	1	0	1	0	0	0	1	0
Mudflows and floods	0	0	1	0	16	0	2	0	2	0	0	0	0	0
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainstorms	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hurricane winds	4	0	1	0	0	0	0	0	0	0	3	0	1	0
Hails	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Snowfalls	1	0	3	0	1	0	0	0	2	0	0	0	0	0
2001														
Landslides	0	0	2	0	3	0	0	0	0	0	0	0	0	0
Avalanches	2	0	0	0	1	2	0	0	1	0	0	0	0	0
Mudflows and floods	0	0	1	0	0	2	5	0	0	0	1	0	0	0
Flooding	1	0	1	0	3	0	1	0	1	0	0	0	0	0
Rainstorms	0	0	4	0	11	0	2	0	4	1	2	0	0	0
Hurricane winds	0	0	3	0	4	0	1	0	2	0	3	0	2	0
Hails	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snowfalls	2	0	1	0	1	0	1	0	1	0	1	0	1	0
2002														
Landslides	8	0	4	0	4	0	2	0	1	0	0	0	0	0
Avalanches	3	0	2	0	3	1	0	0	2	0	2	1	0	0
Mudflows and floods	7	0	6	0	47	0	19	1	3	0	1	0	12	0
Flooding	18	0	0	0	0	0	0	0	1	0	0	0	1	0
Rainstorms	1	0	0	0	0	0	2	4	0	0	0	0	0	0
Hurricane winds	3	0	2	0	4	0	1	0	1	0	0	0	1	0
Hails	12	0	0	0	0	0	0	0	2	0	1	0	0	0
Snowfalls	1	0	0	0	2	1	0	0	0	0	0	0	0	0
2003														
Landslides	0	0	29	38	16	0	2	0	0	0	0	0	0	0
Avalanches	1	0	5	0	6	4	0	0	5	0	8	0	0	0
Mudflows and floods	3	1	11	1	23	0	5	0	0	0	1	0	0	0
Flooding	2	0	0	0	2	0	0	0	1	0	0	0	0	0
Rainstorms	2	0	3	0	2	0	0	0	1	0	0	0	1	0
Hurricane winds	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Hails	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Snowfalls	0	0	2	0	0	0	0	0	2	0	3	0	0	0
2004														
Landslides	6	0	33	40	10	1	1	3	0	0	3	0	0	0
Avalanches	3	0	6	3	7	5	0	0	4	12	3	0	0	0
Mudflows and floods	4	0	9	0	8	1	20	0	1	0	2	0	2	0
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Emergency	Chui		Osh region		Jalal-Abad region		Batken region		Issyk-Kul region		Naryn region		Talas region	
	ES	V	ES	V	ES	V	ES	V	ES	V	ES	V	ES	V
Rainstorms	1	0	0	0	1	1	0	0	0	0	0	0	0	0
Hurricane winds	2	0	0	0	2	0	3	0	0	0	0	0	2	0
Hails	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Snowfalls	0	0	0	0	0	0	0	0	1	0	0	0	1	0
2006														
Landslides	1	0	0	0	5	0	2	0	5	0	0	0	0	0
Avalanches	5	1	1	0	8	1	0	0	4	4	4	2	8	1
Mudflows and floods	3	0	7	0	5	0	8	0	8	0	2	0	0	0
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainstorms	1	0	0	0	2	0	3	0	4	0	3	0	0	0
Hurricane winds	0	0	3	0	1	0	2	0	0	0	0	0	0	0
Hails	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Snowfalls	1	0	0	0	5	0	0	0	1	0	0	0	0	0
2007														
Landslides	0	0	1	0	1	0	0	0	0	0	3	0	0	0
Avalanches	3	0	0	0	9	1	0	0	0	0	1	0	1	1
Mudflows and floods	3	0	21	0	17	0	17	0	8	0	3	0	1	0
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainstorms	0	0	0	0	0	0	0	0	1	0	0	0	2	0
Hurricane winds	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hails	2	0	0	0	0	0	0	0	1	0	0	0	0	0
Snowfalls	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2008														
Landslides	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Avalanches	1	0	6	0	13	1	0	0	2	5	3	0	0	0
Mudflows and floods	0	0	18	0	21	0	26	2	7	3	3	0	7	0
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainstorms	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Hurricane winds	4	0	6	0	4	0	2	0	12	1	2	0	4	0
Hails	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Snowfalls	1	0	0	0	0	0	3	0	0	0	0	0	1	0
2009														
Landslides	0	0	3	0	8	16	1	0	0	0	1	0	0	0
Avalanches	4	0	6	2	19	0	0	0	5	0	1	0	0	0
Mudflows and floods	6	0	26	0	32	0	19	0	4	0	2	0	4	0
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainstorms	1	0	0	0	5	0	0	0	0	0	0	0	0	0
Hurricane winds	3	0	3	0	0	0	1	0	5	0	2	0	0	0
Hails	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Snowfalls	0	0	1	0	0	0	0	0	3	0	0	0	0	0
2010														
Landslides	0	0	21	0	13	0	2	0	0	0	4	0	0	0
Avalanches	8	0	13	1	18	0	0	0	12	1	11	0	1	0
Mudflows and floods	12	0	33	0	47	0	21	7	4	0	7	0	5	0

Emergency	Chui		Osh region		Jalal-Abad region		Batken region		Issyk-Kul region		Naryn region		Talas region	
	ES	V	ES	V	ES	V	ES	V	ES	V	ES	V	ES	V
Flooding	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainstorms	0	0	1	0	0	0	0	0	1	0	0	0	1	0
Hurricane winds	8	0	5	0	3	0	1	0	13	0	1	0	5	0
Hails	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Snowfalls	0	0	3	0	1	0	0	0	1	0	4	0	0	0

ES - the number of emergencies

V - the number of victims as a result of an emergency

ANNEX 2: KEY DATA ON CLIMATE DEPENDENT EMERGENCY SITUATIONS IN THE COUNTRY AS A WHOLE. SOURCE: THE MINISTRY OF EMERGENCY SITUATIONS

Year	ES type								TOTAL ES	Died people	Damage, thousand KGS
	Mudflows and floods	Landslides	Avalanches	Flooding	Rainstorms	Hurricane winds	Hails	Snowfalls			
1990	39	2	6	7	2	2	1	3	110		
1991	32	2	2	5	1	0	0	1	72		
1992	18	18	14	7	4	2	0	1	46	40	7,486.5
1993	61	3	2	1	0	0	0	0	71	27	36,629
1994	81	100	7	4	6	0	0	0	226	139	260,508.2
1995	16	15	47	1	1	0	1	0	95	26	216,182.9
1996	52	32	44	10	3	1	0	1	183	40	3,320.9
1997	53	17	6	9	5	2	0	1	147	44	0
1998	36	21	3	10	7	3	2	2	118	49	1,418,738
1999	35	25	13	10	6	0	0	0	126	24	757,663
2000	27	22	10	3	1	12	0	7	141	22	297,863
2001	9	5	4	7	23	20	0	8	192	76	8,359.7
2002	95	19	12	20	3	12	15	3	241	75	338,400.6
2003	43	47	25	5	9	2	1	8	166	44	3,576,180
2004	46	53	23	4	2	9	2	2	201	91	366,213.4
2005	45	31	21	4	11	5	3	2	182	70	422,680
2006	33	13	30	8	13	6	1	8	185	85	229,302.9
2007	70	5	14	4	3	5	3	0	209	93	815,813.1
2008	83	2	25	26	1	34	1	5	312	281	1,194,694
2009	93	13	35	1	7	14	3	4	227	71	156,589
2010	131	40	63	12	3	36	1	11	439	158	516,910
2011	53	9	11	4	1	17	2	3	227	131	563,420.2

ANNEX 3: EMERGENCIES IN AGRICULTURE. SOURCE: THE NATIONAL STATISTICAL COMMITTEE

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
Wheat					
1991	837	837	0	0	1420
1992	1630	838	334	458	262,0494
1993	510	0	510	0	91,8
1994	14362	9146	1000	4216	62,45934
1995	24986	6505	0	3868	59642,01
1996	16923	16683	113	127	84145,97
1997	12220	10300	751	1169	52080,56
1998	21842	0	0	0	103938,6
1999	26078	24448	1010	620	184115,6
2000	54688	52234	204	2250	651543,3
2001	26558	26558	0	0	353363,2
2002	18675	18675	0	0	214520,1
2003	7889	7065	0	824	707463,7
2004	1131	1013	72	46	16056,88
2005	2009	825	590	396	27074,89
2006	5484	1017	4467	0	45362,06
2007	3607	385	1480	0	57901,44
2008	8159	8117	42	0	272168,1
2009	568	0	568	0	11454,9
2010	1430	0	1177	253	20430,14
2011	4442	2774	1668	0	108397,4
Total	254028	187420	13986	14227	2971496
Barley					
1991	396	0	396	0	66
1992	613	143	227	243	67,80074
1993					
1994	11691	6748	0	4943	67,94293
1995	7135	1617	0	1107	5428,388
1996	6639	6456	138	0	20517,75
1997	2435	1896	207	332	5900,437
1998	6166	0	0	0	24059,38
1999	10821	10345	434	43	40378,28
2000	17499	16465	50	984	101318,3
2001	6779	6779	0	0	56049,65
2002	2861	2861	0	0	30411,72
2003	1881	1599	0	282	137676,1
2004	260	164	86	10	2607,98
2005	449,4	70	311	0	4869,482

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
2006	1782	303	1479	0	35650,47
2007	854	428	426	0	12308,96
2008	2109	2098	11	0	32670,93
2009	602	0	602	0	9896,89
2010	2847	30	413	2404	40936,97
2011	1306	831	475	0	16708,36
Total	85125	58833	5255	10348	577592
Rice					
1991					
1992	181	181	0	0	17,68767
1993					
1994					
1995					
1996	108	108	0	0	1255,576
1997					
1998	740	0	0	0	7230,349
1999	174	174	0	0	19823,23
2000	80	80	0	0	1510,34
2001	70	70	0	0	1105,23
2002	117	117	0	0	2211,3
2003	129	129	0	0	95628,09
2004	68	0	68	0	1594,736
2005	116	86	0	0	1510,349
2006	32	8	24	0	831,616
2007	51	21	30	0	1803,96
2008	17	17	0	0	1204,28
2009					
2010	252	29	223	0	21979,54
2011	168	11	157	0	32157,38
Total	2303	1031	502	0	189863,7
Maize					
1991					
1992					
1993					
1994					
1995	3804	463	197	0	24926,53
1996	3052	2896	156	0	25202,82
1997					
1998					
1999	2870	1339	224	0	39094,79
2000	6278	6278	0	0	108702,2
2001	2915	2915	0	0	97151,49

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
2002					
2003	1059	825	0	234	248170,8
2004	550	527	23	0	16497,64
2005	498	332	166	0	14996,12
2006	99	99	0	0	3526,945
2007	143	36	107	0	8991,134
2008	277	135	142	0	21172,61
2009	103	0	103	0	6784,129
2010	640	0	640	0	32025,21
2011	156	35	121	0	14334,11
Total	22444	15880	1879	234	661576,6
Pulse plants					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000	798	798	0	0	8814,936
2001	30	30	0	0	1620
2002	183	183	0	0	1729,56
2003					
2004	8	8	0	0	154,16
2005					
2006	44	3	41	0	1476,935
2007					
2008	136	136	0	0	3987,97
2009					
2010					
2011	265	264	1	0	8660,405
Total	1464	1422	42	0	26443,97
Oats					
1991					
1992					
1993					
1994					
1995					
1996					
1997					

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
1998					
1999					
2000	330	330	0	0	1164,385
2001	15	15	0	0	245,2074
2002					
2003					
2004					
2005					
2006					
2007	34	0	34	0	574,9182
2008					
2009					
2010	10	0	0	10	111,112
2011					
Total	389	345	34	10	2095,623
Buckwheat					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000					
2001	15	15			30,24
2002					
2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					
2011					
Total	15	15			30,24
Rye					
1991					
1992					
1993					

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains- torms, hails	Frost, snow	
1994					
1995					
1996					
1997					
1998					
1999					
2000	12	12	0	0	40,01256
2001					
2002					
2003					
2004					
2005					
2006					
2007					
2008					
2009					
2010					
2011					
Total	12	12	0	0	40,01256
Tobacco					
1991					
1992	231	231	0	0	989,0762
1993					
1994	73	73	0	0	2,284847
1995					
1996					
1997					
1998	271	0	0	0	5724,648
1999					
2000	21	7	14	0	1058,039
2001					
2002					
2003	72	72	0	0	26398,26
2004	141	141	0	0	6452,661
2005	66	66	0	0	3019,193
2006	22	20	2	0	1274,161
2007	56	0	56	0	4009,643
2008	373	0	373	0	29646,83
2009	57	0	57	0	5326,367
2010	48	0	48	0	4654,823
2011	6	6	0	0	126,9572
Total	1437	616	550	0	88682,95

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
Cotton					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000					
2001					
2002					
2003					
2004					
2005	441	441	0	0	14716,75
2006					
2007	54	54	0	0	2261,395
2008	31	31	0	0	1480,103
2009					
2010	201	0	201	0	14636,92
2011	152	1	151	0	17580,87
Total	879	527	352	0	50676,04
Sugar beat					
1991					
1992	90	66	24	0	50,28779
1993					
1994	1225	0	1225	0	0,66711
1995	31183	31183	0	0	309970,5
1996	1137	857	280	0	15090,56
1997					
1998	923	0	0	0	18561,14
1999	2466	2453	13	0	56846,02
2000	9916	9889	27	0	147562,9
2001	5000	4999	1	0	60108,11
2002	1533	1533	0	0	24810,86
2003	563	352	0	211	171898,4
2004	627	590	37	0	13746,17
2005	56	0	56	0	974,848
2006					
2007	4	0	4	0	52,812
2008					

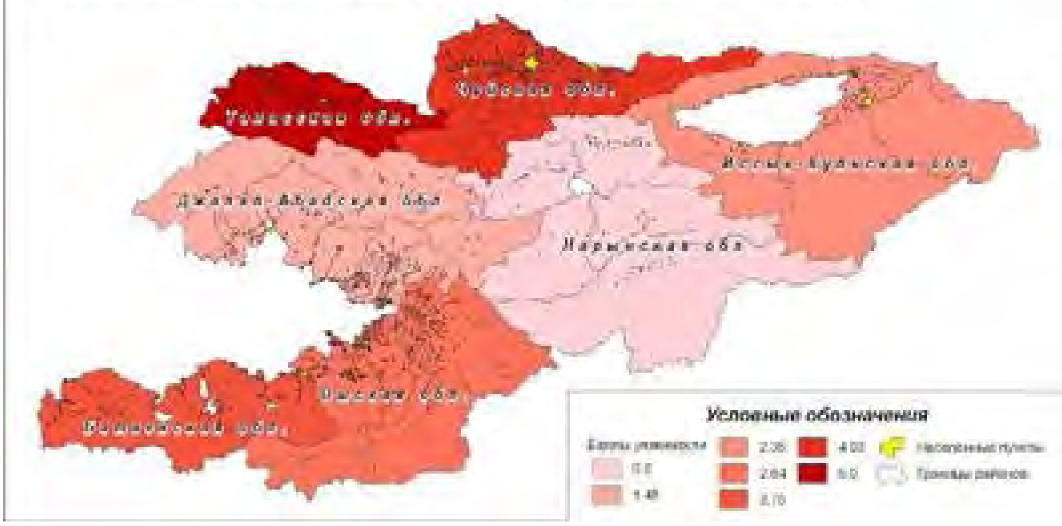
Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
2009					
2010	26	26	0	0	462,576
2011					
Total	54749	51948	1667	211	820136
Oil-bearing crops					
1991	130	0	130	0	2,960672
1992					
1993					
1994					
1995	13614	7605	0	2121	20869,6
1996	3947	3948	0	0	3464,63
1997	1494	1438	29	30	2747,605
1998	3591	2942	519	130	14293,53
1999	2039	2039	0	0	5921,536
2000	3140	2894	32	214	2159,318
2001	835	835	0	0	2166,528
2002	287	287	0	0	495,872
2003	8	8	0	0	164,32
2004	307	249	58	0	905,788
2005	599,2	440	107	0	1728,418
2006	646	328	318	0	1645,644
2007	153	84	69	0	400,764
2008	3215	3214	1	0	8933,756
2009					
2010	120	10	110	0	343,98
2011	1167	968	199	0	22940,16
Total	35292,2	27289	1572	2495	89184,41
Potato					
1991					
1992	84	84	0	0	42,19287
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000	82	40	42	0	4975,267
2001					
2002	9	9	0	0	647,7521
2003	67	67	0	0	63553,78
2004	195	195	0	0	10161,67

Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
2005	304	154	0	0	22031,63
2006	34	34	0	0	6819,987
2007	123	0	123	0	22124,16
2008	91	0	91	0	16028,94
2009	152	0	152	0	25766
2010	413	0	413	0	77341,4
2011	27	24	3	0	6454,501
Total	1581	607	824	0	255947,3
Vegetables					
1991					
1992					
1993					
1994					
1995	154	22	0	38	1546,992
1996	480	481	0	0	42572,77
1997					
1998	325	325	0	0	41674,34
1999	951	365	586	0	116787,7
2000					
2001	351	341	10	0	49663,58
2002	755	755	0	0	104553,9
2003	726	726	0	0	1067822
2004	932	932	0	0	139832,7
2005	890	105	32	0	170656,7
2006	145	96	49	0	21074,98
2007	17	2	15	0	5559,553
2008	70	35	35	0	36438,06
2009	13	0	13	0	5159,96
2010	167	0	167	0	75933,31
2011	113	2	111	0	74283,78
Total	6089	4187	1018	38	1953560
Melons					
1991					
1992					
1993					
1994					
1995					
1996					
1997					
1998					
1999					
2000					

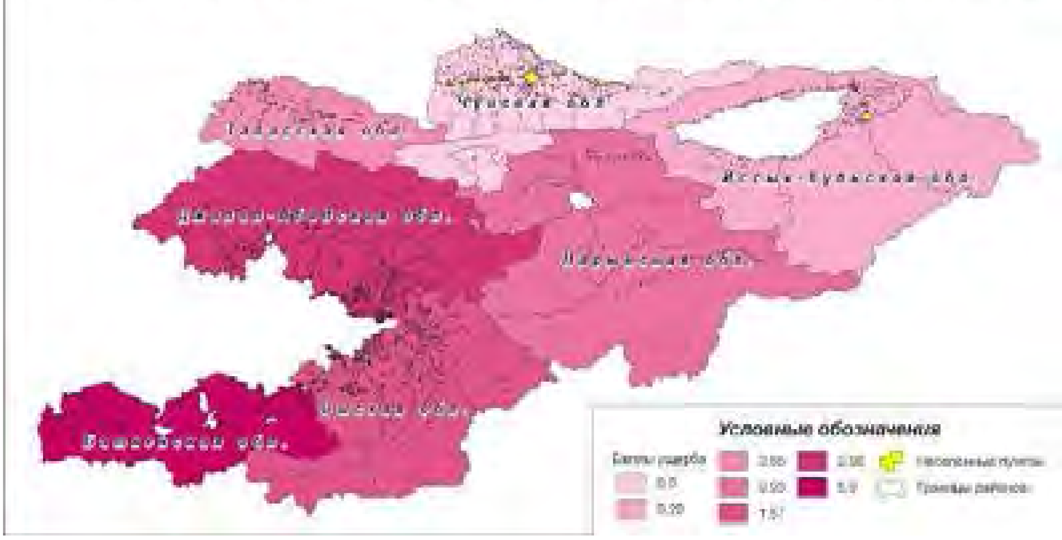
Crop	Total destroyed, ha	Including, ha			Damage, thousand KGS
		Draught, lack of water	Rains-torms, hails	Frost, snow	
2001					
2002					
2003					
2004					
2005	238	13	0	0	29811,29
2006	3	1	2	0	306,3976
2007					
2008	6	6	0	0	2260,78
2009					
2010	25	0	25	0	8256,252
2011	11	0	11	0	3175,126
Total	283	20	38	0	43809,84
Total for 1991-2011					
	466091	350152	27719	27563	7731134

ANNEX 4: MAPS OF VULNERABILITY TO CLIMATE CHANGE AND ADAPTIVE CAPACITY

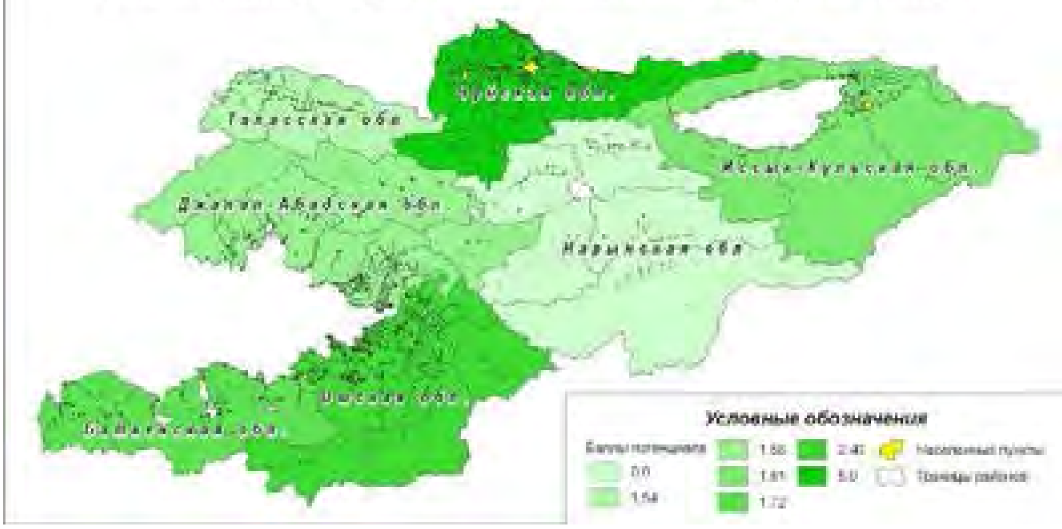
Vulnerability (in grades) of the Kyrgyzstan's agriculture to climate change



Direct damage (in grades) as a result of climate dependent ES for 2000 – 2010 of GRP, %

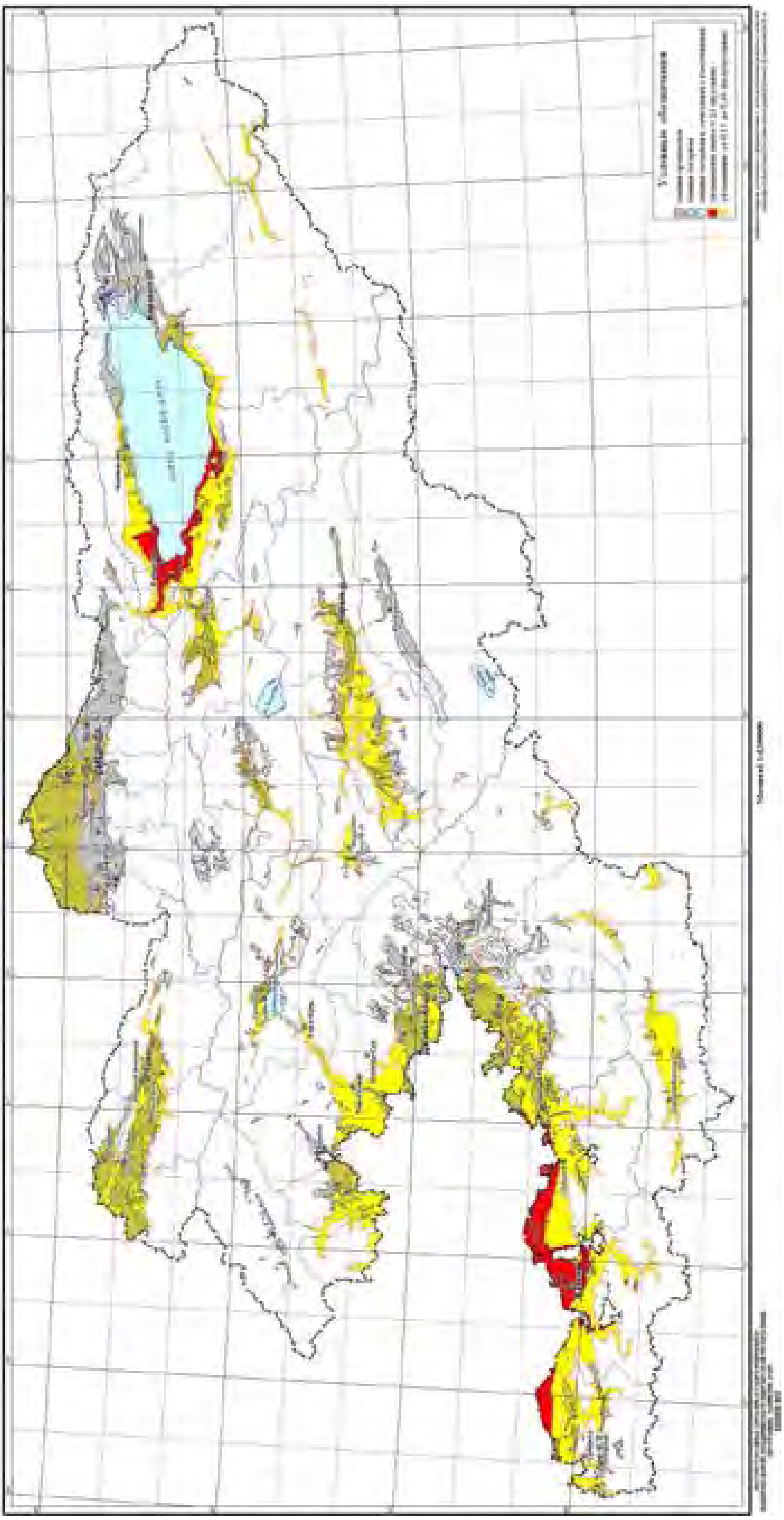


Adaptive capacity (in grades) of the administrative areas to climate change

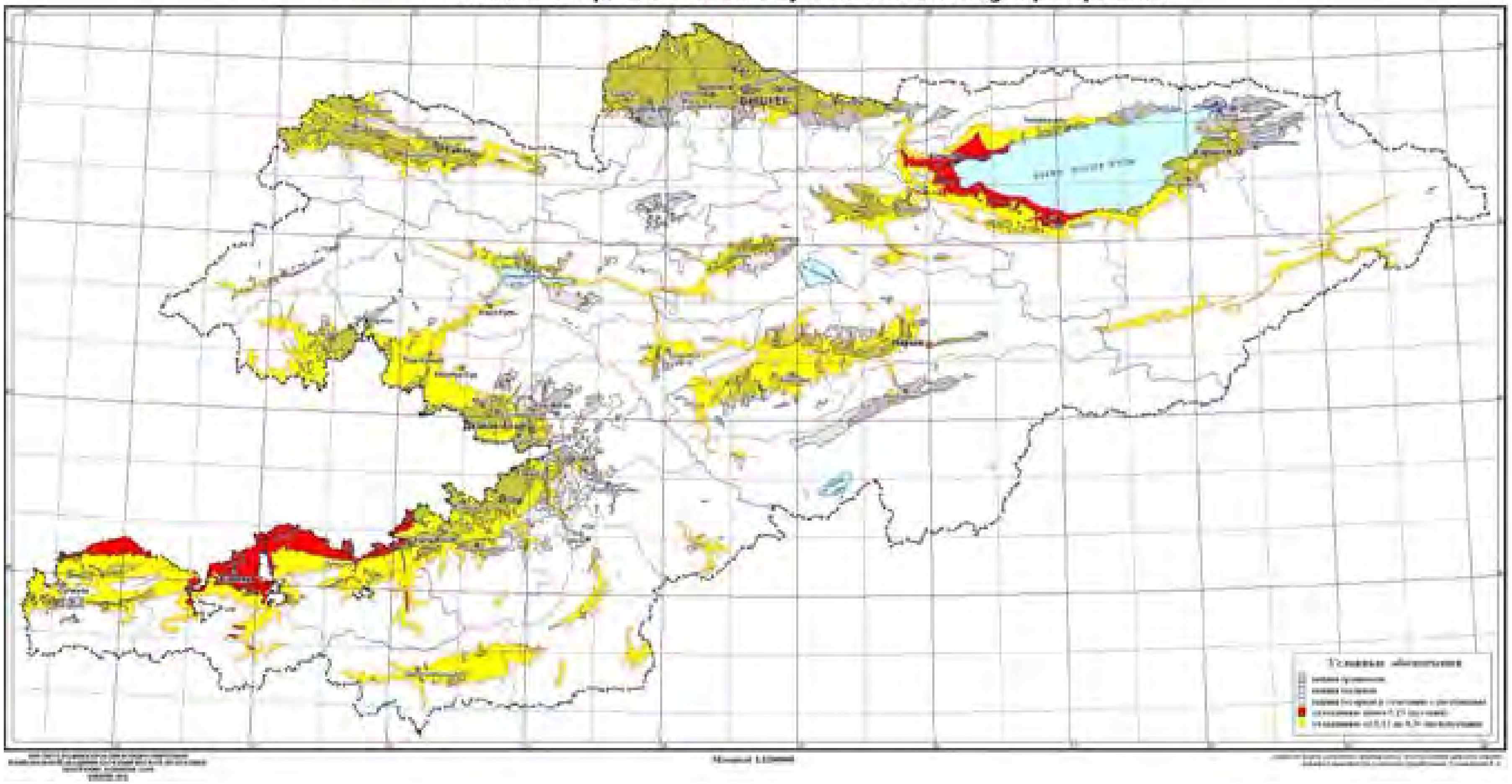


ANNEX 5: HUMIDITY AND CLIMATE CHANGE

Kyrgyzstan's habitats with humidity below 0.13 (desert) and from 0.13 to 0.30 (semi-deserts) in 2000



Kyrgyzstan's habitats with humidity below 0.13 (desert) and from 0.13 to 0.30 (semi-deserts) in case of temperature increase by 1.5°C with unchanged precipitation



Kyrgyzstan's habitats with humidity below 0.13 (desert) and from 0.13 to 0.30 (semi-deserts) in case of temperature increase by 4°C with unchanged precipitation