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THE MOUNTAIN ECOSYSTEMS ASSESSMENT AS A MECHANISM IN THE DEVELOPMENT OF SUSTAINABLE USE OF WATER RESOURCES AND RATIONAL MANAGEMENT OF BIODIVERSITY IN CENTRAL ASIA

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Introduction

Ecosystems provide goods and services required for a happy existence and development of the mankind. But these very ecosystems, their ability to maintain services, depend on the condition of the environment, in particular, on the sufficient volume of water, ensuring their proper functioning. The Millennium Ecosystems Assessment concentrates on the issues of interaction between the services of ecosystems and well-being of people, between their changes and human development as well as on the development of politics at the local, national and global levels to improve the ecosystems management and, consequently, contribution to the well-being of people and poverty reduction. The assessment of ecosystems helps:

- ✓ to improve understanding of links between the ecosystems and well-being of people;
- ✓ to demonstrate the ecosystems potential in poverty reduction and improvement of well-being;
- ✓ to assess compatibility and comparability of policies, pursued by institutions and enterprises in various scopes;
- ✓ to unite economic, environmental, social and cultural trends;
- ✓ to unite information, natural and social sciences;
- ✓ to select politics and management for sustainability of services of ecosystems and their harmonization with human needs; as well as
- ✓ to enhance integrated management of ecosystems.

The Central Asian region is situated in the heart of the Eurasian continent and occupies the territory of 3882 thousand km.² Its population exceeds 53 mln. people. It includes the Republic of Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Turkmenistan and Republic of Uzbekistan, which made a part of the USSR till 1991. Plenty of warmth and sun energy, a rather fertile soil create favourable conditions for the agricultural development. Water resources and natural ecosystems, maintained by these resources, play a special role in the development of the region and solution of issues of its economic development. Water resources of the mountain rivers are used to irrigate and water the lands. Especially large areas of irrigated lands can be found in the middle current and lower courses of the rivers of Amudaria, Syrdaria, Zarafshan, Talas, Naryn, Ili, Chu and submontane plains. Natural conditions are favourable for pasture cattle-breeding, an expanded river network and plenty of artificial reservoirs enhance the development of industrial fish-breeding. From the second half of the 90-s the region has been witnessing the growth of agroindustrial complex (in Kyrgyzstan by 9%, in Tajikistan by 4%, in Turkmenistan by 26%, in Kazakhstan by

29%), the structure of sown areas is being modified: Turkmenistan sees the growth of areas meant for grain; areas meant for orchards, melons and gourds and vegetables expand in Uzbekistan. Kyrgyzstan and Uzbekistan see the growth of major cattle-breeding products. Central Asia is known for its unique landscapes, rich diversity of flora and fauna. The region is characterized with its in-land location in the heart of the Eurasian continent which affects the entire physical-geographical character of the territory, peculiarities of its hydrography, flora and fauna. On the whole, the natural-climatic zonality can be well traced here. Central Asia is peculiar for its aridity, affecting the vulnerable character of its ecosystems. The region is situated in a single environmental space of closed basins of the Caspian and Aral seas, in-land lakes of Balkhash, Issyk-Kul which, combined with the arid climate, sets certain environmental limitations on the economic activity and trade. Well-being of the countries in the region in many respects depends on the natural equilibrium of the zones where rivers take birth – mountain systems of Pamirs, Tien Shan and Altai. High mountain systems take moisture from the top layers of atmosphere, transported by air masses mainly from the Atlantic Ocean, and serve as giant accumulators of potable water. They account for almost the entire volume of water flow accumulated by the Aral Sea basin. But the mountains in the region face growing degradation such as deforestation and erosion, pollution and reduction of pastures. As a result, the hydrological regime is being destroyed and water resources get exhausted. Destruction of water systems has entailed a significant reduction of biodiversity. Losses are especially significant in the water and close to water ecosystems where both large animals and complexes of plant associations and invertebrates, linked to them, have suffered. In certain cases these processes have become irreversible due to the regulation of water flows which, combined with the pollution, brought to reduction of fish stock and now endangers a number of local endemic species and subspecies of fish. On the whole, for the period from 1990 catch of fish from natural reservoirs has decreased by more than 60%.

Central Asian states have developed a certain potential to strengthen cooperation in the field of joint management of water resources which are a decisive factor for the development and safety in the region. Heads of states made a number of important decisions, established regional organizations, launched joint programmes and projects. The countries of the region are actively cooperating with international programmes, are members of many international and regional organizations, parties of major international environmental treaties in biodiversity, climate, desertification and others. But it should be noted that the present legal framework between the countries as well as between the region and world community do not enable to use both their own potential and possibilities of the world community to the maximum. To address environmental issues, to ensure sustainable development and security it is required to develop a new framework for intersectoral and regional cooperation and strengthening of the potential.

Assessment of mountain ecosystems in Central Asia

(preliminary review)

The 1992 UN Conference in Rio-de-Janeiro acknowledged significance of the mountain ecosystems for the future of the mankind, which initiated changes in the perception and attitude to the mountain territories in the consequent years. Since mid-1990s Central Asia has seen growing international cooperation in the field of mountain issues. Presently there are the following projects being implemented in the region and related to the mountain ranges and preservation of their biodiversity: Global Environmental Facility/WB project related to preservation of biodiversity of Western Tien Shan, GEF Nuratau-Kyzylkum project, International Snow Leopard Salvation Foundation and NABU projects, Swiss government projects for forests in Kyrgyzstan and others. To establish intersectoral cooperation and to develop a strategic vision of joint actions, in 2000-2001 the Regional cooperation for sustainable development of mountain territories in Central Asia project was implemented with the support of ADB and Government of Switzerland. With the CAREC expert and financial support, in 2002 there was developed a draft Regional strategy of sustainable development of mountain regions. This strategy and decisions of the World Mountain Summit (Bishkek, 2002) served as a basis for the development of an assessment programme of

mountain ecosystems in Central Asia, initiated and supported by the Millennium Ecosystems Assessment. This programme is aimed to assess the present resort human and natural potential of the mountains, to develop and introduce methods of sustainable use and management of resources of mountain ecosystems.

Significance of mountain territories of the region

(Determining the value of services, provided by the ecosystems)

In the history of nature and culture mountain ranges have played a dual role: as centers of origin of cultured organisms and as natural isolated shelters for ancient biological and cultural-historic relics. Being situated, mainly, in the periphery of countries and regions, mountains still serve as a source of natural resources for the development of plain territories: water, electric power, agricultural products, timber, minerals, and are used for invigoration and recreation. Many plant cultures, being the basis of agriculture, originate from the mountainous countries. Centers of origin of cultured plants lie in the breeding grounds of livestock. Apparently, the sources of development of economic forms and differentiation also relate to mountain regions because the division of labour is stipulated by the diversity of composition of natural benefits, their variety, typical for mountain regions. Thus, the role of mountains as a cradle of human civilization is incontestable. Till now mountain regions keep playing a determining role in the development of human civilization as key regions of preservation of biodiversity, centers of the richest endemism of plants and animals and regions of formation, refinement and supply of potable water to the plains. All the abovementioned facts to a great extent concern mountain areas of Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan.

Environmental-economic significance

From the environmental viewpoint, mountain ecosystems provide numerous supporting services, including formation of water resources and regulation of their quality, biological diversity, feed cycle and soil fertility, atmosphere and climate regulation, protection from heavy showers and storms and prevention of erosion. Mountains bear a great environmental significance for regulation of many natural processes in the region.

- **Generating air.** Forest ecosystems, concentrated in the mountains of the region, affect the quality composition of the air.
- **Regulating climate**. Mountains affect the climate directly, being involved in the atmosphere processes, and indirectly, regulating the water resources. They regulate climate both at local, regional and subregional levels.
- **Regulating water**. Glaciers and mountain snowfields condense major water stock and are the sources of numerous rivers, including those of regional and subglobal significance: Amudaria, Syrdaria, Ili, Chu and Sarydjaz. Location of water-bearing layers in the mountain regions, degree of fixedness of slopes, their common morphology, geological structure actively affect the condition of a water regime in the mountains, foothills and plains. Mudflows take place due to the destruction of ecosystems and objects of social infrastructure.
- **Regulating soil**. Mountains supply plains with fragmental and sedimentary material, weathering, wash-out and water erosion products.
- **Erosion control**. Mountain plants play an important role in securing soil and prevention of landslides and mudflow processes.
- **Seismic processes**: Epicenters of most earthquakes lie at the frontiers of tectonic plates in mountain areas (Darvaz, Kuhistan, Northern and Western Tien Shan, Badahshan, Alay, Kopetdag) because of a hyper tectonic activity in the areas of Alpine folding. Earthquakes strongly affect the ecosystems and social infrastructure.
- **Water refinement and pollution**: Mountain rivers are self-cleaning. Altogether, they may carry the products of erosion of burrs or ore minerals, containing substances and elements, negatively affecting human beings (Sarydjaz river) or surrounding ecosystems.

- **Biological diversity preservation**: A landscape zonality of mountain areas provides for a better biological diversity than in the plains. Many mountain areas are refugiums of ancient flora and fauna, centers of endemism. The processes of speciation, forming are more intensive in the mountains thanks to the spatial and environmental isolation. In many respects thanks to the mountain regions, Central Asia is one of the world centers with an extended biological diversity. Biological diversity also ensures a new material for selective work to maintain many kinds of plants and species of domestic animals. Mountains of the region are centers of origin of species of domestic animals and plants (genetic diversity preservation).
- **Pollinators**: Mountain ecosystems in the region are the largest reserves of various pollinators (bees, lepidopterous, dipterous, coleopterous and others), playing key role in the maintenance of plants stability.
- **Feral herd diseases**: Some especially dangerous feral herd diseases causing epizooty and epidemics, in particular, are related to mountain areas. A number of feral herd diseases takes place due to water transfer (cholera, typhoid, hepatitis A). Damp biotopes, dead and weak reservoirs may be both a source of infection for domestic animals and people and a reserve for bloodsucking parasites and other carriers of diseases.

Social-economic significance

Mountain regions have a great social significance and ensure living and development of many millions of people both in and beyond the region. Mountain ecosystems supply crucial natural resources and services. They are specified as provided services, including potable water, food, fiber, timber, fuel, etc.

- **Mineral resources**: metal and non-metal mineral resources, ores, raw material for construction, chemical industry, power engineering (coal).
- **Hydroenergetic resources**: electric power obtained by hydroelectric stations.
- **Potable water**: most of it can be found in the mountains and used as potable water as well as for industry and agriculture.
- **Mineral drugs**. Mineral waters, muds, salt, clay are used locally and sold throughout the region.
- **Food**: Agricultural products and non-timber products are widely used in mountain areas of the region.
- **Agricultural nonfoods**. Filoselle (sericulture product), wool, leather (cattle-breeding products), wax (beekeeping product).
- **Agricultural fodder**: grassy fodder of natural haymaking and fodder crops, grain and chaff, tuberous and water-melon fodder, pastures.
- **Timber**: Construction wood, agricultural and other wood products.
- **Fuel**. Wood, excrement of agricultural animals.
- **Genetic resources**. Ancestor forms of many fruit-trees (apples, pears, apricots, plums, cherries, walnuts, pomegranates, persimmons), grains (rye, wheat, barley) and decorative crops. A number of local plants are used to breed and enrich the gene pool of decorative crops (tulips, narcissi, gladioluses, peonies, leeks, etc.). Some regions are centers of origin of valuable species of domestic animals.
- **Biochemical, pharmaceutical resources and medicinal plants**. Many mountain plants of the region contain chemical substances, serving as a basis for drugs production. A great number of medicinal plants and fruits of the region are stored to be directly used as decoctions, tinctures, powders, etc. Snake venom, venom of some spiders and insects is also used to produce medicinal and experimental chemicals.
- **Hunting and fish resources**. Many species of wild animals: mammalian, birds and fish are traditionally used in local economics as shoot and catch objects. They hunt game (wild goats, wild boar, roe, fox, marmots, hares, badgers) and birds (black grouse, keclick, ular,

partridges, pheasants, etc.) in the mountains. There is a growing interest in currency-trophy hunting and traditional ways of hunting with falcons, hawks and golden eagles.

- **Decorative resources**. Natural resources of the mountains serve as a basis for decorative flower-growing, amateur collecting and room design. A number of dyes, extracted from plants, serve to manufacture fabrics and carpets, tissue and felt elements of the traditional houses and clothes.
- **Products of traditional folk and artistic crafts**. Wood and mineral products, wool and leather articles, metal and traditional decorations made of natural stones.

Spiritual-cultural significance

The mountains of the region are crucial for spiritual and aesthetic development of communities, serving as an important non-material basis for cultural growth, science and recreation.

- **Social relations**. Diversity of mountain ecosystems has predetermined the formation of two types of specific cultures: nomadic cattle-breeding and settled agricultural. Representatives of the both cultures have been historically interacting through the development of a common market and commodity-money exchange, forming various ethnoses and developing cultural traditions.
- **Objects of cultural and natural heritage**. In the mountains there are many objects of cultural-historical heritage (archaeological monuments, petroglyphs, ancient caves, burials, natural monuments, which ancient legends, stories and historical facts are linked to).
- **Treatment, sports, recreation and tourism**. Recreation activity in the region mainly takes place in the mountains where there are lots of recreation areas, sanatoriums, forest cottages, camping zones. The most famous tourist routes of different levels of complexity can be found here: sports mountaineering, hang- and paragliding, skiing, boating. As the nearby cities are expanding, the mountains are becoming more significant as places where people take rest and where environmental tourism is being developed.

The issues of contemporary use of resources of mountain ecosystems in Central Asia

1. Price to pay for the services of mountain ecosystems (issues and solutions)

About 10% of the regional population lives in the mountain areas. Natality is rather high here and 2-3-fold exceeds the natality rates in Europe. Due to the unfavourable economic and environmental situation and growing poverty in many mountain areas, population migrates to cities located in the plains. This is not true for Tajikistan, however, for here population migrates to the mountains. The economic activity is limited in the mountain areas. There are several levels of issues related to the mountain ecosystems.

The key issue for Central Asia is the fact that expenses and benefits from the use of mountain resources and, particularly, of goods and services maintained by the mountain ecosystems, among which water resources play an important role, are distributed between the countries in an unequal way. This is because Central Asian countries are divided into water-suppliers (Kyrgyzstan and Tajikistan) and water-consumers (Kazakhstan, Turkmenistan, Uzbekistan). The issue of crucial power resources enters the same group of problems: hydro electric power, fuel power engineering. Power resources are distributed between the mountain regions of the countries rather unequally. The ex-USSR regional power system was based upon mutual compensation of expenses between the countries. After the republics of the region gained independence, their partner relations have rather aggravated. The same group of issues includes the issue of reallocation of water resources, closely linked to hydro power engineering, which affects both agriculture of plains and well-being of natural water and close to water ecosystems of a flat country (Table 1).

Most mountains are situated in Kyrgyzstan and Tajikistan, and these countries in many respects depend on resources of these mountains since they only own insignificant areas of fertile valleys. They have to face certain difficulties, common to mountain areas, e.g. a relative inaccessibility, remoteness, fragility of resources and climate severity of mountain territories.

Should mountain territories be more developed, fragile mountain ecosystems might get more exploited, which might bring to their exhaustion. It's a vicious circle, bringing to a growing gap between revenues in the mountains and plains and poverty increase, migration from the mountains to valleys, aggravation of social conditions, abuse of mountain resources and their exhaustion. Besides, these countries bear the main burden of expenses, related to the exploitation of reservoirs and the entire system of water transportation to the valleys. Uzbekistan, Kazakhstan and Turkmenistan consume water for irrigation and, thus, benefit more from using water resources of the mountain regions. But it's presently, and in the future it will be even more, that these countries suffer from exhaustion of mountain water resources and destruction of the sustainable water supply system. Nowadays, as a result of signing of interstate bilateral and multilateral agreements, the mountain countries obtain a fair compensation from the countries downstream for the maintenance of waterways but they do not receive any support for maintenance of reservoirs and water supply systems. There is an Agreement between Kyrgyzstan and Kazakhstan on joint use of hydroengineering facilities, located on the territory of Kyrgyzstan. Because of weakened economic links between the countries of the region, this issue has not been fully addressed, despite the activity of a number of regional organizations, among which the International Foundation for Aral Salvation plays a leading role. Under its auspices, as ordered by heads of CA states, they are presently developing a project of a hydro power consortium, a new subregional economic mechanism to address water-energetic issues and redistribute the additional benefits from cooperation between countries and sectors. Thus, the issues of power engineering and water supply, strategically crucial for the region, may be addressed only through cooperation, through strategic and economic integration between countries of the region.

2. Present condition of water basins and natural capital of Central Asia

Since 1960-s the countries started suffering from shortage of water, the rivers of Amudaria, Syrdaria, Ili and Trima dry up before they reach the lakes (Aral Sea, Balkhash, Manas, Lobnor, Issyk-Kul, etc.). Thus, the process of desertification is progressing in these basins. A dramatic decrease of water resources takes place, mainly, due to the growing irrigation activity and consequent loss of water. But there are also other factors, aggravating the situation (Table 2). Reduction of forest areas and degradation of plants caused by the growing human activity, not taking into account environmental consequences of this activity, have negatively affected water balance in the region. The direct consequence of reduction of forest areas is decreasing conservation of precipitations and plants, growing evaporation areas. Reduction of plants due to the excessive cattle-breeding in the mountains provokes soil erosion. It is said that the upcoming tendencies in the climate change will bring to reduction of water resources. The primary source of river water is melt water from eternal snow and ice, thus, maximum amount of water comes in summer, minimum in winter. According to hydrometeorologists, for the period from 1957 to 1980 glaciers in Central Asia have decreased by 19%, by 2000 – by 25%. The consequence of this decrease for water resources of the region has not been well studied yet which impedes proper planning of water use in Central Asia. The water resources and water supply may be regarded as the main factor, affecting the economic activity and well-being of the local population. Joint control and management of water resources are very important for sustainable social and economic development, as well as for preservation of environment in the region. Because of the hot and dry climate of Central Asia, arable farming was being developed, mainly, along rivers, and most agricultural products are grown in valleys. Irrigated arable farming consumes over 90% of water resources, its expansion in the 1960-s required mobilization of limited water resources of the mountains to irrigate valleys. Further development without taking into account the cost of water resources and ecosystems, maintaining them, may bring to irreversible social and economic consequences affecting the entire region. At the same time it is known that investment of USD1 into preservation of watersheds enables to save from USD7.50 to USD200. That's why the assessment of available mountain water resources and

the ability of ecosystems to maintain them are important for current economic forecast of the future sustainable development of the region.

Besides a large economic potential, Central Asia is rich with mineral resources. Demand for the gold, copper and zinc and other mineral resources extracted in Central Asia is constantly growing. The criteria used by large multinational mining corporations when making decisions related to exploring and construction of new mines should correspond to the geological potential of the region, environmental requirements, political stability of the organizing country and policy of mineral resources extraction, followed by this country. Mining industry also uses water resources, that's why their cost should be included into the final product, as well as expenses for water refinement and waste processing.

In the mountain regions timber, wood and other forest products, e.g. medicinal plants, nuts, mushrooms, honey are an important source of income for the local population. Woods also play an important role in preservation of water resources, soil and biodiversity. The natural woods, growing on steep slopes and along flood-plain territories, are of a special importance. They protect soil from water erosion and keep precipitations, acting as a sponge, and then slowly give water to the rivers which keeps away floods and landslides. Woods are also tourist and recreation areas, they form landscape values, ensure clean air and attractive view. Presently the economic cost of material and non-material forest products has not been fully calculated but apparently it will be growing as the mountain territories are being developed.

Woods and other landscapes are being preserved with the help of a net of guarded territories which are insufficient in Central Asia and the guard itself does not have any explicit regional politics and strategy. Stimuli to preserve biodiversity and criteria used to give a status of guarded territories to a number of mountain areas have changed. Degradation of mountain ecosystems, the need to support a stable level of goods and services produced by them require expansion of the system of guarded territories and radical reorganization of the system of their management. These processes have been launched in the region through international cooperation. But they are not quick enough because of the number of issues related to insufficient potential at structural and institutional levels.

3. Social and economic aspects of use of water resources and ecosystems

Expansion of the irrigation system in the valleys, extensive use of irrigated lands along with the irrational crop rotation, inefficient management of irrigation and drainage systems have brought to undesirable side effects. The level of subsoil waters is growing and causes soil and water salinization; the level of subsoil waters exceeds the critical level of 2 m. for over 60% of irrigated lands in Central Asian republics. Besides, water resources are being wasted with big losses, as a result the soil fertility has aggravated. Excessive growing of cotton and rice, requiring plenty of water, has also badly affected the irrigated valleys. Since independence, production of rice and cotton has been reduced and production of grains has been increased which has somewhat reduced demand for water. Big water losses also take place because of the bad condition of the irrigation system and inefficient management of water resources required for irrigation and, as estimated, make 40%. At the same time, minding growing deficit of water, demand for it has increased by more than a quarter for the last decade. The need in water resources will grow even more after the political and economic situation stabilize and the region will get more developed. So far the volume of water per capita (without irrigation) in the region is much less than that used by other industrial countries due to the low development of industry and, consequently, in the future water use will be growing (Table 2). One of the reasons of low efficiency of use of water resources is the fact that the cost of water is too low compared to the expenses required for its supply. The systems of control of the volume of water used and of the fee, based on the volume of water used, have been introduced only in some cities of the region, that's why people are not interested in saving water and increasing efficiency of a more profitable water use.

Central Asia is one of the richest regions in hydrocarbons and mineral raw materials. But the mountainous countries, Kyrgyzstan and Tajikistan, are rich with water power resources, while having small reserves of organic fuel. As a result, Kyrgyzstan and Tajikistan cannot meet their own needs in power and have to import oil, gas and coal from neighbouring countries. In the Aral Sea basin there are 60 reservoirs and 45 hydroelectric power stations. The largest hydroelectric stations are in Kyrgyzstan (Toktogulskaya station at the Naryn-river with 1200 megawatt of output) and in Tajikistan (Nurekskaya station with 2700 megawatt of output). The region can meet over 71% of the need in power at the expense of hydro-power engineering but most reservoirs of Central Asia were built over 25 years ago, currently their efficiency is 30% lower than before. That's why existing large hydroelectric power stations require repair and modernization. The annual volume of water resources is quite enough for irrigation of valleys. Under the Soviet Union water and power systems were being managed at the regional level in a centralized way, water producers were compensated at the expense of supplies of other power-carriers (gas, coal, oil). But since independence the former system of water use was destroyed. A weak national fuel basis of Kyrgyzstan and Tajikistan requires more water resources in winter in order to ensure production of hydroelectric power. After these states have become independent, they started accumulating water in reservoirs in summer and letting it out during winter in order to produce electric power which negatively affects ecosystems and biodiversity of a flat country. Since 1994 the Interstate Water Use Coordination Commission has been discussing regional issues of use of water resources which it is impossible to address apart from power production. That's why there has been signed an agreement prescribing obligations of Uzbekistan, Kazakhstan, Kyrgyzstan and Tajikistan, which acceded it in 1998, to exchange fuel and power resources. From 1995 on this basis there has been signed a number of similar agreements. But there are lots of difficulties related to their fulfillment. As for the water relocation in the Amudaria basin, present agreements are based on the treaties developed back in the Soviet era, and they will be valid until a new strategy of water resources management is developed. On the whole, presently the countries keep to their quotas and conflicts related to water use are not as critical as in the Syrdaria basin yet.

In the mountain regions of all the countries allocation of power (gas or electricity) at the national level is impeded by remoteness of some regions. Transmission lines often get broken due to atmosphere or natural disasters and there are not enough funds to maintain this system of power allocation. As a result, those living in the mountains use pressed dung and firewood for fuel. The need in firewood brings to reduction of forests which, in its turn, negatively affects land and water resources. Besides, burning of manure (pressed dung) impedes its use as a fertilizer in agriculture. There are also big losses (40-60%) of power when transmitted through transmission lines. Thus, the existing stock of power is being wasted. The purchasing capacity of the population is low, that's why prices for power supply do not reflect the real cost of power supply. In the mountains there are many possibilities to build decentralized small power stations but these possibilities are not used to the full extent since the state monopoly covers a net of power allocation. Market mechanisms do not work in such conditions, that's why governments should realize that investment of capital into decentralized power stations is the way to reduce their own losses. Presently, private power stations are beneficial only for remote areas where it's impossible to get connected to the state allocation system, or as an alternative.

Large volumes of water are polluted with agricultural, mining, industrial wastes. This is a real threat for health of the population, environmental well-being and biodiversity of the region. Pollution of surface and subsoil waters, a major source of potable water, is a result of unmanageable dumping of manufacturing water, leakage of poisonous and radioactive materials from new and old mining waste depositories. Decrease of plants, cutting down of woods, improper soil cultivation and excessive cattle pasturing bring to soil erosion and silting of water supply systems which negatively affects the quality of water. The quality of water is not properly supervised and the legal control system is largely inefficient.

Agricultural problems in the mountain areas cropped up under the Soviet power due to the extensive system of resources exploitation. A large-scaled centralized agricultural activity in the

mountains has damaged traditional ways of use of lands and pastures, nomadic pasture system. Upon independence and economic reforms the lands of sovkhozes and kolkhozes are allocated to small farms. For all the countries this process is especially hard in mountain areas where cattle-breeding is the main factor of agriculture. Market mechanisms have not been developed in this area yet or are being introduced very slowly. The economic crisis that followed independence has brought to closure of industries, processing agricultural products, marketing and reduced most services to farmers which reduced the alternative employability of the population living in the mountains. Natural grass ecosystems, pastures and valleys are very important for economics of the mountain areas. But these pastures have suffered from excessive pasturing and became useless because of their extensive use. Currently there are efforts made to regulate the use of pastures. But the right of ownership and right of use of various pastures are still not clear in most countries. As a result, the pastures located close to villages become too scoured and those located very high are used insufficiently. These pastures are gradually recovering from former excessive pasturing. The possibilities of irrigated arable farming are limited in mountain areas by a short period of plants vegetation. Arable farming on arid lands of the foothills and in the mountain valleys is rather risky because of the changeable regime of precipitations in spring and summer. Fertility of lands good for farming is aggravating due to lack of organic substances and fertilizers. There is no system of maintenance and rehabilitation of productivity of mountain pastures; weeds and vermins are flourishing. These all bring to small harvests and affect cattle-breeding.

Presently all the forest ecosystems in the region suffer from man's impact. During the XX century forests of Central Asia have decreased significantly. The main reasons are exploitation of lands for agricultural reasons and cutting for wood. Deficit of power supply has brought to increased firewood collection, that's why forest boundaries in the mountain territories keep shrinking. Excessive pasturing hampers natural rehabilitation of trees and those grown by people are not enough. The acting prohibition to cut wood for any purposes in all Central Asian states, which was introduced under the Soviet power to preserve forest resources, hampers their management and introduction of market mechanisms of forestation. Lack of market mechanisms of forest management enhances neither their productivity, nor protection of biodiversity, nor economic activity. Biodiversity of mountain territories is endangered by both direct exploitation of animals and plants, having a commercial value, and mediated influence on ecosystems through the expansion of mining and agricultural activity. Weakened and inefficient control enhances predation of flora and fauna on these territories. The guarded territories created to preserve biodiversity practically do not make any profit and budget funds allocated for their maintenance are too few. As a result, the efficiency of their activity is too low. However, upon signing of the Convention on biological diversity, the countries of the region have undertaken positive steps to improve the situation. The national strategies and action plans to preserve biodiversity pay attention both to the increase and expansion of the guarded territories as well as to a stronger structure of their management. But efforts being taken in this regard often fail due to the weak support on the part of the local population which is not involved into management of guarded territories and does not benefit from preservation of biodiversity. The needs of local population, mostly, of the poor, make them exploit resources without any permission and control. On the other hand, commercial hunting, if managed properly, could be a good source of financing for the local population and ensure protection of the environment. Tourism can also become an important source of income both on the guarded and adjacent territories. However, tourism should be managed based on the available capacity in order to preserve normal functions of ecosystems. Traditionally, in the countries of the region they use a flow of resources from the mountains to the flat country. Tourism, on the contrary, is a branch of economics that can become an important source of income for those living in the mountains (Table 3). Presently tourism is the largest and constantly growing industry. There are many various types of tourism proposed for the Central Asian mountains. Mass tourism, involving those living in the mountains, may be based on summer resorts, e.g. Issyk-Kul, as well as on winter sports in the mountains. There are also lots of possibilities for ecotourism, mountaineering and health-improving tourism. It is possible to link mountain tourism with sightseeing in Bukhara,

Samarkand and Khiva in Uzbekistan. But the tourism industry in Central Asia is at the very beginning of its development and depends on special marketing and safety provision. The unstable situation in some regions of Tajikistan, Uzbekistan and Kyrgyzstan may scare tourists off. When developing a stable tourism industry, the governments should conduct an appropriate policy in order to involve local population in tourist activities. A share of economic revenues from the tourist activities in the mountains should be aimed at those living in the mountains and at the maintenance of sustainable condition of ecosystems. This is especially important for a profitable business of trophy hunting in the region. Lack of appropriate policy makes the local population get a miserable profit which makes them uninterested in preservation of environmental resources and uninvolved in the activities related to their protection. Eventually this affects both biological resources and tourism development.

Development of the mining industry may enhance degradation of the environment, first of all, because of the wastes. Mining industry in the CA countries of the former Soviet Union annually produced 25 billion tons of wastes, nowadays the volume of wastes has been reduced insignificantly but there is no stock-taking of wastes in some countries. When extracting, environmental preservation requires large financial expenses but difficulties of economic formation of the independent states made financing of preservation activities unavailable. Toxic wastes are stored in open dumps and at exposed sites which lets toxic agents get into the air, into the surface and subsoil waters. Pollution affects interests of several countries, that's why these are regional transboundary issues. It is needed to coordinate obligations of the parties involved in prevention of a growing threat of pollution with industrial wastes and to establish efficient financial mechanisms of control for the industrial activity since acting legislations do not fit the situation. As a result, human health is endangered. The degree of risk for their health is often not known to the population and, thus, farmers continue irrigating their plots not knowing that the level of water pollution is too high. The wastes of industrial complexes, not functioning nowadays, are practically not processed or refined. These wastes, old mines, quarries and tailing dumps occupy large territories. Most of them are wastes of extraction of nonferrous metals, i.e. a broad range of components that could be used many times. Modern systems of waste transportation or processing are not introduced, though these could ensure both economic profit and benefit for the environment. The first steps in this direction are being made only in large Central Asian cities. Besides, legislations of the countries lack mechanisms encouraging the development of resource-saving branches of economics and introducing limitations, aimed at preservation of the environment.

Introduction of the ecosystem management in mountain regions of Central Asia (legal and contractual aspects)

All the above demonstrates the need to develop the management system, based on ecosystem principles, taking into account the interests of local communities and environment that should be regulated with the help of market mechanisms. Long-term regional goals of sustainable development of mountain territories have been specified in the Regional Strategy and Action Plan for sustainable development of mountain territories (2002) and mentioned in the National Strategies. To achieve these goals it is necessary to involve all types of actual or potential sustainable use of natural mountain resources, tourism and recreation development as well as biodiversity preservation. Natural resources cannot be used without involvement of those living in the valleys, thanks to which a regional approach will help to achieve their objectives. The national level of activities in this regard will prevail since this is an institutional infrastructure and decision-making competency level. But for many fields of activity regional development is a prerequisite of success. The Regional Strategy includes selection criteria for the issues and activities, complying with the regional level, i.e. priority fields of regional development. Based on these criteria, there has been developed the regional Action Plan.

The mountain territories are weakly lobbied by the administration and government bodies. Consequently, the issues of mountain territories and interests of those living in the mountains

should be taken up and supported at the political level. Water resources should be allocated based on fair relations, specifying expenses for timely water provision, water-saving and regulation of apportioning of water in the mountains. Rational interstate use of water resources is of a primary importance for Central Asia and this may be a decisive factor for peaceful development of the entire region. There are power issues linked to the water ones: hydroelectric resources of the mountains could be used much more efficiently for all Central Asian countries than presently. This would restrict the affect of gas-burning on the climate and would be a good contribution to the salvation of glaciers, which are a major source of water for Central Asia. That's why the regional regulation of power engineering should become a part of agreements regulating apportioning of water. The problems of the mountains, according to the selection criteria, and fields of a priority regional cooperation are specified below. The following are the priority fields for such cooperation:

1. **To overcome poverty and develop private business:** this should make a great part of regional efforts in the development of mountain territories, since this will help to improve the condition of water resources and avoid migration to the valleys as well as to prevent conflicts in the mountains, endangering stability of entire Central Asia. This concerns tourism and recreation activity (Table 3). It is necessary to make it attractive to go hiking, sightseeing, and to withdraw administrative and legal barriers all the way along the Great Silk Way, to coordinate and make all the administrative procedures easier.
2. **To preserve biological and landscape diversity,** based on its financial appraisal as a renewable resource and source of sustainable economic development of the region, ensuring genetic resources for the selection activity, development of agriculture, forests, hunting, fishing. Besides, biodiversity is an indicator of the environmental well-being.
3. **To harmonize legislations of the countries in the region** in the field of environmental preservation.
4. **To prevent the hazards**, taking place in the mountains, being of a potential risk both for the mountain territories and adjoining regions (Table 4).
5. **To monitor and forecast** demographic and migration processes in the Central Asian mountains.

The other issues can be best addressed at the national and local levels. The common goal of the Mountain Ecosystems Assessment Programme in Central Asia is to find out their present condition, to assess their resource and economic potential at the local, national and regional levels. Based on this assessment, there will be review undertaken and a real cost of goods and services, produced by the ecosystems, identified. Based on the data obtained, there will be recommendations provided to the state enterprises, private sector, civil community in the field of integration of services of ecosystems into their assessments, plans and activities. The five questions specified below comprise the sphere of interests of the mountain ecosystems assessment:

- What are the current conditions and tendencies in the mountain ecosystems of the region and human well-being, linked to them?
- What are the possible changes in ecosystems and demand for their services as well as consequences of these changes for health, means of subsistence, safety and other components of well-being?
- What can be done to improve well-being and preserve ecosystems in each country? What are the strengths and weaknesses of the steps, activities, processes selected that can be reviewed to achieve or avoid some specific future?
- What are the major factors affecting supply of services of ecosystems, other management decisions and development of politics?

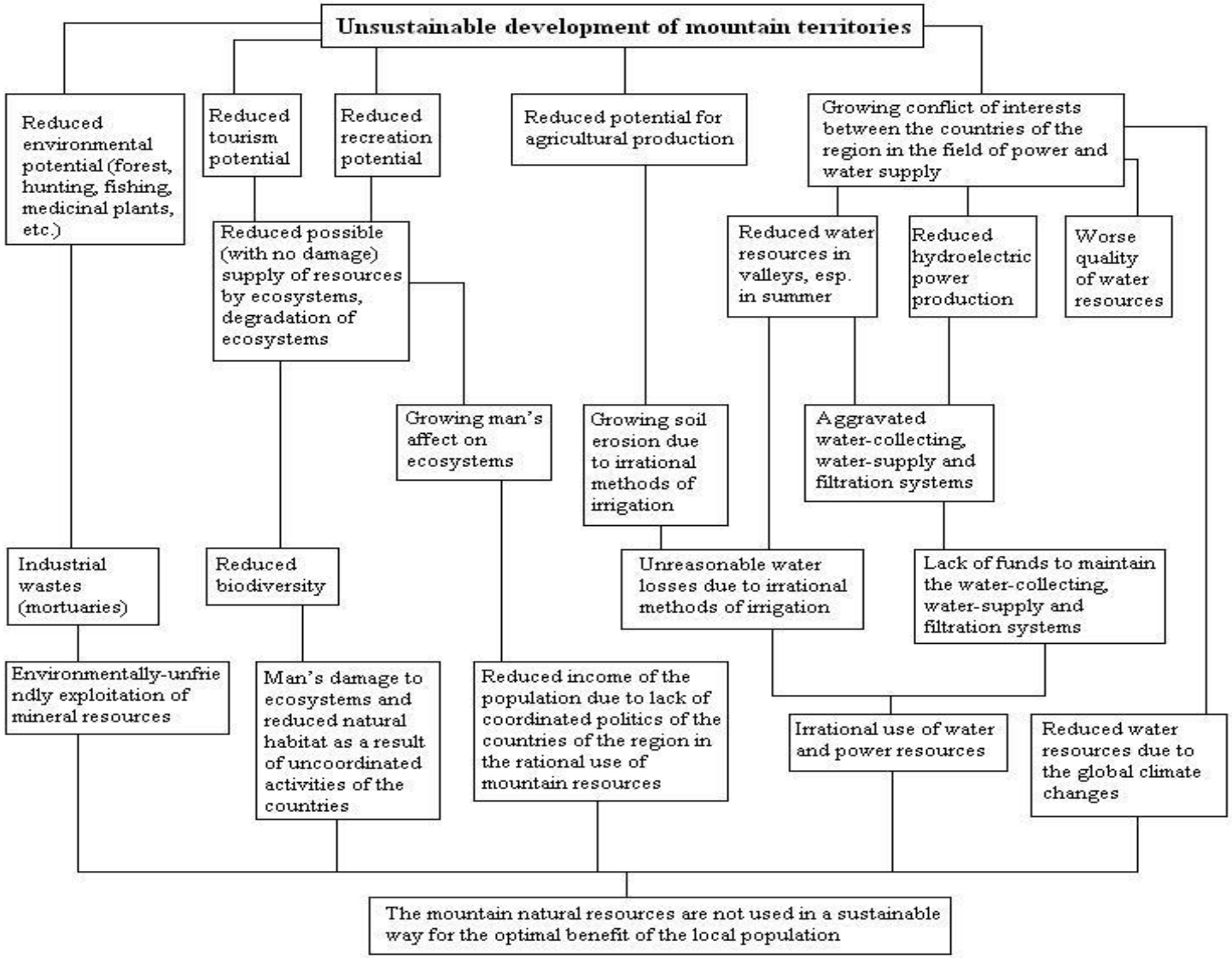
An overall assessment of ecosystems, including the services they provide (consumed by the local communities), moving forces in changing the ecosystems (that may be of a local and global character) may bring essential benefits, demonstrating what mechanisms – political and economic – should be used for sustainable development of the mountain regions. Judging by the demand for such kind of information in Central Asia by various sectors, it is clear that the scope of assessment will surely touch upon the national and regional levels. Since most physical-geographical mountain

provinces of Central Asia have a transboundary position between the countries in the region, we should expect that regional assessments will make a large part of all the scopes. It is expected that the assessments of ecosystems of physical-geographical provinces, having no transboundary position, will mostly present the national interest or may be demanded as local assessments.

The assessment of condition of the ecosystem and tendencies of its changes will be described by each major service of the ecosystem. There will be reviewed the very nature of service, its condition, geographic distribution, tendencies of offer and demand. There will be described the ability of the ecosystems to provide these services and affect of changes in the ecosystems on their provision as well as present dimensions, condition and tendencies of changes of subordinate ecosystems (including forests, internal waters, agrocoenoses, etc.). There will be reviewed the use of various types of ecosystems and made examples of changes, taking place in them. The assessment will pay special attention to the aspects of changes of functions of ecosystems and their affect on human well-being, including indicators of health, environmental safety, traditional culture, economic security and fair access to the resources and distribution of benefits. The script assessment will touch upon several most reliable variants of possible future events, justified by the quantity methods. These scripts will take into account consequences of various probable changes of moving forces on the condition of goods and services of ecosystems (including biodiversity) and human well-being. The feedback assessment analyzes the past and present activities undertaken in order to both preserve the ecosystem and to improve a human well-being in order to develop practical recommendations, instruments and instructions for various users. Assessment of the condition and future tendencies in ecosystems require a new understanding of interconnections, including links between ecosystems of various spatial dimensions, links between institutional systems, playing a certain role in management and use of ecosystems and links with the main moving forces, including economics, technological process and institutional changes. The scientific assessments will be provided as recommendations to various levels of decision-makers and communities.

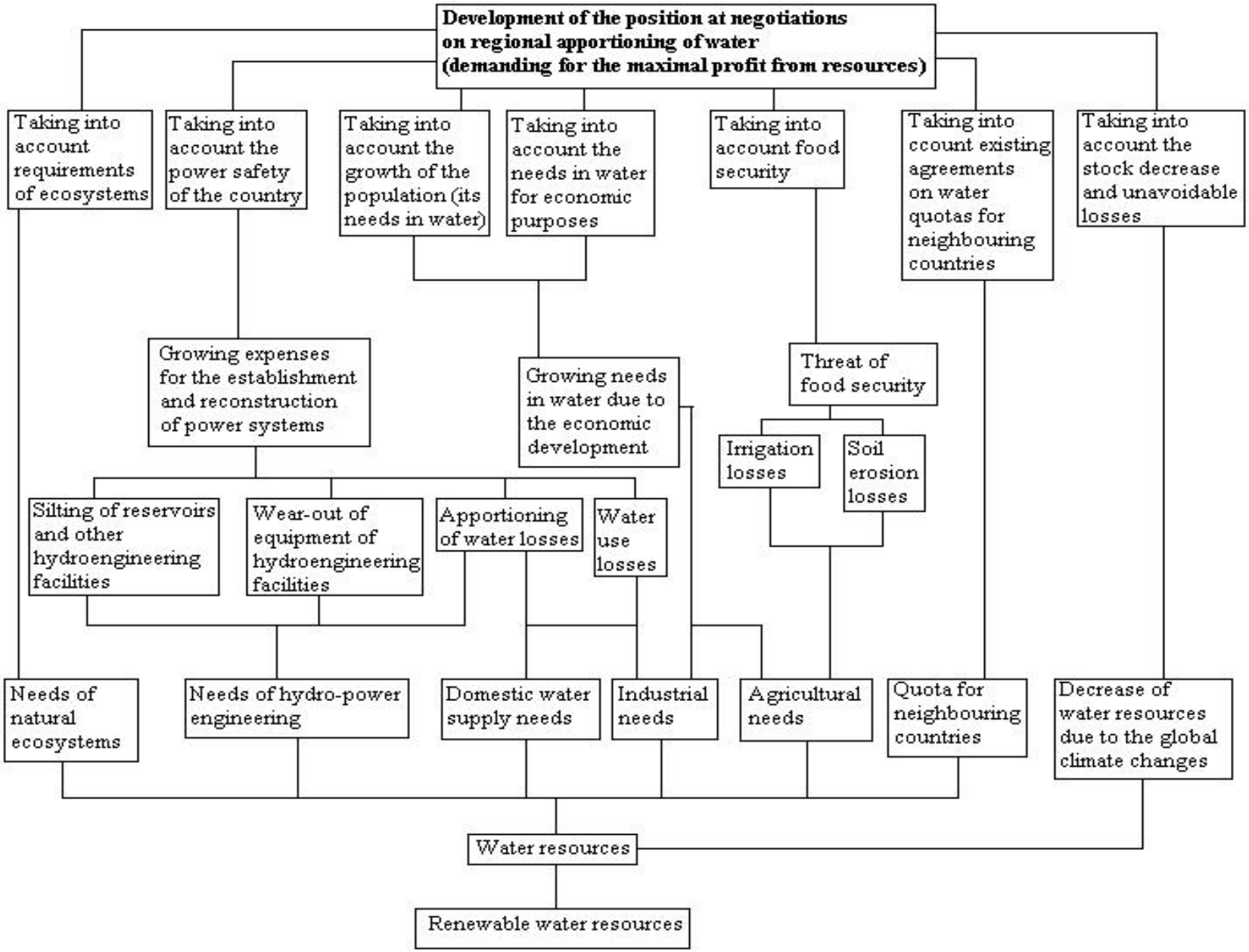
Conclusion

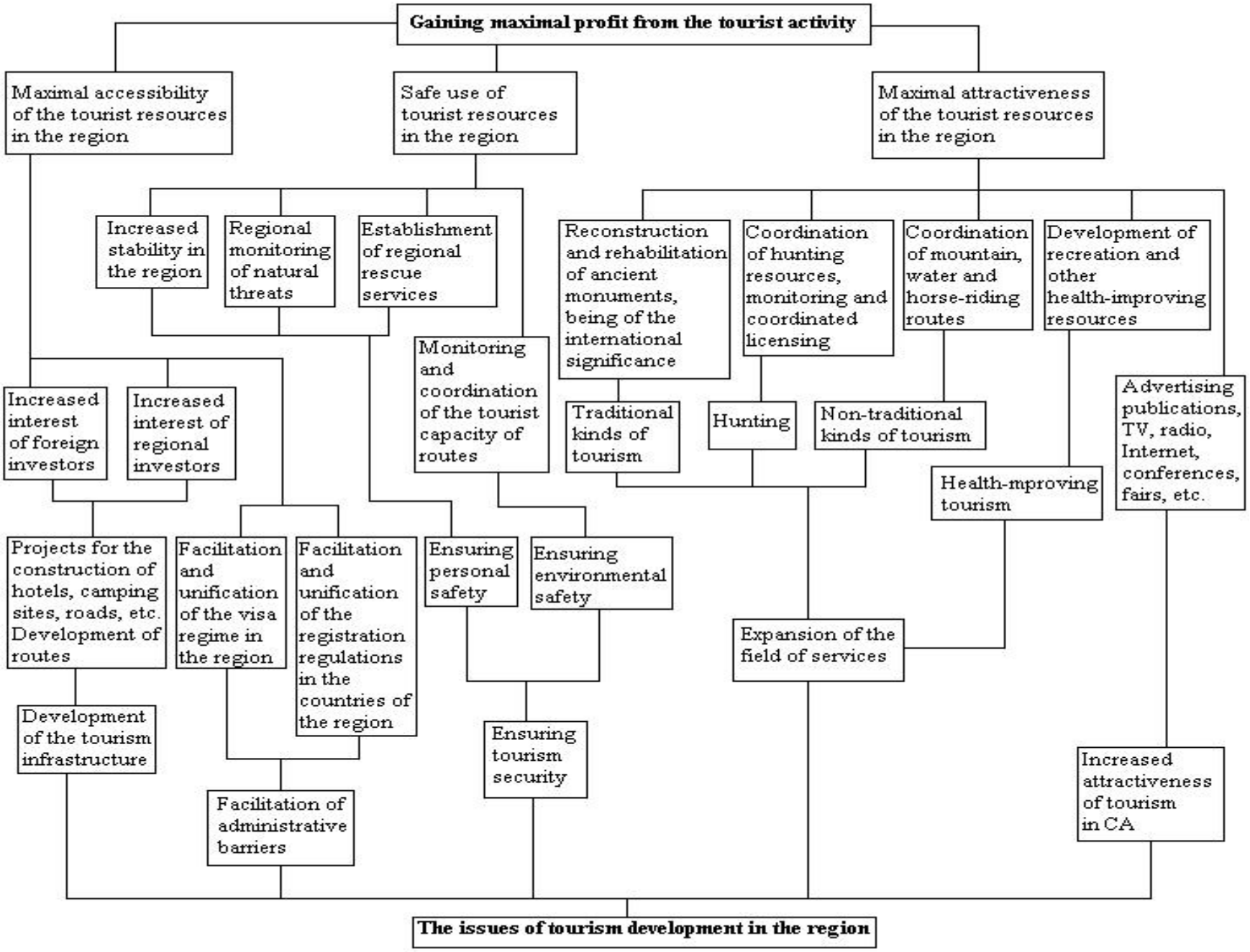
The governments of Central Asian countries have stated that ensuring sustainable functioning of water basin ecosystems, significant for human vital activity, is a priority objective of stable development of the entire region. The CA Mountain Ecosystems Assessment Programme also enhances the achievement of this goal. The outcome of this assessment will let the parties involved join their efforts in order to achieve the major goal of sustainable development of the mountain territories: “Natural resources of the mountain territories are used in a sustainable way, taking into account environmental, social and economical interests for the optimal benefit of the Central Asian population”. It is expected that an explicit assessment of mountain ecosystems, meeting all the requirements of users and the parties involved, will promote strengthening of the political stability and safety in the region. Assessment of the economic significance of goods and services, manufactured and maintained by the ecosystems, will enhance introduction of economic mechanisms in their sustainable use and preservation, which, in its turn, will bring to poverty reduction in the mountain regions through the development of resource-saving and environment-friendly directions of production. In particular, through introduction of a clean development mechanism, power- and resource-saving know-how. The assessment process will enable to calculate the cost of a natural capital at the local, national, regional and subglobal levels. And this will enable to apply the ecosystem approach in management of biodiversity and ecosystems in Central Asia in order to achieve the objectives of sustainable development.

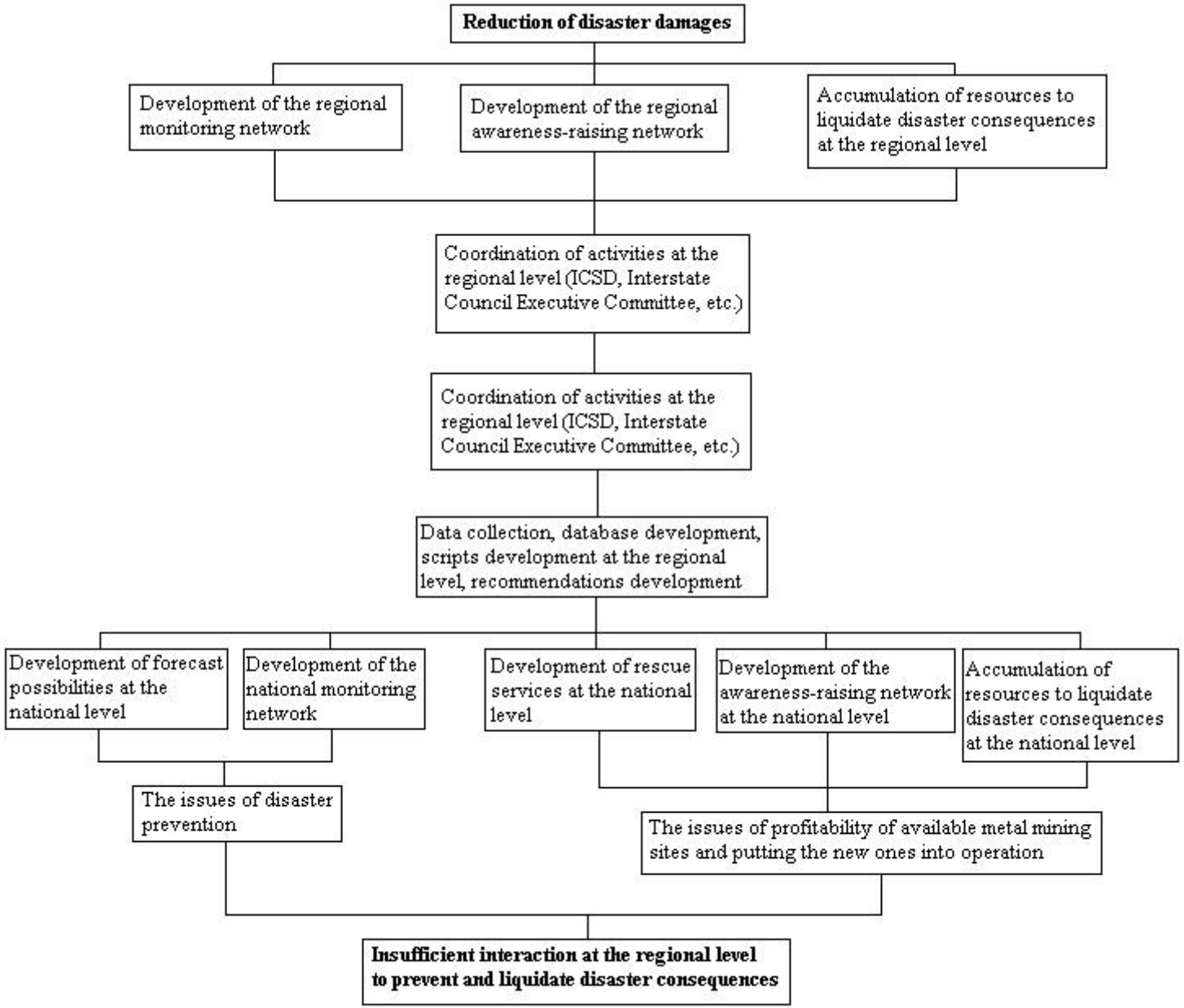


Framework terms

Low gains of each country from regional economic cooperation	Low funds to implement regional programmes	Insufficient cooperation to monitor and liquidate damages of acts of God	Low efficiency of interregional organizations	Low efficiency of regional expert advice on the development of scripts for the overall solution of regional issues	Conflict of interests


Development of the position at negotiations on regional apportioning of water (demanding for the maximal profit from resources)
Taking into account requirements of ecosystems
Taking into account the power safety of the country
Taking into account the growth of the population (its needs in water)
Taking into account the needs in water for economic purposes
Taking into account food security
Taking into ccount existing agreements on water quotas for neighbouring countries
Taking into account the stock decrease and unavoidable losses
Growing expenses for the establishment and reconstruction of power systems
Growing needs in water due to the economic development
Threat of food security
Irrigation losses
Soil erosion losses
Silting of reservoirs and other hydroengineering facilities
Wear-out of equipment of hydroengineering facilities
Apportioning of water losses
Water use losses
Needs of natural ecosystems
Needs of hydro-power engineering
Domestic water supply needs
Industrial needs
Agricultural needs
Quota for neighbouring countries
Decrease of water resources due to the global climate changes
Water resources
Renewable water resources


Gaining maximal profit from the tourist activity
Maximal accessibility of the tourist resources in the region
Safe use of tourist resources in the region
Maximal attractiveness of the tourist resources in the region
Increased stability in the region
Regional monitoring of natural threats
Establishment of regional rescue services
Reconstruction and rehabilitation of ancient monuments, being of the international significance
Coordination of hunting resources, monitoring and coordinated licensing
Coordination of mountain, water and horse-riding routes
Development of recreation and other health-improving resources
Monitoring and coordination of the tourist capacity of routes
Increased interest of foreign investors
Increased interest of regional investors
Traditional kinds of tourism
Hunting
Non-traditional kinds of tourism
Advertising publications, TV, radio, Internet, conferences, fairs, etc.
Health-mproving tourism
Projects for the construction of hotels, camping sites, roads, etc. Development of routes
Facilitation and unification of the visa regime in the region
Facilitation and unification of the registration regulations in the countries of the region
Ensuring personal safety
Ensuring environmental safety
Expansion of the field of services
Development of the tourism infrastructure
Facilitation of administrative barriers
Ensuring tourism security
Increased attractiveness of tourism in CA
The issues of tourism development in the region


Reduction of disaster damages
Development of the regional monitoring network
Development of the regional awareness-raising network
Accumulation of resources to liquidate disaster consequences at the regional level
Coordination of activities at the regional level (ICSD, Interstate Council Executive Committee, etc.)
Coordination of activities at the regional level (ICSD, Interstate Council Executive Committee, etc.)
Data collection, database development, scripts development at the regional level, recommendations development
Development of forecast possibilities at the national level
Development of the national monitoring network
Development of rescue services at the national level
Development of the awareness-raising network at the national level
Accumulation of resources to liquidate disaster consequences at the national level
The issues of disaster prevention
The issues of profitability of available metal mining sites and putting the new ones into operation
Insufficient interaction at the regional level to prevent and liquidate disaster consequences