Report on Issyk-Kul biosphere reserve

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Abstract: Over the last 20 years many regional and international agreements and conventions have been signed. Interestingly, greater attention is paid to assessing the development of policies and projects as well as to capacity building. Within this context in May 1999 the Global Environment Facility (GEF) approved a partnership between the GEF Secretariat and the United Nations Development Programme (UNDP) in order to determine the strategic position for capacity building as new ecological issues appear. Currently projects for Capacity Assessment for Global Environment Management are being implemented in 21 European countries including the Commonwealth of Independent States (CIS). In Kyrgyzstan such projects began when the National Executive Agency of the Ministry of Ecology and Emergencies of the Kyrgyz Republic was appointed. The aim of self-assessment is to identify and analyse national priorities and needs for capacity increase at the individual, institutional and system levels which are necessary for the implementation of three global ecological conventions. Project main goals: (1) Assessment of priority, needs and identification of common problems within the framework of all the conventions; (2) Assessment of national country capacity in the area of implementation of the three conventions, (3) Preparation of the National Strategic Action Plan and (4) Strengthening of dialogue and cooperation among stakeholders.

Keywords: cultural landscapes; global warming; climate change; vulnerability assessment; Mountain Biosphere Reserve; MBR; Global Change in Mountain Regions project; GLOCHAMORE.

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1 Introduction

The project 'National Capacity Self-Assessment for Global Environmental Management in Kyrgyzstan' brings certain benefits to the country because it is not only limited to nature conservation issues but takes into consideration reform in the area of public governance, the interests of national strategies and poverty reduction programmes.

Considering all the points mentioned above it has to be stated that Biosphere Reserves (BRs) are key components when we refer to different concepts and issues related to biodiversity conservation, sustainable land use and natural resources for the benefit of every one. The wealth of biodiversity in the Issyk-Kul BR and Issyk-Kul Lake proposes itself as a scientific laboratory for issues related to the preservation and sustainable use of existing natural resources. The study and consideration of these issues has to be scientifically validated. Considering the importance of global change scientific studies and monitoring in BRs the work is conducted by the Department of Science that dealt with issues related to 'Landscape planning and sustainable land use' and 'Preservation of biodiversity and strictly protected areas'. This research is devoted to the development of decision making for national and regional policies on environmental protection and long term land use.

The main areas of research:

- study of structure, function and dynamics of ecosystems, qualitative and quantitative register of natural resources
- impact assessment of natural ecosystems from human activities, analysis and permanent monitoring of natural and anthropogenic factors that could endanger ecosystems
- experimental work towards strengthening the natural processes weakened by anthropogenic impact and ecosystem functioning, restoration of forests, flora and fauna
- scientific validation of land and ecosystem use management through various methods of ecologically sound land use
- experimental restoration of the degraded natural landscape as the basis of scientific research
- experimental recultivation and sanitation of the impacted BR taking into account requirements to preserve the ecological balance, social and economic development.

The General Direction of the Issyk-Kul BR, in accordance with the law of the Kyrgyz Republic 'On biosphere territories in the Kyrgyz Republic', and within the framework of UNESCO's Man and the Biosphere (MAB) Programme, provides implementation within the following functions:

- preservation of the natural landscape, ecosystems, species and genetic diversity
- assistance in the economical and cultural development of the region, providing an interlink between environmental protection and secure sustainable development
- conducting long term research and environmental monitoring, assistance to the region in the implementation of environmental education programmes, improving the qualification of managers in terms of land use, creation of a basis for testing, standardising and transfer of new technologies to the region that could solve environmental as well as social and economic problems.

It has to be stated that the overall involvement of BRs in general and Mountain Biosphere Reserves (MBR) in particular in a global scientific network is essential as ecology and nature do not recognise boundaries. Natural processes that we call global change are interconnected. Let us consider the type of scientific research carried out in the MBR of Kyrgyzstan, including Issyk-Kul BR (approved in 2001). One of them is the study of climate change and its influence on the forest ecosystems of Kyrgyzstan.

If global warming has the effect of doubling the CO2 content in the atmosphere then there is a real possibility that the forest ecosystem of the Kyrgyz Republic could be impacted. It is well known that climate is defined by complex interactions between the atmosphere and lithosphere, the world's oceans, glaciers and the biosphere. Anthropogenic factors, causing solar energy accumulation, influence heat balance that change climatic conditions.

The BR concept is embedded in the MAB Programme, which was established by UNESCO in 1971. The establishment of a global network of BRs covering all ecosystem types and biogeographic units is a central focus of the MAB Programme and plays an important part in international environmental and nature conservation policies.

To date there are 507 BRs globally. When the first BRs were approved – during the 1970s – the conservation of important natural landscapes was at the fore. This changed in the 1980s with a greater focus on conservation, maintenance and development of cultural landscapes. Such BRs are model regions of sustainable land use in which – together with the inhabitants living and working there – concepts of conservation, maintenance and development are being elaborated and put into action. They can be distinguished from other protected areas by the fact that the people living in the cultural landscape, together with their practices, are an integral part of the BR concept.

In order to meet the nature conservation needs as well as to integrate the functional use of the area, three different zones – corresponding to the impact of human activity – have been identified in BRs:

- The *core area* is characterised by a strict protection regime which forbids any form of land use. The aim is to conserve the biological diversity as well as important natural resources of regional, national and international importance.
- The *buffer zone* can be used extensively as well as seasonally. The aim is to conserve a cultural landscape with its typical and traditional forms of use, which have developed over centuries of human occupation of the area.
- Further development and the optimisation of sustainable land use is the task of the *transition area*. Heavily damaged areas which urgently need regeneration are part of the *rehabilitation zone*.

2 Issyk-Kul BR

Over the past few decades cultural landscapes have declined globally. In Europe this is mainly the consequence of intensive agriculture with its high-productivity affecting soils that increasingly disturb marginal lands and historic cultural landscapes because of their seemingly unprofitable purpose. In Central Asian republics of the former Soviet Union huge natural and cultural landscapes have been destroyed due to ploughing of the steppes

and by irrigating deserts and semi-deserts. Fortunately a vast landscape – the region of central Tien-Shan around Issyk-Kul Lake – was spared as its location was considered inappropriate. This area is one of the last remaining harmonious cultural landscapes in Central Asia that includes almost pristine habitats alongside traditional culture.

Issyk-Kul Lake historically plays an important role in the culture and tradition of the Kyrgyz people. Legend goes that the lake is sacred and up until recently swimming was forbidden. Its purity and wealth of fish species has always been an indicator of the ecological health of the region.

Many attempts have been made in the past to protect the Issyk-Kul Lake and to conserve it for future generations. In 1948 the Issyk-Kul Zapowednik (nature reserve along the southern shoreline) was established. There was a subsequent attempt to protect the entire Issyk-Kul area, which unfortunately failed for political reasons. Since acquiring autonomy, the Kyrgyzstan republic's national and international organisations have also attempted to acquire protection. During the 'Tcholpon-Ata-Conference' in 1994 the Issyk-Kul BR was first formulated as a joint recommendation by all the participants, which was thought to best combine the regional, ecological and economic requirements.

Following the collapse of the Soviet Union and the subsequent political changes during the beginning of the 1990s, the living conditions of the rural communities continue to deteriorate where there is a lack of supply and demand, a collapsed social infrastructure, land rights insecurities as well as a lack of experience of agricultural practices by the land users that resulted impeded the development of sustainable and productive uses. Decisions on land use were made with regard to short-term subsistence needs. The regional and national administrative institutions are still unable to formulate regional development policies in cooperation that integrate uses and conservation needs with the local people.

From 1995 various measures, financed by the German Government via the German Agency for Technical Cooperation (Deutsche Gesellschaftfur) Technische Zusammenarbeit GmbH, GTZ), have been implemented in Kyrgyzstan with the overall aim to establish the Issyk-Kul Biosphere Territory,[1] which was eventually initiated in March 1997.

The main task of the project was to develop a framework plan for application of ecological-sound land use practices in the future and thus form the basis for the establishment of the Issyk-Kul BR. The planned area defined the Issyk-Kul Oblast[2] administrative borders for the project covering 45,000 km^2. This is approximately the size of Switzerland however 60% of the land area is uninhabited.

3 Preconditions for the establishment of the Issyk-Kul BR

The mountain area of the central Tien-Shan region including the Issyk-Kul Lake at its centre is home to many ecosystems of global importance and has a wide variety of endemic wild species of fauna and flora. The Issyk-Kul Lake with its 180 km length and 60 km width is the second highest mountain lake in the world. Due to its depth of 700 m, its low salinity and many warm water sources, it does not freeze in winter. It is located 1600 m above sea level and is surrounded by the mountain ranges of the central Tien-Shan. The central Tien-Shan ranges lies in a west-east direction with certain peaks rising to an altitude of 7439 m.

Starting from the lake shore, all significant landscapes from the subtropics to tundra can be found in an azonal order:

- In the western part of the area, in particular close to the lake, rocky deserts are present. Old lake sediments give the landscape a bizarre appearance.
- Natural semi-deserts are rare in the western part of the Issyk-Kul because a large area has been ploughed and was converted to agricultural land and orchards. A typical plant of the region is Ephedra, a blue-greenish shrub with orange fruit berries.
- Dry Steppes are mainly represented by various wormwood species. They can be found on upward slopes next to semi-deserts in nearly all hilly areas. In the eastern part of the region they can even be found directly adjacent to the lake because of a higher precipitation rate.
- Herb meadows and alpine meadows can be found – depending on their hill exposition – at an altitude of between 1900–3200 m a.s.l. They are considered to contain the highest level of biodiversity in the Tien-Shan formation. They are located on the northern slope among the endemic Tien-Shan spruce. On southern slopes they accompany juniper groves up to an altitude of 3000 m and can also be partly found up to 3400 m.
- Shrubs can be found – according to altitude and exposition – in differing vegetation complexes. Along the lake shore thick buckthorn thickets can be found while higher above the northern slopes berberice and roses appear and on the southern slopes up to 3200 m juniper groves can be found. On the opposite slopes one can find willow and mountain ash.
- Due to climatic conditions forests of the endemic Tien-Shan spruce grow exclusively on the northern slopes at an altitude of 1900–2800 m a.s.l. The distribution of forests is limited to the eastern part of the area with higher precipitation. Its water retaining function is a fundamental component in the natural biological cycle and at the same time offers good protection against erosion.
- Subalpine and alpine meadows can be found from 3200 m upwards. Together with the mountainous steppes and meadows they are the most important pastures for wild and domestic animals.
- Wide and shallow valleys in the high mountain regions between 3000–4000 m are called syrts. The extremely short vegetation period of three months only allows for high mountain cold steppes and swamps on permafrost soil.
- River meads can be found along middle sized rivers and big rivers. They are mainly formed by various willow species.
- Areas with vegetation on the subnival and nival level are important withdrawal areas for nature because – with very few exceptions – hardly any human intervention occurs. Moreover they are home to endangered species such as the snow leopard, Marco-Polo sheep, Pallas's cat (*Felis manul*) and the Himalayan snowcock. The Ibis bill breeds at approximately the same altitude on gravel islands in rivers.

- Cliffs, glaciers and snow fields are the origins of all life on the slopes and in the valleys of the Tien-Shan. They act as freshwater reservoirs for the entire region of Central Asia. The rivers that originate here feed the Aral Sea, the Fergana and Tarim basins as well as the Issyk-Kul Lake.

4 Cultural aspects

For centuries the Krygyz people were semi-nomadic shepherds who migrated seasonally with their livestock throughout the mountain regions. Their dwellings consisted of a circular felt tent, the yurt and during the summer months they would live in the rich meadows in the high mountain areas of the subalpine and alpine level and the syrts, up to an altitude of 4000 m above sea level. However, during winter the shepherds would migrate to the lower lying steppe areas or around the Issyk-Kul Lake. Livestock was the main source of income which provided the families with everything they required for survival: food, clothes, transport and shelter. Russian settlers started to develop the area only 150 years ago. They introduced farming and founded the first villages. Yet Kyrgyz culture still survives today – symbolised by the yurt. Kyrgyz culture is based on an economic system with stable long-term practices and the sustainable use of nature.

Even today some family members still go to the mountains with their yurts and livestock to live there self-sufficiently for four or five months. They ferment fresh mare's milk, which is the basis of *kumys*, a slightly alcoholic yet very healthy beverage. Sheep wool is rolled and treated according to an old technique, which produces the kind of felt used in the construction of yurts and for the manufacture of carpets for walls and floors as well as other consumer goods.

5 Socio-economic aspects

The Issyk-Kul plain consists of three cities and approximately 400 inhabited areas with a total population of 420,000 consisting mainly of Kyrzgyz people. Russians make up the only other ethnic group. The main economic activities in the Issyk-Kul region involve livestock, agriculture, tourism and mining. The former light manufacturing companies ceased their activities more than five years ago.

The large herds of livestock, which were collectively kept during soviet era, caused overgrazing on many pastures and were broken up shortly after the initiation of the privatisation process. This was mainly due to the division of herds, pasture land and technical equipment. During this period the migration of cattle during the summer months ceased as well as the coordinated production of winter fodder.

Livestock production nevertheless plays an important role in the economy and tradition of the country and remains an important means of income for many families. Traditionally, keeping horses and sheep was regarded as important. Sheep provides food and are an important resource in the production of clothes and shelter. Horses are used as a means of transport and *kumys* production. The rise in the number of horses in the country is also an indicator of the revival of Kyrgyz culture. Cows have also traditionally been kept but never in great numbers. Yaks that inhabited high mountain regions were

also rounded up but never needed additional feeding. As Kyrgyz people are largely Muslim and therefore do not eat pork, pig production is of importance only to the Russian part of the population.

The Issyk-Kul plains are mainly used for agricultural production as there is adequate precipitation for farming in the east. In the drier western part of the area, a sufficient harvest can only be achieved through intensive irrigation. In addition to the cultivation of potatoes, wheat and barley, legumes like lucerne and esparsette are planted on large tracts of land. They are also of great importance for soil fertility in terms of nitrogen. The use of weedkillers, pesticides and fungicides as well as mineral fertilisers was reduced due to the shortage of money though from an ecological point of view, this is a welcome effect.

6 Identification of critical problems

The following problems were identified as those that could impede the implementation of measures for the development of sustainable land use.

6.1 Water

Global warming leads to faster glacier melt and thus a future lack of water in this region. The water level of Issyk-Kul Lake drops by 7 cm annually. This can be attributed to the overuse of headwaters and in the use of groundwater as fresh drinking water.

6.2 Vegetation

The vegetation cover in the lower slope zone (grazing land in the autumn and winter) is largely overgrazed and has significantly degraded in previous years.

6.3 Fauna and hunting

Excessive numbers of livestock during the soviet era has led to habitat loss for many wild animal species. For instance snow leopards are increasingly hunted by locals (due to high prices for pelts). Krygyzstan was once believed to have the second largest snow leopard population; today local experts believe that probably 60–80% of the population has been lost.

6.4 Agriculture

A number of different agricultural small holdings were created as a result of privatisation and the division of coowned property. However, the majority of these small holdings are only producing at subsistence level. The soils have reduced fertility and lost their resistance to disease due to a lack of fertilisers and crop rotation. Irrigation systems are often damaged while irrigation schemes prove ineffective.

6.5 Livestock production

An increasing number of animals are falling ill with brucellosis and tuberculosis because of the decline in veterinary services. Endoparasites, which can transfer certain diseases to humans, are spreading. The sheep herds are mixed and pure captive animal breeds are rare. The merino wool can only be sold as a raw material due to its poor quality. The Kyrgyz sheep breed is more suitable for meat production but is becoming increasingly rare.

6.6 Tourism

The majority of recreation centres have yet to be privatised. Coupled with insufficient resources for their maintenance a greater number of these establishments are far below international standards. Presently, tourism in Issyk-Kul is seasonal with a relatively high number of visitors in July and August. No significant tourist flows are noted during the other months.

6.7 Mining

The Kumtor gold mine has been in operation since 2002 and is responsible for significant changes in the landscape. The additional high volume of traffic has resulted in the accumulation of dust on the glaciers, which has the effect of greater ice melt. The transport of cyanide used in gold mining carries additional hazards in the case of an accident.

6.8 Energy

The supply of electricity is very unstable. A large part of the rural population has electricity for between 4 and 8 hr daily. Overland lines are poor, transformation stations are overloaded, and the energy provided no longer meets the growing demand. Wood is increasingly being used as an alternative energy source, which has caused the decline of forests and shrubs. Many tree plantations in the villages have been exhausted due to firewood gathering. The traditional burning of dung means that soils are not receiving much needed fertiliser.

7 Environmentally sound sustainable possibilities of use

Various solutions have been developed towards an environmentally sound and integrated approach to sustainable land use that leads to economic development. These are outlined below.

7.1 Ecologically sound agriculture

Pilot Project: production of humus from waste, drip irrigation and yak breeding on the high plains.

- optimisation of land use with different crops planted each year
- improved irrigation schemes

- balanced use of mineral and organic fertilisers
- stabilisation of the quality of the products offered
- optimisation of livestock according to species and number of individuals and grazing cycles.

7.2 Regional economic activities

Pilot Project: jam production in Cholpon-Ata

- reduction in transportation by using local products; currently practised on a limited scale
- creation of jobs through local manufacturing of raw materials such as fruits, and the regional marketing of these products
- reactivation of former trade links with Kazakhstan and Siberia
- export of processed goods to markets overseas.

7.3 Eco-tourism

Pilot Project: yurt camps in the mountain regions

- eco-tourism as an alternative source of income for local people
- scientific and wildlife watching as an alternative to trophy hunting
- development of a decentralised accommodation system (currently lacking)
- strengthening of environmental awareness of and by local people through tourism.

7.4 Decentralised energy production

Pilot Project: production of solar lamps in Karakol. Use of small water power stations for the decentralised production of electricity for use of a mill and the yurt camps.

- use of renewable energy sources such as sun, water, wind and heat
- production of electricity through small water power stations in the villages (a centralised network is not sufficiently powerful)
- 'Yurt and solar-powered lamps': a combination of tradition and modern technologies
- production of warm water through solar power in small hotels (previously practiced but inactive today).

7.5 Use of traditional technologies

Production of mare's milk for *kumys*, and felt production.

7.6 Nature conservation

Pilot Project: wildlife management and the establishment of an anti-poaching unit.

- integrated nature conservation through the concept 'Conservation through adaptive use'
- strict nature protection in the core areas
- effective enforcement of the protection regimes for endangered species.

7.7 Use of local experience

- Development of projects in close collaboration with local people.
- Integration of local people into the concrete planning of projects.
- Consideration of local priorities while implementing projects.

8 International engagement in Kyrgyzstan

Kyrgyzstan is a young country in transition. In developing the country there has been greater consideration given to the economic dimensions of development. However, Kyrgyzstan has vast and extraordinary territories of intact nature which can only be maintained by ecologically sound and wise practices.

One of the main tasks of the Issyk-Kul BR administration will be to outline and demonstrate the possible options in times of economic hardship. The economic crisis has resulted in a treasury deficit forcing the environment ministry to rely on the involvement of international organisations and investors in this initial phase of proposals for the Issyk-Kul BR.

The environment ministry of the Republic of Kyrgyzstan invites participation and help in the framework of agreement on technical and financial assistance (e.g. sponsorship or investment).

9 Global change issues and the global change in mountain regions project

The Mountain Research Initiative (MRI) and UNESCO's Programme on MAB as well as the International Hydrological Programme (IHP) joined forces to assess and monitor the impact of global change in MBRs. Many of the world's mountain ecosystems are moving along trajectories that couple high rates of environmental change with strong economic changes, whose collective effect may significantly change the ability of mountain regions to provide critical goods and services, both to mountain inhabitants and lowland communities. These issues are being addressed in a global initiative on Global Change Research in Mountain Regions whereby a network of scientists and protected area site managers use MBRs as study and monitoring sites. Issyk-Kul BR has been

selected to join the project and assist in the development of the Global Change in Mountain Regions (GLOCHAMORE) Research Strategy and to specifically implement the research strategy in Issyk-Kul BR (MRI, 2006).

During the preparation of this report it was not possible to find specific data on global change research on Issyk-Kul BR, however, there are data accumulated on different projects that highlights the overall situation related to the multidisciplinary issues of global change. Special emphasis was given to climate change research, which is only one component in the framework of scientific research relevant to global change.

10 Climate change research

10.1 Observed climatic changes

Local climate changes, particularly in mountain areas, may significantly differ from global trends. Thus, according to the Third Intergovernmental Panel on Climate Change (IPCC) Assessment Report (Watson, 2001), during the last century the global average surface air temperature grew by 0.6 + 0.2°C, precipitation grew by 5−10% in most regions at middle and high latitudes of the Northern Hemisphere. The most intensive warming was registered in the periods 1910–1945 and 1976–2000. In 1946–1975, a fall of temperature was registered. The warmest years were the 1990s, with 1998 being the warmest.

The following different climatic areas are clearly distinguished in Kyrgyzstan:

1 Northern, North-Western Kyrgyzstan (NNWK)

2 South-Western Kyrgyzstan (SWK)

3 Issyk-Kul Basin (IKB)

4 Inner Tien-Shan (ITS).

Linear trends of average monthly and annual air temperature and precipitation were estimated at 9 long-range (70–120 years) Meteorological Stations (MS) that are located in these areas at altitudes of between 760 and 3640 m.

The average annual temperature in Kyrgyzstan in the 20th century, on a 100-year time scale, has risen by 1.6°C, which is much higher than the global trend (0.6°C). The maximal warming was registered in winter (2.6°C) and the minimal in summer (1.2°C). Moreover, warming varied considerably between separate climatic zones as well as between stations within zones, that is, high-altitude zones. In NNWK, the warming range within 100 years was 0.8–2°C; in SWK 0.6–2.4°C; in IKB about 2.4°C; in ITS 1.2°C (the same at the three stations). At most stations, warming in winter turned out to be more notable than in summer. In Naryn in January, it reached 5.2°C on a 100-year timescale. Trends of annual temperature values for seven out of nine stations are statistically significant, with 99% confidence probability, which means that temperature rise has exceeded the limits of random variation.

Overall, in the twentieth century precipitation in Kyrgyzstan increased insignificantly by 23 mm, or 6%. In three climatic areas, on a 100-year timescale, annual precipitation increased: in NNWK by 31–93 mm (6–22% of normal precipitation); in SWK by 61–239 mm (16–32%); in IKB by 5–60 mm (to 2%). In the ITS, which occupies a considerable part of Kyrgyzstan's territory, the level either remained virtually the same

(MS Naryn, increase by 11 mm/100 years) or considerably decreased by 126–167 mm over the past 100 years, which is 41–47% of the norm (Issyk-Kul, Suusamyr, Tien-Shan). At about half of all stations, annual rate was statistically significant with 99% confidence probability. Thus, for the pornographically complex mountainous territory of Kyrgyzstan, instrumental observation registered a considerably higher warming than the global average – annual temperature in the twentieth century rose by 1.6°C with changes on the territory in the range of 0.6–2.4°C. Annual precipitation totals on average have undergone minor changes (23 mm, or 6%, increase). However, there is a distinct trend towards a rise of 1–2 mm to 20–30% in all climatic areas in Kyrgyzstan, except for the ITS. Here, in the high-altitude zone, precipitation notably decreased in some places (by 41–47%), which considerably enhanced the aridity of the area.

10.2 Expected climate changes

The current knowledge of science does not yet enable to forecast the climate even within one century. The scenarios in this report were designed on the basis of Global Climatic Models (GCM). Spatial resolution of the models reaches 250 km horizontally and 1 km vertically. According to the IPCC, in general the quality of climate projections with a GCM can be considered if not yet satisfactory, then at least encouraging certainly in the context of a sub continental climate and from seasonal to inter decade resolution. None of the models and climatic scenarios may be declared the best in terms of the high probability provided. It is essential for each area to have a number of climatic scenarios describing the whole range of possible future climatic conditions. For estimating climatic scenarios in Kyrgyzstan for the period up to 2050 and 2100, MAGICC/SCENGEN software, recommended by IPCC, was used. The software helped to define 12 scenarios corresponding with 3 Gems with various sensitivity levels, and two options of greenhouse gas emission scenarios (IS92a – moderately high emissions with doubled CO2 concentration by 2100, and IS92c – moderately low emission with a 35% concentration increase).

It is worth emphasising that the climate scenarios should be used with caution considering a range of possible prospective climatic conditions. Annual warming could be between 1.8°C and 4.4°C, and annual precipitation may vary from a small reduction (by 6%) to significant growth (by 54%). However, if a single scenario had to be chosen, a preliminary expert assessment for the entire territory of Kyrgyzstan by 2100 would state that it is reasonable to expect an average annual temperature increase by 2.5–3.0°C, and an increase in annual precipitation by 10–15% compared to normal precipitation in 1961–1990. This corresponds to climatic changes registered in 1900–2000 and the average scenario assessment of climatic changes by 2100 according to global climate models. In the future it is necessary to conduct a more precise evaluation of perspective climate changes in Kyrgyzstan on the basis of a more comprehensive consideration of local mountain conditions of its territory.

11 Vulnerability assessment and adaptation

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

11.1 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 pornography – not taken into account by Gems – 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 autumn 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.

11.1.1 A climatic scenario

11.1.1.1 Thermal resources *NNWK*: the boundaries of thermal belts will shift upwards by 200–400 m at the altitude of 600–1400 m compared to the existing ones. At the altitude of 1600–2600 m the boundaries of thermal belts will not change.

North-Eastern Kyrgyzstan: the boundaries of thermal belts in the western part of the IKB will shift upwards by 200 m at the altitude of 1600 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 IKB at the altitude of 1600–2600 m will not change compared to the existing ones.

ITS: the boundaries of thermal belts in the northern part of the Tine-Shan region will shift upwards by 200 m at the altitude of 1600 m. The boundaries of thermal belts at the altitude of 1800–2400 m will not change. The boundaries of thermal belts in the central part of the Tine-Shan region will shift upwards by 200–400 m at the altitude of 1200–1800 m, whereas at the altitude of 2000–2800 m they will not change. The boundaries of thermal belts in the south-eastern part of the ITS will not change at the altitude of 2800–3000 m.

SWK: the boundaries of thermal belts will shift upwards by 200–600 m at the altitude of 600–2400 m. At the altitude of 2400–2800 m the boundaries of thermal belts will not change.

11.1.1.2 Moisture resources According to the moisturising scenario an increase in annual precipitation by 17% throughout all four climatic zones is possible. Moreover, the greatest increase in precipitation will occur in the summer in Northern, North-Western, SWK and in the ITS. In North-Eastern Kyrgyzstan the biggest amount of precipitation is expected to occur in the autumn.

11.1.2 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 Table 1.

Table 1 Demographic development in the Kyrgyz Republic until 2100. Population by the end of the period (in thousands)

Year span	*Population (in thousands)*	*Growth rate (in %)*
2000–2010	5444	1.5
2010–2020	6344	1.5
2020–2030	7267	1.4
2030–2040	8192	1.2
2040–2050	9040	1.0
2050–2060	9986	1.0
2060–2070	11,031	1.0
2070–2080	12,185	1.0
2080–2090	13,460	1.0
2090–2100	14,868	1.057

11.1.3 An economic scenario

For assessment of macroeconomic 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.

Taking into consideration the inferences above another conclusion can be drawn namely that climate change will be favourable for hydro-electric engineering. An increase in annual flow will enlarge its potential. 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 Hydro-electric Power Stations (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.
- Hydropower, 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 worldwide 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 trend.
- Increasing the share of ecologically cleaner fuels.
- Working out a development strategy for motorised transport, especially public transport.

11.2 Population health

A significant amount of research is known 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 in the Kyrgyz Republic. This research is not complete, since the impact of other factors was not taken into account.

11.3 Non-infectious diseases

A significant correlation between the rate of urolithiasis (the process of forming stones in the kidney, bladder and/or urethra or urinary tract) 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 seven 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. Based on long-term observations, an average annual temperature in the south is 11.7°C and in the north 4.9°C.

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 calls in Kyrgyzstan could be more than 1%. Research into embryo development pathology has shown that if the temperature changes our sharp retarded development occurs. The most serious damage is observed in the period when major embryo organs and systems are formed. Research conducted in Issyk-Kul has shown that a high temperature, even if it is short lived, may lead to a negative impact on a foetus if it coincides with critical stages of gestation. This pressure is first of all connected with a decrease in oxygen partial pressure during the hot time of the year, which may result in foetal hypoxia. The research has also shown that the perinatal death rate for both at-term and prematurely born infants are higher if they were conceived during the period from July to August. Review of the research has shown that the expected climate change may cause an increase in common illnesses, cardiovascular and broncho-pulmonary pathology, skin diseases and trauma rates. The mortality rate from ischaemic heart disease may increase (particularly for elderly people).

11.4 Infectious diseases

The expected climate change (increase in temperature and precipitation) will lead to an extension of the geographical distribution and incidence of infectious diseases: transmissible infections (malaria); tropical fevers; enteric infections (salmonellosis, escherichiosis, cholera, etc.); parasitic diseases.

At the present time the southern regions of the Republic have a higher temperature and account for a greater proportion of infectious diseases – 30% higher than in the north. The research on association of enteric disease rates with the environmental temperature, taking Bishkek as an example (1999–2001), has shown that under the expected climate change the average increase for the entire Republic may be more than 8%.

The territory of the Kyrgyz Republic lies within the zone where malaria is prevalent. Taking into account the average warming and increase in precipitation, the area in which mosquitoes can spread malaria will increase. Simultaneously, the warm periods will become longer, which will result in extended activity of mosquitoes. All this may lead to a dramatic increase in malaria rates unless stringent preventative measures are taken.

Along with warming and active transboundary access the danger of bringing mosquito-born Hemorrhagic Fevers (HF) into the territory of Kyrgyzstan increases – Dengue HF, Chikungunya HF, yellow fever and so on.

Data is available about the extension of natural plague breeding grounds. The study of newly found breeding grounds has shown that plague pathogens have taken root in the middle mountains and foothills with an active involvement of mouse-like rodents and their fleas. At the present time land that can harbour plague accounts for 16.3% of the Republic's territory.

11.5 Archa-tree forests

As a result of the increase in the sum of above zero temperatures there may be a boundary shift of the habitat zones for every type of archa tree (Zaravshan, semi-spherical and Turkestan) by 2100, each of which has its own preferred altitude. Thus, an increase in the sum of above zero temperatures at an altitude of 1600 m and in the duration of the growing season from 33 to 40 days all types of archa tree will move up by 150–200 m. Nevertheless, the area under archa forest cover might fall by 2100 because of high morbidity and low seed bearing (non-climatic factors).

11.6 Nuciferous forests

At an altitude of 1400–2300 m in the south-west of Kyrgyzstan there may be a bioclimatic productivity increase in areas with sufficient water availability. In dry steppe and semi-desert regions at an altitude of 800–1400 m (pistachio savannoids and amygdaloids) bioclimatic productivity will remain virtually unchanged, and may only worsen as a result of a human induced factors. Generally, walnut trees could move up by 100–150 m in response to an increase in the sum of active temperatures, an increase in water availability and in the duration of the growing season by 30 days. However, the influence of age structure (ripe and overripe forests account for 60%) and human factors has not been taken into consideration.

11.7 Adaptation measures

In the context of human pressures and intensive recreation, the forest ecosystem of Kyrgyzstan could be preserved most of all as a result of organisation and expansion of BRs. By 2100 the forest covered areas should be restored to 340,000 ha, which is 6% of Kyrgyzstan's territory. For this to occur, 3400 ha of different kinds of trees will have to be planted each year.

In order to preserve forest ecosystems in a sustainable manner it is necessary to conduct an inventory of species and intraspecies diversity along with a single methodological approach and a well developed method of forest genetic resource assessment. Another major way of sustainable preservation of forest ecosystems, as well as an improvement in natural resource management, is to carry out poverty alleviation actions among the population. It is essential for local communities to participate in decision making as far as their access to forest resources is concerned, based on community forest use. In addition to measures of preservation and development of natural forest systems, the development of cultivated plantations, for instance industrial poplar plantations (up to 10,000 ha annually) are required. Finally, subordinate legislation and implementation provisions will have to be worked out for the Forest Code (adopted in June 1999), the National Forestry Development Vision and the National Forest Programme.

Assessment of strategies and measures of mitigating the impact on the climate:

- coordination of efforts with different countries in the sphere of GHG emission reduction, including trade in emissions quota
- access to information, to advanced technologies and to financial resources
- public information campaigns about the problems of climate change and involvement of the public in solving these problems
- support of scientific and applied research and of human resource development.

11.8 Specific mitigation measures

11.8.1 Energy production

GHG emissions from energy production constitute about 35% of the total GHG emissions. Considerable potential for GHG emission reduction is concentrated in this sector. The development of a fuel and energy sector, which provides for maximum energy independence of the Republic, as well as sufficient and stable energy supply to consumers, represents the major goal of the Kyrgyz Republic's energy policy. This policy envisages:

- *In the electricity branch*: further development of the river Naryn's hydro-energy potential by constructing the Kambaratinsk HPS with a total capacity of 2260 MW; implementation of the Development Programmes for HPS and Non-Traditional Energy Sources (NTES) that provide for the reconstruction of the existing cascade of Alamedin and Kemin small HPS; rehabilitation and reconstruction of other small HPS with a total power of 10 MW and the output of 84.6 million kWh; construction of several new small HPS with a total power of 68 MW and output of 281 million kWh; installation of photo-electric cells

with the power of 2–3 MW and output of 5.3–7.9 million kWh; micro HPS with a total power of 2–2.5 MW and output of 8.6–10.8 million kWh; wind energy parks with a power of 1.0–1.2 million kWh.

- *In the coal industry*: by the year 2005, an increase of coal mining activities by up to 80% due to an expansion of open coal mining at the lignite deposit of Kara-Keche, and increase by up to 30% of mining rate of existing coal enterprises.
- *In the oil and gas industry*: by the year 2005, increase of oil extraction to 190,000 tonnes and natural gas to 30 million m^3, whereas the need for gas is 800 million m^3.

The development of Kyrgyzstan's hydro-energy and NTESs is of considerable interest, both for energy sector development and simultaneous GHG emission reduction. The main reasons are their renewable nature coupled with their current low utilisation rate, their obvious ecological advantages in comparison with non-renewable fuels, and the high potential capacity of the country's main rivers.

A thoroughly planned policy to develop its energy sector would allow the Kyrgyz Republic to become the biggest electricity producer in the region. The industry would not only be able to fully meet the current electricity needs of the population, but also allow for a switch to all-electric cooking and heating, thereby replacing the organic fuels, which currently take up the greater part of energy consumption. Due to the strict policy of energy saving and the introduction of new technologies it should be possible to keep the growth in energy consumption below the growth of GDP. In the future, considerable shifts in the structure of energy use are expected to take place due to the increase of the electricity share from 24% in 1990 to 55% in 2020. The share of natural gas will decrease from 22% to 12% by 2005 and to 10% in 2020. The share of residual oil will also drop sharply from 12% in 1990 to 1% in 2020.

Two basic scenarios of energy production are being elaborated within Kyrgyzstan's development programme, they are: scenario (A) gives priority to the development of the hydro-energy sector and other renewable energy sources, while scenario (B) concentrates on the development of the (non-renewable) fuel-energy sector aimed instead at the increase of coal mining activities and the expansion of the thermal-electric share in energy production. Comparative evaluation of GHG emissions under both scenarios demonstrates the efficiency of the energy sector development under the scenario (A).

The reduction of GHG emission requires the following actions to be undertaken:

- transition to the use of renewable energy sources, reduction of low-grade coal import, increase of energy efficiency by modernising fuel combustion systems, reduction of fuel use in the heat and energy production
- introduction of a strict energy saving policy; strengthening of monitoring and control systems; reduction of non-technical losses in fuel and energy use
- elaboration of legal mechanisms that stimulate consumers to save energy and increase the use of non-traditional and renewable energy sources
- scientific and applied research on development and implementation of new energy and resource saving technologies; GHG abatement technologies, modern means of GHG emission capture and instruments of GHG measurement

- public awareness and communication on the ecological and social consequences of climate change, and about measures that are being undertaken against it, as well as the involvement of the public in the implementation of these measures.

11.9 Assessment of strategies and measures of mitigating the impact on the climate

11.9.1 Buildings and other structures

The heating of buildings accounts for 13–30% of the total GHG emissions in the Kyrgyz Republic. By the year 2000, the volume of construction fell by 90% compared to 1990. The buildings currently being constructed do not fully meet the construction requirements with respect to energy efficiency and energy conservation. Traditions, social barriers, lack of finance and almost complete absence of the technologies recommended for the reduction of waste and GHGs represent major barriers that hamper full-scale realisation of the potential for energy efficiency increase.

The following main measures are recommended:

- built-in autonomous systems of solar energy supply
- integrated building solutions aimed at energy efficiency increase
- improvement of construction standards and control systems that monitor the application of these standards in the buildings that are under construction.

11.9.2 Transport

The transportation sector, especially its automobile part, accounts for about one third of the total GHG emissions. Motor vehicles make up to 90% of all internal freight and passenger traffic in the Republic, and they are expected to become the preferred mode of transport for all kinds of freight. The exploitation conditions of the vehicle fleet (mountain landscape, poor quality of the roads, deterioration of vehicles etc.) account for the increased GHG emissions. Therefore, the reduction of GHGs from the transportation sector represents one of the primary tasks in the overall GHG emission reduction policy. Low-cost measures could be very effective in this sector. For example, the introduction of a new, locally patented system of electronic ignition that costs about $20 for each consumer could ultimately save up to 15% on fuel and will reduce up to 30% of GHG emissions. The start-up for the production of this device could begin at one of the currently inactive machine factories that have all the necessary equipment and some initial capital.

Other measures of GHG emission reduction include:

- enhancement of state governance and control over the automobile transport sector aimed at GHG emission reduction
- development of public transport and the road network
- fuel cell automobiles
- hybrid electro-mobiles.

11.9.3 Industry

Kyrgyzstan's industry accounts for about 4% of GHG emissions. In recent years this figure has dropped to 1.2% and no significant increase of GHG emissions from this sector is expected in the future. Nevertheless, the industrial sector has great potential for GHG emission reduction.

Such measures should include:

- reduction of energy use and GHG emissions due to the introduction of energy saving technologies and reuse of secondary raw materials and waste
- enhancement of storage and utilisation of materials that replace halogen containing substances; use of alternative technologies and materials with low GWP
- optimisation of industrial processes.

11.9.4 Agriculture

The contribution of agriculture to the emission of carbon dioxide has grown from 7.3% in 1990 to 17.3% in 2000. Reduction of carbon dioxide emissions in agriculture can be achieved through the discontinuance of agricultural waste combustion. In the total structure of methane emission, agricultural methane emissions have grown from 50.4% in 1990 to 65.3% in 2000. Here, methane emission reduction is possible through the enhancement of manure storage systems. The share of this sector in total methane emissions constitutes up to 10.5%.

Measures of GHG emission reduction include:

- development of biotechnologies for crop yield increase (including energy crops)
- discontinuance of agricultural waste combustion
- use of manure for biogas and fertilisers
- expansion and enhancement of informational and educational services to farmers
- facilitation of seed-growing and cattle breeding, as well as adequate provision with modern equipment and fertilisers
- strengthening of state inspections
- enhancement of land cultivation systems in agriculture to decrease energy consumption and prevent soil erosion.

11.9.5 Waste

Annual methane emission of 34–112 Gg constitutes 25–39% of the total GHG emissions. If the emissions from manure storage systems in agriculture are added, then the total share of methane emissions makes up 33–45% of the total GHG emissions and reaches 130 Gg a year, which corresponds to the country's 10% forecasted natural gas needs in 2020.

Methane capture from waste and manure storage systems with biochemical methods will not only reduce GHG emissions but also will simultaneously provide farms with fuel and secure organic fertiliser.

The following measures need to be undertaken:

- stimulating systems of collection, sorting and processing of domestic and agricultural waste
- supporting scientific research in the sphere of waste processing
- strengthening government control.

11.10 Assessment of strategies and measures of mitigating the impact on the climate

11.10.1 Development of links

The development of links is an important element in the National Climate Strategy. Kyrgyzstan's forestry sector is connected to the regulation of land use and other macroeconomic strategies that facilitate the use of forest land for other types of land use (e.g. farming, pasturing and manufacturing).

Planting new trees in existing forests and creating new woods are important for carbon uptake. The National Forestry Strategy envisages an increase of forestland of up to 6% by 2025. Rehabilitating forests, planting new trees, increasing forest density and productivity and reducing illegal tree cutting are expected to lead to a 50% increase of CO2 sinks.

The potential of forest rehabilitation and planting in Kyrgyzstan is estimated at about 1200 ha. If the planned measures are carried out, then the total CO2 sink in forests will amount to about 1336 Gg a year, 30% of which will be attributable to afforestation, and 70% to existing forests. Beside the rehabilitation of natural forests, the development of industrial plantations of fast-growing trees such as poplar is promising for Kyrgyzstan.

11.10.2 Evaluation of basic GHG reduction measures

The lack of financial resources could jeopardise the implementation of these measures therefore the country should try to involve all interested parties, including domestic and foreign investors. Analysis of the data reveals the significant potential of GHG emission reduction if these measures are actually carried out.

Taking into account all the above mentioned points it has to be stated that the same challenges are faced in Issyk-Kul BR due to the many industrial enterprises operating within the buffer zone inevitably creating pressure on the natural ecosystems of Issyk-Kul BR.

The Issyk-Kul BR management is ready to cooperate in the implementation of projects related to the critical issues of global change with particular emphasis on gaps that still need to be covered.

11.11 Brief description of the INDOEX project

Another project conducted in the Kyrgyz Republic was carried out by a group of scientists within the framework of the International Science and Technology Center and dedicated to the study of optic and microphysics characteristics of atmospheric aerosol using laser sensing in the Central Asia region.

At present the anthropogenous offloading onto the natural environment continues to rise leading to magnified pollution of the air basin in particular. With this in mind, the looming ecological crisis has become one of the crucial concerns of everyone in the region. For some regions it has already become a terrible reality. An example of such a crisis is the Aral disaster in Central Asia that has evidently demonstrated the results of poor and irrational utilisation of the natural resources. As a result the annual storms remove millions of tons of harmful saliniferous dust from the dehydrated sea bottom which is transported over great distances and deposited on an underlying surface. Such negative natural-climatic changes have caused serious ecological harm that not only influences this region but many others as well and whose unfavourable environmental impacts affect millions of people.

Another of the greatest challenges faced this century, if not *the* major challenge, is the Atmospheric Brown Clouds problem. Up until quite recently these clouds were mistakenly considered to be bound by the limits of urban regions (e.g. the Denver brown cloud in the USA). Recent studies and satellite data demonstrate that as a result of a long-distance transport the brown clouds (or brown gas) spreads over vast territories including whole continents and oceans. Outcomes of the special experiment (INDOEX) held in the Indian Ocean in February 1999 have shown that 'the brown cloud phenomenon' in Asia, or as it is now called the 'South-Asian Brown Cloud' covers the majority of the Arabian Sea, Bengal Gulf and South Asia, approximately equal to the USA territory in size. Transported over long distances, the brown gas that was usually linked only with urban regions now envelops the entire continent and the oceanic basin. Recent data from a NASA satellite has shown that the aerosol pollutants extend over the vast regions of the world. These phenomena are called the 'South- and North-American Brown Cloud', the 'Asian Brown Cloud' and the 'African Brown Cloud'. The brown gas consists of a mixture of particles of anthropo-genous sulphates, nitrates, organics, black carbon, dust, volatile ashes and natural aerosols such as sea salt and mineral dust. The brown colour is a consequence of absorption and scattering of the solar radiation by the anthropogenous black carbon, ashes, particles of saline dust and nitrogen dioxide. The black carbon strongly absorbs the solar radiation. The screen effect is also greatly promoted by other anthropogenous aerosols (sulphates, organics, nitrates, ashes) strengthening the radiating activity of an underlying surface by two or more times compared with a cloudy sky. The aerosols also magnify the repulsion of the solar radiation adding to the cooling effect of an underlying surface – 'indirect action'. Simultaneously, the aerosols moderate a fraction of the direct solar radiation on an underlying surface and enhance a fraction of the scattered – 'direct action'. The negative impact (cooling effect) of the aerosols can be compared with the 'positive' activity of the greenhouse gases. The major difference here is that the greenhouse gases affect distribution globally while the aerosol-radiative effect is regional. Another difference is that the aerosol impact is negative on an underlying surface and positive in the atmosphere (absorption of the solar radiation by black carbon). Thus aerosols promote asymmetrical variations particularly between the atmosphere and an underlying

surface. In addition, while an increase of precipitation is supposed to take place as an effect of global warming, the huge negative impact of aerosols might bring about a reduction of precipitation.

Available estimates demonstrate that, even if the crystalline carbon content in atmospheric compounds share only a few several millionth of its content in the form of carbon dioxide, and productivity of its formation processes is much less than productivity of the carbon dioxide sources, it might result in incomparably greater effectiveness of the sooty particles in the radiation processes than of carbon dioxide, which is believed to play an especially important role in climatology.

The developing countries in Asia, Africa and Southern America have now become major sources of the aerosol problem particularly black carbon emissions. This especially concerns Asia where the brown gas is particularly dense and extensive during a continuous dry season (from November to May) resulting in an increased vulnerability of the regional population because of the negative impacts of the brown gas on the hydrological cycle, agriculture and health.

The Aral Sea catastrophe, Atmospheric Brown Clouds (brown gas) and other examples on a similar scale prove that the ecological security is in line with the basic strategic components of national security and has become a major issue of national priority.

The results of the studies held on the optical and microphysical parameters of the atmosphere aerosol by a lidar sensing in the Central Asian region are classified. The studies have been undertaken within the framework of the International Science Technology Center Project KR-310 during 2000–2003 at the multiwave lidar complex in Teplokluchenka in Central Tien-Shan.

11.12 Information on the regional models of the atmospheric aerosol

The models are designed on the basis of the experimental material obtained within the framework of project implementation. The regional models are introduced as analytical expressions describing the distribution of the aerosol's optical and microphysical parameters by height. Thus, in essence, the represented models are experimental-analytical.

Resume: the equipment used during this project is capable of producing a broad spectrum of data relevant to global change issues. For example, the long term monitoring of glaciers could be conducted. The data accumulated using this equipment could be analysed during the development of strategies not only on environmental issues but also social and economical issues pertaining to global change.

11.13 How will Issyk-Kul BR be able to implement the GLOCHAMORE research strategy and what is required for its implementation?

First of all it has to be stated that there is a potential in the Kyrgyz Republic to implement the GLOCHAMORE research strategy mainly thanks to its human resources. There are many qualified scientists and experts capable of implementing the research strategy. International organisations are today focusing on ecological problems with special emphasis on social and economic development. On-going projects show the potential and readiness to contribute to the international process as concerns global change issues.

Issyk-kul BR is one of the world's rare ecosystems of the world's importance and development of project proposals to international organisations and donors undoubtedly assist to the implementation of GLOCHAMORE Research Strategy.

However, there are several critical issues that have to be addressed for the most efficient implementation of goals laid in the research strategy. They are the following:

- lack of financial resources to conducts long term monitoring at existing Meteorological Stations
- lack of international projects and initiatives for the development of legislative bases on ecologically sound land use
- implementation of multidisciplinary projects on chain: glaciers, vegetation, soils and human beings.

12 Future steps

Development of unified research strategies for scientists dealing with global change issues in the Kyrgyz Republic. Creation of the Scientific, Information and Educational Center under the auspices of the National Academy of Sciences of the Kyrgyz Republic to address multidisciplinary researches pertained to global change.

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Notes

[1]The term 'Biosphere Territory' is meant in the same way as the term 'BR'. In Russian the meaning of 'Reserve' is connected with a state of conservation which is forbidden any use. Aims and tasks of a BR in the meaning of the UNESCO are not as strong.

[2]The term 'Oblast' refers to a Kyrgyz administrative unit.