5. VULNERABILITY ASSESSMENT AND ADAPTATION

When assessing vulnerability, the most unfavourable scenarios out of all possible were considered in all sections from the point of view of a certain section.

5.1. Basic scenarios

Three major scenarios of expected development have been used for vulnerability assessment – climatic, demographic and economic.

A climatic scenario is a logical continuation of the expected climate assessment by means of GCM with the purpose of rendering climatic conditions concrete in a form suitable for forecast and analysis of vulnerability to an expected climate change.

The Kyrgyz Republic is small in terms of latitude (454 km) and longitude (925 km), so horizontal distances do not have a significant influence on changes in climatic conditions across the territory. By contrast, relief and orography – not taken into account by GCMs – play a major role.

In order to assess the country's vulnerability, a change of climatic factors in different areas has been considered. Two major factors constitute the basis for defining agro-climatic zones in the Republic: thermal conditions and the availability of water. The sum of active air temperatures for the period between the dates of an average daytime temperature steadily rising above 0°C, 5°C and 10°C in spring and fall serves as an indicator of thermal conditions. The altitude of thermal belts within the regions was determined on the basis of the sums of above-zero temperatures for the period between the dates of an average daytime temperature steadily rising above 10°C. The availability of water was assessed on the basis of total precipitation. The calculation results are as follows:

1. Thermal resources

Northern, North-Western Kyrgyzstan. The sums of above-zero temperatures with an average diurnal temperature passing 0°C will increase by 550-850°C, and the duration of a warm period will increase by 20-42 days. When passing 5°C the sums of above-zero temperatures will increase by 350-700°C, and the duration of a period with an air temperature above this limit may increase by 24-42 days. When passing 10°C the sums of above-zero temperatures will increase by 130-600°C, and the duration of the growing season will increase by 24-43 days. The boundaries of thermal belts will shift upwards by 200-400 m at the altitude of 600-1,400 m compared to the existing ones. At the altitude of 1,600-2,600 m the boundaries of thermal belts will not change.

North-Eastern Kyrgyzstan. When passing 0°C the sums of above-zero temperatures will increase by 550-800°C, and the duration of a period with an air temperature above this limit will increase by 23-33 days. Above 5°C the sums of above-zero temperatures will increase by 400-650°C and the duration of a warm period will increase by 26-32 days. When passing 10°C sums of above-zero temperatures will increase by 90-500°C, and the duration of the growing season will increase by 23-63 days. The boundaries of

thermal belts in the western part of the Issyk-Kul basin will shift upwards by 200 m at the altitude of 1,600 m compared to the existing ones, and at the altitude of 1800 m the boundaries of thermal belts will not change. The boundaries of thermal belts in the eastern part of the Issyk-Kul basin at the altitude of 1,600-2,600 m will not change compared to the existing ones.

Inner Tien-Shan. When passing 0°C sums of above-zero temperatures will increase by 500-700°C, the duration of a period with an air temperature above this limit will increase by 15-36 days. When passing 5°C the sums of above-zero temperatures will increase by 350-650°C, and the duration of a warm period will increase by 16-36 days. When passing 10°C sums of above-zero temperatures will increase by 70-550°C, and the duration of the growing season will increase by 18-56 days. The boundaries of thermal belts in the northern part of the Tien-Shan region will shift upwards by 200 m at the altitude of 1,600 m. The boundaries of thermal belts at the altitude of 1,800-2,400 m will not change. The boundaries of thermal belts in the central part of the Tien-Shan region will shift upwards by 200-400 m at the altitude of 1,200-1,800 m, whereas at the altitude of 2,000-2,800 m they will not change. The boundaries of thermal belts in the south-eastern part of the Inner Tien-Shan will not change at the altitude of 2,800-3,000 m.

South-Western Kyrgyzstan. When passing 0°C sums of above-zero temperatures will increase by 500-900°C, the duration of a period with an air temperature above this limit will increase by 21-36 days. When passing 5°C the sums of above-zero temperatures will increase by 400-750°C, and the duration of a warm period will increase by 20-33 days. When passing 10°C sums of above-zero temperatures will increase by 300-600°C, and the duration of the growing season will increase by 18-38 days. The boundaries of thermal belts will shift upwards by 200-600 m at the altitude of 600-2,400 m. At the altitude of 2,400-2,800 m the boundaries of thermal belts will not change.

2. Moisture resources

According to the moisturising scenario an increase in annual precipitation by 17% throughout all the 4 climatic zones is possible. At that, the greatest increase in precipitation will occur in the summer in Northern, North-Western, South-Western Kyrgyzstan and in the Inner Tien-Shan. In North-Eastern Kyrgyzstan the biggest amount of precipitation is expected to occur in the autumn.

Table 5.1. Demographic development in the Kyrgyz Republic until 2100

#	Period	Population by the end of the period (in thousands)	Growth rate (in %)
1	2000 – 2010	5,444	1.5
2	2010 – 2020	6,344	1.5
3	2020 – 2030	7,267	1.4
4	2030 – 2040	8,192	1.2
5	2040 – 2050	9,040	1.0
6	2050 – 2060	9,986	1.0
7	2060 – 2070	11,031	1.0
8	2070 – 2080	12,185	1.0
9	2080 – 2090	13,460	1.0
10	2090 – 2100	14,868	1.0

A demographic scenario. Until the year 2050 the assessment of the American Census Bureau has been used. The assessment for the following decades is based upon the suggestion that the population growth rate in the Republic will remain at the level of 2050, which will most probably result in a slight overvaluation of the amount of population and subsequently in stricter conditions when analysing vulnerability.

An economic scenario. For assessment of macro-economic indicators for a short period of time national development programmes in Kyrgyzstan (National Development Strategy of Kyrgyzstan for 2001-2010, National Poverty Reduction Strategy, etc) have been used. For assessment of macro-economic indicators for a longer period of time (a century) an analogy method has been used, that is, major macroeconomic indicators in the Republic in 2100 are expected to reach the

level that developed countries had in 2000. The results have been adjusted for the current economic structure, the existence of natural resources and an orientation at global development tendencies considering national peculiarities, for instance, a further preferred development of hydro-power and renunciation of nuclear power.

Table 5.2. Some economic indicators for the Kyrgyz Republic

Indicator	Unit	2000	2010	2020	2100
Population	million people	4.91	5.44	6.34	14.87
GDP with PPP	billion $	12.38	19.15	34.28	327.1
GDP with PPP, per capita	$/capita	2,521	3,520	5,407	22,000
Energy consumption, total	million t.o.e.*	2.99	5.7	9.18	32.71
including:					
- coal;	million t.o.e	0.74	1.46	2.96	
- natural gas;	million t.o.e	0.58	1.02	1.44	
- CLM (combustive-lubricating materials);	million t.o.e	1.57	3.09	4.60	
- energy of TPS	million t.o.e	0.1	0.13	0.18	
Energy consumption, per capita	t.o.e./person	0.61	1.05	1.45	2.2
Energy consumption, per $1000 of GDP	t.o.e./$1000 GDP	0.24	0.3	0.27	0.1
Electricity generation	billion kWh	14.8	18.53	27.32	74.36
per capita	kWh/capita	3,014	3,373	4,309	5,000
per $1000 of GDP	kWh/$1000 GDP	1.20	0.97	0.80	0.20
Forest area	thousand hectares	858.5	888.5	918.5	1,194

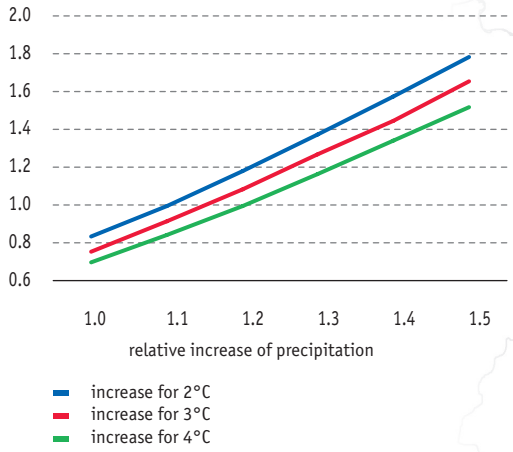
* t.o.e. – tons of oil equivalent

Only those indicators that are required for GHG emission and vulnerability assessment have been considered. Indicators referring to the agricultural development are presented in Tables 5.3 and 5.4 of this chapter. Forecast results are presented in Table 5.2.

5.2. Water resources

A forecast of the total flow of Kyrgyzstan's major rivers (Naryn, Chu, Talas) for a combination of different conditions is presented in Fig.5.1. This forecast has been made based on precipitation and evaporation balance modelling taking into account the relief and types of water catchment area (forests, lakes, etc.)

Figure 5.1. Assessment of change in runoff of the major rivers in the Republic depending on precipitation and temperature relative to the current state. The value 1 stands for the total runoff level based on the existing long-term observations.



As shown in Fig.5.1, given the expected climate change, flow may change to between 0.7 and 1.8 out relative to the existing level. It should be noted that in fact the magnitude of flow is somewhat underestimated, because faster glacier melting is not taken into account. Most of the rivers in the Republic have a snow-and-glacier type of alimentation, and should the temperature go up, their flow will increase, which has been observed over the last few years. During the period from 1973 to 2000 the total river flow increased by 6.3% compared to the preceding period (from 48.9 to 51.9 km^3). In the next 20 years a further increase in flow by 10% has been forecasted based on the worked-out models (up to 55.5 km^3).

At the present time the Kyrgyz Republic utilises no more than 10 km^3 for its own needs. Calculation of water consumption for 2100 that was carried out on the basis of the models indicates that water consumption in the Republic will not exceed 20 km^3 with any development scenario.

Consequently, a vulnerability assessment of water resources independently implemented for the Kyrgyz Republic leads to the following conclusion: the expected change in water resources as a result of climate change is going to be favourable. The forecasted

water supply has been assessed as sufficient in the framework of basic development scenarios.

However, it is a fact that the water resources of the Kyrgyz Republic are life supporting for the neighbouring states and that water supply problems already exist in regional perspective. The acuteness of these problems will increase as time goes on unless mitigation measures are taken. In other words, given the systemic vulnerability assessment of water resources, adaptation measures should be worked out, taking into account the interests of the neighbouring states. Analysis of the regional situation and/or the water-basins of trans-boundary rivers, as well as working out adaptation measures considering economic and political interests and socio-economic situation of all countries involved, goes well beyond the scope of this project. However, the following national actions aimed at mitigation of the general water situation in the region, primarily taking into account the interests of the Kyrgyz Republic, are obviously called for:

Political measures:
- to determine the Republic's quotas from trans-boundary waters, which will suffice for meeting the Republic's future needs.

Instrumental measures:
- to create an integrated information and analytical system for managing the land and water resources in the Republic;
- to create and develop a water market;
- to increase the efficiency of irrigation systems and introduce modern irrigation technologies;

Social measures:
- to encourage and develop a water-saving attitude among the population;
- to involve local communities in water resource management.

Institutional measures:
- to improve water resource management bodies;
- to create target financial and investment structures.

The listed measures have already been discussed in analogous wording and included into different documents on recommendations of the branch development.

5.3. Energy sector

The total energy potential of the Kyrgyz Republic is fairly high, which does not exclude certain problems. The existing oil and gas reserves do not satisfy the Republic's need for oil products. Coal deposits are located far from the major consumers, which significantly increases the cost of using local coal. Thus, with respect to these energy products continuing dependence on import should be expected. Use of unconventional and renewable energy sources is virtually absent.

The overall fuel and energy sector does not heavily depend on the climate. There is little likelihood that the decrease in fuel consumption for heating because of general warming will live up to the expectations, since it does not imply a change in diurnal and annual amplitudes. A decrease in thermal losses by industrial and civil buildings, as well as managing temperature conditions in communal buildings and apartment houses, has by far a more significant potential for reduction in heat consumption.

Taking into consideration the conclusions of Section 5.2 another conclusion can be drawn namely that climate change will be favourable for hydro-electric engineering. An increase in annual flow will enlarge the potential of the branch. Changes in the pattern of annual flow distribution may affect derivative power stations and lead to a lower rate of use of the installed capacity of these stations. A change in annual flow distribution will not affect pressurised HPSs.

Therefore, the expected climate change will not have a direct negative impact on Kyrgyzstan's overall energy supply. However, this does not exclude that certain measures will be taken for ensuring a more sustainable development of power engineering, which takes ecological factors into account. A programme for developing the power-engineering complex of Kyrgyzstan should comprise the following measures:

- harmonising the conditions of usage of rivers that are important for irrigation and hydro-power, taking into account the interests of all states of the region;
- creating prerequisites for a fuller use of the hydro-power potential;
- reducing electric and thermal energy losses and introducing energy-saving technologies;
- increasing the share of renewable energy sources in the energy balance. Based on world practice, it is hard to expect a substantial increase in the use of geothermal, solar and wind energy, etc. These constitute approximately 0.5% of world-wide capacity nowadays. Taking into consideration that waste processing accounts for 10% of energy use in the entire world, it is necessary to expedite the development of this very trend;
- increasing the share of ecologically cleaner fuels;
- working out a development strategy for motorised transport, especially public transport.

5.4. Population health

A significant amount of research is known about proving that climate affects one's health. In the context of this project a supplementary analysis of medical statistics has been conducted in order to establish a quantitative relationship between temperature increase and the state of health, given the conditions of the Kyrgyz Republic. This research is not complete, since the impact of other factors was not taken into account.

Non-infectious diseases

A significant correlation between the urolithiasis rate and temperature has been determined. The disease rate in the south of Kyrgyzstan (Osh, Jalal-Abad oblast) is twice as high as in the north (Issyk-Kul, Naryn oblast) for adults and 7 times as high for children. Taking into consideration the forecasted climate change a significant increase in the urolithiasis rate in the Republic may be expected. An average annual temperature in the south and in the north is 11.7 and 4.9°C respectively, based on long-term observations.

A linear association has been found between the number of times during the hot season (May-August) that the ambulance service was contacted for general medical problems on the one hand, and the level of partial oxygen pressure and temperature on the other. Given the expected climate change (increase by approximately 3°C) the increase in ambulance call-out rate in the whole Kyrgyzstan could be more than 1%.